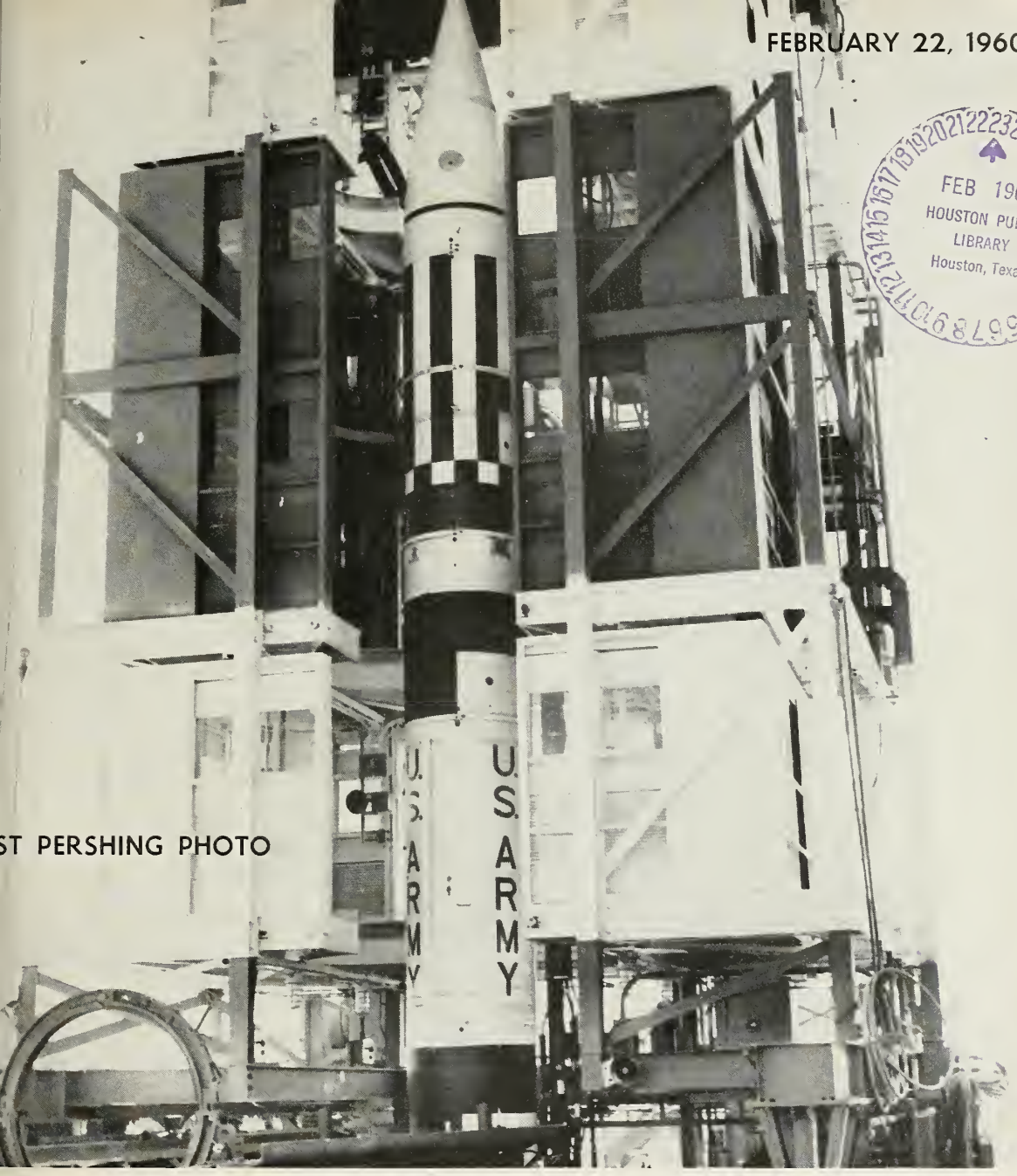
FEBRUARY 22, 1960



ST PERSHING PHOTO

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION

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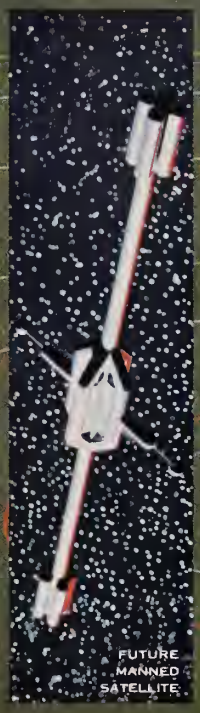

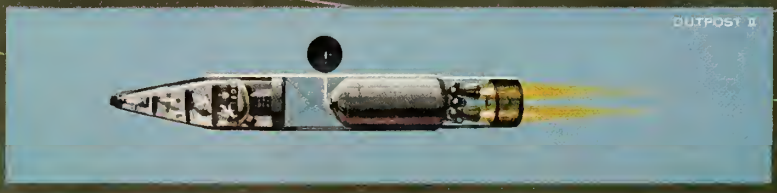

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Missiles and Rockets Volume 6 Number 8

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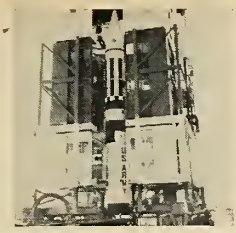
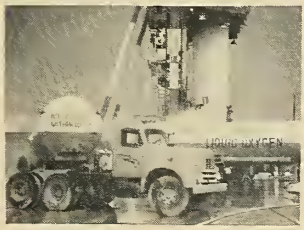


COVER: Martin *Pershing* surface-to-surface ballistic missile stands in gantry at Cape Canaveral, where it was first photographed during President Eisenhower's recent visit.

NEW duplexing filters being tested at GE's Syracuse plant, where radar is being built for the Ballistic Missile Early Warning System. In rear is a huge scanning-switch assembly. Picture story starts on p. 20.



VACUUM—insulated LOX semi-trailers deliver the vital fuel oxidizer to a missile at the Cape. They brought the liquid from nearby facility built and operated for Air Force by Air Products. See LOX story, p. 24.

'HARD SITE' launchers for AF's *Mace* are being built near tip of Canaveral. This is part of $28 million worth of construction under way at the Cape. Turn to p. 28.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

31,600 copies this issue

FEBRUARY 22 HEADLINES

ASTRIONICS

PROPULSION ENGINEERING

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THE MISSILE WEEK

U.S. Reg. Pdg.

DEPARTMENTS

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Washington Countdown

IN THE PENTAGON

Missile Gap Facts . . .

for confused Congressmen and taxpayers:

. . . *Atlases* are piling up at Convair's San Diego plant awaiting completion of operational bases. The backlog is running at more than two dozen birds.

. . . The San Diego plant is operating on about one and a half shifts a day. Production could be more than doubled.

. . . Base construction can be speeded up anytime the Administration wants to meet the bill. Less than five percent of the nation's construction capability is being used.

• • •

The Zeus drone program . . .

may be in jeopardy. The Defense Department is considering possible savings from using ICBM's launched in training exercises from Vandenberg AFB—rather than Chrysler *Jupiters*—during *Zeus* tests in the Pacific next year.

• • •

An anti-missile ray . . .

is beginning to look to some experts like a feasible bet in the years ahead. One proposal under consideration is aimed at perfecting a weapon that could destroy an oncoming missile at a range of 1000 miles.

• • •

NATO will decide . . .

which second generation solid U.S. missile, if any it wants to adopt as a NATO IRBM. The Joint Chiefs of Staff turned the problem over to the NATO nations after reaching a deadlock on making a choice itself.

• • •

The go-ahead on *Sky Bolt* . . .

R&D is a victory for the Air Force over the Defense Department. Pentagon R&E officials held up a decision on the development program for months after Douglas completed design studies.

• • •

The first *Midas* . . .

test satellite is expected to be launched by the Air Force at Cape Canaveral within a matter of weeks. The infrared early warning *Midas* system may eventually involve more than a dozen satellites.

• • •

Job description . . .

tagged by Air Force Maj. "Brandy" Griffith on his new assignment as Project officer for *Scout* at Cape Canaveral is "den mother."

ON CAPITOL HILL

A better break . . .

for small defense contractors will be the goal of a Senate investigation this spring. Senators are considering ways to shake up current Pentagon procedures for contract negotiation.

• • •

A breathing spell . . .

in the defense debate over missiles is expected to last for weeks in the Senate. The reason: the all-out Senate struggle over civil rights legislation.

AT NASA

Signals from the moon . . .

may be sent to the earth by a U.S. transmitter sometime in 1961. NASA will attempt to rough-land the transmitter in a 600-pound *Agena-B* payload. An *Atlas* will be used to launch it.

• • •

NASA's launching calendar . . .

for the next few months includes:

. . . A *Thor-Able* paddlewheel satellite to be launched toward Venus' orbit in late February.

. . . An *Atlas-Able* paddlewheel to be launched into orbit around the moon in April or May.

• • •

The first satellites . . .

to be launched from Wallops Island—America's third satellite launching base—will be boosted by *Scouts* this summer. One will boost into orbit a payload for testing the resistance of various materials to the impact of meteorites.

INTERNATIONAL

British missile cruisers . . .

London, Kent, Hampshire and Devonshire are scheduled to be equipped with surface-to-air *Seacats* and *Seaslugs*. Refitting will be completed by 1963.

• • •

The Iranian Army . . .

is considering purchase of Nord-Aviation's *SS-10* and *SS-11* antitank missiles. Iranian officials recently watched the French wire-guided missiles go through their paces at a demonstration at Mehrabad.

• • •

An Italian MRBM . . .

is under development by Sispre—the combine owned jointly by Fiat and Finmeccanica. Sispre also has a contract to produce the new 700-mile missile.

Industry Countdown

MANUFACTURING

Helios is a nuclear . . .
rocket conceived by Convair's Krafft Ehricke as a means of leapfrogging Russia in space. *Helios* would have a takeoff weight of 1.8 million pounds and thrust of 2.4 million lbs. Booster of four liquid hydrogen-LOX engines would take the nuclear sustainer to more than 150,000 ft. before cutting loose. Dimensions of the vehicle: 250 ft. in length, 32 ft. id. *Helios* could put a 230,000 to 250,000 lb. payload in a 300-mile orbit—30,000 to 50,000 lbs. more than the proposed *Nova* chemical rocket which would have a takeoff weight of 4 million lbs. and thrust of 6 million lbs.

• • •

Cost of *Helios* . . .
is estimated at $1.2 billion to $1.5 billion. Ehricke said it could be developed by 1968-69 if adequate funding began in FY 1962.

• • •

Boeing is tapped . . .
to handle systems integration for the Douglas *Sky Bolt* ALBM. Other subs are Nortronics, GE and Aerojet.

• • •

Ceramic radomes . . .
are being brazed to the titanium body of *Bomarc B* by Boeing. The radome is nine ft. long and three ft. id.

• • •

New *Atlas* ICBM crew . . .
training center is being established at Sheppard AFB, Wichita Falls, Tex., by Convair and the Air Training Command. Ninety percent of combat missile crewmen will get their basic instruction there, with Chanute AFB carrying the balance. Crew integration and training shots will continue at Vandenberg AFB, Calif., (see M/R, Jan. 4, p. 12.)

PROPULSION

Aerojet appears the winner . . .
in the Air Force big solid booster contest. Company representatives have been invited to Edwards AFB to negotiate a contract. AF stressed that contract winner would have to share the cost of expanding facilities. Apparently Aerojet's bid called for a smaller AF payment than did the others.

Ignition of cut-grain . . .
Polaris motor after an underwater launch is scheduled by the Navy for the first time on April 20 off San Clemente Island. The missile will be powered just long enough to prove out ignition.

ASTRIONICS

Complete inertial guidance . . .
system for mobile ballistic missiles (presumably railroad-launched *Minuteman* ICBM) will be developed at AC Spark Plug's new Advanced Concepts Research and Development Laboratories, El Segundo, Calif. The new labs —electronic, optic and digital computer—are being dedicated Feb. 25. They are headed by H. L. Shulman, formerly of STL.

• • •

There's more unity . . .
among telemetry interests with the decision of the powerful Institute of Radio Engineers to rejoin the National Telemetering Conference. (Other members: AIEE, ISA, ARS and IAS.)

• • •

One for the calendar . . .
EIA's Defense Market Planning Seminar being held March 15 in Washington will have such panel members as Dr. Howard Wilcox, deputy director of DOD R&E; the director of the Navy's weapon systems evaluation group, Vice Adm. John H. Sides, and Dr. N. I. Korman, director of RCA's advanced military systems.

WE HEAR THAT

The Russians claim . . .
they have developed a new material—"Sital"—which is harder than carbon steel, lighter than aluminum and does not soften at 2552°F . . . Collins Radio is now participating in France's OMERA in association with a French radar company—Télécommunications Radioélectriques et Téléphoniques . . . Atlas Corp. has submitted a plan to divest itself of Summers Gyroscope stock . . . Signing of a $475 million contract by RCA now brings the total investment in BMEWS to more than $700 million . . . and Space Electronics Corp., Glendale, Calif., is working on a terminal guidance system for the *Titan* ICBM under a $96,000 contract with Avco.

Good Picture of Sandia

To the Editor:

We read your article ("Sandia Corp.: 1 Customer, 1 Competitor," by Frank G. McGuire, M/R, Jan. 18) with keen interest and full appreciation for the job you did under rather difficult circumstances. The comments I have received so far indicate that our people feel you have done the best job yet in describing our role in the weapons program.

We would like to have the permission of Missiles & Rockets to reproduce the article for distribution to our employees and for selected use in recruiting . . .

T. B. Sherwin
Public Relations Supervisor
Sandia Corporation
Sandia Base
Albuquerque, N.M.

The comments are appreciated and permission has been granted.—Ed.

To the Editor:

As an engineer at Sandia's Livermore Laboratory, I was most interested in the article concerning Sandia.

Because of the nature of our work—most of it classified—it is difficult even to tell our children and relatives just what we do. Your article is the best we have seen.

Would it be possible to obtain a few tear sheets of the Sandia article? They would be greatly appreciated.

R. C. Wishart
1511 Sunny Court
Walnut Creek, Calif.

Copies are on the way.—Ed.

Twisters from Plasma Pinch?

To the Editor:

The article "Lightning—Future Red Weapon" (M/R, Aug. 24, p. 13) and a subsequent letter on the subject (M/R, Oct. 5, p. 50) were instrumental in starting this writer on a quest for knowledge on pinched plasma phenomena, a subject covered in the comparatively new field of Magnetohydrodynamics.

Research into this field, particularly on the attempts by the AEC to attain controlled thermonuclear reactions, uncovered an interesting correlation between the raw materials, electric currents, voltages and induced magnetic fields of the controlled fusion attempts, and the conditions existing in "tornado"-spawning thunderstorms.

This correlation and considerable further research have led me to formulate a hypothesis that tornadoes may be the result of a pinched plasma phenomenon within such thunderstorms—this phenomenon caused by recurrent strokes of "ionizing" lightning in a particular area over a relatively short period of time.

Eyewitness accounts over a period of years have contained reports of intense illumination, crackling electrical discharge sounds, and peculiar odors of sulphur, brimstone, ozone, etc., during and after the passage of tornadoes. One such report included the sighting of balls of orange fire being thrown out of the tornado center and then exploding into smaller gobs of fire particles.

This writer intends to investigate this theory through the Oklahoma State University Tornado Laboratory during the Spring of 1960 and invites any and all opinions, loud guffaws, or supporting testimony on the subject.

L. L. Eppley, Jr.
810 West McElroy Avenue
Stillwater, Okla.

Haven for Incompetents?

To the Editor:

Permit me to congratulate you most sincerely upon your editorial "A Captive Small Business?"

Perhaps the subject matter of this editorial strikes me particularly forcibly because for some time I have been on the Ohio "National Board of Field Advisors," and have had some occasion to keep in touch with the activities of the Small Business Administration; and, in fact, to criticize some of these activities which I think are not in the true interest of, or representative of, the sound small business man.

Unfortunately, the SBA has been subject to the efforts of being used as a tool for speculative and incompetent people who frequently seem to feel that they are entitled to financing and help, mainly because they have been unable to get financing or run a successful business otherwise. In at least one instance of this sort, I interceded in Washington with some minor success; but I still have the feeling that this sort of thing occurs too often . . .

Paul C. Rodgers
President
Burton-Rodgers Inc.
Cincinnati, Ohio

TAC Procurement

To the Editor:

The Jan. 11 issue of M/R included an item on Tactical Air Command which seems to be an unfair criticism of our procurement policies. I refer to the statement in the column "Industry Countdown" which implied that TAC was not cooperating in the equipment standardization program by insisting on its own missile carrier loader. The reason stated for this was that the command "just wanted to be different."

Unfortunately the comment was so broad and indefinite that we could not tie it to any specific piece of equipment. In fact we could find no instance in which TAC's requirements for missile carriers or loaders were not satisfied by existing Air Force equipment.

I'm sure you realize that like other elements of the Armed Forces, we are working within a very tight budgetary limitation. To spend extra money for an item of equipment, "just to be different" would be a detriment to TAC as well as the Air Force. When this command does purchase specialized equipment, it is only after long study and with the firm conviction that no other equipment will do the job satisfactorily.

The integration of missiles and aircraft within Tactical Air Command is proceeding as fast as funding and the state of the art will allow. We would do nothing to jeopardize this progress and ask your help in accurately presenting our activities to the public.

Joseph A. Stuart, Jr.
Colonel, USAF
Information Officer
Tactical Air Command
Langley AFB, Va.

More on *Saturn* vs. F1

To the Editor:

We have watched with interest the confusion between the *Saturn* and the F-1 (Let the People Know, M/R, Dec. 28, and Letters to the Editor, M/R, Jan. 18). You cannot compare apples and oranges. The F-1 is an *engine* under development while the *Saturn* is an approved funded *vehicle* development.

Mr. W. G. Huber
2101 Fulton Drive
Huntsville, Ala.

Mr. C. H. Rutland
1019 Fairway Drive
Huntsville, Ala.

Mr. E. A. Weaver
406 Newman Avenue
Huntsville, Ala.

Rawlings 'Homecoming'

To the Editor:

I was quite pleased to see the article (M/R, Jan. 25) citing General Rawlings' speech which he made to our Dayton-Wright Chapter of Armed Forces Communications and Electronics Association on 14 January.

We were extremely happy to have General Rawlings "back home" for this occasion.

W. H. Shade
President
Dayton-Wright Chapter
Armed Forces Communications and Electronics Association
Room 412, 333 West First St.
Dayton 2, Ohio

NASA Tells of *Mercury*, Moon Plans

Schedule given Congress includes rough landing payload on moon in 1961

by Paul Means

National Aeronautics and Space Administration testimony before Congress last week revealed preliminary steps to be taken in the program for manned lunar flight, and more detailed information about the man-in-space Project *Mercury*.

Of particular interest were the space agency's plans to:

• Orbit a *Scout* payload this summer designed to test spacecraft materials' resistance to meteoritic impact;

• Launch a 600-pound *Atlas-Agena* payload in 1961, part of which will be rough-landed on the moon in working order to transmit information back to earth;

• Subject the *Atlas*-launched *Mercury* capsule to a variety of sub-orbital trajectories to provide complete qualification of the capsule and all of its systems.

NASA Assistant Director of Research Richard V. Rhode pointed out various problems which must be solved before manned rockets can go to the moon and return, and the specific NASA programs to overcome these problems.

Specific difficulties presently deterring lengthy manned flights, according to Rhode, are the hazard of meteoritic impact, and the problems of guidance and attitude of the spacecraft. He pointed to present work on the ground at Ames Research Center, which simulates meteoritic impact by firing small balls about 1/16-in. in diameter out of high-speed helium guns at speeds up to 14,000 mph.

This research, according to Rhode, has shown that one possible way of handling the meteoroid threat is to build a light shell or "bumper" around the spacecraft, on which the particles will disintegrate upon impact before striking the underlying structure. Results are even better, Rhode said, if the area between the two layers is filled with low-density glass wool. Tests at Ames show that particles going as fast as 7000 mph will be stopped by this type of structure.

• **Summer test**—First test in space of this theory will be this summer, when a *Scout* will launch a puncture-experiment satellite into orbit. The satellite will contain short tubes running lengthwise made of metal of various thicknesses, with gas under pressure. When a tube is punctured by a meteoroid, the gas will leak out and the information will be radioed back to earth.

NASA is attempting to solve the guidance and control problems of manned lunar flight, according to Rhode, by conducting research on highly sensitive sighting, or sensor systems. Such systems, which take as their reference point the lunar horizon or a star, must be accurate to within .005 degrees.

The third problem that must be overcome before manned lunar flight is possible, according to Rhode, is the lack of detailed information about the moon itself. Launches intended to overcome this problem include a moon orbiter by *Atlas-Able* in 1960, a rough landing by *Atlas-Agena B* in 1961, and soft landings by *Centaur* and *Saturn* within a few years.

Rhode described a spacecraft (see picture) under development by the Jet Propulsion Laboratory, which will be launched in 1961. The craft will weigh about 700 pounds and will be launched by an *Atlas-Agena B*.

This craft has two folding-vane solar energy collectors and a dish-type antenna which transmits and receives signals to and from the earth. The main body contains attitude control and navigation equipment, instruments and radios. At the top is a capsule that will be separated from the spacecraft proper and landed safely on the moon.

During the early phases of the flight, according to Rhode, injection and mid-course guidance are exerted. As the spacecraft approaches the moon, the small capsule is separated from the main spacecraft and retro-rockets are fired to slow the capsule's speed. The main spacecraft crashes and is destroyed. The small capsule lands on the moon, its impact energy absorbed by penetration spikes, and goes into operation obtaining data and transmitting it back to earth.

Testimony by George M. Low, chief of NASA manned space flight programs, gave more details about the instrumentation of the *Mercury* capsule, and the varied trajectories that will be used in connection with the *Atlas* test shots.

• **Panel**—The astronauts instrumentation panel (see photo next page) has sequence controls to the left of center, allowing the pilot to back up essentially every function that would normally be performed automatically. On the extreme left panel are switches used to lock out the automatic attitude control system, and to activate the manual control system. Then—by using the manual control stick, together with flight instruments—the astronaut can maintain the capsule in the proper orientation.

Another handle on the left-hand panel allows the astronaut to decompress the capsule in case of fire or a buildup of toxic gases. Venting the capsule to the outside vacuum will extinguish a fire or remove noxious gases, and a second handle will repressurize the capsule.

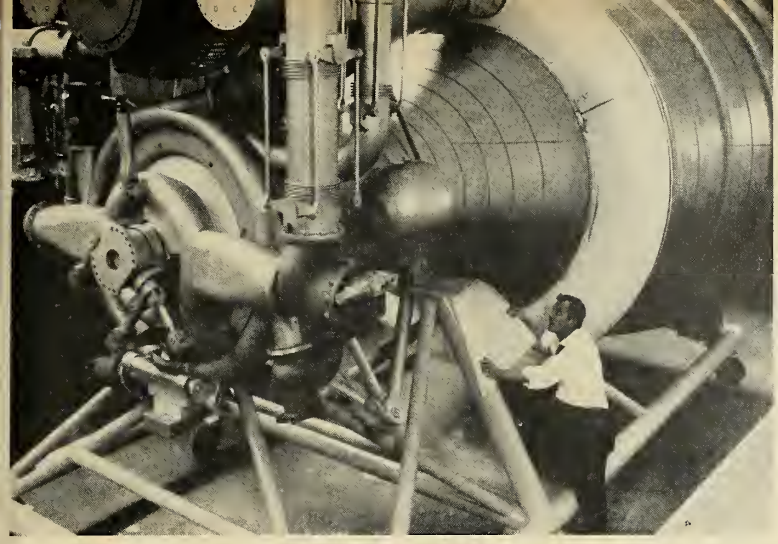
The panel on the right contains instruments and switches for the control of life-support, electrical and communication systems; and warning lights that indicate the malfunctioning of any of these systems.

Three types of trajectories, according to Lowe, will be used in qualifying the McDonnell capsule with the Convair *Atlas*. The first type will subject the capsule to the worst type of re-entry possible, with the capsule plunging back into the atmosphere from an altitude of 140 miles with a peak deceleration of 19 g.

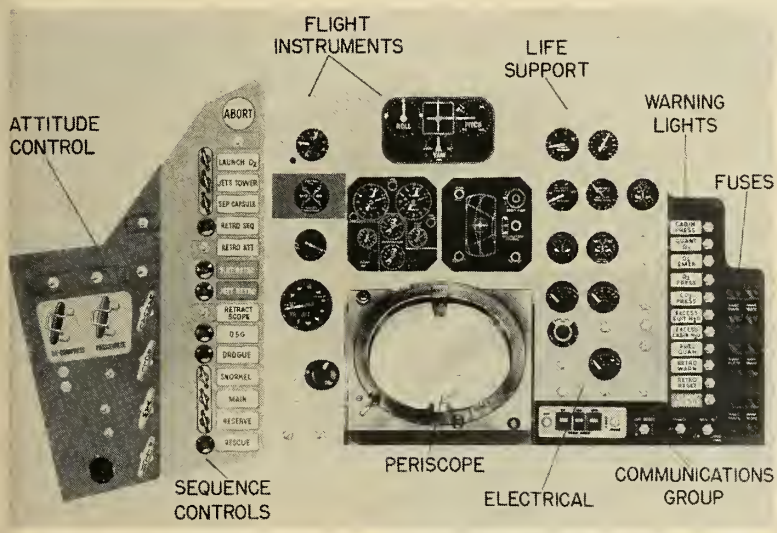
The second type of trajectory to be used will duplicate exactly the velocity, altitude and angle of orbital re-entry without actually going into orbit. Objectives of this trajectory are to qualify the capsule and its heat protection under actual re-entry conditions, and to determine the stability characteristics of the capsule and the functioning of the reaction control system.

The third type of trajectory will be one which actually inserts the capsule into orbit, but immediately turns it around and effects re-entry. During this flight, according to Lowe, an altitude of 120 miles will be reached and a range of 4000 miles will be attained. This flight will give the necessary operational experience needed before orbital flights can be attempted.

After these tests, the *Atlas*-launched capsule will be put into the final orbital trajectory, with instrument and primate tests leading to the final manned orbital flight.



FIRST PHOTOGRAPH of North American's early full-scale mockup of its 1.5 million pound thrust F-1 engine was released last week by NASA.



ASTRONAUT'S PANEL in *Mercury* capsule allows attitude control with instantaneous visual presentation of vital flight factors.

ARTIST'S CONCEPTION of how hard landing would be made on moon using *Atlas-Agena* vehicle with midcourse guidance correction.

—news briefs—

• **London**—The British announced they will join the United States in construction of a third BMEWS station in Flyingdale Moor, Yorkshire—midway between London and Edinburgh. The other two BMEWS stations are under construction at Clear, Alaska, and Thule, Greenland.

• **Dahlgren, Va.**—The Pentagon continued to withhold the reason why the Navy kept secret from its sister services for more than a month the tracking of Unknown 1-60—the polar-orbiting mystery satellite popularly known as "Lonesome George." Meantime, sources disclosed that Navy's Spasur—the dark satellite detection fence—picked up traces of Lonesome George for weeks before even the Navy discovered it.

• **Washington**—Pentagon comptroller Franklin B. Lincoln, Jr., told the Senate Defense Appropriations Subcommittee that $2.2 billion of planned missile obligational funds in FY 1961 will be used for *Atlas, Titan, Polaris* and *Minuteman*. That is $600 million more than in FY 1960 and $900 million more than in FY 1959.

• **Washington**—Lt. Gen. Arthur G. Trudeau, Army R&D Chief, told the House Space Committee that *Nike-Zeus* antimissile-missiles could be operational before 1965 if the program had a "full blast" go ahead. However, Army Secretary Wilber Brucker said the Defense Department is considering a sizeable cutback in *Zeus* R&D funding.

• **Los Angeles**—Sen. Stuart Symington (D-Mo.) called for the unification of all U.S. space programs under one man who would report directly to the President. Symington said: "The exploration of space is America's new manifest destiny."

• **Hartford, Conn.**—The Pratt & Whitney liquid hydrogen-LOX engine has been burned as long as four minutes at 15,000 lbs. thrust, H. M. Horner, chairman of United Aircraft Corp., reported last week. Horner also told the Connecticut Editorial Writers Assn. that United's P&W Division accomplished six major developments in its indirect cycle aircraft nuclear propulsion program last year, although security forbids detailing their nature. Both the P&W indirect cycle unit and General Electric's direct cycle unit are to be tested soon at the National Reactor Testing Station, Arco, Idaho.

• **Wallops Island, Va.**—An *Aerobee-Hi* sounding rocket carrying a 150-lb. payload crashed into the Atlantic Feb. 16, after its second stage failed to operate. The NASA rocket was designed to collect data on micrometeorites in the upper atmosphere.

Siegler Moves Into Solid State Devices With Merger

The Siegler Corp. of Los Angeles is moving into production of equipment utilizing solid state devices, with a merger with Magnetic Amplifiers, Inc.

Magnetic Amplifiers products include flight control systems, commercial TACAN equipment, automatic checkout equipment, servo systems and speed controls. Siegler Co. is engaged in military and commercial electronics, heating, and cooling equipment and specialized machinery.

• **In other important mergers**—Gorham Manufacturing Co. has acquired all the assets of Pickard & Burns, Inc., prominent in electronic navigation, communications and radar systems and instrumentation. Gorham also has recently formed an R&D group and is expected to increase its defense role appreciably.

Dynex, Inc.'s president announces that the Optics Manufacturing Corp. has become a wholly-owned subsidiary. Anaheim Electronics Co., Inc., has been purchased by the Electronic Engineering Co. of California. A new insulated wire firm enters the missile scene with the formation of Irradiated Insulations, Inc., by Carlisle Corp. and Radiation Applications, Inc. (an affiliate of Schenley Industries, Inc.).

Olin Mathieson Chemical Corp. and Pennsalt Chemicals Corp. are joining forces in an equally-owned joint subsidiary, to be known as Penn-Olin Chemical Co. The $6,500,000 venture will produce sodium chlorate and other chlorate compounds.

Articles of incorporation are on file for Astro Components Corp., a new research and development firm for explosives and rocket fuels in Albuquerque, N.M.

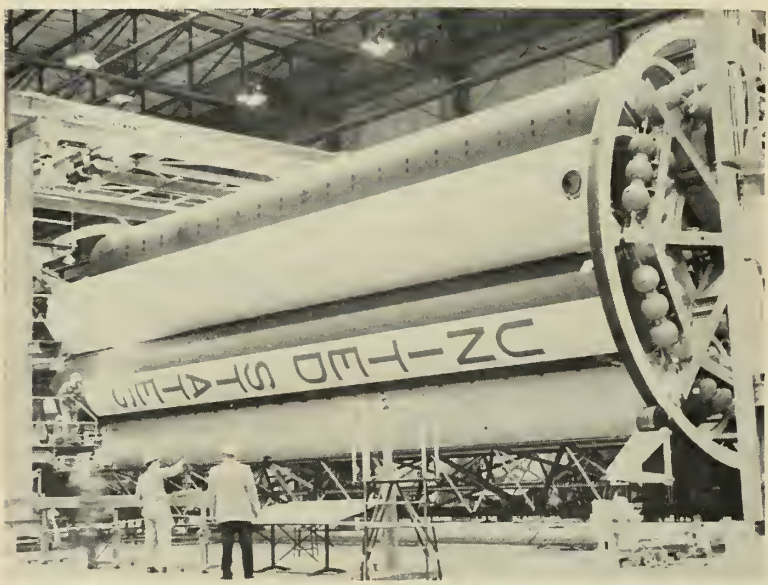
• **Building and expanding**—Sylvania Electric Products, Inc. is planning a new electron tube research and development center at Emporium, Pa. A new environmental testing facility for missiles is now in operation by Associated Testing Laboratories, Inc. The Martin Co. has a big contract with the Orlando, Fla., center, but it is available for other prime and subcontracting firms in the Southeast.

Litton Industries is expanding its electron tube division with a $2-million addition to its Industrial Road, San Carlos, Calif., building. Sperry Utah Engineering Lab will have a new $1,200,000 office building by July 30.

A new California manufacturing plant is planned by the Computer Division of Bendix Aviation Corp., increasing its Los Angeles facilities by 70%.

Realigning structure, Royal Industries, Inc. changes its corporate structure from a parent company with four subsidiary corporations to a single company with four divisions. The divisions are Vard, formerly Vard, Inc.; Audiotone, formerly Audio Company of America; Royal Jet, from Royal Jet, Inc. and Ideal-Aerosmith, from Ideal-Aerosmith, Inc.

Saturn's Fabrication Progress



ENGINEERS use optical instruments to make final assembly alignment checks on 22-ft.-diameter *Saturn* booster at Redstone Arsenal. This photograph, released by the Army last week, shows good fabrication progress since M/R published first exclusive photographs of *Saturn* assembly (Feb. 8, pp. 14-18). Three-stage system will be about 200 ft. long. Center LOX tank has length of 625 in. and 105-in.-diameter. Eight other LOX and kerosene fuel tanks have 70-in.-diameter and 675-in. length.

Ames Studying New ICBM Detection Method

MOFFETT FIELD, CALIF.—Possibility of a new, completely passive detection method for intercontinental ballistic missiles is under study here at Ames Research Center of National Aeronautics and Space Administration. The center is currently studying a theory which holds that radio frequency energy is generated by a high-speed body, and that this energy is detectable by a passive receiver.

Answers being sought by scientists at Ames would indicate the validity of the theory; what frequency ranges are involved; intensity of the energy; and how velocity, altitude, density and other variables would affect the phenomenon.

Ames officials strongly emphasize that the research is in its earliest stages and no significant results have been obtained. High-speed projectiles are being fired from one of the air-guns at the research center as part of the program. Presumably, the effect would take place only in the atmosphere.

The work stems from a theory dating back to 1914, when it was noted that persons sometimes heard a meteor before seeing it. It was then theorized that the high-speed body generated radio waves which were made audible by a metallic object near the witness. (Cases have been known wherein stoves, beds and even false teeth have picked up radio stations.)

In similar work in the same field, Lincoln Laboratory of Massachusetts Institute of Technology is probing the wakes of high-speed bodies with microwave beams to determine the reflectivity and transmissivity of the ionized particles in the wake. This would provide another means of detection and tracking.

NATIONAL ROCKET CLUB President Nelson P. Jackson opens up Third Annual National Missile/Space Conference at panel on "Space Challenge—Philosophy." Among panelists: Rear Adm. Thomas F. Connolly, Deputy Chief, Bureau of Weapons; Ernest Lindley, Newsweek Magazine, and Dr. Donald Michael, Brookings Institution.

Space: Place For Future Wars

Missile/Space Conference hears pleas for 'adventurous' DOD space program

by William E. Howard

Military and industry leaders urged the United States last week to take an "adventurous" approach toward space —with the high hope of removing future wars from this planet.

Speakers and panelists told the National Missile/Space Conference in Washington that lunar and cislunar space—by their vast distances—offer a means of preventing "ethnicide" by relieving the almost instantaneous response time being built into U.S. and Russian ICBM's.

The two-day conference was climaxed by the third annual Dr. Robert H. Goddard Memorial Dinner and the award of the Goddard Trophy by MISSILES AND ROCKETS MAGAZINE to Karel Jan (Charley) Bossart for his outstanding contribution to the development of the Convair *Atlas* ICBM. M/R Executive Editor Clarke Newlon made the presentation. Other awards:

• The Borg-Warner Missile Industry Award was presented to Thiokol Chemical Corp.'s Reaction Motors Division for its successful development and production of prepackaged liquid engines, the Guardian I and Guardian II, used in the *Sparrow III* air-to-air missile and *Bullpup* air-to-surface missile.

• The Astronautics Engineer Achievement Award was presented to Richard B. Canright, chief of research at Douglas Aircraft, by the National Rocket Club for his contributions to the *Saturn* and *Centaur* booster programs and the 1.5-million-lb.-thrust rocket engine projects.

• **'Leapfrog' proposal**—The conference sponsored by the National Rocket Club also heard Dr. Krafft A. Ehricke of Convair assert that a combination nuclear-chemical rocket offers the U.S. a "real good chance to leapfrog" the Soviets in space. He said a well-financed start in FY 1962 could see a huge *Helios* rocket developed by 1968-69 (see p. 8. this issue).

Ehricke said he believes the Russians will try to send a scientific payload to Mars in August. The German-born scientist suggested that *Lunik III*, which photographed the farside of the moon last October, may have been a test flight of the "interplanetary station" the Soviets will use in a Mars shot.

• **Making a choice**—Some of the harshest criticism of the nation's space effort came from Dr. Arthur Kantrowitz, director of the Avco-Everett Research Laboratory, who declared that the Eisenhower Administration has decided unequivocally that "we are not competing with anybody" in space.

Likening the mastery of space to a "genie," Kantrowitz said:

"When the genie presents you with the wishes, among which you may choose, if you choose comfort—and typical of the comfort wishes is the program for a balanced budget with no new taxes—you may get the comfort for a while.

"If you choose the adventure (of going into space) it is one of the firmest facts of our experience that in the long run we get more comfort and luxury than by choosing comfort in the first place. And so this brings us to the point where we can see how to live happily ever after."

Ticking off surveillance, weather, communications and astronomical satellites as truly important space programs now in progress, Kantrowitz predicted

answer to population problems?

COFFEE BREAK brought together Col. Charles I. Davis, Industrial College of Armed Forces; Navy Capt. F. M. Sanger, Jr., Weapons Program System, Office of Naval Material; C. E. Pritchett, assistant Superintendent of Sales, Western Electric; and Dr. James H. Trundock, Jr., of IBM.

that with progress the cost of putting a pound of payload into space will be about $100—comparable to the cost of making airplanes.

"We are very quickly going to reach the situation where we can put into space numbers of objects comparable to the number of airplanes we can buy. This gives us a tremendous opportunity for invention," he said.

Space technology, Kantrowitz said, can help make the U.S. retaliatory force secure "so that we need never contemplate the necessity of its hasty employment." Distances available in space "can be translated into times, thus it will take days to reach and destroy an object at the distance of the moon. We can, by using these distances, acquire precious time in which to make the fateful decision of unleashing our retaliatory force."

• **Easing population**—He suggested that space also may be the solution to the population pressures of an earth made "too small a place for mankind" by nuclear weapons. "The power of nuclear weapons in the present situation where it is possessed by four nations creates a very dangerous situation. When nuclear weapons are possessed by 40 powers I am not sure that the situation will be tolerable," he added.

The physicist said the population explosion could be solved by colonizing the moon or other planets, but he felt living in space itself—presumably on a city-like space station—would be more attractive. "This would be a larger departure from earthly living than moving to another planet."

Kantrowitz also attacked the development program of NASA, charging that the civilian space agency was spending hundreds of millions of dollars in-house "and only $4 million outhouse" in research.

• **New ARDC program**—A new Air Force program aimed at reducing the overlapping of scientific effort by keeping persons in the field up to date with their colleagues was outlined to a marketing panel by Lt. Gen. Mark E. Bradley, Jr., deputy chief of materiel. Called "CATE" for Current ARDC Technical Efforts, the program is basically a directory of scientists and engineers working in all technical areas and where they can be contacted. It will begin in March.

Indicating there would be no major changes forthcoming in the manner in which the Air Force does business, Bradley did however make these points:

• The AF intends to build up its "organic" capability to a "plateau so that we will be in a better position to control, direct, change and review our projects" to strengthen its management controls.

• The tremendous cost of space vehicles will "necessitate the procurement of relatively few end items and will dictate a degree of reliability which we are presently not enjoying."

• There is a major requirement for development of a recoverable space booster.

• R&D ground environment for space weapon systems should be constructed with a view in mind of subsequent utilization by the operational command. This could mean "significant savings."

• **Military role stressed**—Canright, a former ARPA official, said "the United States could win a war in space." He told a panel discussing the "philosophy" of the space challenge that AICBM's—"missile destroyers"—could force the Russians into space and thus avert a war on earth which would—if it started—amount to an "international suicide pact" or "ethnicide."

Rear Adm. Thomas F. Connally, assistant chief of the Bureau of Naval Weapons for the Pacific Missile Range, declared that it "would be folly to keep the military out of space."

One dissenter on this panel was Rep. James G. Fulton (R-Pa.), who said this country and Russia should cooperate in space and not operate there by the "law of the jungle." Referring to the Russians as "wonderful people—and we must treat them as human beings," the Republican Congressman conceded, however, that the Russians may present a military threat in space overnight. Therefore, "the military must be alert to space operations and must stay involved in them."

Fulton was taking issue with a statement by Andrew G. Haley, general counsel of the American Rocket Society, after he said:

"At the present time, only one certain, essential and positive issue actually is before us: 'Who controls the moon controls the earth'."

Haley added that it was the "clear duty" of the national leadership to use every means, including war, to prevent an alien power from controlling the moon. Foley said this would be reducing a scientific area to "law of the jungle."

• **Plea for firm requirements**—The president of Consolidated Diesel Electric Corp., Norman I. Schafler, speaking on the marketing problems of medium-sized companies, said:

"We would like to see the prime contractors firm up their 'make or buy' decisions before requesting proposals from prospective suppliers."

He said there are too many cases where very detailed and costly proposals have been submitted to primes when the program is later altered or the "prime contractor elects to build the item himself." Another sore point, said Schafler, is the need for a better way to advise industry of the requirements of weapon system managers. Not being able to afford large sales staffs to become acquainted with needs of all the big contractors, he said, smaller companies either have to concentrate on a small portion of the field or try to cover all of the contractors partially.

Schafler suggested that a system of posting requirements would be a solution to the problem.

• **Belt tightening**—Another panel member, Donald E. Perry, managing editor of MISSILES AND ROCKETS, expressed doubt that any new missile or space programs would be "sold" during the remainder of this election year. Instead of being a new business year, Perry said, 1960 would be remembered as "Product Improvement Year" by the industry. He predicted increased belt tightening "as contracts get fewer and fewer and competition gets stronger and stronger . . ."

• **In to win**—There is no point in changing the nation's existing space set-up, Sen. Thomas J. Dodd (D-Conn.) told a legislative panel, "unless there is a decision by the President and his Administration and by the Congress that the United States is going to get into this space competition with the single objective of winning it."

He said "we have got to make a national decision that we will not continue to play second place." It is Dodd's position that such a national decision should be made and we should "spend the money and make the effort necessary to do so."

On the question of whether the missile/space issue should be injected into the forthcoming presidential political campaigns Dodd said he is against partisan bickering, but it is a function of the American system of government to publicly examine the adequacy of these programs.

"If our space and defense programs are adequate, if we are doing all that we could and should do in these fields," he said, "then public discussion can only continually remind our friends and opponents in the world of our indisputable strength and rapid progress. It is only when our programs are deficient that public discussion of these deficiencies is embarrassing—both to our leaders and to our country."

The Connecticut lawmaker—referring to the raging controversy over the Missile Gap—said "most of the complaints about public airing of these issues have as their objective saving the Administration, rather than the country, from embarrassment."

REP. James Fulton (R-Pa.) and Dr. S. Fred Singer, University of Maryland, discuss pending panel program on "Space Challenge."

REGISTRANTS sign-up for four panel discussions and Third Annual Dr. Robert H. Goddard Memorial Dinner. Right, Andrew G. Haley, past president of International Astronautical Federation.

Rover Gets More Spending Authority, No More Money

The Administration has upped its authorization for spending on the Project *Rover* nuclear rocket in the 1961 fiscal year but no more money was allowed, Sen. Clinton P. Anderson (D-N.M.) reported last week.

Anderson, chairman of the House-Senate Committee on Atomic Energy, said the Budget Bureau took the action after an appeal for more funds by John A. McCone, Chairman of the Atomic Energy Commission.

Anderson made the disclosure in a statement issued after his committee held a one-day closed hearing on the status of *Rover*. Here, Anderson said, is what happened:

The AEC requested $20 million in FY 1961 for construction of test facilities for *Rover*. President Eisenhower, at the recommendation of the Budget Bureau, cut this to $13 million.

At the same time, the Administration ordered a slowdown in the *Rover* testing schedule. The first ground test of the rocket was moved back from 1963 to 1964. The first flight test, which had been set for 1965 or 1966, was rescheduled for the period 1968-69.

After McCone's appeal, the Budget Bureau raised the AEC spending authorization to $20 million, as originally requested. However, the actual appropriation requested from Congress was not changed. The AEC was told that it might shift some funds to *Rover* from somewhere else if it wished to do so.

Project *Rover* is jointly administered by the AEC and the National Aeronautics and Space Administration.

Preflight Testing of New X-15 Engine Completed

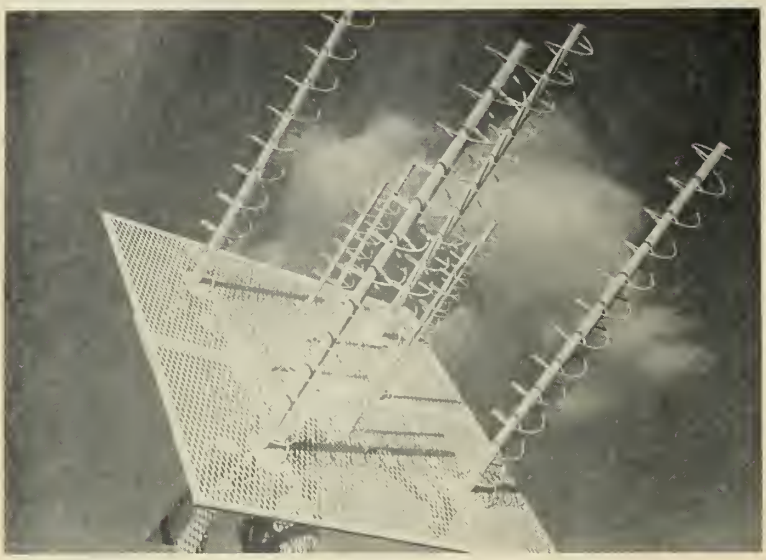
All tests in the Pre-Flight Rating Test program on the high-thrust *X-15* rocket aircraft engine have been completed, Reaction Motors Division of Thiokol Chemical Co. has announced.

Thiokol said this means the U.S. now has a fully throttleable rocket engine for manned flight with control exercised at the pilot's discretion.

The new engine, designated *XLR-99-RM-1*, provides more than 50,000 lbs. of thrust for about 90 sec. It will replace the interim powerplant consisting of two 12,000-lb.-thrust *XLR-11* engines. It will be installed in the *X-15* after current tests with the interim powerplant.

Harrison Storms, chief engineer for North American Aviation, prime for *X-15*, said it may fly with the new powerplant by May 15.

Mercury Antenna Contract Let



THESE ARE one type of antenna Canoga will make for Project *Mercury*.

LOS ANGELES—Canoga Division of Underwood Corp. has received a contract in excess of $1 million for design and manufacture of all antennas for Project *Mercury* ground-based telemetry, communications and command control.

Canoga President George H. Nibbe said first deliveries are tentatively scheduled for midyear. The program calls for some 50 antenna systems. There will be 13 automatic tracking quadhelix antennas to be used for acquisition and tracking of VHF telemetry signals.

Angle data from the tracking antennas can be fed to slaved radars, communications and command antennas and computers. These will provide extrapolations for "down-range" orbital data as well as orbit prediction for subsequent passes.

All steerable antenna systems and radars along the anticipated orbit will be positioned automatically from computer output until the acquisition aid antennas are tracking.

Canoga antennas will track by means of a phase-comparison simultaneous lobing technique. Acquisition aid antennas when not tracking will be slaved to tracking radars and used only for reception of telemetry signals.

Other antennas covered by the contract include quad-helices for the purpose of telemetry and voice communications receiving as well as a third group of command control and voice communications transmitting.

Antennas in the latter group utilize four outboard helices operating in the 200-300 megacycle region for command transmission purposes.

Polarizations of opposite sense for transmitting and receiving helices is used to minimize interference between voice transmitting and receiving antennas at the same location.

RCA Gets $474.8 Million BMEWS Installation Award

Air Force last week announced award of a $474,831,000 contract to Radio Corporation of America for work on the Ballistic Missile Early Warning System (BMEWS). (See special construction report, p. 28.)

The award, according to the Department of Defense, brings total BMEWS investment in the missile warning system to more than $700 million. RCA has been working on the project for more than a year. Remaining work will spread over several more years.

Ultimately the system is expected to cost about $800 million. The first station in Thule, Greenland, is expected to be operating before the end of this year. A second station in Clear, Alaska, is to be completed in 1961.

Missile R&D Far More Costly Than Production

About 60 cents of each missile dollar goes to research and development—thus exceeding production costs of the missile, according to Orval R. Cook, president of the Aerospace Industries Association.

This shows a new trend since war years when money spent for aircraft went predominantly to production. However, in today's intercontinental bomber, R&D amounts to as much as 20%.

Cook noted that employment figures also reflect the emphasis on engineering, tooling and other indirect specialties—over direct production. In 1959, for 30 plants surveyed by the USAF's Air Materiel Command, 65% of the 451,098 workers were engaged in indirect specialties. In 1955, the figure for 469,794 employees in the same plants was 60%. In the peak employment war year of 1943, statistics show that only 20% were engaged in R&D, while 80% were directly in manufacturing.

Hawk kills Honest John

SEQUENCE of shots from official Army film shows Raytheon *Hawk* finding and killing Douglas *Honest John* in test over White Sands, N.M., Jan. 29. Army called it first known kill of its kind. First photo shows *Honest John* in flight; second, *Hawk* taking off; third, *Hawk* changes course and dives for kill; fourth, intercept and explosion.

Low-Level Multiplexer Passes Tests

Radiation, Inc. takes big step forward with its Radiplex 89—first true low-level system—which drastically cuts size of equipment; unit design for Minuteman

A significant forward step in telemetry and data acquisition has been taken with successful operation of the first true low-level electronic multiplexer.

The unit—Radiation, Inc.'s Radiplex 89—has been operationally tested at Thiokol's Utah Division static test stands. In parallel tests with conventional units using preamplifiers, the Radiplex exhibited 10-microvolt resolution and provided more accurate data than the comparative system.

Low-level multiplexing has been a much sought-after but elusive goal for many years. Until now, so-called low-level units could handle signals only down to about ten millivolts.

The big advantage of such a system is, of course, the elimination of preamps—with their size, power requirements, and noise problems. The 48-channel Radiplex unit boils down to one single chassis the equipment formerly requiring three 6-foot cabinets.

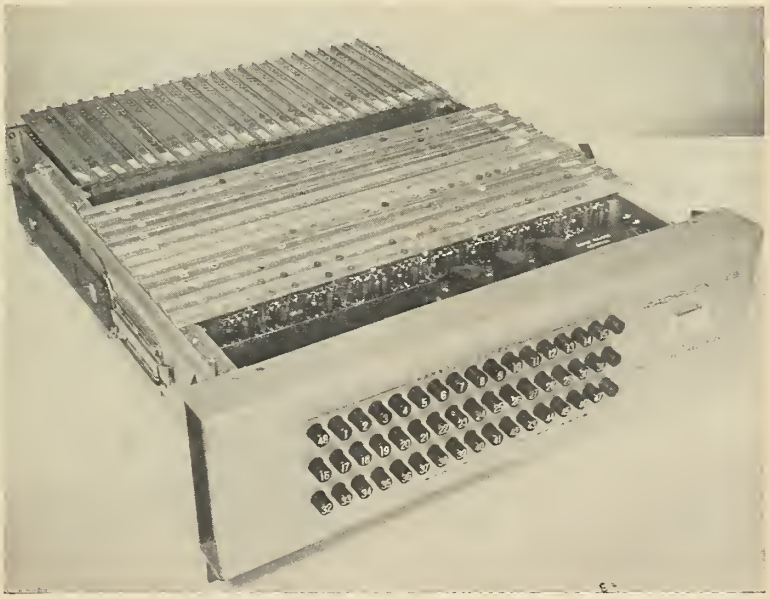
Such a system is particularly desirable in air- and missile-borne instrumentation. It will help solve one of the greatest problems in the use of digital telemetry equipment: size and complexity. One unit is already being designed for use in the *Minuteman* PCM system. Other 96-channel units will be used in airborne installations.

In application, multiplexers are used to continuously sample outputs from strain gages, thermocouples, and other types of transducers. Thus many channels of information may be carried on one data channel. Earliest types were simple electrical switches; electrical commutating discs, switching tubes, and electronic switches have all been used. The biggest problem in the process, however, is the noise generated by the switch itself—noise of sufficiently high level to overcome output signals of relatively low level. In consequence, transducer outputs have had to be preamplified before they were usable; and, as mentioned, preamplification posed its own problems.

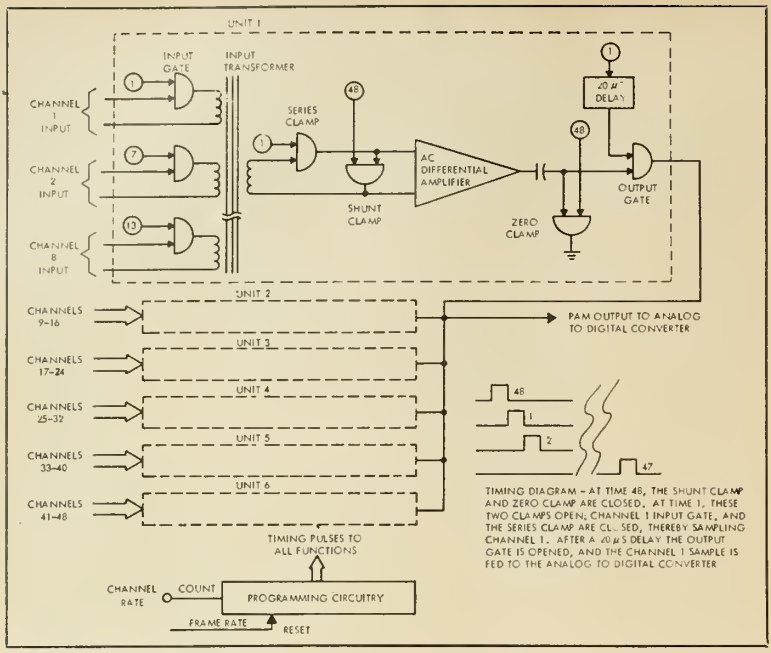
• **Unique features**—Several different developments by Radiation engineers were combined to achieve the resolution, low noise level, freedom from crosstalk and other qualities that make the Radiplex 89 unique.

The first of these is the electronic switches, which use transistors instead of the usual diode gates. The transistors are considerably less noisy in the operating range involved than are diode gates. Second, they permit isolation of the switching impulses from the data itself. Third, they are inherently low-level devices in contrast to the high-level diode switches which have been used in the past.

The second unique feature is the special coupling transformer developed for linking the input switches with the amplifiers, and the way these transformers are used. Six transformers are employed, each one with eight isolated windings, yielding a total capacity of 48 channels. Input signals are rotated among the six transformers so that each one has five-channel intervals for recovery. This provides ample time for all transients to decay to less than 0.1% before that transformer is used again. The isolation of transformer windings, together with placement of the transistor input gates in relation to the input winding, result in common mode rejection of 10^6:1 and crosstalk of less than 0.05%.



MULTIPLEXER is of solid-state construction throughout. All circuits are mounted on plug-in boards. The unit shown combines all the equipment needed to handle 48 channels and replaces that which would otherwise take up three full cabinets.



SIMPLIFIED block diagram of multiplexer shows its unique arrangement for rotating inputs to the six transformers for isolation and recovery.

A third very important development is design of low-level amplifiers and clamping circuits in the inputs and outputs of the amplifiers. These permit zeroing of amplifiers immediately before each signal is applied to the amplifier. This provides compensation for loss of dc reference due to input transformer coupling, and results in linearity in 0.1%.

The output gating also contributes significantly to performance of the Radiplex 89. The same timing pulse used for zero clamping of the low-level amplifiers is used as a timing pulse to these output gates. It delays and shortens readout to insure elimination of spikes which might interfere with coder operation, and delivers a smooth and essentially level output to the coder.

Another useful feature of the low-level Radiplex 89 is its program flexibility. Internally the unit consists of six sections, each with eight-input channel capability. At a 24-word rate, each section is independently driven at a 4000 cps rate. This may be subdivided among the 8 channels in groups of 1, 2, 4 and 8, thereby providing channel sampling rates of 4000, 2000, 1000 and 500 cps, respectively. Additional units may be used in series at equivalently lower sampling rates. Flexibility of programming is accomplished by use of alternate programmer matrix boards.

The Radiplex, while actually designed for operation with the Radicon coder, is compatible with most other coders. If used with the Radicon, push-button channel select switches make it possible to view any one of the 48 channels on a digital display.

Tube Market May Be $900-Million This Year

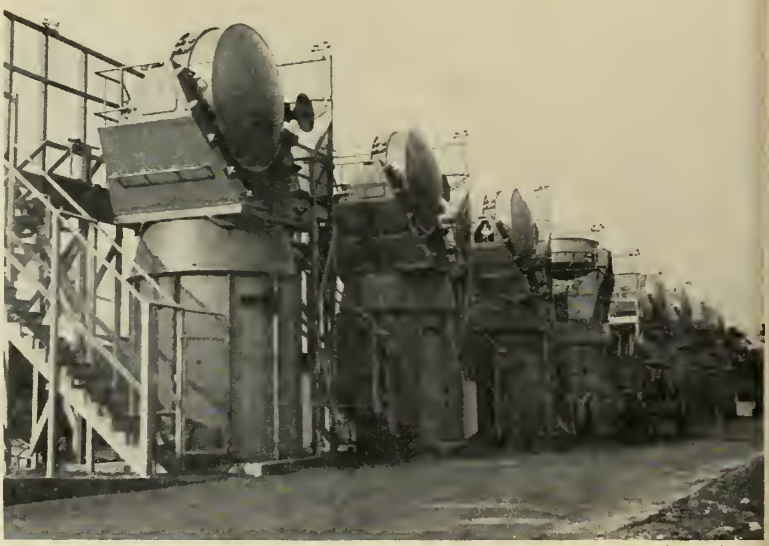
Heavy demands for electron tubes by military and industrial users, and a strong market for home entertainment products, should boost the electronics industry's tube sales to an all-time high of $900 million in 1960.

This is the prediction of Douglas Y. Smith, vice-president and general manager, RCA Electron Tube Division, who said in Newark, N.J., that tubes are finding new uses in the rapidly-expanding electronics industry.

"As an illustration of the tube's importance to the nation's space program," he said, "a single test launching at Cape Canaveral may require as many as 100,000 electron tubes inside the rocket and at ground control stations."

"Factory sales of all types of electron tubes by the industry totaled approximately $870 million in 1959, an increase of nearly 12% over the 1958 level," he pointed out. "Of last year's total, receiving tubes accounted for nearly $370 million, industrial and military tubes represented approximately $250 million, with the balance of about $250 million in TV picture tubes. Greatest expansion was in industrial tube sales which rose about 20% over the 1958 sales levels."

Terrier Radars for Long Beach



THESE AN/SPG-55 radars for *Terrier*, developed by Sperry Gyroscope Co., will be installed on the nuclear-powered USS Long Beach. *Terrier* radar is completely automatic; from the time the target is designated until the radar goes into automatic tracking, the operator's sole function is as an observer. Equipment supplied by Sperry for the Long Beach includes four SPG-55 radars, two SPG-49 *(Talos)* and SPW-2 radars, two Mark III computers, and one WDE system.

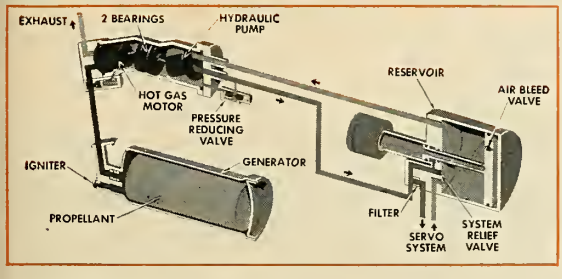
FLIGHT HARDWARE...NOW

VICKERS HOT GAS AUXILIARY POWER SYSTEMS

for missiles and spacecraft

CONCEPT

Vickers piston motors — as used in virtually all existing commercial and military aircraft — are now modified to operate efficiently on propellant-generated hot gas, or bleed gas from the main propulsion system. Minimum weight is achieved by mounting the hot gas motor "shaft-to-shaft" with a Vickers piston hydraulic pump in a common housing. The motorpump, a simple gas generator, hydraulic reservoir, filter, and relief valve are integrally mounted to form a complete Auxiliary Power System in a compact package.



DEVELOPMENT

Production line Vickers hydraulic motors have been operating on hot gas for over 2 years. Units have run on gases as hot as 2300°F without modification.

The present flight hardware was built and tested after an intensive prototype development effort. Test program motorpumps have accumulated over 100 runs each for 1 minute of operation cycle. Since the current development program is aimed at meeting known APS requirements, no limits have been established on the operating cycle duration for this type of equipment.

CONCLUSIONS

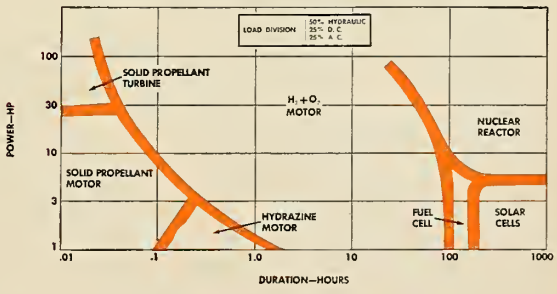
Performance and reliability goals for this concept have been met successfully. A complete hot gas APS package in the 2 - 8 horsepower range, shown above, is available within 90 days. Customer specifications for these and larger systems are invited. Write for Bulletin A-5223B.

APPLICATIONS

Because of the increasing scope of APS applications, Vickers conducted a series of studies to establish criteria for APS selection. Recent study results (published in March, 1959) indicate that for short duration operation, hot gas motors offer the best weight advantage in the 1 to 30 hp range. See curve below.

Attractive reliability and early delivery resulting from extensive use of proven hardware may extend the application of these systems to an even greater range of second and third generation missiles and spacecraft. Additional advantages include: low speed equipment (up to 10,000 rpm), convenient ground checkout, growth potential, and no alert time required.

OPTIMUM WEIGHT NON-PROPULSIVE POWER SYSTEMS



AERO HYDRAULICS DIVISION

VICKERS INCORPORATED

DETROIT 32, MICHIGAN

division of:

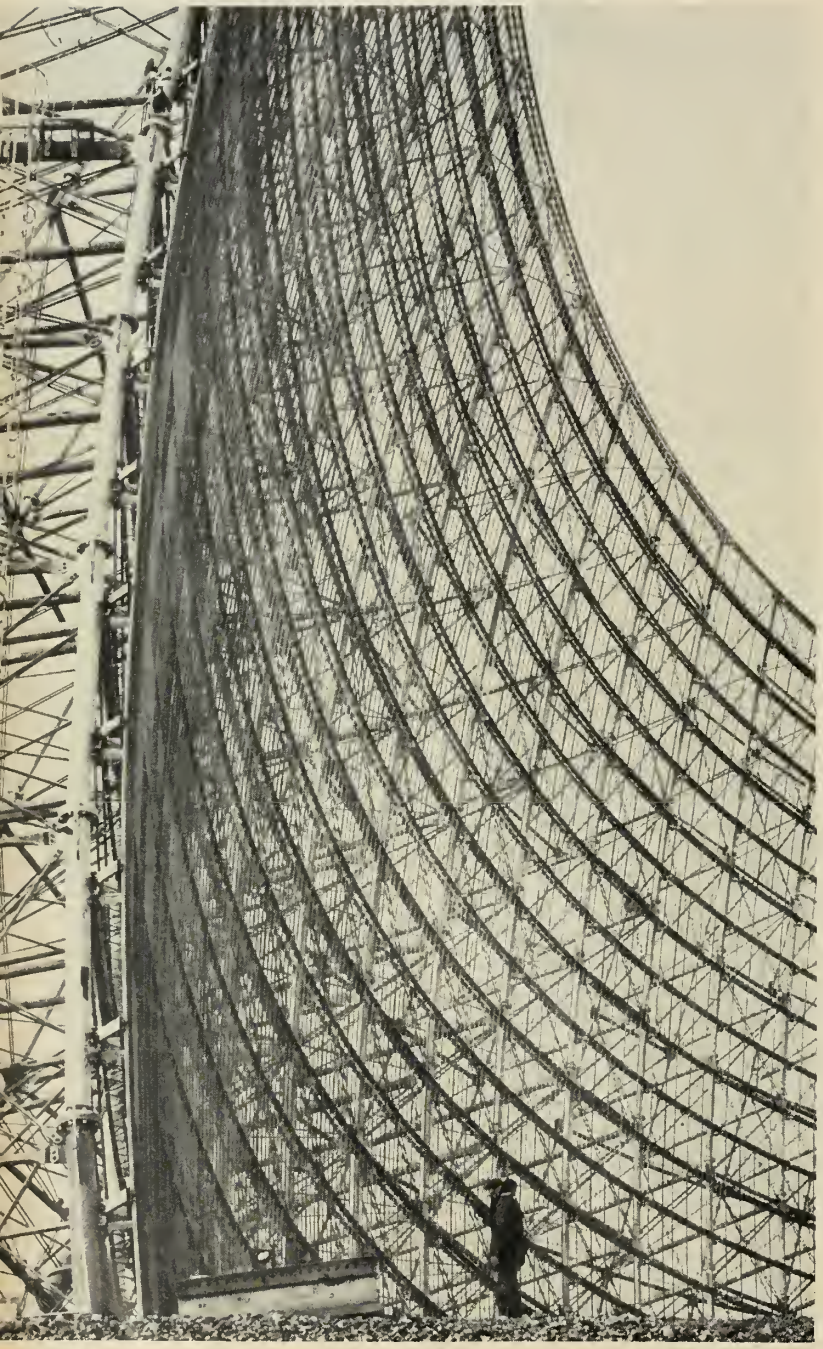
SPERRY RAND CORPORATION

8386

Circle No. 3 on Subscriber Service Card.

GE Progressing With BMEWS Rada

2000 to 3000-mile-range surveillance system being built under $100-million RCA subcontract



Under a subcontract to Radio Corporation of America, prime for the Air Force Ballistic Missile Early Warning System, General Electric designed and is building and testing the surveillance or detection radar system. Expected to have a range of from 2000-3000 miles, GE's contract for the colossus exceeds $100 million.

The entire BMEWS system includes sites at Thule, Greenland, Clear, Alaska, and another somewhere in Scotland. RCA also has built a test and training site at Moorestown, N.J., for its tracking radar system. It is expected that total cost of BMEWS will approach $1 billion.

Shown here are photographs of some of the equipment and part of the installation at Site 1 in Thule, now under construction.

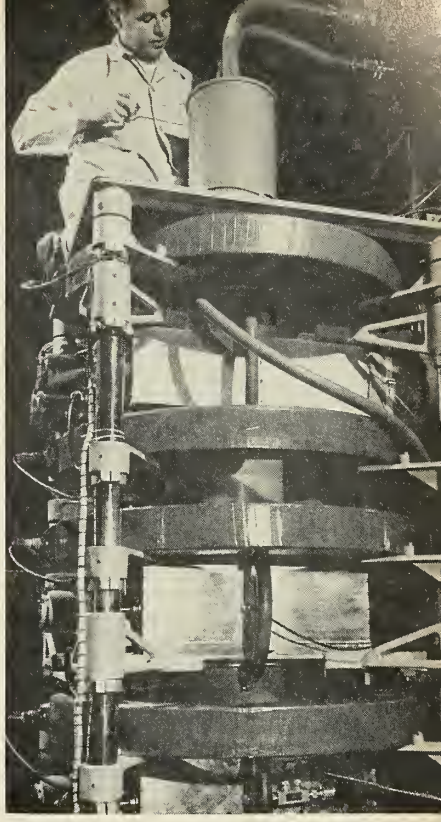
←

NEW USAF SURVEILLANCE radar antenna at BMEWS Site 1 in Thule dwarfs workman and bulldozer in foreground. Over 160-ft. high, the 12-in. diameter nickel-steel pipe used in its construction never had been manufactured in the U.S. prior to the award of the BMEWS contract. Built to withstand 185-mph winds with up to a 6-in. coating of ice, structure was erected to a 0.75-in. tolerance overall.

→

NEWLY-DESIGNED duplexing filters (foreground) are being tested in Syracuse, N.Y. In the background, is one of the massive scanning-switch assemblies. An unusual high-speed rotary switch, its function is to permit transmission and reception of radar pulses alternately. Cycle is programmed many times per second. The duplexer blocks transmitted energy from the receivers but passes reflected radar pulses to the receivers.

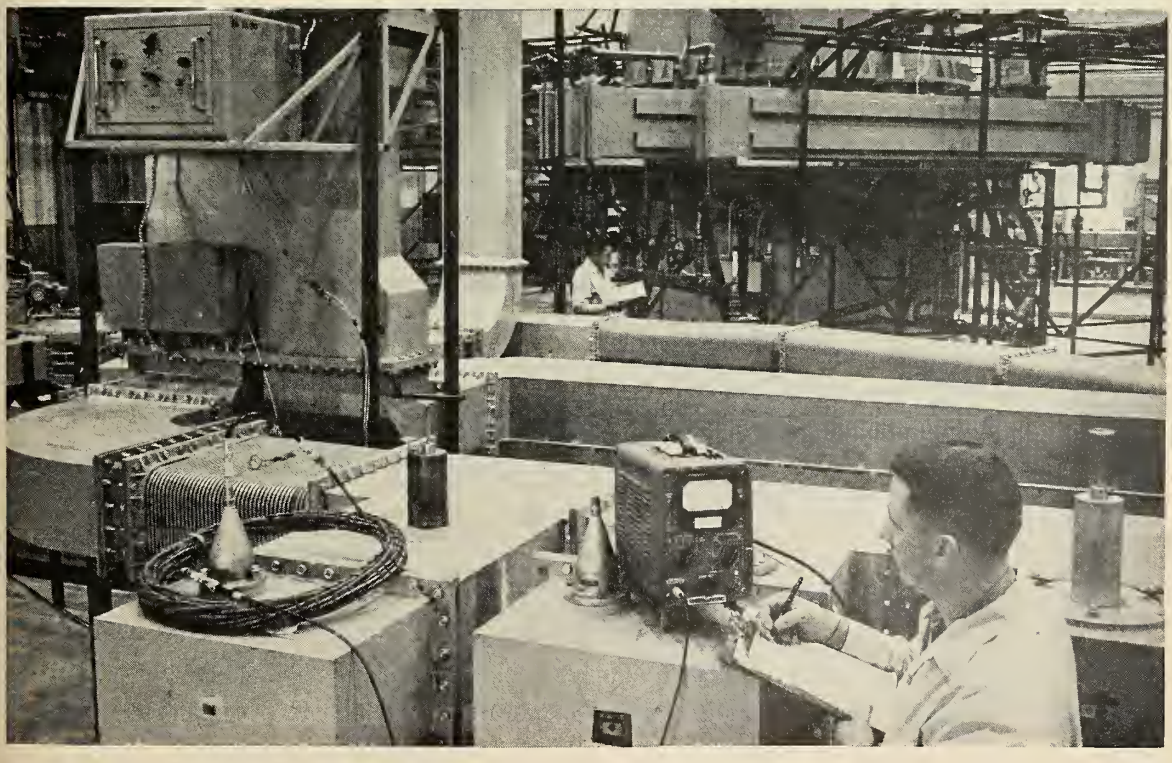
nstallation



GROUPS of these 9-ft. klystron amplifier tubes are used in each of the multi-megawatt-pulse transmitters. Because of the very high power used, over 2000 55-gallon drums of oil are needed for cooling. At the GE test laboratory, a 34,000-volt input is converted to 120,000 volts, dc to operate the system. (Note the man-sized focus coils encircling the klystron.)

BMEWS Surveillance Radar Statistics

Item	Size (each)	Weight Each	Weight Total	No. in use per Site	Manufacturer
AN/FPS-50 Radar Surveillance System	.....	.....	13,350 tons	1	General Elec.-Heavy Military Electronics Dept.
Transmitters:	.....	278 tons	2,221 tons	8	Continental
Cooling oil	.....	.....	.....	111,110 gal.	Electronics Mfg.
Klystrons	9 ft. high	1,600 lbs.	.....	.....	Eitel-McCullough Varian
Scanning switch assembly	16.5'h x 21' dia.	76,600 lbs.	613,000 lbs.	8	General Bronze Corp.
Antennas:	165'h x 400' lg.	1,500 tons	6,000 tons	4	D. S. Kennedy & Co.
Backstays	3.5' dia. x 60'h	7.5 tons	150 tons	(20/ant.)	
Concrete footings	10,000 cu. yds. total	.....	.....	160	
Reflector panels	5' x 7' each	.....	.....	2240/ant.	
Nickel-steel constr. pipe	6" to 12" dia.	.....	.....	4.5 miles	
Aluminum waveguide	.....	.....	1,574 tons	21 miles	
Feedhorns	.....	.....	.....	704	
De-icers	3360 BTU/hr.	.....	.....	16	Carrier Corp.
Elec. Equip. Cabinets	.....	.....	.....	294	
Monitor & Control Consoles	.....	.....	.....	10	
Cable	.....	.....	175 tons	15,000 pc.	



Speedy Readout

Wide Potential Seen in Data Processing

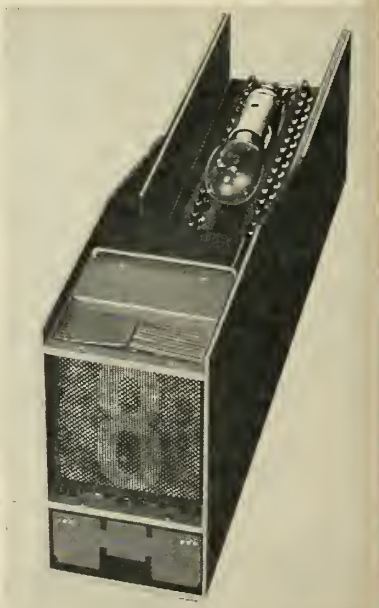
A new simplified high-speed readout display should have wide potential in automatic data processing. Using a technique of light interference, the unit accepts a binary-coded decimal input and displays alpha-numeric characters.

Developed by Industrial Electronics Engineers, Inc., North Hollywood, Calif., the "Slide Plate" has a one-plane in-line presentation, has a memory, and will function with transistorized equipment. In addition, IEE states, the unit is highly reliable and will cost less than $40.

The device accepts any binary-coded decimal or teleprinter code up to six information bits. Translation is performed without the need for auxiliary circuits, and operation is at a change rate of 30-40 readings per second.

Designed to operate on less than 5 milliwatts signal power, the Slide Plate can be connected directly to transistor or vacuum-tube flip-flops. A unique feature of the device, according to IEE, is that it will retain a displayed alpha-numeric character until commanded to accept and display a new signal input. Again, no auxiliary memory or storage equipment is required.

Checkback and verification circuits



SLIDE PLATE readout unit, developed by Industrial Electronics Engineering, employs light interference technique and very low power (5mw) for high-speed display.

are provided to assure that signals have been accepted properly, and permanent output storage is supplied.

Various models will be available providing 10, 16, or 40 characters. For special applications, up to 64 characters can be provided, said IEE.

Method Improves Measuring Of Frequency-Response

Moscow—Soviet scientists K. V. Zakharov and V. K. Svyatoduch report that they have designed a new measuring set for obtaining frequency-response characteristics of nonlinear automatic control systems.

The lack of a satisfactory method for obtaining these measurements had reportedly caused reluctance to use the frequency-response approach for analysis of nonlinear systems. Chief difficulties in designing a measuring set capable of meeting the measuring requirements were experienced in connection with the presence of higher harmonic oscillations which exist in the output of a nonlinear system subjected to a sinusoidal input force. Harmonic-analysis methods are considered cumbersome and too slow, as they require complex calculations and preliminary oscillographic recording of the process under study.

This electronic device is reportedly capable of performing direct harmonic analysis of the output signals of nonlinear servo systems operating with signals in the form of electrical voltages in the 0.25-50-cps range. (*Avtomatika i telemekhanika*, No. 12, 1959, pp. 1679-1686.)

Quality-Control Analyzer Proposed for Testing

Moscow—The Department of the Technology of the Moscow Higher Technical School imeni Bauman has proposed a quality-control analyzer for testing of magnetic amplifiers.

Although there is a trend toward extending the use of magnetic amplifiers, their introduction on a large scale is said to be hindered by poor technology—mainly by inefficient methods of quality control—manually performed, slow and inaccurate.

The measuring circuit can operate either on industrial or on elevated frequencies. Results of measurements, automatically performed, present complete information on performance of the amplifier during testing. Use of the analyzer is anticipated not only for industrial quality control but also in laboratory prototype testing, where this device will be of importance in accelerating experimental work on development of new models. (*Mashinostroyeniye i priborostroyeniye*, No. 2, 1959.

LOX Supply Stirs Industry Debate

Missile/space use generates $100 million business and takes 22% of nation's output. Air Products backs in-house production, Linde for commercial supply

by Jay Holmes

Liquid oxygen, the pale blue supercold fluid that provides air for most ballistic missiles and big rockets, has generated more than $100 million in business—and a major industry controversy—in less than four years.

Furthermore, the level of missile/space LOX consumption is expected to rise in the early 1960's despite inroads being made by solid propellants and storable liquids.

Military security regulations and industry's jealous guarding of its secrets make it impossible to obtain a completely authoritative summary of the LOX business. In addition, most LOX is produced at on-site government plants—rather than purchased from commercial suppliers.

An analysis of the figures available and estimates by industry sources indicates that at least 22% of the nation's production of high-purity (99.5-100%) oxygen goes for missile/space use. The bulk of the remainder is consumed by the steel and chemical industries.

Last year, the U.S. Commerce Department reports, 43.5 billion cubic feet of high-purity oxygen was shipped commercially. According to M/R estimates, the military consumed another 11.3 billion cubic feet produced in its own facilities. Some in industry think the chemical industry produced another 10 billion at captive plants; however, Commerce Department officials insist no such large amount could go unreported. Lower-purity oxygen production totaled about 32.5 billion, making a grand total of 92 to 98 billion cubic feet.

In 1960, barring new railroad or steel strikes, Commerce Department officials expect an across-the-board rise of more than 10%, which would bring the grand total to 105 or 110 billion.

• **Rising curve**—Missile/space LOX consumption is expected to soar in the next few years because of the fantastic quantities burned in testing the 1½-mega-pound *Saturn* and *Nova* booster rockets, the recent NASA-ABMA decision to develop liquid hydrogen-LOX upper stages for *Saturn*, continued testing of the *Atlas* and *Titan* ICBM's and the planned construction of at least 18 *Atlas* and *Titan* launching bases.

Each *Atlas* and *Titan* holds more than 55 tons of LOX when fully loaded. The *Saturn* booster alone will hold more than 200 tons.

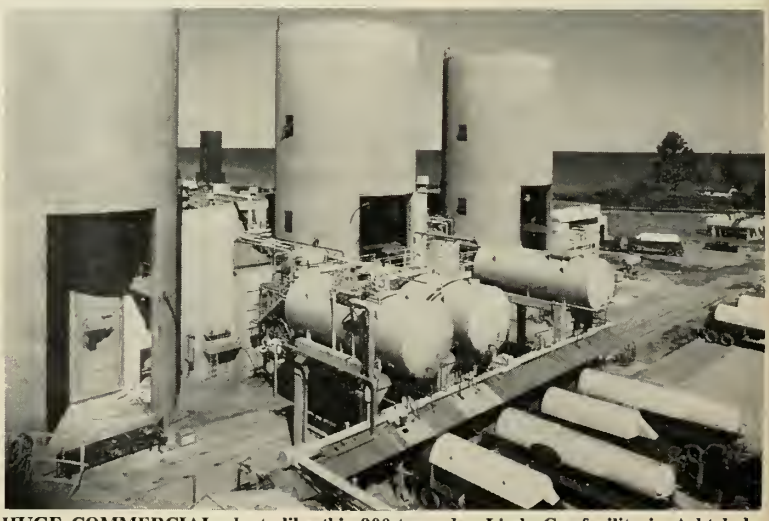
In the steel industry, which devours more than half of the oxygen of all purity grades produced in the United States, oxygen use is on a steeply rising curve because of its rapid spread in open-hearth lancing and the basic oxygen steelmaking process.

• **Procurement controversy**—The great bulk of missile/space LOX is produced on Air Force and Army-owned facilities. In 1959, only about 20% was procured commercially. Some say the government should have obtained much more commercially. Others maintain that present procedures have saved millions of dollars.

Two major companies represent the prevalent opposing philosophies. Air Products Inc., of Allentown, Pa., which has built five major plants and 507 smaller ones for the Air Force and Army since World War II, is the champion of government in-house production. Linde Co. Division of Union Carbide Corp.—the nation's largest producer of industrial gases, with about 50 plants across the nation—has thus far supplied LOX only through commercial channels. However, the company is equipped to build and sell producing plants.

Air Products reported last month that the five largest Air Force plants it built have produced one million tons of liquid oxygen and nitrogen since the first went on stream May 17, 1956. This is the equivalent of 24.2 billion cubic feet. Assuming that nitrogen production was about 10% of the oxygen level, the five plants produced about 22 billion cubic feet of oxygen in less than four years.

Since 1956, Air Products' government revenues for cryogenic liquid pro-



HUGE COMMERCIAL plants like this 900-ton-a-day Linde Co. facility in Ashtabula, Ohio, supply LOX for the steel and chemical industries as well as missile/space needs and ship by rail or truck.

duction and handling equipment have exceeded $95 million, plus another $36 million paid to subcontractors. The overall $131 million, however, includes a classified sum paid for construction and operation of a large liquid hydrogen plant at West Palm Beach, Fla.

For comparison, the Commerce Department reports that 142 billion cubic feet of high-purity oxygen were shipped commercially from 1956 through 1959. Thus, oxygen from the five plants equalled about 15.5% of the nation's commercial production during the four years. The nation's total production of high-purity oxygen over the four years probably was between 190 and 200 billion cubic feet. If so, the five Air Force plants produced between 11 and 11.6% of the total.

Air Products contends that the Air Force saved at least $30 million by building the five plants—at Santa Susana, Nimbus and Edwards AFB, Calif., Denver, and Cape Canaveral. The plants cost $20 million to build, Air Products says, and the operating cost has been $18.5 million—a total of $38.5 million. The Pennsylvania company says the million tons would have cost about $70 million if procured commercially.

• **Built-in inefficiency?**—Linde spokesmen did not directly dispute the figures cited. However, they noted that prices have historically gone down with increasing volume and that, if very large amounts were procured, prices would drop well below present levels—perhaps as low as $40 a ton.

Linde spokesmen stressed the point that methods of supply must be suited to requirements. If high-capacity plants are built at locations where the demand varies widely, they said, there must be adequate storage facilities and distribution methods to carry off the excess.

In commercial operation, Linde said, variability of demand from individual consumers balances off when one large plant is used as a central source. Development of super insulations has made it possible to ship LOX great distances by rail or truck, according to Linde. This makes it possible to profit from the savings inherent in operating a very large plant.

Air Products said the five installations make 85% of the Air Force's total consumption. The installations' daily capacities are 412.5 tons at Santa Susana, 330 at Nimbus and 165 at the three other locations. Besides these, Air Products has built or is building a classified number of 27.5-ton plants at operational ICBM bases, such as Vandenberg AFB. The Air Products statement was approved by the Air Force.

TRUCKS DELIVER LOX to missile being readied for launching at Cape Canaveral. Air Force has nearby plant with 165-ton daily capacity. Loaded ICBM swallows more than 55 tons of the cryogenic.

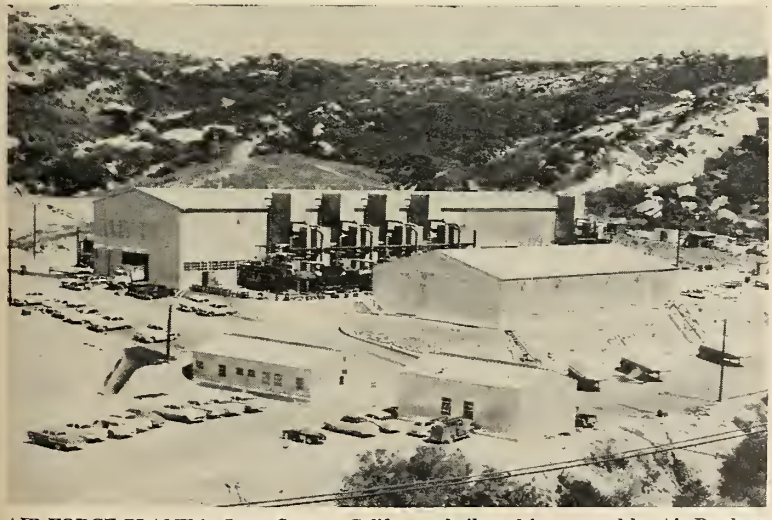
• **Air Force buying**—In addition to its in-house production, the Air Force fills some of its needs through commercial procurement. Some of the latter supplies requirements where there are no Air Force plants. Some of it also supplements production of Air Force plants at times of peak demand.

The Air Force procures oxygen through Olmsted AFB, Middletown, Pa., under annual call contracts. Under the contracts, the Air Force does not guarantee purchase of any specific amount, but the purchaser guarantees his selling price. The call contracts for 1959—designated IFB 36-600-59-128—authorized about 95,000 tons production.

The Air Force's Ballistic Missile Division declined to say how much actually was consumed. However, industry sources indicated the figure was about 83,000 tons, about 87.5% of that authorized.

The bid awards, based on the original estimates, totaled $9,674,450. The largest single award of $7,865,000 went to Linde. If actual consumption on the Linde contract followed the reported 87.5% average, its 1959 Air Force business totaled about $6,900,000.

Other awards went to Air Reduction Co. Pacific Division, San Francisco; Victor Equipment Co., San Francisco; Burdett Oxygen Co., Norristown, Pa.; Liquid Carbonic Division, General Dynamics Corp., Chicago; Industrial Air Products, Portland, Ore.; Pacific Oxygen Co., Oakland, Calif.; National Cylinder Gas Division, Chemetron



AIR FORCE PLANT in Santa Susana, Calif., was built and is operated by Air Products Inc. to serve missile/space needs. Most of the plant's 330-ton daily capacity is used by nearby Rocketdyne plant.

Corp., Chicago; Air Reduction Sales Co., New York; Dye Oxygen Co., Phoenix, Ariz.; and Sierra Oxygen Co., Reno, Nev.

• **Army arrangements**—The Army, like the Air Force, uses small in-house plants at operational bases. For instance, each *Redstone* battalion is assigned a mobile 5-ton LOX plant manned by Engineers. There are 32 such plants in all. Also, the Army at one time had 11 mobile 20-ton plants and one 50-ton plant. All were developed by the Army Engineers and Air Products and built by Air Products. The 50-ton plant and three of the 20-ton plants have been turned over to the Air Force. Five are in storage and the remaining three at the Engineers' school and research and development center at Ft. Belvoir, Va.

For missile R&D at Redstone Arsenal, the Army has been obtaining its LOX through commercial channels. Linde is a major supplier, but several other companies also have been active. The Army refuses to list its suppliers —their names are classified confidential.

Procurement at Redstone has risen steadily since 1956, although the Army says its needs are decreasing, with most development work completed on its liquid-fueled missiles. *Saturn*, the only major project at Redstone that will use large quantities of LOX, will be transferred to NASA next month.

For the fiscal years 1957-59 and thus far in the current fiscal year, Redstone has consumed 1,550,760,000 cu. ft. of high-purity oxygen, the equivalent of 64,000 tons. Since the Army reported by fiscal years, the exact 1959 total is not available. However, it appears to have been about 39,000 tons.

No estimate is available of the Army's in-house LOX production at mobile plants operated by the Engineers. To arrive at an overall estimate, M/R used a figure of 5000 tons.

• **Fixing the total**—The Air Force did not say how much of the four-year, million-ton total at its five major plants was produced in 1959. However, it must have been about half, since four of the five went on-stream in 1957 and industry sources have said the consumption curve rose steadily. This estimate agrees with the Air Force-approved statement that the plants produced 85% of its requirements, and the industry report that 83,000 tons were procured commercially.

Applying the 10:1 oxygen-nitrogen ratio to 1959 production, the five-plant total would be 455,000 tons of oxygen and 45,000 of nitrogen. Total Air Force 1959 consumption would be 545,000 tons, of which 83,000 tons were procured commercially and 7000 tons at smaller Air Force installations.

This leads to an overall estimate of 589,000 tons consumed by the military for missile/space use, of which 467,000 tons were produced in-house. Recapitulating:

Source	1959 Production (tons)
5 Air Force Plants	455,000
Other Air Force	7,000
Army in-house	5,000
Total military in-house	467,000
Air Force procured	83,000
Army procured	39,000
Total military procured	122,000
Military total	589,000

The military in-house total of 467,000 tons is equivalent to 11.3 billion cubic feet. Adding commercial shipments of 43.5 billion cubic feet and an

LOX-Nitrogen Plants

Location	Capacity (tons per day)	Owner	Operator	Principal Users
Santa Susana, Calif.	412.5	USAF	Air Products Inc.	Rocketdyne
Nimbus, Calif.	330	USAF	Air Products Inc.	Aerojet-General
Pittsburg, Calif.	300	Linde Co.	Linde Co.	Rocket Companies
Denver	165	USAF	Air Products Inc.	Martin Co.
Patrick AF8, Fla.	165	USAF	Air Products Inc.	Cape Canaveral
Edwards AF8, Calif.	165	USAF	Air Products Inc.	Air Force, NASA
Plants under construction (due to be completed in mid-1960)				
Huntsville, Ala.	135	Linde Co.	Linde Co.	Redstone Arsenal and southern region
Neosho, Mo.	135	Linde Co.	Linde Co.	Rocketdyne and Ft. Crowder
Major commercial plants				
East Chicago	900	Linde Co.	Linde Co.	Steel, chemical industries
Ashtabula, Ohio	900	Linde Co.	Linde Co.	Steel, chemical industries
Fontana, Calif.	800	Linde Co.	Linde Co.	Steel, chemical industries
Kitanny, Pa.	700	Linde Co.	Linde Co.	Steel, chemical industries
Essington, Pa.	500	Linde Co.	Linde Co.	Steel, chemical industries
Butler, Pa.	375	Air Reduction Co.	Air Reduction Co.	Steel, chemical industries
Riverton, N.J.	275	Air Reduction Co.	Air Reduction Co.	Steel, chemical industries

Other companies supplying missile/space LOX

Company	Location	Production Capacity (Tons/day)	Estimated 1959 Air Force Sales*
Air Reduction, Pacific Co.	San Francisco	Unavailable	$646,150
Victor Equipment Co.	San Francisco	(4 plants)	$358,500
Burdett Oxygen Co.	Norristown, Pa.	5	$218,500
Liquid Carbonic Div. General Dynamic Corp.	Chicago	Unavailable	$192,300
Industrial Air Products	Portland, Ore.	27.5	$ 86,000
Pacific Ogygen Co.	Oakland, Calif	Unavailable	$ 80,000
National Cylinder Gas Div. Chemetron Corp.	Chicago	(48 plants)	$ 78,000
Air Reduction Co. Sales Co.	New York	(62 plants)	$ 50,000
Dye Oxygen Co.	Phoenix, Ariz.	Unavailable	$ 50,000
Sierra Oxygen Co.	Reno, Nev.	3	$ 50,000
Big Three Welding Supply Co.	Ft. Worth, Tex.	25	

estimated 10 billion cubic feet produced in captive commercial plants brings a grand total of 64.8 billion cubic feet for the nation's total high-purity oxygen production.

Of this, the military total of 589,000 tons represents 14.2 billion cubic feet—or about 22% of the total. If the captive plant production is less than 10 billion cubic feet, as Commerce Department officials insist, then the total is lower and the military share is even higher.

Although total missile/space use of LOX is expected to rise, the share of the overall total may remain static. For the steel and chemical industries also expect to continue the increase in their oxygen consumption in the next few years.

In rockets, LOX-based systems are strong because of the reliability that has developed from experience and because their impulse is close to the highest possible for chemical systems. Hydrogen and fluorine provide the highest impulse and thus—at least theoretically—the best combination. But liquid fluorine costs $5 a pound and produces extremely corrosive products. LOX and hydrogen develop an impulse just 5% less than hydrogen-fluorine and the product is harmless H_2O.

But the biggest argument for oxygen is cost—less than two cents a pound if enough is consumed. And the raw material is abundant everywhere and free—free as the air we breathe.

Another Proposal

Lockheed Outlines Big Solid Motor

Large solid boosters are definitely in the running for space missions from the standpoint of feasibility and technological development.

Giulio Panelli of Lockheed Aircraft Corp's New Design Section told the Institute of Aeronautical Sciences in New York that the big solids compare favorably with similar liquid engines on a system performance basis.

Several vehicles were outlined in the study performed under contract from the National Aeronautics and Space Administration. The Lockheed scientist mentioned specifically:

• A one-million-pound gross weight vehicle designed to place a 40,000-lb. payload in a 300-nautical mile orbit. Twice the length of the *Atlas*, the three-stage bird would have a first stage containing four solid motors, each holding 110,000 lbs. of propellant, generating a total thrust of 3.5 million lbs. The second stage would cluster four LOX-RP-1 188,000 lb. thrust engines. The third stage would be composed of two LOX-liquid hydrogen engines, each having 150,000 lbs. thrust.

• A five-million-pound gross weight vehicle capable of hauling 214,000 lbs. of payload into a 300-nautical mile orbit. The solid first stage would consist of seven motors developing a thrust level of 17.5 million lbs. and carrying 2,191,000 lbs. of fuel. The second stage—containing two LOX, RP-1 engines of 1.5 million lbs. thrust each—and the final stage using ten 150,000-lb.-thrust oxygen-hydrogen engines would complete the vehicle.

• Another 5 million-lb. gross weight vehicle, differing slightly in the propellant weights in the second and third stages but including a fourth stage, could place 79,500 lbs. of payload in a 24-hour equatorial orbit 20,000 nautical miles above the earth.

Panelli said that initial thrust-to-gross-weight ratio was given a great deal of consideration because of its effect on the payload.

Considering the 300-mile orbital missions, the scientist said that payload increases rapidly with an increase in the ratio from about 1.25 to 2.5. The payload increases at a much lower rate up to about a thrust-to-weight ratio of 4, and then begins to decrease.

Panelli showed that maximum payload is obtained when booster weight is about 35% of gross weight. Reduction in payload is gradual until the booster reaches about 65% of total weight; beyond this point, the drop is rapid. The Lockheed designer pointed out that the payload reaches zero before the vehicle is all booster or single stage.

The liquid propellant payload capacities were not calculated as part of the study but were derived from published reports. These sources indicate that in a 300-mile orbital mission the *Saturn* has a capacity from 26,000 to 34,000 lbs. payload in the million-lb. weight category, and the *Nova* has a payload of about 150,000 lbs. in the 5-million-lbs. weight slot, for the same mission.

• **$$ considerations**—Cost comparisons were based on the fact that the cost of a liquid engine is directly proportional to the thrust level while the cost of a solid motor is based on design sophistication and propellant weight. The payload capability of solid boosters is improved because of the increased thrust-to-weight ratio and the consequent gravity loss reduction. Although this effect is the same regardless of the type of booster, the increased thrust level in a solid rocket is not as expensive as that in a liquid rocket because of the cost relationships.

Panelli said that considerations in the mass ratio of missile stages and their resultant effect on payload were also included in the study. He showed that the reduction in payload is small over a large range of mass ratios. This in effect permits changes in staging ratios, within limits, which do not have a great influence on the payload size.

Structural changes of the same magnitudes would have a different effect depending on which stage of the vehicle was involved. These range from least in the first to most in the last—as might be expected. Panelli concluded by remarking that the typical designs described in the solid boosters could be produced by any of the U.S. solid propellant firms within a few years. He added that none of the proposed concepts were to be taken as complete, since cost and logistics would have to be considered along with performance.

Rocketdyne Division of North American Aviation last week disclosed some details on the physical properties of its liquid polybutadiene-based solid propellants.

Rocketdyne has said that polybutadiene-based propellants have physical properties that make them ideal for use in a very large motor, such as the two-megaton space booster under consideration by the Air Force. The company says they have less resistance to tear and less tendency to slump than present-day polyurethane-based propellants.

The data has been confirmed in motor firings up to 10 in. in diameter, Rocketdyne said. See chart below.

Rocketdyne Solid Properties

Rate of Strain (in/in/min)	Temp. (F)	Elongation (%)	Tensile (psi)	Modulus (psi)
0.77	—75	53	568	5900
0.77	170	52	97	350
0.77	75	63	135	510
15.	75	67	190	620
220.	75	69	250	1250

$28 Million in Construction At Cape

Funds going into new test facilities for Mace, Minuteman, Pershing, Centaur, Saturn and Azusa missile tracking network

When President Eisenhower toured the Missile Test Annex recently, he viewed a flurry of building which represented more than $28 million of the defense appropriation. And another $3½ million is going to miscellaneous projects at Patrick AFB and the down-range stations of the Atlantic Missile Range.

Most of the money being poured into the Cape is going to new missile programs. The Air Force *Minuteman* and *Mace*, the Army *Pershing*, the Air Force-NASA *Centaur* and the Army-NASA *Saturn* all are being tested there.

An additional project—to be operational in a few months—is the new Azusa Mark II, an improved missile tracking facility able to measure flight positions up to one-tenth foot at distances up to hundreds of miles down range from its Cape Canaveral site.

First of the four new missile launch facilities to be completed will be the $2,460,000 *Pershing* complex. Buildings in this area include a blockhouse with an eight-foot-thick roof, two launching pads with service towers, a missile installation and checkout building and a helicopter parking apron.

Flight tests of the advanced Air Force *Mace-B* have already been conducted at AFMTC, using conventional launching facilities. However, the 1200-mile-range air breather will get its own "pad"—two reinforced, concrete bomb-proof shelters early this spring.

Construction for the *Minuteman*, second generation Air Force ICBM has cost $6,605,000. In the complex are two igloo-type blockhouses, 50-ft. in diameter with four foot-thick walls. *Minuteman* boasts four launch pads, two ground-level and two silo-type. Completion of the entire area is expected later this year.

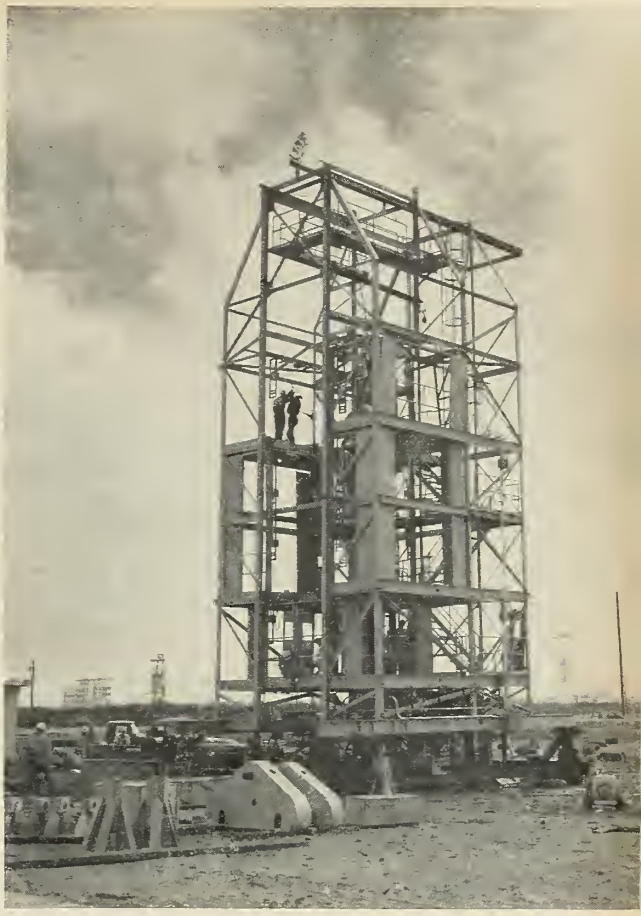
By mid-year a new facility is expected to be in operation. Named the "Space Systems Complex," the group has a *Titan*-type blockhouse, a launch pad and service tower similar to *Atlas* facilities, and a *Titan* and *Saturn*-type blockhouse. The $3,246,000 facility is expected to be used for *Centaur*.

Work on the *Saturn* group is not expected to be finished until early 1961. The Army-NASA project will have a blockhouse, a missile launch pad, a giant 28-story service tower and an umbilical tower.

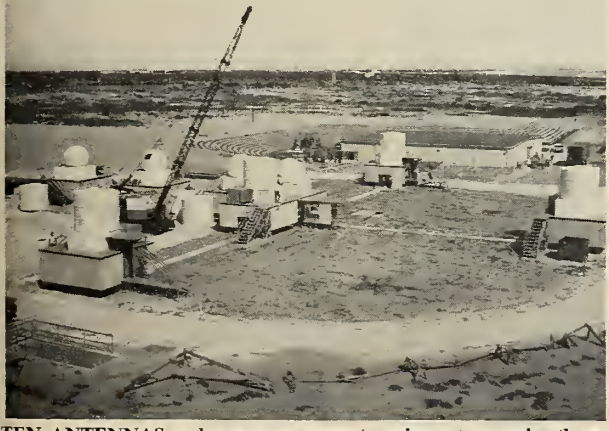
MINUTEMAN'S two concrete-shell blockhouses, left, will be covered with sandbags for extra protection. Assembly and fuel storage facilities are being built elsewhere on the Cape.

GRANDDADDY of them all, *Saturn* will have the largest service tower on the Cape—rising 305 feet off the ground. Contracts for blockhouse and other facilities total $10 million.

CAPE CANAVERAL MISSILE TEST ANNEX points of interest are: 1) Central Control, 2) Industrial Area, 3) Heavy Ballistic Launch Area, 4) ICBM Launch Area, 5) Original Cape Launch Area, 6) Heavy Ballistic Launch Area (Proposed), 7) IRBM Launch Area, 8) R&D Cruise Launch Area, (Proposed) 9) Training Cruise Launch Area (Proposed), 10) Troop Bivouac Area, 11) Harbor Facilities, 12) Liquid Oxygen Plant, 13) Transmitter Area, 14) Explosive (Fuel) Storage, 15) Receiver Area, 16) Skid Strip.



MISSILE SERVICE TOWERS are the skyline at Cape Canaveral. In the foreground is one of two *Pershing* facilities, while *Thor, Jupiter,* and *Redstone* dot the background.



TEN ANTENNAS and necessary support equipment comprise the new Azusa Mark II tracking system built for the Air Force by Convair. The system can detect flight positions of up to one-tenth foot.

HARD SITE LAUNCHER for AF *Mace* is one of two prototype operational models. The tubes at the rear of the launchers are flame deflectors.

Fatigue Life of Bolts Upped

The fatigue life of bolts can be increased from four to twelve times their present endurance through a new development in nuts by the Elastic Stop Nut Corp. of Union, N.J.

The new concept Double/Durability nuts, has been under study by North American, Lockheed's Missile and Space Division, Chance Vought and Rocketdyne for possible incorporation into existing missile and airframe designs and future vehicles.

Engineers at ESN found that the fatigue failure of a threaded connection usually occurs at the first fully engaged

ESN EQUA-STRESS thread form (right) shows redistribution of stresses when compared to standard nut (left). (A) is the wide base thread change, and (B) illustrates the bottom countersink.

thread of the bolt and seldom in the nut body because it is loaded in relatively pure compression. Although there is stress at all points of engagement of the nut and bolt threads, the greatest is on the first fully engaged thread above the nut base.

The new nut embodies two changes —flexible lower nut threads and a special, small-angle bottom countersink. The effect of these innovations is to redistribute the load over a greater portion of the nut, increasing the fatigue life of the bolt.

• **Reducing bases**—Flexibility is obtained by reducing the bases of each of the threads in the lower part of the nut. Then these threads deflect a greater amount, redistributing the load so that a smaller part of it is transmitted to the bolt by the lower nut threads. Since maximum pressure on a thread is carried near the pitch diameter and the new thread has a standard pitch diameter, the load is carried in the same radial location.

The special countersink increases the minor diameter of the lower nut threads. This truncation provides a gradual effective increase in pitch of the nut threads to accommodate the growth in pitch which occurs in the bolt threads.

In applying this to a full line of nuts, modifications must be determined individually for the specific thread size and related to the sizes, thread heights, hardness and external configurations.

In existing designs, the new bolt will increase reliability and reduce maintenance time—new designs can depend on smaller connections or fewer large ones, with resultant savings in space and weight.

Armour Friction Studies Include Single Crystals

The high temperature seal and bearing qualities of synthetic sapphires are being investigated by the Armour Research Foundation of the University of Illinois under an Air Force Air Research and Development Command contract.

Quartz, titanium dioxide, spinel and boron carbide are the other inorganic single crystal materials up for evaluation. The single crystal types were chosen because they present the best available surfaces for the friction studies which are the basis of the program.

A device which measures the frictional force encountered by the passage of a slider over the material to be tested at temperatures up to 4000°F was developed for the studies. Surface damage caused by friction and wear is observed in several ways, including optical and electron microscopy.

Under the direction of senior scientist Charles Riesz, the investigation will determine how speed, surface roughness, hardness, and crystal orientation influence the specific mechanism of friction and wear in single crystals of inorganic non-metallic materials.

Corning Makes Glass for *Mercury* Capsule Viewports

The first astronaut will do his sightseeing through four panes of polished, high-temperature glass.

The rectangular panels are being produced by Corning Glass for McDonnell Aircraft, builder of the *Mercury* capsule.

The viewports will consist of two outer panels of 96% silica glass separated by a heat-retarding air space from two inner panels of heat-resistant aluminosilicate glass. The window is designed to withstand re-entry temperatures and remain watertight in an ocean landing.

Observations taken by the pilot through the port will help in determining the vehicle's attitude and the optical quality of the glass will permit astronomical photographs.

New Resin May Be Used As Solid Propellant Binder

A new line of epoxy resins with a possible role as solid propellant binders has been announced by Food Machinery and Chemical Corp.

Basically epoxidized polyolefins, the resins are in many potentially reactive groups located internally and externally along the hydrocarbon chain. Designated "Oxiron," they are polyfunctional, exhibiting curing versatility through multiple epoxy and hydroxy groups—and through double bonds.

The resins are stable at elevated temperatures, retaining their electrical properties.

Beryllium Oxide Output Tripled in Plant Expansion

Production of beryllium oxide ceramic materials at National Beryllia Corp. will be tripled with completion of expanded facilities at the firm's Haskell, N.J., plant.

Conventional hot and cold pressing methods, new extrusion and slip-casting techniques and specially-equipped machine tools are part of the expansion program.

Basic and applied research facilities were also increased. C. E. Nelson, President, said that beryllium oxide fibers and foam, metal-ceramic combinations and methods for production of larger beryllia shapes than currently possible, are projects being investigated in the laboratories.

The machine shop is equipped to avoid the toxic dust problems associated with the working of beryllium oxides, and parts can be formed to customer specifications before delivery.

Beryllium Welding Studied by British Agency

Various methods of joining crack-sensitive beryllium have been under study by the Beryllium Section of the British Atomic Weapons Research Establishment, Aldermaston, Berkshire.

Conditions in the satisfactory production of fusion welds were determined although butt welding of beryllium sheets still presents problems.

European Missile Market Wide Open

But good products and selling know-how are must—U.S. companies show preference for Geneva sales offices, with Paris second

by Anthony Vandyk

GENEVA, SWITZERLAND—With Europe now enjoying a prosperity never before known and currency restrictions on their way out, prospects have never been so bright for the U.S. missile salesman with a good product and good selling know-how.

The European missile market is wide open. The few European missiles that have reached the production stage are relatively simple ones. There is increasing realization that Europe cannot afford to parallel the U.S. missile program and that the most logical course is either to buy U.S.-manufactured missiles or build them under license.

But how can you penetrate the market? Basically there are two ways: Set up your own office in Europe and have your sales force operate from there—or have your salesmen based at the head office in the United States. Although the jet age has made commuting across the Atlantic much easier than it used to be, more and more companies are showing a preference to have their own set-up in Europe.

(There is a third method of selling in Europe—to operate through a European agent; but few U.S. missile manufacturers have found this method satisfactory.)

• **Geneva HQ**—Geneva has been chosen as the location for the European offices of most U.S. aircraft and missile manufacturers. Among the companies located here are Boeing, Convair, Douglas, General Electric, Grumman, Lockheed, North American and RCA.

Situated almost in the center of Western Europe and endowed with good communications, Geneva also offers a favorable company tax situation, a stable currency and a working climate more like that of the U.S. than anything else in Europe. Geneva's main disadvantage at present is an acute housing shortage.

• **Paris for contacts**—Second choice as a European office location is Paris. Lockheed recently decided to make Paris its main European headquarters, although it will retain its Geneva office.

Other companies that have chosen Paris include Aerojet-General, Chance Vought, Hughes, Northrop and Republic Aviation. The main advantage of Paris is that the North Atlantic Treaty Organization (NATO) and the Supreme Headquarters Allied Powers in Europe (SHAPE) are located there.

Although life has become a little easier in Paris in recent years, there is still a shortage of office space and housing. Such factors as the old-fashioned telephone system, the lack of taxis at certain times of day, and the tendency of certain vital services to go on strike do not make life too easy for the American businessmen based in the French capital.

Just how important contacts with the headquarters of NATO and SHAPE are for the purpose of doing business in Europe is a moot point. Certainly, officials in NATO's Division of Production and Logistics are extremely well informed on all the weapons and production facilities of the West.

At SHAPE headquarters just outside Paris, briefings can be obtained on overall European military requirements. And at the NATO Maintenance Supply Services Agency (NAMSSA) at Boulogne/Billancourt in the suburbs of Paris, information can be obtained on what equipment is being purchased on a joint basis by the NATO nations. The NATO Advisory Group on Aeronautical Research and Development (AGARD) can also supply useful information.

• **Washington briefings**—Some of the information obtainable from NATO and SHAPE in Paris can also be obtained in Washington. In fact, before a company sends a salesman to Europe he should first visit Washington. Most Washington representatives are able to tell Europe-bound salesmen where to get background information. The military attachés in the embassies of the nations where the sales efforts is to be made are also key men to be seen. Some of the larger nations have military procurement missions in Washington, and these are sometimes more knowledgeable than the attachés.

Introductions to the U.S. attachés in the European countries to be visited can be arranged through the Pentagon, the Commerce Department and the State Department. In certain countries the salesman may find the U.S. Military Aid Advisory Groups (MAAG) a more fruitful source of information than the attachés, but contact should be made with the attaché.

The commercial staffs of U.S. embassies in Europe can often give useful background on foreign companies which might be interested in concluding license agreements. The Export Service of the Aerospace Industries Association in Washington can also be helpful.

• **Observing formalities**—Before leaving for Europe the salesman is advised to set up as many appointments as possible by correspondence. Getting in to see European officials without an appointment is extremely difficult; trying to contact them by phone is almost impossible.

If there is no opportunity to make the appointment until the salesman arrives on the spot, an embassy official should be asked to make an introductory phone call. He is more likely to find the European official "in" than is the salesman. However, embassy officials cannot be expected to do more than pave the way; once the salesman has been put in contact with the European he wants to meet he is obviously on his own.

In general, the European government official or military officer is on the formal side and does not respond favorably to being addressed on a first-name basis until the contact is really close. It is difficult to get to know these people very quickly; and the salesman must adjust his tempo to that of his potential customers.

He should not be surprised to find that his first invitation to take European officials out to a meal—or even to buy them a drink—will be courteously refused. Business has to be done in the office and premature offers of hospitality may be greeted with suspicion.

The same applies to give-aways, although after a short acquaintanceship

most European government officials—and particularly military officers—will be glad to accept a missile or an aircraft model "for my son." Dealing with European businessmen is a little easier. There is generally less formality, and more willingness to discuss things, in a restaurant than in an office.

• **On-the-spot selling**—Most experienced U.S. salesmen operating in Europe agree that while contacts with NATO and SHAPE headquarters in Paris may be valuable for background, the actual selling job has to be done in the country concerned. The military staffs in the capitals of the various countries still call the shots on national requirements while civilian officials usually hold the pursestrings.

A major factor in selling to the European nations is of course the U.S. "give-away" program. No European nation wants to buy something that it could get for free. And many would prefer to get an inferior article for free than pay for something better. The Pentagon can give the salesman the best briefing on what materiel is likely to be made available to European nations under the grant-aid program. And it should also be able to indicate whether this program is to involve the procurement of European missiles for the NATO nations.

Let's say it again: the European missile market is wide open. The prospects have never been so bright. All it takes is salesmanship.

British Satellite to Make 6 Ionospheric Experiments

by G. V. E. Thompson

LONDON—Work has started on the construction of British equipment to be carried in the first Anglo-American satellite. This will be launched in a U.S.-built *Scout* vehicle from a site on the East Coast of the U.S. towards the end of 1961.

The proposed orbit will carry the satellite over the British Isles and it will be visible as far north as Edinburgh. The altitude would vary between 200 and 600 miles and a lifetime of at least six months is expected.

NASA and a British National Committee on Space Research delegation discussed the project in Washington recently and agreed on a program. The first satellite will carry apparatus for six scientific experiments in the ionosphere. This part of the payload will weigh about 20 lb. and the rest of the satellite (telemetry, structure and solar power units) will be American-built and weigh around 100 lb.

• **University College experiments**—The head of the British Committee is Professor H. S. W. Massey, of University College, London. For several years he and his colleagues in the Physics Department have been studying ionized gases, and plan two experiments embodying the techniques they have developed.

The first will use a small sperical probe to measure the temperature of the electrons in the ionosphere. The probe will be mounted flush with the skin of the satellite and will be associated with electronic means for studying the current/voltage curve. This system is insensitive to changes in satellite potential and to photoelectric currents.

The second ionization study is intended to yield information about the variation in the nature of the positive ions with time of day, latitude and season. The ion energy spectrum is measured, and because the speed of the satellite is large in comparison with the mean random speed of the ions, their mass spectrum is easily obtained. For this experiment, another spherical probe is used, fitted with a 4-in. diam. screen charged to repel electrons.

Being spherical, the probe is insensitive to satellite orientation; it is also mounted on the spin axis of the satellite, so that it does not wander in and out of its wake.

Two other experiments are being contributed by Prof. Massey's group. The flux of Lyman-alpha radiation will be measured by an ionization chamber with a lithium fluoride window and filled with nitric oxide; soft X-rays will be recorded by proportional counters feeding an automatic analysis system.

• **Birmingham University studies**—The fifth instrument to be installed in the *Scout* satellite will measure the free electron population density in space and the electrostatic potential of the satellite vehicle relative to its space environment. Provided by the Electron Physics Department of the University of Birmingham, it consists of a subminiature electronics package which provides a 10 mc/s source frequency and a slowly varying bias voltage to two sensing electrodes, each a few square inches in area and a few inches apart. Transistors are used throughout and electron populations down to a few thousand per cubic centimetre can be measured, so that the instrument should prove suitable for use also in satellites with highly eccentric orbits and in orbits and in deep space probes.

• **Cosmic ray counter**—The other experiment to be made with the first Anglo-American satellite has been devised by a group at Imperial College, London, led by Dr. H. Elliot. It will count the nuclei of carbon and heavier elements arriving at the earth and thus yield information about cosmic radiation that is not confused by the protons of the Van Allen radiation belts.

As in the case of the other experiments, this equipment will be tested in rocket firings at Woomera before installation in the satellite. It will also be flown in aircraft and high-altitude balloons when the satellite is in orbit, to obtain complementary data.

• **Other *Scout* firings**—Two other Anglo-American satellites are scheduled at present. The second (in 1962) will make radio-astronomical and meteorological observations. The third is to be held in reserve, but will be launched in 1963 if all goes well.

The data collected from all radio stations will be sent to Britain for analysis, though some might be distributed elsewhere if found too much to handle. Some of the experiments are similar to those carried out by American and Russian scientists, but use of different techniques will make cross-checks possible.

Japanese to Purchase *Tartar* Missiles from U.S.

TOKYO—The Japanese Government is expected shortly to order 42 *Tartar* guided missiles from the United States, along with two launchers and a firing command device which will be installed on a new Japanese Maritime Self-Defense Force destroyer.

Construction work on the 2600-ton destroyer will be started in the near future.

Informed sources report that agreement on the *Tartar* purchase has been reached between the Japanese Defense Agency and the U.S. Defense Department. The U.S. Government reportedly has agreed to shoulder half of the expected $11,857,500 bill.

Russians Stall U.S. Bid for U.N. Talks on Space Uses

The Soviet Union again applied delaying tactics to a United States plea to begin United Nations committee talks on peaceful uses of outer space.

Arkady A. Sobolov, Soviet permanent delegate to the UN, informed the U.S. deputy representative that Russia

felt that the Committee's work should not begin until the latter part of March. On January 5, the United States called for a meeting in January, or at the latest early February. No explanation was offered for the Soviet delay in answering.

Another U.S. suggestion—to hold an international scientific conference for the exchange of outer space information in Geneva during the first two weeks of this September—apparently was not mentioned by Sobolov. U.S. officials had voiced hope that the UN Committee work would get underway as soon as possible, since considerable groundwork will be necessary for the proposed Geneva conference. The 1960 session of the United Nations begins Sept. 20.

British Society Plans Two Symposia This Year

LONDON—The British Interplanetary Society is planning a symposium on rocket and satellite instrumentation to be held on Sept. 1, to be followed by a space navigation symposium towards the end of the year, a society officer recently disclosed.

In April of 1961, the Society plans to hold an European Programme on Space Technology, with a week or 10-day exhibition on astronautics.

New films on Soviet space research were shown at the Feb. 10 meeting of the Society by Professor Masevich, vice president of the Astronomical Council of the USSR Academy of Sciences, and professor of Astrophysics at Moscow University.

French Astronautics Group Adds Members, Activities

by an M/R Correspondent

PARIS—The French Society of Astronautics is undertaking a study of a circumlunar trajectory for a three-man space ship, it was disclosed at the Annual General Assembly here recently.

The navigation committee of the Society, conducting the research, will work extensively with electronic computers.

Other standing committees of the Society are: propulsion, structural materials, space physics, aerothermodynamics, electronics, biology, and legal space matters.

Membership of the fast-growing group has jumped from 221 members in 1958 to 541 in 1959. It plans to take an increasingly large role in the International Astronautical Congress to be held in Stockholm this August.

The French Society also announced that it has obtained office and conference premises for a Paris headquarters of the IAF and its Academy.

Other work of the society includes operation of a French Center for Aero- and Astronautics Medicine, and assistance to young engineers. A series of 18 lectures and help in organizing laboratories is provided for young astronautics fans.

U.S., Japanese to Discuss Joint Space Research Work

TOKYO—Three Japanese scientists will visit the United States within the next few weeks to pave the way for future cooperation between the two countries in Japanese space development. The trio will be here at NASA's invitation.

Groundwork toward a cooperative arrangement was laid in 1959 when the director of the Japanese Science and Technology Agency proposed to NASA that the two countries cooperate in outer space research. Japanese Prime Minister Kishi put forward a similar request when he visited in January.

Secretary of State Christian Herter promised after the Prime Minister's visit that the U.S. would cooperate with Japan in some scientific and outer space projects aimed at gathering information on weather and other non-military problems.

Some Japanese scientists have complained, however, that negotiations conducted between the two countries up to now have indicated that the U.S. is not as "positively interested" in the joint research as Japan had originally expected.

Chemical-Contracting Group Formed by British Firms

LONDON—Formation of the first United Kingdom consortium of chemical producers and contracting firms has been announced. Its members are Constructors John Brown Ltd. (CJB), Boots Pure Drug Co. Ltd., Murgatroyd's Salt & Chemical Co. and Whiffen & Sons Ltd.

This latest combination follows the development during the last few years of consortia of British engineering firms to handle large nuclear energy projects, and the more recent amalgamation of missile/aircraft companies.

The consortium will handle overseas projects, and CJB have already quoted for supplying 10 plants to Russia. CJB will handle the plant construction, and the three chemical companies will provide the process know-how.

Whiffen's are the main producers of hydrazine and its derivatives in Britain.

Other chemical consortia are likely to follow. This type of grouping can compete on good terms with large foreign organizations, at the same time enabling its constituent firms to retain their individuality and avoiding the formation of monopolies or trusts.

Tokyo University Rocket Set For March Testing

TOKYO—The Tokyo University's Industrial Technology Institute is expected to launch its first *Kappa* rocket of 1960 during the latter part of March.

The two-stage *Kappa 8D* rocket test will be conducted on Michikawa Beach, Akita Prefecture, under the direction of a Tokyo University Professor.

The launching is designed to test only the first stage of the two-stage rocket. The 10.12-meter-long rocket, weighing 1.2 tons, is expected to reach an altitude of 25 kilometers before falling into the Japan Sea about 40 kilometers from the beach.

If the initial test proves successful, a new type of *Kappa* rocket capable of reaching an altitude of 100 kilometers will be tested.

Radio Telescope Built For CM-, MM-Wave Ranges

MOSCOW—The Physical Institute imeni P. N. Lebedev, USSR Academy of Sciences, has assembled a new radio telescope for radio-astronomical observations in the cm- and mm-wave ranges.

Designed by P. D. Kalachev and A. Ye. Salomonovich, the antenna of the telescope is a parabolic, sheet-metal reflector 22 mm in diameter with a focal length of 9.5 m. The reflector is rotated by servomotors according to a preset program; it can also be used for automatic tracking of a point in space. An optical telescope is incorporated for sighting and tracking purposes in clear weather.

The control of the radio telescope is centralized in a dispatcher cabin mounted directly on the rotating platform; the cabin also houses recorders and other equipment. The h-f units of the receivers, however, are mounted close to the focus of the paraboloid. Experimental observations carried out since May, 1959, reportedly show that the precision with which the telescope is manufactured meets design requirements for a directional pattern (on a 3.2 cm wavelength) of about six angular minutes at the half-power points. Preliminary evaluation of directional properties on an 8mm wavelength showed a pattern of no more than two angular minutes. *(Radio-teckhnika i elektronika,* No. 12, 1959, p.p. 2-92,-2093.)

'Smallest' Transmission Unit Produced

The world's smallest transmission unit—only one-half inch in diameter—has been designed and produced by Bowmar Instrument Corporation.

Developed to meet the minimum space-weight requirements of electromechanical systems in satellites two or three years hence, the tiny "size five" gearhead and speed reducer unit weighs only a few grams and measures ¾ in. in length, the company said.

Bowmar officials added that the unit, designed to increase or decrease the speed of servo-motors, is only two-thirds the size of the "size eight" unit, formerly the tiniest in this field of precision miniature parts. It is capable of producing step-up or step-down ratios of from 10:1 to 2025:1, they said.

Circle No. 225 on Subscriber Service Card

Hypersonic Nozzle

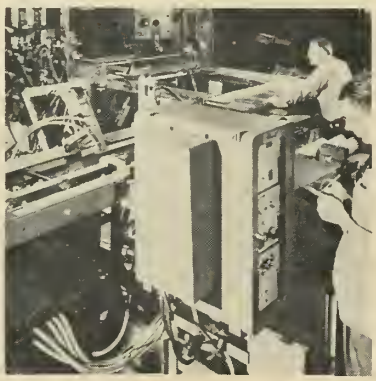
A hypersonic nozzle developed and manufactured by the Electronics Division of the Gorham Manufacturing Company has been credited with a vital role in achieving wind tunnel velocities of more than Mach 7 (5300 mph) in the wind tunnel of the Naval Supersonic Laboratory at the Massachusetts Institute of Technology. These hypersonic speeds, which double the velocities previously achieved in the tunnel, were made possible by placing the Gorham nozzle, which looks something like a giant cigar holder, into an existing lower-speed supersonic tunnel.

Circle No. 226 on Subscriber Service Card.

Electronic Welding Control

An electronic spotwelding control, known as the "Monautronic V-2 Feedback Spotwelding Control," that utilizes digital and analog computer elements, is now being manufactured on a production basis by The Budd Company.

Employing the feedback principle, the Monautronic V-2 unit produces quality welds regardless of actual in-process variables that may produce poor welds even with the best conventional controls.



Among the types of weld variables compensated for by the new Budd control are: line voltage fluctuations, changes in amount of applied electrode force, electrode wear, variations in surface finish, fitup, thickness or hardness of material; variations in amount of ferrous material in secondary circuit, contamination of metal surfaces, variations in horn and electrode lengths causing reactance changes, and proximity of other welds.

Circle No. 227 on Subscriber Service Card.

Adhesive System Bonds 'Non-Bondable' Teflon

A new adhesive system has been developed for bonding "non-bondable" Teflon to itself and to other materials.

Designated PA-746 by the manufacturer, Plastic Associates, the new adhesive system is supplied in kit form for both laboratory and production-line applications. Each kit includes a treating agent which prepares the Teflon surface, plus a two-part bonding agent that cures in a few hours to form a high-strength adhesive joint.

Circle No. 228 on Subscriber Service Card.

Silver Zinc Battery

A new, ultra-compact, automatically activated silver-zinc battery provides one ampere-hour of 28-volt current for missiles where reliable auxiliary power and space requirements are critical.

The Cook Battery's Model P63A weighs 4.2 pounds and is only 2.75″ x 5.5″ x 5″ in size. The battery contains 19 cells, which are of a special foil plate construction to reduce anode gassing and to provide maximum reliability and freedom from short circuits.

The battery provides 6 ampere current with a maximum current of 15 amperes. Discharge time is 10 minutes.

Circle No. 229 on Subscriber Service Card.

Curing Agent Aids RTV Silicone Rubber

The preparation of RTV (room temperature vulcanizing) silicone rubber is now improved and simplified with introduction of three new paste-type curing agents by General Electric's Silicone Products Department.

RTV liquid silicone rubber, used in sealing, potting and encapsulating applications, cures at room temperature after the addition of a curing agent.

These new paste curing agents,

dentified as RTV-992, -993, and -994, implify and improve the processing of RTV compounds in several ways. By iluting the liquid curing agent into paste, a greater quantity is required o effect a cure. As a result, it is much asier to accurately weigh and measure he catalyst.

Circle No. 230 on Subscriber Service Card.

Midget Bead Thermistor

A newly developed midget bead hermistor, used in electronics equipment for measuring temperature on he inside and outside surfaces of the *Polaris* and *Atlas* missiles, is so small hat it easily passes through the eye of n ordinary needle.

The bead thermistor is .010 in. in liameter and is mounted on a wire 001 in. in diameter. One pound of hese tiny instruments, manufactured by Gulton Industries, Inc., would have a value of $1,000,000.

Made of manganese nickel oxide, he thermistors can be used inside a ypodermic needle to measure blood

emperature. They are also used in radio frequency power measurements n the microwave field and in the measurement of low gas pressures. They can measure temperatures ranging from —76°F to 572°F.

The tiny devices must be packaged in three separate containers, with careful instructions on each container explaining proper handling procedures. Unless utmost care is exercised, the thermistor could easily be lost before it is used.

High-powered microscopes must be used in constructing the bead thermistors, which are almost invisible to the naked eye.

Circle No. 231 on Subscriber Service Card.

Exploding Bridgewire

An Exploding Bridgewire System (EBW) offers a new concept for safety and reliability in missile ordnance systems. The new EBW System performs rocket motor initiation, missile stage separation, thrust termination, missile destruct upon command and other ordnance functions. A wide range of configurations make the EBW System a direct replacement for conventional detonation systems and provide unequalled safety and reliability along with weight and space savings in multi-stage vehicles.

The EBW System reduces the total weight and design complexity normally required in missile systems by eliminating the need for elaborate electromechanical safing mechanisms.

Circle No. 232 on Subscriber Service Card.

Precision Arc Welder

A new shielded-arc welder designed for precision welding applications is now available from the Vacuum Tube Products division of Hughes Aircraft Company.

The welder, designated the VTW-14, may be used with any of the inert-gas, shielded-arc welding heads now available. It can be used either manually or in automatic machines to precision weld thin metal parts such as metal bellows, stainless steel tubing, electron tube components, or instrument parts. The welder will handle both ferrous and non-ferrous alloys from approximately .001 to .025 inches in thickness and is designed to operate on a continuous production-line basis, Sutherland said.

Circle No. 233 on Subscriber Service Card.

New Molykote Lubricant

A new molybdenum disulfide lubricant, Molykote M-55-Plus, for extreme pressure applications—on drills, taps, cold metal forming dies, punches, etc.—is announced by The Alpha-Molykote Corporation. It supersedes M-55, the 5% EP dispersion in medium oil, and outperforms its predecessor by 116% in welding-load tests and 71% in wear resistance tests.

Circle No. 234 on Subscriber Service Card.

28 Channel Recorder

A magnetic tape loop recorder-reproducer capable of handling up to 28 channels in receiving and recording analog computer data has been developed by Telectro Industries Corp.

In describing the versatile unit, Stanley Rosenberg, board chairman, said that it is fully automatic and reproduces data at speeds from 1 in./sec. to 60 in./sec., with speeds controlled by one knob on the front panel, thus eliminating the need for belt or pulley changes.

Little or no maintenance is required for the precision recording heads which are of long-wearing, self-cleaning con-

struction. They do not require demagnetization after prolonged use, and head gaps are aligned to within 100 micro-inches gap scatter and ± one min. of correct azimuth.

The tape loop runs vertically on the tape transport and on a specially-designed series of rollers and positioning guides to assure correct alignment at all times. Loops can be of any length from 2 to 75 ft., and arrangements can be made to accommodate other lengths. Standard units are available for tapes ¼, ½ and 1 in. wide.

Circle No. 235 on Subscriber Service Card.

Corrosion Measurer

A corrosion measurement probe which checks electrical resistance has been produced by Thompson Ramo Wooldridge Inc. The probe will be manufactured and marketed by the Crest Instrument Division of TRW's subsidiary, Magna Products Inc.

Main use of the new probe will be in measuring hard-to-detect liquid and gaseous contaminants. It can detect the slightest change in humidity, ozone concentration, water content in a non-aqueous liquid, or other environmental conditions which have a tendency to attack metal.

The essential element of the probe is a vacuum-deposited film of metal, 2 to 50 millionths of an inch thick. The metal varies with the application, but usually is one which is readily attacked by the compound being measured. Since the instrument connected to the probe can detect as little as five *billionths* of an inch of metal loss, the concentration of the corrosive compound can be quickly detected even though it is extremely small. By "sensitizing" the metal surface beforehand with a chemical treatment, the progress of corrosion can be detected literally atom by atom.

Circle No. 236 on Subscriber Service Card.

Viton-to-Metal Gaskets

Stillman Rubber Company has announced acceptance by the aircraft/missile industry of its new Still-Seal Gaskets for sealing hot fluids.

The gasket design incorporates bonding of duPont Viton to carefully engineered metal gaskets to achieve absolute sealing of hot fluids in the fuel, air and liquid systems of aircraft and missiles. Because of the many shortcomings of most rubber compounds in the presence of hot hydrocarbons and other materials, it has long been a design problem to accomplish a positive seal in hot fluid systems. It was quickly apparent that Viton would resist the deteriorating ef-

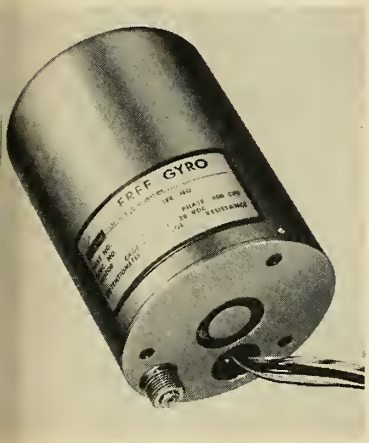
ects of these hard-to-handle hot fluids f it could be combined with a metal gasket which would hold the Viton eal in place under a wide range of pressures and temperatures.

Circle No. 237 on Subscriber Service Card.

Miniature Free Gyro

Giannini Controls Corp. has developed a two-axis free gyro which measures 4in. x 2.75in. dia. and weighs ess than 2½ lbs.

Equipped with a synchro-type pick-off on the outer gimbal, the 3417 Gyro



is ideal for missile guidance where a small yet reliable instrument is required. The rugged unit will withstand 40 g acceleration and shock, and will operate over a temperature range of −54°C to 71°C.

Circle No. 238 on Subscriber Service Card.

Telemetry Signal Simulator

Telemetrics, Inc. has produced a telemetry electronic signal simulator, Model ESS-200, which simulates an accurate PAM pulse train for use in accurate calibration and checkout of telemetry ground stations.

The ESS-200 provides pulse and frame rates conforming to IRIG standards, and other rates between 6 pps and 3600 pps. Negative and positive variable output signals are available with provisions for introducing missing pulses. Linearity and stability are within 0.2%. The noise and crosstalk are less than 0.1%. The ESS-200 is only 5.25 in. high and fits a standard 19-in. relay rack.

Circle No. 239 on Subscriber Service Card.

Dust-Free Cabinet

Specialaire, a dust-free illuminated work chamber with double filtration for maximum air cleanliness, is now available for standard work benches. The self-contained cabinet was designed to provide high dust arrestance for assembly, research and test of ball bearings, optical components and other precision instruments in both cleaned and non-cleaned areas.

Rejects due to dust contamination are eliminated by use of the new portable cabinet, whose continuous flow of filtered air prevents fine dust particles from entering the work area. The cleaned air passing out of the cabinet acts as a shield against lint, pollen, dust or dust-borne bacteria. The self-charging electrostatic filtration has an arrestance value of 95% on dust particles ranging from .08 to 80 microns in diameter.

Circle No. 240 on Subscriber Service Card.

Anti-Weld Grease

Lehigh Chemical Company is marketing a synthetic anti-seize compound for extreme high-temperature applications.

Called Anderol L-751, it is a mixture of a thermally stable silicone oil with a solid-type lubricant blended to the consistency of a medium soft grease. Its excellent thermal stability and anti-weld properties meet requirements for high-temperature ranges of 400°F. to 600°F.

Anderol L-751 is available in 1-lb. and 5-lb. cans, 14-oz. cartridges and 35 lb., 100-lb., and 400-lb. drums.

Circle No. 241 on Subscriber Service Card.

New Switch Design

The Beam-X, a new decimal electronic switch, is expected to effect a major change in basic electronic design logic from binary to decimal systems, according to Burroughs Corporation's Electronic Tube Division. The Beam-X Switch uses small rod magnets within a vacuum to control the position of an electron beam to any one of ten output positions.

The result is a decimal switch so

reduced in size, weight, cost and power requirements as to outperform all existing vacuum, magnetic, and solid-state devices in multiposition switching, counting, distributing, multiplexing, and allied operations. In a typical ten-position switching application, the new Beam-X decimal switch eliminates the 90 transistors, diodes, and resistors which must be used with binary logic to achieve the same results.

Circle No. 242 on Subscriber Service Card.

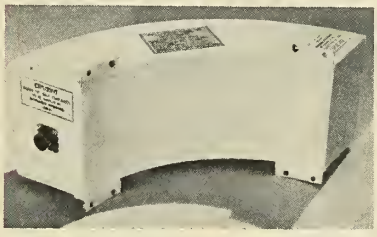
Low-Density Fillers

A new resin-compatible, low-density filler, called Globe-O-Sil, is offered by Hastings Plastics, Inc.

Globe-O-Sil is described as a hollow sphere of silicone dioxide whose outstanding features include a low density of four pounds per cubic foot, 2300°F melting point, good floatability, white color, three hundred to six hundred micron size, and low cost.

Circle No. 243 on Subscriber Service Card.

Contour Batteries



A "configured" silver-zinc primary battery has been designed for missile APU systems by Cook Batteries, a subsidiary of Telecomputing Corp. The Model P58A is an automatically activated 20-cell unit shaped to an 88° arc. Battery size is 11 x 5 in. It weighs only 13 lbs.

The battery has a capacity of 7 ampere-hours, and produces 14 amperes at 28 volts. Maximum current is 50 amps. Discharge time is 30 minutes at 14 amperes.

Circle No. 244 on Subscriber Service Card.

Quality Etched Surfaces

High-quality etched surfaces can be prepared in a matter of minutes by inexperienced personnel using Nuclear Materials and Equipment Corp's Cathodic Vacuum Etcher, Model 4CVE.

Samples mounted by conventional techniques may be analyzed and various types and degrees of etching can be obtained, from very light to very deep, through proper selection of operating conditions.

Model 4CVR, a remote version of the 4CVE, is designed particularly for use with irradiated materials.

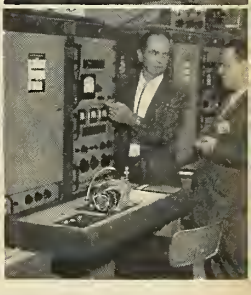
Circle No. 245 on Subscriber Service Card.


Motorola
VISITOR

The sophisticated and complex programs I read about in Missiles and Rockets magazine provide stimulus and pressure for laboratories such as ours to bring about the early availability of microelectronics modules . . . an approach which holds great promise for a new order of reliability in the face of increasing electronic equipment complexity," says James R. Black (left), Manager of Microelectronics Laboratory of the Solid State Electronics Department, Motorola Military Electronics Division. In the photograph to the right, Mr. Black shows Don Perry, of Missiles and Rockets magazine, examples of thin-film capacitors and resistors which are prototypes of planned microelectronics production units. Special thin-film deposition techniques at Motorola have yielded advanced devices of this kind with unusually high operating characteristics and uniformity.

Motorola's mesa transistors operating area can be covered by the diameter of a human hair . . . or three of them would only take up the space of the period at the end of this sentence. C. Harry Knowles (left), shows Don Perry of M/R the operational diagrams of two germanium mesa transistors — one a UHF amplifier device, and the other a high frequency switch whose switching speed has been timed at less than 5 millimicroseconds.

"Engineering administration involves such a heavy load today that I must sharply restrict my outside reading. I find the weekly issues of Missiles and Rockets a very valuable source of information on current space events," says Dr. Robert E. Samuelson (left), Assistant General Manager. Dr. Samuelson discusses operation PATE — Programmed Automatic Test Equipment — with Don Perry of M/R. Motorola's PATE performs the highly involved, complex adjustments and tests in the Bomarc missile link servo command system that will cut test time as much as 80%. PATE also completely eliminates human error in Bomarc analysis and computational tests.



WHO READS MISSILES AND ROCKETS?

Well, for instance . . .

TOP ENGINEERS AT MOTOROLA

"Missiles and Rockets is one of the very few publications that finds its way into my brief case for after-hours reading," says Joseph A. Chambers (left), Vice President and General Manager, Motorola's Western Electronics Center. Here Mr. Chambers shows Don Perry, Managing Editor of Missiles and Rockets magazine, the finer points of Motorola's Command Receiver developed for the Army Ballistic Missile Agency for use in deep space probe vehicles and earth-orbit satellites.

Motorola's highly experienced Solid State Electronics Department, in close cooperation with the Semiconductor Products Division, is advancing the state of the art on several fronts, with heavy emphasis on microelectronics.

Communications, radar, guidance, navigation and surveillance systems, telemetry and data processing are the main interests of Motorola's Military Electronics Division.

At Motorola, the policy is to develop and maintain a diversified interest in research and development in all areas of advanced electronics. Motorola's Solid State Department exemplifies this flexibility within the Military Electronics Division.

TELL YOUR PRODUCT OR CAPABILITY STORY TO 29,000 MISSILE TECHNICIANS . . . PAID SUBSCRIBERS . . . THROUGH THE PAGES OF MISSILES AND ROCKETS MAGAZINE—THE TECHNICAL/NEWS WEEKLY OF THE MISSILE/SPACE MARKET.

M/R

missiles and rockets

AN AMERICAN AVIATION PUBLICATION

1001 VERMONT AVENUE, N. W., WASHINGTON 5, D. C.

Astronauts Will Earn Their Way

by an M/R Correspondent

Few people remain who believe that manned flight into the cosmos will be a joyride. With this in mind, many influential scientists have queried the role of man in space, and suggested that modern technological instruments can do more, cheaper and quicker.

The argument would seem to be convincing, backed up as it is by vast amounts of data relayed from space by U.S. and Russian satellites and space probes—especially the excellent and unconfused photographs of the hidden side of the moon by *Lunik III*. In contrast, statements about the flexibility of the human and his ability to do the work of several machines appear vague and inconclusive.

Nonetheless, man-in-space has a role that goes beyond the vanity of *Homo sapiens*—a job in which the astronaut can justify his voyage in simple terms of feasibility and the payload. The astronaut can more than establish his claim to priority because of the many intangibles to which he may prove much more adaptable than any collection of machines.

• **Sun-period 126?**—The price of conquering space will not be small, whether it's done with instrumented probes or manned vehicles. At first glance some possible endeavors look hardly worth the effort.

One example is the sun-period space laboratory, in which a spaceship orbits as a satellite of the sun at a speed equal to the angular rotation of some latitude of the non-uniformly spinning solar surface. From this vantage point, a surface phenomenon such as a sun-spot could be studied continuously over a long period.

But, apart from the great engineering problems it poses in the form of long-term attitude control delayed-thrust restarting, communications and heat protection while orbiting as close as 15 million miles to the sun, the injection of the stationary solarium laboratory into orbit demands enormous velocity—of the order of 130,000 feet per second. A rocket such as the 250-ft.-tall, six-million-pounds-thrust *Nova* might be able to put a 10-lb. payload into such an orbit, using liquid hydrogen to fuel the earth take-off stages, and a storable propellant for the final transfer impulse. For the station to survive a day, half of its weight in orbit would have to be used for heat protection, since the platform would receive as much radiant heat in two weeks as a similar body at an earth distance would receive in a year. And there would still be the need to communicate with the earth—nearly a hundred million miles away.

Nevertheless, it is conceivable that an experiment into solar processes from such a stationary platform could bring control of nuclear fusion much closer to realization. Is it worth the effort?

Unfortunately, there is no simple answer. The only safe conclusion is that the mode of propulsion should be quite different from present-day rocket practice, perhaps taking advantage of the increased solar radiation flux to increase the ratio of payload to propulsion weights.

• **Manned rendezvous**—At this juncture it seems appropriate to mention the techniques of manned rendezvous, which, coupled with rocketry improved beyond the conventional chemical fuels, could destroy existing prejudices towards the stationary solarium and most other deep space missions.

Rendezvous operations have some appeal for construction or maintenance purposes; they would aid the exploitation of complex space systems such as the 24-hour orbit television relay by adding somewhat to the feasibility and potential lifetime of the system. As for manned space journeys, it is difficult to see how they could be accomplished without resorting to orbital assembly methods, even for flights to the moon.

A take-off thrust of 10 million pounds or more would be needed if a rocket were to fly directly to the moon, land and return to earth, assuming it relied on chemical propellants of a storable character and carried a crew of two or three astronauts. Such a rocket is not even in the planning stages today.

The use of rendezvousing does not ordinarily reduce the fuel required for a mission; on the contrary, it increases it—both on account of the need for rendezvous maneuvers and because of departure via a satellite orbit. The advantage offered by rendezvous is the feasibility it adds by reducing size and weight of the rocket vehicle. Practica secondary advantages are inherent im proved reliability, lower cost and cor densed time-scale.

• **'Astrotugging'**—When the variou available methods for rendezvousin spaceships are compared, it become clear that success can be mor readily assured if humans are use and that the use of an astronaut-har poon device, an extravagant version o which has been called an "astrotug, would save considerably in fuel ex penditure, compared to a purely me chanical procedure.

On a typical mission, the sequenc of rendezvous operations is compli cated and varied, and involves a num ber of human decisions, but the flexi bility of the human is such that a event that would have aborted the en tire launch in the automatic systen would be merely a source of delay i the astronaut-harpoon berthing opera tion.

Where primary assembly is in volved—and this should be just abov the earth's atmosphere, both to con serve fuel and to avoid radiation ex posure—the subassemblies would b launched into a temporary cluste orbit. Payloads whose orbits are grossl misplaced would be rejected and re placed, and—since they are primaril fuel tanks—could be used later o other missions.

The first decision would be th order in which the subassemblie should be intercepted; this is importan because it would determine the inpu parameters for the initial maneuve and largely influence the quantity o fuel that would be consumed in th succeeding rendezvous. The second de cision would be how much time t allot for the initial maneuver; this i likely to be the most expensive singl velocity outlay, and if the cluster ele ments were widely scattered, it migh be safest to transfer orbits slowly, con serving fuel.

Time, however, is at a premium o space voyages, and generally it is pref erable to avoid slow-transit, least-en ergy transfer and to exploit instea fixed transfer time or fixed fuel tra jectories. What to do in a particula circumstance is a tricky problem de manding skilled judgment on the par of the spaceship commander.

• **Harpooning**—When the first uster was approached, the astronaut- ırpoon would be launched. The shell- ce structure would be visually guided the component payload and a nylon ord that had been paid out from the ırent ship would be made secure by eans of mechanical hands operated y the astronaut.

If the two rendezvousing ships were oing too fast relative to one another, ıe cord would be automatically re- ased before it was subjected to a estructive tension. Before this hap- ened, the pilot of the parent ship ould fire a vernier rocket to reduce ıe relative speed—a decision he would kely favor if the otherwise ensuing elay were expected to have serious onsequences.

A spin would be imparted to the ehicles through attachment and sub- equent winding in of the cord; atti- ıde stabilization would be required to liminate the spin before the next ren- ezvous was attempted.

• **Other possibilities**—Besides pri- ıary assembly just above the earth's tmosphere, rendezvousing can be used o advantage about other plants and he moon. If atmospheric heating and eceleration were unimportant, as with he atmosphere-free moon, it would be nnecessary to waste fuel by landing he earth return payload. This could e left in orbit along with fuel for the eturn trip.

In this fashion, the efficiency of the manned lunar expedition could be just about doubled. Initially beyond the capability of even a *Nova* rocket, it is brought by manned rendezvousing within the grasp of a handful of *Atlas-Centaurs,* or two *Saturn* rockets, with the proper combination of oxygen-hydrogen and storable propellant upper stages.

The stationary solarium laboratory, allegedly the most important deep-space mission in terms of knowledge it might provide, would influence life on earth, yet would not likely be a mission to which humans are assigned. But it would be brought much closer to possible realization by combining rendezvous assembly methods with some form of propulsion, such as the solar turbine, that alters the mass ratios completely.

Assembly operations—achieved by rendezvousing—represent a major contribution to space technology by the astronauts themselves. The rendezvous-trained astronaut is not yet spent. Icarus and Hermes are just two of several important asteroids that come very close to the earth at some stage of their eccentric orbits through solar space.

Both are small planetoids, about a mile or so across, but they have some very interesting orbit characteristics. Icarus falls within 17 million miles of the sun, passes the earth at four million miles and finds its aphelion beyond the constellation of Mars. It is nature's own solar probe, with the smallest asteroid orbit known.

Hermes is even more spectacular—it gets between the earth and the moon on certain phases of its trajectory.

These planetoids are worthy of exploration. When they make their nearer approaches to earth, expeditions should be dispatched to them. The landing would not be appreciably different than rendezvousing two spaceships; similar human operations would be required.

Perhaps, if Icarus has not developed dangerous radioactivity from its constant proximity to the sun, it would prove possible to dig a cave which would act both as a heat shield during the perihelion passages and as protection against space radiation hazards such as solar flares.

Manned journeys into deep space may be long delayed on account of the weight penalty of the radiation shield; hitch-hiking on an asteroid may be an acceptable way out of the dilemma.

The astronaut has a job to do, and a place, in space flight. He will truly work his passage.

Firebee in production

T. CLAUDE RYAN, (third from left) President of the Ryan Aeronautical Company, oins Air Force and other Ryan officials in inspecting the first *Firebee* target missile o roll off the Ryan production lines.

GE Official Sees Hazards In 'Guardian Angel' Buying

The "Guardian Angel" principle in military procurement is picking the taxpayer's pocket—and could be disastrous in 10 years, charges a General Electric Co. official.

The principle of looking out for the smaller firms in military purchasing is a result of public misconception about "opposition" between large and small businesses—creating a political issue, according to L. Berkley Davis, general manager of GE's Electronics Components Division. In an article written for *The General Electric Defense Quarterly,* Davis declares that such opposition does not exist, and actually large and small defense contractors are dependent on one another for tasks they cannot economically handle themselves.

He feels that without the large-scale company to break a project into smaller pieces the small firm could not participate. He adds: "roughly 53 cents of every defense dollar received by General Electric is passed along to small suppliers."

Mirror to Weigh 4 Tons

The mirror for the new Crimean Astrophysical Observatory telescope will have a diameter of 2.6m and weigh 4 tons, according to *Pravda.* It is now being completed in the Leningrad Optical Plant.

contracts

AIR FORCE

$474,831,000—**Radio Corp. of America**, New York City, for work on the Ballistic Missile Early Warning System.

$172,365—**Boeing Airplane Co., Pilotless Aircraft Div.**, Seattle, for modification kits applicable to *IM99A*.

$82,500—**Sverdrup & Parcel Engineering Co.**, St. Louis, for initial design of vertical rocket engine altitude test cell.

$60,623—**Boeing Airplane Co., Pilotless Aircraft Div.**, for data in support of the *IM99A* missile, and tool replacement of ramjet fuel expulsion diaphragm (two contracts).

$40,990—**Electro Mechanical Research, Inc.**, Sarasota, Fla., for repair and modification of telemetry equipment.

NASA

$91,745—**Beckman & Whitney, Inc.**, San Carlos, Calif. for high-speed motion picture camera for high-speed impact studies in the Hypervelocity Ballistic Range, NASA, Moffett Field.

$66,433—**Ampex Corp.**, Birmingham, Mich., for magnetic tape recording system for Lewis Research Center.

NAVY

$292,539—**General Dynamics Corp., Electric Boat Div.**, Groton, Conn., for a design study in connection with the installation of nuclear submarine type auxiliary electrical and propulsion components and systems.

$66,493—**Lenkurt Electric Co., Inc.**, San Carlos, Calif. for communication equipment.

$30,515—**Panoramic Radio Products**, Mt. Vernon, N.Y., for panoramic telemetering indicator.

$27,736—**Rese Engineering, Inc.**, Philadelphia, for random-access magnetic core memory system.

ARMY

$82,799,690—**The Martin Co.**, for *Pershing* (two contracts).

$2,667,475—**Douglas Aircraft Co.**, Santa Monica, for *Nike-Hercules* missile launching area items.

$2,198,253—**California Institute of Technology**, Pasadena, for research and development of guided missiles.

$1,213,508—**Raytheon Co.**, Andover, Mass., for replenishment and repair parts for *Hawk* missile system (two contracts).

$1,138,475—**California Institute of Technology**, for wind tunnel testing for *Nike-Zeus* (two contracts).

$1,028,392—**Sperry Rand**, Salt Lake City, for research and development and repair parts for *Sergeant* guided missile system (3 contracts).

$935,367—**Hayes Aircraft Corp.**, Birmingham, Ala., for engineering and design services and specialized services for manufacture of special tooling and missile components—supplementary (two contracts).

$481,500—**Aerojet-General Corp.**, Azusa, Calif. (classified).

$400,000—**Gilfillan Bros., Inc.**, Los Angeles, for *Nike* system components.

$288,332—**Douglas Aircraft Co., Inc.**, Santa Monica, for *Nike* replenishment spare parts (two contracts).

$247,652—**Brown Engineering Co.**, Huntsville, for engineering and design services.

$188,892—**The Martin Co.**, Orlando, replenishment spare parts and components for *Lacrosse* missile.

$95,000—**General Electric Co.**, Burlington, Vt., for engineering design and development on *M61 (T171E3)* and fabrication and testing of mechanical accessories and components.

$72,025—**Task Corp.**, Anaheim, Calif., for wind tunnel test equipment for *Nike-Zeus*.

$57,319—**Radioplane Div. of Northrop Corp.**, Van Nuys, Calif., for *Hawk* target missile flight services.

$46,860—**Redstone Machine & Tool Corp.**, Huntsville, for manufacturing fabrication of missile test components and fixtures.

$48,823—**Western Electric Co., Inc.**, New York City, for electron tubes.

$45,000—**North American Aviation, Inc.**, Canoga Park, Calif., for rocket engines.

$43,270—**Brown Instrument Div.**, Minneapolis-Honeywell Regulator Co., Philadelphia, for potentiometer recorders, various numbers of pens for meteorological recording.

$33,040—**University of Cincinnati**, continuation of studies in septic and irreversible shock.

$29,160—**Technical Appliance Corp.**, Sherburne, N.Y. for electronic satellite tracking equipment, antenna arrays.

$28,909—**Heiland Div., Minneapolis-Honeywell Regulator Co.**, Denver, for oscillograph, direct recording with galvanometers and amplifier system.

RE Convention Covers Military Work

Following are abstracts of papers esented at the 1960 Winter Military lectronics Convention in Los Angeles. ne conference was sponsored by the stitute of Radio Engineers' Profes- onal Group on Military Electronics. urther information on the papers may obtained from the IRE, 1 E. 79th ., New York 21, N.Y.

ngle Aperture CW Radar Techniques, . R. Boughnou and W. S. O'Hare, Ray- eon Company, Maynard, Mass.

In the past, CW Radar has not been nsidered for many airborne applications ainly because of inadequacy of transmit- ng tubes and the requirements for two ntennas.

Improvements in tubes for CW transmit- rs have made possible advances in tech- ques for single-dish CW radar.

The principles of the basic single-dish dar system are discussed along with the sults of experimental programs.

Satellite Navigation System Employing Synchronized Pattern, G. E. Townsend, Kork, and J. D. Kraft, The Martin ompany, Missiles and Electronics Di- ision, Baltimore.

Detailed investigations of the means by hich a satellite may be navigated in the icinity of the earth have uncovered few ew techniques which are capable of pro- iding the required navigational accuracies.

However, one new approach has re- ealed a promising technique employing a ynchronized pattern of satellites. This is ased on the measurement of position and elocity with respect to those of three isible satellites and requires as inputs only hree simultaneous measurements of range nd range rate.

atellite Auxiliary Power Systems, Nels . Palmquist, Jr., Satellite Systems ranch, Lockheed Aircraft Corp., Mis- ile and Space Division, Sunnyvale, Calif.

The general requirements of auxiliary ower systems for satellites are presented, n particular those of the *Discoverer II* ehicle.

The auxiliary power system is formulated nd its flight performance is evaluated. A rief look at future systems such as solar hotovoltaic, nuclear, thermoelectric, and igh-energy batteries is also presented.

Explorer VI Digital Telemetry-TELEBIT, . E. Gottfried, Space Technology Lab- ratories, Inc., Los Angeles.

The digital telemetry system, TELEBIT, ow aboard *Explorer VI*, is described. Some f the design considerations and the actual mplementation are discussed.

Communications System for Project *Mercury* Space Capsule, William Benner, McDonnell Aircraft Corp., St. Louis.

The basic capsule for Project *Mercury* relies heavily on the system of communications with ground stations. This system employs several different communications paths: HF voice, UHF voice, commands from the ground, telemetry from the capsule, as well as beacons for radar tracking and recovery. To insure continuity of operation, multiple techniques and supplementary modes provide reliability and redundancy.

The problems and solutions described should find application in other military electronic programs.

Specialized Reconnaissance Techniques, James C. de Froekert, Stanford Electronics Labs., Stanford University, Stanford, Calif.

Several new techniques for signal sorting reconnaissance applications are described. The techniques to be discussed include: (1) pulse-by-pulse frequency measurement on an instantaneous basis over a wide range of frequencies, (2) identification of simultaneous and sequentially puised radars, (3) indication of frequency-jumping systems, and (4) unusual data recording techniques.

An AN/AAS-5 Infrared Reconnaissance System, W. B. Birtley and D. D. Chaffee, Jr., HRB-Singer, Inc. State College, Pa.

Described is an IR reconnaissance system developed by HRB-Singer, Inc., for airborne use by the Army Signal Corps. The system is unique in that it is a dual channel arrangement using two detectors simultaneously and employing interchangeable detector-preamp assemblies.

Also discussed is a nitrogen liquifier for supplying detector coolant in the field. Transistor circuits unique to IR detectors and IR systems are also mentioned.

A Stationary Sun Position Sensor, G. C. Anthony, IBM, Military Products Division, Owego, N.Y.

A description of a stationary sun position sensor system which determines one axis of a coordinate reference system in interplanetary space. Total orientation of the vehicle may be established when the sensor system is used in conjunction with a sighting telescope to establish a second axis. The sensor system will provide space axis rates about two of the three inertial axes. In addition, the sensor will supply attitude information for orienting solar cells or sun sensing instruments toward the sun.

Development of Portable Atomic Frequency Standard for Missile-borne and Satellite-borne Applications, Dr. M. L. Stitch and Dr. H. Lyons, Hughes Research Laboratories, Hughes Aircraft Company, Culver City, Calif.

Work under way at HAC may lead to a missile-borne atomic frequency standard of the ammonia maser type with long-term frequency stability of three parts of 10^{11} or better and short-term stability of five parts in 10^{12} or better. Some of the problems associated with development for different classes of applications are discussed.

The possibilities of an ammonia maser type frequency standard are explored, together with the relative merits of the ammonia maser type frequency standard as compared to other types.

Cryogenic Gyros, W. H. Culver and M. H. Davis, The RAND Corp., Santa Monica, Calif.

Effects unique to very low temperatures offer some interesting new approaches to gyro design. The phenomena of superfluidity and superconductivity and the general mechanical stability of materials at a temperature of a few degrees Kelvin make it possible to realize certain idealized conditions in practice. A gyro design making use of some of these phenomena is described.

Basic Principles of Fuzing High Explosive Warheads for Use Against Air Targets, V. A. Brown and A. V. Sylwester, U.S. Naval Ordnance Lab., Corona, Calif.

The objective of the fuze designer is stated in terms of burst control requirements. The missile-target encounter is described and illustrated in terms of a convenient target-centered frame of reference. The effects of the conflicting requirements imposed by the wide variation in encounter parameters, such as target size, relative velocity, intercept aspect, miss distance, and altitude are discussed. The influence of warhead characteristics upon burst control requirements is treated, and there is a brief survey of the ability of various methods of target detection to meet burst control requirements.

Missile and Satellite Detection System, H. Kilberg, RCA Service Co., Patrick Air Force Base, Fla.

The Frequency Control and Analysis program of the future at the Atlantic Missile Range is largely governed by the requirements of detecting and tracking missiles and satellites, both cooperative and non-cooperative, to obtain orbital data in support of Project *Space Track*.

Antenna systems, receiving systems, and signal converter and analyzing systems are the areas of development where special work was done by the FCA Laboratory of the AMR.

Components are described, and the reasons for their selection, as well as their limitations, are discussed.

Ballistic Missile Space Communications System Concept, Charles A. Strom, Jr., Rome Air Development Center, Griffiss AFB, N.Y.

This paper summarizes many of the factors of the communications system that tend to restrict or affect the total ballistic missile system performance. Suggestions are made of elements of the communications system that should be considered early in the development program to better integrate

the communications subsystem with the overall system. Promising new developments and the techniques which will overcome some of the deficiencies of today's communication subsystem support to the ballistic missile and space flight systems are highlighted.

Sub-Surface Radio Communications Links, H. A. Norby, Space Electronics Corp., Glendale, Calif.

The historical background of sub-surface electromagnetic communication and its propagation theory is discussed briefly. Recent field test data obtained at the Boron Test Site of Space Electronics Corp. is included and used as the basis for a brief discussion of the relationships between range, power, noise level, and information rate.

Development status of sub-surface radio communication is summarized and preliminary design criteria for potential system applications are presented.

Re-entry Radiation from an IRBM, Dr. W. N. Arnquist, System Development Corp., Santa Monica, Calif.; D. D. Woodbridge, U.S. Army Ballistic Missile Agency, Huntsville, Ala.

The radiation emitted when a high speed body re-enters the atmosphere is an important source of information concerning the physical processes taking place. For about two years the Army Ballistic Missile Agency has conducted a measurement program known as Project *Gaslight* which has utilized *Jupiter* firings, and, to a limited extent, both *Thor* and *Polaris* firings. An account is given of the instrumentation employed and some of the results obtained.

Re-entry Guidance and Flight Path Control, James E. Vaeth, The Martin Company, Missiles and Electronics Division, Baltimore.

This paper discusses the abilities and limitations of a specific flight path control law for range maneuvering during the atmospheric phase of re-entry from orbit, as determined by a digital computer study. Results of the study demonstrate that a relatively simple guidance and flight path control loop, utilizing a preprogrammed normalized trajectory plus vehicle velocity and range-to-go measurements, is very effective; range dispersions of more than ±100 miles, due to initial conditions or to uncertainties in lift-to-drag ratio, are reduced to less than one mile. Variations in terminal accuracy are evolved as functions of control law gain, velocity measurement errors (via inertial guidance or ground radar tracking) and severe headwinds.

High Accuracy Telemetry for *Sergeant* Weapon System, W. Arens, Jet Propulsion Laboratory, Pasadena, Calif.

This paper discusses the design and development of a telemetering system for the *Sergeant* weapon system capable of attaining an accuracy of reproducibility of a 0.1% of full scale for a limited number of guidance system performance characteristics.

Recent Advances in Transistorized Telemetry, Joe H. Smith, Texas Instruments Inc., Apparatus Division, Dallas.

This paper covers specific areas in which Texas Instruments has made notable achievements during recent months. Specifically discussed are: (1) a highly flexible and reliable 8-bit PCM system with low-level capabilities, (2) high-and low-level solid-state multipliers, (3) transistorized transmitters and subcarrier oscillators designed to rigid requirements of *Mercury, Centaur,* and *Vega.*

The AN/DPN-63 Subminiaturized C-Band Transponder, Liscum Diven, Fredrick L. Koch, Motorola, Inc., Western Military Electronics Center, Phoenix.

The AN/DPN-63, a subminiaturized C-Band transponder designed to extend the tracking range of the AN/FPS-16 Radar, incorporates a number of advanced design techniques.

The volume of this C-Band transponder is less than 100 cubic inches including batteries. With the exception of the 400 watt magnetron, silicon semiconductors are used throughout.

Exceptionally high transponder delay stability is required in order not to compromise the range accuracy of set AN/FPS-16 radar; the unique automatic gain control circuit to meet this objective is described.

The modulator uses a new semiconductor device to perform the switching function. Use of semiconductors in pulse modulators of various power levels and duty cycles is discussed, and a unique re-usable encapsulating method is shown.

Solids Meeting

Abstracts from ARS Princeton Conference

The American Rocket Society's Solid Propellant Rocket Research Conference was held recently at Princeton University.

Abstracts of a portion of the papers presented have been compiled and are presented as a service to M/R readers. Further information may be obtained from the American Rocket Society 500 Fifth Ave., New York 36, N.Y.

The Mechanism of Ignition of Composite Solid Propellants by Hot Gases, R. F. McAlevy, P. L. Cowan, and M. Summerfield, Guggenheim Jet Propulsion Center, Princeton University, Princeton, N.J.

Ignition of composite solid propellants of the ammonium perchlorate type has been accomplished in a shock tube filled with a mixture of oxygen and nitrogen. The time interval between the instant of contact of the propellant sample by hot gas and the subsequent emission of light as detected by a photocell, has been measured as a function of oxygen concentration for several different propellants. It was found that the ignition times varied inversely with the oxygen concentration.

A new theoretical approach has been developed for the ignition of a composite propellant by a hot gas, the essential element of which is that the flame first starts in the gaseous layer adjacent to the propellant. The observed ignition delay is simply the time required for enough fuel to vaporize to create a combustible gaseous mixture.

Combustion Instability in Solid Rockets Using Propellants with Suspended Metallic Powders, Sin I. Cheng, Princeton University, Princeton, N.J.

The stability of the acoustic oscillations in the chamber of a solid-propellant rocket is analyzed to reveal the effect of the addition of the metallic powders to a basic solid propellant. The dissipative action of the oscillation of the particles in the condensed phases is neglected. The oxidation of the metallic powders is considered as distributed heat sources to the gas system.

Heat Transfer Stability Analysis of Solid Propellant Rocket Motors in the Study of Resonant Burning, Reuel Shinnar and Menachem Dishon, Technion, Haifa, Israel.

This paper presents a theoretical investigation of the causes of unstable burning in solid-propellant rocket motors. A possible mechanism of unstable burning is developed. Small perturbation analysis is applied to a set of differential equations describing heat transfer in the solid as well as in the gas film near the burning surface. Criteria of instability are derived directly from the equations having only the physical properties of the propellant as parameters.

It is shown why an endothermic reaction at the decomposing surface of the solid propellant favors stability. The stabilizing influence of turbulators and radial holes drilled into the charge is explained.

The Slotted-tube Grain Design and Some Practical Modifications for Use by Grain Designers, Max W. Stone, Rohm & Haas Company, Redstone Arsenal Research Division, Huntsville, Ala.

A mathematical analysis was made of the internal-burning slotted-tube configuration which has some distinct advantages for certain solid-propellant applications. Those advantages are zero sliver, high loading density and thick web capability, low stress concentration, and mandrels that can be made in less time and more cheaply than star mandrels. The disadvantage centers in the fact that an insulating liner is required to protect the motor wall in the slot region.

The results of the mathematical analysis were programmed for an electronic computer and calculations made for a wide range of the parameters of interest.

names in the news

William J. Kuehl: Named manager-ngineering, General Electric's Light Military Electronics Dept., succeeding **O. H. Winn,** recently promoted to general manager of the Capacitor Dept. Kuehl, who joined GE in 1948, was formerly manager-Communication and Navigation Engineering, directing MED's *Polaris* fire control and guidance rojects.

KUEHL

Bryan F. LaPlante: Appointed director of The Mitre Corp.'s recently opened Washington, D.C., office. Was formerly assistant to the general manager and Congressional Liaison Officer of the U.S. Atomic Energy Commission, and recently with Joyce & Fisher Associates.

LaPLANTE

Warren P. Turner: Named product manager, military products and solid propellants, for the Energy Div. of Olin Mathieson Chemical Corp. Was formerly special assistant to the vice president and technical director for high-energy fuels. Prior to joining the firm in 1958, as director of applications and contracts ivision of Reaction Motors, Inc.

TURNER

Joseph H. Laurinec: Joins ASCOP, a ivision of Electro-Mechanical Research, Inc., as manager of administration, responsible for production scheduling and planning operations. Was formerly engineering manager at The Martin Co.'s Denver Division, where he directed development and production of all nissile instrumentation systems, including round support, system checkout and data ecording systems.

LAURINEC

Charles T. Cosser: Appointed director f marketing for Lockheed Electronics-Newport Division. Previously directed narketing activities for Interstate Elecronics Corp.

Homer A. Ray, Jr.: Selected for the ewly created position of engineering assistant at Rixon Electronics Inc.

Previous posts: Manager, Engineering Div., Smith Electronics Inc., chief engineer and director of Photogrammetry, Inc.

James Hannum: Formerly of Hughes Aircraft Co.'s communications division, joins Houston Fearless Corp. as manager, communications research.

Howard Speer, of Hughes Communications division, also joins the company's research group as senior staff engineer.

George H. Stoner, Boeing Airplane Co.'s program manager for *Dyna-Soar,* named the following to his staff:

William E. Ramsden, assistant program manager; **Benson Hamlin,** system manager; **Paul Sanders,** customer requirements manager; **Ellis Levin,** systems growth manager; and **Robert F. Watt,** program planning and control manager.

Ramsen, with the company since 1930, joined the *Dyna-Soar* group early in January after serving as program manager for development of the B-70 wing. Hamlin was project manager for Bell Aircraft Corp. on the advanced rocket boost glide weapon system (ROBO), later designated *Dyna-Soar.* Sanders, with the company since 1950 joined the program in 1957 as engineering representative in the Dayton, Ohio, office. Levin joined the company in 1942 to participate in gas turbine and guided missile research. Watt has been with the company for 22 years, working in nuclear propulsion.

Dr. T. Paul Torda: Named director of propulsion and fluids research at Armour Research Foundation of Illinois Institute of Technology. Was formerly professor of mechanical engineering at the Polytechnic Institute of Brooklyn.

Dr. Victor B. Corey: Appointed vice president, United Control Corp., responsible for development of precision components. Previous posts: Technical director, Donner Scientific Co.; executive engineer, Electronics Div., Willys Motors.

Dr. Alex J. Paszyc: Manager and chief engineer, Architect-Engineer Div., Pacific Automation Products, Inc. Previous posts: chief engineer, J. H. Pomeroy & Co., Inc.; project manager, Ralph M. Parsons Co.; project engineer, H. A. Simons, Ltd.

William H. Happe, Jr.: Formerly assistant general manager, promoted to general manager, Princeton Div., Curtiss-Wright Corp. Prior to joining the company in 1954, was director of IT&T Corp.'s Vacuum Tube Division.

Gen. O. P. "Opie" Weyland (USAF ret.): Named a consultant to Aerojet-General and a member of the corporate advisory board.

Thomas J. Carroll: Formerly with Philco, elected chief physicist at Semimetals, Inc.

when and where

FEBRUARY

American Institute of Chemical Engineers, Biltmore Hotel, Atlanta, Feb. 21-24.

Engineering Materials & Design Exhibition, Industrial and Trade Fairs, Ltd., Earls Court, London. Feb. 22-26.

British Interplanetary Society, London Branch, Institution of Plant Engineers, "Some Problems Encountered in the Design of Large Rocket Test Beds," Royal Society of Arts, London, Feb. 23.

National Association of Corrosion Engineers, Tulsa Section, 11th Annual Corrosion Short Course, Mayo Hotel. Tulsa. Feb. 24-26.

MARCH

Navy League Seapower Symposium, Sheraton Park Hotel, Washington, D.C., Mar. 1-3.

Royal Astronomical Society and Royal Meteorological Society, "The British Rocket Programme," Royal Society of Arts, London, Mar. 4.

British Interplanetary Society, "The Exploration of the Moon," Caxton Hall, London, Mar. 5.

Association of Mechanical Engineers, Gas Turbine Power and Hydraulic Conference, Rice Hotel, Houston, Mar. 6-9.

Society of Instrument Technology, "Data Reduction for Guided Weapon trials at Aberporth," Manson House, London, Mar. 7.

Heat Transfer Symposium, Mechanical Engineering Dept., University of Florida, Gainesville, Mar. 7-8.

Society for Aircraft Material and Process Engineers, Midwest Chapter Symposium, "Processing Materials for Re-entry Structures," Miami Hotel. Dayton, Ohio, Mar. 9-10.

Mechanical Properties of Engineering Ceramics, North Carolina State College School of Engineering, and Office of Ordnance Research, US Army, NC State College, Raleigh, Mar. 9-11.

National Flight Propulsion Meeting, Institute of the Aeronautical Sciences, (classified), Cleveland, Mar. 10-11.

Electronics Industries Association, Defense Planning Seminar, Statler Hilton Hotel, Washington, D.C., Mar. 15.

Symposium on Optical Spectrometric Measurement of High Temperatures, sponsored by University of Chicago's applied Science Laboratories; Jarrell-Ash Co.; National Science Foundation, at University of Chicago, Mar. 23-25.

22nd Annual American Power Confer ence, sponsored by Illinois Institut of Technology, American Society o Mechanical Engineers and others Sherman Hotel, Chicago, Mar. 29 31.

APRIL

University of Connecticut, Sixth an nual Advanced Statistical Qualit Control Institute, Storrs, April 3-1

Solar Energy Symposium, America Society of Mechanical Engineer and Mechanical Engineering Dept University of Florida, Gainesvill April 4-5.

1960 Nuclear Congress: "What Will th Future Development of Nuclea Energy Demand From Engineers? sponsored by 28 engineering, scien tific, management and technica organizations. Includes 6th Nuclea Engineering and Science Confer ence; 8th NICB Atomic Energy i Industry Conference; 6th Interna tional Atomic Exposition, New Yor Coliseum, New York City, Apri 4-7.

American Chemical Society, 137th Na tional Meeting, Cleveland, April 5 14.

American Rocket Society, Structura Design of Space Vehicles Confer ence, Biltmore Hotel, Santa Bar bara. April 6-8.

Institute of Environmental Sciences 1960 National Meeting, "Hyper Environments — Space Frontier, Biltmore Hotel, Los Angeles, Apri 6-8.

Royal Aeronautical Society, Coventr Branch, The Optimum Size o Rocket Engines, Coventry, England April 7.

Society of Instrument Technology, "Th Electronic Computer as a Unit i an Automatic Data-Processing Sys tem for Missile Trials" Overheu London, April 7.

ASME-SAM Management Engineerin Conference, Statler-Hilton Hote New York, April 7-8.

IRE and ARS, Southern Ohio, Four teenth Annual Spring Technica Conference, Hotel Alms, Cincinnati April 12-13.

British Institution of Radio Engineers Computer Group, "Guided Weapo Control," London, April 13.

Symposium on Chemical Reactions i the Lower and Upper Atmosphere Stanford Research Institute, Marl Hopkins Hotel, San Francisco April 18-20.

Advertiser's Index

Industry Needs a Hint From DOD

One of the more interesting—and critical—problems the defense industry faces these uncertain days is that of diversification—the broadening and increasing of in-house capability.

It not only affects the big primes in acquiring the smaller companies which will give them added skills and capabilities, but it also vitally concerns the little man. (If he isn't swallowed up, will he be frozen out?)

There are several points which emerge fairly clearly:

1. The possession of diversified facilities gives the big contractor a better basis of negotiation. As his own capabilities increase so does his grasp of the overall problem.

2. Diversification permits spreading of contracts. Most of the big companies would rather have one-fifth of five contracts than five fifths of one contract. This spreads the effect of a cancellation and mitigates the pain of the "hot poker and cold shower" treatment to which contractors are particularly sensitive.

3. It is not likely to affect the smaller, unmerged company for the same reasons which have made him successful in the past; his skills and his products cannot be supplanted in the eyes of either industry or government. He will have to be aggressive, ingenious and resourceful for he will find himself more and more in competition with the big primes.

There are other sides to the problem, however. In the past months the military services have made certain oblique changes in their procurement practices. Particularly is this true of the Air Force, largest of the military buyers and, more particularly, largest in the burgeoning missile/space business.

The Air Force has indicated it will itself maintain a greater in-house capability. Many of the management problems which in the past have been delegated to the prime or major contractor, the Air Force now intends to hold to itself. Gen. Schriever, AF R&D boss, has particularly emphasized it. This could mean greatly decreased responsibilities for the prime and a larger spreading of contract money.

Another factor in the situation is that several bills have been introduced in both chambers of Congress, such as S-422 by Senators O'Mahoney and Kefauver and HR-2325 by Rep. Celler. Both of these bills require prior notification to the government before mergers of defense industries of any size.

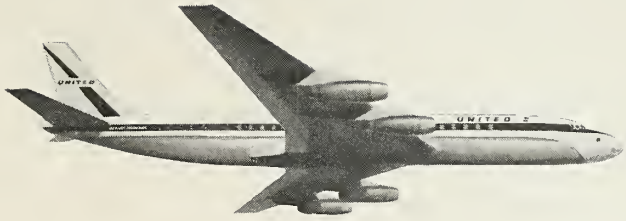
This one is thorny because mergers of corporations are not usually negotiated under the bright glare of publicity and the necessity of prior notification might throw a monkey wrench into many such deals from almost any angle.

It would seem logical that right now the defense industry would welcome some guidelines from the Department of Defense. The government of Great Britain has told its missile and aerospace business to merge and concentrate competition.

Would DOD like to encourage more defense industry mergers in this country? More diversification and in-house capabilities? Or would our Administration prefer to see as many companies as possible in the business, thus maintaining a broad mobilization base? Or is the attitude pure *laissez faire*?

Industry wouldn't necessarily follow such guidelines—but we suspect industry would strongly like some hints in accordance with changing times and changing procurement policies.

Clarke Newlon



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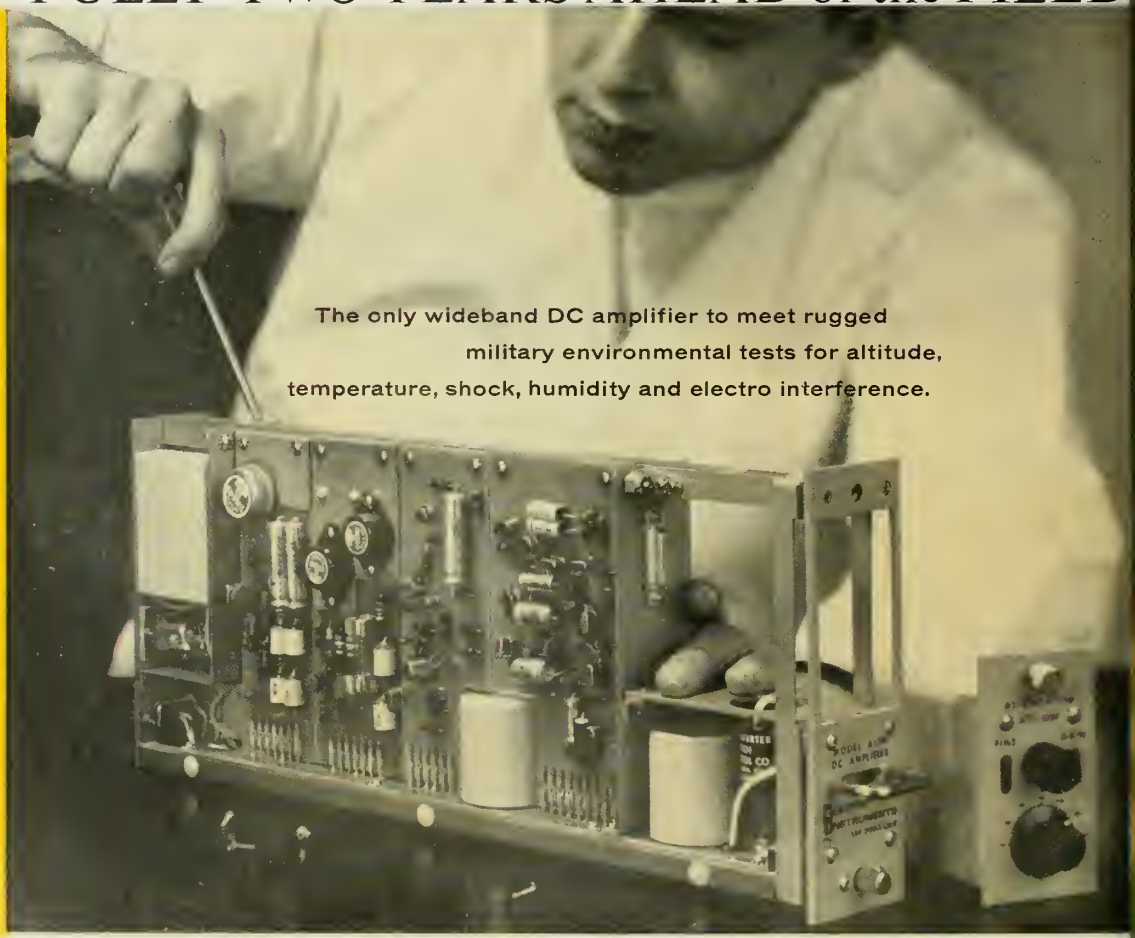

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