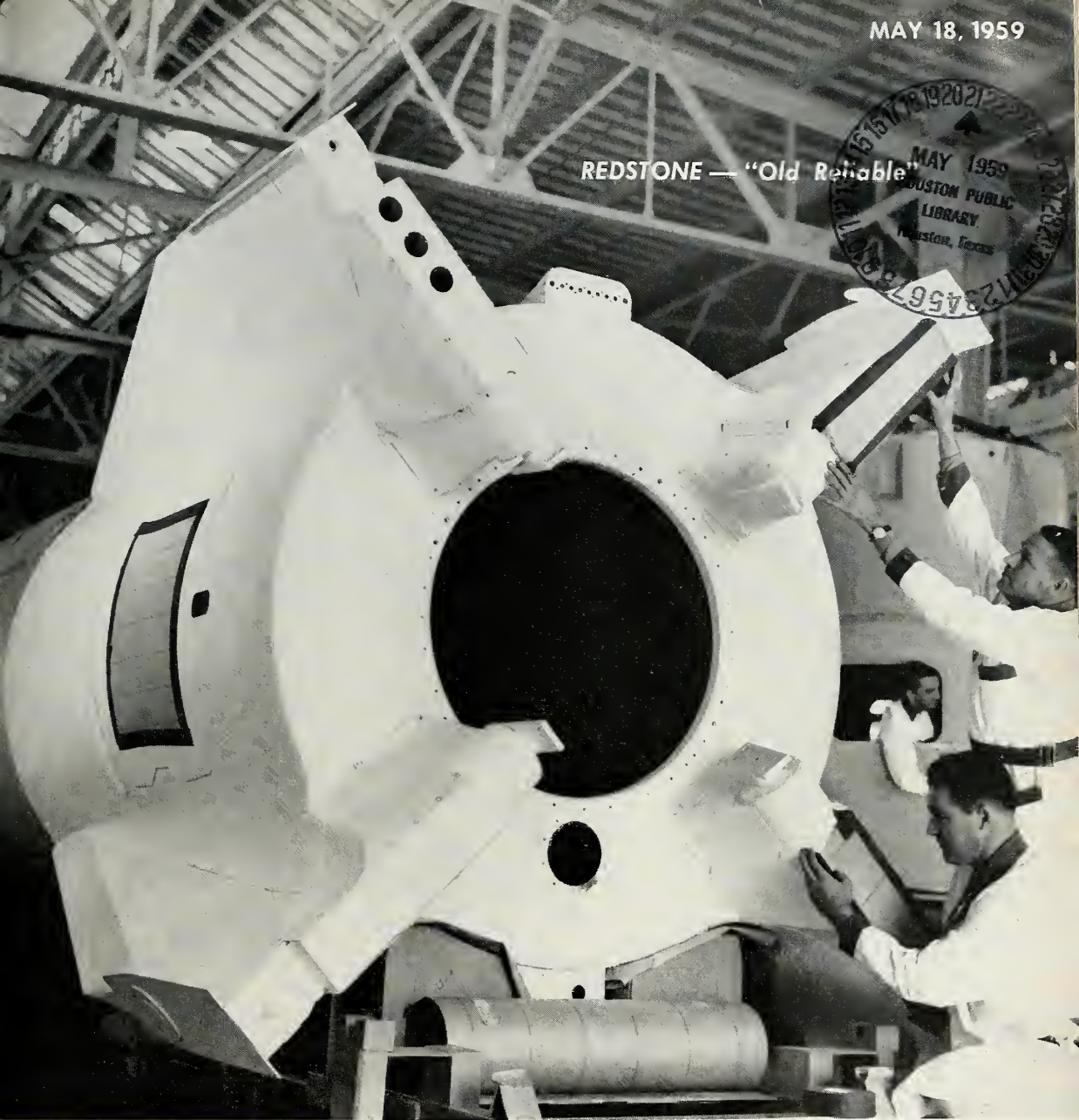
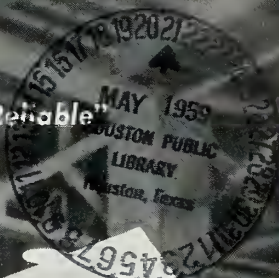


MAY 18, 1959

REDSTONE — "Old Reliable"

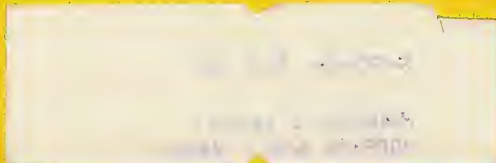


missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

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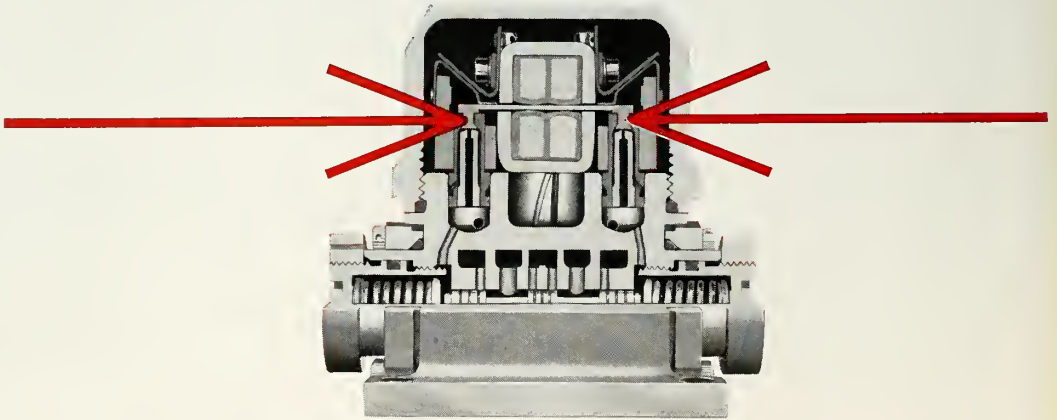
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PRODUCTION**

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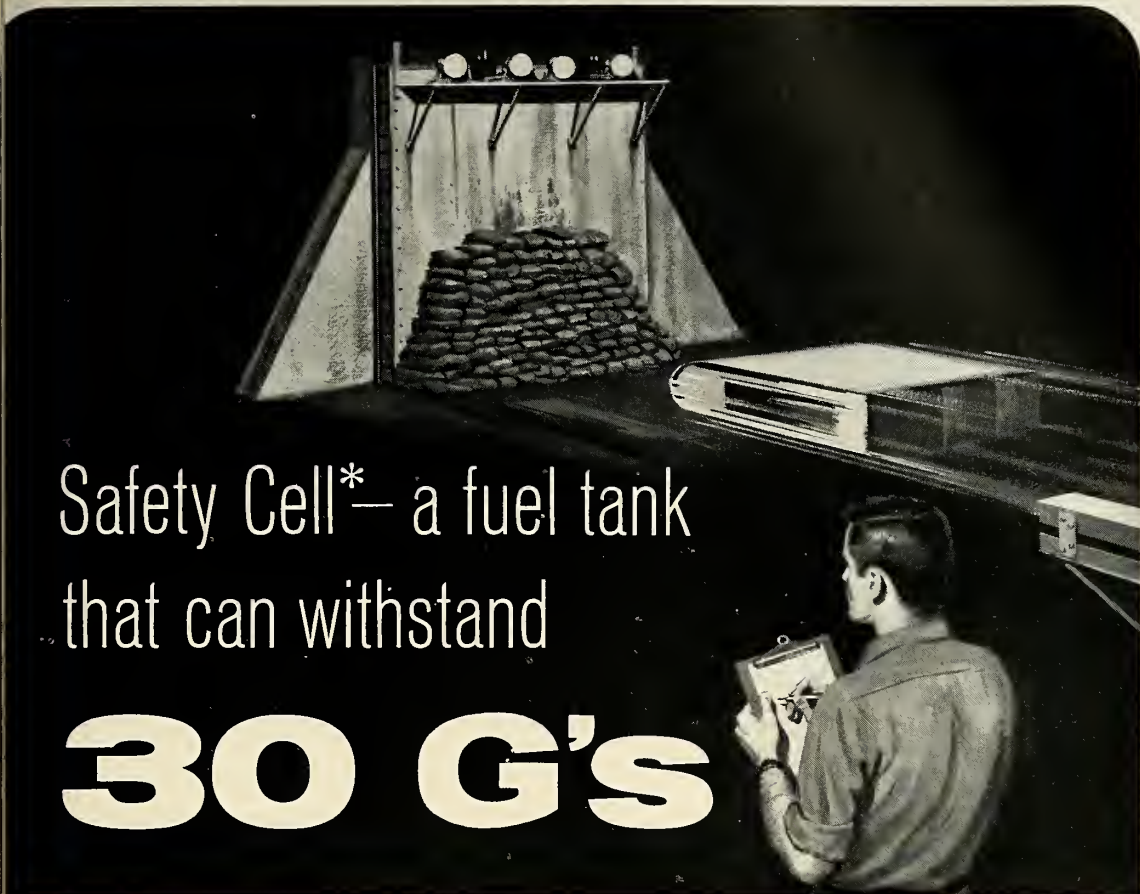
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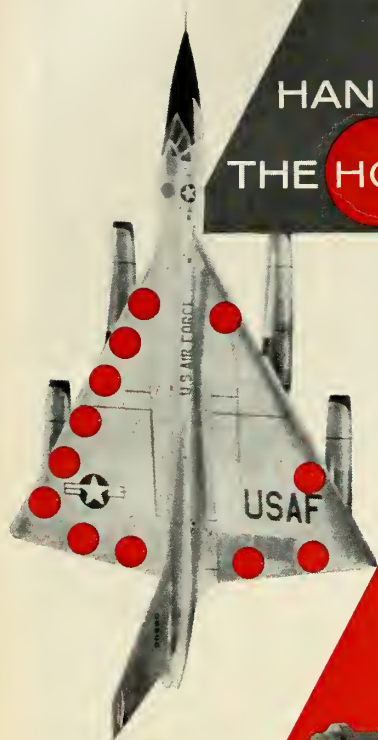
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GOOD YEAR

* Safety Cell—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

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Missiles and rockets, May 18, 1959

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airfoil pressures
to 5000 psi
... at 600°F.*



Testing the hot ones is easy for rugged CEC Pressure Pickups... the 4-316A and 4-317, both designed for a wide range of pressure measurements at extremely high temperatures. Hundreds of these unique pickups were used to measure the dynamic and static pressure differential on airfoil surfaces of the Convair B-58 during the testing program for the nation's first supersonic bomber.

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missiles and rockets

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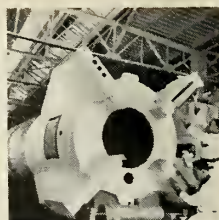
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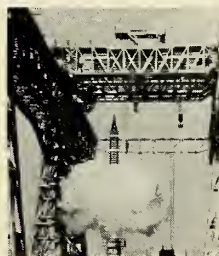
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COVER: Redstones for Project Mercury are now being fabricated at Reynolds Metals' Sheffield, Ala. division.

MISSILE BASEBALL



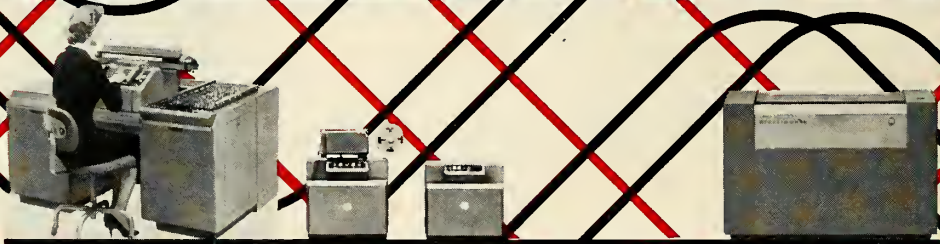
"OPERATION Skycatch" is the newest phase of development of the Polaris FBM launching system. At San Francisco Naval Shipyard, as shown in these sequence photographs, a huge overhead assembly catches the multi-ton dummy missile in mid air. The method simplifies retrieval procedure and also permits accurate study of the effects of launch stresses. Westinghouse is prime contractor under Lockheed for the launching system.



220 System

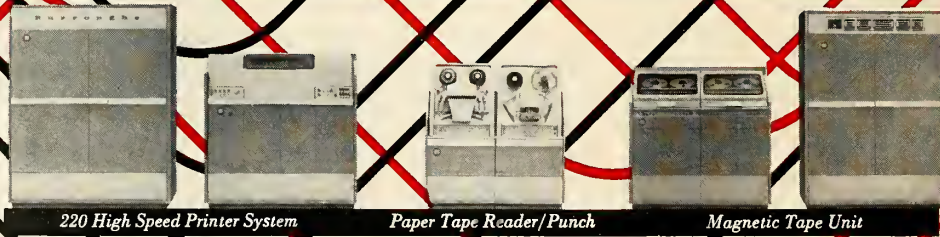


205 System



E101 System

Datafile



220 High Speed Printer System

Paper Tape Reader/Punch

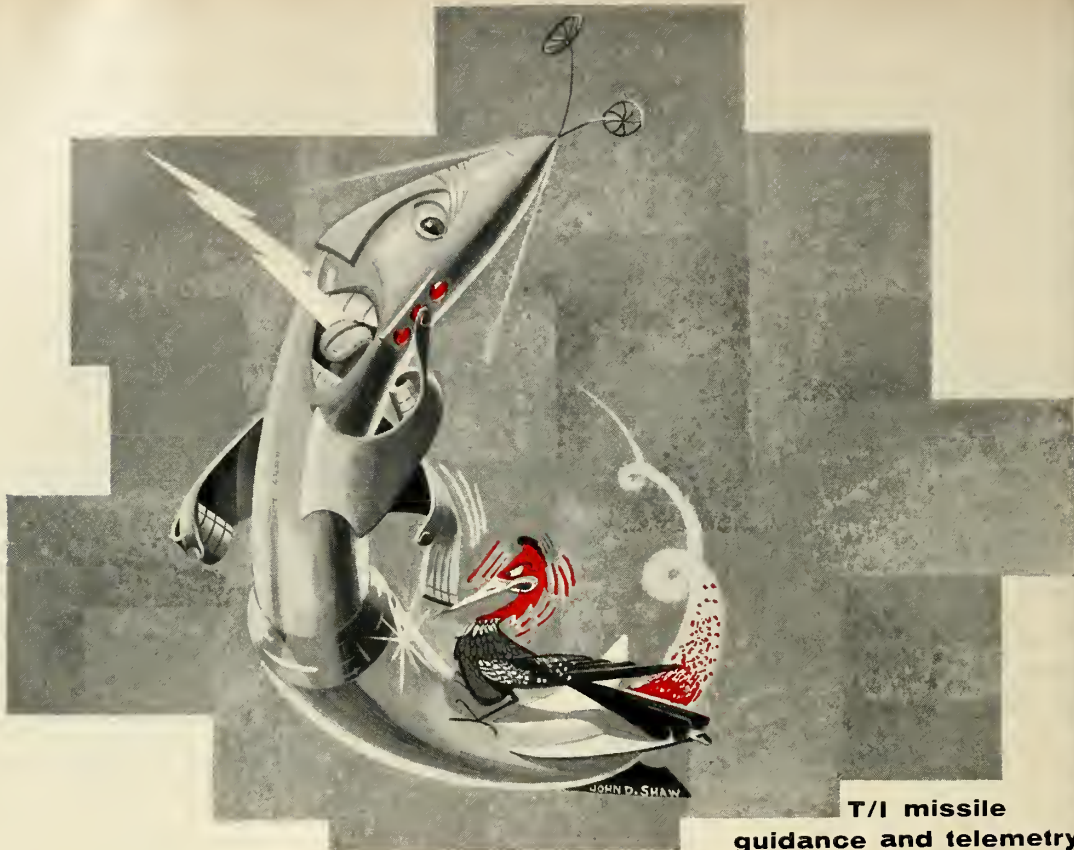
Magnetic Tape Unit

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The Next Deputy Defense Secretary

It would be difficult to over-estimate the importance of choosing wisely the man who will succeed Donald A. Quarles as Deputy Secretary of the Department of Defense. He must be selected with an eye to his scientific background, for his managerial effectiveness, for his familiarity with the Defense Department and its thousands of complexities—and for the problem of maintaining a continuity of experience in this top defense post.

It is difficult to think of a man whose presence in the Pentagon will be more greatly missed than Donald Quarles, who died in his sleep a few days ago, as quietly as he had lived. It would also be difficult to find a man who brought to the job a greater combination of attributes needed to fill it and a greater devotion to duty. Don Quarles literally gave his life for his country. A few weeks ago he was urged to take a vacation. He replied that he hadn't the time. Doctors discovered after his death that the cause of it could have been averted by a little rest and a little relaxation of the tensions he unavoidably built up through the over-long hours and concentration he continually practiced.

Two Secretaries of Defense, Charles Wilson and Neil McElroy, leaned heavily on Don Quarles for guidance, especially in the military scientific field which broadened immeasurably after *Sputnik*. Many of the decisions which brought about our present military and space posture were, whether you like them or not, directly attributable to Mr. Quarles.

Lacking in scientific knowledge himself, Secretary McElroy must now find a man for his deputy who will adjudicate the split personality in the Defense Department which he, himself, has created; the three-headed organization of military space development—Directorate of Science and Engineering, Advanced Research Projects Agency and Special Assistant for Guided Missiles.

The man who helps Secretary McElroy with those decisions must also be prepared to step into the top job should the Secretary adhere to his original determination to return to his corporation position in late summer or autumn. The appointee must be prepared to name his own deputy and to remain on until the new administration. The greatest of all dangers to the country and its military program could be a lack of continuity in the office.

There have been a number of names suggested as a successor for Mr. Quarles and they cover a wide field—Henry Cabot Lodge Jr., the U.S. United Nations representative; Gen. Alfred M. Gruenther, former SHAPE commander and present head of the American Red Cross; Wilfred J. McNeil, assistant secretary and comptroller of the Department of Defense; and William C. Foster, present executive

vice president of Olin Mathieson Chemical Corporation.

Also possibly under consideration are Richard Horner, Assistant Secretary of Air Force for Research and Development, and Thomas J. Gates, Jr., Secretary of the Navy. Chiefly against the latter two is the fact that each is identified with one of the services and would draw immediate opposition from the others. Also, Mr. Horner has accepted a new post as general manager of NASA which he will assume on June 1 and which would complicate his acceptance.

On the others: Mr. Lodge, however brilliant otherwise, would be thrown into an unfamiliar field for which he is little prepared. He served in the Army during World War II and was President Eisenhower's campaign manager in 1952. Mr. McNeil is a career Pentagonist and certainly is familiar with all its operations, although his experience has been strictly financial and he would not be a popular choice with the services, where there is a feeling that he sometimes over-controls with the purse strings.

The appointment of Gen. Gruenther would require the passage of a special law because the act creating the office of Secretary of Defense specifies that it must be held by a civilian.

While not the most prominently mentioned, William Foster is possibly the most logical and the best qualified of the men whose names have been suggested. Actually, he was also under consideration for Mr. McElroy's position—if he left in the Autumn and if Mr. Quarles had not been named.

Bill Foster has held a variety of high level government jobs including Under Secretary of Commerce, Deputy Administrator of ECA and Deputy U.S. Special Representative in Europe, a NATO post.

And—he was Deputy Secretary of Defense from September, 1951 to January, 1953, serving under Republican Secretary Robert Lovitt during a Democratic Administration. He was educated at M.I.T. and, importantly, has never been very far away from OSD and its operations since leaving his position there.

As a member of the Gaither Committee, he is credited largely with writing the report of a year ago which recommended sweeping changes and reorganizations in OSD, many of which have been put into effect.

We have no idea who will be selected for the post, but we do feel strongly that the importance of choosing the right man is of vital consequence to the country. Selecting anyone but the best available man would be a great tragedy for it is one of the most important jobs in the world today.

Clarke Newlon

What are your missile fluid line design problems?

When you have problems in the fabrication and design of tube components involving critical tolerances for any missile, power plant and ground handling applications call STRATOFLEX.

For example, two special aluminum elbow tubing assemblies (shown below) were designed to convey liquid oxygen in missile power plants. These assemblies were designed and manufactured to rigid specifications. Made from 4.500 O.D. x .125 wall tube and machined flanges, dimensions between sealing surfaces (up to 16 inches) were held to tolerances of $\pm .010$ on linear and $\pm 1/2$ degree on angular dimensions.

Other design problems are being solved daily by Stratoflex Engineering. Allow your Stratoflex Representative to acquaint you with these specialized services.



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SFG-9



STEPS IN THE RACE TO OUTER SPACE

Nuclear Rocketship

Despite the sky-high transportation costs, lunar manufacturing should prove economically viable. With unlimited Solar power, controlled atmospheres and advanced automation, a considerable commerce could be realized in delicate instruments, rare minerals, reactor cores and other items that might be more efficiently processed or produced in the Moon's perfect vacuum.

To supply the Moon colonists, and to carry their production back to Earth, special rocketships will be developed.

Nuclear energy is the most promising source of propellant power. The ship shown here utilizes nuclear fission for heat and hydrogen gas as a working fuel. From pressurized tanks, the gas is fed through a heat exchanger, expanded, and expelled for the motive thrust.

When the craft leaves Earth, it carries only enough gas for a one-way trip. For, by extracting hydrogen and oxygen from Lunar rocks, Moon settlers will be able to

refuel the rocketship for the return voyage. This will permit smaller fuel tanks on the craft and larger payloads.

Inertial navigation systems will play an increasing role in the exploration of outer space. **ARMA** is actively supporting the Air Force's program in long range missiles and is in the vanguard of the race to outer space. **ARMA**, Garden City, N. Y. A Division of American Bosch Arma Corp.

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BRUNSWICK "SHOOTS" THE RADOME RANGE TO 1200° F

Brunswick makes a new breach in the thermal barrier with newly developed non-metallic materials that boost the temperature tolerance of radomes and nose cones to 1000-1200°F for limited exposure periods — almost twice the previous limit. This new advance in Brunswick's Strickland 'B' Process of filament winding opens a new chapter in aircraft and missile designing.

New "SBP" filament winding results in the highest strength-to-weight ratios ever obtained in radomes and nose cones with significant weight savings over conventional structures. With unmatched electrical uniformity, Brunswick builds them to meet the tightest tolerances for dielectric constants and compound configurations. Brunswick offers full electronic testing facilities.

Brunswick radomes and nose cones now slice skyward on such supersonic aircraft as the advanced Convair F-106; on such missiles as the Boeing Bomarc and Lockheed Q5. For details on Brunswick's leadership in research, development and testing, write: The Brunswick-Balke-Collender Company, Defense Products Division, 1700 Messler St., Muskegon, Mich.



BRUNSWICK

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washington countdown

IN THE PENTAGON

The Pentagon has cut the number of IRBM squadrons for NATO to eight—five Douglas *Thor* and three Chrysler *Jupiter*. Four 15-*Thor* squadrons go to Britain; probably all three 15-*Jupiter* squadrons go to Italy. That leaves only one *Thor* squadron for Turkey.

• • •

The secret Goodyear *Pinpoint* guidance system now under development will be used in ballistic missiles in conjunction with inertial guidance. *Pinpoint*—successor to topographical map-reading *Atran*—apparently will be used to direct the missile to its target with greatly improved accuracy during the terminal phase of flight.

• • •

The Navy expects to extend the range of Lockheed's *Polaris* considerably beyond 1500 nautical miles during the next four or five years. However, it says the first *Polarises* put into submarines next year will have a 1200-mile range. It says no modification of the submarines will be necessary as the range is extended.

• • •

The Air Force sees the Boeing *Minuteman* as a bargain weapon compared to *Atlas* and *Titan*. Cost of a *Minuteman* including its hardened site and related expenses is expected to run about \$1.5 million, compared to more than \$10 million for the *Atlas*.

• • •

The Navy is considering the use of inflatable rubber planes as missile-carrying drones. The planes could be flown from carriers.

• • •

Bigger megaton warheads are in the works for both the Convair *Atlas* and the Martin *Titan*. Until recently the *Atlas* has been scheduled to pack a four megaton warhead . . . the *Titan* seven.

• • •

The first of the Martin *Mace* groups being sent to USAF troops in West Germany is expected to be operational this summer. The *Matadors* that the 60-missile *Mace* groups are replacing are going to West German troops. Plans call for quickly replacing all three U.S. *Matador* groups with *Maces*.

Meantime, the *Mace*, which can be fired from mobile launchers, is about to go into hardened sites. The FY 1960 budget calls for spending \$10.2 million on hardened *Mace* sites in West Germany. (M/R, May 11.)

ON CAPITOL HILL

The House Defense Appropriations Subcommittee is readying a multi-million-dollar package increase in the FY 1960 budget for ICBM's. Extra money is included for *Atlas*, *Titan* and *Minuteman*. Some say the fattened appropriations bill will reach the House floor by early next month.

• • •

But some Congressmen don't hold out much hope that the Pentagon will pay any attention to the increase even if it clears Congress. The Air Force already has proposed that the nine-squadron *Atlas* program be increased considerably—possibly doubled. However, Defense Secretary Neil H. McElroy has made clear that he is opposed to it. Probable fate of any Congressional increase at this time: The money will be impounded.

AT NASA

A new NASA attempt to take over the Army's Redstone Arsenal appears almost certain prior to the formulation of a supplemental FY 1960 budget or the FY 1961 budget. If the move flops again, attempts will be made to put enough money in the new budgets to give NASA a similar facility. NASA officials have no complaints with the Army's cooperation at Redstone. But they feel that the space agency will need all of Redstone's in-house capability to design and integrate the newer space systems.

AROUND TOWN

The United States is planning to cooperate fully with Britain on its plans to develop a space exploration program of its own. Look for possible joint projects of increasing magnitude. So far the British are planning to turn out instruments for satellites and adapt some of their missiles for possible launchings.



a comparison:

4 MAGNESIUM ALLOYS for elevated temperature service

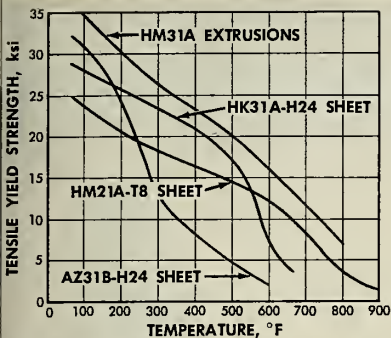
A wide variety of elevated temperature alloys extends the use of lightweight magnesium into the critical 300°-800°F. temperature range.

Name your weapon—Jupiter C, Polaris, Talos, Discoverer, Falcon or Bomarc. All make extensive use of elevated temperature magnesium alloys. Improved resistance to creep, increased stiffness and strength and exceptional shop characteristics are the long suit of these materials. At elevated temperatures they maintain a high ratio of fatigue strength to static strength. (About the same ratio as standard magnesium alloys at room temperature.)

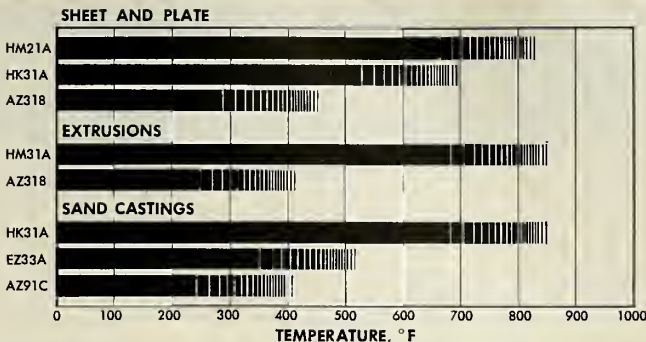
SHEET AND PLATE

Alloys HK31A and HM21A have been widely used for many different parts in missiles, rockets and aircraft. Some of the most common applications include body skins, engine air inlets and ducts, nose cowlings and cones, external and internal skins on control surfaces. HK31A extends the usefulness of light-

missiles and rockets, May 18, 1959



New alloys have extended magnesium's useful service temperature range.



A comparison of short-time tensile yield strength exhibited by a standard magnesium alloy and the commonly used elevated temperature alloys.

weight magnesium to a temperature of 500°F. and above. HM21A withstands temperatures up to 700°F. and higher for short time periods. And it exhibits better creep resistance above 350°F. and better static properties above 550°F., than does HK31A.

FORGINGS

At operating temperatures up to 800°F., HM21A offers excellent mechanical properties, optimum creep resistance. HK31A has better room and elevated temperature properties up to 400°F. Both have good forgeability.

CASTINGS

Engine air inlets and ducts and housings for electronic guidance systems are examples of the many applications of cast magnesium alloys HK31A and EZ33A. EZ33A has good general properties in the 350°-500°F. range. HK31A is recommended up to 700°F. and above. Components of military systems weighing as much as 105 lbs. have been cast in one piece with HK31A. A new elevated temperature alloy for die casting is now in development and will soon be available.

EXTRUSIONS

Alloy HM31A has put the many benefits of elevated temperature magnesium into extrusion form. This alloy is used as ribs and stiffeners in missile bodies, instrumentation booms and external tunnel fairings for wiring and plumbing, etc. HM31A maintains high elastic modulus, excellent creep resistance and strength at elevated temperatures. Elevated temperature exposure at 600°F. for 1,000 hours causes no change in room temperature properties and only a slight drop in creep strength.

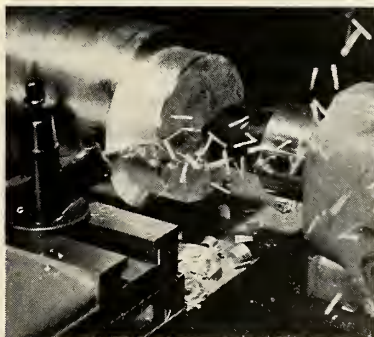
ELEVATED TEMPERATURE MAGNESIUM EXCELS IN PRODUCTION

The elevated temperature alloys possess the best welding characteristics of all magnesium alloys. Arc welded joints can be easily made and welding compatibility of magnesium alloys is excellent. For example, HK31A sheet can be welded to HM31A extrusions.

Weld efficiencies at room temperature range from 70% to 80%. At temperatures above 400°F., HK31A has a weld efficiency of 100%. The same goes for HM21A above 500°F. In general, preheating and stress relieving are unnecessary with these alloys. They can be readily spot welded and are not subject to cracking.

Machining operations can be carried out at extremely high speeds, with heavier depths of cut and higher rates of feed than are possible with other metals. All chemical treatments used to finish standard magnesium alloys are

applicable to the elevated temperature alloys, with the exception of Dow 7, which does not coat satisfactorily on magnesium-thorium alloys. For extended service above 400°F., the anodic treatments are preferred.



Elevated temperature alloys possess the same excellent shop characteristics—such as machining, forming and welding—as the standard magnesium alloys.

MAGNESIUM ALLOYS FOR ELEVATED TEMPERATURE APPLICATIONS

SHEET	HK31A HM21A
PLATE	HK31A HM21A
FORGINGS	HK31A HM21A
CASTINGS	HK31A EZ33A
EXTRUSIONS	HM31A



WRITE TODAY for this new 27-page illustrated brochure on magnesium alloys in aircraft and missiles. THE DOW CHEMICAL COMPANY, Midland, Michigan, Magnesium Sales Dept., I301CL5-18

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AIRCRAFT
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NAVAL AVIATION MAKES HISTORY

with ALL-JET TRAINING



NAVCAD Earland R. Clark of Stroudsburg, Pa., receiving congratulations from Rear Admiral Joseph M. Carson, Chief of Naval Air Basic Training.

On March 13 at the Naval Air Basic Training Center, Saufley Field, Pensacola, Florida, the first student pilot in Naval Aviation history soloed a primary jet aircraft—without previous propeller-driven aircraft experience. The flight was made in a TT-1 “Pinto”—designed specifically by Temco for all-jet training.

The first primary jet trainer ever purchased by any of the U. S. military services, the Pinto is designed for today’s jet age. It is built closely along the lines of high-performance jet fighter aircraft and gives the student pilot the “feel” of jet training from the very beginning.

With its high safety standards, fine handling characteristics, optimum maintenance provisions and overall reliability, the Pinto is an ideal primary jet trainer. From initial cost to operation and maintenance, it is designed to provide better pilots at less cost, in less time. All in all, it gives the Navy a decided edge in the ever-advancing pace of military jet aviation.



ELECTRONICS • AIRCRAFT • MISSILES

SYSTEMS MANAGEMENT

DEVELOPMENT

DIRECTED RESEARCH

PRODUCTION

industry countdown

STRUCTURES

Navy is complaining to Congress its 1960 FY request of \$35.3 million for *Asroc* and *Subroc* is "about one-half" of what should be spent for ASW torpedoes. Both missiles are now ready for production. Over next five years, Navy plans to spend \$100 million modernizing 200 ships for ASW capability, some with the Minneapolis-Honeywell *Asroc* (rocket assisted antisubmarine missile) which has replaced the *Rat* (rocket assisted torpedo.) Goodyear's *Subroc* (anti-submarine rocket missile), Navy says, will furnish submarines with "enormous kill potential."

• • •

Missile procurement is being cut back 15% by Air Force. In the 1960 FY, the AF plans to procure 1232 missiles compared to 1462 in Fiscal 1959. Figures do not include rockets and drones.

• • •

NASA contractors are now eligible for financial backing under the Defense Production Act of 1950. President Eisenhower has authorized the space agency to use the law to guarantee loans and other financial aid to insure delivery of goods or services.

• • •

Chances are good four-year extension of Renegotiation Act will pass Congress as approved by House Ways & Means Committee. Bill eases present provisions for two-year loss carry-forward to five years and provides appeal from tax court findings. Four-year extension is compromise between permanent extension demanded by House Armed Services Committee Chairman Carl Vinson and 27-month continuation sought by DOD.

PROPULSION

Look for speed-up in *Centaur* upper stage space vehicle development as a result of "breakthrough" in large-scale production and storage capability of liquid hydrogen. ARDC says "purest (liquid) hydrogen ever made" is now being turned out in quantities at Air Products plants in Painesville, Ohio, and Palm Beach and at Stearns-Roger Mfg. Co., Bakersfield, Calif. Ample supply may enable Convair *Centaur*, which has Pratt & Whitney LOX and liquid hydrogen second-stage engine, to advance production timetable now scheduled for "sometime" in 1961.

Coming up in June: second-stage flight testing of Martin's *Titan*. Largest second-stage rocket ever to be flown, the Aerojet-General propulsion system develops 80,000 pounds of thrust at altitude using LOX and RP-1 fuel. *Titan* is expected to be "approaching operational" by mid-1960.

ELECTRONICS

BMEWS and SAGE programmed construction in FY 1960 will top \$124 million—with \$76.3 million going into "hardened" SAGE installations to house completely transistorized computers in supercombat centers.

• • •

At Clear, Alaska, \$18 million worth of BMEWS construction is getting underway. Principal contractors for Corps of Engineers are Morris Knudsen and Patti McDonald (surveillance radar and scanner building); Baker & Ford (antenna and transmitter building); William A. Smith (railroad relocation). A&E is by Metcalf & Eddy and Skidmore, Owings & Merrill. Bids will be opened June 10 by Alaska district engineer on a powerplant. BMEWS systems contractor is RCA.

• • •

Keeping industry's doors shut to visiting Communist technical teams is being urged by Sprague Electric Co. President Julien Sprague. With one good look, says Sprague, a competent engineer may save 10 years of research simply by learning that a particular process can be accomplished by a new technique.

• • •

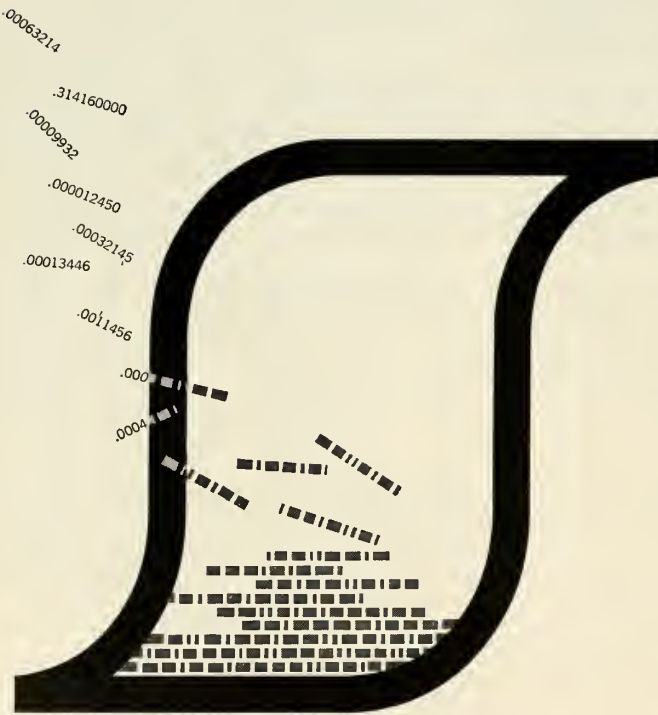
Expenditure of \$2 billion on missile electronics in Fiscal 1960 is forecast by EIA President David R. Hull. The weapon systems concept, adds Hull, should be continued because it enables the military to "buy competent management" and fixes responsibility for production and integration of complicated systems.

ASTROPHYSICS

Evidence is piling up that solar eruptions have a "braking" effect on the speed of earth satellites. Says Dr. W. O. Roberts of the University of Colorado: "Satellites appear to decelerate more rapidly at times of high solar activity, to experience greater drag." As yet, no explanation for this phenomenon.

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*"SCOTCH" Brand high potency oxides
let you pack more bits per inch!*

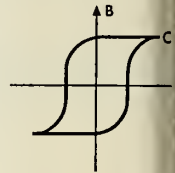


Every day SCOTCH Brand High Resolution Tapes are getting the nod for more instrumentation jobs. The reason? Performance. In taping high frequency data, the sharper resolution lets you pack more pulses to the inch—a greater density of information to each foot of tape.

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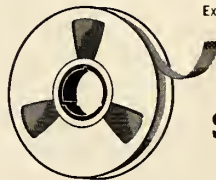


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U.S. Decides to Push ALBM— 'Invulnerable' Defense Weapon

*Douglas wins competition and begins design study
based on concepts tested by Lockheed, Convair and Martin;
GE said to have guidance contract*

by James Baar

WASHINGTON—U.S. grand strategy the future of missile warfare took sharp turn this month. It came with award of an Air Force contract development of America's air-launched ballistic missile—the much-delayed ALBM.

Douglas Aircraft Co., a dark horse contender who won the contract over competitors, has six months to come with a refined design and cost study first step in its development program.

The solid two-stage ALBM will be ordered after the concept already proved feasible in the firing of test missiles designed by a Lockheed-Convair team and Martin—both losing competitors for the development contract.

General Electric Co. is reported to be working on guidance and nose cone for the missile. Other subcontractors are expected to be announced shortly, a Thiokol believed ahead for the guidance contract.

The Air Force paid Martin \$5 million and Lockheed \$3.5 million for preliminary feasibility studies. Results were shared with all 15 competitors for the development contract. The Air Force also had an ALBM study contract with McDonnell.

Cost of the development contract is not known. The Air Force said it could be negotiated.

• **Program vague**—Meantime, many details of the program were withheld. If released at all, they were left vague.

But the overall scope and meaning of the program was clear. All one had

to do was look at the key characteristics the ALBM was expected to have.

- It will deliver a nuclear warhead.
- It will have a range of more than 1000 miles—possibly as much as 1500.
- It will be launched from supersonic bombers flying at up to more than 70,000 feet.
- It will travel a ballistic path out of the atmosphere and back at hypersonic speeds that will make it unstoppable once it is launched.
- It will have greatly improved guidance that will give it considerably greater accuracy than is considered acceptable for missiles with much larger warheads.

In simplest terms, the ALBM is merely an advance on the North American *Hound Dog*. But the advance is tremendous.

The air-breathing *Hound Dog*—recently launched successfully from a B-52 flying over the Atlantic Missile Range—was swiftly developed from off-the-shelf components for service during the years of the Missile Gap.

Its Pratt & Whitney turbo-jet engine enables it to carry a nuclear warhead 500 miles at only about Mach 1.7. It was designed for launching from the B-52G.

• **Use on B-70**—The ALBM will be developed for launching from the B-70 designed to travel at Mach 3 and the Convair B-58 designed to fly at Mach 2. It also will be launched from the intercontinental B-52G.

The B-70, still under early development, will have true intercontinental range. The B-58, scheduled to be operational next year, can be made intercontinental with refueling in flight.

Also, the ALBM is designed to be the Sunday punch of the CAMAL—the much-delayed program aimed at placing supersonic nuclear-powered planes on station in the skies.

And, finally, the ALBM is the obvious stepping stone to development of the space-launched ballistic missile which would be fired from a manned space craft or an orbiting satellite.

• **ALBM strategy**—The strategy involved in use of such a weapon as the ALBM has been hinted repeatedly in speeches and statements by top officials.

Supersonic and hypersonic bombers armed with two or possibly four ALBM's would stand by either on ground or air alert.

On word of a believed attack, they will streak toward their targets. On word that the attack is actual, they will launch their ASM's while still hundreds—possibly more than 1000—miles from enemy borders.

The launched ALBM's will perform at least two key missions:

- They will strike heavily defended areas deep in enemy territory where bombers would come under intense attack.
- They will smash defenses in the path of the bombers such as heavy artillery opens the way for infantry.

Then the bombers with their huge megaton capacity and their great accuracy will strike.

On the other hand, the nearly-sonic CAMAL (Continuously Airborne Missile Launching and Low Level) would carry possibly four to eight ALBM's. However, the plane itself would not be a bomber, too. It would combine being a launching platform with such roles

as providing early warning of attack.

The CAMAL program has been delayed repeatedly while military planners argued over whether they wanted to develop an advanced supersonic nuclear-powered aircraft or merely the best nuclear-powered aircraft that could be put into the air in the shortest time. It appears that the advocates of the latter have almost won.

CAMAL has the same obvious advantage as the *Polaris* nuclear-powered submarine—a means of maintaining an instantaneously ready retaliatory force that would be most difficult to find and destroy.

Some experts say the CAMAL plane could be operational in five years if the program were pushed. Others say considerably less time would be needed.

ALBM itself is expected to be operational much earlier than that.

• **No known defense**—Whatever the method of delivery, there is no known defense against the ALBM once it is launched. The only defense is to destroy the mother planes before launching.

This is one of the prime reasons that the Air Force is developing the North American F-108 with a range of more than 1000 miles. U.S. planners must assume that Russia also is working on development of an ALBM—as well as a long-range supersonic interceptor.

All in all, many in the Air Force

believe that the ALBM is such an attractive weapon that it will become the primary method for delivering the Air Force's strategic striking power in the future—both in the atmosphere and in space.

They base this conclusion on the grounds that the ALBM overcomes a number of the drawbacks of the ICBM while retaining most of its principal benefits.

• **ICBM faults**—One of these drawbacks is the stationary ICBM launching site which can be zeroed in by an attacker. Some experts contend that such bases will be vulnerable no matter how hard they are made.

The second prime ICBM drawback is its inflexibility. Once launched it can not be recalled. Also, because its launching site is stationary, the enemy knows the direction of the attack.

Third is the tremendous cost of the hardened ICBM bases. Comparatively, the ALBM is expected to be an economical weapon.

The Navy has also cited these drawbacks as reason for development of the *Polaris*. But some Air Force planners say not even the *Polaris* will have the flexibility of the ALBM.

Therefore, development of the ALBM is a turning point in U.S. strategic planning so far little appreciated either by Congress or the public.

Until now American retaliatory power has been generally seen as twofold: The SAC bomber fleets and the

building squadrons of ICBM's.

In many circles, the first of these already partly obsolescent—has been regarded as a weapon of the past & must be maintained at most five years or so.

By then SAC is expected to armed not only with the liquid Ccvair *Atlas* and Martin *Titau* but t solid Boeing *Minuteman*. Hundreds. *Minutemen* are expected to be stalled in hardened bases around country as well as on such portal platforms as railroad flat cars.

Even before then the United States is expected to have a fleet of *Pola* submarines on station.

Many—particularly economic minded Congressmen—have believed there is no need with all of this & the manned bomber, too.

• **ICBM vs. ALBM**—The Air Force planners disagree.

They contend that for America, rely on the ICBM alone for its ma retaliatory power would be similar France's reliance on the Maginot Line in World War II.

They argue that the ICBM is designed to meet a particular type threat and strategic situation. But one can say what the threat and strategic situation may be 10 to 15 years from now.

Moreover, they argue that relying principally on the ICBM leads toward molding U.S. retaliatory force solely as a deterrent of terror.

Under such a policy, the United States would forget for the most part about trying to destroy an enemy military power and concentrate on obliterating X number of his cities and X millions of his people.

Advocates of the policy argue that it would free millions of dollars for building limited war capability. They also argue that the continuing attempt to be ready to destroy enemy military power can only lead to bankruptcy and disaster.

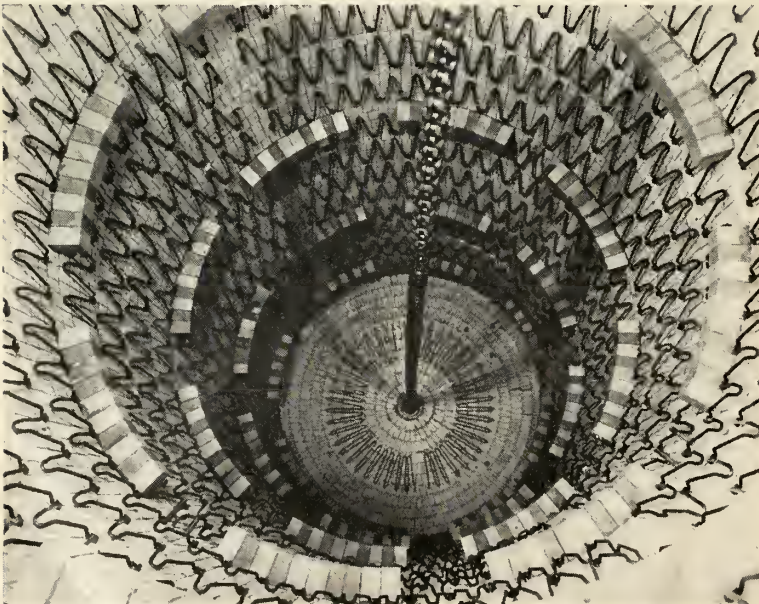
Opponents of the policy argue that it is the highroad to American defeat.

They contend that only the ability to destroy Russian military power would deter the Kremlin. For they contend no man can say that the Soviet leader would not be willing to pay 50 million Russian lives . . . 75 million . . . 10 million . . . if that were all that stood in the path of world conquest.

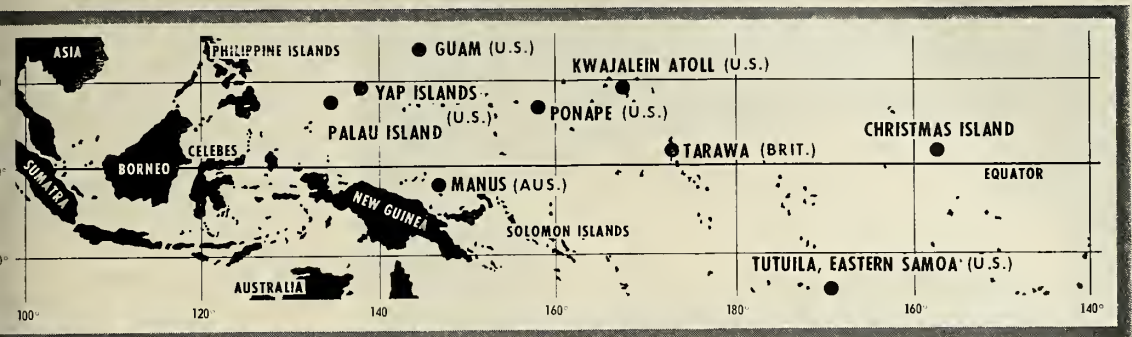
Therefore, they say the Defense Department today must be preparing the flexible forces that may be needed to meet the unknown challenges tomorrow.

Key to such a flexible force is the ALBM.

New Furnace Capability



NEW CONTROLLED atmosphere hardening furnace at Lindberg Steel Treating Co.'s plant at Melrose, Ill. Furnace is big enough to take Boeing *Minuteman's* rocket motor case.



POSSIBLE ISLANDS for equatorial astronautics base.

U.S. Seeks Manus Launch Site

ARPA has engineering plan to spend millions on tying island into PMR; NASA may help in development of site when selected

by William E. Howard

WASHINGTON—Scorpion-shaped Manus Island crouching a lazy jump in the equator in the far Pacific may be swept up soon by the Space

Unbeknownst to its 15,000 woolly-haired inhabitants, whose major occupations are growing coconuts and practicing *mana* (magic)—and sometimes when things are very dull, cannibalism—Manus is being eyed as an equatorial rocket and satellite launch-site. All of which spells millions of dollars more in support equipment and construction.

The United States, M/R has been, is formally approaching Australia to obtain permission to develop and integrate the 20x50-mile volcanic island into the Pacific Missile Range. Australia holds trusteeship over Manus. Embassy officials have indicated they expect no obstacles when negotiations reach the firm-up stage.

Just when this may be is uncertain, for several other Pacific locations are being considered. Among them are the U.S. trust territory islands of Palau, Yap, Kwajalein Atoll and Ponape; the U.S. possessions of Guam and Tutuila in Eastern Samoa; Britain's Tarawa Atoll, and Christmas Island, whose possession is disputed by the

Second of a Series on MISSILE SUPPORT

U.S. and Britain.

Still another proposal being kicked around the Pentagon is to build Texas Towers in the mouth of the Amazon River. But experts are questioning the feasibility of this idea from the standpoint of both cost and size.

• **Money and time**—Authoritative engineering estimates put the cost of fully developing an island like Manus into a self-sufficient launching base at about \$100 million—at stateside prices. In remote areas this figure would be multiplied by a construction cost index of 2.00 to 3.00 and it could go still higher if the project is enlarged or put on a crash basis.

And it would take over seven years to complete at an ordinary pace.

However, early launch capability, planners say, could be achieved for about \$23 million (stateside) and in about four years. A task force undoubtedly could bring it about a lot sooner.

Significantly, ARPA hopes to establish a global communications network within four years with Project *Courier*, which would utilize a system of three

24-hour satellites moving in orbit 22,400 miles from the equator. Key to early attainment of this project would be an equatorial launching.

Although it would be possible to launch communications satellites from Cape Canaveral or Vandenberg AFB, it would require more than 40% of the payload to shift them into an equatorial orbit. Improvement in the state-of-the-art in guidance and propulsion also would be needed.

Thus, as one military official puts it, an equatorial launch would be "easier and cheaper in the long run."

• **Safety factor**—Development of one-million pound thrust booster rockets and their attendant safety problems also is spurring consideration of establishing launch facilities in a more remote area. Some missilemen fear this point may be proved when the first attempt is made this fall to fire ARPA's *Saturn* booster—a cluster of eight *Jupiters*—at the Cape. They are wondering what will happen to Cocoa Beach if the cluster explodes.

A third factor bearing on the building of one or more equatorial launch sites is the anticipated future acceleration of space programs. They could in a few years completely overtax present facilities.

In looking over possible Pacific



MISSILE NEEDS would rival World War II development of Manus as U.S. naval base.

locations, planners have established these criteria: The potential site preferably should lie within 5 degrees of the equator, although practical considerations such as international agreements and land availability should not rule out sites within 15 degrees of the equator; there should be maximum easterly overwater travel; it should be situated where existing, programmed and proposed tracking, control and communication facilities may be utilized, and the site should be large enough to support required installations. It would also be desirable for the U.S. to own or have a voice in the control of the area.

• **Elevation 3000 feet**—On nearly all counts, Manus more than fills the bill. Largest of the Admiralty Island group, it lies 200 miles north of New Guinea in latitude 2 degrees south and longitude 147 degrees east.

Important to rocket firings, the topography of Manus is hilly, with elevations ranging from 1500 to 3000 feet. Dense, tropical rain forests cover most of the lowlands, but higher areas are grassy and dotted with pine forests. Mean temperature is about 80°F, the mean relative humidity 85-90%. Rainfall averages 150 inches throughout the year.

Some World War II facilities have been restored, so that the island has an abundant water supply, power and sewage disposal facilities. The Australians also have installed a new wharf, dry dock and refueling facilities and repaved the 6000-foot airfield runway.

These physical advantages are far superior to those of Tarawa Atoll (Latitude 1° 30' N Longitude 173° E) and Christmas Island (Latitude 2° N Longitude 157° W) which also are situated close to the equator. Tarawa's land mass is only 7¾ square miles compared to Manus' 1000 square miles.

Its population is 3600, and while the harbor is good, there is a limited water supply. Christmas Island covers 160 square miles, but has limited water and only "fair weather" anchorage facilities. Its disputed ownership is also a drawback.

Kwajalein, already scheduled for *Nike-Zeus* testing, lies farther away from the equator at Latitude 9° N Longitude 167° 40' E. It is comprised of 80 small, low-lying, sandy islands, has an excellent anchorage in a 655 square mile lagoon, but limited water supply.

• **Other possible sites**—Ponape (Latitude 7° N Longitude 158° E) and Palau (Latitude 7° 30' N Longitude 134° 30' E) are both U.S. trust territories. Ponape has a total area of 160 square miles and Palau, 216 square miles. Both, however, have quite large populations for their size and therefore present limited opportunity for development of a large installation and room for the operational force. The full complement for a launch site is envisioned as numbering 1200 scientists and technicians and 1700 dependents—a total of 3000.

Tutuila in Eastern Samoa (Latitude 14° S Longitude 170° 30' W), another U.S. possession, extends over only 76 square miles and has a population now of 22,400. Otherwise it has elevations to 2140 feet and excellent harbor facilities. Guam (Latitude 13° 20' N Longitude 144° 40' E) offers 225 square miles, but already is crowded with a large U.S. naval installation and a population of 59,500.

Lack of water would be a restrictive factor on the Yap Islands (Latitude 9° 30' N Longitude 138° 10' E) along with available land. The area comprising four closely placed islands covers about 80 square miles and is hilly terrain.

Manus, on the other hand, offers the potential for supporting a large population with its abundant water supply and land area. As a down-range subcenter of the PMR, it would be well positioned geographically for not only equatorial, but the launching of polar-orbited space vehicles. It could also serve well as a logistic center for future down-range tracking stations.

An all-inclusive preliminary feasibility study of Manus has been made by the Ralph M. Parsons Co., Los Angeles architectural and engineering firm, which conceives of development progressing through five phases—starting with task force capability.

To fit the island for launching at the earliest possible date, there would be a minimum of construction at maximum use made of government-furnished portable facilities such as oxygen generating plants, power generators and (bachelor) housing accommodations.

Over the long haul there would be a requirement for complete technical support and community facilities.

• **Launching complex**—Technical facilities embracing the launching base, tracking station and communication center would represent the biggest cash outlay—almost \$10 million initially at about \$34 million (stateside) to complete.

The launch complex would include pads, gantry, buildings for control service and shops; fuel and oxidizer storage; missile check-out and assembly buildings; a warehouse; hydroelectric generation and oxygen-nitrogen liquefaction plants, and installations for instrumentation and control systems.

The communications center would require buildings for programming, receiving and transmitting; an emergency power plant; and antenna "farms" for transmitters and receivers.

Tracking station facilities would embrace structures for telemetry, data processing, angle and optical trackers, a boresight tower, antennas and transmitters, and the instrumentation system.

Support facilities, including supply maintenance and administration, would be concentrated at Lorengau Harbor and nearby Mokerang Airfield. They would require in addition to warehouse and storage structures, a tank farm, pipelines and pumping station, docks and tanker unloading buoys.

More buildings would be needed to house administrative offices, personnel and security offices, a laboratory, engineering section, a fire station and the other necessities of a large base.

Whether such a comprehensive

to change the face of Manus or any other Pacific island becomes a reality, may be decided soon. ARPA officials are reported to be studying a plan, and although no money has been budgeted yet for construction, the agency could initiate engineering studies at any time. Such a site undoubtedly would prove its value particularly in the *Dyna-Soar* program.

NASA also is known to be interested in an equatorial launching site, but is yet to demonstrate any wild enthusiasm—such as allocating money.

An official of the space agency, aware of the two-year lead time needed to get such a site ready for a shoot, told M/R that "as of this week, anyway" no programs scheduled during the next two years by NASA would

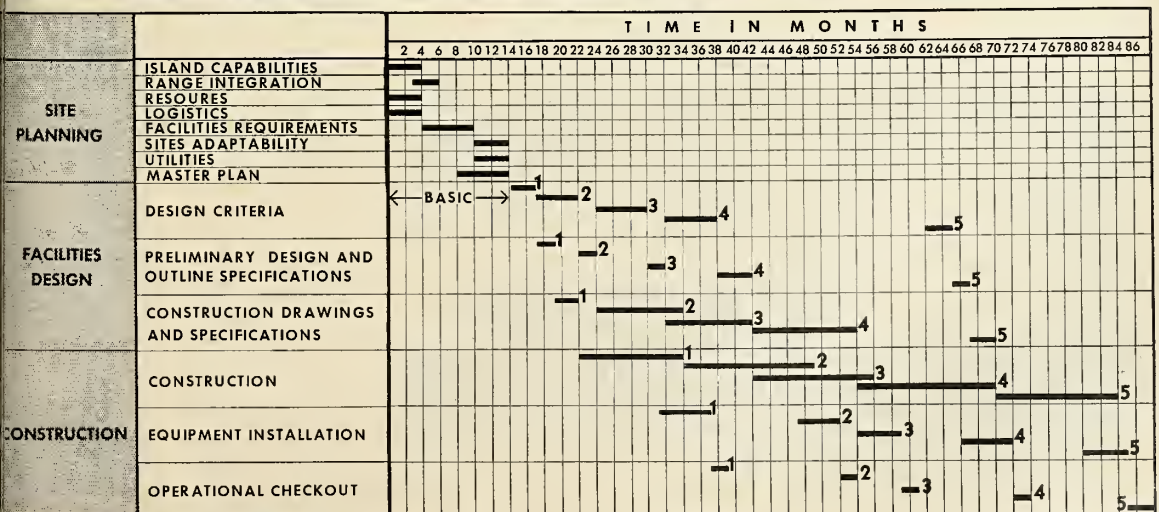
absolutely require such a base. He said that an equatorial orbit would not help the *Mercury* manned space capsule project, because launch and recovery will be "much less" expensive and easier technically off the Cape.

Other NASA experts concede that they would be happy to see ARPA go ahead with a Pacific site. And in that event, NASA might help pay for it.

ESTIMATED COSTS FOR DEVELOPING MANUS ISLAND

	PHASE ONE CONSTRUCTION	PHASE TWO CONSTRUCTION	PHASE THREE CONSTRUCTION	PHASE FOUR CONSTRUCTION	PHASE FIVE CONSTRUCTION	TOTALS
TECHNICAL FACILITIES						
LAUNCHING BASE	\$8,400,000	\$4,750,000	\$3,950,000	\$7,500,000	\$3,750,000	\$28,350,000
TRACKING STATION	520,000	500,000	1,100,000			2,120,000
COMMUNICATIONS CENTER	1,030,000	400,000	850,000	580,000	600,000	3,460,000
	<u>\$9,950,000</u>	<u>\$5,650,000</u>	<u>\$5,900,000</u>	<u>\$8,080,000</u>	<u>\$4,350,000</u>	<u>\$33,930,000</u>
SUPPORT FACILITIES						
ADMINISTRATION	\$ 780,000	\$6,110,000	\$1,400,000	\$ 500,000	\$ 510,000	\$ 9,300,000
MAINTENANCE	500,000	885,000	200,000	250,000	300,000	2,135,000
SUPPLY	4,250,000	1,405,000	600,000	1,450,000	400,000	8,105,000
	<u>\$5,530,000</u>	<u>\$8,400,000</u>	<u>\$2,200,000</u>	<u>\$2,200,000</u>	<u>\$1,210,000</u>	<u>\$19,540,000</u>
COMMUNITY FACILITIES						
HOUSING	\$3,200,000	\$3,200,000	\$4,120,000	\$3,640,000	\$3,640,000	\$17,800,000
EDUCATIONAL			660,000	3,000,000	3,000,000	3,660,000
MUNICIPAL	250,000		1,000,000	50,000	50,000	1,330,000
RELIGIOUS				340,000	340,000	340,000
SERVICES	450,000	235,000	200,000	320,000	50,000	1,455,000
RECREATIONAL	20,000	75,000	170,000	40,000	400,000	705,000
	<u>\$4,120,000</u>	<u>\$3,510,000</u>	<u>\$6,150,000</u>	<u>\$4,000,000</u>	<u>\$7,480,000</u>	<u>\$25,260,000</u>
UTILITIES AND TRANSPORTATION						
ELECTRIC POWER	\$ 950,000	\$6,700,000	\$6,450,000	\$ 450,000	\$ 450,000	\$15,000,000
WATER	1,300,000	900,000	500,000	300,000	400,000	3,400,000
SEWERAGE	300,000	100,000	470,000	100,000	100,000	1,070,000
COMMUNICATIONS	250,000	100,000	150,000	100,000	200,000	800,000
ROADS	800,000	500,000	300,000	400,000	500,000	2,500,000
AIRFIELD						
LIGHTHOUSES						
LABOR						
	<u>\$3,600,000</u>	<u>\$8,300,000</u>	<u>\$7,870,000</u>	<u>\$1,350,000</u>	<u>\$1,650,000</u>	<u>\$22,770,000</u>
ESTIMATED STATESIDE COSTS	<u>\$23,200,000</u>	<u>\$25,860,000</u>	<u>\$22,120,000</u>	<u>\$15,630,000</u>	<u>\$14,690,000</u>	
CUMULATIVE ESTIMATED STATESIDE COSTS	<u>\$23,200,000</u>	<u>\$49,060,000</u>	<u>\$71,180,000</u>	<u>\$86,810,000</u>	<u>\$101,500,000</u>	<u>\$101,500,000</u>

OP TABLE shows estimated costs for five-step development of Manus into self-sufficient equatorial launch base. In table below required time of planning, design and construction is plotted. Numbered lines correspond to phases of construction in upper table.



Senate Armed Services Committee has virtually dictated to DOD which missile interceptor system to continue—*Nike-Hercules* or *Bomarc*. The committee slashed \$17.3 million from the \$22.4 million request for *Nike* installations, but approved the full authorization for Boeing's *Bomarc*.

Manned space vehicle applications may be in sight for new "aerial bobbed" pilot ejection capsule developed by 18-member Industry Crew Escape Systems Committee under ARDC for the F-106 supersonic jet interceptor. Capsule is propelled from aircraft by 7000-pound-thrust solid-fueled rocket. Convair has \$1.5 million contract to produce first units.

Smithsonian Optical Tracking Station at Woomera, Australia, on May 1, 3 and 4 photographed *Vanguard I* six-inch satellite at its apogee 2500 miles from earth with Baker-Nunn precision camera. Feat was comparable to photographing a golf ball from 600 miles away and indicates significant advance in tracking capability.

The first of three heat shields of laminated phenolic resins for *Mercury* space capsule has been delivered by General Electric to NASA. Shields will be tested in July.

Complete orbit of the Van Allen radiation belt will be possible with *Vega*, says Convair-Astronautics Manager J. R. Dempsey. The NASA space vehicle to boost large payloads into orbit would be capable of carrying powerful telemetering equipment to give more complete data about the

belt. Dempsey says *Vega* also will be used to measure the gravitational fields of the moon and planets and the composition of the atmosphere of the planets.

Steel industry sources feel an alloy of chromium, nickel, molybdenum and aluminum may be the structural metal for the first manned lunar space craft. Relatively low in cost, the alloy withstands temperatures up to 1000°F and can be produced in large volume.

Navy reports "entirely successful" a stage-separation, flight control reactions and systems performance test of the Lockheed *Polaris* May 8. Range and impact were not primary objectives, but the solid-fueled missile traveled 700 miles. In addition, the Navy says a problem has been resolved in the missile's jetvators, which were affected by high temperature in earlier flights.

Keel of first U.S. nuclear-powered guided missile frigate—the Bainbridge—has been laid at the Bethlehem Steel Co. Quincy, Mass., shipyard. Besides twin surface-to-air *Terriers* mounted fore and aft, the high-speed 550-foot warship also will carry ASW weapons and conventional armament.

Marquardt Corp.'s Ogden, Utah, plant will begin delivering *Bomarc* engines on a fixed-price basis this month. At Ogden, the company also is starting up production on the Super *Bomarc* IM-99B engine. These will be cost-plus-fixed-fee units.

Solid-propellant production capacity

of 500,000 pounds per month is now reported by Grand Central Rocket Redlands, Calif. The company says has added about \$2.5 million in new R&D facilities in the past eight months and revamped its top management.

East Coast-West Coast warfare or defense business is rocking Congress. Easterners have introduced legislation which the Westerners claim is directed at taking contracts away from California companies. Meantime, the Los Angeles Chamber of Commerce has whipped up a "task force" of city officials and manufacturers to "defend" the state's missile-aircraft industries.

Delivery of first thrust chamber for ARPA's *Saturn* H-1 cluster of eight *Jupiter* engines has been completed by the Rocketdyne Division of North American Aviation. Static firing of fully-assembled cluster at ABMA Huntsville, Ala., now reportedly is set for mid-October. First flight test may be attempted in the middle of next year at Cape Canaveral.

Cutter Laboratories Berkeley Calif., pharmaceutical firm, has acquired Olympic Plastics Co. of Los Angeles—a supplier of high-temperature plastics for missiles and rockets. Olympic management and personnel will remain unchanged by the merger.

A second X-15 is being built by North American Aviation to carry out the first powered flight of the rocket research aircraft. X-15 No. 1, which has been taken aloft in captive flight still must pass a glide test before the powered flight test of No. 2 airplane

Satellite network to aid in the search and rescue of lost or stranded vehicles, nose cones and space capsule is being proposed by Space Electronic Corp. Doppler technique would be applied in locating signals broadcast by subminiature radio transmitter in the object sought.

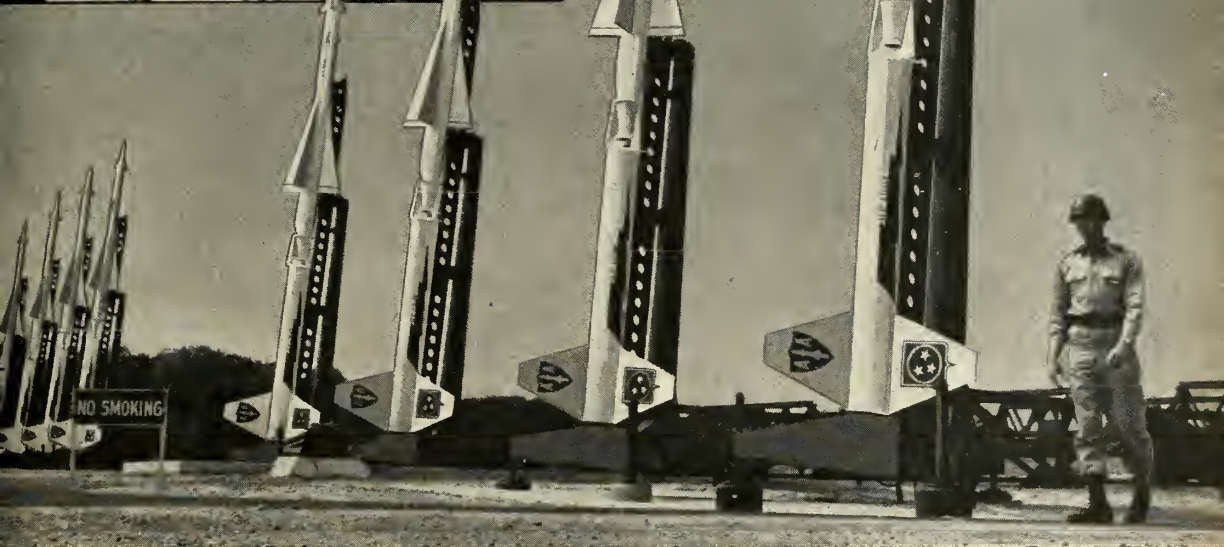
Firing of *Jupiter* IRBM May 6 by AF 864th Technical Training Squadron was to test complete missile operation in tactical configuration—including the warhead and fuzing apparatus working together as a system. The missile successfully completed its programmed 1500-mile flight.

Ryan Aeronautical Co. will break ground this summer for an electronics test facility at San Diego, Calif. New installation will support the company's electronics R&D program.

—First Operational Mace—



THREE TAC missile groups in West Germany are receiving the Martin *Mace*, 1000-mile range all-weather missile capable of delivering nuclear warhead. AF has programmed \$193 million for *Mace*, which will be deployed in hard bases.



Martin electronics . . . eyes for missiles

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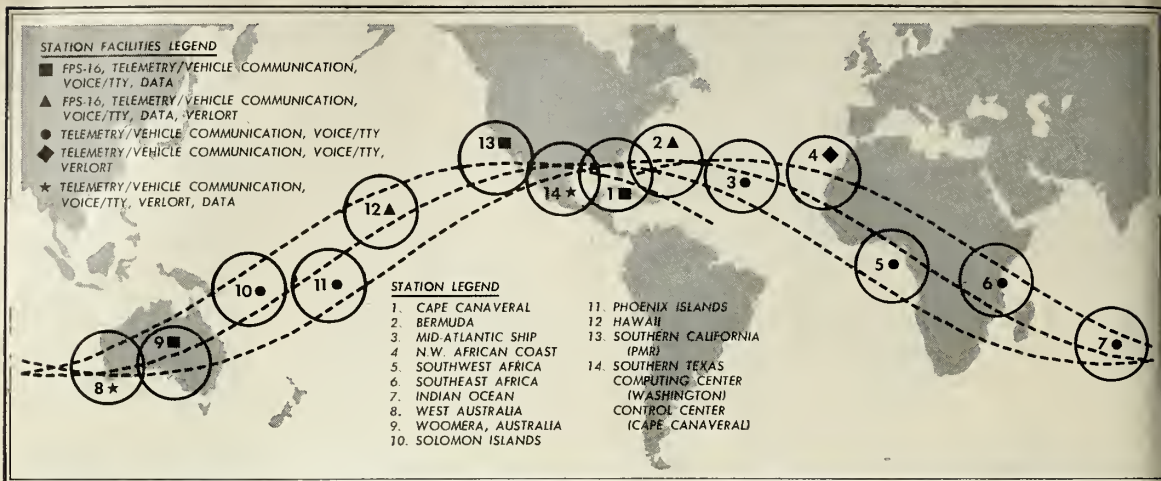
From a remote location, the Missile Master electronic control center detects approaching planes, determines "friend or foe", assigns targets for a whole ground-to-air missile battery and gives command to fire.

Martin's new R&D and production facility, located in beautiful Orlando, Florida, offers unlimited growth potential to the man who can make his mark in missilery and electronics. Gray matter is the priceless commodity we seek. Would you come and bring yours?

Senior level openings for Electronic Engineers, Physicists, and Electrical engineers in these design areas: pulse circuitry, electronic packaging, transistor circuitry, production test equipment, digital and analog computer. Opportunities for men experienced in calculating solid state parameters, molecular distribution and quantum mechanics. Send confidential resume to: J. F. Wallace, Director of Professional Staffing, The Martin Company, Orlando 34, Florida.



A great name in electronics/missiles



ORBITS AND tracking station locations needed for planned range.

NASA's Project Mercury Range To Cost \$12 Million Plus

World-wide tracking system with unprecedented reliability must be operating within year

by Paul Means and Hal Gettings

WASHINGTON—Final briefing on the Project Mercury Range contract is being given by NASA at Langley Field on May 18 for the 18 competing firms.

NASA hopes to award the contract, initially worth over \$12 million, to the winning firm or team of firms by July 1. The range must be in operation by May, 1960, when orbiting of the first six dead loads and six animal loads will get under way.

Responsibilities of the Project Mercury range contractor will embrace integration of the entire system including the computers at the Goddard Space Center's temporary headquarters (NRL), the master control center at Cape Canaveral, the world-wide tracking system and the direct data relay lines.

The contractor's duties will also include construction of some of the 14 major stations on the range—three of them to be built at Hawaii, Texas and Bermuda—and integration into the

system of 10 sub-stations, which may involve as many as five ships.

• **Unprecedented demands**—The integrated tracking, communications and telemetry facilities for Project Mercury will comprise the most complete global data link system yet devised. Requirements for the manned missile will demand links much more complicated and reliable than any needed for unmanned vehicles.

Super-accurate trajectory information, voice communication between vehicle and ground, a world-wide communications link, and complete reliability are all essential to the success of the project.

Plans are to use existing facilities wherever possible. But much new equipment will have to be designed and new facilities installed to complete the necessary instrumentation.

Tracking and communications will be required continuously during launch, post-insertion and re-entry, and periodically during orbit. The system must be adequate for emergencies with im-

pect prediction always available and communication with the vehicle possible.

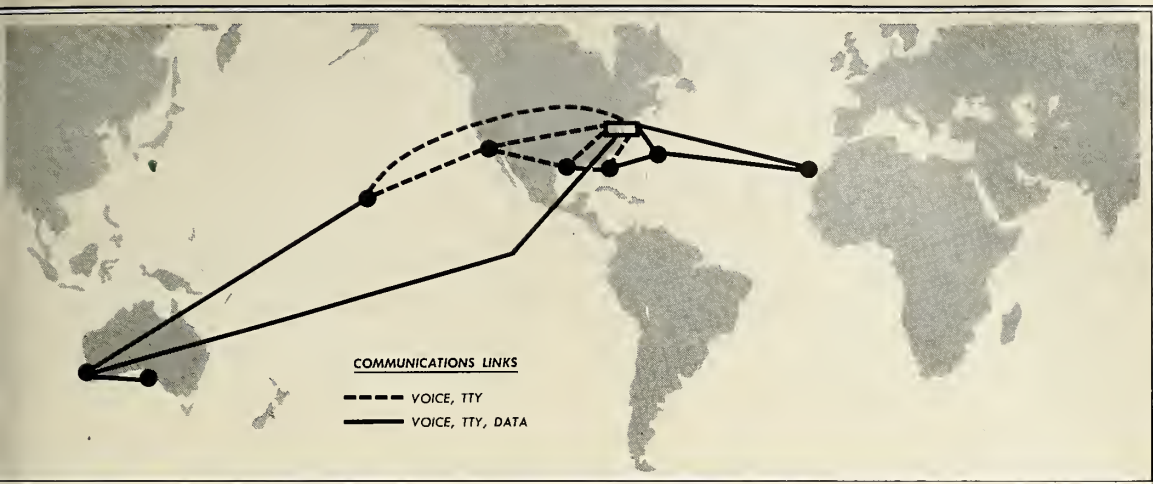
Basic range functions will include: (1) determination of vehicle location; (2) monitoring of vehicle and occupant status, and (3) abort and re-entry initiation control.

Radio communications with the vehicle will call for two voice channels (UHF and HF), one command, and two FM/FM telemetering channels.

Inter-station communications will include voice, teleprinter, and data circuits. Reliability requirements are 99.99% for the U.S.-Hawaii cable circuits and as high as the state-of-the-art will allow for overseas radio.

One of the best-kept secrets will be the frequencies on which the Project Mercury radios send and receive. This is to keep curious hams from tuning to the frequency and accidentally setting off the abort mechanism or making the capsule give other premature responses.

• **Hint of Cost**—Entire cost of the missiles and rockets, May 18, 1959



DIRECT COMMUNICATION links needed between tracking stations and computing centers.

ange has not been announced, but previous NASA budgets provide \$5,500,000 for the construction of the Southern Texas station and \$12,500,000 for integration and construction of the range.

Final make-up of the *Mercury* range will depend a great deal on its performance during the deadweight and animal payload orbits beginning in mid-1960. NASA officials think it will take a year and a half of testing to prove the range, capsule and booster.

Basic idea is to get the system to operate satisfactorily without manned control of the capsule, so that the direct voice communications system and the astronaut's controls in the capsule will be only added safety measures.

Ideally, the astronaut will not have to use any of the controls at his disposal, and NASA will not let man inside in the capsule until the system has proven that it doesn't need him.

Insert into the near circular orbit (apogee 120 miles, perigee 110 miles) will come about 400 miles north and east of the Cape Canaveral launching site. Retro-firing will commence on the third orbit 600 miles from the West Coast, with impact in the Atlantic Ocean about 400 miles from Cape Canaveral.

Almost continuous tracking is needed in order to get an accurate estimate of impact area at any moment that the capsule needs to abort from its orbit.

The orbit is designed to keep the astronaut over friendly territory at all times so that the capsule can be recovered regardless of where in the orbit it had to abort.

Meanwhile, training, indoctrination and education of the seven astronauts who will "fly" the *Mercury* capsule has begun at Langley Field, Va.

The initial phase of the program will include: 1) science education; 2) space flight familiarization; 3) operation of the *Mercury* vehicle; 4) participation in vehicle development; 5) high-performance aircraft flight training; 6)

familiarization with support equipment and launch crew operation.

The program will use existing research, development, training, and test facilities of the armed services, industry, and educational institutions.

Mach 1400 Shock Waves Created

EVERETT, MASS.—Interplanetary shock waves, which travel at speeds in excess of 1,000,000 mph (Mach 1400), have been duplicated in the laboratory.

Using an electrical charge of 4,000,000 kilowatts in a 30-inch shock tube, scientists at Avco's Everett Research Laboratory successfully reproduced for the first time the thin shock waves which result from solar flares. A temperature of 1.5 million degrees was generated by the ionized gas wave which was contained within a magnetic "cylinder."

These fantastic conditions were obtained under the supervision of Dr. Arthur Kantrowitz and Prof. Thomas Gold. Dr. Gold first advanced the theory that interplanetary shock waves, generated by solar flares, were responsible for "squashing" the earth's magnetic field with great suddenness. He suggested that the shock wave travelled by collision of force fields surrounding hydrogen ions and electrons. The "thin" shock wave produced in the laboratory confirmed this theory.

Avco has been responsible for a great deal of the research work on reentry problems associated with the *Atlas*, *Titan*, and *Minuteman* missiles. Their advanced shock tube experiments have yielded much data on re-entry heating. The facility was the first to obtain the Mach 25 speeds needed for problem study.

Much of the hypervelocity research has been sponsored by the Air Force

Office of Scientific Research in Cambridge, Mass.

Another significance of this experimental work lies in the clearer understanding of very high temperature (ionized) gas called "plasma," its nature and how to confine and direct it by magnetic fields. One and one-half million degree gas temperatures are obtained in the electric shock tube. At this temperature, all known matter would vaporize instantly. In the apparatus, this ultra hot gas is confined within a "magnetic wall."

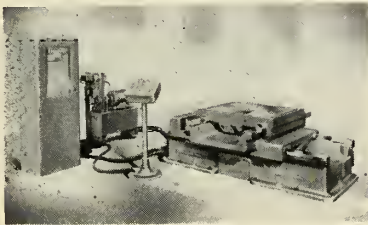
By using a rarefied mass of hydrogen, pushed by a magnetic field tightly confined in the shock tube on every side except one, velocities in excess of 1,000,000 miles per hour were obtained. The four billion watt electrical impulse needed to achieve this is produced by discharge from condensers in two millionths of a second.

The electric shock tube which produced this thin, high-speed shock wave was developed by Dr. Richard Patrick, an Avco physicist, expert in the young science of magnetohydrodynamics (MHD). Earlier experiments at the Avco-Everett Research Laboratory had obtained high temperatures in a "pill-box" apparatus which produced cylindrically converging shock waves in deuterium gas. Drs. G. Sargent James and Harry Petschek and Nelson Kemp, all physicists at the laboratory, are widely known for their contributions to current understanding of MHD.

Tape-Controlled Table Works to Millionth-Inch

A new positioning table capable of accuracy equal to the finest jig borer has been developed by **The American Tool Works Company**, for application to heavy-duty production drilling and boring jobs, both short and long run.

Numerically controlled by an endless punched tape, the 8000-lb. position table is of rugged construction. It can support heavy workpieces, positioning the work anywhere within a 30" x 20"



working area with an accuracy of $\pm .000250$ " (non-accumulative) on either axis, or repeating a position within ± 50 millionths (.000050"). And, according to company engineers, the table can hold these accuracies even when installed out in the shop.

Unlike a jig borer or a spacer table with set stops or dials, the new machine is fast in positioning and does not depend upon the skill of the operator. The table travels automatically from one position to the next, moving simultaneously on both axes ("x" and "y") at the same speed from start to finish of movement—yet with no over-travel. Actuation is entirely hydraulic, eliminating both traversing screws or nuts and their associated back-lash problems and motors with their inertia problems. Because the hydraulic actuating cylinders are in a balanced closed circuit, the table is rigidly held in position when the pistons are at rest. There are no clamps to produce a shift in table position.

The new tape-controlled table, reports American Tool, is suited for job-lot runs, large or small. With the endless punched tape, as soon as one workpiece is complete the machine is ready for the next without rethreading of the tape. Intermediate positions on the end-

less tape cannot be lost, since the hole pattern, once punched, remains in proper relationship for the entire life of the tape—good for thousands of pieces. The tape's small size also facilitates economical storage.

The complete tape control system of the machine is housed in a pressurized cabinet, designed to keep out shop dust and dirt. An operator's control panel is mounted on a separate stand which can be moved about for maximum convenience.

A punched tape can be installed in the control system cabinet in a few seconds. It can be inserted under the reader in any position inasmuch as the control unit will automatically locate the "start." This "start" is usually the loading position directing the table to travel to its furthest front position. This permits the operator to load and unload his workpiece with a hoist, if needed.

During operation, the punched tape is read pneumatically by a flow of low-pressure air. This air, passing through the holes in the tape, actuates a selected series of switches, signalling the electronic control system where the positioning table is to move (in terms of "x" and "y") to arrive at the next working location. The electronic circuits then actuate the machine's hydraulic system to perform the required travel.

Feed-back signals—which tell the electronic system (product of **The Sperry Gyroscope Company**) where the table is presently located and announce its arrival at the new position—are supplied by two Farrand electronic scales, one each on the "x" and "y" coordinates. Each scale is made of glass with embossed wiring, and is read by a slider which maintains a .005" air space away from the scale surface. By virtue of this air gap, wear of any kind is prevented. These electronic scales are located in two hermetically sealed housings.

The use of air pressure for reading the punched tape prevents elongation or opening up of the punched holes and preserves accuracy of the original tape. There are no mechanical steel tape-reading fingers of any type in the system. The same air pressurizes the control cabinet, keeping out dust and dirt.

Circle No. 238 on Subscriber Service Card.

Valve Assembly Features Titanium Bellows

Packless valve stem assemblies with seamless bellows made of titanium, believed to be the first ever made from the light metal, are being produced for a homogeneous reactor project at Oak Ridge National Laboratories by Fulton Sylphon Division, **Robertshaw-Fulton Controls Company**.

The assemblies are being used in an all-titanium primary reactor loop de-



signed to carry a highly corrosive uranyl sulphate solution at high temperature and pressure.

Experiments showed that gold-plated bellows were unsatisfactory.

Performance requirements for the bellows assemblies were unusually high. They called for operation at 300°C at pressure of 2500 psig (constant), with 1/8" stroke, spring rate not over 1250 lbs. per inch. Outside diameter of the finished bellows is about 1 1/4".

Problems in manufacture of the bellows concerned basic difficulty in forming titanium, due to its low elongation properties. The bellows were made from grade 55 sheet titanium.

Circle No. 239 on Subscriber Service Card.

Safety Claimed for Bi-fluid Tester

Amthor Testing Instrument Co. announces "the first successful bi-fluid tester, type 472, that can test oxygen equipment, and still employ oil or glycerine in the separate piston-cylinder chamber, without any danger or hazard."

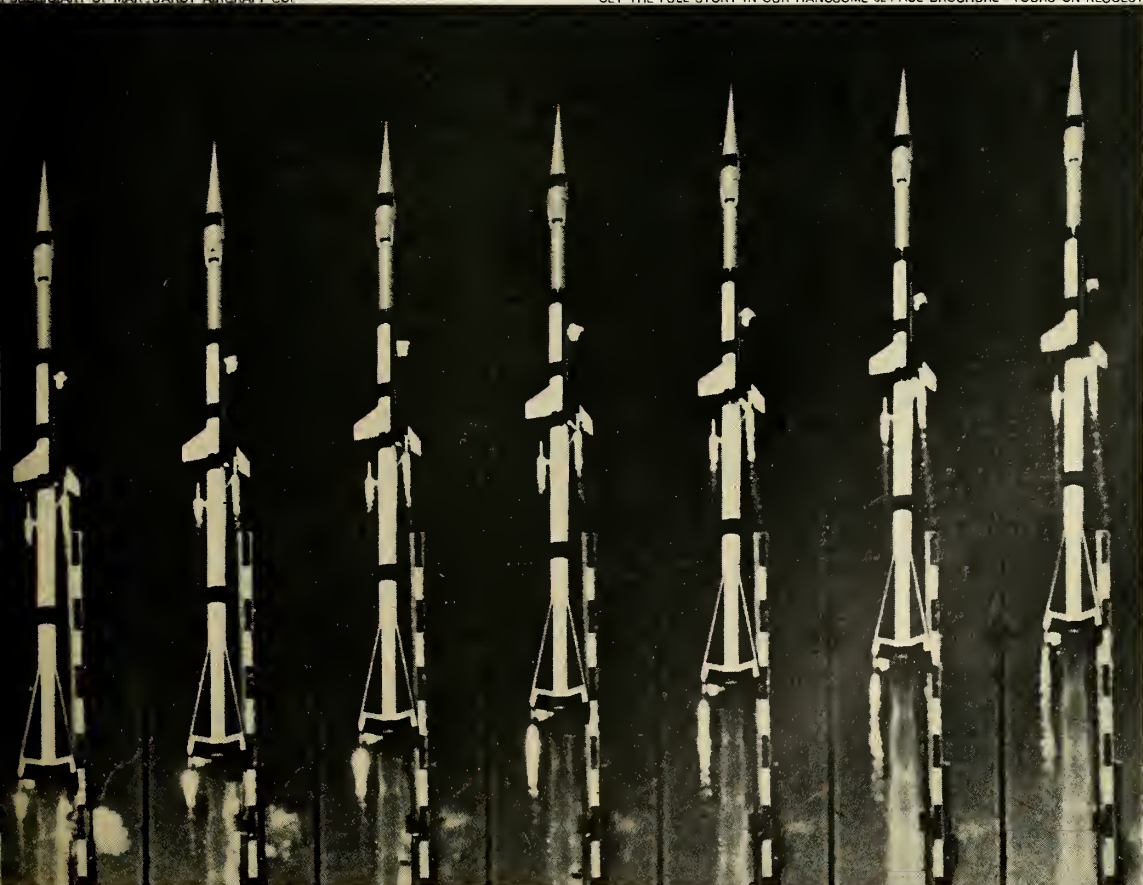
The Amthor BI-FLUID tester offers critical performance in testing all types of equipment that might present the same problems as oxygen equipment.

Constructed with a 2-piston hydraulic system, the tester is used for testing missiles and rockets, May 18, 1959

From drawing board conception to outer space performance—CDC offers complete responsibility. Building systems on paper is one thing. Building them in the shop is another. Hardware currently performing in the upper atmosphere and out in orbit attests to the fact that CDC does both, and does them well. CDC offers you across-the-board services in rocket and missile systems: propulsion, electronics, telemetry, instrumentation and ground support. One responsibility for all! Cooper Development Corporation
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SCIENTISTS, CREATIVE ENGINEERS—INVESTIGATE THIS FIELD WITH A FUTURE, CHALLENGING WORKING ENVIRONMENT IN SOUTHERN CALIFORNIA.

lic hand pump, this new tester, the company claims, surpasses any other previous tester in operating performance due to its ease of operation. The volume per stroke of the large pump piston is approximately 8 times greater than that of the small pump piston, thereby allowing quick filling of the unit under test. The large pump piston automatically becomes inactive with increasing pressure, thus enabling the operator to create 10,000 P.S.I. with approximately 17 lbs. hand pressure.

This new BI-FLUID design is said to be economical, accurate and safe and eliminate the possibility of contamination and risk of oxidation. Pure water which may be used as the hydraulic fluid for the gauge or unit under test is easily removed and never reused; thus production time is saved, while the use of oil or glycerine as the hydraulic fluid for the piston-cylinder assures accurate and sensitive performance.

Circle No. 225 on Subscriber Service Card.

Pressure Control Snap Switch Is Marketed

United Electric Controls Co. now offers an aneroid absolute pressure control which incorporates a double-throw, high-temperature-withstanding, snap-action switch, for rockets and missiles. This small, rugged, lightweight control is ideal where space and weight are important factors.

For specifications covering this type of controls and other pressure and temperature controls manufactured by UE, write to the company.

Circle No. 226 on Subscriber Service Card.

Instrument Measures Material Erosion Rate

A new technique for measuring erosion is provided by Era Engineering Inc.'s Material Erosion Rate Instrument (MERI). This instrument will measure the thickness of any material under free flight or laboratory conditions. The output is in the form of an electrical signal which can be recorded on magnetic tape or telemetered to a remote receiver.

This new technique for continuous thickness measurement consists basically of impregnating a small element of the eroding structure with a radioactive material and measuring the resulting radiation as a function of time. The radioactive material is uniformly distributed throughout a small cylindrical hole drilled perpendicular to the surface to be studied.

As the surface is removed, the activated material is carried away in proportionate amounts. The output of the instrument is a direct measure of the amount of activated material remain-



ing as a function of time and thus a measure of the thickness as a function of time. For any given material (metal, metal oxide, plastic, etc.), a binder with essentially the same physical and thermal properties as the original material can be procured to hold the few micrograms of radioactive emitter used. This insures that the surface of the activated plug coincides with the surface of the structural material.

The MERI consists of a small detector probe, electronic circuitry for measuring the radiation level, and an activated plug. The entire system is subminiaturized and has been tested for operation in a rocket vehicle environment. It can be supplied with internal batteries, or can operate from external power supplies.

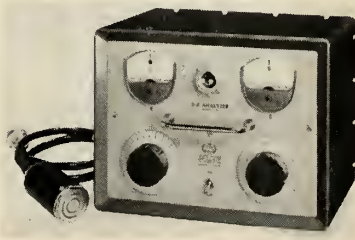
Circle No. 227 on Subscriber Service Card.

D-K Analyzer Detects Contaminants

Delsen Corp. has developed the "D-K Analyzer," a portable, non-destructive, direct reading instrument which measures the dissipation factor and dielectric constant of any non-conductive media. Several probe forms are available which facilitate use of a single instrument for measurements of both solid and liquid media.

The instrument can be used to investigate effects of processing and formulation variables on the dielectric properties of solid insulating materials, to detect non-uniformities in the electrical properties of insulators, and to inspect incoming materials for both uniformity and conformance to standards.

In many cases the "D-K Analyzer" can be used to detect the presence of moisture or other contaminants in sol-



ids, powders or liquids, as well as to measure the dielectric properties of electrical insulating liquids such as transformer oils. As a tool of the physical chemist, dielectric properties can be used to distinguish between isomers of the same organic compound to detect the presence of weak organic acids, and to detect moisture in many organic liquids.

The "D-K Analyzer" is available as a battery-operated unit for portable use, or as a laboratory instrument with a plug-in power supply. In either form the "D-K Analyzer" measures 9" x 12" x 9" and weighs less than 15 pounds.

Circle No. 228 on Subscriber Service Card.

Coaxial Switch Fits In Small Package

The Miniature Coaxial Switch series was developed by the General Communication Company to provide the characteristics of its Standard Coaxial Switch series in the smallest possible package.

Features are:

High reliability, low VSWR, low crosstalk, low input impedance and long life.

Dimensions: 3-7/32" height x 1-1/2" diameter. Electrical Characteristics: frequency range—0 to 6000 mc.; VSWR—1.3:1 max. to 6000 mc.; insertion loss—less than 0.2 db at 1000 mc.; less than 0.5 db at 6000 mc.; RF Power Rating—100 watts at 3000 mc.; voltage rating—500 volts peak; crosstalk—greater than 60 db at 1000 mc.; greater than 40 db at 6000 mc.; impedance—51 ohms; operating voltage—20 to 30 volts DC; operating current—1.5 amp. max. at 28 volts.

Mechanical Characteristics: type—single-pole, two-position; operative life—100,000 cycles minimum; temperature range—-55°C to +55°C; switching rate—40 cycles per minute; switching time—0.15 second; RF connector—Type N; Power connector—Type GS02-10SL-3P-113; weight—12 ounces.

Circle No. 229 on Subscriber Service Card.

Eder-Lite Speeds Flaw Detection

The Eder-Lite made by Eder Instrument Co., is a miniature transformer in a cylindrical handle that fits in the palm of your hand. Slender extensions of various lengths screw into this transformer. A tiny tungsten bulb is threaded to fit into the extension. Using various extensions and bulbs, you can assemble exactly the lighting unit you need for your work. The different extensions and bulbs are interchangeable and can be used with a

What the eye would see on the other side of the moon has intrigued and defied the imaginations of scientific minds for centuries. But there's another way to look at moon trips—from a very much down-to-earth point of view. The Space Age is built upon the ingenuity and capabilities of American scientists and engineers who have solved the myriad problems of the space arts—propulsion, stabilization, and control of launching vehicles—and the transmittal, reduction, and analysis of data so that man can comprehend the scientific import of his achievement. The Telecomputing Corporation, through the specialized activities of its six divisions, has contributed significantly to advancements in each of these areas of the space arts. Look to the skills, experience, and facilities of Telecomputing for the solution of your control and data processing problems. Write today for your copy of the TC story—"Blueprint For Progress."

ANOTHER WAY TO LOOK AT IT

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BRUBAKER ELECTRONICS An R & D leader in the field of ground and airborne IFF components, test & checkout equipments—IFF systems analysis—Air Traffic control systems—radar beaconry—detection equipments.



WHITTAKER GYRO Leading producer of electrically driven and spring-wound free gyros, rate and floated rate gyros for advanced missile systems—rate of roll, pitch, and yaw indicators for manned aircraft—bank and turn indicators.



DATA INSTRUMENTS Pioneers in equipments for fast and accurate analysis of test data, with automatic recording of punched cards, tapes, or printed lists—for aircraft and missile flight tests, industrial and scientific applications.



ENGINEERING SERVICES Specialists in rapid, accurate reduction and evaluation of military and commercial data. Currently handling data reduction for daily missile firings at Nolloman Air Force Base.



WHITTAKER CONTROLS The largest developer and builder of custom-built high-performance hydraulic, pneumatic, and fuel valves, controls, and regulators for advanced missile, aircraft, and industrial applications.



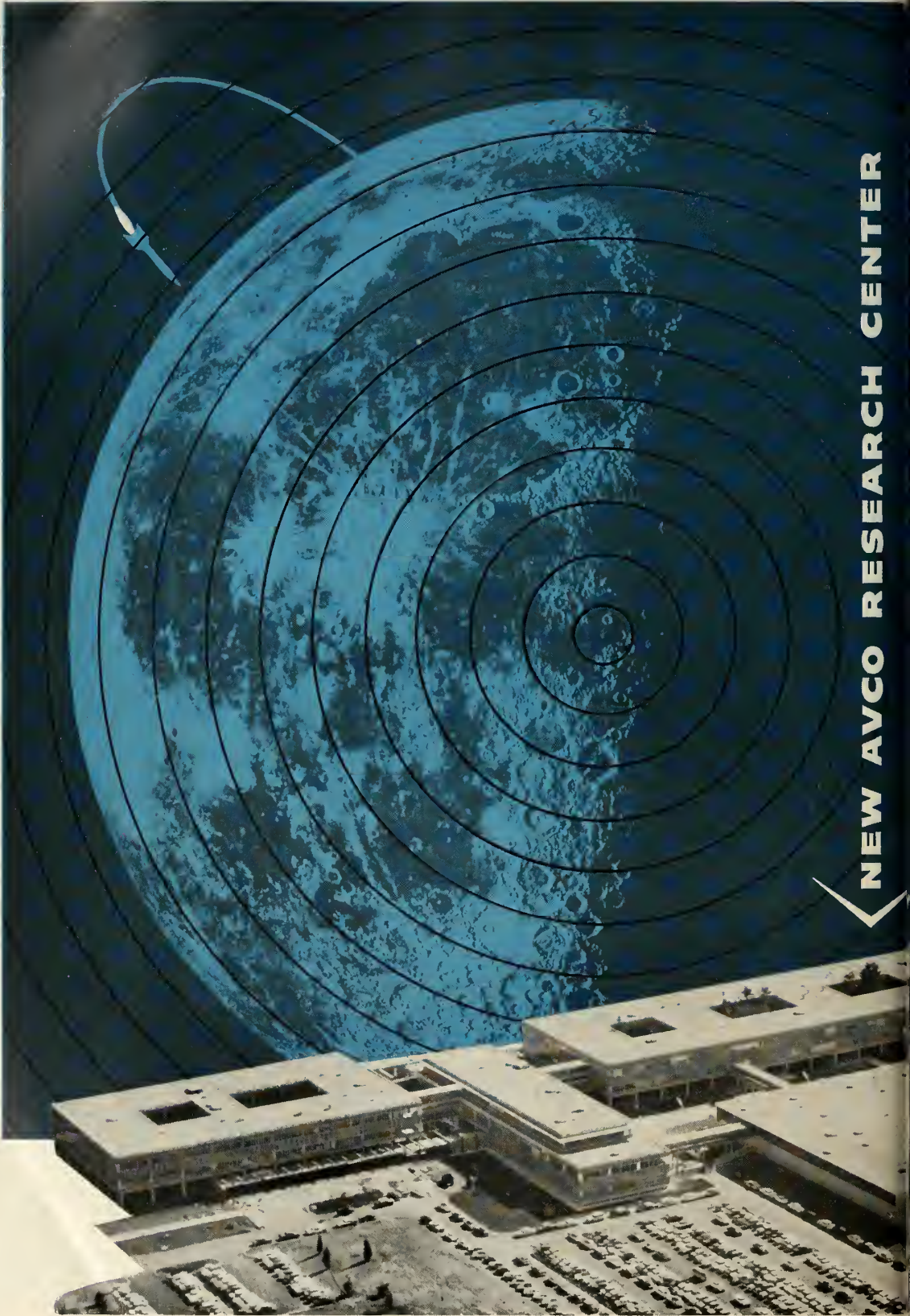
NUCLEAR INSTRUMENTS Designers and builders of high quality, reliable equipments for prelaunch checkout and testing of nuclear special weapons.

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NEW AVCO RESEARCH CENTER





Space age research gets a new headquarters

One of the largest and best-equipped research facilities in the nation is the new 16-million-dollar Avco Research Center at Wilmington, Massachusetts. Here, research and development in space age technology is already being conducted in areas ranging from missile re-entry to satellite design. From work such as this—and equally important work at the nearby Avco Research Laboratory—will come further contributions to national security and the conquest of space!

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single transformer for different jobs. The Eder-Lite slender extension tubes fit through holes, inside crevices, around corners. Use a flexible tube, semi-flexible, or rigid tube of various lengths and angles. You get a bright beam of light right on the area you are examining.

Mirrors provide vision and illumination around corners and curves and through holes (such as spark plug holes in engines). The new 1/8" diameter Eder-Lite will get light into the tiniest crevice. Magnifiers provide light and 10-time magnification for precision work. The "Bull's Eye" attachment gives a beam instead of diffused light.

Eder "directed light" eliminates glare. The illuminated inspection area stands out by contrast, improving visibility. The metal housing also protects the light bulb from breakage and prolongs its life.

Circle No. 230 on Subscriber Service Card.

Electron Diffractograph Offered For Metallurgy

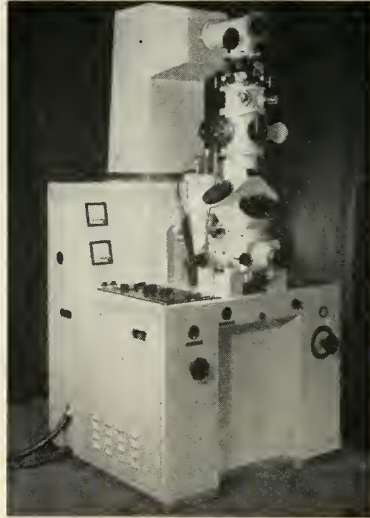
A new model of the Trueb, Tauer Electron Diffractograph is announced by the United States distributors, **New England Scientific Instruments Co.** This instrument is useful for research on the structure of materials. It is currently being used in solid state studies, in metallurgy, in chemistry, and in many other applications. It is valuable for the study of thin layers and of surfaces including changes induced thereon by processes of friction, lubrication, polishing, corrosion, temperature variation, catalysis, radiation damage, chemical agents, phase changes and so on.

The diffractograph can be used either for direct observation of the diffraction pattern on a fluorescent screen or for photographic recording. Photographs can be taken on plates, roll film, or on a special cinematic camera which permits structural changes to be continuously recorded. The observation chamber has three viewing ports with a fluorescent screen three inches in diameter which can be pivoted externally.

The instrument contains a metal discharge tube with a cold cathode of effectively infinite life which generates the electrons. The beam is accelerated through a variable potential of 20 to 50 KV applied to an anode diaphragm which is positioned in a self-centering cone. The beam axis adjustments are easily made by means of independent plane and spherical movements of the alignment sections. The beam diameter is less than 10 microns which results in an optical line width of less than 100 microns. Specimens more than an inch in diameter can be introduced into the air lock and studied under variable

temperature conditions up to 900°C, a continuous measurement of the temperature being provided by a thermocouple element. The sample can be moved and rotated so that its entire surface can be explored. A special device has been provided to neutralize the charge which would otherwise collect on the sample during an exposure.

The Trueb, Tauer Electron Diffractograph is suited for the currently used methods of electron diffraction study: Debye-Scherrer, Kikuchi, convergent beam of large aperture, paral-



lel beam and so on. Two electromagnetic lenses of variable focal length make possible the following arrangements: focussing on the fluorescent screen for powder diagrams, focussing on the sample for small beam diffraction, focussing above the sample for shadow microscopy, observing an image of the sample at 50 times magnification, and observing magnified reflections from the sample.

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Quiet Amplifier Has Varied Use

The model 108 Quiet Amplifier of **Zacharias Electronics Corp.** is an ultra low noise instrument which features a gain of 100 over a frequency range of 1 cycle-per-second to 1 megacycle-per-second. The equivalent input noise is 1.5 microvolts maximum for a 10 kilocycle bandwidth anywhere between 10 cycles-per-second and 1 megacycle per second, and 4 microvolts maximum for a 100 kilocycle bandwidth. An input impedance of 8 megohms minimizes loading of circuits under test. The 600 ohm output impedance is suitable for driving a wide variety of loads. A max-



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Associated Research Inc.'s "Thumper" is a device used to pinpoint within a few feet defective insulation determined through high-potential testing of electric power cables, or faults developed in service. This precision fault locating is achieved regardless of length of cable by the conversion of high-voltage, low-current output of a DC high-potting instrument into a high-voltage, high-current impulse supply.

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The "Thumper" Fault Locator is rated at 25 KV. The great available energy permits high instantaneous peak currents which result in an extremely loud discharge, even though the fault is some distance from the point of test.

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The unit is approximately 15" wide x 5" deep x 15" high and weighs about 90 pounds. Price is \$995.00.

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A statistical probability of state?

The gradient of a scalar?

Macrocosmic phenomenon or
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and thus the velocity, and with the control available to the pilot, the Dyna-Soar aircraft can circumnavigate the earth, followed by a normal and controlled landing. Boeing Airplane Company, one of the competing companies for the development contract for the complete boost-glide system, has delegated to RCA the responsibility for the development of important electronic components of Dyna-Soar.



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Top Scientists Find Argus Opening New Avenue of Experimentation

First detailed discussion of historic tests

confirms theories of Christofilos, who calls for further projects

by Charles D. LaFond

WASHINGTON—Three small Argus bombs, detonated high in the atmosphere over the South Atlantic in the summer of 1958, created a new avenue of scientific experimentation.

The significance of the experiment, now well known as Argus, was staggering. For the first time in history, geophysical phenomena on a world-wide scale could be measured and related to a quantitatively-known cause. This, of course, was the injection into the earth's magnetic field of a known quantity of electrons of known energies at a particular time and position in space.

The results of this experiment confirmed the theories presented to the government in a proposal for the future by Nicholas C. Christofilos in 1957. Although the overall story of Argus was broken earlier this year, only recently have the details been revealed. This is a summary of the whole series of events we now call the Argus experiment.

• History of effort—Prelude to Argus, according to Dr. Richard W. Porter, Chairman of the Technical Panel of the Earth Satellite Program to the U.S. Committee for the International Geophysical Year, was provided by the first U.S. IGY satellite, Explorer I, launched on Jan. 31, 1958. The existence of a belt of high-intensity corpuscular radiation near the earth was discovered accidentally while primary cosmic rays were being measured in the upper layers of the atmosphere.

Telemetered data indicated that the satellite was passing through regions of such high intensity that the counting circuits, including the Geiger-Mueller tube itself, were saturated. The levels below the lower limit for the radiation magnitude were established approximately

The joint space symposium at the 96th Annual Meeting of the National Academy of Science, co-sponsored by the American Physical Society and the National Aeronautics and Space Administration, drew upon the aristocracy of this nation's scientific community.

Response to the symposium was overwhelming. Open-to-the-public advance notices resulted in standing room only in the Academy's Great Hall and latecomers were queued out of the building.

Discussion of the problems, recent results, and future research in space science were presented in three principal sections: a detailed discussion (for the first time) of the Argus experiment, and a two-part program on problems in space exploration.

by subsequent laboratory comparative studies. Data from Explorer III in March, 1958, further substantiated the earlier findings.

Preliminary conclusions on existence of a radiation belt by Dr. James A. Van Allen and his staff at the State University of Iowa were presented before the Academy last year. The belt, beginning at just beyond 1000 miles from the earth's surface, was postulated to extend another 2000 miles in depth (outward).

Because the observed intensity increased so rapidly between 700 and 1000 km, it was concluded that the primary radiation was being restrained or trapped by the earth's magnetic field and thus consisted of charged particles with energies much less than those associated with cosmic rays.

To continue the research, the IGY Committee requested and received two additional Jupiter C vehicles. Of these, only Explorer IV attained orbit.

At the same time that IGY plan-

ning was in progress for Explorer IV, Advanced Research Projects Agency of the DOD was planning the Argus experiment. Thus, Dr. Porter made it clear that despite erroneous reports Argus was a Pentagon project, not IGY. The confusion resulted from the fact that Explorer IV, although intended to gather natural radiation phenomena, would also be in a position and was instrumented to measure the artificially-produced radiation to be injected by the Argus effort.

On Aug. 27, 1958, the first Argus nuclear blast occurred, producing a 1 to 2-kiloton yield (altitude 480 km; long. 12° W, lat. 38° S). This was the first of three rockets to be fired from the U.S.S. Norton Sound in the South Atlantic.

As Explorer IV continually passed through the Argus I artificial radiation shell, its radiation instruments measured and reported to ground stations the absolute intensity and position of the trapped radiation. Electron-density rate of decay as a function of altitude and observations of shell thickness were studied to provide a better understanding of natural radiation electro-dynamics.

Two more firings on Aug. 30 and Sept. 3 resulted in similar recorded phenomena.

Near the end of September—its batteries exhausted—Explorer IV sent its last observation. The intensity at that time was barely discernible above the natural radiation background.

• Original proposal—As has been fully reported before, the proposal for detonating a small thermo-nuclear bomb in space originated with Christofilos of the Livermore Radiation Laboratory, University of California, in October 1957. His proposal, in short, was based on these theories:

• Charged particles released in the



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earth's magnetic field would be trapped under certain conditions; thus, it might be possible to extrapolate the electron-layer idea into a global experiment.

• By its nature, an A-bomb burst releases very energetic electrons. These, injected at one point in the atmosphere, could follow the earth's magnetic lines. A portion of these electrons would be trapped in the magnetic field and thence oscillate in a north-south direction.

• Because electrons in this field would drift eastward, an A-bomb burst could envelop the earth with a thin shell of trapped electrons.

• Moreover, within a relatively short time, scattering and diffusion would dissipate the radiation shell. Calculations indicated a survival time for the radiation shell of the order of several days with proper burst position and altitude.

• Finally, calculations showed that the desired effect could be established and measured using a small A-bomb.

The Christofilos proposal to carry out such an experiment was examined and accepted as feasible by a scientific review group; the decision to proceed with the experiment by ARPA was made in April, 1958.

• **Initial planning**—The detection instruments and associated electronics for the *Explorer IV* satellite were designed and produced within Dr. Van Allen's department of physics at the State University of Iowa. As indicated earlier by Dr. Porter, the instruments were designed around the dual need for studying both the natural and the artificially injected radiation belts. A breakdown of the characteristics of

To meet numerous requests from readers, M/R has made available reprints of the recent series of articles by Dr. S. Fred Singer on the meaning of Project Argus. Copies of the combined series may be obtained by writing to the magazine. The rate is 50¢ for a single order (bulk rates on request).

the detectors employed is shown in Table I.

In addition to their cognizance over detection instrumentation, the Van Allen group also studied and made recommendations for firing sites. Several considerations led to the choice of bomb-burst sites, said Van Allen:

• Safety reasons demanded an isolated firing area.

• To maximize trapped particle lifetime, an intermediate latitude was needed to permit comprehensive observations. A low latitude would decrease lifetime because of particle collisions in the denser air. At a high latitude, the corresponding magnetic line of force extends farther from the earth in the equatorial plane. Perturbations in the extremities of the geomagnetic field would cause a decrease in trapped life time.

• The radiation-shell position had to permit satellite interception at a low altitude and through an orbit inclined at a maximum of 51° to the equatorial plane. (This was a practical limit imposed by the existing U.S. facilities at that time.) Also, an intermediate latitude was preferable because the satel-

lite orbit would intercept the shell at a less oblique angle.

• Since it was known that the natural radiation intensity diminishes rapidly at a given altitude with distance northward or southward from the magnetic equator, background radiation would be less at an intermediate latitude.

• In the South Atlantic, the scale magnitude of the geomagnetic field is less than that at any other point of earth at intermediate latitudes. Therefore, trapped lifetime of charged particles, for a given burst altitude, would be longest there.

• A good observation site near the point conjugate to the firing point was needed—preferably an island. (The Azores met these requirements.)

• **Observations**—During the month preceding *Argus I* (July 26 to Aug. 26), many observations served to establish the detailed spatial dependence of the natural, trapped radiation and many of its properties in terms of the characteristics of the detectors devised for the two-fold observation program, Van Allen said.

The geometric relationships between the orbit of *Explorer IV* and the chosen magnetic shell are easily calculated in theory. In a favorable case, the satellite orbit would intersect the *Argus* shell four times during each revolution around the earth. These intersections would be at various altitudes, latitudes and longitudes.

Van Allen indicated that in practice the number of observed intersections from which significant data were obtained was much less than four per orbit due to a variety of reasons (i.e., low altitude, shell tilt, excessive range, points of relatively high background radiation).

Supplementing the use of *Explorer IV* for observing the *Argus* effects, the Air Force Special Weapons Center participated with Project *Jason*. This consisted of firing a series of five-stage solid-propellant, high-altitude sounding rockets from three primary sites: Cap Canaveral, Wallops Island, Va., and Ramey AFB, Puerto Rico. To measure background radiation prior to *Argus* a preliminary firing from Patrick AFB was accomplished on Aug. 15, 1958.

• **High success**—Thirteen successful firings were accomplished in all (out of 19) during the *Argus* effort. Each delivered a 50-lb. payload to an average 550-mile height. Instrumentation consisted of eight Geiger counters employing varying shielding and different degrees of collimation (to observe

TABLE I. Summary of Detector Characteristics (Explorer IV)

CHANNEL	DETECTOR	SHIELDING	SENSITIVE TO:	GEOMETRIC FACTOR
1	Geiger-Mueller counter (Anton 302); cylinder approximately 7mm x 9mm	1.2 g/cm ² Fe + 1.6 g/cm ² Pb (minimum)	Electrons of E > 5 Mev; Protons of E > 40 Mev; X-rays of E > 80 kev; with low efficiency	Omnidirectional geometric factor 0.14 cm ² for min. stopping power; 0.82 cm ² for penetrability 7 g/cm ²
2	Plastic scintillator 0.76 cm dia., 0.18 cm thick; pulse detector	0.14 g/cm ² of aluminum over window	Electron of E > 580 kev; Protons of E > 10 Mev. Axis to detector ⊥ to payload axis	0.040 cm ² steradian for min. stopping power; 4.2 cm ² steradian for penetrability > 5 g/cm ²
3	Same as Channel 1 except less shielding	1.2 g/cm ² Fe (minimum)	Electrons of E > 3 Mev. Protons of E > 30 Mev. X-ray of E > 20 kev with low efficiency	Omnidirectional geometric factor 0.14 cm ² for min. stopping power; 0.70 cm ² for stopping power > 5 g/cm ²
4	Cesium-iodide crystal 0.76 cm dia., 0.20 cm thick; total energy-d.c. electrometer	1.0 mg/cm ² of nickel and aluminum over window	Electrons of E > 20 kev; Protons of E > 400 kev; X-rays Axis to detector ⊥ to payload axis	0.0235 cm ² steradian for min. stopping power; 4.7 cm ² steradian for penetrability > 5 g/cm ²



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angular distribution of electron flux). Telemetry gear was also included. The package was designed and constructed by Lockheed Missiles and Space Division.

In a cooperative effort by AF Cambridge Research Center and Stanford Research Institute, an additional program was instituted for observing side effects of *Argus*. Artificial aurora, radio propagation characteristics in the VLF range, and ionospheric absorption all were observed and analyzed.

The observation of auroral ionization was performed using two radar equipments (backscatter sounders) operating at a frequency near 27 mc. One was installed on the U.S.S. *Albatross*, operating south of the Azores; the other on a U.S. Navy vessel (not identified) near the detonation area.

For the VLF observations, several locations were used employing a broadband receiver, loop antenna, magnetic tape recorder, and associated calibration equipment. Each setup was similar to the whistler recorders used in the IGY program. Signals from radio stations GBZ-England (19.6 kc), NPG-Seattle (18.6 kc), and NDT-Japan (17.1 kc) were analyzed for variations in signal strength.

Three IGY riometer stations, on frequencies near 30, 60, and 120 mc, were used to measure ionospheric absorption in the higher frequency band. The antennas were vertically-directed, three-element, Yagi arrays of approximately 60° half-power beamwidth.

• **Results**—In all, the *Explorer IV* made 162 passes through the radiation shell during which significant data were obtained. The three radiation shells were determined to be from 70 to 220 km thick at the low altitude of observation. Also, Van Allen observed that the *Argus* shells occurred within the "slot" between the two natural radiation zones, probably because atmospheric density is anomalously high there.

This radiation-free zone may have been explained in a recent paper by Dr. Alexander J. Dessler, a scientist of the Lockheed Missiles and Space Division. A weak spot in the earth's magnetic field known as the "Cape-town Anomaly" is approximately 1000 miles long by 300 miles wide. Dessler theorized that radiation particles, reflected back and forth in the magnetic field, fall into this area and are absorbed by the atmosphere below. Radiation in this area is 1/30 the intensity of the lower Van Allen radiation belt.

Although the exact cause of the radiation decay has not been deter-

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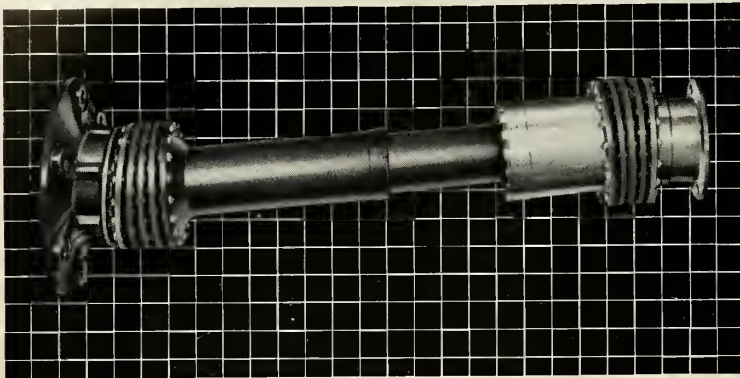
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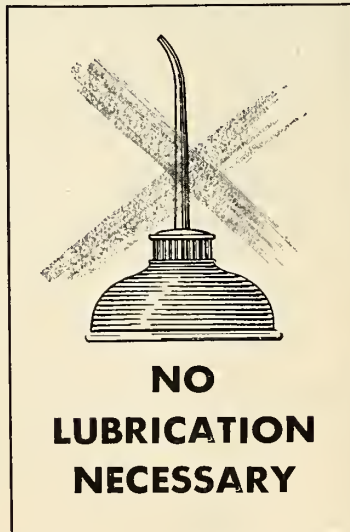
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mined, it is however, a composite of both atmospheric and magnetic effects, he said. "A very rapid drop in intensity of *Argus I* and *Argus II* on Sept. 4 suggests that the great solar magnetic storm of that date may have caused a greatly enhanced rate of loss of stored particles."

The attempt by Project *Jason* to observe the electron shell produced by *Argus I* was not entirely successful, although some data was obtained. Following *Argus II*, a total of ten rockets were fired successfully and much information was obtained. The rockets penetrated the shell at an altitude of 200 to 300 miles. A region of very high radiation was observed to be about 12 miles thick, although increases in radiation levels were observed 400 miles to either side. Both the width and location of the shell remained constant (plus or minus five miles) for the period of observation which was 100 hours. This extreme constancy, considering the fact that electrons traveled from north to south more than a million times or drifted around the world more than one hundred times, verified hypotheses as to the earth's magnetic field and the character of space as far out as one earth's radius. Also, a narrow region of intense counting rate was observed, initially 100,000 times normal.

Analysis of the data indicated the intensity of the shells decayed approximately inversely as the time from the burst. This is consistent with the theory that the electrons are predominantly lost through scattering in the atmosphere near the mirror points.

According to the Air Force, the angular distribution of the flux was measured and the electron flux was observed to be confined to a plane within the resolution of the counters (plus or minus 15°). Rocket orientation was determined by analyzing telemetry signal strength records; it was thereby determined that the plane of the flux was perpendicular to the magnetic field lines (plus or minus 5°). This measurement confirmed the supposition that the electrons were trapped. The energy spectrum was measured and found to be deficient in high-energy electrons when compared to a fission beta spectrum.

Auroral radar echoes were obtained on all three explosions by radar near the launch end and on Events I and III by the radar near the Azores. Negative results on the Alberman's radar for Event II were probably caused by unfavorable location of the ship. The echoes appeared within seconds after the explosion at the launch radar, and

missiles and rockets, May 18, 1959



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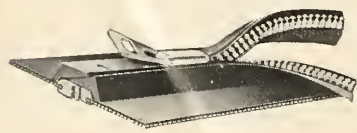
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somewhat later, although less than a minute, at the conjugate region radar. Echoes were observed in one case for one hour and fifteen minutes at the conjugate region radar, and in one case for five hours at the launch region radar.

The radar echoes moved outwards in range, and although initially there was a single well-defined echo, at some stages in the echo development more than one trace was visible, and the echo at times became widely spread in range. It is believed probable that part of the time a sporadic ionization patch existed, producing "ground-scatter" echoes; however, it is believed that most observed echoes were directly back-scattered from field aligned irregularities.

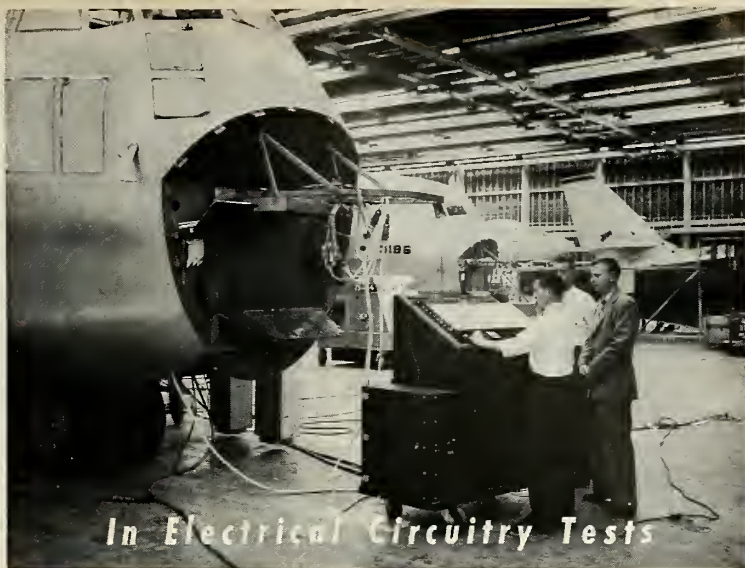
A combination of visual auroral observations and the radar records permitted the location of the conjugate magnetic point to be determined; this measured conjugate point agreed with theoretical expectations to within about 100 km.

• **Signal changes**—VLF recordings of GBZ in England taken in the Azores and in Spain showed abrupt decreases in signal strength, following *Argus II* and *III*, amounting to from 6 db to 12 db. At Stanford, signals from NPG in Seattle and NDT in Japan were analyzed for Events II and III. Both showed slight increases in signal strength for some minutes following the explosions.

A possible explanation for these observations is that the electrons scattered from the *Argus* shell (and near the conjugate area the ionized debris) changed the ionization in the lower ionosphere, apparently penetrating to low heights near the conjugate area and producing absorption.

All riometer units operated satisfactorily during the experiments, but results were negative in the sense that no significant absorption increases were recorded following the *Argus* effort. The measurements demonstrated that although there was sufficient perturbation of the ionosphere to produce reduced signal strength or absorption of VLF signals, the perturbations were either not large enough or not widespread enough to be detectable on equipment sensitive to absorption in the high-frequency range.

As a result of the satellite particle-counting experiments in the *Argus* effort and comparison of electron density in the trapped electron shells with counting rates in the Van Allen belts, it is now believed that the level of synchrotron noise from the *Argus* experiments should have been below the



In Electrical Circuitry Tests

DIT-MCO Is Faster and More Reliable Than Other Methods

Take tape read-out tests, for example. This method requires extra machines to translate test information or a genius to remember the code used on the tape. Either way, it's a costly process. Compare this to the DIT-MCO Automatic Circuit Analyzer and its exclusive Matrix Chart.

The DIT-MCO Circuit Analyzer performs the entire test itself. There's no need for complex machines to translate test information. All data concerning errors, circuit numbers, type of flows, etc., appears on the Matrix Chart, so there's no need for complicated wiring diagrams or charts! And, the DIT-MCO Circuit Analyzer checks one circuit against all others... over 2,000 in about three minutes... with accuracy never before possible in any test system.

Some testers use a maze of colored, flashing lights. Operators of such test machines must refer to 100, 500 or even 1,000 miniature lights to try and locate errors. Charts and diagrams must also be used... with a resultant high number of human errors.

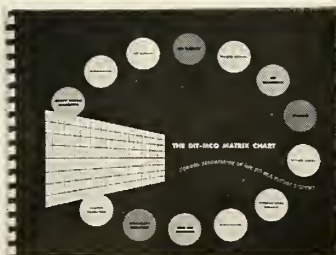
The DIT-MCO Circuit Analyzer injects human decision into every test but in such a way that chances of human errors are nil. The easy-to-read Matrix Chart employs only two lights to quickly pinpoint every circuitry flow. Yet, anyone, with less than one hour's instruction, can operate the DIT-MCO Automatic Circuit Analyzer and perform test functions once thought impossible!

These are just a few reasons why DIT-MCO is faster and more reliable than other methods in electrical circuitry tests. Why not get the complete story? Write today for free Matrix Chart booklet.

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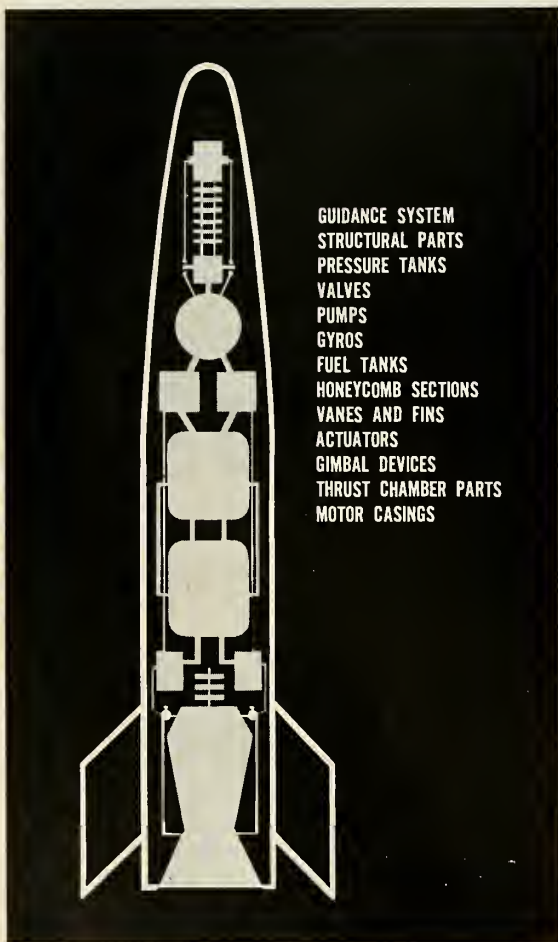


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detectable level. The riometer experiments during *Argus* provide confirmation that the noise level was in fact below the level of conventional cosmic noise radiometers even in the 30-mc frequency range. No detectable increases in noise levels were observed on the riometers which were operated in the *Argus* experiments.

• **Further analyses and tests**—Data received from the *Argus* experiments are not completely analyzed, but Van Allen said the work will continue at the S.U.I. Data Reduction Center. All of the theories postulated by Christofilos appear to have been verified in the experiment. Based on the almost unqualified success of the *Argus* project, Christofilos said that repeated tests of this kind are needed to obtain more data on the earth's magnetic field, the polar aurora borealis, and many other geophysical phenomena. It already has been useful interpreting the Van Allen belt, he said.

Christofilos emphasized the harmlessness of using small A-bombs in space with respect to creating a radiation hazard to manned space travel. But he warned that bombs of megaton strength would create a radiation menace of lethal dosage (400 roentgens) to a satellite-borne man within 3 hours.

New High-Temperature Carbon Theory Formed

BERKELEY, CALIF.—Scientists at the University of California have formed a corrected theory of the behavior of carbon at extremely high temperatures. The data is considered highly useful in the operation of nuclear reactors and may have a bearing on operation of nuclear rocket engines.

According to Dr. Kenneth S. Pitzer, Dean of the College of Chemistry at U.C., present nuclear reactors have not been operated at temperatures and efficiencies allowed by the graphite structural components. This is laid to the lack of knowledge concerning the temperature ceilings of graphite.

Previously, it was assumed that when carbon is heated to temperatures high enough to vaporize it, heat drives the atoms apart so that the resulting gas is composed almost entirely of single carbon atoms, with a few molecules composed of two atoms.

A theoretical study of the problem by Dr. Pitzer and Dr. Enrico Clementi—assuming that the carbon gas is in contact with and in equilibrium with solid carbon—finds that above 2000°C there should be very few single carbon atoms.

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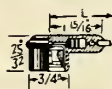
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This is a new series of Tube Cap Connectors using special silicone components for high reliability applications. They provide the highest degree of resistance to temperature extremes and are virtually unaffected by ozone and corona. The excellent dielectric characteristics make them ideal for high voltage. Skirts and sealed-in leads guard against flashover at high altitudes. Additional features include anti-corona cup and long-life spring contacts.

Clip this out—keep handy for part numbers and specs on connectors below for either 1/4" or 3/8" top caps. Prefix 90 for 1/4"; 91 for 3/8". Lead wire 18" long from center of cap or length to your specs.



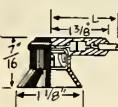
≅90 or 91SCCSL beryllium copper contact, cadmium plated nests in anti-corona cup. Silicone rubber insulation throughout.



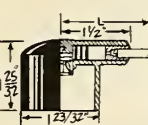
≅90 or 91SCCRSL beryllium copper contact, cadmium plated nests in anti-corona cup. Silicone rubber insulation throughout. Takes up to one watt resistor—specify value and tolerance.



≅90 or 91SCCOSL beryllium copper contact, cadmium plated nests in anti-corona cup. Skirt clings to tube—guards against flash-over. Silicone rubber insulation throughout.



≅90 or 91SCCORSL beryllium copper contact, cadmium plated enclosed in anti-corona cup. Skirt clings to tube—helps suppress corona—guards against arc-over. Takes up to one watt resistor. Specify value and tolerance.



≅90 or 91CCSTLRL beryllium copper contact, cadmium plated nests in anti-corona cup. Glass-filled silicone insulation on cap; silicone rubber on lead. Long skirt for arc-over. Takes up to 2 watt resistor. Specify value and tolerance.

Besides new silicone types—Alden provides a complete series of connectors for 1/4", 3/8" and 1/2" cap in your choice of phenolic, mica, polyethylene, nylon and Kel-F. Complete hi-voltage cable assemblies are available using Alden hi-voltage disconnects and tube cap connectors.

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Some Highlights of AWA's Convention

Missile-launching nuclear airship is Goodyear proposal; GE for ablative nose cone

WASHINGTON—The General Electric Co. is putting its bets on the ablative nose cone—rather than the heat sink type—as the “best solution” for the ICBM.

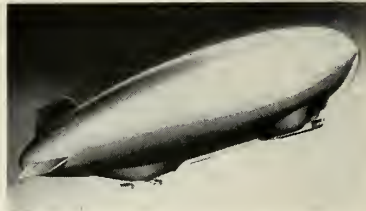
The Goodyear Aircraft Corp. wants to build for the Navy a fleet of huge nuclear-powered blimps capable of launching ALBM's and fighting submarines.

These were two of the top disclosures at the Aviation Writers Association's week-long meeting that opened May 11.

• **Benefits**—H. W. Paige, GE Missile and Space Vehicle Department general manager, said GE is turning away from the heat sink nose cone because the ablative nose cone is:

- Considerably lighter.
- Less expensive.
- Not made with toxic beryllium.

The new GE RVX-2 ablative nose



ARTIST'S IDEA of the 4,500,000 cubic foot airship proposed by Goodyear.

cone—shown publicly for the first time—weighs about one ton. The dunce-cap shaped cone is about 12 feet high and about five feet wide at the base.

So far it has been flown once. However, the *Atlas* that carried it from Cape Canaveral failed to travel the full 5000-mile course and the nose cone was lost in the Atlantic.

Paige said the RVX-2 succeeds the

RVX-1 which has been repeatedly, a *Thor-Able*.

The RVX-2 is being designed *Atlas*. However, it may later be used on such second generation missiles *Minuteman*.

• **The nuclear blimp**—The proposed missile-launching blimp would be 4.5 million cubic foot non-rigid airship. That is about three times larger than present Navy blimps but still not as large as the huge German airship of the 1930's.

The missile blimp would fly 10,000 feet at speeds of 70 to 100 knots. Its range would be practically unlimited.

The 540-foot airship would be made of a newly-developed dacron cloth coated with adduct synthetic rubber. The cloth is highly resistant to radiation.

An 86-foot control car would provide roomy accommodations for officers and men. It would have two decks.

• **Possible first**—The ship's great length would make possible the placement of the nuclear reactor far enough behind the control car to provide a radiation-safe environment no more dangerous than an atomic plant.

The blimp's turbo-prop engine also would be capable of operation on chemical fuel during takeoffs and landings in order to avoid contamination. Goodyear officials said the reactor would have to provide only about one-twentieth of the power required for a plane because of the blimp's buoyancy.

Goodyear officials said they have told the Navy they could produce an operational missile airship by 1963, far sooner than experts have said. Nuclear-powered plane could be developed even if the program were greatly accelerated.

Officials said the missile blimp, besides being a missile launcher and submarine fighter, could be used as a powerful early warning station.

They brushed aside possible arguments that the huge blimp would be an easy target.

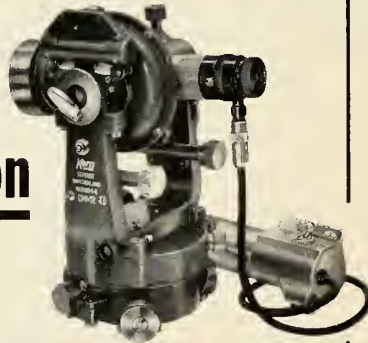
“It would be extremely mobile and could carry powerful defensive weapons,” one said. “And it would be harder to find than an aircraft carrier

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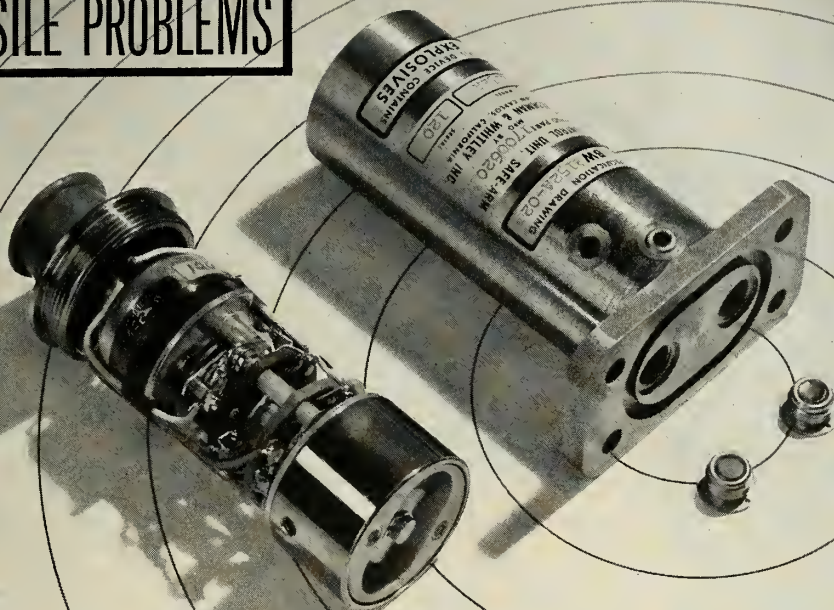


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Ten years of pioneering in the missile component field has made possible this new line of Beckman & Whitley solenoid-operated safe/arm explosive initiators. Unit on the left has cover removed to show internal arrangement.

Weighing only 1.85 lb loaded, this model is 5 in. by 3 in. by 1 $\frac{3}{4}$ in. It was designed to military requirements. It can be armed or disarmed by remote electrical signal and includes both visual and electrical telemetering facilities for indication of armed or disarmed condition. On reception of a

command firing signal, the unit will initiate associated primacord, low-energy detonating cord, (LEDC) or bulk charges.

This may be just what you need. On the other hand, Beckman & Whitley can provide the engineering capability, the production facilities, and perhaps most important, the speed necessary to give you anything you *do* need in the line of propellant-actuated devices.

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high temperature PLASTICS



Continuing research in the field of high temperature plastic molding has enabled Olympic to create fiberglass missile components such as nose cones, radomes and heat reflective shields.



High strength, heat resisting structural parts and exhaust deflectors, insulators and nozzles have been produced that perform as high as 5000° F.



Standard electrical terminal strips now adopted as NAS 1066, as well as special design terminal blocks, have been developed to withstand continuous service to 600° F.

OLYMPIC



Plastics Company, Inc.

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Advantages of hybrid nuclear-chemical rocket engines are presented in the American Rocket Society Journal by Leon Green, Jr. and James M. Carter, Aerojet-General. Chief merit of the water light metal preheated propellant system is that it removes the performance limitations to which light metal fuels are restricted by high latent heats of vaporization.

Other advantages: performance limits imposed on conventional nuclear heat transfer systems by mechanical strength of the core structure are avoided by operation of the core at reduced temperatures; problems connected with cryogenic liquids are eliminated; reactor power requirements are eased by using chemical energy as a supplement.

A water-magnesium hybrid system is cited as a low-cost system that can be built with today's materials and knowledge. However, Green and Carter say advanced systems, such as those using high performance lithium, would involve additional study and would be more costly.

Pacific Engineering's new ammonium perchlorate semiworks plant at Henderson, Nev., is using a new type of electrolytic cell. The plant has been operating "quite well" for about five months, but only now does Pacific Engineering President Fred Gibson talk about the cost-cutting cell. It features a nonmetallic anode that avoids use of platinum. However, he won't say what it is, only that the cell is "appreciably more efficient" than the usual cells.

Puzzled by cermet? Here's a thumbnail rundown of how, where and where to use the carbide-base cermet—chromium, titanium and tungsten carbide. Chromium carbides have relatively low melting points, high resistance to corrosion, extremely high resistance to oxidation, high thermal expansion and low density. Use them for valve parts, bearings, nonmagnetic applications. Titanium carbide has very high melting points, remain quite strong at high temperatures, offer good resistance to oxidation and thermal shock. Use for torch tips, hot dies and guides, gas turbine nozzle vanes. Tungsten carbides nowadays usually feature enough cobalt to give them high impact strength. They offer excellent abrasion resistance. Use them in structures, precision rolls, wire drawing dies.

Graphite nozzles are coated with carbides of titanium, zirconium, niobium, tantalum, and silicon by a new metal vapor technique developed at Battelle Institute. Halides (chlorides, fluorides, bromide iodides) of the metals are vaporized in a pressure-temperature range that will not let the metal deposit on the graphite surface, but will cause reaction of the metal with the graphite to form the metal carbide. Coating rate can be controlled for uniform coating. The developers, J. M. Blocher, Jr., and I. E. Campbell, are now at National Steel, Weirton, W.Va.

Stauffer Chemical and Hercules Powder will use a Ziegler process to make pyrophoric fuels in a new joint venture. The product, aluminum trialkyls and other aluminum alkyls, will be produced at the rate of only 1 million lb/yr, and will be used as intermediates in production of industrial chemicals as well as for fuels and high altitude flame sustainers.

Look for lithium perchlorate—one of the best solid-propellant oxidizers hit upon yet—to roll out of the HEF (Hooker Chemical and Foote Mineral) Columbus, Miss., ammonium perchlorate plant before many more months. The industry says commercial production is not yet feasible because of lack of demand. But the new Columbus plant was designed for easy conversion to the lithium oxidizer. An insider says big enough demand appears on the horizon.

Allied-Kennecott Titanium Corporation has postponed plans to build a large-scale Ti plant "because of excess capacity for the metal due to defense cutbacks." Instead, the company will increase its search to broaden the metal's commercial uses.

people

Appointment of **Richard E. Horner** as associate administrator of the National Aeronautics and Space Administration will be administrator **T. Keith Glennan** and assistant **Hugh L. Dryden** from operational management and allow them to devote full time to planning and policy decisions. Horner's current post as Assistant Air Force Secretary for Research and Development is expected to go to **I. Joseph Charyk**, chief AF scientist. The move is scheduled for June 1.

NASA has also appointed former *Vanguard* director **Dr. John P. Hagen** as assistant director for program coordination to review and coordinate the space agency's scientific and technical programs. The *Vanguard* staff will be intergrated to other NASA projects.

David H. Newby, space and aeronautics scientist, has been appointed representative of NASA at the Army Ordnance Missile Command, Huntsville, Ala., where his duties will include technical monitoring of NASA-funded projects.

Dr. Clifford C. Furnas, onetime Assistant Secretary of Defense, R&D, has been named vice-chairman of the Army Scientific Advisory Panel. Furnas, currently chancellor of the University of Buffalo, succeeds **Dr. James W. McRae**, who recently was named chairman. Outgoing chairman **Richard S. Morse**, in turn, will succeed **Dr. William H. Martin**, retiring as the Army's Director of Research and Development.

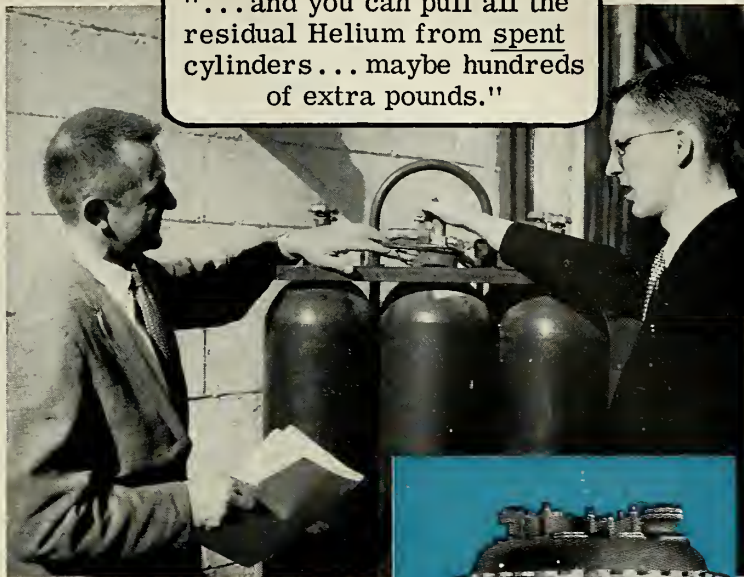
Frank Randall, president of Amperex Electronic Corp., has been elected vice president of North American Philips Company, Inc. Amperex is an affiliate of N. A. Philips. Randall retains his position as president of Amperex as well as vice president and director of Ferroxcube Corp. of America, also an affiliate of N. A. Philips.

Karel J. Bossart, assistant to the vice president-engineering for Convair Division of General Dynamics Corporation, was named the California Air Force Association's "Man of the Year in Science." Bossart, "Father of the *Atlas*" intercontinental ballistic missile, last year received the Air Force Exceptional Civilian Service Award for his leadership in developing the free world's first ICBM.

From the *Atlas* program's inception as the MX 774 *Hiroc* research rocket in 1946, Bossart has been intimately associated with the *Atlas* throughout its design and development period. He served as chief engineer on the *Atlas* program and in March, 1957, was promoted to technical director of Convair-Astronautics. Among the breakthroughs in rocketry developed by Bossart and his associates in the MX 774 and *Atlas* programs are the first separable nose cone, the first integral fuel tanks and the first swiveling engines for directional rocket control.

Missiles and rockets, May 18, 1959

"... and you can pull all the residual Helium from spent cylinders... maybe hundreds of extra pounds."



... without contaminating the Helium!

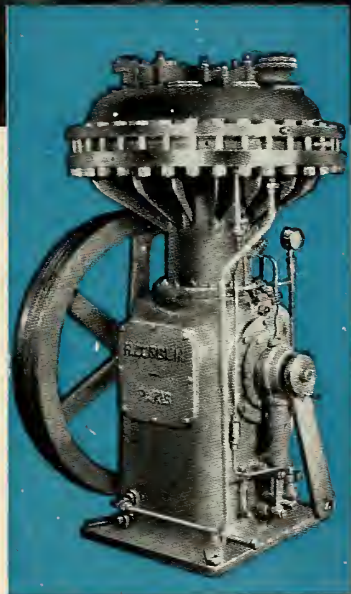
All residual helium may be pulled from cylinders previously thought to be "spent" by using a Corblin Diaphragm Compressor.

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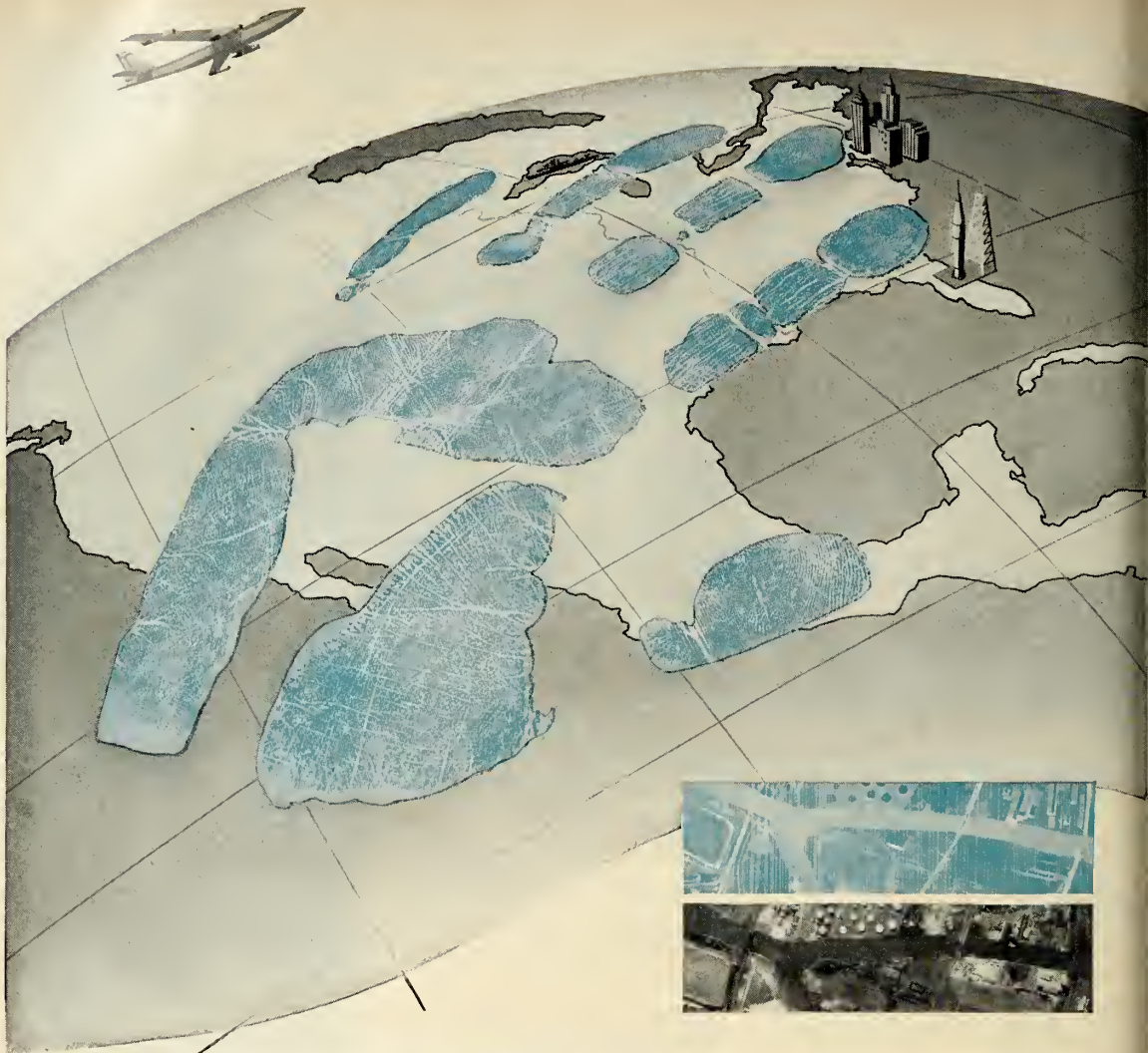
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Aerial reconnaissance systems of the future will depend on infrared detectors and scanners for operation around the clock. Each surveillance target or object of military or geophysical significance will have its own characteristic fingerprint in the infrared spectrum.

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Extensive flight test data are being analyzed and catalogued to provide the guide to infrared interpretation. Also, test results are being correlated with laboratory techniques to predict the response of sensors and synthesize the infrared pictures they will produce. Thus, it will be

possible to plan missions exactly as they will appear to the infrared observer.

Other infrared work includes target and background radiometric studies, detector studies, and infrared instrumentation for geophysical satellites, seekers, search, track, fire control, early warning, aerial intercept, collision warning, communication, mapping, horizon sensing, and infrared augmentation for target drones. Progress in infrared research and development exemplifies Bendix leadership in "the systems of tomorrow." Major Programs include the AN/AMQ-15 Weather Reconnaissance System and the Eagle air-to-air missile system. Inquiries are invited with respect to positions for better engineers and scientists.

Bendix Systems Division

ANN ARBOR, MICHIGAN



Crosley Division, Avco Corp., has appointed **Gerard W. Kaufhold** sales manager for infrared systems. Kaufhold was formerly at Republic Aviation Corp., Farmingdale, N.Y., as research and development project administrator, and fighter plane project engineer with the Air Force Air Materiel Command.



KAUFHOLD

The National Aeronautics and Space Administration and the Department of Defense have set up a joint working group on search and recovery aspects of the Project Mercury manned orbital vehicle program and have named as co-chairmen of the group **Edmond C. Buckley**, assistant NASA director for Space Flight Operations, and **Rear Adm. J. W. Cannon**, assistant Chief of Naval Operations (Fleet Operations).

David E. Shoner, 37, has been appointed assistant program director for the Minuteman ICBM program, Space Technology Laboratories, Inc. An author of four technical papers who has three patents pending, Shoner was formerly with Aerophysics Development Corp., Hughes Aircraft Co., Jet Propulsion Laboratory and the Naval Ordnance Test Station at Inyokern, Calif.

Two new divisions have been set up as a result of reorganization of the engineering group at Ramo-Wooldridge division of Thompson Ramo-Wooldridge Inc. The Systems Technology Division will be headed by **T. B. Bissett**, with **Bernard Berman** as associate director. **Wilton E. Mohr** will be acting director of Data Processing Division.

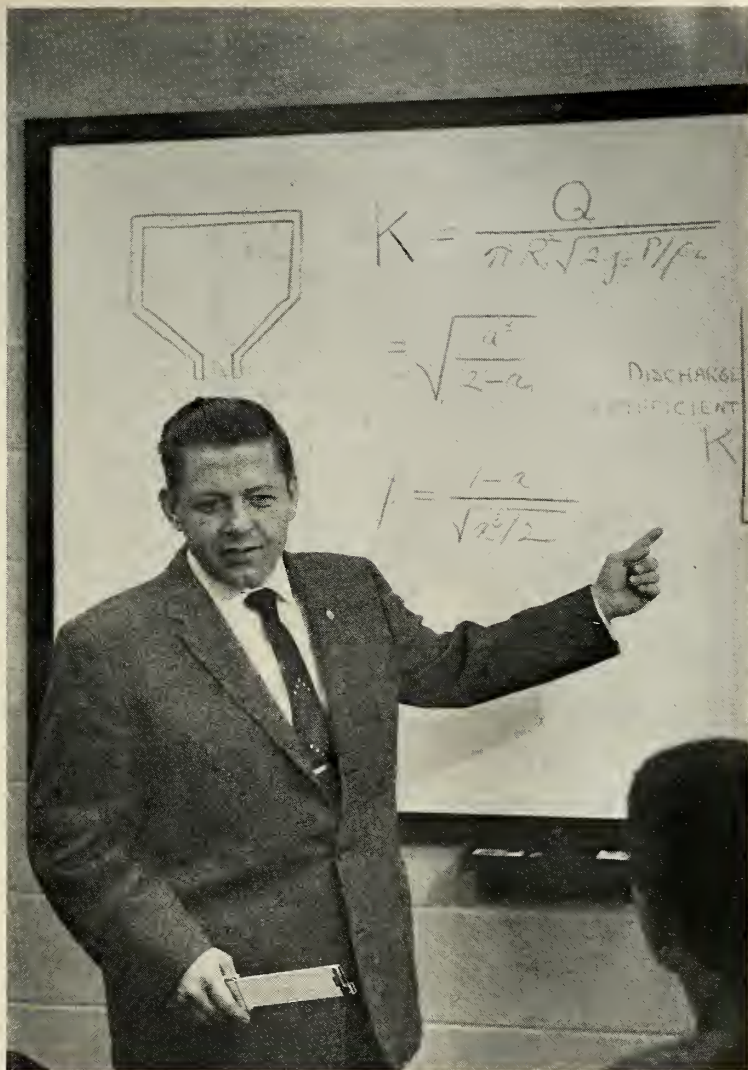
Dr. James T. Grey, recently scientific adviser to the USAF director of research and development, has been appointed director of the research planning staff, Rocket Divisions, Thiokol Chemical Corp. His responsibilities will include study of non-military or commercial applications for rockets, rocket components and propellants. His work for USAF was mainly in fuels, combustion, propulsion, chemistry and materials.



GREY

Marvin G. Whitney has been appointed vice president in the Semi-conductor Division, Hoffman Electronics Corp. and manager of the division's new West Coast plant. Whitney, previously a vice president of the company's Consumer Products Division, joined Hoffman in 1953 as the division's director of engineering and manufacturing, and later served as an administrative assistant to the president

missiles and rockets, May 18, 1959



Here is a man you should know he's a DELAVAN FUEL INJECTOR SPECIALIST

His name is Paul D. Burgess. He's a senior project engineer on Fuel Injector Development, specializing in injection devices for thrust augmentation and primary fuel injection. He's been with Delavan 5 years, and has designed and developed fuel injectors for use on some of the most advanced aircraft engines, scheduled for production in the near future. Men like Paul Burgess, concentrating their talents on fuel injector development, have made Delavan the world's largest nozzle specialist. They're the main reasons leading turbo-jet, rocket and APU manufacturers rely on Delavan for fuel injection problem solving.

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by Fred S. Hunter



missile tracker for china lake

Kollmorgen Missile Tracking Binoculars are an integral part of an acquisition and photography system which records tactical air-to-air missile performance at China Lake Naval Ordnance Testing Station. These binoculars, adapted from a basic Kollmorgen design, are high magnification, wide-field instruments with unusual light-gathering power. An operator is able to spot a missile-launching aircraft and track the missile from the time it is fired until it finds its target—all at extreme ranges. Among other Kollmorgen contributions to the missiles field are the bunker periscopes at Cape Canaveral.

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There appear to be several good reasons why the proposed merger of Thiokol Chemical Corp. and Marquardt Aircraft Corp. would benefit both companies, their managements and their stockholders. Uppermost, however, is that the consolidated company would have systems capability. In other words, it could expand in the missile field up to and including the production of a vehicle.

Thiokol, a chemical company, has little in the way of hardware, except for its Reaction Motors division. Consolidated with Marquardt, it would have three propulsion systems, airframe capability, guidance experience, ground support equipment, test equipment—everything necessary to become a big operator in the missile picture.

The proposed merger is expected to go through to consummation with the consolidated company to be known as the Thiokol-Marquardt Corp. J. W. Crosby, now president of Thiokol, would become chairman of the board, and Roy E. Marquardt, now president of Marquardt, would become president. The top level of management probably would be expanded by two executive vice presidencies; one for supervision of the present Thiokol enterprises, the other for the present Marquardt operations.

In view of the fact that Thiokol will be the acquiring company, headquarters for the merged concern might remain in Trenton, N.J., but a more logical development could be establishment of general offices in a new location such as Salt Lake City. Thiokol's Utah division is at Brigham City, only 20 miles from Salt Lake, and Marquardt's *Bomarc* manufacturing plant is at Ogden in the same area.

Machine shops in southern California are at a low ebb because airframe volume is down, but missiles, particularly in the ground support phase, are picking up some of the slack. The Langley Corp. in San Diego, for example, had a net loss of \$73,768 in 1958. But this year it will make some money, its President M. B. Laddon reports.

In the last five months Langley's level of unfilled orders has climbed from \$800,000 to \$1.2 million and the missile portion of the backlog has increased to about 25% currently from 10% a year ago. A further gain is anticipated. Among Langley's missile products are an assembly for a *Hawk* missile launcher and swivel joints and valves for fueling the *Atlas* ICBM. "We are looking for products, techniques and activities that will continue to take us out of the job-shop field," said Laddon in reporting his company's interest in favorable acquisitions that could broaden the base of the business.

Bidding on ICBM launching site installations seems to have become very tight. Wells Benz, Inc., a San Diego and Phoenix construction company which has done considerable of the work at Point Mugu and Point Arguello, was the low bidder at \$5,314,872 for the job at Spokane, which the government had estimated would cost \$8,553,000.

Louis D. Statham, president of Statham Instruments, Inc., says the operations of the company's Puerto Rico subsidiary have far exceeded "our fondest profit and production expectations," and have helped triple the size of the parent company in Los Angeles. The Statham subsidiary is soon to open a second plant on the island.

Joint test program on the Convair F-106 and its weapons subsystems is being completed at the Air Force Missile Test Center, Holloman Air Force Base. The F-106 incorporates Hughes Aircraft's new MA-1 fire control system and carries the new GAR-3 *Super Falcon*. In combat, it can carry a mixed load of *Falcons* and Douglas *Genie* air-to-air rockets.

Rear envelope of the Douglas C-133B, redesigned specially to carry the *Atlas* ICBM, opens up like an airplane hangar.

missiles and rockets, May 18, 1959

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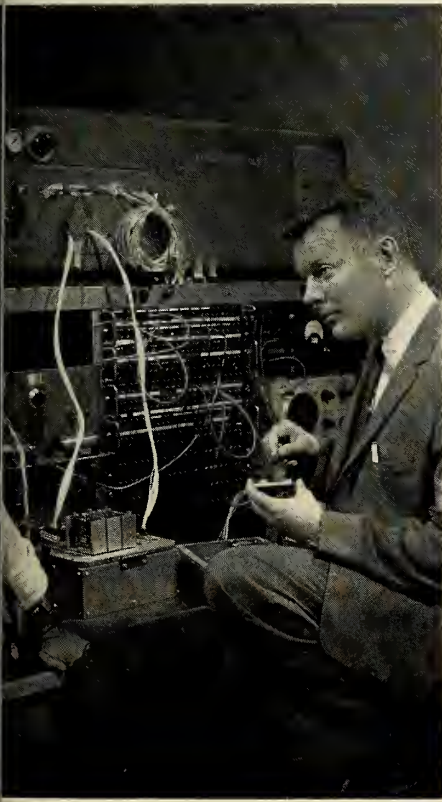
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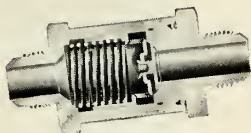
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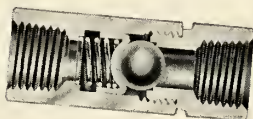
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missiles and rockets, May 18, 1959

contract awards

NAVY

1,000,000—Westinghouse Electric Corp., Electronics Div., for advanced ship-board radar systems.

1,464,023—Federal Electric Corp., Paramus, N.J., for operation of range instrumentation equipment at Point Arguello. (Sub-contractors—Rheem Manufacturing Co., Marquardt Aircraft Company, for ordnance handling toxic fuels.)

1,033,550—Westinghouse Electric Corp., Washington, D.C., for design and furnishing core handling and refueling equipment.

57,605—Bendix Radio Div., Bendix Aviation Corp., Baltimore, for companion units of action Minitrack electronics.

7,093—Aircraft Armaments, Inc., Cockeysville, Md., for guided missile telemetering antennas, reproducible record dwellings and pamphlets.

6,800—General Electric Co., Lynn, Mass., for research on gas-lubricated bearings.

ARMY

1,900,165—Thiokol Chemical Corp., Longhorn Div., Marshall, Tex., for production of rocket motors and plant maintenance.

1,671,100—Western Electric Co., Inc., for research and development of Nike-Zeus.

1,988,895—Virginia Engineering Co., Inc., Newport News, Va., for Bomarc facilities at Langley AFB.

1,190,767—Douglas Aircraft Co., Inc., for missile launching items.

723,000—Allied Chemical Corp., General Chemical Div., for supporting research on high-energy oxidizers for advanced solid rocket propellants.

581,654—Northrop Corp., Radioplane Div., for target missile research and development.

38,793—Douglas Aircraft Co., for launching area parts and repairs.

16,625—Olin Mathieson Chemical Corp., for research and development on high-energy fuels for advanced solid rocket propellants.

294,041—Western Electric Co., Inc., N.Y., for Nike spare parts and components (four contracts).

279,106—Western Electric Co., Inc., for Nike spare parts and components (four contracts).

100,000—California Institute of Technology, for research and development.

27,550—RCA, Service Co. Div., Camden, N.J., for research and study of signals transmitted from satellite and space vehicles.

84,185—Sylvania Electric Products, Inc., for research and study of Nike-Zeus acquisition radars.

81,635—Raytheon Mfg. Co., for electronic assemblies for Hawk missile system (40% subcontract work will be available).

57,750—North American Aviation, Inc., Rocketdyne Div., for design and development.

\$38,663—Barnes Engineering Co., Stamford, Conn., for research in measurement of re-entry bodies of missiles.

\$29,724—Gilfillan Bros. Inc., Los Angeles, for repair parts.

AIR FORCE

\$10,000,000—The Martin Co., Baltimore, for auxiliary equipment for the TM-76B Mace.

\$850,000—Kollsman Instrument Corp., Elmhurst, N.Y., for components of

MD-1 automatic astro compass. Installation and spares for B-52 aircraft.

\$800,000—Marquardt Aircraft Co., for radar target simulators, spare parts, ground support equipment, data and service.

\$500,000—Bohannon Manufacturing Co., Compton, Calif., for follow-up production of force ejection systems for external stores for use on the F-101-B aircraft. (Contract awarded by McDonnell Corp.)



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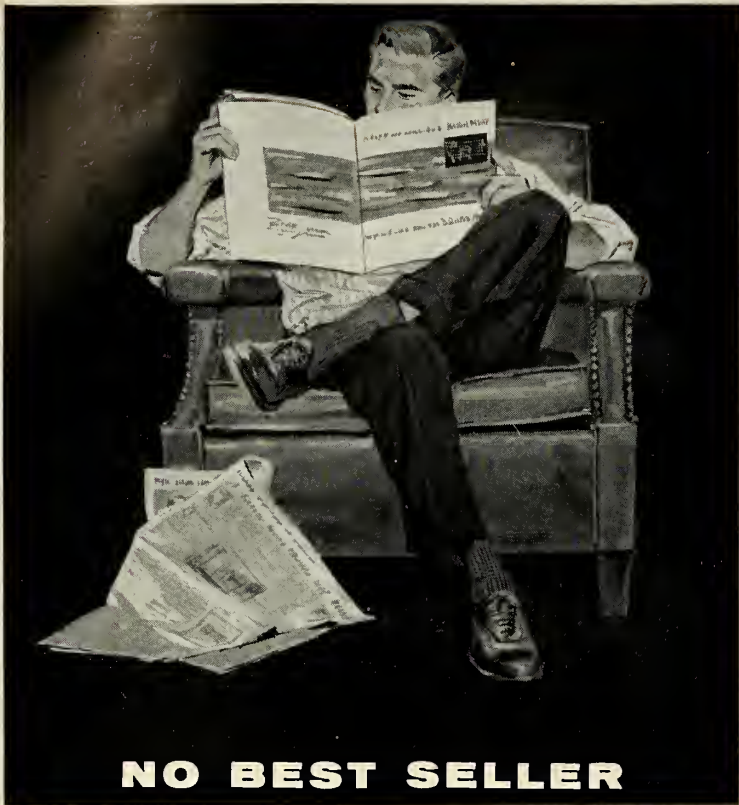
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... contract awards

- \$126,000—Hughes Aircraft Co., for continuation of SAGE integration program.
- \$78,837—Continental Aviation & Engineering Corp., Detroit, for six J69-T-29 engines for Q-2C drone aircraft.
- \$63,800—Raytheon Manufacturing Co., Microwave and Power Tube Div., for miscellaneous tubes.
- \$62,660—Eagle-Picher Co., Chemical Div., for water-activated batteries.
- \$60,688—Instrument Corp. of Florida, for mobile shelters for mounting BC-4 cameras and other related items.
- \$57,910—Columbia University, for research in the physics and chemistry of gases at high temperatures.
- \$49,107—PSP Engineering Co., Maywood, Calif., for solenoid-electrical.
- \$40,756—University of Colorado, for research directed toward design and development of Biaxial Pointing Controls and rocket-borne telemeter systems.
- \$40,009—University of Rochester, Rochester, N.Y., for continued research on problems of gas dynamics of cosmic scales.
- \$39,623—North American Aviation, for miscellaneous spare parts used in 2.75 Rocket Package Assembly.
- \$37,000—Southwest Research Institute, San Antonio, Tex., for additional facilities for missile lubrication research and test development.
- \$36,275—University of Minnesota, for rocket sled ballistics to be used in support of Project 7856.
- \$25,826—Chromcraft Corp., St. Louis, for intervalometers used with launcher rocket.
- \$20,554—Swanson & Youngdale, Inc., Minneapolis, for construction of storage base, LOX addition Project Ellsworth.

UCLA Undertakes 3 Year Study of Free Radicals

LOS ANGELES—A three-year study of free radicals has been begun by scientists at UCLA in order to clarify the basic electronic structure of the molecule.

The work will involve use of a new technique—electron paramagnetic resonance spectroscopy—allowing measurement of the energy levels of the electrons in the radicals by varying the applied magnetic field and the frequency of the exciting electromagnetic radiation.

The research will be conducted by Dr. Daniel Kivelson, who has received a \$27,400 grant from the National Science Foundation.

The free radical can be created artificially, but is rarely found in nature. Nearly all natural molecules have an even number of electrons, while the free radical contains an odd number. It is an important link in many chemical reactions, serving frequently as an intermediate between the stable, natural molecules.

missiles and rockets, May 18, 1959

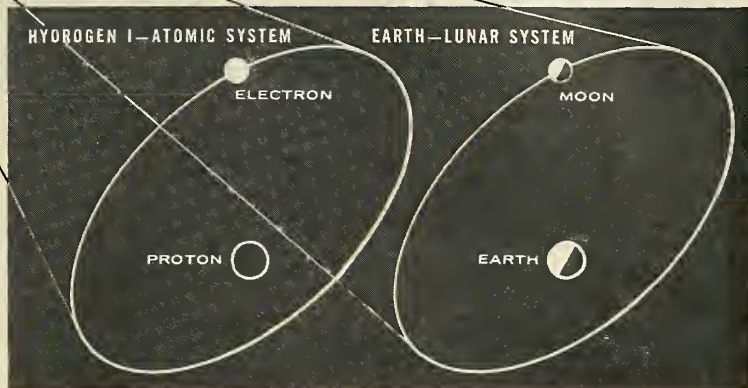
ENGINEERS - SCIENTISTS

$$P(k_1, k_2, \dots, k_m) = \frac{n!}{r_1! r_2! \dots r_m!} P_1^{k_1} P_2^{k_2} \dots P_m^{k_m}$$



BOLD MINDS

Is order and organization in
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underlying principle of the universe...
or does a fundamental state of
randomness prevail in the cosmos
as might be expressed
by the multinomial
formula at left?



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BOLD MINDS have sought to understand the forces at work in the universe, and as they developed working hypotheses, endeavored to turn all knowledge to their own purposes, devising philosophical and mechanical systems of their own.

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of a "flat" world has changed to an oblate orbiting spheroid—mere speck in a vast and expanding universe; so "empty" formless space is regarded as a curved continuum occupied by random knots of turbulence (creating the new branch of mechanics—hydromagnetics).

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Engineering Institutes, The University of Wisconsin, University Extension Division and The College of Engineering
The New Wisconsin Center Bldg.
Madison, May 19-20.

American Institute of Electrical Engineers, Middle Eastern District, Satellite Tracking Session, Lord Baltimore Hotel, Baltimore, May 19-21.

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

Instrument Society of America, 1959 Ohio Valley Instrument and Automation Exhibit and Symposium, Cincinnati Section, Music Hall, Cincinnati, May 21-22.

Institution of Electrical Engineers, The Radio and Telecommunication Section, International Transistor Exhibition and Convention, Earl's Court London, May 21-27.

Federation Aeronautique Internationale
Annual Meeting, Moscow, May 24 June 5.

The National Missile Industry Conference
sponsored by The National Rocket Club in cooperation with Electronics Industries Assn., Sheraton Park Hotel Washington, D.C., May 25-27.

American Rocket Society, Institute of the Aeronautical Sciences, American Institute of Electrical Engineers and The Instrument Society of America, "Investigation of Space" Conference
Brown Palace and Cosmopolitan Hotel Denver, May 25-27.

American Society for Quality Control
All-Industry Production and Quality Control Exposition and Convention
Cleveland Public Hall and Hotel Sheraton, Cleveland, May 25-27.

missiles and rockets, May 18, 1959

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ROPLASTIC POLYMER. The development of a new acrylic-type thermoplastic polymer possessing high heat resistance and an exceptional combination of strength and toughness has been announced by the J. T. Baker Co. The material designated by the code #PL-12, has a heat distortion point of 240°F, a tensile modulus of 415,000 psi and a Charpy impact strength of 1.0 ft. lb. Injection molding and extrusion of PL-12 can be carried out by conventional acrylic techniques.

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SWITCH. A magnetic amplifier circuit for the first time the reliability of all-static construction and the ability to perform logical switching functions. The small unit serves as an on, or not gate, or as a bi-stable memory device. Designer and manufacturer: Pacific Magnetic Corp. Called MC-785 logic type magnetic amplifier the unit is made primarily for control and check-out applications. It replaces three relays in logical switching applications and is suited for pressure and temperature detection and control infrared detection, motion, servomechanisms, computer applications and in other logic applications. It withstands extremes of shock, vibration and temperature, has no moving parts, requires no servicing, and has unlimited shelf and use life. The unit has input control windings, a bias winding and two gate windings. It operates from a 70V center-tapped transformer on a 115V line at 400 cps, has fast response, and accepts a minimum signal of only 2 milliwatts. Nominal power is 28 WDC at 10 watts. The complete unit is fully encapsulated and operates over a temperature range of 0 to 100°C. Dimensions: 2" x 1 1/4". Weight: 10 oz.

Circle No. 241 on Subscriber Service Card.

MAKE SYNCROS. Luther Manufacturing Co. has announced availability of high-accuracy pancake syncros and solenoids. These syncros end resolvers are designed and manufactured for

inertial guidance systems where a pancake configuration is necessary for space and weight limitations. These units are available in size 20 to size 27, featuring accuracies down to 5 minutes. Their electrical properties are designed to match standard components for accuracy, voltage gradient and impedances. They can be obtained with flanges and hubs as an integral part for ease of installation and adjustment.

Circle No. 242 on Subscriber Service Card.

CONTROL VALVES. A two-way valve which allows independently-controlled flow in either or both directions is announced by True-Flo Valve Co. Available in standard IPS from 1/8" to 3/4", the units are adaptable to hydraulic or pneumatic applications in pressures as high as 5000 psi. The valves are female-threaded to dryseal specifications and are available in brass, steel, aluminum, stainless, and special alloys. Extreme dependability, lower friction loss, and greater flow at all temperatures are claimed due to design which eliminates internal gaskets, springs, or hinged parts.

Circle No. 243 on Subscriber Service Card.

TIMING GOVERNOR. A universal timing governor, designed for application to a variety of timing devices, is now being offered by Precision Products Inc. The governor features a patented self-starting movement housed in a stainless steel case with a transparent tamper-proof cover. It is easy to attach to an associated device and easily removed for servicing. A small connecting drive pin may be used to connect working mechanism to power supply.

Circle No. 244 on Subscriber Service Card.

TITANIUM HOOKS. Titanium anode hooks and baskets, with high corrosion-resistant qualities, have been developed for the plating industry by Mellory-Sharon Metals Corp. Both hooks and baskets are available in standard sizes and shapes. Standard titanium hooks range in size from 3 1/2" to 8", with special sizes on request. Fabricated from pure titanium, the hooks and baskets are said to have an indefinite life in highly corrosive mixtures.

Circle No. 245 on Subscriber Service Card.

**MISSILES AND
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MISSILE LITERATURE

MERCURY SWITCHES. Newly-revised Catalog 90b describes the standard line of Honeywell mercury switches, manufactured by Micro Switch, a Division of Minneapolis-Honeywell Regulator Company. Included are photographs, dimensions, electrical ratings, drawings, application information and complete technical data.

Circle No. 206 on Subscriber Service Card.

MISSILE LEXICON. A new book, Missiles From Concept to Countdown, just published by the Aircraft Industries Association, puts into proper perspective the relationship of the missile to the Nation's arsenal; the complexities of its manufacture; the reasons for its cost; and its potential both in war and for peace. This primer has been prepared in response to thousands of inquiries from throughout the Nation for information concerning this newest form of automatic weaponry manufactured by the United States aircraft industry, and the rapidly expanding developments and achievements in the field of space exploration.

Circle No. 207 on Subscriber Service Card.

MAGNET WIRE. High-temperature ceramic insulated magnet wire for service up to 1000°F. is the subject of a new 8-page brochure just issued by Secon Metals Corporation of White Plains, N.Y. It contains the basic information on the original research performed approximately one year ago as well as the engineering data which was compiled during the past year.

Circle No. 208 on Subscriber Service Card.

BRAZING. A single-page 8 1/2 x 11 two-color engineering data sheet discussing Microbrax Vapo-Flux, which produces wetting and flow of brazing alloys in marginal or poor dry hydrogen atmospheres, is now available from Stainless Processing Division, Wall Colmonoy Corp. Included in the engineering data sheet are properties, uses and methods of applying Vapo-Flux to aid in brazing in pure hydrogen or inert atmospheres.

Circle No. 200 on Subscriber Service Card.

LOCKNUTS. Locknuts combing high strength with lightweight for use in missile and related applications at temperatures up to 1200°F are described in a new bulletin offered by Standard Pressed Steel Co. Suitable for use on present MS9033 bolts as well as on stronger fasteners now being developed, the one-piece, all metal featherweight locknuts—designated FN1216 series—are rated at minimum tensile strengths of 160,000 pounds per square inch at room temperature, and more than 140,000 psi at 1200°F. Photos, design drawings and charts supplement text in the four-page illustrated bulletin in pointing up configuration and principal design features. These include overall height than present high-beam type nuts, reduced cross-flats dimension of the 12-point wrenching drive and smaller outside dimensions. These permit use of shorter companion bolts and installation of nuts closer to bulkheads, saving space.

Circle No. 201 on Subscriber Service Card.

COMPUTERS. Publication of a new textbook on the basic principles, language

and characteristics of electronic puters was announced by the RCA Ice Co., a division of Radio Corporation of America. The 114-page book, on "The Language and Symbolology of tal Computer Systems," explains of the basic characteristics of puters. It discusses Boolean algebra practical terms, and contains a reference of logic diagrams and s used by various computer manufacturer and a dictionary of computer nology. "In the digital computer the language is a combination of bols and words which, unfortunately vary among different manufacturer users," D. H. Kunsman, President of RCA Service Co. said. "This book fords a common index of that language for the many engineering as well as engineering people, who must work or provide services for a computer group."

Circle No. 202 on Subscriber Service Card.

SERVO COMPONENTS. A 12-page booklet, entitled Nomenclature of Rotating Servo Components, has been prepared to help engineers who use servo components. It covers standard mil type synchros, resolvers, motors and tachometer generators. Complete explanations of the symbols which identify units are included as well as definitions of all important characteristics of units. It is available from the Ketay Dept. of the Naval Div. of the United Aircraft Corp.

Circle No. 203 on Subscriber Service Card.

AUTOMATED CHECKOUT. Several approaches have recently been developed to solve the problem of maintaining complex military electronic equipment in a state of combat readiness. The technique described by the Checkmate Automatic Test Equipment Co. in their latest "14 Men in a Box," which utilizes a series of portable "black boxes" performing a programmed sequence of automatic checkout procedures, initiates a test, the operator simply pushes a button on the panel; the results are shown by green and red "no go" lamps. Each black box is designed to test a specific equipment in the case of large systems, a special unit. A copy of "14 Men in a Box" is available from the Checkmate Automatic Test Equipment Co.

Circle No. 204 on Subscriber Service Card.

SELSYNS AND SYNCHROS. A 16-page bulletin discusses complete line of General Electric selsyn and synchro transmittal devices used for extremely accurate transmission of electrical data between two or more points. Most commonly used models of high-accuracy class for precise control applications are described. Accuracy is from plus or minus 1. plus or minus .3°. Illustrated publication discusses selsyn and synchro generators, motors control transformer differential generators, differential motors, tandem selsyns, and synchro operation. Bulletin includes schematic and line drawings, figures, tables, and dimensions.

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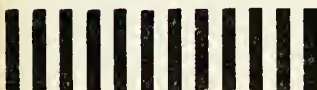
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● **New Missile Products**

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INSTANTANEOUS RESPONSE

Grove Regulators... For over twenty years—from the first missile experiments in the Navy Experimental Station at Annapolis to the launching pads at Cape Canaveral—setting the standards for the control of high pressure fluids...the regulators which served as the critical control on World War II flame throwers and torpedoes...and made missile development work possible...Grove High Pressure Regulators...frequently imitated but never equaled.

Powreactor Dome Regulator—Model GH-408 • 50-6000 psi inlet...5-3000 psi reduced pressure

GROVE VALVE and REGULATOR COMPANY

29 Hollis St., Oakland 8, California • 2559 W. Olympic Blvd., Los Angeles 6, California
in other principal cities



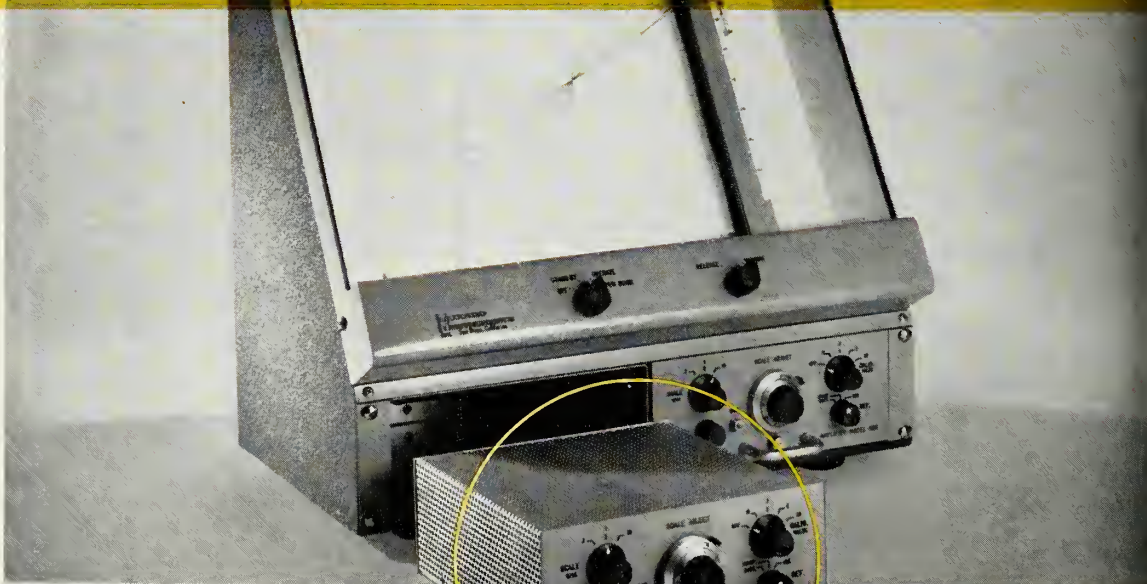
Subsidiary of Walworth

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NEW! Electro Instruments totally-transistorized, modular

XY recorders!



**NEW
ENGINEERING
IMPROVEMENTS
THROUGHOUT!**

- Faster slewing speeds—
Pen: 30"/sec.;
Carriage: 30"/sec.
- Greater accuracies—
Static: 0.1%;
Dynamic: 0.2%.
- 0.05% internal
calibration.
- High precision internal
Zener diode reference.
- New improved vacuum
hold-down system.
- Vernier control between
ranges.
- Input function modules in rack mountable case can be removed from plotter for remote operation.
- Calibrated scales on both axes.
- Front panel gain control.
- Vacuum release on front panel.
- Visible ink supply.

One basic plotter with input modules available for general-purpose, computer, low level differential, time base, curve following and other specialized functions.

	Model 410 Computer Module	Model 420 General Purpose Module	Model 430 Low Level Differential Module	Model 450 Curve Follower Module	Model 460 Time Base Module
Input Ranges	Single Ended 0.1, 1.0, 10v/in, calibrated vernier	Single-Ended 16 steps, 1m v/in to 100 v/in, plus vernier	Differential 16 steps, 1m v/in to 100 v/in, plus vernier	Single-Ended	Single Ended 0.1, 0.2, 0.3, 0.6, 1.0, 2.0 in/sec
Accuracy: Static	± 0.1% F/s	± 0.1% F/s	± 0.15% F/s	± 0.25% F/s	(time) ± 1.0% F/s
Accuracy: Dynamic	± 0.2% F/s	± 0.2% F/s	± 0.2% F/s	± 0.1% F/s	(sweep) ± 0.5% F/s
Linearity					
Input Resistance	2 megs, all ranges	1 meg to 3 megs Depending on range	1 meg to 3 megs Depending on range		
Zero Adjust	Full scale X and Y plus 9" offset	Full scale X and Y plus 9" offset	Full scale X and Y plus 9" offset		
Reference	Internal Zener diode and external = 100v computer.	Internal Zener diode	Internal Zener diode		Internal Zener diode
Calibration	Internal 0.1, 1.0, 10v Accurate to ± 0.05%				
Common Mode Rejection			0c, 120 db AC, 100 db at 60 cps 50 v dc or peak ac		
Max. Common Mode Voltage					
Principle of Operation				60 cps magnetic induction	Electronic Integration
Zero Drift				None	

Dimensions All Modules: 8½" W x 3½" H x 7¾" D

**Model
400 Plotter**

- Recording Size: 10" x 15"
- Slewing Speed: X, 40"/sec; Y, 30"/sec
- Inputs: X and Y inputs, and computer reference
- Power: 115 ± 10 v, 60 cps
- Dimensions: 19" W x 19½" H x 11¾" D
- Ambient Temperature Range: 0-55°C
- Controls: Power off, standby, operate, pen; vacuum release; curve follower, amplifier; local, remote.

3540 Aero Court
San Diego 11, California



Electro Instruments, Inc.