MARCH 30, 1959

HELI-ARC WELDING FOR TITAN

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

EXCLUSIVE

THE STORY BEHIND OPERATION ARGUS
BY DR. S. FRED SINGER

OUR MISSILES VS. THE RUSSIANS'
BY SEN. SYMINGTON AND REP. FULTON

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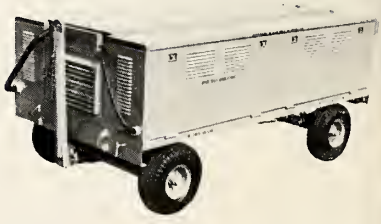

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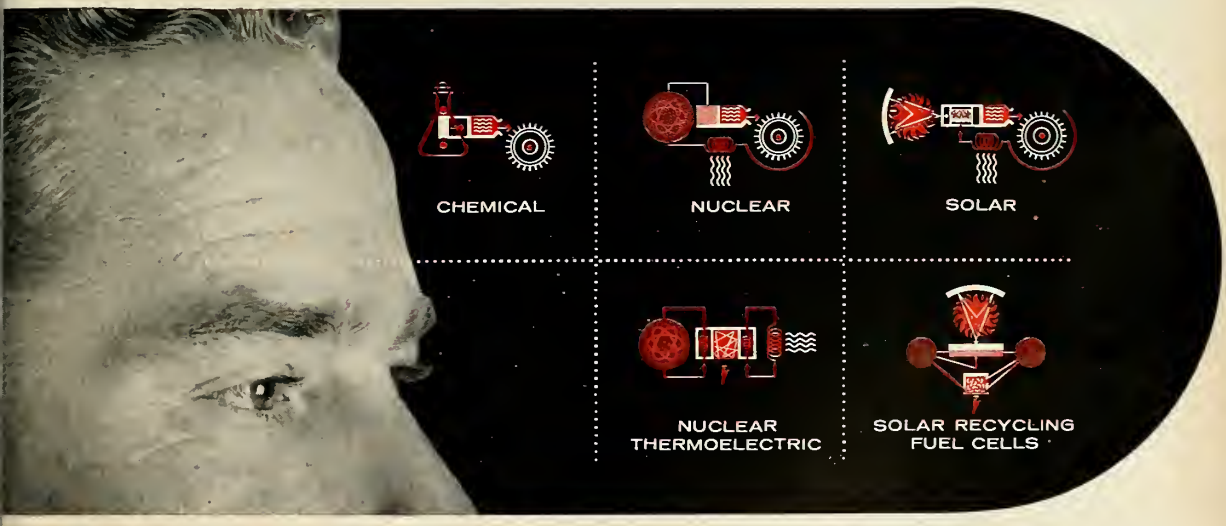

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missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

MARCH 30 HEADLINES

ASTRONAUTICS ENGINEERING

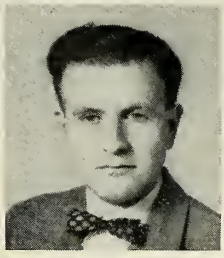
MISSILE SUPPORT EQUIPMENT

MISSILE ELECTRONICS

THE MISSILE WEEK

DEPARTMENTS

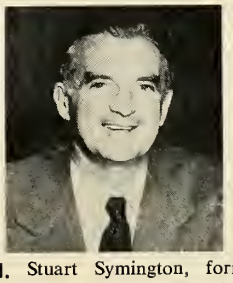
COVER: Welding operation for thrust chamber of *Titan* at Aerojet-General in Sacramento.



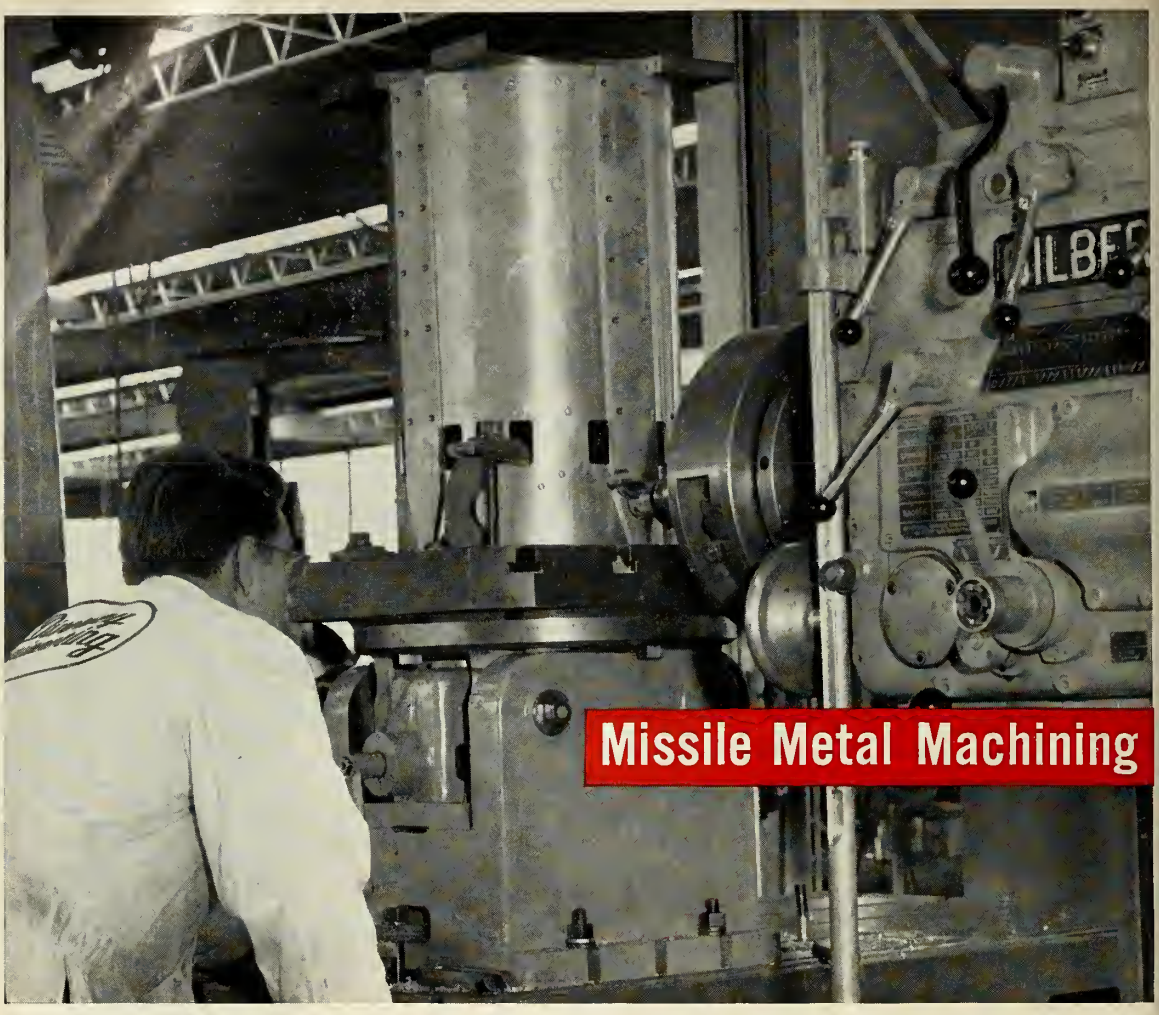
PROF. S. Fred Singer gives the scientific implications of nuclear explosions in space. (p. 33)

DR. Hubertus Strughold tells what's needed in space medicine in exclusive interview (p. 22)

CONGRESSMAN James G. Fulton defends administration's defense policies. (p. 18)



SEN. Stuart Symington, former AF secretary, criticizes administration defense policies.



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FROM NOSE TO NOZZLE, FROM FIN TO FIN, CONTOUR TURNED PARTS—WITH PRECISION BUILT IN

Quarles Best to Replace McElroy

Looking a little into the future we can anticipate late this summer the appointment of a new Secretary of Defense, one of the more hazardous political exercises indulged in by the White House. It is hazardous because any new man, even one who may have been on the fringes of U.S. defense business, must spend the first year just trying to encompass the tremendous scope and intricate details of that position. This leaves him for these many months at the mercy of his advisers and there is always the grave danger that he will listen to the wrong advice.

There is an old saw in the Pentagon to the effect that every time a new secretary is appointed every admiral and general drags his pet plan for saving the nation out of the bottom drawer, blows off the dust and presents it hopefully to his fresh and inexperienced audience.

In the situation coming coming up, Neil H. McElroy, the present Secretary of Defense, will return, he has announced, to his old job in industry. Sitting in the Number Two job is Deputy Secretary Donald A. Quarles, the one man who probably knows most about the U.S. defense picture in all its infinite detail.

Don Quarles started his Pentagon service on Sept. 1, 1953, as Assistant Secretary of Defense for Research and Development, a job for which his scientific training and background eminently qualified him. From there he became Secretary of the Air Force, a position he filled capably and left reluctantly to take on his present post. For years now, he has borne up under the burden of carrying out the policies of men with whom he frequently did not agree—Charles E. Wilson and McElroy.

He has done this for several reasons, the primary of which is probably his great esteem for President Eisenhower. The President asked him to take the deputy job and stay in it. Don Quarles took it and stayed. His other reasons include a strong party loyalty, a dedicated patriotism and the fact that he is convinced that he can do the job better than anyone else.

When McElroy leaves, whether it be August, September or October, the new appointee will have less than a year and a half to serve before a change of administration inexorably moves him out. He will have a year to learn the job and to make decisions on the advice of his staff. He will have a few months remaining in which he is capable of deciding and judging for himself. If he is a competent man of proven ability he probably will not want to step into such a situation. If he is a "name" chosen for political reasons, the nation can't afford him.

In either case it would mean that Deputy Secretary Quarles would be running the office to a large degree, patiently guiding again the unsure actions of a newcomer on whose decisions the survival of the United States might depend.

And somewhere in this long-drawn-out process the patience of Don Quarles may come to an end. Whether or not he was promised the top job when McElroy left, either tacitly or directly, probably very few people know. But there must be a limit to how much a man can take for either personal or party loyalty.

We suggest that Don Quarles should be named Secretary of Defense when McElroy leaves, not so much because he has earned it (which he obviously has) but because he is the best man available. We say this fully conscious of the fact that in the estimation of associates and even close friends Mr. Quarles has several characteristics—perhaps convictions is a better word—which make him less than ideal for the job.

One is over-caution. Another is his acceptance of the team (or party) decision even when he is personally convinced that the decision is wrong. However, in some quarters these are called virtues, not faults. Don Quarles has been for long periods in corporations where the team decision was unquestioned and for other periods in spots where his main job was to hold down the coattails of high-flying superiors. His devotion to the team and his caution are honestly acquired. Boldness, were boldness needed, might come from the authority of the top position.

If a new man is named Secretary of Defense and Don Quarles leaves the result will be either fearful indecision for months or dangerous chaos. The country simply cannot afford a complete change. If a new man is named and Quarles stays—he will be making the decisions anyway. Quarles has delivered selfless, devoted and competent service. He is by any yardstick best qualified. Give him the job.

Clarke Newlon

washington countdown

IN THE PENTAGON

Navy electronic guidance experts are seeking some research tips by studying techniques used by bats. Navy researchers say their studies are expected to provide a rational basis for developing mechanical and electronic analogue systems for long-range target selection and navigation.

• • •

Delayed reorganization of the Air Research Development Command will get underway within a few weeks. Naming of a successor to Lt. Gen. Samuel E. Anderson Jr. as chief of ARDC has stalled things. The Air Force now is considering the possibility of putting its big research laboratories at Wright Development Center and Cambridge under the Office of Scientific Research.

• • •

One *Polaris* submarine on station, according to operations analysis, is equivalent to an inventory of 2,000 to 4,000 deployed B-29 aircraft loaded with conventional bombs ready to make a simultaneous attack on several important targets, according to Brig. Gen. A. W. Betts.

• • •

Over 50% of the 11 missiles in the Navy's guided missile program will be operational by the end of this year, according to Rear Adm. K. S. Masterson, head of CNO's Guided Missiles Division. Operational at present are: *Sidewinder, Regulus I, Terrier, Sparrow III* and *Talos* with *Bullpup* to come later this year. Under development are *Polaris, Subroc, Tartar, Eagle* and *Corvus.*

• • •

Project *Argus* was a major topic of conversation and conflict. While it is true that certain frequencies are affected by the radioactive blanket emanating from such high altitude shots, Army R&D spokesmen insist that the frequencies utilized in the *Nike-Zeus* system are not.

ON CAPITOL HILL

The House Information Subcommittee is preparing for a showdown over the Air Force refusal to give Congress the full text of a secret survey of management of the Air Force ballistic missile program. Chairman John E. Moss (D-Calif.) said the subcommittee is "exploring in great detail alternatives to enforce the law."

Congressional pressure is mounting for greater international cooperation on space programs. Members of both the House and Senate Space Committees are urging that new attempts be made toward setting up more IGY-type projects involving both the United States and Russia.

AT NASA

Two super antennas are being modified to receive data from NASA's tentatively-scheduled Venus rockets this June. One antenna is the 60-foot telemetry dish at South Point, Hawaii. The other is the 250-foot radio telescope at Jodrell Bank, England. NASA has said launching the Venus rockets this summer depends on whether the powerful rockets and communications equipment would be available in time.

• • •

The modified feeds for the Venus shot antennas—designed and built on a crash basis in less than three months—are scheduled to be delivered shortly. The modified feed systems will enable the antennas to receive up to four simultaneous transmissions on frequencies in the 100-1000 mc range. They also will enable the antennas to send. The modified feeds will provide circular polarization on all frequencies with linear and crossed-linear on certain bands.

AROUND TOWN

Government and industry officials increasingly think materials may be the big bottleneck in future development of missiles and space ships. The National Research Council, Aircraft Industries Association and NASA are working on the problems anticipated. The National Research Council is getting out a report pinpointing some of them—and some of the possible solutions.

• • •

Dr. James Van Allen says the inner Van Allen radiation belt around the earth is a far greater threat to space travel than the outer one. Van Allen says the 1/8-inch lead shielding in *Pioneer IV* cut out almost all radiation as the moon probe flashed through the outer belt. But, he says, when the probe passed through the inner belt the probe's radiation counters acted as if the shielding weren't there.

industry countdown

STRUCTURES

ARPA may ask industry to study another manned, maneuverable space vehicle of more "sophisticated" capability than NASA's *Mercury* project. Space Science and Technology Coordinator David A. Young of ARPA believes it could be done in about three years for $400 million. Weight would be about 20,000 lbs. with 1½ million lb. thrust engine.

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Advances in glass-plastic blending for nose, exit cones and missile structures are reported by Hughes Aircraft Co. microwave laboratories. Firing test of exit cone showed 1/16 inch interior scouring with "no appreciable" efficiency loss. Material also resists salt water corrosion.

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Effects of radiation upon fuels and materials will be studied in a new laboratory to be built at Middletown, Conn., with AF funds by Pratt & Whitney Aircraft Co.'s Connecticut Aircraft Nuclear Engine Laboratory.

• • •

Sounding rockets in Project *Argus* were five-stage *Argo E-5s*, 57-ft. long and weighing 7,000 lbs. Built by Aerolab Development Co., the vehicles can boost a 50 lb. instrument payload to 500 miles.

PROPULSION

Word of possible major breakthrough by Stauffer Chemical and Aerojet-General team in direct hydrogen reduction of boron is being spread by Wall Streeters. If true, cost of high energy fuels may be sharply reduced. Process also may be applied to reduction of titanium, columbium and tantalum.

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$5 million NASA contract for development of 35,000 lb. *Vega* liquid second stage engine goes to General Electric Co. Engine will be modification of *Vanguard* first stage and is to have start and restart capability.

• • •

Highly-fluorinated synthetic elastomer for missile fuel cells has been developed for use at 400°F in a wide variety of corrosive chemicals. Minnesota Mining and Manufacturing Co.'s Chemical Division says the elastomer resists HEF or HiCal fuels, red fuming nitric acid and up to 90% hydrogen peroxide.

ELECTRONICS

Costs are still holding back widespread field use of advanced telemetering systems such as *Vanguard* ARRF, which automatically reduces data at 2½ times real-time rate, and Holloman AFB rocket-sled PCM system. Study is underway of "compatible" combination with new digital techniques to avoid scrapping existing analog equipment entirely.

• • •

NASA's launch this Fall of 100-ft. diameter sphere will be primary study of "passive" communications system. Radiowaves will be bounced off the aluminum vapor coating as it orbits at 1000 miles and picked up by ground receivers of ultra-high sensitivity.

• • •

Any company willing to gamble $300 million on commercial communication satellite system may expect a $30-40 million annual return. Dr. Eberhardt Rechtin, chief of JPL's guidance research division, believes system and payoff are achievable within five years.

• • •

AF *Thor-Able II* firing March 20 reportedly demonstrated the transistorized radio-inertial guidance system for *Titan* is electronically jam-proof. Bell Telephone Laboratories says the ground-placed digital computer made by Remington-Rand Univac stores trajectory data, provides steering commands in flight and calculates "exact spot" of missile impact. In latest firing, however, the AF failed to recover the *Thor-Able II* nose cone from the South Atlantic despite new instrumentation.

ASTROPHYSICS

University of Michigan astronomers are developing experiment to "shoot" the planets photoelectrically from satellite observatories. Light readings will be made over selected radiation wave lengths.

• • •

Radar contact with Venus by MIT's Lincoln Laboratory indicates the solar system is 0.0013% smaller than believed heretofore. Two hits in February, 1958, took 295.5065 seconds and 302.9842 seconds, placing Venus about 28,227,000 miles from Earth.

More Industry Items on Page 32 . . .

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missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AOMC Recommends 'No Funds' for Missile *Able*

Only 8 Lacrosse battalions; Prototype Pershing testing soon; Chrysler submits Jupiter for target missile

by Donald E. Perry

HUNTSVILLE—About the only way Army Ordnance Missile Command can fund many desirable advanced missile projects during 1960 will be by "bootlegging" small amounts of funds from one project to another.

Reliable sources have told M/R that:

• *Missile A*—This 65-75-mile solid-propelled ballistic missile successor to the *John* family has received a "no funding" recommendation from AOMC for FY 1960. While *Missile A* has had what has often been referred to as "high priority," many persons are at loss on why such a recommendation was made by AOMC and forwarded on to the Pentagon. Some sources say, however, that a funding decision may be made after July 1.

It is known that AOMC's Ordnance Missile Laboratories on the Redstone Reservation has been selected by an evaluation committee to do as much preliminary work "in house" as is possible on *Missile A*. The committee has recommended Thiokol for the engine development and Minneapolis-Honeywell to supply the inertial guidance.

Firms who had entered the *Missile A* competition in addition to M-H included General Electric, Martin, Cornell Aeronautical Labs, Armour Research Foundation, and Douglas.

• *Mauler*—This small, easily-transported infrared homing missile for use against low-flying aircraft has the entire blessing of AOMC and an arsenal evaluation committee has reportedly picked Convair. Others in the competition are Sperry Rand, GE, Convair and Martin. With AOMC's recommendation the project is in the Pentagon for JCS review. *Mauler's* infrared system will give troops surface-to-air offense with six missiles per unit. (M/R, Nov. 17, p. 46).

A companion to *Mauler* is *Redeye*, surface-to-air bazooka, still in the feasibility study stage. It will remain in that stage as far as FY 1960 funds are concerned, M/R has been told.

• *Lacrosse*—This Martin air-to-surface, 20-mile range, terminally-guided missile will be funded for only eight battalions. However, more funds will be made available during 1960 in the development of an advanced *Lacrosse*, immune to electronic countermeasures.

AOMC has given no thought to funding of *Missile B* and *Missile C* systems, M/R has been told.

Missile D is the solid-propelled 700-mile range *Pershing* which is enjoying increased funding and will come in for even more in FY 1961. However, AOMC sources say some engineering schedules are "slipping slightly," although any lost ground will be regained when prototype testing starts on a limited scale within months.

AICBM target missile—Five companies have submitted proposals. Chrysler's now is being evaluated by AOMC with the recommendation that Chrysler be permitted to go ahead with development and building of an early prototype. This probably would embrace a less expensive guidance system and storable liquids. Sources pointed out to M/R that use of *Jupiter* as an AICBM target missile can be relatively inexpensive and that early availability is assured for testing with *Nike-Zeus*. Other advanced thinking for *Jupiter* is substituting nitrogen tetroxide for LOX and switching RP for alcohol.

• *Nike-Zeus*—While many Pentagon chiefs rule out volume production of this three-stage solid rocket system now, AOMC is insisting on stepped up development work and campaigning hard for a production commitment, even if in limited quantities. Sources have told M/R that target detection is no longer a major problem with radar technology now sufficiently advanced for accurate discrimination of warhead from diversionary objects which are re-entering the atmosphere.

In *Missile A*, feasibility studies amounted to less than $100 million to each participating company. Chance-Vought carried out an unfunded study with about $6 million in its own funds for another version called *Firepower*. It is the decision that *Missile A* will employ inertial guidance rather than being a free rocket.

About the Cover

Aerojet-General is using the heli-arc welding process in producing chamber assemblies for the high-thrust *Titan* rocket engine.

The thrust chambers are fabricated with hollow, tapered stainless steel tubing. The throat areas are welded first and then silver brazing is used on the skirt area to complete the chambers. These operations are used on chambers requiring special fabrication.

For production type chambers being produced in the 308,000-foot manufacturing plant, a speedier and more advanced technique of furnace brazing is being employed.

Highlights of IRE Convention

Transistor output to pass $350 million by 1963; sales to near $300 million.

by Charles LaFond

NEW YORK—Choosing a replica of *Vanguard I* as a symbol of this year's show, the 47th Annual IRE National Convention attracted some 60,000 electronics engineers, scientists, and manufacturers who viewed over 950 exhibits and participated in 54 technical sessions.

More than 17,000 different pieces of electronic apparatus—representing the very latest in scientific advances—were on display. The exhibition, it was announced, was the largest technical show ever staged anywhere in the world. To indicate just how big it was, a megawatt of electrical power was required to operate the displays each day.

In technical sessions at the Waldorf Astoria and the Coliseum, 275 papers were presented describing new developments in 28 branches of the art, ranging from space flight and medical electronics to stereophonic sound and air traffic safety.

• **Convention summary**—The highlight of the program was a special symposium March 24, when 10 of the nation's top authorities discussed "Future Developments in Space." Eric A. Walker, president of Pennsylvania State University, was chairman. Panel members included Lt. Gen. James M. Gavin (Ret.), vice-president of Arthur D. Little, Inc.; and Homer E. Newell, Jr., assistant director for space sciences, National Aeronautics and Space Administration. The symposium was one of three sessions on space technology.

Other events of unusual interest included a session on electronic teaching aids and another on Russian electronics technology.

The technical session program was preceded by the annual meeting of the IRE on March 23 in the Waldorf Astoria. The featured speaker was Donald B. Sinclair, vice-president of the IRE and vice-president of the General Radio Company, who spoke on "science and Coexistence."

• **Banquet**—As M/R went to press, Institute members and guests were scheduled to attend the annual banquet in the Waldorf Astoria Grand Ballroom on Wednesday evening, when the principal speaker was to be Lloyd V. Berkner, president of Associated Universities, Inc., and international president of the International Scientific Radio Union. His subject was "The IRE Enters Space." Ernest Weber, IRE president, was to announce the Institute's annual awards.

The IRE's highest technical award, the Medal of Honor, will go to E. Leon Chaffee, former director of the Cruft Laboratory, Harvard University, for "outstanding research contributions and . . . dedication to training for leadership in radio engineering."

The Morris Liebmann Memorial Prize will go jointly to Charles H. Townes, professor of physics, Columbia University, and Nicolaas Bloembergen, Gordon McKay professor of applied physics, Harvard University, "for fundamental and original contributions to the MASER."

Jack W. Herbstreit, chief of the tropospheric propagation research section, National Bureau of Standards, was named to receive the Harry Diamond Memorial Award for "original research and leadership in radiowave propagation."

The Vladimir K. Zworykin Television Prize will go to Paul Weimer, group leader of pickup tube research, RCA Laboratories, "for contributions to photoconductive-type pickup tubes."

The 1959 W.R.G. Baker Award will be given to Richard D. Thornton, assistant professor of electrical engineering, Massachusetts Institute of Technology; Franklin H. Blecher of Bell Telephone Laboratories, Inc., Murray Hill, N.J., will receive the 1959 Browder J. Thompson Memorial Prize Award.

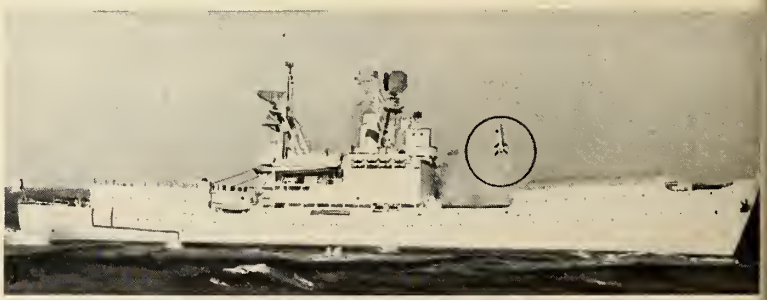
• **Recruiting**—With more jobs available than usual, the annual game of proselyting engineers got off to a slow but determined start. There were bulletin boards heavy with job lures, newspaper ads, hospitality suites, and roving raiders.

• **Transistors**—An incomparable future is foreseen for the transistor and electronic computer by leading electronics firms exhibiting at the show. The annual output is expected to approach or pass the 350-million mark by 1963—about three times the expected unit production for 1959, with sales nearing $300 million.

By 1965, combined military-commercial transistor production should reach about a half-billion units a year, with unit prices averaging "less than that of vacuum tubes," perhaps less than $1 each.

Millions of the tiny units are expected in a year or two to be the mainstay of the country's telephone networks, forming the largest application of transistor electronics on earth.

Launching of the Maruca



FRANCE'S *Maruca* surface-to-air missile (in circle) is launched from the new French missiles testing ship, the Ile d'Oléron, described as containing more electronics than any other French vessel. Newly reconverted, it once was a German transport.

Atlas Bases to be Hardened

Titan and Atlas will both be continued, Pentagon tells Congress, but Bomarc sites are cut sharply

by James Baar

WASHINGTON—The Pentagon has disclosed it plans to face the years of the missile gap with mostly "hard" ICBM bases.

It said it is considering hardening at least some of the first four "soft" above-ground bases for Convair's *Atlas*. And it said the next five *Atlas* bases—two more than previously announced as being planned—would be hard along with all future ones.

However, the Air Force made clear that it has rejected proposals to drop further work on Martin's "hard-based" *Titan* in favor of building only improved models of the *Atlas*.

The disclosures—made in closed-door testimony before the House Defense Appropriations Subcommittee—mean the Air Force has determined the *Atlas*' radio inertial guidance system can be switched for the all-inertial guidance system originally designed for the *Titan*.

That will enable *Atlas* to be kept in heavily-protected underground bases able to withstand pressures up to 100 lbs. psi. Air Force Secretary James H. Douglas said "with the present state of the art the hardened sites are likely to withstand any attack that we foresee."

• *Atlas* **vs.** *Titan*—Douglas said the Air Force considered dropping *Titan* after receiving a Convair proposal to increase the production of an "improved" *Atlas*.

Air Force officials originally estimated a switch to only *Atlas* would save $1 billion over four years. But the estimate was reduced after further study to $400 million.

Douglas said the Air Force decided to go ahead with both *Titan* and *Atlas* because it was "unwilling to rely for our big missile program on one propulsion producer."

He said the Air Force also wants to develop a better nose cone for *Atlas* and the nose cone and advanced guidance system that are part of the *Titan* program.

• **Congressional discontent**—Subcommittee members clearly indicated discontent with administration acceptance of taking second place to Russia in ICBM armament during the missile gap.

They proposed as one possible solution a crash program to develop many more "hard" *Atlas* bases than are now planned. They proposed as another possible solution greatly increasing the manufacture of *Atlas* for use at "soft" bases—either for increasing the numbers available for a first retaliatory salvo or even a second salvo if the base survived the initial exchange in a nuclear war.

Air Force officials said the proposals already have been rejected for various reasons. But M/R has learned that Pentagon officials still are considering a Convair proposal to build six or more "hard" *Atlas* bases for a total cost of $500 to $750 million. The money is not included in the FY 1960 budget.

Other developments brought out in the hearings:

Minuteman—Boeing's *Minuteman* ICBM will be able to deliver a warhead about ¼ as heavy as one delivered by an *Atlas* and about 1/7 to 1/8 as heavy as one delivered by a *Titan*. However, the solid-propellant *Minuteman* is expected to cost only about $2 million at first and only $1 million eventually. An *Atlas* was estimated in the hearings to cost about $10 million.

Hound Dog—North American's *Hound Dog*, a turbo-jet powered air-to-surface missile, has yet to demonstrate very high reliability. *Hound Dog* is designed for firing from B-52s to destroy heavily defended targets. An extra $48 million given the Air Force last year for the program has not been used. The Air Force said the program was already moving as rapidly as possible.

Eagle—Bendix's *Eagle* will be a money-saver for the Navy. The missile will be launched by slow, inexpensive planes equipped with radar for tracking enemy planes. Supersonic speed and performance will be built into the missile—not the launching plane.

Regulus—Chance-Vought's *Regulus II* may be bought by France for the French Navy, and possibly for land bases. Navy officials said the 1200-mile range missile may possibly be shipped to France as part of the foreign military aid program.

Polaris—The Navy requested—and was denied in the President's budget—six new *Polaris* submarines and advance procurement authority for seven more. Also a total of more than $800 million was knocked out of the *Polaris* program.

Nike-Zeus—General Maxwell Taylor, Army Chief of Staff, renewed the Army's argument that the United States should go ahead with a $1 billion-a-year program to develop the *Nike-Zeus* AICBM. He admitted risks, but he said "it is the only weapon that can give us a defensive capability against the incoming missile . . . and the risks are worth taking." The subcommittee plans to look into the *Zeus* further.

Bomarc—The number of bases for the surface-to-air interceptor has been cut from 29 to 19.

Mace—Martin's *Mace* is expected to be operational this spring and delivered to U.S. forces in Europe. The Air Force will use the new tactical missile to replace eventually the *Matador*. The *Mace*—The Air Force's new tactical missile designed to deliver a nuclear warhead—also will be sent to U.S. forces in the Far East at a later date.

Pershing—The Pentagon is stepping up work on Martin's solid propellant *Pershing* to narrow the interim between the time it will be ready and the ending of production of the liquid-propelled *Redstone* that it is replacing. The Army is planning to keep the *Redstone* operational for some time, even after *Pershings* become available, and some *Redstone* may be used in the foreign military aid program.

Snark—The Air Force said its subsonic *Snark* would be fully operational this fall and the first full squadrons would be stationed by early next year. It said it decided to go ahead with the *Snark* because it was almost fully operational and it carries a large warhead. However, the *Snark* will not be further improved and the slow missile's lifetime is expected to be short. One subcommittee member said he could knock the *Snark* down with a rock.

ARS Meeting Stresses Ground Support Equipment

Pre-launch problems, data handling and missile performance comes up in technical papers delivered by specialists

by William O. Miller

DAYTONA BEACH—Ground support and handling was the theme of the first specialist meeting of the American Rocket Society—the National Flight Testing Conference—which got underway last week at this Florida resort. Specific areas discussed included ground support, countdown and prelaunch problems and data systems. Secret sessions were held on missile performance, instrumentation, flight experience and range support.

James F. Thompson of the Radio Corporation of America Service Co., Patrick AFB, was the conference chairman. Dr. John Sterner of Space Technology Laboratories was program coordinator. The speaker for the banquet held on Tuesday night was Homer J. Stewart, director of the office of program planning and evaluation of the National Aeronautics and Space Administration. Luncheon speakers were Brig. Gen. John A. Barclay, commander of the Army Ballistic Missile Agency, and Rear Adm. John T. Hayward, Assistant Chief of Naval Operations for Research and Development.

This first specialist conference of the ARS will be followed later this year by additional meetings dealing with other special areas of interest including rocket propellant thermodynamics, solid propellants and controllable satellites.

The meeting was launched with morning sessions last Monday on ground support and data systems.

More than 25 technical papers, prepared by representatives of industry, government and the military covered all phases of the broad ground support effort.

• **Cryogenic liquids**—Ground support and handling of liquid fuel missiles should be subjected to the same meticulous testing as the missile system itself, Andrew J. Pickett of ABMA, Patrick AFB, told those attending the Florida meeting.

Steady burning condition of the fuel is dependent upon the oxidizer and fuel start system providing the flow of propellant at precisely the right time and with the proper pressures, Pickett said. If they fail, the rocket engine will never attain the burning state required and result will be destruction of the missile.

Another important function of ground support equipment is to provide high-pressure gas pressurization both on the ground and aboard the missile itself, during the critical phase —usually between the start of an automatic sequence and the missile lift-off or simulated lift-off for a captive firing.

Transfer of liquid fuels and oxidizers requires special equipment and special handling techniques, Pickett said, and the evaporation problem inherent in the use of cryogenic liquids demands a replenishment system—either automatic or semi-automatic.

In conclusion, Pickett said the quality control problem probably is the cause of more ground support trouble than all other reasons combined. He urged adherence to design tolerances.

William H. Lawrence of the AF Flight Test Center, Edwards AFB, discussed operational problems with high-pressure helium, and described how helium is handled at the Missile Static Test site. Corrosive qualities of helium make it necessary to make wide use of stainless steel.

System reliability depends, said Lawrence, on a central pump station, tielines, mobile pumps and transfer trailers, in addition to reliability of individual components such as valves, fittings, and seals. Reliability of components is of utmost importance, he continued.

"We endeavor to stimulate private industry to develop better components for fixed cost purchase," he said, "and where this is not feasible we utilize a cost-plus-fixed fee development contract for prototype items to meet our specifications."

• **Experienced personnel**—Continuing the discussion of propellant handling, J. W. Schultz of Pan American World Airways, Patrick AFB, said prevention of accidents depends largely upon employment of experienced personnel, strict quality control, use of portable filters in liquid oxygen transfer, adequate maintenance of hydrocarbon fuel filters, periodic cleaning of propellant transfer equipment and inspection of protective clothing and equipment issued personnel.

• **Data systems**—The Data Systems session opened with a paper on electronic processing and analysis of high-frequency data by William C. Adams of Edwards AFB. The energy produced by the sound field of a rocket stream is greater than that produced by the direct mechanical transmission of vibration of a rocket engine, making the sound field the most important source of vibration in the missile. He said other sources of vibration include the turbulent boundary layer pressure fluctuations, oscillatory shock waves associated with nodal disturbances and sound fields produced by the turbulent wake of the missile.

E. T. Hatcher, of RCA Service Co., Patrick AFB, discussed the target acquisition data handling system for missile tracking at the Atlantic Missile Range. He said the forthcoming ballistic missile chain radar system will consist of FPS-16 instrumentation radars with 5000-mile range units located at Cape Canaveral, Grand Bahama and San Salvador Island for continuous tracking of IRBM's and ICBM's through burnout.

Though very successful, the Mod II radar chain has definite limitations for application to the new generation of pulse radars (FPS-16), especially as distance between sites is increased. Granularity probably is the most severe limitation, he said.

• **Command telemetry**—By utilizing high-speed computers on the ground and the required radio links to the missile, it might be possible to complete an entire program during a single flight. Great improvements in flight test pro-

rams could be achieved if the data ould be analyzed in time to be useful o the purpose of the flight.

"Command Telemetry," the name hosen for this method of commanding he performance of an instrumentation ystem, was the title of the paper pre-ented by Leonard S. Taylor of White Sands Missile Range.

At another data systems session on he second day of the conference, R. . Duffin and Thomas W. Schmidt of he Office of Ordnance Research, Dur-ıam, N.C., presented a paper entitled, 'A Simple Formula for Prediction and Automatic Scrutation."

"Real Time Analysis" was discussed by Guenther Hintze, Chief of the Flight Simulation Laboratory at the White Sands Missile Range, who called t a new approach in flight testing. He aid considerable development of bet-er techniques and equipment, and mooth incorporation of these into the ontinuing test programs appear to be nandatory.

New developments for faster data reduction are in progress, he said, and should lead to processing and analyzing of flight data in real time, so that by using this data, some control can be exercised over the actual flight.

Duane C. Brown, RCA Service Co., Patrick AFB, presented a solution to a broad class of estimation prob-ems. A. E. Hoffmann-Heyden, of the same company, discussed the tracking of satellites with AN/FPS-16 instru-mentation radars. He reported that the *Sputnik II* C-Band echo produced an entirely different picture than expected from a slowly tumbling cylindrical re-flector. He said it was characterized by broad intervals of high and con-sistent signal level over consecutive viewing sectors of about 80° and sep-arated by a lobe structure.

The broad high-level regions, ac-cording to Hoffmann-Heyden, suggested the presence of corner or lens type reflectors as integral parts of the rocket body. *Sputnik III* carrier rocket's C-Band echoes indicated no intentional echo enhancement, he said, and this appeared logical assuming separated carrier rocket was not the object of particular tracking endeavor.

• **Countdowns**—At an afternoon session dealing with countdowns, John S. Harrison of Convair-Astronautics said experience with *Atlas* showed that countdown procedure should be established early in the design phases of the missile program to give the designers a composite operational plan.

Too often, he said, the bulk of attention is given to the technical countdown document, but success also depends on use of the countdown as a tool. Most countdown problems, he said, have resulted from human factors such as tension and confusion during countdown, breaches of discipline on intercommunications, and even over-confidence on the part of the crew members.

The *Thor* countdown system was presented by T. J. Gordon of Douglas Aircraft Co., Patrick AFB. He told the ARS members that the key to efficient countdown management is autonomy —the ability to decide on the course of action without consulting higher command.

"The command function must be centered in the blockhouse," he said.

While it is desirable to employ automatic sequencing in operational missiles, Gordon declared, manual handling of research and development launchings is desirable so that countdown crew can observe and understand what is happening as a result of their commands and vary the countdown as necessary in light of past experience.

Using *Bomarc* as the example, Herbert W. Bethel of Boeing Airplane Co. discussed the automatic countdown checkout which he said was a requisite for defensive missile systems. *Bomarc* will be placed in "ready storage" and can so remain for as long as a year with periodic checkouts.

The second period of the *Bomarc* countdown is the "warm-up period"—the first 15 minutes after an alert. During this time power is applied, gyros started, and other systems activitated.

The third period is the actual "fire-up" during which the missile receives its pre-launch commands, flight control electronics are checked over and *Bomarc* is switched to its internal power supply.

• **Missile performance**—In discussing solving of flight test problems for rocket propulsion systems, D. K. Huzel and N. D. Johnson of Rocketdyne suggested a drag cable or land line of some 100 feet during the first seconds of flight to offset lack of high-frequency response of the telemetry. He said it was estimated that up to 80% of failures occur or have their origin in the period just preceding launch and during the first few seconds of flight.

On the same subject of problems in servicing nuclear rockets, Sidney G. Rumbold, of Aerojet-General Corp., said a specific impulse of 800 seconds seems well within capabilities of the nuclear rocket as compared with about 400 seconds attainable with high-energy chemical propellants.

A challenging task in developing the nuclear rocket, Rumbold said, would be handling a single, lightweight tank 25 feet in diameter and 100 feet long, which would be used to hold the fuel. He used liquid hydrogen as an example. The use of liquid hydrogen and radiation are the basis for most of the problems anticipated, but he was confident the problems of size and radiation would be solved.

Rumbold described the representative 500,000-pound-thrust nuclear rocket as follows: reactor with a graphite core using U^{235} fissionable nuclear fuel, with a theoretical specific impulse of 720 seconds, mass ratio of 0.75, take-off weight 250,000 pounds, tank diameter 25 feet, and overall length 126 feet.

C. M. Wedertz of Douglas Aircraft discussed the missile handling equipment for flight test programs, using *Thor* as an example. He pointed out that special equipment was needed because *Thor* is relatively thin-skinned and certain portions of the missile must be maintained in a controlled environment. Lighter, more transportable ground equipment now is in production to make *Thor* independent of climate or urban facilities.

New GSE for Nike

QUARTERMASTER Corps' "Ranger," all-purpose vehicle is being used to lift *Nike-Hercules* to its launching rack for union with the booster. It can pull 19,000 lbs. and lift 10,000 lbs.

an m/r exclusive:

U.S. Survival in the Atomic/Missile Age

Rep. James G. FULTON

REP. FULTON (R-Pa.), a ranking Republican member of the House Science and Astronautics Committee and the House Foreign Affairs Committee, is serving his eighth term in Congress, and has made the defense and space posture of the nation one of his major fields of inquiry.

Big Nation power plays today are as fast as a big league baseball game. A crack of the bat, or a line drive down center field, and the strategic positions of the teams change, and the stands are electrified. Few people get hurt either in the stands or on the field, but it is certainly interesting and attracts the white flooding light of publicity and solid support of the fans.

Underneath, the owners and backers are playing a deadly serious game. No team can win all the time, but if any group or team is unsuccessful too long they may lose the ball park as well as the team and fans.

The two big league powers, USA and USSR, are and have been winning and losing ball games for the last twelve years. But it is still a tight series and no one has a really decisive advantage. Both powers have their own ball parks, teams on the field, and plenty of interest—excitement from the nations in their own bleachers as well as the uncommitted nations in the general admission seats. Anybody who tries to give the results of this world series during the tight twelfth game is permitting his bravery to get beyond his reason.

Neither the USSR nor USA has such overwhelming strength that it can eliminate the other. Each has sufficient current strength in various fields so that neither could destroy the other without being nearly destroyed itself, which is clearly unprofitable. The best proof of this is the military stalemate that has existed since 1948, when the USA and the Free World first began its military and economic buildup with the Marshall plan, NATO, etc.

So, does the argument of who is ahead in the ICBM race really profit us? In the missile and rocket field each nation surpasses the other in different ways, but neither one presently has an effective strategic superiority.

We have no information that the Soviets have operational ICBM weapon capability, nor do we know that there has been a successful target re-entry by a Soviet ICBM in which the CEP (circle of probable error) has been accurate enough to indicate that it is at this date even a partially successful military weaponry system. I challenge anybody to prove otherwise.

Statements giving the USSR this capability are pure guess work. Of course, the Soviets have their IRBM land range, and their southwest-to-northeast ICBM land range, largely over Siberia. But successful missile flights of the length that the USA has completed over the Atlantic missile range from Cape Canaveral to Ascension Island, would fall in the Pacific Ocean on Russia's ICBM range. Their range is too short for land fall, and there is no evidence of successful Russian ICBM sea re-entry shots, such as this country has publicly announced.

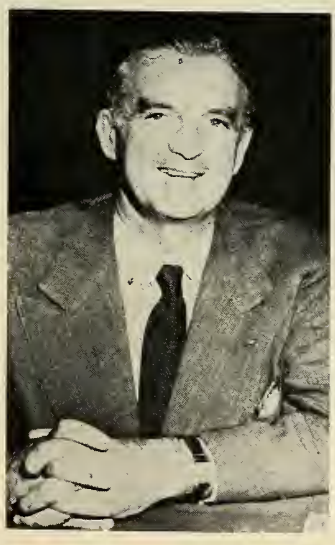
Foreign policy commitments must be sustained in a lawless world with equally extensive military and economic strength. The Soviets have a big army, massive artillery and tanks, plus a large and rapidly obsolescent submarine fleet which could be of little use in a missile nuclear war.

The best that critics of the administration's ICBM

(See FULTON page 38)

wo eminent lawmakers write their own widely divergent views n the Russian threat and how the U.S. should counter it

Sen. Stuart SYMINGTON



SEN. SYMINGTON (D-Mo.), a Democratic member of the Senate Aeronautical and Space Sciences Committee and the Senate Armed Services Committee, is serving his second term in the Senate, and was previously Secretary of the Air Force in the Truman Administration.

There are many experts on past wars, but none on future wars. As Gen. Maxwell D. Taylor, Chief of Staff of the U.S. Army, testified: "In my judgment, any dogmatic prediction of what will take place after an initial nuclear exchange is beyond the human capability."

Let us hope there will never be any real experts on nuclear wars, not on the grounds that no one would survive to become an expert, but on the premise that we may have the courage and the wisdom to prevent such destruction from ever getting started.

It is not enough, however, for us to be comforted by such hope. We must also be prepared for the dreadful alternative. In fact, such preparedness may well be the only sound basis upon which the hope for peace may grow.

Many sincere and informed people have varying judgments as to what constitutes adequate preparedness or adequate defense. Such differences are understandable. But there are certain propositions upon which, in my judgment, there should be substantial agreement. They are:

If a nuclear war does happen, it will come with such suddenness and destruction that there will be no time to defend or retaliate with any strength except that already in existence. Neither weapons on the drawing boards nor those whose production was postponed will have any effect upon the outcome of the conflict.

Since the time factor for response to an attack may be but a matter of minutes, the state of readiness of our weapons is of crucial importance. Those forces not so alert may be no asset; in fact, they may turn out to have been an actual handicap as a pre-attack source of unwarranted complacency.

It is wrong to measure our retaliatory strength in terms of what we have available before an attack has occurred. Our strength should be judged on what we believe we would have left, and could use, after attack.

With the premise that we would not be the aggressor, this nation must have substantially more retaliatory strength, or substantially better dispersed and protected retaliatory strength, than the pre-attack strength of the attacker.

The Communists are building up their strategic strike capability at a faster rate than we are. Therefore, obviously our relative position is deteriorating. Under such circumstances, some day in the near future we may well find ourselves with a post-attack capability insufficient to meet the requirements either of deterrence or of adequate retaliation.

The capability for swift retaliatory delivery of nuclear weapons has great significance in international negotiations and also in the imposition of control over others without the use of the weapons as such. This power is often referred to in terms of "nuclear blackmail."

It is a matter of U.S. policy, not lack of U.S. economic strength, which has allowed the Russians to develop and produce strategic striking power at a greater rate than

(See SYMINGTON page 39)

Industry Tells Congress:

Do More Basic Propulsion Research Now

by William E. Howard

WASHINGTON—Industry experts have told Congress the timetable for U.S. space exploration hinges largely upon an immediate stepup in industrial basic research to reveal the factors—chiefly cost—which ultimately will determine the choice of propulsion systems.

A concerted effort now to produce more basic knowledge to indicate which chemical, nuclear and electrical systems should be pushed to production was viewed as possibly shaving years and millions of dollars from engineering missions to the moon and planets. It could result in a harder timetable than the present generalized "5 to 10 years."

Soundings by the House Committee on Science and Astronautics produced urgent recommendations to:

• Greatly expand liquid and solid fuel research. Witnesses said more chemists should be put to work synthesizing high-energy compounds and developing storables and hypergolics needed for maneuvering and stopping and starting in space.

There is an "immediate need" for comprehensive development of operational capacity with a highly reliable system for upper rocket stages using liquid hydrogen and liquid oxygen or liquid fluorine. High cryogenic engine applied research should be expanded.

• Build larger liquid-fueled engines. Six-million-lb.-thrust capacity and higher is required to launch moon and Mars vehicles.

To make these engines economically feasible, development of recoverable boosters should be pushed along with reduction in hardware weight and development of cheaper, expendable "production" models.

Former Navy Secretary Dan A. Kimball, now president of Aerojet-General Corp., said improvements in boosters alone might save up to $1 million a shot, providing a more expensive recoverable booster could be re-used a half-dozen times or more.

• Initiate at once an industrial program, apart from AEC research, to develop a usable test nuclear-powered vehicle. No accurate cost estimates appear possible otherwise for producing a nuclear rocket because of the enormous and still unexplored problems involved in heat transfer and radiation hazard, if used as a first stage or for manned flight.

In this connection, another Aerojet-General witness said work is progressing there on a hydrogen propulsion reactor which appears feasible "in a considerably shorter time scale than *Rover* and for considerably less money since it uses already-developed gas cooled reactors." The system does not have the (4500°F) temperature problem of *Rover,* nor ion gun problems.

However, T. F. Dixon, chief engineer of North American Aviation's Rocketdyne Division which is working on *Rover,* said the project is moving ahead. He said it could be speeded up by hiking the present $20 million-a-year funding to $40 million.

Nuclear thrust/weight advantage more than doubling the best expected chemical specific impulse of 450 seconds, several witnesses agreed, make it the most likely interplanetary vehicle once development problems are licked.

• **Russia ahead**—While there is no supporting evidence, the committee was told it is a "safe assumption" that Soviet scientists are in front in the race to produce electrical propulsion systems. Aerojet-General witnesses said for this reason the U.S. program should be boosted. They said a flyable electrical propulsion system may be attainable in five years, possibly three.

Although the hearings were billed as mostly "educational" for the 20 freshmen committee members, industry recommendations elicited some quick reaction.

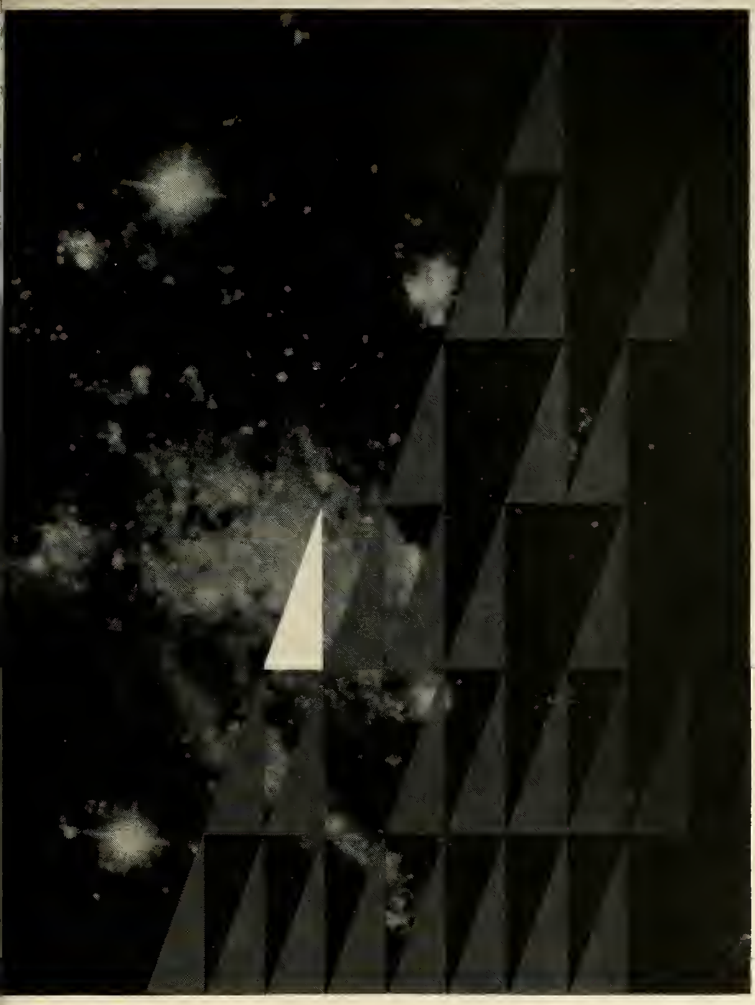
• **Basic research bills**—Rep. James G. Fulton (R-Pa.) filed legislation to give NASA and the National Science Foundation what would amount to a "blank check" to back "overall research" of fuels and propulsion systems. Fulton specified development of chemical, ion, photon and solar propulsion.

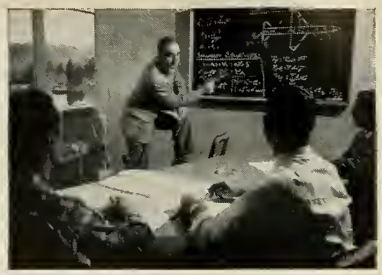
Rep. Emilio Q. Daddario (D-Conn.) pledged efforts to get more money for the *Rover* nuclear rocket. And Committee Chairman Overton Brooks (D-La.) said he would push his bill to add a flat 10% for basic research to all R&D contracts over $100,000.

Asked by Brooks how he felt about the bill, Dr. H. W. Ritchey, vice-president and director of the rockets division of Thiokol Chemical Corp., said: "May we stand up and cheer?"

First Photo of Hound Dog

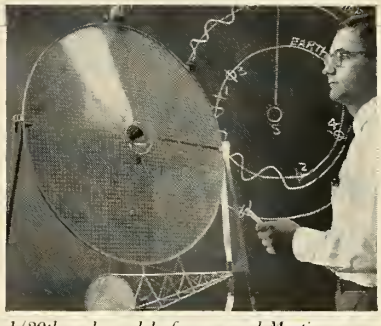
TRAINING and test model of North American GAM-77 *Hound Dog* rests on its pylon under wing of B-52. Test vehicle will have same aerodynamic characteristics as the operational bird.





Boeing engineers work in small groups. Ability and initiative get plenty of visibility.

Test of ballistic missile propulsion system. Other tests cover space vehicle control units.



1/20th scale model of unmanned Martian reconnaissance vehicle, a Boeing study project.

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for Engineers and Scientists

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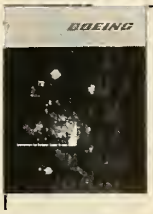

Mr. Stanley M. Little
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Seattle 24, Washington

Please send me a free copy of "Environment for Dynamic Career Growth."

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an exclusive interview with . . .

The AF Space Medicine Chief

Dr. Hubertus Strughold looks beyond Project Mercury to time when space flights may last months; emphasizes that long-range medical research must be pressed now

Q: **Dr. Strughold, I suppose you are familiar with Project *Mercury*—that is, the plan recently announced by the National Aeronautics and Space Administration, to send a man into orbit—are you personally involved?**

A: Naturally, I am familiar with it; however, if you ask, am I associated with it, the answer is, "No." If you mean, does it lie within my sphere of interest, I would reply, "Yes, it does." In fact, I worked along such lines.

Q: **To put a man in space?**

A: Let us say, rather, to create an artificial environment with which it is possible to put a man in space, an environment in a capsule.

Q: **Didn't you suggest to the research council of the School of Aviation Medicine at Randolph AFB that an experimental space cabin should be provided for research in this respect?**

A: Yes, in 1953. It was immediately approved and was delivered in 1954. Since that time, we have been conducting studies of the requirements for a man-in-space capsule—first for just a few hours, then for 24 hours, later for seven days and longer. That was the cabin in which Airman Donald Farrell spent a week about a year ago.

Q: **Weren't there some comments that the real space flight situation can't be studied in such an earth-bound experimental cabin?**

A: Of course it cannot. Actually it is not the purpose of such an experimental chamber to simulate all the conditions encountered in space flight. We cannot produce for instance the state of dynamic weightlessness, certain radiations and certain psychological factors.

Q: **What do you actually study?**

A: It is the purpose of a space cabin simulator—as we call this chamber—to test a sealed cabin equipped with air regenerating devices as to its capability to keep a man alive and alert over a longer period of time. More in detail we study the best kind of artificial atmosphere, the best pattern of day-night cycle, the psychology of isolation and confinement. Our aim is to attain an optimum of comfort, a maximum of efficiency of the air regenerating and controlling devices and a minimum concerning their volume and weight in terms of economic logistics.

Q: **Isn't there a great deal of duplication in space medicine research or bioastronautics? As you know, the word "duplication" always comes up in the hearings conducted by the special space committees of the Senate and the House.**

A: Duplication is a waste of money, of course, and should be avoided. But this word must not be confused with "overlapping." There are always at different places and sometimes at the same place different aspects about the same thing; different methods of approach. This is necessary to get a complete picture of the problem and to get the solution faster. I think overlapping in every kind of research is sound and should not be avoided.

Q: **Returning to NASA's Project *Mércury*, how do the experiments in your space cabin simulator fit into the picture of this project?**

A: With Project *Mercury* we are now entering the engineering phase of the man-in-space program to build such a system into a capsule which can be fitted on a booster rocket as the nose cone or terminal stage. The same is of course the case with the cabin of the *X-15* and that of the *Dyna-Soar* type of vehicle.

Q: **Have you medical people cooperated with the engineers?**

A: In our medical research, we always consult with the engineers, taking into consideration their practical limitations—for example, the size and weight of the system, using present booster vehicles. Similarly, they have consulted with us in designing cabins for the various vehicles.

Photo by William Vandivert, TIME Inc.

"BUBBLES," hangs in F94C cockpit in weightless state during flight by Dr. Siegried Gerathewohol.

Q: Then you don't believe that your work is done? That everything we need to know about man in space is now known?

A: On the contrary, there are many areas in which we require much more information. For example, the radiation belt around the Earth, discovered last year by Dr. James A. Van Allen. We must learn its precise boundaries, its type and intensity and origin, so that we can learn to protect the pilot from too much exposure as he passes through it. Perhaps we must avoid it. The discovery of this radiation belt is perhaps the most important one in geophysics during the past 50 years. And we should all be proud that this was done with U.S. satellites.

Q: Could there be other dangerous conditions in space that are still unknown?

A: There could be. Just as Van Allen's radiation belt was unknown, until the *Explorer* satellites revealed it.

Q: So there is still a great deal of basic medical research to be done on—and in—space?

A: Definitely, yes.

Q: Going beyond the first orbital flights in the *Mercury* capsule?

A: Far beyond those flights. My understanding is that the *Mercury* satellite will attain a maximum altitude of approximately 150 miles. It will carry only one man. After several circuits of the earth, it will descend into the atmosphere again, and will be lowered by parachute to the ground, or to the ocean, where it will be recovered.

Q: That is the flight plan proposed by NASA?

A: Yes, and now we must prepare to place very much larger vehicles in orbit, carrying two or more men. We must look forward to satellites at much greater altitudes—with lifetimes of days, weeks and months. We have to prepare for flights to the moon and the other planets. All these projects require medical experiments before the engineers will be ready to go ahead with them.

Q: Are you carrying on such experiments at the School of Aviation Medicine?

A: Indeed we are. My colleagues in the Division of Space Medicine—Col. Paul Campbell, its chief, Lt. Col. George Steinkamp and Lt. Col. David Simons are among them—have a number of such experiments under way, and others planned. In a few months, we will move into our new laboratories at Brooks AFB in San Antonio. There we will have, for example, a space cabin—or capsule—for two men. We will be able to examine their psychological effects upon each other, to cite an example.

Again, we make studies of metabolic rhythms—day-night cycles—in preparation for extended flights in space, where there are no natural alternations for day and night. The use of green water plants—algae—in a closed ecological system, such as a space vehicle on a long voyage to Mars, is one of our projects.

Q: The purpose of the plants is to renew the cabin air?

A: Yes. To absorb carbon dioxide and supply fresh oxygen, by photosynthesis. Also we continue to study the functional effects of weightlessness.

Q: How about acceleration and deceleration, during takeoff and re-entry? The capsule doesn't take care of these problems?

A: Only to a limited degree, by cushioning the effects somewhat.

Q: Is there a possibility that the pilot will black out from the tremendous g forces at those times?

A: We must do everything to avoid this. At the time of launching, and again on re-entry in this type of capsule, the pilot will be in a supine position—on his back. In that position, he can take a greater number of g's than if he were sitting upright. The acceleration on takeoff is gradual, and lasts only a few minutes. Re-entry is a more complicated problem, but there are various technological means to soften the shock of plunging back into the atmosphere.

Q: You say "technological means." That's the engineer's province, isn't it?

A: Quite so. We do not try to solve all the problems by medical research. We determine what man's tolerance is to certain stresses—in this case to acceleration or deceleration under various conditions. Remember the heroic experiment on a sled by Col. John P. Stapp! Then it is up to the engineers to provide a vehicle well within the tolerable limits. That is the kind of consultation between the medical researcher and the engineer that I mentioned earlier.

But I also would like to mention that we have physicians and physiologists of great skill who have developed animal capsules and recording devices that amaze the visiting engineers.

Q: One last question: There is always so much talk about the time table—how about this in space medicine?

A: The time table in astronautics will be determined by space technology in the first place. We in space medicine must be able to sense all the possible future technological developments for at least 20 years and make our plans accordingly. The solution of some of the biological problems may take 10 years or more. Therefore the space doctors must work on *all* conceivable problems at the same time to meet all the technical advancements in astronautics. And the time is *now!*

. . . There could be other dangerous conditions in space . . .

. . . We must prepare for more than one man in a capsule . . .

. . . Space timetable will depend on advances . . .

Navy's Reorganization to Affect Research

Rear Adm. Hayward—probably next DCNO—discusses what's needed from industry

by William O. Miller

WASHINGTON—The increasing importance of research and development in the Navy is pointed up by the proposed upgrading of the present assistant chief of Naval operations for research and development to deputy chief of Naval operations. With this would go the three stars of a vice admiral, putting the Navy's man on a par rankwise with his opposite numbers in the Army and Air Force.

All indications are that the man presently holding the job, Rear Adm. John T. Hayward, will be given another star, and take over the new office with its broadened responsibilities. This would mean jumping him over some 150 senior rear admirals to become vice admiral.

HAYWARD

The new deputy chief of naval operations for development, under the proposed plan, would be charged with coordination of all research, development, test and evaluation programs. In addition, he would take over the Guided Missiles Division now under the deputy chief of Naval operations (Air) and would assume scientific data collection and development coordination now carried out by the Office of Naval Research.

The proposal recommends that the organization of the DCNO (Development) be aligned by weapon systems to be responsive to the weapon system concept. Another major change proposed would be merger of the Bureau of Ordnance and the Bureau of Aeronautics in a Bureau of Naval Weapons.

Secretary of the Navy Thomas S. Gates, Jr., has said he will announce his decision regarding the reorganization recommendations about May 1.

• **Hayward's views**—In discussing the growing responsibilities of his office, Adm. Hayward recently made several observations: research and development efforts of the services should not be combined; the nation needs one space agency; his door is wide open for research suggestions from industry; in missiles, solids have the edge on liquid propellants; and he does not think the state of the art has progressed far enough for a nuclear aircraft crash program.

Hayward recently told the House Space and Astronautics Committee that he favors a single space agency and that the amount of money he had asked for Navy R&D work had been cut by one third.

"Most of the $248.7 million cut which resulted in reducing the budget from the requested $770.7 million to $522 million," Hayward said, "will be taken out of the systems part of R&D operations, representing about 40% of the budget and program activity."

Major systems affected by the cut, Hayward said, include the Naval Tactical Data System, the antisubmarine seaplane replacement for the P5M Marlin and the technical development plans of several other systems.

Hayward told the Congressmen that if he had gotten the additional $249 million he had asked for, $150 million would have been put into basic

and applied research.

• **Areas**—What areas of investigation would get emphasis if he were given the money? Solid state physics, various electronic phenomena and low-energy nuclear physics.

He said the various areas of interest under investigation and development are difficult to define. More than 1500 universities and other non-profit organizations hold contracts for research work through his office. The number of contracts with private industry exceeds this.

"It's hard to put a project in a specific area," Hayward said, citing solar battery component work as a state-of-the-art example. "The solar battery works beautifully in the *Vanguard* satellite and might work just as well in communications equipment taken ashore by Marines. The MASER could have many applications all across the front just as the transistor currently is being utilized. Experimental work with pentaboraine and water for torpedo propulsion units could well have application in the missile field," he added.

• **How obtained**—How does his office decide who does what research?

"It's a two-way street," he explains. Frequently the office goes to industry and outlines a requirement, then considers proposed approaches, and then lets contracts. On the other hand, research institutions or industrial firms may come to Hayward's office to sell.

Hayward cited as an example Aerojet-General's work on slow burning gas-generating solid propellants.

"Aerojet came to us and showed results of some work they had done on their own with ammonium nitrate 'cigarette burning' grain solid propellants," Hayward said. We liked what we saw and told them to go ahead. They ended up with some really fine results in the field of torpedo propulsion, which is only part of the whole field of gas generating fuels."

As an example of the other method, Hayward cited how the Navy went to industry with a broad problem of non-acoustic submarine detection research.

"We liked the proposals of three outfits, Stromberg-Carlson, General Electric and Ramo-Wooldridge," he continued, "and we gave contracts to all three." The results are evident.

Communications, Hayward said, is the greatest obstacle to full utilization of the nuclear submarine. A key research problem must be solved, which will enable submarines to communicate reliably with aircraft and surface ships. This, he said, is only one problem in the physics of the sea. He pointed out that the Russians' oceanographic program is 30 times the size of this country's.

• **Centralization?**—Hayward is all for one space agency and for centralization of authority in scientific programming. However, that is just half the story:

"We must have centralization in authority, but decentralization in management and implementation," he said.

However, he does not favor a single military R&D organization.

"Centralization in research is bad, because each of us has different problems and the problems must be related to the environment," he explained. He believes the Advanced Research Projects Agency is serving a very useful purpose as a coordinator of the efforts of the military.

• **State of the art**—Consideration of the state of the art has been neglected in this country, Hayward said. It is impossible, he added, to invent on schedule after coming up with a full-blown system—prior "home work" in the state of the art and availability of reliable components would make it quicker and cheaper to put together a sensible system.

He said better program management could be had with more emphasis on component development and less on weapon systems reaching ahead of the current state of the art.

Program analysis would do much to cure the ills of the present system. The admiral had these recommendations:

1. Decide what is to be done.

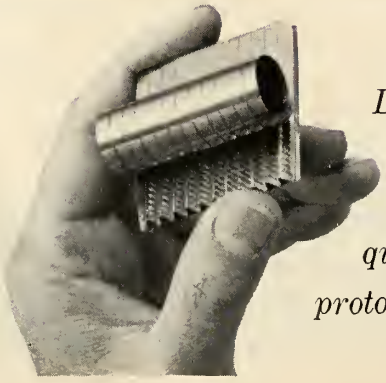
2. Explore the state of the art in the particular area so as to be able to measure the risks involved.

3. Limit the number of risks insofar as possible by designing within the state of the art.

After 8 years of research North American introduces a low-cost Space Age material:

SPACE

A WELDED STEEL SANDWICH



Designers may now obtain experimental quantities for prototype development

WHAT IT IS: SPACEMETAL is a stainless steel sandwich with the light weigh high strength, and heat resistanc required for Space Age missiles an planes. Inner sheet is beaded to form V-shaped corrugation which allow rapid heat dissipation, permits hydr static testing for quality control. Yield weight savings (theoretical) as high a 75 percent over solid materials.

Manufactured b

METAL

THAT'S BEING MACHINE-PRODUCED

HOW IT'S MADE: Production line machinery, developed by the Missile Division of North American Aviation, manufactures SPACEMETAL at the rate of 50 square feet per minute. The sandwich is now produced in 30-inch-wide panels, from type-301 stainless steel with a nominal gauge of 0.156 inches. Resistance welding eliminates excess weight of brazing or adhesive materials.

WHY IT'S STRONGER: SPACEMETAL'S V-configuration core offers greater strength in one direction than usual honeycomb structure. SPACEMETAL is 235 times stiffer and can carry 23 times the bending load of solid type-301 stainless steel of equal weight. Beads along the sides of the corrugation double its crushing strength and improve other physical properties.

HOW TO GET IT: SPACEMETAL is available in experimental quantities to designers seeking its unique properties for application in missiles, supersonic aircraft, and related projects. Please write for complete information, outlining your requirements, to: SPACEMETAL, Dept. 496 C, Missile Division, North American Aviation, Inc., 12215 Lakewood Blvd., Downey, Calif.

THE MISSILE DIVISION OF NORTH AMERICAN AVIATION, INC.

DATICO Described As A Near-Universal Test Facility

Programmed tester developed by Nortronics automatically checks out complex military hardware; company says it will sharply cut costs.

by Charles D. LaFond

ANAHEIM, CALIF.—A practical dream three years ago and a prototype only one year ago, the Digital Automatic Tape Intelligence Check-out is today a proven test facility.

Dubbed DATICO, this programmed automatic check-out system was developed here under the steady guidance of Dr. William F. Ballhaus, general manager and vice president of the Nortronics Division of Northrop Aviation, Inc.

DATICO is the result of a far-sighted engineering effort to reduce the myriad of specialized single- and limited-purpose test equipments necessary to check out complicated military hardware. The goal was to produce a single complex having almost universal applicability to missile and aircraft systems.

It has been functioning successfully for more than 2000 hours of operating life during the past year. Check-out tests have been performed on several missile and aircraft systems, subsystems, and components. The results to date show very substantial savings in time, manpower, and dollars.

• **Arguments against**—The concept of automatic systems testing does not stand without opposition. Many have argued that the development of such a facility would only result in an unreliable, over-complicated monstrosity. Opponents have maintained that by its very nature operating personnel would lose the skills necessary to repair it upon failure. Another convincing case has been made based on its wartime use. "There will be no time or even any need for extensive systems testing," they say.

Nortronics believes that DATICO answers these arguments completely and convincingly. To better understand what it can do, we can first see how it is constructed and then consider its designed features.

• **System description**—The DATICO system (see p. 30) is comprised of five major sub-systems: programmer, scanner and service section, measurement section, comparator, and read-out. For high-speed testing, all may operate automatically. A manual override switch is provided to allow the operator, at his discretion, to correct improper adjustments, verify or challenge results, or to perform other control functions.

A failure-alarm system is incorporated in DATICO which locates any malfunction immediately; modularized sub-systems permit rapid replacement of defective units without the need for tools. The system also provides fail-safe operation if malfunction occurs in the system under test or within DATICO.

• **Programmer**—A pre-wired patch board and punched information tape establish the test functions and parameters. Together, they are small in size, lightweight, and readily installed in the programmer. The responses of all of the other four sub-systems are determined by the programmer in sequential operations. In addition, the programmer provides a decimal-to-binary data conversion which is used to store binary limit values in the comparator.

• **Scanner and service section**—Address and command. These are the operating modes of the scanner, an electro-mechanical communicator. Under programmer demand, the scanner selects from many the applicable test point. Until the address function is accomplished, the programmer cannot advance.

In the command mode, all of the various service equipments providing stimuli to the machine under test are controlled through a relay section—sequentially actuated on command. A series of relay matrices establishes the applicable test configuration.

• **Measurement section**—Two basic measuring devices make up this section: a digital multimeter and an extremely accurate universal counter-timer. The multimeter transforms ac and dc voltages, voltage ratios, and resistances to digital values. Similarly, frequency or frequency ratio, events-per-unit-time, count, pulse width, time interval, and period are changed to digital values by the counter-timer. The timer employed is accurate to one part in a million.

• **Comparator**—All of the binary-logic circuitry necessary for determining in- or out-of-tolerance conditions of the various measurements is contained in the comparator. It, too, is a completely electro-mechanical unit possessing memory, decision, and command capabilities. As stated earlier,

binary limit values are supplied to the comparator by the programmer for storage.

Thus, when a measured value is received, it can be compared within these limits. "Hi-Go-Lo" signals are generated based on this evaluation. A simplified diagram of these command and resulting read-out functions is shown (p. 31).

The evaluation by the comparator is based on digital-computer arithmetic, or, more specifically, it employs complementary subtraction (p. 32). A carry-go, or "computer yes," command to continue testing can only occur when (1) the upper measurement limit exceeds the test reading and (2) the test reading exceeds the lower limit. If either comparison results in no carry, the read-out is printed in red on the record tape. Simultaneously, alarm circuits are actuated and the test sequence is halted. Testing can continue only if the faulty area is corrected or if the operator employs the manual override switch.

• **Read-out**—Obviously, test data read-outs can be provided satisfactorily in many ways. The DATICO prototype system was provided with one of the simplest, but probably more reliable and practicable methods.

A visual display provides the operator with the test-point number, measured test value (decimal), and the comparator evaluation of either "hi," "lo," or "go." In case of malfunction, a letter indicating the area of failure is caused to replace the normal comparator decision. Likewise, when settling periods are programmed, an explanatory symbol replaces the comparator decision.

A printer provides a permanent tape record of test results, in decimal form, along with the test-point identification number. Satisfactory test results are printed in black, unsatisfactory results in red.

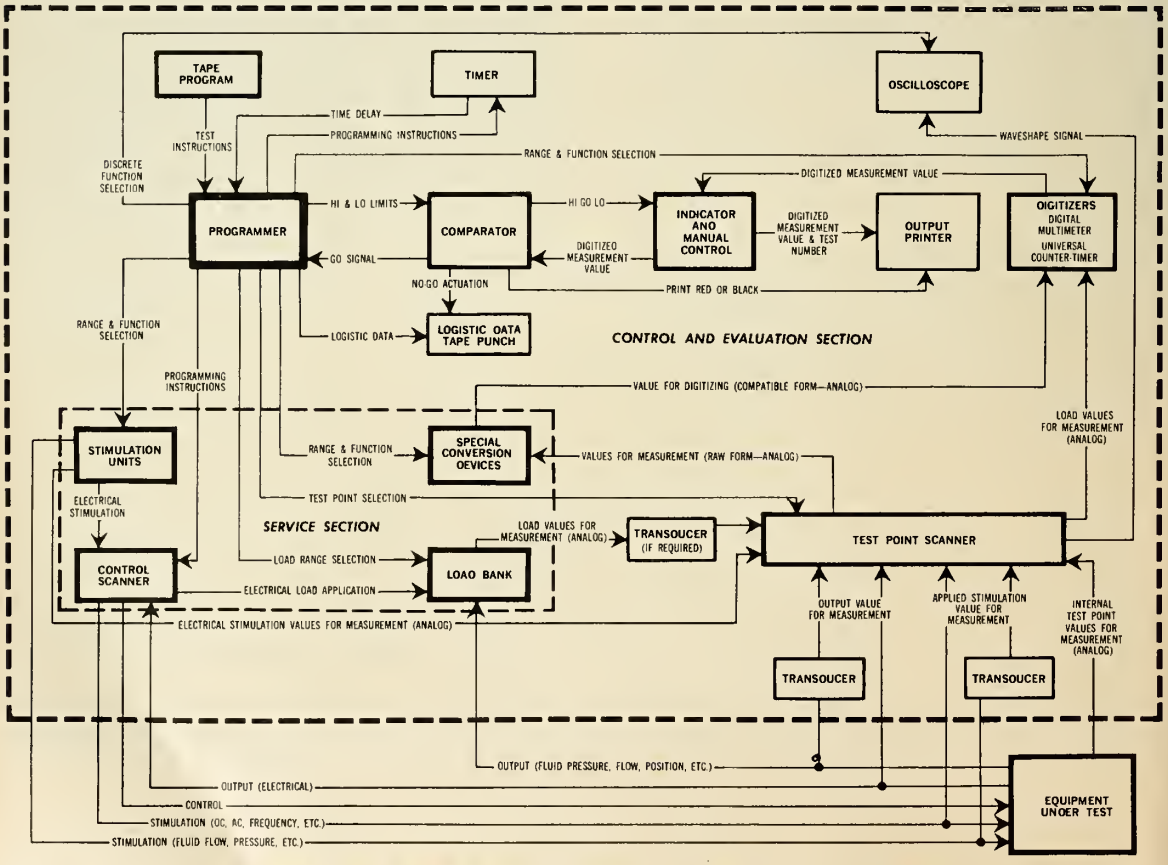
A supplementary read-out can be obtained by adding an auxiliary tape punch unit to record all test failures. This provides a means for direct teleprinter transmission to obtain replacement parts or for computer use in developing statistical failure data.

A horn provides audible alarm for out-of-tolerance results, and, simultaneously, a warning lamp is lighted.

Design Considerations

What can DATICO do and how does it do it? We know what we would like to have a "universal" check-out system do, but how closely does DATICO fill the bill?

• **Adaptability**—The first step, following an analysis of the test needs for a particular system-to-be-tested, is to "marry" DATICO to the subject. The switching theory utilized in DATICO is highly standardized, and its integration with the test subject is rapid. For example, only minimum change is needed to apply it to airborne and ancillary components following an original weapon-system marriage with DATICO. The use of perforated mylar-paper tape and a wiring panel individualize the particular system check-out.



THIS TYPICAL DATICO functional block diagram has been proposed for use with *Nike-Hercules* system.

• **Operational scope**—DATICO can now perform, under human observance and ultimate control, all the functions necessary to isolate and indicate faulty or out-of-tolerance chassis, circuits, and modular components. It can provide both temporal test observations for the operator and a permanent printed and/or punched record of an entire test program.

• **Self-checking**—In addition to accomplishing its major testing role, a universal check-out system must perform another duty. To provide test information only is not sufficient. There must be reasonable assurance at all times that the data produced are correct and complete. DATICO had to be self-calibrating and self-checking. Calibration is automatically employed at regular intervals or it may be accomplished prior to critical tests. Through the use of its own special test tapes and wiring panel, DATICO can check-out and verify its calibration. The system is self-stopping in case of malfunction.

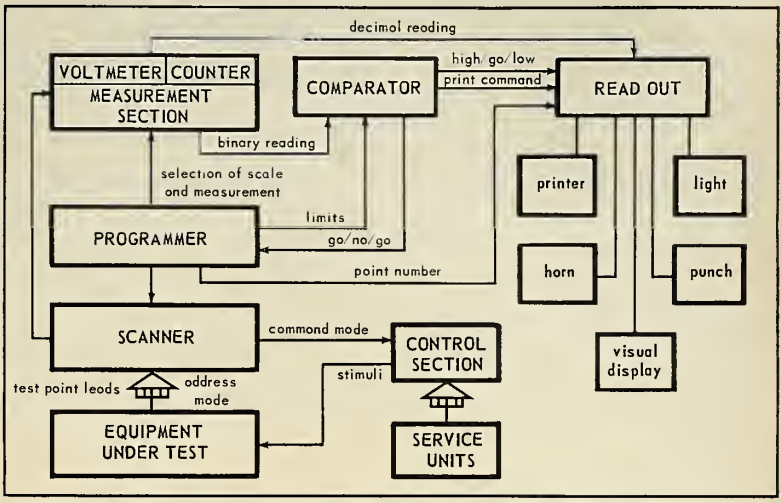
All this can be performed by DATICO with a minimum requirement for decision and manual operation by the test operator.

• **Portability**—But, what about portability and power requirements? To perform as required is fundamental; yet, if the bulk and weight of the check-out system are excessive or the power needs too unusual, all of this fine performance and flexibility would be ludicrous.

As designed for testing the Army's *Nike-Hercules* guided missile system, all of the DATICO equipment will be mounted in two standard Army type M-109 vans. A trailer will house the required primary power source, such as a 115 V, 60-cps, single-phase, 3-kva generator.

• **Testing time**—Of necessity, DATICO is a low-speed test system. But operating at a rate of approximately 20 measurements per minute, less time is required normally to complete the actual tests than is required for the connection and warm-up of the tested item. The testing speed is governed by the scope of the measurement, and it must be compatible with the process or reaction time of the item being checked out.

• **Reliability**—Reliability of prototype models of DATICO has been very high. Component failures have been negligible, no stepping switches have failed and only a few relays have been replaced. Silicon diodes experienced the greatest number of failures and these resulted from faulty experimental circuit connections—the diodes were subjected to improper voltages. Four vacuum tube failures comprised the bulk of the remaining failures.



COMMAND AND readout functions are shown in system block diagram.

• **Personnel skill levels**—A last, but certainly far from least, consideration inherent in the development of DATICO is the skill-level requirements for operating it. To be most useful to both military and industry users, DATICO had to be operable by persons available in a normal manpower pool.

Certainly an experienced electronics system engineer, trained in the principles of programming and on the operation of DATICO, is necessary. He will be the man to analyze the system under test, determine and prepare the test program and test limits, and alter test sequences to keep abreast of equipment modifications. But this one engineer can be used to supervise many test facilities without compromising his efficiency. Skill level: college degree in electrical engineering, or equivalent; equipment design experience, and a nine-week specialized training course.

A well-trained electronic-equipment specialist, versed in advanced electronic theory, can handle the close supervision of one or more test facilities. Six weeks of DATICO training will be sufficient to qualify him, but he must be familiar with the systems being tested.

One operator-maintenance man is required for each DATICO system. Drawn from the upper-middle skill-level group in an average electronics-technician pool, he can be qualified with four weeks of specialized training.

Finally, an operator-trainee should be provided. Basic electronics training and a three-week specialized course should be sufficient to turn him into a useful assistant to the DATICO operator.

• **Current production**—The success achieved by Nortronics in the development of DATICO is attested to not only by its application to such systems as the *Snark, Nike,* and *Sergeant* but in its current backlog. In progress now is a two-phase program to integrate this check-out system with the Army's *Nike-Hercules* system and to develop DATICO for universal application to all six of the currently operational Army Ordnance missile systems.

The Air Force is currently using DATICO for testing airborne radio equipment. It also has ordered development of a multi-purpose check-out system for electronic equipment.

A Nortronics spokesman has indicated that because of its diverse applicability, the DATICO concept is currently being considered by many of the large missile and aircraft prime contractors, some commercial airlines, NATO, and several European sources.

The reason: Nortronics says that the use of DATICO can result in savings of up to 75% in manpower, 90% in overall checkout time, and 50% in acquisition cost.

• **Limitations**—It would be naive to presume that this early design of DATICO is not without certain limitations. Here are the principal limiting features: (1) There are no solid-state switching components employed. It was decided during the initial development of DATICO to hold to sound, proven engineering practices to facilitate early mass production. Transistor switching was saved for more sophisticated facilities of the future.

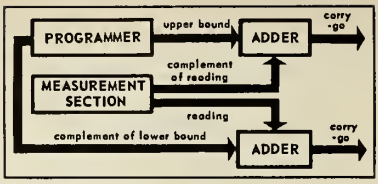
(2) Although faster than already

existing test practices, DATICO is a relatively low-speed device. For many applications, where tests might be performed on the order of 10,000 per second, DATICO is too slow.

(3) Basically, only Go or No-Go indications are provided. Conversely, all of the test limits must be capable of definition to be measurable.

(4) This is an extension of (3). That is, trends cannot be derived from test results. There is no provision in the data for indicating the overall condition of the system with respect to accuracy, reliability and safety.

• **Future developments**—Employing the DATICO philosophy, Nortronics is continuing its program to produce improved designs and greater sophistication in its complementary systems. These are now in the latter stages of development.



COMPARATOR logic diagram.

A smaller, low-cost unit is in progress called DATIMITE. Weighing less than 200 lbs., this portable system is transistorized and employs new comparison and measurement techniques. It is designed for factory, depot and field use.

A nearly completed high-speed universal tester is called NORSCAN—Nortronics System Computing Analyzer. Representing the most current state-of-the-art, the designers believe that this facility provides the answer, for other applications, to all of the limitations in DATICO. Rugged, completely transistorized and completely flexible, this system provides a "confidence index" to indicate how good a Go reading really is.

NORSCAN utilizes a switching matrix capable of making 10,000 measurements per second. An analog-to-digital signal data convertor provides conversion with an accuracy of 0.01% and at a speed of 25 microseconds. An internally programmed digital computer uses a magnetic drum to store up to 500,000 information bits and a core buffer having a capacity of 1000 bits. A 400-character-per-second tape reader feeds the input to the computer. Once done, the test procedure is programmed automatically thereafter.

more about the missile week

(Continued from page 11)

Deployment of 35 more U.S. missile units in Europe by the end of 1959 has been disclosed by the Defense Department. The breakdown: 3 *Nike,* 5 *Honest John* and 2 *Corporal* battalions and one squadron each of IRBM and *Matador* missiles will be delivered by July 1 to Italy, France, Germany, Turkey and Great Britain. By Dec. 29, 16 *Honest John,* 6 *Nike* battalions and one IRBM squadron will be delivered to Denmark, Norway, France, West Germany, the Netherlands, Greece, Turkey and Great Britain. Assignment of units by nation is not known, except the IRBM's will go to Britain under the Mutual Assistance Program pact.

Expect payload cost-per-pound to drop to $100 by 1964, says ABMA's H. H. Koelle. Bigger vehicles, more powerful fuels, higher firing rates and recoverable boosters will do it. Koelle notes the payload pound cost already has plunged from $1 million in 1957 to $50,000 currently and probably will hit $10,000 in 1960.

Forgings of high temperature-resistant NST 881, a new titanium alloy are being evaluated for use in *Dyna-Soar* landing gear. Mallory-Sharon Corp., Niles, Ohio, reports production forgings of "excellent" long-term characteristics at 1100 F and short-term characteristics at 1600 F have been made without difficulty.

Universal-Cyclops Steel Corp.'s Refractomet Division has succeeded in producing a 36x96-inch sheet of columbium .028 inch thick from a 325 lb. ingot. The company also has cast a 470 lb. columbium 1% zirconium alloy ingot. Both achievements are considered breakthroughs in milling the metal.

Industrial quantities of 98-99% pure neodymium—which appears capable of increasing heat resistance of magnesium alloys used in missiles—are being produced by the Nuclear Corp. of America, Burbank, Calif. One of the more abundant rare earths, neodymium has a melting point of over 1800°F and a boiling point exceeding 5400°F.

A 10-inch ram-jet generating 3500 F is being used at Chance Vought Aircraft Inc. to test nose cones for re-entry capability.

Refusal of the Air Force to hand a ballistic missile program management survey to the Government Accounting Office is causing Capitol Hill repercussions. Members of the House Government Information Subcommittee brand the action strictly "illegal." They may demand a judicial review of the "executive privilege" exercised by the AF to withhold the report.

Battle over NASA's expanded Wallops Island test range is getting hotter. The Federal Aviation Agency is now in the fray on the use of air space and the routing of aircraft which fly close to the range. FAA indicates NASA ought to use existing ranges at Cape Canaveral and Vandenberg AFB.

Red tape snarling cost-plus-fixed-fee research and development contracts "just isn't worth it" to Charles E. Hastings, president and chief engineer of Hastings-Raydist Inc., a small electronics instrument firm. Hastings told the Senate Small Business Subcommittee his company broke off dealings with the government in 1955 to avoid "financial ruin." Costs running too high to absorb involved obtaining approval in each contract for purchasing, accounting, wage administration, personnel, security and every variety of record keeping. The Small Business Administration is investigating.

Texas Instruments at IRE announced both a major developmental advance in ultra microscopic semiconductor solid circuitry and the introduction and availability of a new semi-conductor device. The circuitry involves the creation of a complete match head size working circuit within tiny single pieces of semi-conductor material. The product is a gallium arsenide diode which operate at temperatures far beyond the capabilities of any other commercial semi-conductor device (325°C).

Fast tax write-off on 70% of $8.2 million allocated to development of the *Centaur* lox and hydrogen rocket engine has been granted the Pratt & Whitney Division of United Aircraft Corp. by the Office of Civil and Defense Mobilization. Other write-offs were okayed for: Boeing Airplane Co., 65% of $2.5 million for R&D on space vehicles and missiles; General Electric Co., Syracuse, N.Y., 55% of $978,000 for ballistic missile electronic guidance system; Aerojet-General Corp., 60% of $175,000 for R&D of rocket propulsion systems.

an m/r exclusive

Nuclear Explosions in Space

A scientific explanation of PROJECT ARGUS and how an electron accelerator could lead to creation of an artificial particle belt

First of four articles by PROF. S. FRED SINGER

In the April 6 issue: Nuclear Explosions in Space and their Direct Effect upon Space Vehicles Carrying Men or Nuclear Warheads.

In the April 13 issue: Nuclear Explosions in Space and Their Direct Effect upon Radar and Long-Range Communications including ICBM Detection.

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

WASHINGTON—On March 19, 1959, the press revealed the existence of Project *Argus*. During August and September of 1958, three separate atomic blasts were set off 300 miles above the South Atlantic. The atomic bombs reportedly were of small size, in the kiloton range.

They were carried to altitude by three-stage *X-17* rockets launched from the guided missile ship USS Norton Sound. The effects of the explosions were observed not only by the *Explorer IV* satellite, but also from ground stations more than 8000 miles away in the North Atlantic where artificial aurora was reportedly produced by the atomic explosions.

The results were said to have confirmed the predictions of Nicholas C. Christofilos, who instigated the project.

• **Questions raised**—The release of this data, though incomplete, immediately raises questions of a political, military and scientific nature. Some of them are: (1) Can atomic explosions in space be detected, and if so, what are the possible methods? (2) If concealment of such tests is possible, can their effects be harmful to inhabitants of the earth? Can they, for example, produce changes in weather, as has been claimed by Soviet scientists? (3) From the military point of view, is it conceivable that such explosions can blanket the radar defense system against ballistic missiles? (4) Can the effects of these explosions interfere with worldwide communications? Assuming such military applications are possible, does this imply a serious revision of strategic concepts involved in anti-ICBM work?

Further problems are raised by the more direct effects on vehicles and men operating in space. Do such explosions have effects on human beings in satellites or in vehicles of the *Dyna-Soar* type, or even on high-flying aircraft, or can such effects be overcome by adequate shielding? Are direct effects on missiles possible? Could, for example, missile electronics be destroyed or the missile warhead be triggered?

From a scientific point of view, the major questions raised are whether such explosions can tell us more about the origin of the natural radiation belts around the earth; whether such explosions can affect and possibly do away with the radiation belts or whether they increase the level of radiation. These questions lead naturally to the possibility that there may be other methods, aside from atomic explosions, for affecting the natural radiation belts or for producing an artificial one.

• **Answers available**—As we shall see, practically all of these questions can be answered in a direct way, some of them affirmatively. The only equipment needed is a thorough understanding of the output of an atomic bomb, the properties of the earth's magnetic field and atmosphere at high altitudes, and the interactions of the products of the atomic explosion with the field and the atmosphere.

All of the relevant facts and theories have already appeared in the open scientific literature. The writer, for example, developed a theory for the trapping of charged particles in the earth's magnetic field as long as three years ago. It, in turn, was based on basic theories developed by the Swedish astrophysicist Alfvén. Even earlier, Ross Gunn in the U.S. and a Norwegian astrophysicist, Störmer, made many fundamental mathematical investigations of the motion of particles in a magnetic field.

The only item in doubt and not released is a description of the nature of particles and radiations coming from an atomic explosion. However, a basic knowledge of nuclear physics, and in particular of the fission process of uranium, can supply much of the needed information. Thus, any competent physicist either here or in the Soviet Union or in Europe can work out the consequences of atomic explosions in space.

• **Trapping in earth's field**—Basic to all the discussion to follow is an understanding of the motion of charged particles in a magnetic field. The important facts are shown in Fig. 1. It should be noted that only charged particles of small mass are affected by the field of the earth; this means protons, ions and electrons. A rocket which is charged up will not describe such spirals in the earth's magnetic field; neither will an uncharged particle such as a neutron. They are essentially not deflected by a magnetic field.

A proton or electron will simply spiral about a line of force. The spiral can be quite flat with pitch angle of 90° just as in a cyclotron. Or it can have a smaller pitch angle, in which case it will progress along the line of force and trace out a helix or screw thread. The pitch angle depends essentially on how the particle is started out in its motion in the magnetic field.

The situation becomes of great interest when the magnetic field changes in intensity, as it does in the case of the earth. As the particle moves into a region where the magnetic field increases (as shown by the fact that the lines of force crowd together), the pitch angle steepens, the spiral becomes flat, and the particle is reflected at the point where the pitch angle reaches 90°.

A quick look at Fig. 2 will show that the earth's magnetic field is constructed in such a way that its strength increases as one approaches the earth's surface. Therefore, a particle released in space will spiral about a line of force until it reaches a point where the magnetic field is strong enough to reflect it. From then on it will bounce back and forth between the mirror points and be trapped.

The two major problems now are: (1) How do particles get into the magnetic trap, how many, and where? (2) How long are particles stored in the magnetic trap and what happens to them to remove them?

• **Natural radiation belts**—It had been pointed out earlier, that the sun may inject particles in the earth's magnetic field, which then remain trapped. This hypothesis was developed to account for the aurora and magnetic storms. It was also suggested that high-altitude probes should look for this trapped radiation (see the article on Project *Farside* in m/r, October, 1957). The *Pioneer* rocket demonstrated the existence of a belt of such trapped particles, very likely connected with the aurora, and thereby turned the hypothesis into fact.

The inner radiation belt, found by Dr. James A. Van Allen in *Explorer* satellites, is probably not connected with the aurora and therefore not of solar origin. We believe that it is produced by the impact of cosmic rays on the earth's upper atmosphere which results in emission of high-energy neutrons. On the way out into space some of these neutrons decay radioactively into protons and electrons which are then trapped by the earth's magnetic field.

The cosmic-ray theory predicts a maximum close to the earth and also predicts that this radiation belt can only exist at latitudes near the equator

About the Author

* Professor S. Fred Singer of the University of Maryland, became interested in the possibility of trapped particles forming a "radiation belt" around the earth while performing research on aurora phenomena. In 1956, he authored a paper on the theory of trapped particles in the earth's magnetic field, and a year later, worked out some of the consequences of hydrogen bomb explosions in space.

At that time he published what effects such an explosion would have on the moon. He withheld from publication the effects of such an explosion on the earth's magnetic field; but wrote his ideas to several outstanding scientists.

During this same period (1956-1957) Dr. Singer was acting as consultant to the Air Force on Project *Farside*, a project to fire rockets into space from a balloon-lifted platform, and designed to check on—among other things—the existence of a belt of trapped radiation. The *Farside* firings took place in the fall of 1957 but were not sufficiently successful to provide conclusive data. *Explorer I*, of course, proved the existence of the radiation belt.

Dr. Singer has been associate professor of physics at the University of Maryland since 1953. He was graduated from Ohio State University and holds master's and Ph.D degrees in physics from Princeton. He served in the Navy in 1945-1946, and from 1950 to 1955 held an Air Force commission. From 1946 to 1950 he was with the Johns Hopkins Applied Physics Laboratory. Because M/R believes that information on the effects of atomic bursts in space is of vital importance to everyone engaged in space engineering, we have asked him to prepare this series of technical articles on the subject.

TABLE 1

Properties of Earth's Radiation Belts

	HARD (COSMIC-RAY)[a]	SOFT (AURORAL)[b]
ORIGIN	From the decay of cosmic-ray albedo neutrons which come out of the earth's atmosphere	From solar corpuscular streams with subsequent acceleration near the earth
NATURE	Protons between 10-400 Mev	Electrons and protons of less than 1 Mev
SHIELDING	Difficult to absorb and shield	Easily absorbed
LOCATION	Equator and low latitudes	Auroral latitudes
	Close to the earth	Far from the earth
TIME DEPENDENCE	Constant in time	Variable, increases when sun is active

References: Physical Review Letters, Vol. 1, p. 181, 1958; and Transactions American Geophysical Union, Vol. 38, pp. 175-190, 1957

TABLE 2

Travel Times in Earth's Magnetic Field for Particles*

(assumed to be 5 million electron volt electrons)

TRANSFER TIME (between "mirror" points in opposite hemispheres):
Along low latitude line of force—1/10 second
Along auroral line of force—1/2 second

DRIFT TIME AROUND EARTH (for particles moving along line of force which reaches maximum distance R_e in the equatorial plane and intersects the top of the atmosphere, about 300 miles, at magnetic latitude λ ; R_e is measured in earth radii—4000 miles)

R_e	λ	Drift time (seconds)
1.1	17°	730
1.5	35°	540
3.0	54°	270
5.0	63°	160
7.0	68°	120

*Reference: Transactions of American Geophysical Union, Vol 38, pp. 175-190, 1957

(see Fig. 3 and Table 1).

• **Particle motion**—In addition to bouncing back and forth between the mirror points, which are located on about the same meridian, it has been shown that the particles will also drift in longitude. Positive particles will drift to the west, and negative particles, such as electrons, will drift to the east.

It is of great practical importance in discussing the effects of high-altitude explosions to know the speed with which the particles transfer from the Southern to Northern Hemisphere and the speed with which they drift around the earth. The calculations made in connection with the trapped particle theory of magnetic storms and aurorae are reproduced in Table 2.

An important consideration in discussing high-altitude atomic tests is to know what fraction of the particles released is immediately dumped into the atmosphere and what fraction is stored in the earth's field. Calculations show that this result depends on the exact location at which the explosion is carried out.

This can be seen as follows: If we release a particle above the equator with a certain initial velocity and therefore a certain initial pitch angle, then as it proceeds along the line of force it will either be reflected before it hits the atmosphere, or it will hit the atmosphere first, in which case it will be absorbed and therefore removed from storage.

We can now define a critical pitch angle at the equator: particles that have a smaller angle hit the atmosphere while those that have a larger angle are reflected and stored. Table 3 gives this information for a number of lines of force. [A line of force is defined by the latitude at which it intersects the earth's surface. It then sweeps out to a very high altitude above the equator and re-enters the earth in the other hemisphere at approximately the same magnetic latitude.]

If we assume an isotropic burst above the equator, then the last column in Table 3 gives the fraction of particles stored. However, if we move along the same line of force off the equator, the fraction stored becomes less and less.

Finally, if the explosion takes place just above the atmosphere, practically all of the particles will be released into the atmosphere and only a few will be stored. This fact can be clearly seen from Fig. 2. Only particles which start out with a pitch angle of nearly 90° will again be reflected above the atmosphere at the other hemisphere, but as we shall see later, their lifetime will not be very long.

The point of bomb burst therefore is controlled by the effect one wants to achieve. If one wants to dump the particles into the atmosphere in the opposite hemisphere, for example in order to produce interference with communication, the burst altitude should be as low as possible. For added effect, the burst should take place over a magnetic anomaly where the magnetic field is higher than usual. Then the particles going to the opposite hemisphere will enter the atmosphere much deeper and produce more pronounced effects.

On the other hand, if one wants to lose as little of the radiation as possible into the atmosphere and store

TABLE 3

Fraction of Particles which Remain Trapped*

It is assumed that particles are released isotropically at a point which is near the plane of the magnetic equator. Particles having a pitch angle less than α_c are immediately absorbed into the atmosphere. The rest remain trapped with a life time which increases with the particle's pitch angle α_e (always referred to when the particle crosses the equatorial plane). Particles with α_e=90° stay in the equatorial plane and live longest.

LINE OF FORCE DEFINED BY		CRITICAL PITCH ANGLE	FRACTION TRAPPED**
R_e	λ	d_c	
1.1	17°	55°	57%
1.5	35°	27°	89%
3.0	54°	12°	97%
5.0	63°	9°	99%
7.0	68°	2°	99.9%

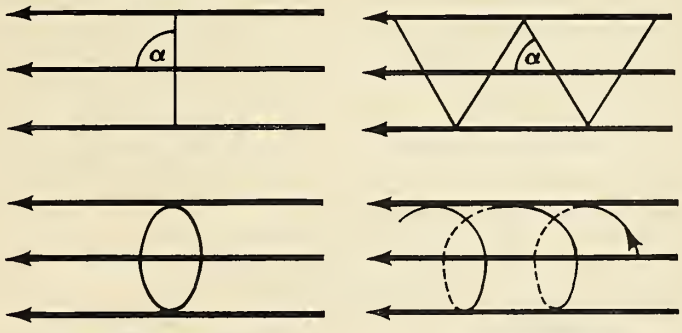
*Reference: Physical Review Letters, Vol. 1, p. 171, 1958

**This fraction is greatly reduced when the burst point is off the equatorial plane, and becomes very small when it is at the limit of the atmosphere.

Figure 1

PARTICLE MOTION AND REFLECTION IN MAGNETIC FIELD

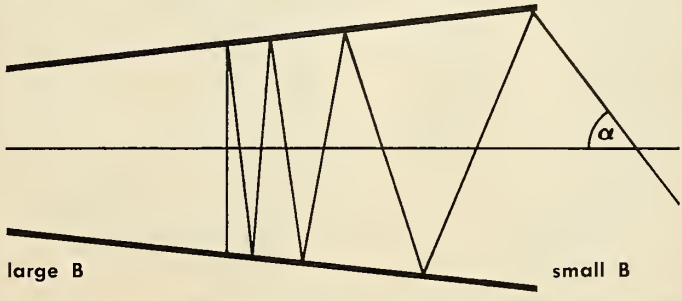
CASE 1: HOMOGENEOUS FIELD



(a) Pitch angles α=90° (particle does not advance)

(b) Pitch angle less than 90° (particle traces out helix)

CASE 2: NONHOMOGENEOUS FIELD (shown by converging lines of force)



As particle moves into region of stronger field B the pitch angle steepens, reaches its maximum value of 90°, at which point the particle is reflected. The relation between α and B is given by $\sin^2 \alpha/B$=constant (Reference: H. Alfven Cosmical Electrodynamics, Oxford Press, 1950).

it for a long time, the burst point should be high above the equator.

• **Particle lifetime**—A crucial problem is the lifetime of the particles trapped in the field. In the absence of any atmosphere and in a perfect magnetic field, the particles could stay trapped forever and build up to very high intensity values. But in fact there exists a very tenuous atmosphere around the earth which becomes more and more ionized the higher we go. As the trapped particles collide with atmospheric atoms or ions or atmospheric electrons, they are scattered and their pitch angle changes slightly.

If, by chance, the pitch angle should drop below the critical value, then the trapped particle is immediately released into the atmosphere and of course disappears. It is almost immediately obvious that those particles which penetrate deepest into the atmosphere, where the density is highest, will have the shortest lifetime, while the particles which stay close to the equator, and therefore at high altitudes, will be preserved much longer.

But in addition to the atmosphere, particles can also be scattered when they collide with inhomogeneities of the magnetic field, and this effect sets a limit to lifetime at higher altitudes. But at low altitudes the atmospheric effect is so much stronger that it determines the lifetime of the trapped particles.

• **Artificial radiation belt**—For scientific purposes, an atomic explosion is a very crude injection device. A much more refined measurement is possible if one uses an electron accelerator. Then the energy of the electrons can be precisely controlled, the direction of injection can be controlled if desired, and the number of electrons released is definitely known. It can be turned on or turned off at will.

Because of these advantages, it is very likely that such a project will get underway very soon. With a nuclear test ban in effect, this would be the only way of simulating the particle radiation released in an atomic explosion. Such experiments therefore have a certain military value as well.

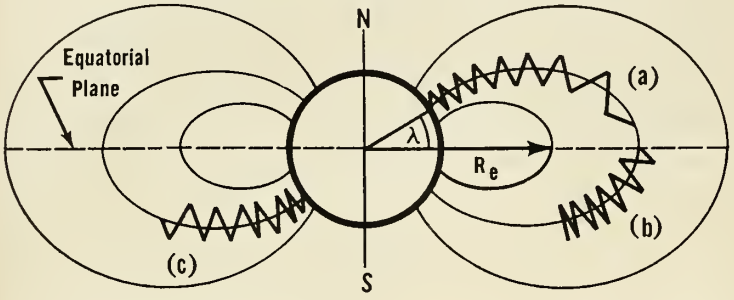
From a practical point of view, an accelerator weighing only a few hundred pounds is capable of emitting electrons up to the highest energies present in atomic blasts, something like several million electron volts. The accelerator could be carried aloft in a rocket and enough electrons spewed out to give a significant increase in reading above the normal background of trapped radiation.

On the other hand, it may be more desirable to put the accelerator into a satellite to allow it to operate for a much longer time. The writer has calculated the behavior of an electron cloud released artificially from an accelerator. It will produce a thin curtain of trapped radiation which rapidly spreads over the whole earth. After a few seconds, the curtain will begin to contract and assume the shape of a napkin ring. After a few days, most of the radiation will have disappeared and the ring will become smaller and smaller. Finally, the particles will be concentrated mainly around the equator.

An average lifetime for the phenomenon is of the order of two weeks. This should be long enough to allow detailed observations both with sounding rockets which go through the layer and with satellites which can traverse the layer every time they orbit into it.

The creation of an artificial radiation belt raises implications concerning its military value. The project can always be carried out so that no harmful effects will be produced either on the earth or on space vehicles, but a more detailed discussion is reserved for later.

Figure 2
PARTICLE TRAPPING IN EARTH'S MAGNETIC FIELD



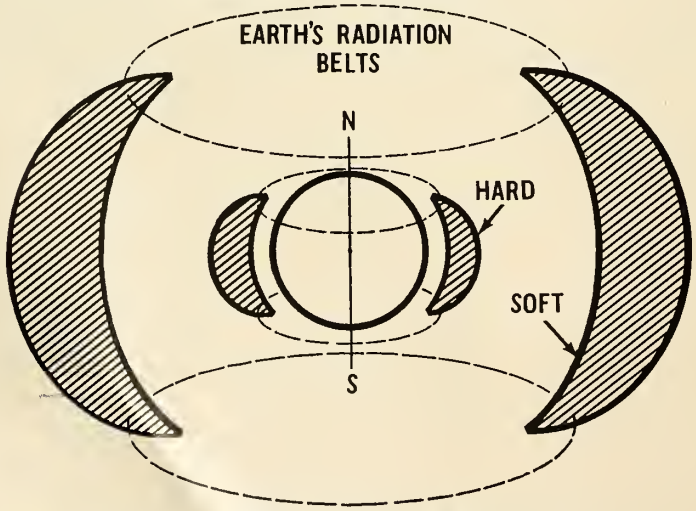
R_e (distance in equatorial plane) defines line of force; also defined by λ, the latitude at which it intersects the earth (or top of atmosphere).

CASE (a): Particle starts with pitch angle less than α_c, hits atmosphere before it is reflected.

CASE (b): Particle starts with large α_c, is reflected and stored.

CASE (c): Particle starts with same pitch angle as in (b), but too far off the equatorial plane; it hits atmosphere.

Figure 3
EARTH'S RADIATION BELTS



From Pioneer data (after Van Allen).

Army Progresses in Micro-Modules

60 companies assist in development of sugar lump-size radios.
Future holds promise of single module for circuit functions

NEW YORK—The U.S. Army's micro-module program has made remarkable progress in its subminiaturization of whole assemblies. Underway since April, 1958, the program already has resulted in the development of radios the size of a sugar lump. Working models showing this concept were unveiled here for the first public showing by the Army and Radio Corporation of America.

RCA is prime contractor in the $5 million, two-year contract. In cooperation with RCA are over 60 other companies providing materials and components. In time, it is expected that most of the electronics industry will become involved with the task as equipment builders or as element and module suppliers.

The Army announced that progress so far indicates the promise of a tenfold reduction in size and weight of today's most refined equipment. That is, those equipments already using printed circuits, transistors and other miniaturized components. In some cases the reductions can be 20 to 1, and further shrinking is considered feasible, according to Dr. Charles B. Jolliffe, vice president and technical director of RCA.

• **Tiny flakes**—The smallest units of a micro-module are tiny flakes of conducting, semi-conducting, or insulating materials, 0.01 inch thick and 1/3 inch square. Controlled processing turns them into micro-elements which can do the job of specific components such as resistors, transistors, capacitors, diodes, inductors and crystals. A group of microelements are stacked up, interconnected, and encased to form the micro-module itself. These operate at complete circuits, such as amplifiers, oscillators, and other complex electronic functions.

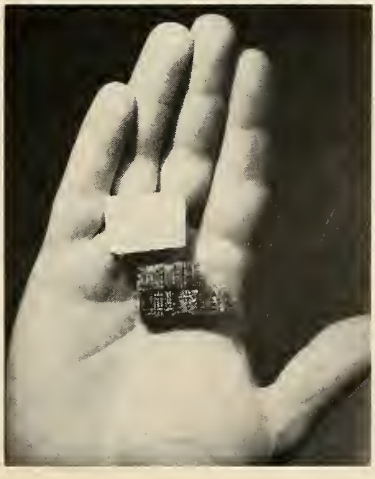
The whole concept, envisioned to take advantage of continuing progress in electronics, will permit combining numerous circuit functions within a single module. In addition, the modules will be compatible with conventional component structures.

Micro-modules are expected ultimately to play an important part in space age missilery. Their small size can save critical space and weight in satellite systems and rockets—perhaps manned.

The size of sensory, data-gathering and telemetering systems such as those currently being placed in orbit could be considerably reduced through the use of micro-modules. They could make possible larger and more diversified space operations with no gain over present electronic poundage.

Smallness, highly important within itself for military and other purposes, is but one merit of micro-modules.

• **Promise**—Since the program was launched, tests carried out by RCA and Army Signal Corps engineers show that the tiny cubes promise to be highly dependable, long-lived, use little power, deliver high performance, and greatly simplify repairs. They are extremely rugged due to their simplicity and monolithic shape.



Sperry's SCAR Permits Star-fixing by Periscope

WASHINGTON—Some of the details of an electronic navigational aid used by our nuclear-powered submarines have been released by the Navy. Designated SCAR, for Submarine Celestial Altitude Recorder, the device permits celestial navigation by a submerged submarine.

"Shooting the stars" is a time-honored and always-reliable method of establishing a ship's location at sea. Nowadays, it provides a means of checking the accuracy of inertial and other advanced navigational systems.

Produced by Sperry Piedmont Company, division of Sperry Rand Corporation, SCAR has been demonstrated successfully in the record-breaking underwater performances of Nautilus, Seawolf and Skate.

With the device installed in a periscope, the navigator has only to sight the sun, moon, or a star and then depress a switch. SCAR then automatically computes the exact altitude of the sighted body. The paper-tape printed results indicate the sighting angle in degrees and minutes, in addition to the exact time of sighting to the nearest second. The timer is accurate within one second per day.

After two or more of these sightings, the navigating officer can establish his position. This last manual computation is a traditional procedure. Thus, SCAR replaces the watch and sextant but with the additional advantage of not requiring the underwater craft to surface.

. . . FULTON

(Continued from page 18)

program can do is to wring their hands about the threat of 1961-1962. They say: "What will happen then if we project the present type of production missile vehicles to 1962?"

There is no doubt of U.S. superiority in the guidance and control fields, and in tracking and telemetry. We and our allies have a world-wide network of ground stations aiding us in these fields. The USSR has none outside of her territory and satellites.

Let us knock out claims of supposed superiority of the USSR in large thrust boosters at the present time. Samuel K. Hoffman, vice president and general manager of the Rocketdyne Div. of North American Aviation Corp., testified before the House Committee on Science and Astronautics on March 16, 1959, that we have under construction a million-and-a-half-pound thrust engine, and by clustering six to ten million pounds of thrust is entirely feasible.

Do not underestimate our advances in the production and use of IRBM's for the defense of the U.S. and the free world from European bases, as well as from over 250 Free World bases scattered everywhere. We can get to a target with more missiles, more accurate CEP, in half the time, and half the expense of the ICBM long-range missiles.

Russia must depend on an ICBM range of 4000 to 8000 miles launched from her own territory. The U.S. has been smart in moving her defenses to forward bases outside her borders with ranges for IRBM missiles of only 400 to 1500 miles to target areas on the average.

Why should the U.S. take Senator Symington's advice and adopt Russia's strategy of ICBM's? Now—we should fill out our U.S. defense production immediately to support our forward bases which give us defense in depth, and we must now continue emphasis on research and development in the ICBM field rather than production. We should not now make the decision to match Russia's 1961-62 strength as predicted by Senator Symington to be 3000 ICBM's—they are probably the "Big Bertha" cannons of World War I transferred to World War III.

The ICBM capability of all nations has been tremendously handicapped already by the high-space nuclear shots by the U.S. in September, 1958, in the South Atlantic which can knock out most of our present electronic missiles guidance systems. The new U.S. ability to jam and make ineffective radar and radio installations over wide areas has given the U.S. Strategic Air Force.

Air Force a new lease on life because SAC now cannot be stopped, in all probability, by current Russian radar defense methods of standard design. What a breakthrough!

In conclusion, I think the facts show that neither of the major power baseball teams is going to win the game —at least by waging total nuclear war with all of its devastating implications. The game is going to go on, and our best strategy is to keep a present, vigilant deterrent that will keep the other side from waging total war—but also to spend money, not on producing obsolete weapons now, but on research and development that is going to produce the weapons that will win the ball-games of the future.

It is an untidy world, and threats to our national security are a problem that will be with us for some time. Crash programs are not the answer. But a well-considered program which will keep the peace at present, and will also produce the weapons that will keep the peace in future years is the best way to survive in the missile nuclear age.

. . . SYMINGTON

(Continued from page 19)

this country. Economically, the United States is much stronger today than the USSR. With millions less people, we produce more than twice as much as the Soviet does. It is true that their rate of progress, as well as that of the Chinese, is greater than ours, but it is also true that we can far outproduce the Soviets in weaponry with less drain and less strain.

Knowledge of our production potential, however, is not enough. We must use it. There is no time left for complacency. Rather, we should look with clear vision at realties.

Already, the Soviets are ahead of us in important aspects of space exploration. They are also ahead of us in ballistic missiles.

The Sino-Soviet empire already is employing these leads in their dealings with other nations. If we are not to default in our position of leadership in the free world, therefore, we must step up our economic, moral and defense pace.

This does not necessarily mean large increases in our defense spending. We can, and should, cut down the current waste of tax money by discontinuing the production of obsolete and useless weapons systems and also by eliminating existing duplication between the services.

This is no time to lose confidence in our democratic free enterprise system. Now, more than ever before, is the time to reassert that confidence.

contract awards

NASA

WASHINGTON—The civilian space agency announced it had signed a $5,000,000 contract with General Electric Co. for development of a liquid propellant engine to power the second stage of the *Vega* space vehicle. Delivery is expected early next year.

It said the engine will be a modification of the *Vanguard* first-stage engine. Combined with an *Atlas* vehicle as the first-stage, according to NASA, the *Vega* will be capable of carrying "significant" payloads on interplanetary missions.

Earlier, NASA announced some previously-undisclosed contracts awarded last month, including:

$770,000—**Minneapolis-Honeywell Regulator Co.**, for guidance system for Project *Scout*.

$470,000—**The Smithsonian Institution**, for electronic tracking and data reduction equipment.

$170,000—**Aerojet-General Corp.**, for shipping rigs for Aerojet *Senior* boosters to be used in Project *Scout*.

AIR FORCE

$300,000,000—**Boeing Airplane Co.**, for production of *Bomarc B* solid-fueled 400-mile ground-to-air missiles and ground support equipment (includes $128,000,000 committed in prior years).

$12,125,000—**American Machine & Foundry Co.**, for design and development of training base launchers for *Titan* (a follow-on contract).

$2,327,000—**Aeronutronic Systems, Inc.**, subsidiary of Ford Motor Co., for classified development and testing of vehicles in support of ICBM program.

$1,000,000—**Catalytic Construction Co. of Pennsylvania**, for setting up the third tactical *Bomarc* base at Otis AFB, Cape Cod, Mass. (a sub-contract from Boeing).

$835,146—**Raytheon Mfg. Co.**, for electron tubes (several contracts).

$518,000—**Sylvania Electric Products Inc.**, for electron tubes.

$483,600—**Telecomputing Corp.**, for precision gyros for *Bomarc* and spare parts for floated rate gyros (add-on contracts from Boeing).

$426,572—**Grand Central Rocket Co.**, for rocket engines and motors in support of *Minuteman* test track project.

$205,573—**RCA Defense Electronic Products Div.**, for various electronic items.

$188,445—**Bendix Aviation Corp., Pacific Div.**, for various electronic items.

$187,652—**Instrument Corp. of Florida**, Melbourne, Fla., for shutter control and synchronization system for Wild BC-4 ballistic cameras.

$140,675—**Varian Associates**, Palo Alto, Calif., for klystron tubes.

$129,000—**Cornell University**, for research on theoretical and experimental investigations in high-speed aerodynamics.

$110,000—**Dynamic Research, Inc.**, Los Angeles, for increase in funds.

$100,760—**New York University**, for continued research on non-linear theories of deformation and buckling.

$93,720—**Sundstrand Machine Tool Co., Sundstrand Aviation Div.**, for recirculating valves and boost pump assemblies in support of *Black Knight* engine.

$79,460—**University of Chicago**, for design, development and production of a prototype model of a cosmic ray counter for experimental, developmental and research purposes.

ARMY

$1,455,197—**Aerojet-General Corp.**, for instrumentation and installation.

$303,458—**Motorola Inc., Military Electronics Div.**, for AN/DKT-8 (XO-4) missile telemetry systems for the *Jupiter* program.

$300,000—**North American Aviation, Inc.**, for rocket engines.

$225,994—**Camco Construction Co., Inc.**, Fullerton, Calif., for storage base P.O.L. at Vandenburg AFB.

$152,954—**Raytheon Mfg. Co.**, for gyro accelerometers for *Hawk*.

$106,160—Gilfillan Bros., Inc., for radio beacons and repair parts (two contracts).
$87,000—Alexis B. Kononoff, Miami, Fla., for design of *Minuteman* launch facilities at Patrick AFB.
$72,500—Rader & Associates, Miami, Fla., for design of *Minuteman* launch facilities at Patrick AFB.

NAVY

$64,600,000—Raytheon Mfg. Co., for further production of *Sparrow III* missiles.
$461,595—Raytheon Mfg. Co., for electron tubes (three contracts).
$238,862—Dale Benz, Inc., Contractors, San Diego, for addition to range operations bldg., Naval Missile Facility, Point Arguello.
$157,500—Westinghouse Electric Corp., for electron tubes.
$72,580—Kuthe Laboratories, Inc., Newark, N.J., for electron tubes.

NASA Planning Bid For Equatorial Launch Site

WASHINGTON—Only big addition to the current launching site program will be a demand for an equatorial launching site. However, the general feeling is that at present National Aeronautic and Space Administration and the Defense Department have all they can say grace over. Result is that the demand won't be heard loudly before the FY 1961 budget is prepared.

Decision as to when and how to ask for the new launching site will be made by NASA in consultation with the Space Council. Preliminary studies made prior to the creation of NASA as well as work to be done by NASA space science groups will establish the need. Timing will depend on the satisfaction of current needs first.

Importance of the equatorial launching site was summed up as follows: "The unique properties of an equatorial orbit lead to a distinct need for an equatorial launching site. These are: (1) narrow track over the earth's surface; (2) best departure point for an interplanatary operation; (3) capability for all other types of orbit; and, (4) a minimum requirement for ground stations and communications systems."

Further studies to be made will undoubtedly consider the possibilities of using ship or islands as launch sites as well as the logistics problems involved in creating an equatorial site.

UCLA Develops New Ceramic-Metal Process

LOS ANGELES—The University of California's Department of Engineering has developed a new process for combining ceramics and metals for application in high-temperature structural members.

The concept involves flame-spraying of thin alternate layers of molten metals and ceramics on a rotating disc. After cooling for a period, this "layer cake" is crushed into small grains.

propulsion engineering

Exotic metals and refractories can be molded to shape with a plasma arc torch that reaches 30,000 degrees F. The arc is struck between two electrodes within the torch; a high-speed gas stream protects the torch from the immense heat and carries, in the molten state, the material to be formed. Metal, fed from wire, is sprayed onto any surface to be coated (the surface does not get appreciably hot). Make a refractory nozzle or nose cone this way: Feed the high-temperature refractory as a powder into the gas stream which carries it into the arc where it melts; spray it on a shaped mandrel; dissolve away the mandrel. Or make a graphite nozzle and spray it with tungsten.

The plasma arc torch was developed by Linde Co. as an outgrowth of earlier plating research. It costs too much for most people who would need it. Electrical back-up alone runs probably $250,000. Because of its high operation noise, Linde will contract individual plating jobs in its own shops. Carbides, zirconium, titanium and Moly-B have been applied to all manner of surfaces, including reinforced plastics.

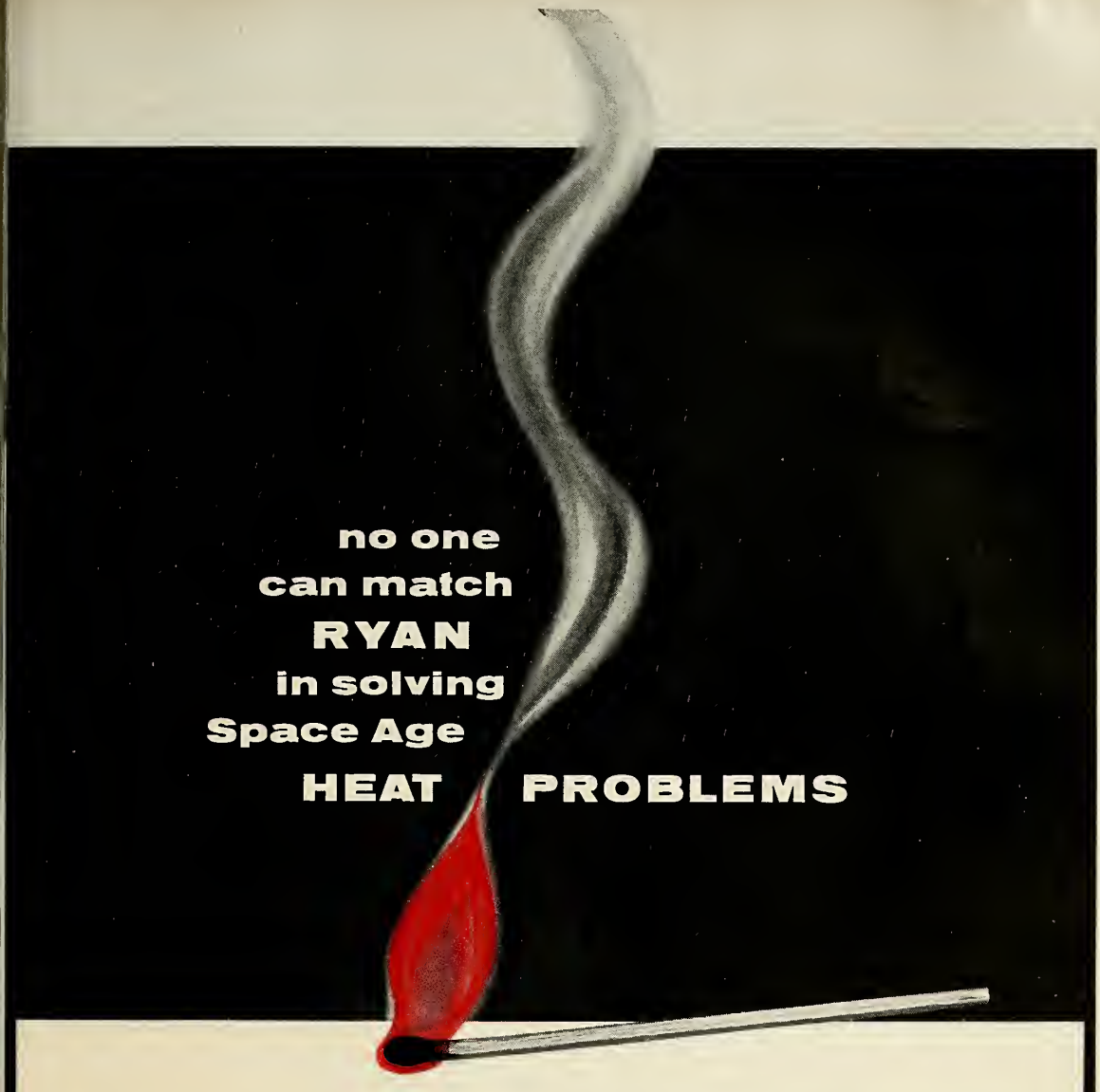
Shippable and storable liquid hydrogen news also comes from Linde. People have been waiting for the National Bureau of Standards' ortho-to-para hydrogen conversion process announced last year to go commercial. "We've been shipping para-hydrogen for quite some time now," says a Linde official, referring to the company's Tonowanda, N.Y., facility. Ortho-hydrogen naturally wants to convert to para-hydrogen, with release of heat which vaporizes the liquid. This is why liquid H_2 is almost impossible to store or ship conveniently. Bureau of Standards speeded up the natural conversion with a ferric oxide catalyst. With nearly all H_2 in a tank in the form of para-hydrogen, there is no further natural warming.

Explosion forming of metal parts is gradually emerging into a science. The latest step: Discovery that an ammonium nitrate-fuel oil combination is synergized—or helped—by water. Most explosion forming is carried out under water. The NH_4OH-oil combination is a superior dry operation explosive. It goes even better under water. Apparently the water cools the gaseous products and shifts the equilibrium in the right direction.

Navy's prepackaged liquid propellants use mixed amines as the fuel, insiders say. Oxidizer is HNO_3. More important than the "package" aspect is the fact that these engines, especially *Guardian*, are successful new developments in variable thrust. Flow rate of fuel and oxidizer is controllable, produces in effect several engines in one.

Hercules Powder's capability in solid rocket engines—as opposed to propellants alone—improves with acquisition of Young Development Laboratories, Rocky Hill, N.J. Young produces filament-wound reinforced plastics, gradually replacing stainless steel and other metals for encasing small grains. A point not widely circulated will get this marriage off to a flying start: Young has been active in Hercules solid propellant development for the past decade.

British liberal press is pushing the government to switch defense reliance from liquid to solid-fueled missiles. The liberals attack Duncan Sandys' recent Defence White Paper as trying to sell the nation on the *Blue Streak* which, they say, is only a "liquid fuel missile of the same technological age group as the *Thor*."



But if you want to try, do this:

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SPACE COMMUNICATIONS: As man's explorations reach farther into outer space, it becomes necessary to make great improvements in communications. One of Lockheed's many contributions in this field is a miniaturized satellite tape recorder, able to store three million pieces of scientific data anywhere in its travels and on return to range of earth stations, transmit it on command. Marconi's original sending key depicts man's first successful attempt to communicate by wave impulse.

SPACE COMMUNICATIONS

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

Lockheed's activities in the missile field began before World War II when the company designed and flew a pilotless aircraft for the Army Air Corps. Today the Missiles and Space Division embraces every facet of research and development, engineering, test and manufacture. It has complete capability in more than 40 areas of science and technology, from concept to operation.

The Division's advanced research and development programs now under intensive study provide a fascinating challenge to creative engineering. These programs include: man in space; space communications; electronics; ionic, nuclear and solar propulsion; magnetohydrodynamics; oceanography; computer research and development; operations research and analysis; human engineering; electromagnetic wave propagation and radiation; materials and processes and others.

Programs such as the Navy Polaris FBM; Discoverer Satellite; Army Kingfisher; Air Force Q-5 and X-7 reach far into the future and require a bold and imaginative approach where only theory now exists. It is a rewarding future which scientists and engineers of outstanding talent and inquiring mind are invited to share.
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letters

Thanks from Raborn

To the Editor:

May I compliment you on your choice of your cover illustration (AX-1 *Polaris* launching) contained in your Feb. 2 issue? She is a beautiful lady and we are confident that she will fly like one, and meet all of her requirements.

Rear Adm. W. F. Raborn,
U.S. Navy
Director, Special Projects
Department of the Navy
Washington, D.C.

Bouquet for Haggerty

To the Editor:

It was a great delight and a tremendous pleasure to read the top-notch story prepared by James J. Haggerty, Jr., in the March 9 issue, on the finest and brainiest General (Lt. Gen. S. E. Anderson) for whom I have ever had a chance to work.

Haggerty's story was well researched, factual and seemd to me to give proper credit to a real gentleman and one of the finest Commanders of ARDC.

B. G. Holtzman
Brigadier General, USAF
Commander
Hqtrs. Air Force Office of Scientific Research
U.S. Air Force
Washington, D.C.

Energy Conversion

To the Editor:

I was particularly intrigued by the recent article concerning the chemical energy conversion cell under development by Lockheed. If this development turns out completely successful it could have an effect as far-reaching as—and more immediate than—the development of nuclear energy for propulsive purposes.

This is particularly interesting when consideration is given to the point that such an end usage of fossil fuels would not further pollute the atmosphere with ozone and carbon dioxide—a factor causing grave concern to various scientific agencies. I hope that you will follow this development as it progresses.

Joseph E. Hamilton
37 South Prospect St.
Hagerstown, Md.

Your interest in the round-up is appreciated, and we plan to keep our readers abreast of this development.

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AF m ARMED FORCES management

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people

Dr. Mervin J. Kelly, retiring chairman and former president of Bell Telephone Laboratories, has been engaged by International Business Machines Corp. as a consultant on research and engineering matters. Kelly recently received the James Forrestal Medal of the National Security Industrial Association and the John Fritz Medal for "achievements in electronics, leadership of a great industrial research laboratory, and contributions to the defense of the country through science and technology."


KELLY

Three top-level executive promotions at North American Aviation's Los Angeles Division have been announced: **Charles E. Ryker** was named controller; **James E. Driskell** assumes the post of director of personnel, and **Robert S. Johnson** becomes assistant to the general manager.

Krafft A. Ehricke was recently elected a member of the board of directors of Kentrol Hawaii, Ltd., electronics firm. A pioneer in missile development and space flight, Ehricke helped to develop the German *V-2* and later worked with the U.S. Army's rocket and missile development program. He was a member of the team which developed the Convair *Atlas,* America's first ICBM. He retains his post at Convair-Astronautics.


EHRICKE

Dr. Alan Lovelace was named one of the ten winners of the Eleventh Annual Arthur S. Flemming Awards "for his foresight in recognizing the need for a research program in the area of inorganic polymers," which led to establishment of a section by the Air Force to conduct such research. The competition honors outstanding men under 40 years of age in the scientific or management fields. Lovelace is a senior project engineer at ARDC's Wright Air Development Center, Dayton, Ohio.

The Martin Co. has announced appointment of **George D. Sands,** physical chemist, as director of scientific requirements. He was formerly Chief of the Nuclear Branch of the Army's Transportation Research and Engineering Command, Director of Scientific Requirements.

Ira H. Abbott is the new Deputy Director of Aeronautical and Space Research for NASA. He will also serve as Assistant Director of Research (Aerodynamics and Flight Mechanics), a position he has held since NASA was established in October last year. Starting with the National Advisory Committee for Aeronautics, NASA's predecessor, in 1929 as a junior aeronautical engineer at the Langley Aeronautical Laboratory, Abbott was named Assistant Director of Research in 1949.

Andre G. Clavier, who retired as vice president and technical director of ITT Laboratories, has been appointed scientific advisor to the Laboratories president, **Henri Busignies.** Formerly in charge of company-sponsored projects at the ITT's research division, he has held the post of vice president since 1956 and is celebrating his 30th anniversary with the ITT System.


CLAVIER

Dr. Robert M. Page, father of the pulse radar system, has won the third annual Captain Robert Dexter Conrad Award, for outstanding R&D achievements for the Navy. Page, Director of research for the Naval Research Laboratory, built the first pulse radar system which detected aircraft in flight in 1934. He holds more than 40 patents with 27 pending and his recent inventions include the monopulse radar.

The award was established by the Office of Naval Research.

Lt. Col. Martin L. Raines has been assigned as the Army Ordnance Missile Command's liaison officer to the National Aeronautics and Space Administration at Langley Field, Va. He will be concerned with space programs which the Missile Command works on under NASA direction.

Nicholas E. Golovin, former chief scientist at the White Sands, N.M., Missile Range has been named director of New Technical Operations Division in ARPA. He will manage the agency's military space technology programs and advanced research in ballistic missile defense and solid fuels.

Dr. Herbert R. J. Grosch is the new space program manager for International Business Machine Corp.'s military products division. He will be in charge of the *Vanguard* Center in Washington, D.C., and will maintain liaison with the space laboratory in the division's Owego, N.Y., plant and the Watson scientific computing laboratory at Columbia University.


GROSCH

Dr. George C. Szego has joined Space Technology Laboratories, Inc. He will conduct research on advanced energy sources and propulsion systems in STL's special projects office. He formerly was manager of space propulsion operations at General Electric Co. in Cincinnati.

Dr. Vincent J. Cushing, recently of Armour Research Foundation, has been appointed a weapon system manager of the missiles and space systems division of United Aircraft Corp. and will supervise all phases of its efforts in small tactical weapons. Since 1950 Dr. Cushing has been director of propulsion and fluids research of the Armour Research Foundation at the Illinois Institute of Technology in Chicago.

Propellex Chemical Division, Chromally Corp., reports the addition of project engineer **Wendell L. Haubein,** in connection with a solid propellant gas generator contract.

Recently appointed to the post of director, systems management division, Cook Electric Co., is **Harold Neal,** formerly with Stromberg-Carlson, a division of General Dynamics Corp.

Dr. Willard R. Sittner takes over as manager of the Semiconductor Division of the Sperry Rand Corp. Since 1949 he has served as manager in major semiconductor operations at Bell Telephone Laboratories, Western Electric Co., Hughes Aircraft Co., Pacific Semiconductors Inc. and Motorola Semiconductor Products. He holds a number of patents on semiconductor devices and is the author of numerous technical papers.


SITTNER

missile business

by William E. Howard

While defense spending remains on even keel, shifting allocations and greater concentration on selected missile models have added a note of caution to some individual forecasts for 1959. Generally, the industry outlook is for sales and profits to continue at the 1958 pace or higher in a competitive climate. Some uncertainty may be attributable to lower backlogs as the new year started. An m/r survey of 11 missile/aircraft manufacturers shows 1958 backlogs at $8.4 billion—$1.1 billion less than the previous year.

Of the 11 companies, only three reported higher dollar volumes of unfilled orders as they went into the new year. They were the Martin Co., $832 million—up $37 million; Republic Aviation Co., $442 million—up $90 million; and Ryan Aeronautical Co., $129 million—up $12 million. The biggest backlog was reported by Boeing Aircraft Inc., which had $2.4 billion in orders on tap as of Jan. 1. The figure is $7 million below its record backlog of a year ago.

Down $259 million at $1.5 billion was Douglas Aircraft Co. There were some dramatic changes in the sales and earnings picture for companies with heavy investments in the missile-space business, and having small commercial stakes. Decreased earnings in 1958 were reported, on the other hand, by firms with strength in both military and commercial business. These setbacks were attributed to the writing off of stepped up development costs.

In this latter category were Boeing and Douglas. Both had 1958 sales increases of more than $100 million, bolstered by missile/space orders. However, Boeing's earnings dropped $10 million and those of Douglas slid $13 million. Reflecting the gathering momentum of the Space Age are Aerojet-General Inc. and the Martin Co. Aerojet-General sales soared from $161 million to $218 million and earnings rose from $3.8 million to $6 million in 1958. Martin increased sales by $60 million—at $483 million—and its earnings of $11.7 million were up almost $2 million from the previous year.

Aerojet-General President Dan A. Kimball forecasts that in the 1959 FY ending Nov. 30 sales should hit about $300 million—an increase of about 37%. In a speech to some investment bankers in Chicago, Kimball said sales and earnings for quarter ending Feb. 28 were up approximately 67% from the corresponding period of a year ago. He indicated that the company—which makes engines for most of the major U.S. missile programs—is in the midst of a heavy recruitment drive.

"We expect to have more than 20,000 (employes) by mid-1959," the former Navy secretary said. The current payroll is 18,000. A reflection of the concern of some over changing industry conditions is contained in the annual report of Jack & Heintz, Inc., missile electronics firm. President Frank R. Kohnstamm says "the outlook for this year is hard to forecast." Funds for both research and production of missiles, he notes, "are being concentrated in selected models and, at the same time, the expenditures for manned military aircraft—and the number of models in production—are gradually diminishing."

Taking note of a 1958 drop of $6 million in J&H sales, Kohnstamm said he is hopeful of increasing volume this year on the strength of greater sales effort and with new products getting into the hardware stage. One thing appears certain. Kohnstamm told his stockholders, the industry this year is "acutely competitive."

when and where

MARCH

Society of Automotive Engineers, National Aeronautic Meeting, Hotel Commodore, New York, March 31-Apr. 3.

APRIL

Conference on Electrically Exploded Wires, sponsored by the Thermal Radiation Laboratory of the Geophysics Research Directorate of the Air Force Cambridge Research Center, Somerset Hotel, Boston, Apr. 2-3.

American Society for Quality Control, Portland Chapter, Oregon Museum of Science and Industry, Portland, Apr. 3-4.

1959 Nuclear Congress, Municipal Auditorium, Cleveland. For information: Engineers Joint Council, 29 West 39th St., New York, Apr. 5-10.

Fifth National Military-Industrial Conference, Palmer House, Chicago, Apr. 6-8.

American Welding Society, 1959 Welding Show and 40th Annual Convention, International Amphitheatre and Hotel Sherman, Chicago, Apr. 7-10.

International Conference on Fracture, Sponsors: Air Force Office of Scientific Research/Solid State Sciences Div., Office of Naval Research, National Science Foundation, National Academy of Sciences/NRC. Massachusetts Institute of Technology, Cambridge, Apr. 12-16.

Air Force Association, World Congress of Flight, Las Vegas, Apr. 12-19.

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

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

American Society of Tool Engineers, Annual Meeting, Schroeder Hotel, Milwaukee, Apr. 18-22.

American Rocket Society, Man-in-Space Conference, Hotel Chamberlain, Hampton, Va., Apr. 20-22.

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

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

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

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

MAY

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

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

Instrument Society of America, 5th National Instrumentation Flight Test Symposium, Seattle, May 4-7.

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

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

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

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

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

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

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

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

American Society of Mechanical Engineers, Design Engineering Conference, Convention Hall, Philadelphia, May 25-28.

Federation Aeronautique Internationale, Annual Conference, Moscow, May 28-31.

JUNE

American Rocket Society, Semiannual Meeting, San Diego, June 8-11.

United Nations Educational, Scientific and Cultural Organization, Paris, June 15-20.

Cornell University Industrial Engineering Seminars, Cornell University, Ithaca, N.Y., June 16-19.

American Institute of Electrical Engineers, Air Transportation Conference, Olympic Hotel, Seattle, June 24-26.

RCA Demonstrates Thimble-Size Tubes

WASHINGTON—In a recent demonstration before representatives of the electronics industry, military, and press, RCA introduced prototypes of its thimble-size electron tubes.

Called "Nuvistors," the tiny tubes are capable of operation in temperatures from −320°F to +350°F. Since they are larger and require high power, the Newistors are not expected or intended to replace transistors.

Advertiser's Index

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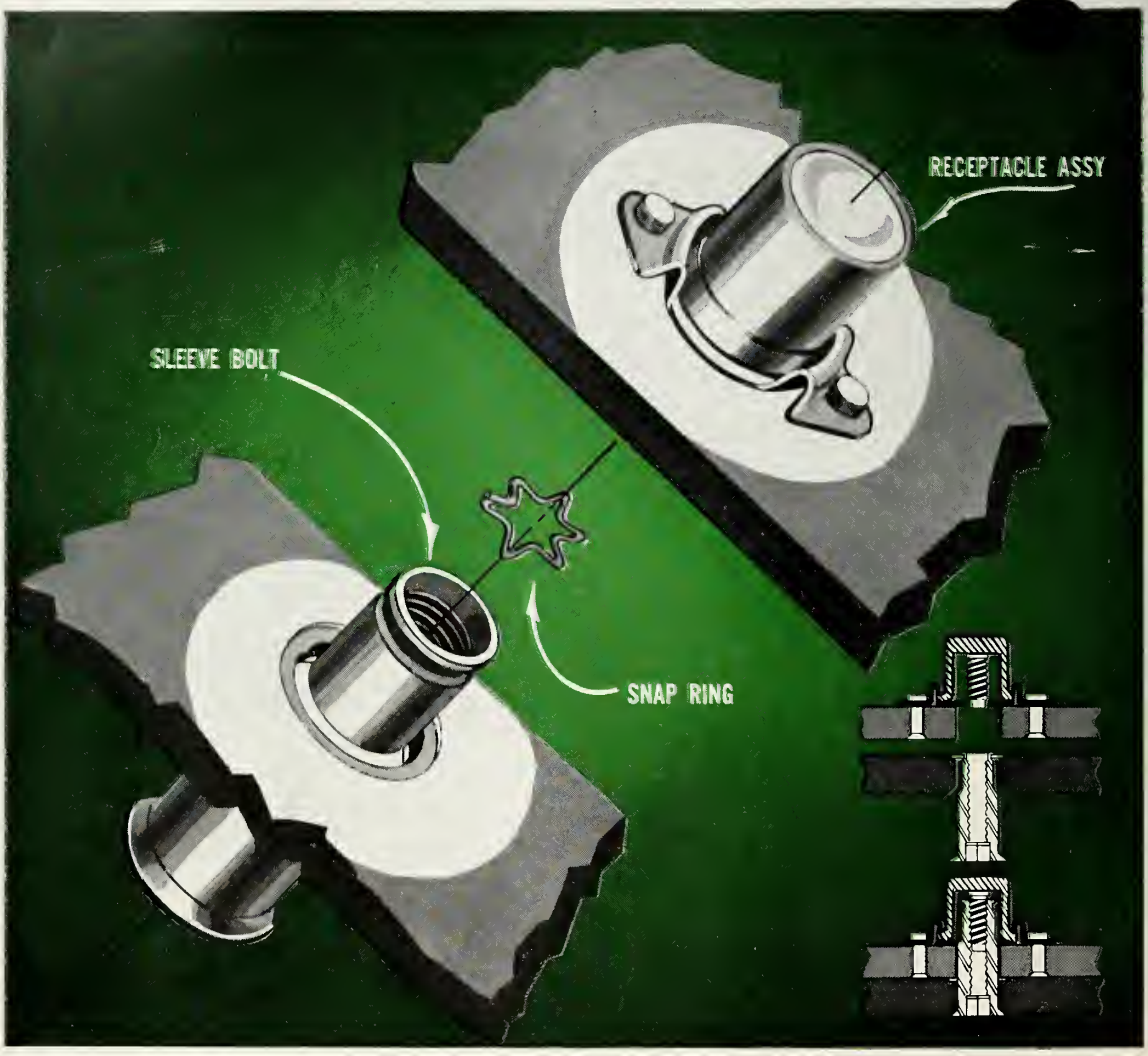

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