JUNE 1, 1959

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION

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missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

JUNE 1 HEADLINES

SPECIAL SECTION

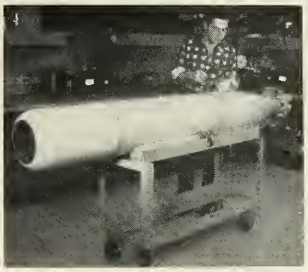
MISSILE SUPPORT

MISSILE ELECTRONICS

THE MISSILE WEEK

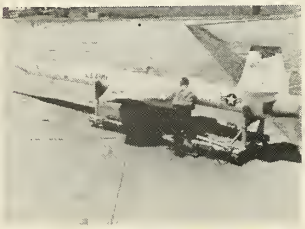
DEPARTMENTS

COVER: Scott Crossfield checks out *X-15* prior to first drop with engine ignition.



GE'S MK 44 acoustic homing torpedo is latest entry in Navy's arsenal. It can be surface-launched or air-dropped in the vicinity of its submerged target.

ANOTHER GE development is this Gun and Guided Missile Director MK 73 which controls the Navy's *Tartar* Surface-to-air missile. Director has gearless power drive.



GE also has developed silicone sealant for Lockheed's *Kingfisher* which improves recovery chances and cuts manufacturing costs $1600 per missile.

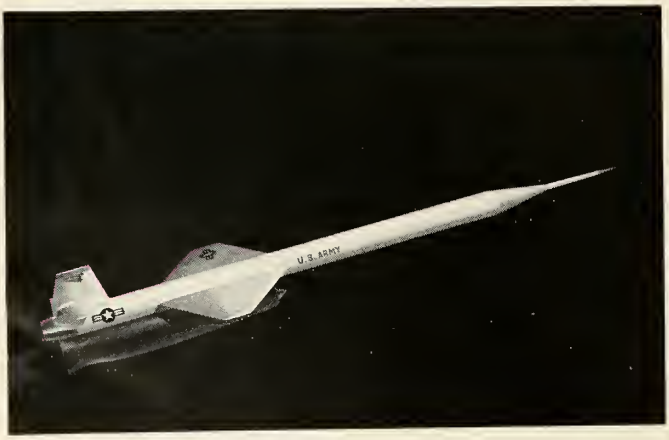
What Lockheed is doing today to develop
Tomorrow's missiles and spacecraft

The world's first polar-orbiting satellites...the world's fastest ramjet target drone...a "fuel cell" that produces auxiliary power for spacecraft in a radically different way...a TV camera-transmitter—the world's smallest—that gives engineers and scientists on the ground a televised report of what takes place in test missiles during flight. These are just a few of the many activities and achievements of Lockheed's Missiles and Space Division.

Lockheed is System Manager and Prime Contractor of the ARPA DISCOVERER satellite series—and the U. S. Navy's POLARIS missile. Both are highest priority programs of the U. S. Government. And both are ahead of schedule.

A Lockheed MSD work-force of over 16,000—including 3,500 scientists and engineers—is engaged in all phases of missile and space technology: satellite systems development; space communications; electronics; ionic, nuclear, and solar propulsion; magnetohydrodynamics; computer research and development; flight sciences; materials and processes; human engineering; electromagnetic wave propagation and radiation—and many other advanced fields.

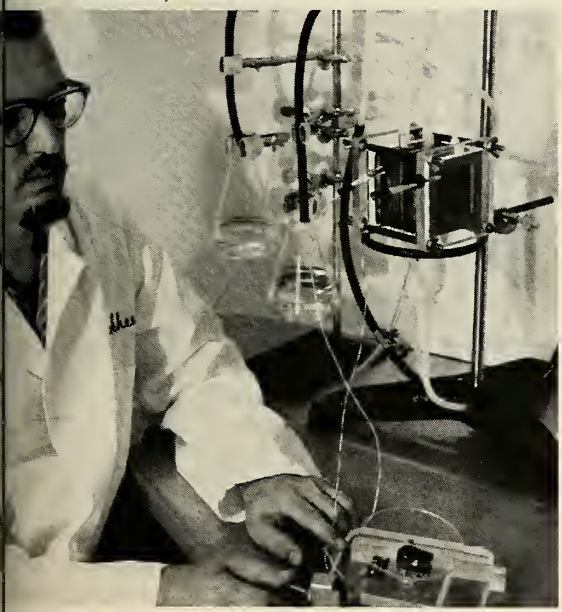
From these efforts at Lockheed will come many significant breakthroughs and scientific "firsts"—to speed the development of tomorrow's missiles and spacecraft.



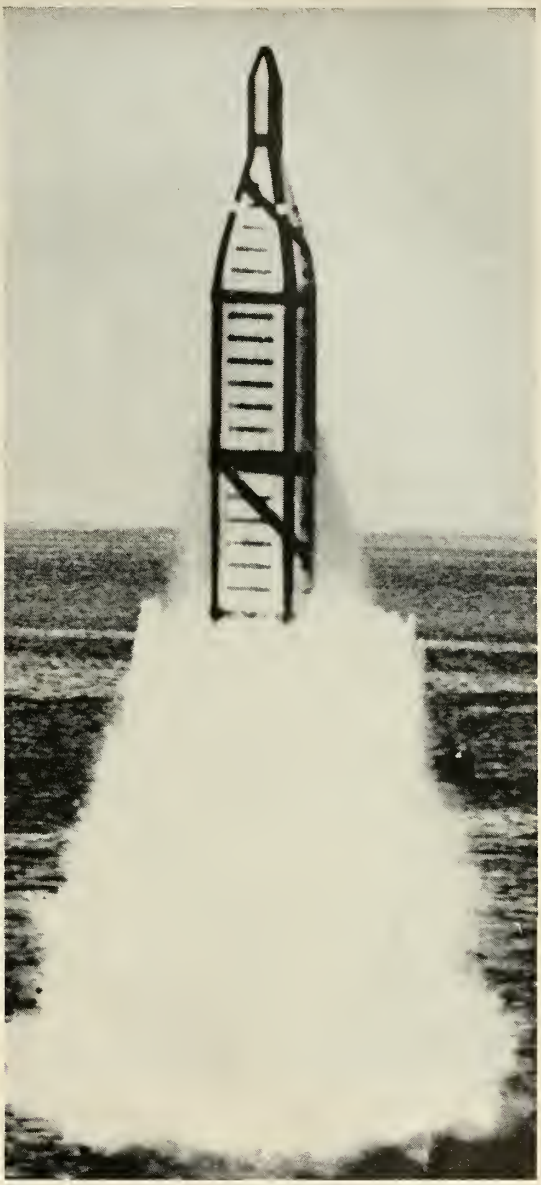
Ramjet-powered supersonic target, Lockheed Q-5 KINGFISHER electronically simulates enemy attackers—is being used by U. S. Army to evaluate and sharpen our nation's missile marksmanship, increase our defense capabilities.

First polar-orbiting satellites, the Lockheed DISCOVERER I and II were orbited in two succ launches. Lockheed is System Manager for this advanced scientific research program.

ısmitting performance data from missiles and test vehicles, ct to ground stations, Lockheed-developed TV camera-mitter and PAM-FM telemetry systems are acknowledged to e world's smallest, world's best.



olutionary "fuel cell," under development at Lockheed, con- chemical energy directly into electrical power—for auxiliary er requirements of miniaturized spacecraft instrumentation space communications systems.



Erupting from beneath the sea, a full-scale POLARIS test vehicle demonstrates how operational missile will be launched from submerged U.S. Navy subs. Ultimate range of the POLARIS will be 1500 nautical miles.

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NUCLEAR REACTOR DESIGN & DEVELOPMENT • GROUND SUPPORT EQUIPMENT • WORLD-WIDE AIRCRAFT MAINTENANCE

W. P. Knight

Bill Knight is a rocket chemist. His field of interest is research on advanced solid and liquid propellants to meet the stringent requirements of today's military programs (and tomorrow's).

The continued success of the American missile program depends on men like Bill Knight.

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Proposed—A Unified Strategic Command

The Joint Chiefs of Staff are considering the creation by mid-1960 of a single unified command for the strategic warfare forces of this country—a command to include those components from the Air Force and the Navy which have strategic weapon systems. It would probably be called simply the U.S. Strategic Command.

The commander would report directly to the Joint Chiefs and not to his own service and he would have operational control of the combat units assigned to him, regardless of service, both in the cold war and in a hot war should it develop.

The commander would most likely be Air Force due to its preponderance of strength in the field, with the deputy a Navy man and the staff combined USAF and USN.

The formal papers proposing such a move were presented to the Joint Chiefs several days ago and have circulated widely through the higher echelons of all services of the Pentagon. The proposal recommends implementation of such a command arrangement to become effective by the time the first *Polaris*-equipped vessel is ready for operation employment (mid-1960). It also recommends that concurrently with the activation of such a command the present SAC go out of existence as a specified command, i.e., one which reports directly to the JCS as SAC now does, and remain simply as an Air Force component command.

The proposal was put forward by General Thomas White, chief of staff of the Air Force (and a member of the JCS, of course) and is known to be favored by many high officers of both the Air and Sea services.

Several cogent reasons have been advanced as to why the big bombers and long-range missiles of the Strategic Air Command and the intermediate range missiles of the Navy should be unified under one commander:

- Formation in peacetime of a strategic force which would operate effectively in the event of a war.
- Prevention of overlapping and duplicating roles.
- A firm and effective assignment of strategic targets.
- Assurance of instant response to higher command, instant reaction and instant application of full strength.

In his proposal to the Joint Chiefs, General White recommended that the Joint Staff, in conjunction with the Air Force and the Navy, join to define the mission, responsibilities and organizational establishment of the new U.S. Strategic Command. In the services, such a task would probably fall to General Thomas Power, SAC commander, and possibly to Rear Admiral L. R. Despit, Director of the Undersea Warfare Division, Office Chief of Naval Operations, since the Navy has no strategic division as such.

This combine probably would also develop organization arrangements, manning and the phasing of implementing action by timetable.

* * *

This proposal by the Air Force Chief of Staff to take a very intractable bull by the horns and wrestle it into submission is quite in keeping, both for the man and for the present trend to reorganize the services by missions rather than by color of uniform.

For one thing, General White has more than once made it known that he favors unification of the services. For another, his proposal is fully in accord with both the intent and the spirit of the Reorganization Act of 1958, other parts of which have already been implemented.

The North American Air Defense Command at Colorado Springs not only unifies the U.S. Services but includes the Canadians as well. The Alaskan Command has long been unified, as have the service units in Europe and the Far East. Before the Reorganization Act these unified commanders could give orders to other service units only through their parent organizations—usually in Washington. Now the commander has direct control and reports to the JCS, as would the new Strategic Commander proposed by General White.

When the soldiers, sailors, airmen and marines all climb into one uniform and become identified by their mission instead of their service, is a matter of conjecture, although it certainly seems inevitable. But to group the strategic forces of the country—with their overwhelmingly important task of deterrence through the threat of massive retaliation—under one unified command seems to make a great deal of sense in an imperative situation.

One of the weakest links in the American strategic position has been that the Navy and the Air Force have never been able to coordinate strategic targets. With a considerable capability in the strategic field, the Navy would never make a firm individual target commitment because of a wish to remain completely mobile. And SAC would never accept anything less than a firm specific commitment. In the event of war, the delay of decision in just this one area could be disastrous.

And . . . if this proposal is the first step toward a unified Tactical Command, a unified Training Command, a unified Materiel Command and so on—so much the better.

Clarke Newlon

...NEWS IS HAPPENING AT NORTHROP

Now being produced and delivered to the U.S. Army Signal Corps, the Radioplane SD-1 gives greater battlefield surveillance flexibility to combat units than ever before. (This photo of terrain was actually taken from an SD-1 at 1,000 feet.)

RADIOPLANE PRODUCES FIRST COMBAT-READY SURVEILLANCE DRONE

Meeting tough Army Signal Corps requirements and being produced in operational quantities, the SD-1 is proved and ready to fly unmanned photo reconnaissance missions for tactical troops.

Highly mobile, the camera-carrying SD-1 may be zero-length launched in rough terrain from a camouflaged position. It is flown by remote control over enemy installations on surveillance missions without risking a pilot's life or man-carrying aircraft. Within minutes after the SD-1 returns from its mission, photographs are delivered to the requesting unit.

Other specialized sensory equipment may be carried by the SD-1 depending on particular mission requirements.

This Army-Radioplane achievement exemplifies Radioplane teamwork with all of the U.S. Armed Forces. Radioplane provides a complete drone family spanning medium speeds through supersonic performances.

RADIOPLAN

Von Nuys, California, and El Paso, Te
A Division of
NORTHROP CORPORATION

washington countdown

IN THE PENTAGON

ARPA is pushing ahead seriously with its program aimed at developing a space platform weighing several thousand tons. The platform would be launched into space with nuclear-bomb propelled rockets. ARPA describes the team working on the program as made up of "some of the best men in the country."

• • •

The Pentagon is reportedly near a decision whether to develop a storable propellant for the Convair *Atlas*. A storable propellant for the nation's first liquid ICBM would give it two extra pluses: Faster reaction time and mobility.

• • •

A possible new interservice squabble may be in the making over who will operate the "satellite fence" developed across southern United States. ARPA directed development. Both the Army and the Air Force played a part. Now ARPA is ready to turn it over to one of the services.

• • •

The Air Force is planning to spend about $23 million in FY 1960 on development of a new secret missile—the anti-radar missile. The ARM apparently would be air-launched from attacking bombers. It most likely would foul enemy radar by dropping chaff and/or by carrying electronic jamming equipment.

• • •

The Army's *Davy Crockett* missile has blossomed into a family of weapons. The secret missile—tipped with a nuclear warhead—is understood to be small enough to be fired by an infantryman from a bazooka-type weapon.

• • •

A couple of notes on the Missile Gap calendar:

The Martin *Titan* timescale is about two years behind the Convair *Atlas*—not one as believed in many quarters, according to Congressional testimony by the late Donald Quarles.

Some six months could be shaved from the Boeing *Minuteman* program. Cost would be about $100 to $300 million depending on who in the Pentagon is doing the estimating.

• • •

The Navy wants to cut back R&D funds for two new anti-submarine missiles and boost R&D funds for two others. The cuts are slated for Minneapolis-Honeywell's *Asroc* and Westinghouse's *Astor*—understood to be an anti-submarine torpedo rocket. Boosts are slated for Goodyear's *Subroc* and *Little Lulu* —believed to be a surface-to-surface missile.

ON CAPITOL HILL

A leading Congressional figure close to the nation's space program says the Russians have made a number of space shots since *Lunik* in January. He says he received the information from "good authority." He says the Russians apparently are withholding any announcements until they have something sensational to disclose.

• • •

Some Congressmen are predicting that the Senate and House may settle their dispute over the Boeing *Bomarc* and the Western Electric *Nike-Hercules* with a compromise involving *Atlas*. The possible deal: The Senate would go along with a House desire for more funds for *Atlas*. At the same time, the House would put back some of the funds asked for *Nike-Hercules*.

• • •

Despite opposition from the Administration and some influential Congressmen, Congress appears certain to keep a double hold on NASA. The House already has voted to make NASA secure Congressional authorization for all programs before securing any appropriations in the next five years. Many powerful senators want to make the arrangement permanent. Outlook: The least NASA can expect is the House's five-year clause.

AT NASA

The schedule for Project *Mercury* includes more than two dozen launchings before any attempt will be made to put a man into orbit. One of the last before the big one will be the firing of a manned space capsule down the Atlantic Missile Range with a *Redstone* booster.

AROUND TOWN

Plans are moving ahead rapidly to make Raytheon *Hawks* the first American-type missile to be produced cooperatively by NATO countries. The second probably will be Philco *Sidewinders*. The U.S. military aid program is helping get the programs under way. The NATO countries involved are reported ready to pay $400 million for the NATO-made *Hawks*.

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STRUCTURES

Thoric—intercontinental version of Douglas *Thor* IRBM—is being evaluated by Air Force as means of accelerating nation's ICBM readiness. Question is whether *Thoric* should be advanced on "crash" basis to back up *Atlas*. Configuration would be adaptation of liquid two-stage *Thor-Able* test vehicle which has hurled experimental nose cones 5000 miles down Atlantic Missile Range.

• • •

Cincinnati Testing Labs will receive contract to produce nose cones for Martin-Orlando's *Pershing*—800-mile MRBM solid-fueled successor to *Redstone*.

• • •

Steel gantry 305 feet high—tall as a 28-story building and the largest in U.S.—will be constructed at Redstone soon to erect and service *Saturn* space vehicle. Hugh mobile tower is indicative of the size of ABMA-ARPA's giant rocket, which will have a cluster of eight H-1 Rocketdyne engines as its booster and three other stages. Fire and lightning protection, heating and air conditioning will be incorporated in the structure along with three elevators, bridge crane, "on-board" diesel electric generator and six service platforms. AOMC and Army Corps of Engineers developed the gantry design in conjunction with Maurice H. Connell & Associates, Miami A&E.

• • •

In midst of heated DOD and Congressional sniping at the interceptor missile program, Air Force last week launched first Boeing "super" *Bomarc-B*. Despite charges it will be ineffective against ICBM's, many Capitol observers say 400-mile *Bomarc-B* probably will be phased in when ready as "best available"—with cut in *Nike-Hercules* program.

• • •

A $20 million tag is attached to the Air Launched Ballistic Missile program in the 1960 defense budget. This will pay for six-month design-cost study getting under way by Douglas and early prototype development.

• • •

Russian "mole" missile? Rocket tunnel digger which spouts compressed air and liquid fuel-fed flame to eat through rock and earth is being used by Soviets, according to Hungarian magazine *Magyar Nemzet*. (Translation available in Scientific Information Report issued by U.S. Commerce Department Office of Technical Services.)

PROPULSION

Watch for first static firing of Pratt & Whitney liquid hydrogen rocket motor about mid-fall. Test will be conducted near Lake Okeechobee.

• • •

Little progress is reported in merger talks being conducted by Thiokol Chemical and Marquardt Corp. Thiokol expects sales to hit $150 million in 1959—against $89 million last year—with a slight upward movement in earnings.

ELECTRONICS

Small Business Administration is licensing Electronics Capital Corp., San Diego., as closed-end non-diversified management investment company. It will be the first to concentrate in one field—small business electronics. ECC plans through 1.8 million stock issue to acquire $16 million for investment in small business securities. No government funds are involved.

• • •

Air Force contract for prototype development of transistorized SAGE computer is being awarded to IBM. For underground installation, computer will be 1/9 size present models and reportedly will have computation capability increased sevenfold.

ASTROPHYSICS

Capture of micrometeorites 150 miles in space and bringing them back to earth will be attempted in September by ARDC and Cambridge Research Center. Scientists will use Aerojet-General *Aerobee* rocket with snap-open nose cone. Micrometeorites will imbed in strip of sticky film. Recovery will be with a parachute. If successful project would yield first real data on composition of debris encountered by missiles and space vehicles.

SPACE MEDICINE

Full-pressure space suit being unveiled June 2 by Navy and B. F. Goodrich is designed to allow man to walk on moon. Wearers can withstand 19 g's in first 40 inches of ejection test and dunking in brine solution at −60°F. Navy says pilot wearing suit would survive as long as one hour after ditching in Arctic waters.

More about the Missile Week on page 29.

PIONEERING IN SOLID PROPULSION SYSTEMS

From the first American jet-assisted airplane takeoff to the first of our second generation guided ballistic missile systems, the Jet Propulsion Laboratory continues to be an active pioneer

In August 1941, America's first jet-assisted airplane takeoff was accomplished with an Ercoupe monoplane, using JPL developed solid propellant rockets. Scientists at JPL shortly discovered that a powdered perchlorate oxidizer, mixed with a liquefied plastic fuel binder, could be cast directly in plastic-lined light-weight motor cases. Thus a safe and cheap method was now available for preparing large internal-burning composite propellant charges. This basic process became the foundation for the modern solid propellant industry.

In 1954, U. S. Army Ordnance requested JPL to develop a compact, rugged long-range guided missile weapon system that could be transported, aimed and fired as simply as a cannon. Within five years, JPL perfected the Sergeant, the first of America's second-generation guided ballistic missiles. In January 1958, clusters of small- Sergeants helped launch America's earth satellite, the JPL built Exp which provided vital space environ information.

Now under the direction of the tional Aeronautics and Space Adm tration, the experienced JPL rese and development team continue apply solid propellant vehicles for s exploration.

jpl

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missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Red Threat From Antarctica

U.S. and other nations are worried about Russian bases build-up and submarine missile launching potential

by James Baar

VASHINGTON—At the frozen bot- of the earth Russia is moving a position from which its missile drons could outflank the Free ld.

Half of Antarctica—that empty, d continent twice the size of the ed States—is rapidly turning from e to red.

Meantime, the United States at for the present is accepting sec- place to Russia in the comparative e of its Antarctic operations.

Proposals to equip American bases portable nuclear reactors and to d a year-round jet landing field at Murdo Sound are presently stalled lack of funds.

Another proposal to build a satel- tracking station at the South Pole has been at least temporarily ved.

Many knowledgeable officials in the ed States, Australia, South Amer- New Zealand and Africa are look- toward the South with increasing n.

• **Southern exposure**—From the vy Antarctic coasts and plateaus sia is in a position to have the re Southern Hemisphere within missile range. Moreover, big Rus- ICBM's could strike the United es from Antarctica without notice. The multi-billion dollar BMEWS em—designed to give SAC a life- eath 15 minute warning of ICBM's aking across the North Pole— ld be silent.

Naval patrols watching for missile- ching submarines on the U.S. East West Coasts would find nothing. lear death would come from the uarded and undefended South.

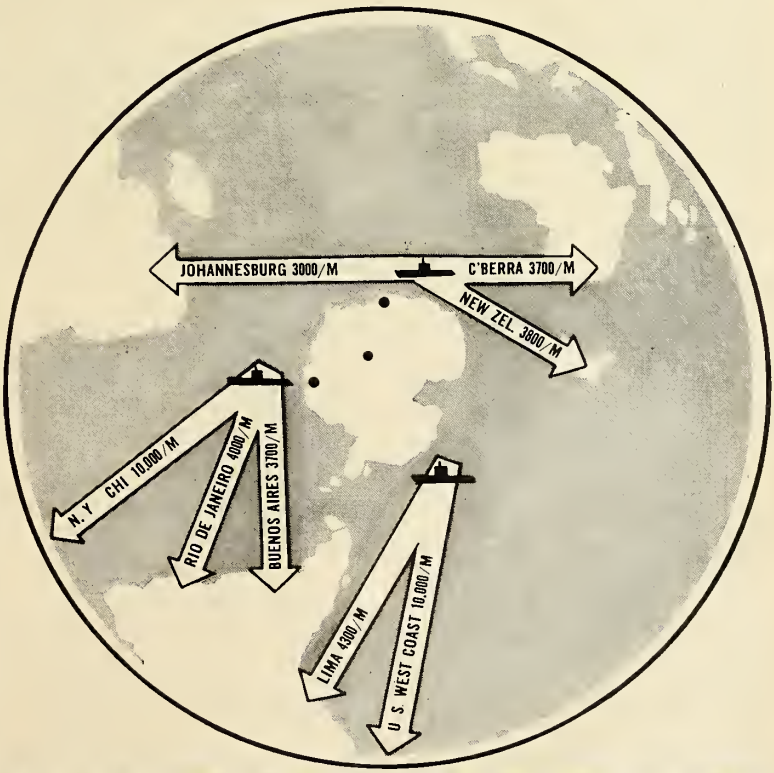
The earliest Antarctic threat involves the use of missile-launching conventional submarines operating out of the Soviet Union's increasing number of Antarctic bases.

Missile-armed submarine packs drawn from the Soviet Union's huge fleet of some 450 submarines could be sent into the South Polar seas at any time. There they could hide along the thousands of miles of empty Antarctic coast, waiting for the signal to strike.

Johannesburg . . . Canberra . . . Lima . . . Buenos Aires . . . Rio de Janeiro . . . Melbourne . . . Wellington . . . all are within a maximum of some 4000 miles of the White Continent.

• **Bases by hundreds?**—But using submarines is only the first and easiest step. The Soviets can put their ICBM's on Antarctica itself.

Missile sites—soft, or hardened—



SOVIET SUBS working from Antarctic could strike many targets without detection.

No U.S. Plans for Missile Site . . .

can be built inside the Antarctic glacier, in the opinion of U.S. experts. The Russians could build hundreds of them both near the Soviet-occupied coasts of East Antarctica and on the great plateaus in the interior.

New York . . . Washington . . . Chicago . . . Denver . . . Seattle . . . Los Angeles . . . all of the United States lying within a huge 10,000-mile arc would be reachable.

The effect on the cold war would be tremendous.

Not only would U.S. warning systems and defenses be outflanked, but three powerful new factors would be introduced into the East-West conflict:

• The U.S. heartland for the first time since the American Revolution would be menaced simultaneously on two broad fronts. Russia would have found a counter to U.S. overseas bases.

• Much U.S. ICBM power would have to be turned toward the unpopulated Antarctic wastes, thereby lessening the value of the ICBM squadrons as a deterrent of terror.

• South America and Africa would become much more sensitive to Soviet pressure as the shadow of Soviet missile might spread across both continents.

U.S. experts see nothing insurmountable in the way of establishing Soviet ICBM bases in Antarctica. As for firing missiles under Antarctic conditions, they note the United States already has fired missiles under generally similar conditions at Fort Churchill, Canada.

As for building Antarctic missile sites, they note that the United States already is building research living quarters in the Arctic glacier near Thule, Greenland.

The research building near Thule is being constructed mostly out of insulating materials put together inside a hole dug out of the glacier with a specially-designed Peters snow plow. Walls of the hole support the building.

One expert said under-glacier installations could be hardened merely by putting them deeper into the glacier.

He said that so far the United States has no plans for building such a missile site itself. However, he said it had been given a considerable amount of thought by engineers.

Officials closest to U.S. Antarctic expeditions say they have seen no evidence so far that the Russians are about to build South Polar missile sites.

• **Red carpets**—However, they say there is no question that the Russians are in Antarctica to stay and that they are expanding their operations. And these operations—still scientific—are laying a basis that could rapidly take on a military character whenever Moscow so decreed.

At present, the Russians occupy Antarctic sites at Mirny and Lazarev on the East Antarctic Coast and Komsomol'skaya and Vostok in the interior. The Poles have been given the Soviet interior base called Oazis. The Mirny base has carpets on the floor and wallpaper on the walls.

The Soviets are planning overland exploratory trips from Mirny to Lazarev via the Pole of Inaccessability and possibly one far west into Marie Byrd Land and the Bellinghausen Coast where much U.S. exploration has been concentrated.

Also, the Soviet Slava whaling flotilla recently circumnavigated Antarctica for the first time and was last reported headed toward the Bellinghausen Sea off Marie Byrd Land.

So far, Soviet rocket activity in Antarctica has been confined to the firing of some two dozen sounding rockets from the Soviet vessel 'Ob off the Antarctic coasts. Soviet scientists previously have said Russia was considering launching satellites from Antarctica.

• **U.S. de-emphasis**—As Soviet operations in Antarctica have increased, U.S. operations have decreased somewhat since the end of the International Geophysical Year in 1958.

The United States during IGY operated seven bases: McMurdo, Byrd, Ellsworth, Hallett, Wilkes, Little America and Scott-Amundsen at the South Pole.

At present, the United States is continuing to operate McMurdo, Byrd and Scott-Amundsen. It is operating Hallett jointly with New Zealand, Wilkes with Australia and Ellsworth with Argentina. Argentina and Australia have taken custody of Wilkes and Ellsworth.

Little America, considered the most important American base scientifically, has been closed because of lack of money.

• **Some planning**—The National Science Foundation has asked for $4 million dollars for FY 1960 for Antarctic research. The Navy has asked for nearly $16 million to provide logistical support.

No money is included for the nuclear reactors, the McMurdo landing field or a tracking station.

The reactors, which could be t ported by plane, are estimated to $3 million each.

Cost of building a 7800-foot field on the ground at McMur estimated at about $85 million. mated cost of a 10,000-foot ai capable of accommodating any j about $100 million.

The reactors would provide power for McMurdo, Byrd and S Amundsen bases, reducing the am of shipping to Antarctica by a half. The airfield would open Southern Hemisphere Great C route over the South Pole.

The polar tracking station w enable U.S. technicians to track satellites on every pass around earth. It also would serve as a c point for detecting unannounced silent polar satellites launched Russia.

Supporters of the tracking st proposal contend it would be only first step in the assumption of an portant role for Antarctica in Space Age.

They say Antarctica is the obv gateway to space because of the in the deadly Van Allen Radiation over the polar regions.

For this reason as well as scien and overriding strategic reasons are urging increases in the U.S. arctic effort.

Meantime, tractors bearing flags are moving through the Antar snows in increasing numbers. The sile submarines, then the missile s could come at any time.

Connector Reliability Improvement Is Urged

BALTIMORE—Electrical connec are an important part of any mis system. Many are in critical locati where their failure could cause fai of a whole system. Consequently, e though they are small and uncom cated, more attention must be gi to improving their reliability.

L. L. Resser and M. J. Sm engineers for The Martin Co., sented a paper at the AIEE meet here this month, outlining sev parameters that should be conside in connector design.

Some possible solutions suggest

• Double seals at the mating face of the connectors.

• Seals at the ends of the c nectors.

• Potting or single-piece constr tion of the insert proper.

• Snap-in contacts for cable-shi ing connections, with bonded foll up grommets.

NASA Patents Rights Debated

Question is how much proprietary interest should space agency retain over inventions performed under contract

ASHINGTON—How much of a ietary interest should NASA re- ver inventions conceived during erformance of a NASA contract? is question recently has been the t of strong debate at patent r meetings across the country, t waiver-of-patent hearings held ASA in Washington.

ASA held the hearings to give e and rocket industry patent rs a chance to voice their criticism e present interim regulations be- NASA drafts permanent regula-

fter the hearing, NASA General sel John A. Johnson stated that egulations would be modified after d his staff had an opportunity to the criticisms voiced by the in- y lawyers.

ASA's present regulations come fire from companies used to do- usiness with the Department of se because they are stricter than patent regulations. Conversely, ical companies used to contract- nder the very strict Atomic En- Commission patent rules find A's regulations very agreeable.

he missile and rocket industry oint is that NASA regulations d retain too many patents for the nment. NASA lawyers believe that nt regulations are not as harsh as try lawyers think, and that it is nterest of the United States" for A to retain proprietary interests me patents.

he effect of present NASA regu- s and the definition of the term he interest of the United States" oints much in dispute.

Here are complaints—Basic com- ts lodged by industry patent law- are:

. The regulations discourage indus- rom entering into NASA contracts use the decision as to who gets s to inventions is not decided un- ter the contract is signed;

. NASA keeps too many of the nts. All they really need is a non-exclusive royalty-free license to use the invention;

3. It is unfair to take an invention of one company and give the exclusive license for the production of that invention to another company;

4. The burden of proof is on the company to show why it should retain rights to its own inventions;

5. The regulations are not "in the interest of the United States" because in many cases the most competent contractor will refuse to accept a NASA contract under the current regulations.

• **Answers**—The NASA legal staff's answers to the above objections are:

If NASA's Administrator allowed the contracting officer to waive possible future patents in the contract, the Administrator would be surrendering his discretionary power, would put him in an untenable position under the law. Industry interest in NASA contracts has been high, indicating that the patent regulations do not discourage bids.

Because of the restrictions as to what type of patents NASA can retain, and because of NASA's pre-stated intention to administer the regulations liberally, fewer patents will be retained than many industry lawyers think. If NASA only retained a non-exclusive license on some inventions, it could not get risk capital to produce the invention.

In many cases a contractor does not want to, or by law cannot acquire rights to an invention. NASA needs the power to give an exclusive license of one company's invention to another in order that the invention can be fully developed and produced in the interest of the United States.

The burden of proof on the contractor to show why he should retain rights to his own invention is very limited, and is necessary to carry out the provisions of the law.

The regulations, though in need of modification, are in the interests in the United States in that they allow the fullest development and use of important inventions in the area of space development.

• **Contrary policies**—NASA lawyers point out that the agency's patent provisions are stricter than DOD's because Congress made them stricter.

They point to the statement made recently by Administrator T. Keith Glennan in which he stated that: "Two such contrary patent policies followed by Government agencies working in closely related fields of research and development, can be detrimental to the kind of cooperation that we must have from industry, if our joint effort is to go forward with effectiveness and dispatch. We are well aware of the attitude of industry toward this question. On the other hand, it must be recognized that these rules are written into the law, and we cannot ignore them. The Administrator of NASA has authority to waive these patent rights, but only if his judgment tells him that such an action is clearly in the public interest."

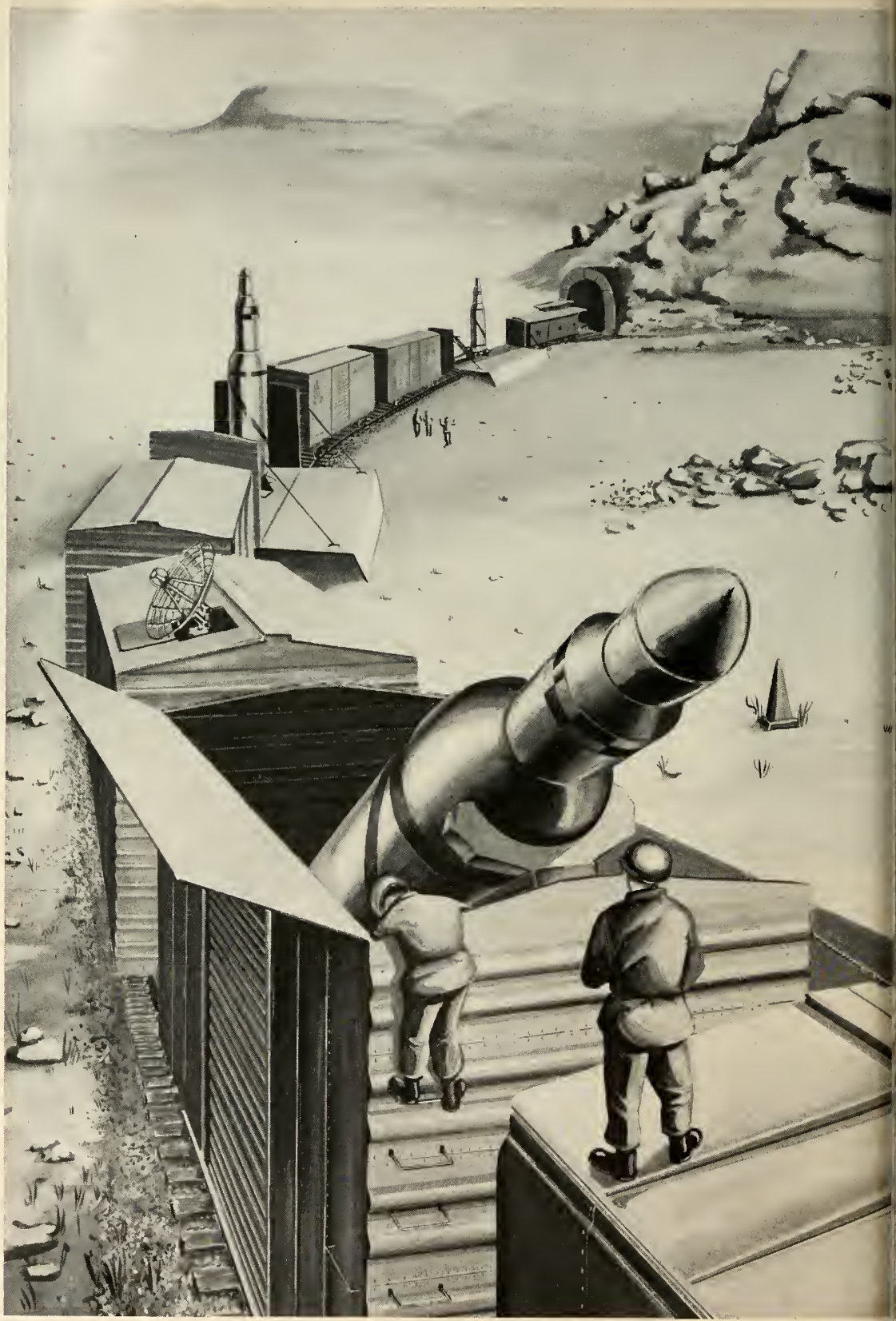
• **Revision?**—Many industry and NASA patent lawyers think that Congress may revise the two organizations' patent regulations in order to reconcile them.

But NASA lawyers do not intend to ask Congress to do so. They feel that the provisions of the law are broad enough to allow them to work out regulations acceptable to industry.

Under the law, the Administrator has the power to waive patents, and the major dispute between industry and NASA is where to draw the line.

Industry would like inventions to be indexed into classes, with the waiver of patent rights by NASA on certain classes of inventions to be automatic. NASA counters that such a system would be infeasible in that an invention in any devised class or category could be so vital to the national interest that the government should retain proprietary rights.

The consensus is that the revisions NASA is presently making of its waiver-of-patent regulations will meet some, but not all of industry's objections.



Minuteman Rail Concept Pushed

200 missile trains appear possible which should open up a whole new field of missile support equipment running into multi-million dollar program

by William E. Howard

WASHINGTON—*Minuteman* is in the ess of being married to a boxcar.

mbracing the theory that mobility make the nation's ICBM deterrent knock-out proof, U.S. strategists well-advanced plans to mount the -fueled Boeing *Minuteman* on rails mouflaged as ordinary freight s, M/R has learned.

ntinually shunted around the try on secret schedules, missile s would be invulnerable to all but cky hit. The enemy would never for sure where they were. In time ert they could hide out in tunnels mine entrances.

he cars would be specially con- ted, perhaps "hardened" to 5 or psi, and air-conditioned to pro- the crew from radioactive fallout. trains would speed in time of at- to a pre-determined firing point g the track, or possibly a siding, nuclear-tipped missiles would be ched in moments directly from cars.

his concept of mobile task forces ing pushed hard by the Air Force. he time *Minuteman* is operational 963, its wedding to a train is cted to carve out a whole new of missile support running into ireds of millions of dollars.

t is possible that as many as 200 ile trains may be mobilized, re- ing special railroad cars and other ile handling and support equip- t.

On war game "sandtables" elusive ile trains add up to one of the t unstoppable weapon systems yet sed in the chill sweat to find an imate" deterrent to Russia. For in ition to will-o'-the-wisp deploy- t, they have the key tactical ad- tage of being able to fire from wn reference points. All targeting data would be "pre-cut" to benchmarks or mile posts strung beside the railroad track.

Thus, a boxcar-launched *Minuteman* would have all the accuracy, but not the vulnerability, of one in an underground silo, which can be zeroed in like a "sitting duck" by an enemy missile.

"Mobility and hardness are the two basic parameters," a high Defense Department planner told M/R. "The higher the degree of each in combination, the more difficult it'll be for the other fellow to knock you out. That's what is so important about this missile train concept.

"This is how it can be done—and should be done."

• *Titan* **mobility**—In the quickening drift toward mobility, M/R has been told, plans also are being developed by the Air Force Ballistic Missile Division to use barges, oil tankers and special truck task forces as ICBM launching platforms.

Moreover, considerable study is being given to adapting the liquid-fueled *Thor* IRBM and *Atlas* and *Titan* to one or more of these moveable platforms. Size and fuel handling are problems with the 90-foot *Titan* and 75-foot *Atlas*. However, a decision reportedly is in the mill at the Pentagon whether to go ahead with development of a storable liquid propellant for *Atlas*.

If one is devised, it could be a major step toward making both *Atlas* and *Titan* mobile. This could be a factor, too, in plans to build several billion dollars worth of underground ICBM bases, in addition to those under construction.

Fourth of a Series on Missile Support

Asked recently by a House Appropriations Subcommittee member if missile mobility is a "countermeasure" to the Navy's submarine-launched *Polaris*, former BMD commander Maj. Gen. Bernard A. Schriever replied:

"No. We are just getting tired of being accused of having our feet set in concrete."

Production of *Minuteman* presently is programmed at 2600 units and consideration is being given to making half of them mobile. If one train could handle six missiles, it would take 200 trains to mobilize 1200 *Minutemen*.

• **Cost factor**—Air Force authorities estimate that it will cost $1.5 million to put one *Minuteman* in a silo—including the missile, which is expected to come off the production line at about $750,000 apiece. Chief advantage of the fixed launching site is in lower maintenance cost. *Minuteman* was conceived as a second generation ICBM which, because of its solid fuel, can be deployed in squadrons of 60 in remote areas in tamper-proof silos under "black-box" surveillance—removing the requirement of crews to check on the condition of fuel, launch and guidance systems.

By utilizing existing rolling stock, the cost of putting *Minuteman* on rails would be comparable to a fixed system. But the cost of operating a train with a crew of 30 to 40 men would boost the overall annual outlay.

Research and analysis of the feasibility of mobile platforms, M/R has learned, was part of the proposal when Boeing was awarded the *Minuteman* contract last fall. To generate some broad parameters on performance and economics, a study was initiated and is still underway. Contributing, among others, are the Association of American Railroads and American Car & Foundry, one of the nation's largest railroad car manufacturers.

• **Two designs**—Studies thus far have produced at least two distinct designs, both centering around the launching car. In one detailed to some degree by the BMD, the missile car would be 110 feet long and capable of accommodating two 55-foot *Minutemen*. It would have a rounded, hinged cover under which the missiles would ride horizontally, protected by special cushioning gear.

For launching, the cover would be thrown back and the missiles raised to a vertical position on a ring stand. The car would be protected for possible re-use by a special blast deflector.

Remainder of the train would be made up of standard equipment.

The second, more elaborate concept calls for complete concealment in standard-appearing boxcars—so the train would be indistinguishable from another freight. This would make it that much harder for enemy agents to keep track of the train's whereabouts.

Since the standard boxcar averages 43 feet, the missile car would have to be specially tailored to fit the 55-foot length of *Minuteman*. This limitation probably would restrict the car to carrying one missile. To launch, the hinged sides and top of the car would fold out to the ground. As with the oversized double missile car, *Minuteman* would be raised on a ring stand with an electrically powered hydraulic lifting arm.

Extra shock absorbing effects are required in both designs to prevent damage to the missile while in transit. And the missile car decks and end panels probably would be fabricated of high-temperature resistant steel alloys to withstand takeoff blast.

More engineering and expense would be required to convert available rolling stock for a camouflaged missile train into cars to accommodate communication, telemetry and data processing, personnel and dining.

To harden the cars to withstand bomb blast over pressures of even 5 psi, some experts say, would run up the cost of the trains to an exorbitant figure. Moreover, they point out that hardening could not be very effective anyway, since it is more than likely a nuclear bomb blast at any proximity would knock a railroad car off its tracks. They contend it would be much more feasible therefore to run the trains into tunnels and mines during an alert.

• **15-car train**—A typical missile train of the camouflaged variety is conceived as being comprised of about 15 cars. They would include, in addition to six missile launchers, one car each for communications and telemetry-data processing, one for equipment, two for spare missiles, two personnel cars, a diner and—to make it look real—a caboose.

While no firm estimates have been made available, AAR figures indicate a fully-equipped missile car for a camouflaged train would cost in the neighborhood of $100,000—exclusive of the missile. A 110-foot car might be $150,000 or more. Cost of outfitting cars for personnel—$50,000 each. And the other cars also would have to be specially fitted and air-conditioned at about the same price. Thus a 15-car missile train would come to about $1 million. The diesel electric engine, if not leased from a railroad, would add another $250,000 for a total of $1,250,000.

In comparison, a luxury streamliner consisting of a two-unit diesel locomotive and 13 cars would cost $2.7 million.

Equipping the missile train communications and targeting cars along with other support equipment, however, might entail expenditure of another $1 million, bringing the total for one train ready for deployment with missiles to approximately $6.7 million.

This appears relatively cheap compared to a hardened *Titan* base, which costs about $40 million just for the brick and mortar to house personnel and silos for nine missiles.

• **Blocked tracks?**—One obvious drawback of a rail launching system is its inflexibility. In time of emergency, missile trains might be prevented from moving to their target control points by rail traffic, bomb damage or even sabotage to the tracks. This is one reason why some experts are in favor of a missile truck convoy which would prowl the nation's superhighways in continual readiness to respond to an attack.

Railroad authorities believe that through efficient planning and careful routing the drawback may be minimized. They point out that there is ample room on the sprawling rail network covering some 386,000 miles to "lose" a couple of hundred trains. Each day approximately 30,000 trains—half of them freight—are on the move over the country. This is approximately 50% of the trains operating in 1930 during the railroad heyday.

A prototype rail launching car for *Minuteman* is under development. Schriever says the Air Force is "going down the line simultaneously" on both the fixed and mobile operational concepts.

First firing of *Minuteman* from a silo could come late next year—either at Cape Canaveral or at Edwards AFB. Facilities are being built at both. And the first shot from a boxcar may be scheduled at the same time.

New Transducer Uses Seen in Space Medicine

PHILADELPHIA—Space medicine have issued a transducer challeng the electronics industry. At a Phil phia's Franklin Institute sympos medicine experts pointed out that and better transducers are neede provide the answers that medicine have to know if man can surviv space. And they are looking to tronics to provide the means to s and transmit the many physiolo parameters they must measure.

The one-day Space Medicine E tronics Symposium brought toge representatives of medicine and tronics in industry, the armed fo and government agencies.

To date, communications bet electronics and medicine has been little to produce any significant re The Philadelphia meeting was an e to bring about better communica and acquaint electronics with s medicine problems.

Theodore Kaslow, vice presiden gineering of the Decker Corpora defined the ideal transducer and po out three parameters that are espec important to medicine and are, t beyond the state of the art:

1. An objective measure of threshold and level;

2. An objective measure of ness, or awareness; and

3. A measure of cerebral cir tion.

Some work has been done by Decker Corporation on the cer circulation problem. Preliminary using an opthalmic artery pulse pi indicate that techniques and transd can be developed to provide the swers needed.

Present medical methods of ob ing physiological data—skin and temperatures, pulse and respiration blood pressure, skin resistance, action, etc.—are too crude and l to be used on a man in a space ronment. The subject's comfort, matic pickup and recording/tran ting capability, volume and weight itations, and other requirements al tate entirely different techniques equipment from those used in the tor's office.

Gordon Vaeth of ARPA said "we cannot prove today that ma survive and perform in space." H that in spite of the feeling by som man is an obsolete and expensive h in a space vehicle, he feels that has a function to perform that c be accomplished by machines.

He pointed out that man is the complete and flexible computer able today and can serve as a efficient data filter or discriminat

How Is DOD Moving on Reliability?

Some observers say it is in all directions but Air Force has come up with a new reliability monitoring system which should give better standards

by Betty Oswald

WASHINGTON—Reliability is rapidly ›oming the most important headache ·d both by the Defense Depart·t and the National Aeronautics and ce Administration. The old slogan 9.44% pure just isn't good enough the thousands of pieces and sub·ems which make up advanced pons and space systems.

But how do you achieve reliability? ense Department, according to e observers is moving in all direc·s at one time. However, effort ts for the most part at design level er than at the level of materials ch make reliability of design components themselves feasible. ether this is good enough is furi·ly debated among research people, icularly those who are concerned a the failure to develop a firm ma·als research program looking ahead a new generation of requirements.

Latest DOD effort deals with en·ering drawings and associated lists M-D-70327) which spell out in e 25 pages exactly what shall be the engineering drawings, and how erials, parts and components are to identified. And to "insure quality design activity (either military or ufacturer) is required to establish maintain an adequate procedure checking, review and maintenance rawings, associated lists, and docu·ts prepared or furnished under this ·ification."

• **New monitoring**—And the Air ce has developed a reliability mon·ing program designed to correct as ckly as possible situations such as recent development of "bugs" af·ing the *Atlas,* which resulted in r faulty firings in a row.

The policy statement is contained AFL 84-1. It is predicated on the mption that "reliability is a param·" that can be quantitatively speci·, estimated, assessed or measured at designated steps or monitoring nts of a weapon system's life cycle ." It recognizes, however, that in·ased funding will be required, in e cases, to obtain higher confidence els in the demonstration testing se.

AF's program is supplemental. It does not replace contractor's normal reliability monitoring as well as surveillance by AF contracting agencies. It is based on an expression of quantitative contractor reliability (i.e. 50% at a certain date, 95-100% by another date).

Reliability monitoring points established by the AF are: (1) Detailed design study, which includes studies of both system and subsystem reliability covering the entire design and including prediction of reliability wherever feasible; (2) Pre-prototype, involving design engineering inspection or a release of nearly all of the engineering; (3) Prototype, at which time laboratory testing has established compatibility of weapon systems and subsystems and special test vehicles have been used to obtain data for improvement of design, etc.; (4) Pre-production demonstration. Here sufficient reliability must be shown to warrant a production go-ahead; (5) Service evaluation. Here the question is whether the system is capable of being produced in quantity without significant loss of reliability or performance; (6) Full-scale production, during which the effort is to assure that the level of reliability designed into the system is maintained; and, (7) Product improvement, during which AF hopes to move close to the perfect.

• **Reliability specified**—At each of these points, the degree of reliability required will be specified in the contract. At each of these points the status of reliability is to be reviewed and, on the answers found, a determination will be made whether to move to the next step in the life cycle of the weapon.

However, it's uncertain whether this latest program is good enough. Indications are that there will be more emphasis on the bits and pieces which go to make up the missile system, and perhaps somewhat less emphasis on the complete weapon system. This means more technical development work as recommended by the Stever Committee which recently reviewed the status of the Air Force research effort.

Thor Plastered

TECHNICIANS coat nose cone of *Thor-Able* re-entry vehicle with plaster to make cast of its surface. Vehicle is first to be recovered after successful flight over 5000-mile ICBM distance. Avco's Research and Advanced Development Division developed ablating heat shield material which protected cone from extreme temperatures encountered during re-entry into earth's atmospbere. (Dark substance behind cone is ablative material which flowed back over main body during re-entry heating.)

Swiss Firm Turns Out Most Missiles in Italy

Contraves AG developing into big supplier with its RSD-58 and RSC-57 missiles

by Anthony Vandyk

ZURICH—Contraves AG, which is developing into one of Europe's most respected missile manufacturers, is a Swiss firm which turns out most of its products in Italy.

The head office and plant of Contraves, a component of Switzerland's Oerlikon-Buehrle industrial empire, are located in a suburb of this great manufacturing city. But production is mainly handled by an Italian subsidiary company, Contraves Italiana.

This unusual arrangement is a result of Switzerland's traditional neutrality. Swiss policy does not encourage the export of armaments—and the market within the country is extremely limited. Furthermore, since Switzerland is outside NATO, prospects for a Swiss company trying to sell its products to NATO member countries—the main European military market—obviously are not good.

• **No Red business**—These factors were behind the decision of Contraves to set up Contraves Italiana in Rome. Using the design of prototype facilities of the Swiss organization, Contraves Italiana as an Italian company is in an excellent position to obtain orders from NATO countries. The Contraves organization also takes orders from countries outside NATO but has a policy of not doing business with Iron Curtain countries.

To date, most of Contraves' missile business has come from the Italian and Swiss governments, but there have been token orders from the U.S., Japan, and Germany. Contracts are being negotiated with other countries.

The U.S. Air Force was Contraves' American customer. It evaluated the Swiss anti-aircraft missile at the Holloman Air Development Center in 1953.

Because Contraves missiles are developed without government financing, the company's salesmen are not hampered by security in their efforts to sell their products on the world market. There are no aspects of the *RSD-58* and *RSC-57* SAM's or the *Mosquito* SSM which cannot be freely discussed with potential customers.

Contraves makes no attempt to avoid talking prices. The tactical *RSD-58* version of the anti-aircraft missile is priced at between $15,000 and $18,000 per round, while the training *RSC-57* version costs roughly twice as much. The anti-tank *Mosquito* is tagged at $900 in both its training and tactical versions.

• **"Against birds"**—Now able to offer two highly competitive types of missiles on the world market, Contraves has come a long way since its foundation in 1936 as a modest anti-aircraft research organization (Contra-Aves means "against birds"!). The first products that stemmed from its work were tracking systems; from the original pre-war models were developed complex theodolites, which form the basis of the Contraves EOTS (Electronic Optical Tracking System), standard equipment at the leading missile ranges of the Western World. More than 100 sets of EOTS equipment have been sold by Contraves.

Another Contraves specialty is fire control equipment. The Fledermaus probably represents the ultimate in this type of equipment for anti-aircraft guns. Experience in this field obviously has aided in perfecting fire control systems for Contraves missiles.

The Japanese Self-Defense Force expects to fire its first Contraves anti-aircraft training missile this summer. The Swiss company has concluded a licensing and agency agreement with Mitsubishi Electric Manufacturing Company of Tokyo. Prospects are good that the Self-Defense Force will place a production order with this conce Under the terms of the agreem Mitsubishi can sell Japanese-built n siles to any neighboring countries cept those in the Communist bloc.

• **Heavy subcontracting**—Contra policy favors maximum subcontract and most of its anti-aircraft missile s tem is manufactured by subcontracto Much of the radar comes from Alt werke, a Zurich electronic compa that was one of Contraves' early ba ers. The beam guidance radar conta a HF transmitter made by another Swiss company, Brown Boveri. Forei companies also figure in the Contra program. For example, Belgiu MBLE company is responsible for t target-tracking radar.

Although the basic Contraves SA is not new, constant improvements being made. Operating radius has be increased to over 20 miles and a so

CONTAINER with two missiles weig only 23 lbs. and is strapped on bac

ppellant is being substituted for the crrently-used liquid-fuel rocket mo-t. The present motor develops about 200 lbs. thrust and combustion lasts about 45 seconds, sufficient to move t missile up to Mach 2.5,

A particular selling point made by Contraves officials is that since neither t SAM nor the little *Mosquito* SSM e boosters they can be deployed close t inhabited locations and troop con-ntrations.

One of the main features of the Contraves SAM system is its mobility, c imed to be at least as great as that c a normal heavy-caliber anti-aircraft a illery battery. The heaviest of the ssile battery's units weighs only 12,-00 pounds. Nonetheless, the *RSD-58* t tical missile can attain Mach 2.5 d has an operating radius of over 2 miles and a ceiling of 30 miles.

The minimum distance at which i can be used is from 8000 to 16,500 et, according to the speed of the t get. Launching weight is about 900 s. The warhead contains about 90 s. of high explosive. Behind it is an ectronic equipment also weighing out 90 lbs.

• **Fast firing**—The beam guidance stem permits several missiles to be ed simultaneously from the same bat-ry. Up to twelve missiles a minute ay be launched. This high rate of fire quires fast loading on the double unching ramps; this is largely achieved rough automation.

The training version of the *RSD-58,* e *RSC-57,* is fitted with a parachute stead of a warhead and thus is not pendable. The recovery system in-udes two parachutes and special echanism. After the end of combus-on, the missile is split into two parts, the nose and the main body returning to earth separately. As many as ten recoveries have been made with individual missiles tested at the Italian Air Force's range on the Mediterranean island of Sardinia.

• **Anti-tank**—Contraves is working very closely with the German firm of Bolkow in connection with its program for the little *Mosquito* anti-tank missile. This wire-guided SSM competes in a market so far dominated by France's Nord *SS-10* and *SS-11* missiles.

The Swiss-designed SSM is considerably smaller than the French weapon and weighs only about 23 lbs. A container with two missiles including warhead that can be strapped on to a soldier's back (see photos) weighs only 54 lbs. Guidance equipment weighs 8 lbs. Despite its modest size (3 feet long and 2 feet in wing span) the *Mosquito* has a remarkable performance. It travels at 16,500 ft. per minute and has an operating radius of about 6000 ft.

Although the missiles of its own design are tops in their category, there is little doubt that Contraves would be extremely interested in acquiring the license to build advanced birds of foreign design. Notably missing from the company's catalog is an AAM in the *Sidewinder* category.

It could well be that by the time the Swiss Air Force is ready to make its choice of a supersonic fighter, probably this fall, Contraves will have a proposal regarding the weapon system. In all events, it seems that the company's success with its past projects guarantees it a permanent place among the leaders of the European missile industry.

CONTRAVES *Mosquito* SSM uses boosters that can be deployed closed to inhabited locations and troop concentrations.

S. K. Hoffman Receives M/R's Goddard Trophy

WASHINGTON—Samuel K. Hoffman, vice president and general manager of the Rocketdyne Division of North American Aviation Inc., last week was awarded the Dr. Robert H. Goddard Memorial Trophy—an annual presentation by Missiles and Rockets.

The award was made at the end of a three-day National Missile Industry Conference sponsored by the National Rocket Club. Hoffman was honored for leadership in producing the *Jupiter C* liquid rocket engines which launched the first U.S. earth satellite *Explorer I,* on Jan. 31, 1958, and engines for the first successful flight of a long-range ballistic missile, an *Atlas.*

An industry award presented by Borg-Warner Corp. also cited Rocketdyne for outstanding achievement with liquid-propellant engines.

Dr. William H. Pickering of Jet Propulsion Laboratory received the Daniel, Mann, Johnson & Mendenhall Space Flight Achievement Award.

Space Industries Small Business awards were presented to: Cooper Development Corp., Monrovia, Calif., for design and fabrication of the three final *Jupiter C* stages used in the *Explorer* series; and Cincinnati Testing Laboratory for developing the first successful IRBM re-entry nose cone.

Other Highlights—During one of the work sessions, Dr. Herbert F. York, the DOD's director of R&E, reported that the ARPA-Army cluster of eight *Jupiters* for *Saturn's* space booster will be effective if only seven of its motors ignite. York also forecast a need for more research money for NASA and DOD as the astronautics program diverges more from the missile program.

"Off-again-on-again" Pentagon plans for a nuclear-powered plane (CAMAL) were critized by Sen. Henry M. Jackson (D-Wash.), a member of the Armed Services Committee and long-time supporter of the project. Jackson challenged whether development of the plane would take five years, as estimated in recently released Congressional testimony by Lt. Gen. Roscoe C. Wilson, Air Force deputy chief of staff for development. The Senator thinks it could be done sooner, and that the first one should be a seaplane.

And William S. Palmer, vice president of Templeton, Dobbrow and Vance, Inc., mutual fund managers, cautioned that prices of missile stocks have reached "unrealistic" heights because of "wild speculation."

U.S. May Seek Pact to Silence Outworn Satellites

Delegation at Geneva meeting will also propose radio frequencies to be reserved for space use only

by Paul Means

WASHINGTON—Future U.S. satellites containing permanent power sources will house destruct mechanisms allowing their transmitters to be turned off when their usefulness is over.

An attempt to obtain an international regulation to this effect may be made this August at the Radio Conference of the International Telegraphic Union at Geneva, which will also take up the problem of the allocation of frequencies for space use.

The problem of permanent power sources in satellites first arose when the Navy launched *Vanguard I*. The satellite's batteries were charged by solar cells, allowing it to send signals back to earth ad infinitum.

Because of its almost perfect orbit, *Vanguard I* still provides useful information to the nation's scientists. But when the value of its information is ended, there will be no way to turn *Vanguard I's* transmitter off.

And a great many satellites in space with permanent power sources would clutter up valuable frequency bands for many years to come.

The next two satellites with solar cell-charged batteries that the U.S. intends to orbit are *Thor-Able III* (the paddle wheel satellite) and *Explorer VI*.

A destruct mechanism in *Thor-Able III* will not be necessary because its orbit (30,000-mile apogee, 150-mile perigee) will be short-lived. But *Explorer VI*, a long-life radiation experiment satellite, will contain either a destruct mechanism which will turn the transmitter off, or a device allowing the transmitter to be turned off and on as information is needed. Its power will be supplied by solar cells charging nickel cadmium batteries.

A satellite transmitter's signal can be terminated by: (1) a circuit breaker; (2) by applying too much volt to a transistor, allowing the oscilla to burn it out, or (3) by using a ti fuze.

Because some satellites in sta orbits will give useful information fr time to time in years to come, NA and ARPA scientists are also perfe ing a device that would allow the tra mitter to be turned on and off as formation is to be required.

• **Space bands**—Another probl created by the Space Age is the fir ing of frequency bands for space u in a radio spectrum already burden by military and commercial commu cations.

The U.S. proposal before the 1(nation International Telegraphic Uni will be that 25.600 to 25.650 mc., reserved for the exclusive use of spa transmissions. This band would used for earth-space transmissio fixed service transmissions (radio a television network satellites), mob service transmissions and space-to-spa transmissions.

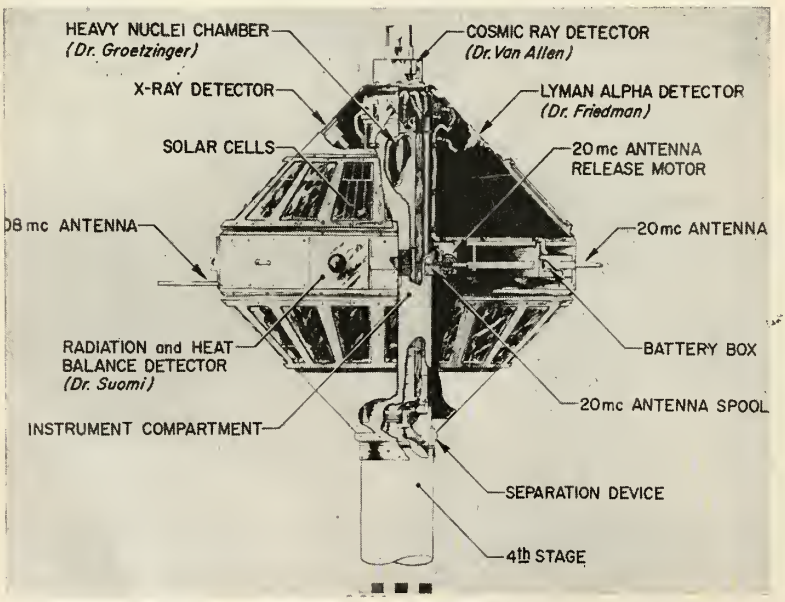
Recognizing that space operatio will demand more frequency bands the future, the U.S. proposal will al request that the following bands al be set aside for space use: 1700-17 mc.; 1825 to 1850 mc.; 2275 to 23 mc.; 8300 to 8400 mc.; 15,150 15,250 mc.; and 31,500 to 31,800 m

The U.S. proposal requests that t latter frequencies be used primarily f ground-to-space station, and space-t space transmissions. The propos would not exclude fixed and mobi service uses of these frequencies pr vided this would not hamper spa vehicles and stations in communicati with each other and the ground.

• **Hopeful outlook**—Since the Sovi Union is the only other space powe what are the possibilities of effecting a international agreement allocating fr quencies for space?

U.S. officials think chances a pretty good.

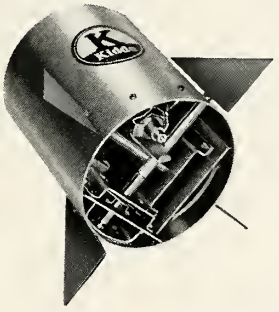
They point out that internation agreements become difficult to effe



PAYLOAD of *Explorer VI* will contain a transmitter powered by solar cells. Plans call for a device to either shut off or control output of the transmitter at will.

Don't miss it!

Be sure to see the working models of the new Kidde hot and cold gas servo systems at the Western National Astronautical Society Exposition of the American Rocket Society at the El Cortez Hotel in San Diego June 9 to 11 Booth 83



Kidde hot and cold gas servo systems can be tailored to fit a wide range of applications. Illustrated above, rocket guidance control. They are low in cost, light in weight. Kidde gas servo systems have low current and gas consumption, have few moving parts, and are extremely reliable. They operate at temperatures exceeding 1600° F.

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only when nations have proprietary terests involved. At this point, no tion has much of a vested interes space.

In 1946 at Atlantic City, the had little difficulty in bringing a an international agreement for quency allocations. Both the Soviet U.S. delegations signed the agreem and it has been kept. The coming the Space Age is the major reason modifying the 1946 agreement.

The pact reached by the ITU comes a multilateral treaty after ra cation by the governments of the m ber nations. And the treaty is bin on those nations signing the agreem

Another point encouraging ITU cials is that the Radio Conference be held in August—the same mo that the Summit Conference is expe to be held. The Russians are expe to be on their best behavior—should sign agreements as non-con versial as the allocation of frequen for space.

Details of *Atlas* Construction Disclosed

WASHINGTON—Details of some the materials and manufacturing m ods involved in production of *A* have been revealed by J. R. Demp vice president of Convair's Astro tics Division, which makes the big

In a recent talk here, Dempsey that thin-gauge tank walls of the mi form the complete frame. He ad that the tank, about 60 feet in le and 10 feet in diameter, has no inte framework and hence must be kept der pressure, like a football, even w it is unfueled.

The material used is a special c rolled austenitic steel (AISI grade 3 produced by Washington Steel Co Washington, Pa., Dempsey disclo It is delivered in coils consisting long flexible bands about one wide. The tank is welded together its thinnest wall section meets a sp fication for minimum tensile stre of about 200,000 psi.

The bulkhead separates two pro lant storage tanks. A domed stair steel bulkhead forms the forward of the tank and a third bulkhead conical shape makes up the aft sect

After welding is completed, tank is pressurized by gas to take wrinkles out of its skin. Pressures less than 10 pounds per square are required in the tanks.

Advantage of the tank const tion, Dempsey said, is that it can converted to other missions witl any change in the basic design or w ing equipment. He denied that pressurization made the missile e vulnerable to damage or destructi

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enate is expected shortly to ap-
e the House-passed four-year ex-
on of the Renegotiation Act,
h expires June 30. The bill omits
stry-backed proposals to broaden
ptions and allow higher profit
s.

At Cape Canaveral, 1500 workers
ing a carpenters' strike against
ractors returned to work in
rests of national defense," al-
gh still supporting the strike. So
no missile firings have been af-
d by the walkout.

Sharp attack on both the Army
-*Hercules* and Air Force *Bomarc*
ceptors has been made by Vice
iral J. T. Hayward, deputy chief
Naval Operations. The $25 billion
defense network is a soon-to-be-
ated Maginot Line, Hayward says,
use of the 15-minute ballistic mis-
warning time. His recommenda-
stop pouring money into a fixed
ing and defense system.

rmy scientist Dr. Ernst Stuhlinger
ves in 1965-70 period nuclear-
ered unmanned ferry may be de-
ped to haul building material,
pment, food, water and oxygen to
ly a base on the moon. Total
ht of space ferry would be 84 tons
a payload capacity of 50 tons,
h would be a detachable landing
cle propelled by hydrogen and
X engines.

The Air Force is acting as execu-
agent for ARPA on *Midas* (missile
nse alarm satellite). Order was
ed in November, 1958. ARPA has
geted $18 million in FY 1960 for
project—an increase of $6 million
n the current fiscal year.

exaco Inc. is moving into the high-
gy fuel R&D field with the acquisi-
of Experiment Incorporated, Rich-
nd, Va. . . . On the West Coast,
Reduction Pacific Co. is building
million LOX, liquid nitrogen and
n plant at Richmond, Calif., with
aily 30-ton capacity . . . Linde
's new 165-ton-a-day LOX and
id nitrogen plant at Pittsburg,
if., began deliveries May 14—a
nth ahead of schedule. The com-
y says the advanced production
e "relieved what could have become
ritical shortage." . . . NASA has
en Callery Chemical a $175,000
tract to evaluate a new rocket pro-
pellant with liquid and solid applications which—if practicable—will permit substantial increases in payload weights.

Improvement of vapor phase deposition of chromium, molybdenum and tungsten is reported by Alloyd Research Corp., Watertown, Mass. Possible electronic industry applications include component coating with high-purity, high-density tungsten to prevent contaminants in base materials from adversely affecting electronic emission characteristics. Thicker "coatings" raises possibility of fabricating thin electronic parts of refractory metals. Heavy coating of tungsten on graphite also may be feasible for improving heat characteristics of rocket nozzles.

Space balloon to probe atmospheric density at 300 miles will be launched soon by Air Force Cambridge Research Center. Boosted by *Arobee* and *Sparrow* rockets, balloon will be ejected in 18-pound package, which will unfold into 9-foot mylar plastic sphere reinforced by dacron threads. Inflation will be accomplished by evaporation of ethyl alcohol followed by capsule discharge of freon gas into plastic struts inside the balloon. System was designed by Arthur D. Little Co.

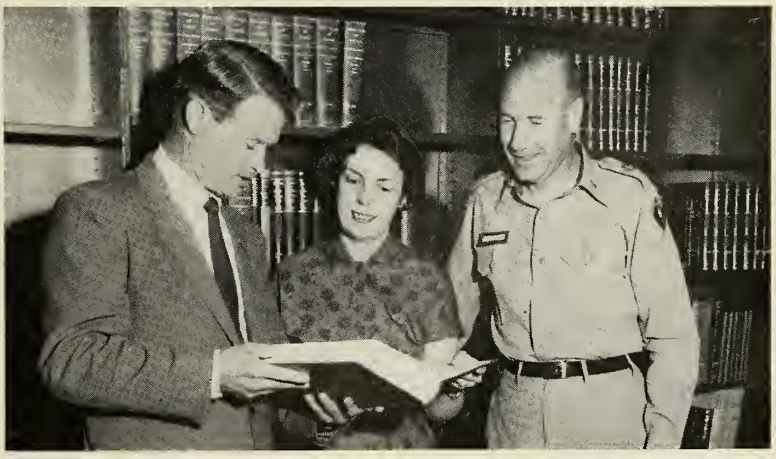
Prime contract has been awarded Marquardt Corp. by Air Force to expand its effort on project *Pluto*—joint AF and AEC feasibility study of nuclear ramjet engines.

Fast tax write-off certification has been granted by the OCDM to Bendix Aviation for missile R&D—60% of $1 million; Hughes Aircraft for electronic systems R&D—65% of $400,000; Lear Inc. for R&D and production of missile components—60% of $1.9 million.

Mergers & Expansions—Royal Industries has acquired Pacific Electronic Controls Corp., Monravia, Calif., potentiometer maker . . . Machlett Laboratories Inc. stockholders and those of Raytheon Inc. have approved merger conditions . . . Hewlett-Packard Co. has initiated $1.9 million in building construction for a planned $2.7 million expansion at Stanford Industrial Park, Palo Alto, Calif. . . . 28% more plant space will be added by Sperry Electronic Tube Division of Sperry Rand at Gainsville, Fla., to expand production of microwave tubes. Employment will be boosted by 30% to more than 800 by mid-1960, the company says . . . Electronic Communications Inc. is building a 150,000-square-foot manufacturing plant at St. Petersburg, Fla.

Russia, says National Bureau of Standards Director Allen V. Astin, is leading the "entire world" in high-temperature development. And equally important in the Missile Gap, Astin says the U.S. is behind the Soviets in industry-wide verification of industrial and scientific instrument calibration. He says Russians have established a network of calibration centers for the mandatory interchange of data about technological components.

Magazines for 'Space Academy'



FIRST MISSILE library, at Army Ordnance Guided Missile School, Redstone Arsenal, gets bound copies of M/R. Executive Editor Clarke Newlon makes the presentation.

SCOUTING THE FRINGE OF SPA

5 manned research vehicle rehearses for first flight

by Erica M. Karr

If all goes according to plan, the *X-15* will have made its first powered flight before the next two months are up. The hybrid rocket-plane, offspring of a nationwide project involving over 300 companies—large and small—recently completed its fourth captive flight test and is expected to undergo a glide-flight landing test within the next two weeks. First space-fringe flight to 100 miles is due "sometime next year," according to prime contractor North American Aviation, Inc.

Primary role of the *X-15* is to get data on actual flight conditions beyond the atmosphere and the effects on man and machine during exit and re-entry. To do the job the vehicle will carry over 1300 pounds of instrumentation involving approximately 600 temperature pickups and 140 pressure pickups.

Minor bugs have been worked out of the system during an extensive ground testing program and the captive flights have proven out all systems except the engine. During these trial runs, the *X-15*, locked under the wing of a B-52, has been under continual surveillance by two television cameras in the mother plane which has taken the manned space bird to 42,000 feet at Mach .8.

The mated combination has been checked out for aerodynamic characteristics while North American's design engineer and test pilot, Scott Crossfield, checked out the control and communications systems from the cockpit during simulated launch.

Although Crossfield will take the 50-foot ship through final flight test phases,

---

NEEDLENOSED *X-15,* being readied for captive flight test under B-52 wing, is fed helium gas which is chilled by passage through liquid nitrogen of minus 320°. Nitrogen, which boils at this temperature, causes ground fog. Chilling gas increases fuel load.

Another Exclusive
Cornell Capa Picture Story

. . . two faces of one man

Air Force Maj. Bob White will probably be the man who will nose the *X-15* in and out of the atmosphere on its first full flight.

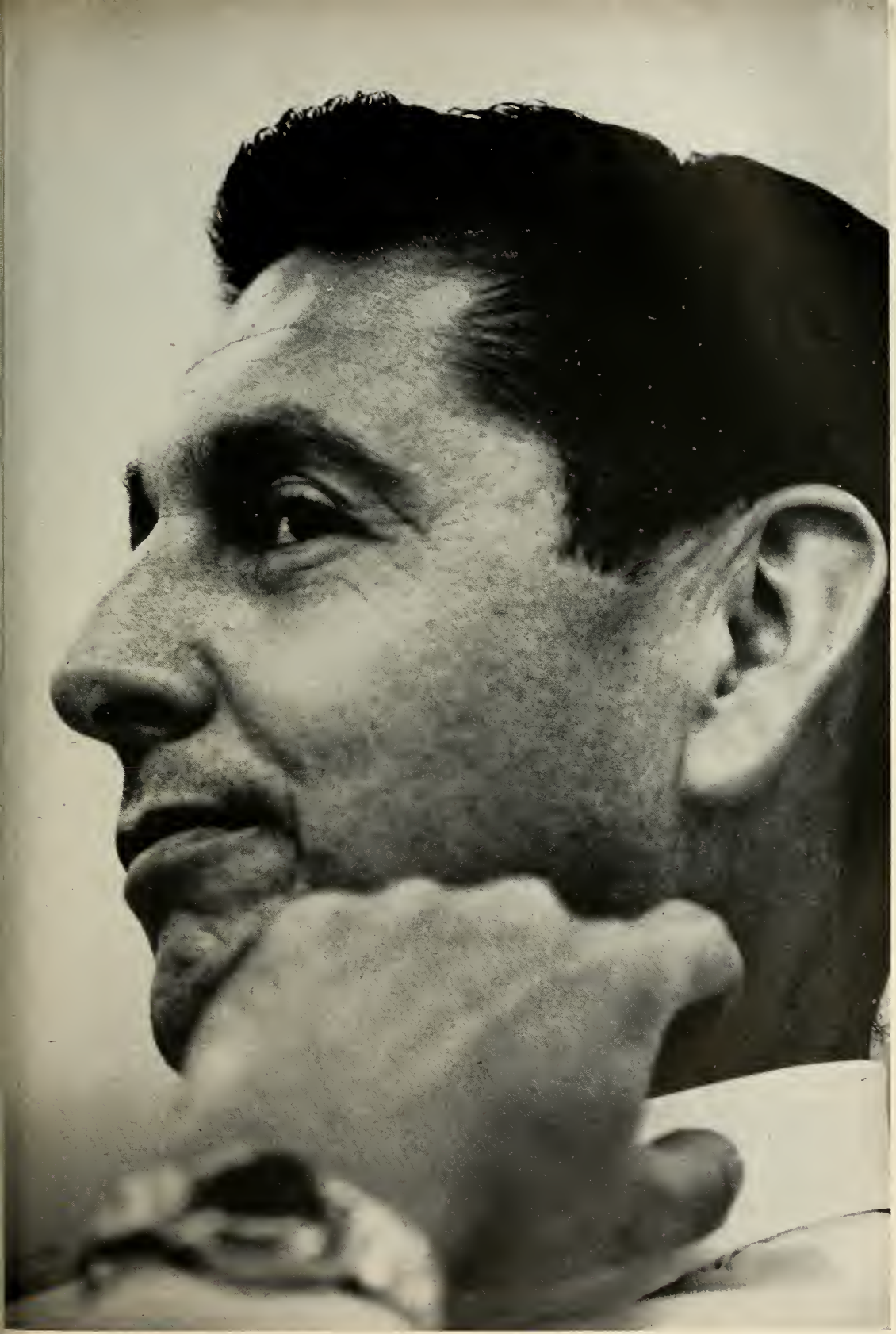
In this unusual account, the camera of Photographer Cornell Capa has caught behind-the-scenes highlights before, during and after a recent captive flight, culmination of the over 3½ years' work to date in bringing the *X-15* to the threshold of proven reliability.

Crossfield, who has lived with the program since its inception, often putting in 100-hour weeks toward its realization, and the *X-15* both will undergo their stiffest test to date in the glide-landing run. Falling vertically with an initial speed of 100 mph, and moving with a ground speed over 400 mph, Crossfield will have about two minutes to test control responses before he tackles the tricky problem of landing.

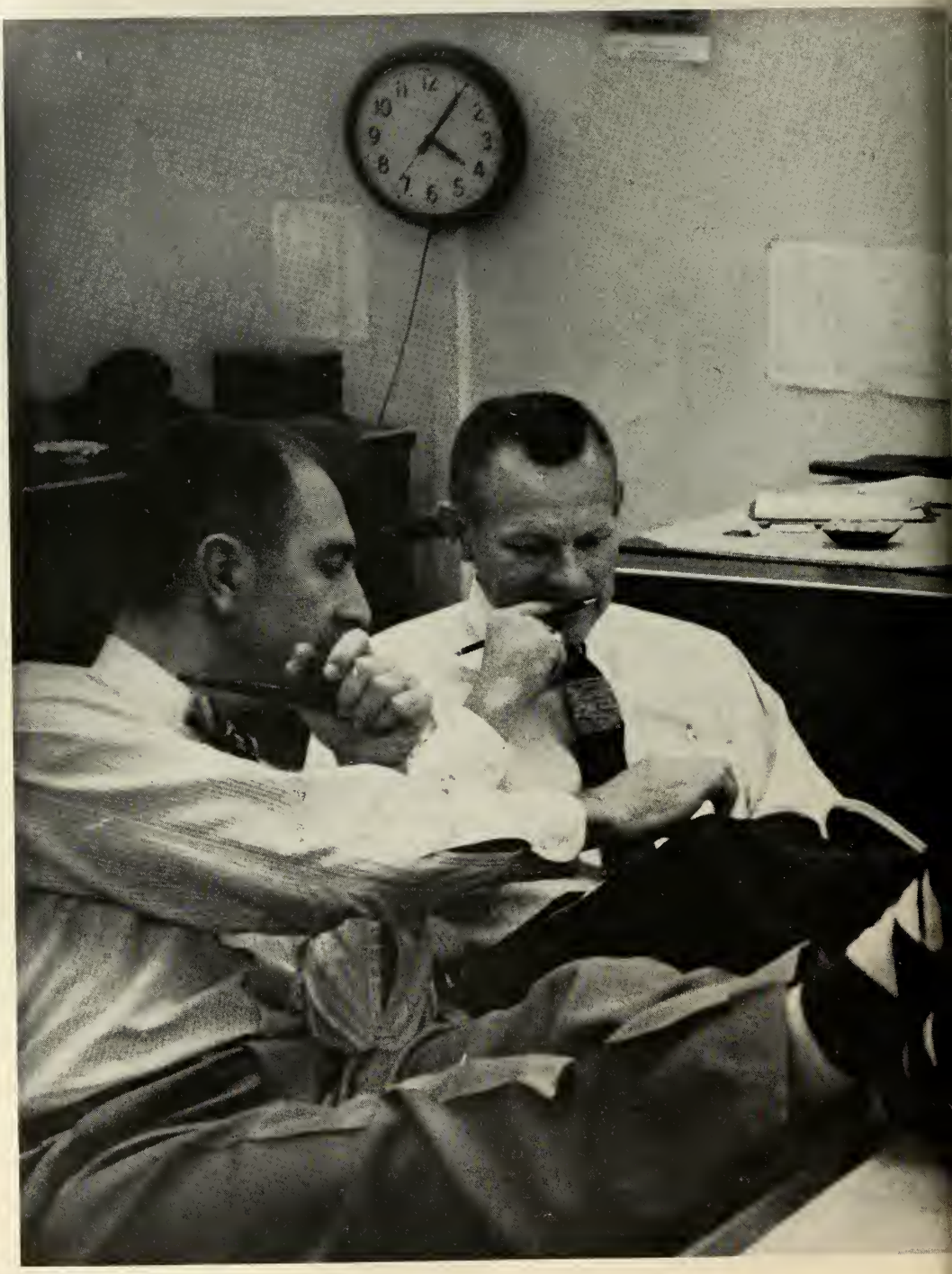
Among major contributors to the program which is expected to cost over $120 million through the third vehicle: Reaction Motors Division of Thiokol Corp. supplies the liquid propellant powerplant which will boost the *X-15* to 4000 mph. Auxiliary power units come from General Electric's Accessory Engine Division. Garrett Corp. makes the liquid nitrogen cooling and pressurization system. Pressurization suit, tested by Crossfield in the captive tests, was developed by a brassiere and girdle manufacturer, the David Clark Co. The nickel alloy—Inconel X—from International Nickel Co. will bring the *X-15* through the high temperatures of re-entry.

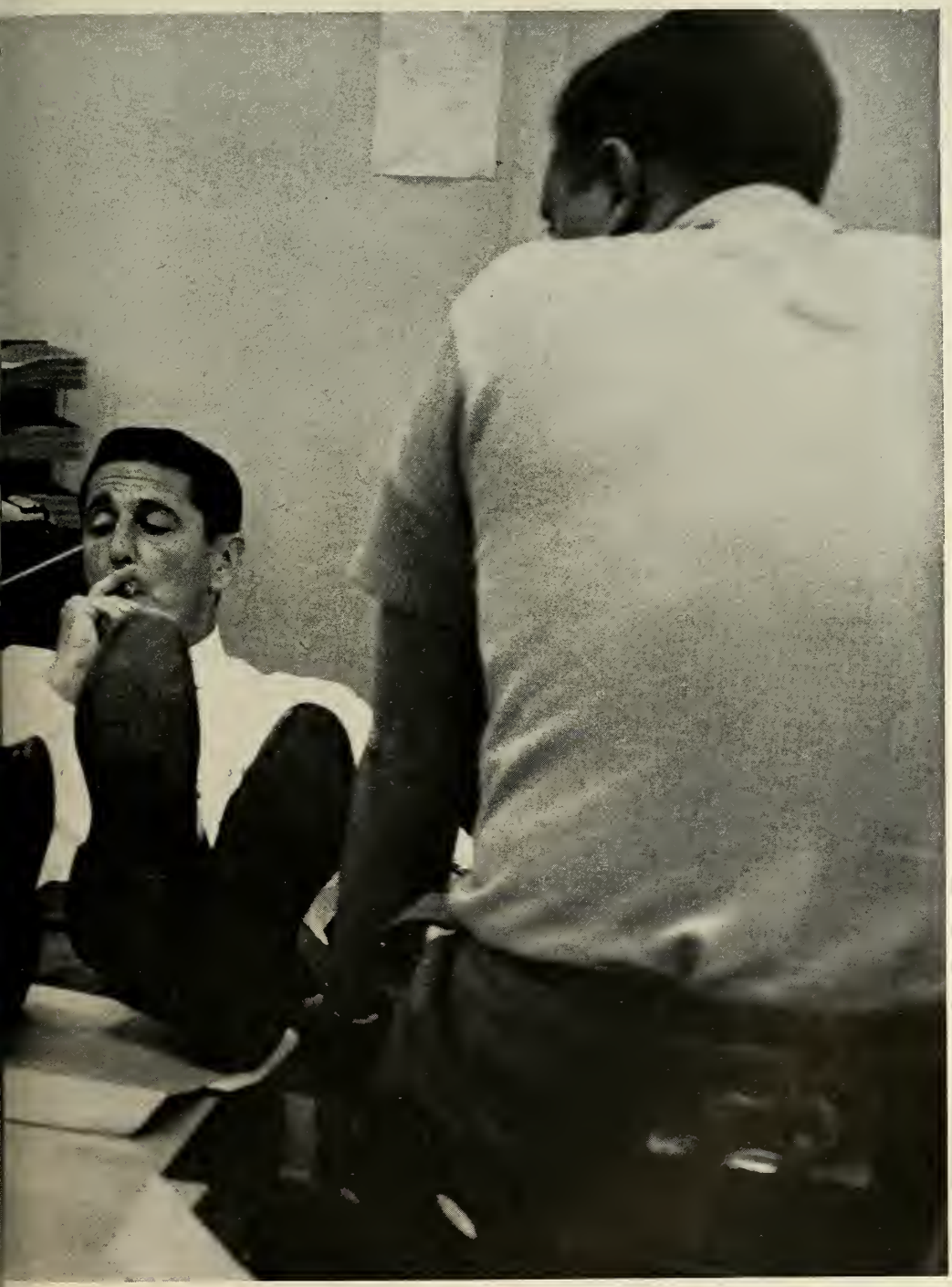
Ballistic rockets for out-of-the-atmosphere control come from Bell Aircraft, while Sperry Gyroscope developed the in-flight electronic indicator system to transmit altitude, speed and angle of attack to the pilot and recording apparatus. Instrumentation, much of it produced by Lear and NASA, will have a temperature environment provided by a system developed at AiResearch Mfg. Co.

DISTORTED FACE of test pilot Scott Crossfield reflects terrific pull of 4 g's forward and 7.33 g's down in *X-15* re-entry simulation. Right: The normal Crossfield face.



. . . Relaxed conference with vital implications





FEET ON DESK, North American's Sam Richter, flight test engineer; Q. C. Harvey, test operations supervisor; Crossfield and Bill Berkowitz, launch panel operator, discuss countdown procedure for new *X-15* test.

TOWER WATCH. Assistant project engineers Raun Robinson and Bud Benner watch captive flight while tuned in on radio with control unit.

***X-15* PILOTS,** present and future, Joe Walker, NASA; AF Capt. Bob White, LCDR Petersen and Scott.

NASA, Air Force and Navy pilots will put *X-15* through paces where NAA's Scott Crossfield leaves off.

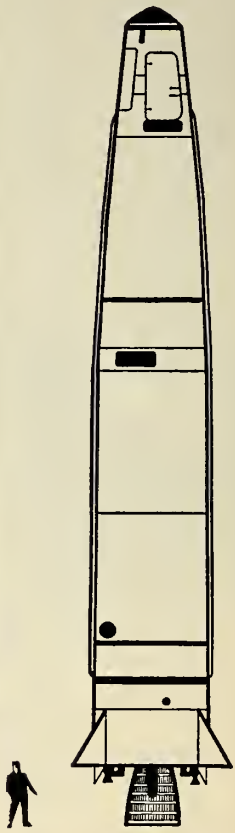
Final checkout on suit and machine, ready for takeoff . . .

The man:

. . . a launch-control specialist in a *Thor* SAC squadron. His instruments report each automatic step in the launching procedure of the big IRBM. U.S. Air Force and Royal Air Force missilemen are receiving *Thor* training side-by-side . . . have readied and fired these missiles within a 20-minute count-down.

The missions:

. . . are many—because of the Douglas *Thor's* versatility. As a highly mobile weapon with atomic capability, it sternly warns potential enemies against aggression. As a powerful and reliable booster, it is playing a leading role in our exploration of outer space with satellites and probes.



The missile:

. . . can destroy targets as far as 1500 miles away within minutes after hostile action is detected. Douglas *Thor* missiles were the first intermediate range ballistic missiles to be deployed overseas. The United Kingdom has announced the delivery of the first *Thors*, for operation by Royal Air Force personnel.

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Simple Solion May Fill Low-Frequency Gap

Very small and lightweight, solion gives high sensitivity, low power input. Here lead wires are welded on integrator.

by Charles D. LaFond

WASHINGTON—The solion, a liquid-state device, is one of the newer additions to the electronic components field providing one more link in the evolution of dynamic circuit elements. Employing ions in solution as a charge carrier, the solion contrasts sharply with vacuum tubes and transistors in which the charges are transported by electrons.

Much research has been devoted to development of solion technology, but the art is still in its infancy with respect to application. So far, the solion has shown some very desirable attributes not now available in either electron tubes or transistors. A rapid summary of some of the virtues of solion units will readily explain why interest is spreading.

• **Strong points**—Solions, for low-frequency use, require low voltage and no power (0.9V dry cell supply and lowest of all devices produced commercially, the 10-15 milliwatts standby). They are highly stable (with some exceptions), long-lived, rugged, light and compact.

They can provide high amplification and circuits free of electrical circuit memory. When they are used as detectors, flows as small as 10^{-5} milliliters/sec. can be indicated and pressures as low as 1 dyne/sq. cm. will get a response.

Finally, they are simple in design, easy to manufacture and uncomplicated in operation.

• **And drawbacks**—Solions also have certain characteristics and limitations which will confine their use. They are restricted to low-frequency applications. They are unique technologically and designers require sound electrochemical knowledge. They are sensitive to temperature change, vibration, and position (these can be anticipated and compensated). Current manufacturing facilities including mass-production machinery are either limited or nonexistent.

• **Description**—The simplest type of solion (the term is generic) is a sealed unit containing two electrodes immersed in an electrolyte—the whole functioning as a diode. Configurations vary with the role. In general, the electrodes are fabricated from platinum or other noble metal. Serving as conductive surfaces only, they are not a part of the electrochemical reaction.

The electrolyte most commonly used is iodine-potassium iodide. It provides a reversible system (redox) wherein there is never a net change in any solution component—only local concentrations vary at the electrodes.

Highly sensitive to low-level stimuli, the solion is most suitable for low-frequency (0-200 cps) applications. Requiring from 0.01 to 0.001 the power required for transistors, research indicates that within its frequency range it may be more efficient than transistors.

Reason for the frequency limitation is the inherently high ratio of the ion mass to that of an electron (in an iodine solution, the ratio is about 233,000:1). On the other hand, since vacuum tubes and transistors are not used at such low frequencies—that is, without burdensome circuitry—the solion fills the gap.

• **History of solion**—The idea of concentration polarization, determined by Nernst in 1904, is a foundation of solion technology. The principle is basic to the consideration of polarography and a primary strut in the theories of electrochemical overvoltage. Basic quantitative theory in these areas has achieved wide dissemination in European technical publications and behind the Iron Curtain.

Dr. D. S. Muzzey, Jr., then of Shell Oil Company, first studied the effects of using an electrode in a solution for acoustic and pressure transducers.

Later studies during World War II at the U.S. Naval Ordnance Laboratory (NOL), Silver Spring, Md., demonstrated the reversibility of an iodine-iodide closed system.

Following proof of feasibility for practical solion units, the Emhart Manufacturing Company of Hartford, Conn., successfully completed a contract for the Navy Bureau of Ordnance to manufacture some small units.

Pioneering in early applications of the solion, National Carbon Company, a division of Union Carbide Corporation, together with Texas Research Associates has been developing a whole line of experimental solion components.

• **Basic principles**—All of the so-called liquid state devices are electrochemical units, and certain common fundamental laws or theories govern the phenomena associated with each. To better understand the function and operation of a solion device, a few of the more dominant concepts should be reviewed.

In a galvanic cell, the voltage measured at the point of zero current flow in an electrode is called reversible potential. Applying an emf with an increasing current to one electrode will eventually cause the measured potential to change from the reversible potential. The amount of this voltage deviation from the reversible potential is the overvoltage; the electrode is considered to be polarized.

Overvoltage is a function of chemical processes at the electrode and can be considered as the result of three different processes: (1) Activation overvoltage is caused by a too-slow chemical reaction; (2) Film overvoltage results from formation of an insoluble film over the electrode surface. Actually the film serves as a resistance in

the circuit and results in a proportional voltage drop; (3) Concentration overvoltage, or concentration polarization, is caused by an electrolytic diffusion rate that is too slow at the surface of the electrode.

In an electrochemical system the rate of diffusion serves as a current limiter since the current flow is proportional to electrode area, salt concentration, and the diffusion coefficient of the cation or anion under consideration. This limit, the diffusion current, is proportional to the concentration of the solution. (Polarography is an analytic technique using this knowledge of specific diffusion currents for different compounds in solution.)

It follows then that to make use of the concentration polarization, the solutions must be affected with an external force in a manner associated with function of the particular solion device; that is, disturb the solution to alter or upset the diffusion layer, or force the flow of different concentrations of solution in juxtaposition about the same electrode.

Finally, two additional phenomena should be discussed. Between a solid surface and a solution there exists a state of electrical imbalance. An "electrical double layer" of ions is distributed along the boundary. Oppositely charged ions are tightly bound to the will move with respect to this surface. The result is a situation similar to a charged parallel plate condenser, although the potential drop perpendicular to the surface is not as sharp as in solid surface, but a few farther away a condenser. The ions in motion have a net charge opposite to that of the fixed ions.

To utilize this phenomenon, capillary tubes can be used to permit a net charge in this second layer significantly high with respect to the rest of the solution. Considering only one tube and providing that electrodes are located at the tube ends, with an applied potential, the fluid will be moved in one direction by a phenomenon known as electro-osmosis.

• **Progress to date**—What has been accomplished so far with solion? Early research at NOL and DRL indicated feasibility of the following: an electrochemical readout integrator, a low-frequency acoustic flow-detector (with logarithmic response and full range of at least 80 db), a micropump, an amplifier (with amplification factor of 300), and product units.

The solion is still considered experimental by the company, which has not yet decided to move to commercial production. High on their list of potentials is their electrical readout integrator. (Samples are available to other companies interested in the present or future use of solions.)

As described by National Carbon Co., the following is a list of anticipated uses for their existing solion components:

• **Solion Electrical Readout Integrator (SERI)**—

(1) Integration of output from tomatic product analyzer to deter necessary input correction.

(2) To sense temperature and duce error signal for correction o put through control circuit.

(3) Very-low-frequency ampl (to dc) for use in control circuits.

(4) Integration of output from vironmental sensors of various for use in routine testing and in term rocket or missile flights.

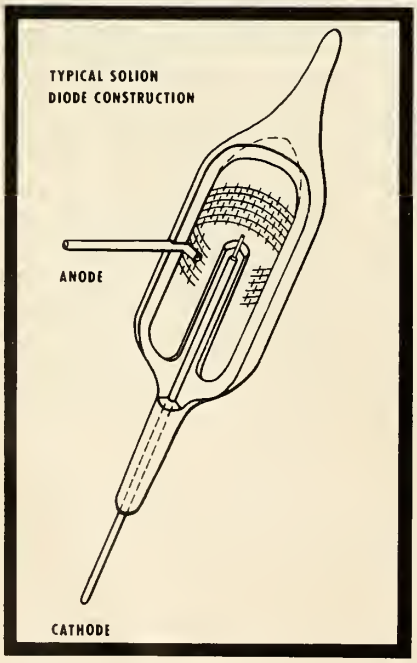
• **Solion Visual Readout Int tor—**

The solion visual readout integ has much larger integral capacity the SERI and the ability to retain integral for several months to an a racy within 5%. This type unit is ently being used to integrate the ou from a microphone in a noise meter.

• **Solion Detectors—**

The solion flow detector prod small electrical currents in respons applied pressure at frequencies bet 0.001 and 200 cps. The functi form of the relation between cu and pressure can be varied over a range by proper electrode config tions. One type of solion detect presently being used experimentall detect low-frequency acoustic signa water. Another type detector is b used in an experimental accelerom

The Emhart Manufacturing Co the first manufacturer for the N has the production know-how for lion fabrication. Company spokes have indicated that it is still too to predict future commercializatio solions.



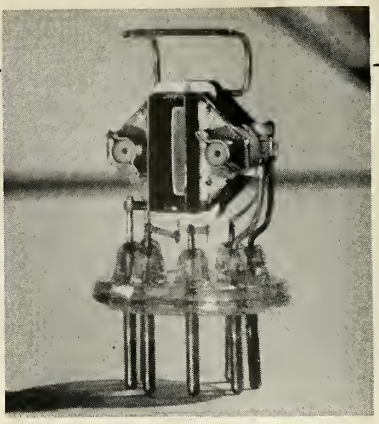
CHARACTERISTICS of solion integrator, left; circuit arrangements employing concept, right.

PROPOSED SOLION CIRCUIT COMPONENTS

DEVICE	FUNCTION	BLOCK DIAGRAM
Diode	Switch, rectifier, clipper	
Pressure Transducer	Converts pressure to voltage—linear function	
Pressure Transducer	Converts pressure to voltage—exponential function	
Osmotic Pressure Transducer	Converts electrical input to pressure output	
Derivative Unit	Converts pressure to voltage—rate function	
Derivative Unit	Output voltage proportional to the derivative of input voltage	
Product Unit	Output voltage proportional to the product of input current and pressure	
Product Unit	Output voltage is proportional to the product of two input currents	
Integrator	Output voltage is proportional to the integral of input current	

Tubes and Transistors: Where Do We Stand?

M/R survey shows that if anyone wins 'battle' it'll be to benefit of entire industry



SYLVANIA's stack tubes combine advantages of glass and ceramic.

by Hal Gettings

WASHINGTON—If anyone wins the le" between tubes and transistors ust be the electronics industry as a e. The development and phenomeprowth of the transistor has served oaden the scope of electronics and nce the state of the art at a faster than ever before. The tube industan thank the transistor for giving kick in its transconductance and ng it make some unprecedented ress of its own.

Tubes have seen many significant ovements made recently. The istor, the ceramic tube, coldode, Sarong, and other innovations served to cut down on many of vacuum tube's shortcomings. Transrs, too, have jumped ahead to new ibilities with the new high-temperagallium-arsenide semiconductors, solid-circuit modules, the erroney-named "molecular electronics," more rigidly controlled production niques.

In spite of the fantastic increase in number of transistor units sold year, the receiving tube has lost ground. Indeed, more tubes are cted to be sold in 1965 than before. The obvious conclusion is the market is expanding at a rate parable to the transistor's growth.

• **Intelligent design**—At the risk of necessarily elaborating on the obs, the only solution to the problem tubes vs. transistors is intelligent ification and design. This seems to he consensus of the industry and rnment representatives, design eners, prime contractors, and conants contacted by M/R editors to lve the problem.

The day may sometime come when engineer can crank all the desired acteristics, application, size, weight, shape of a proposed system into a computer and come up immediately with an answer as to what circuits and components to use.

Until that day, however, this work must be done by man. And for that man to do a satisfactory job on the design he must know and consider many things.

Two facets of this "intelligent" approach seem to have particular merit:

1) All factors must be thoroughly considered before specifying or designing either tubes or transistors into a circuit;

2) Consideration must be given to marriage of the two when advantages can be gained by so doing.

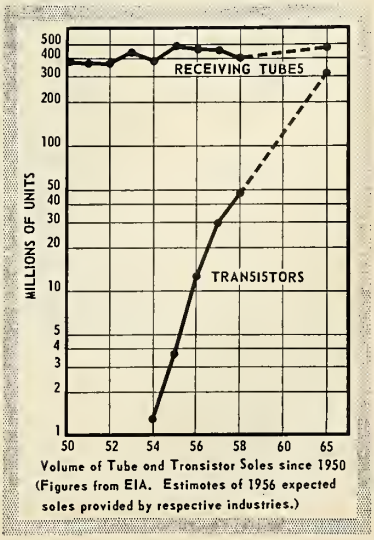
The first point requires that the final decision be made as far down the line as possible. The design engineer who must, in the end, tie the circuit together and make it work, should be given as much freedom as possible in making the choice, subject to other factors in the system or circuit design.

And he, of course, must make his decision based on a thorough study of the problem and the best solution. Ideally, such a man should be entirely objective in his choice; he should have no preconceived notions as to one being better than the other.

• **Hybrid techniques**—Possibly one of the greatest relatively unexplored possibilities is that of using hybrid techniques: designing tube/transistor combinations to take advantage of the best features of each. Some little has been done here—Motorola has a hybrid automobile radio that reportedly is a good basic design—but undoubtedly much more can be accomplished. Such an approach may solve many problems and open up new areas not even considered before.

There are, of course, many applications where nearly everyone agrees that transistors are the answer. Where

GE's solid-state thyratron can switch kilowatts of power in microseconds.



Volume of Tube and Transistor Sales since 1950
(Figures from EIA. Estimates of 1956 expected sales provided by respective industries.)

size and weight and power dissipation requirements are of first importance—and are not overweighed by other factors—then transistors can unquestionably do the job.

They have been proven in computers, battery-powered devices, underwater communication cable amplifiers, dc-dc and dc-ac converters, audio amplifiers, etc., where their obvious advantages make them first choice. Transistors' main selling points—small size, light weight, efficiency—can certainly be used to advantage in today's requirement for things smaller, lighter, and cheaper to build and operate.

Currently, IBM is developing a prototype transistorized SAGE computer under an Air Force contract. This unit will reportedly have seven times the computation capability of the present unit and will be only about 10% its size. Some thought is being given to ultimately transistorizing the entire SAGE installation.

• **Transistorization buys**—In a paper delivered last week at the National Telemetering Conference, Max A. Lowy, Data Control Systems, Inc., made an interesting comparison of identical transistor and vacuum tube 16-band FM/FM telemetry systems.

A condensed summary of his findings are shown in the table. His conclusion is that transistorized systems are more expensive, but this extra money buys reduced volume, reduced weight, better performances, and higher reliability in this particular case.

Other things being equal, the transistor has been and will be the obvious choice between the two for its size, weight, and power advantage. Not ; however, nor in the foreseeable fut can it do everything the tube can It's a mistake to expect it to an greater mistake to try to force it to jobs beyond its capabilities.

Ideally, it would seem that should be able to draw a graph: h are the parameters within which tube is best, here the transistors, ; here either or both. Unfortunately, question is not that simple. Altho frequency, heat, power, radiation, ; any number of other considerati influence the choice between the t the lines cannot be sharply drawn.

Much propaganda has been put by both tube and transistor manu turers. Both are competing for a m ket and their respective claims m be, to a certain extent, subject Consider some of the areas stres by one or the other and see if definite conclusions can be reached

• **Reliability**—So many factors e into considerations of reliability t generalities cannot be easily defi Both tubes and transistors have formed well in rugged applicati where the initial design and packag techniques were good. At the hig temperatures and over wide ranges signal and power levels, tubes defini hold an edge. Under extreme envir ments, transistors are generally c ceded to be better. Especially after initial operating period, transistors sh an exceptional stability over long t periods. Some variation of characte tics has been shown by transistors a relatively long storage.

• **Radiation**—Tube manufactu argue that transistors are inhere much more susceptible to high-ene gamma radiation, and this is t Transistors have been subject to m more radiation testing than tubes, h ever, and more data is available. In dition, the semiconductor makers p out that the tolerance levels of so state devices are as high and someti higher than those of other circuit c ponents and personnel.

• **Noise**—In applications wh noise is an important considerat tubes definitely are the choice. Tran tors have an inherently higher n figure.

• **Size and weight:**—Here the t sistor is indisputably king so long the advantage is not thrown away compensatory or protection circuits.

• **Temperature**—Transistors are more sensitive to temperature variati than tubes and cannot operate at higher temperatures (over 200°) or c wide ranges with reliable stability. P ress is being made in this area, h ever, by such devices as Texas Ins ment's gallium arsenide diode wh operates up to 325°C.

COMPARISON OF IDENTICAL VACUUM TUBE AND TRANSISTOR TELEMETRY SYSTEMS

	Vacuum Tube		Transistor	
	UNIT 1	UNIT 2	UNIT 1	UNIT 2
Total Battery Power (watts)	81	155	10	4.5
Total Volume (cu. in.)	208	375	103	197
Total Weight (lbs.) (incl. battery)	21	29	8	13
Total cost of system (less mtg. base & battery box)	$4315	$6610	$9710	$7805

• **Impedance**—Low-impedance cir-ts definitely favor transistors. High edance (over 200 ohm) requires es. A wide range of both input and put impedance is available with es.

• **Frequency**—Transistors are gen-ly suitable only at the lower fre-ncies. With careful selection and, in e cases, compensation, satisfactory formance may be obtained even up 300 mc. Generally speaking, of rse, power is universely proportional requency.

• **Power dissipation**—The transistor ere, again, the acknowledged leader. ecially in huge computer installa-s, where the cooling load is tremen-s and a cooling equipment break-n could be critical, transistorization rs many advantages. It must be re-nbered, however, that transistor cir-ry must sometimes also be temper-e-regulated and that it is much e sensitive to even relatively slight ations.

• **Voltage**—Tubes are definitely the ice where higher voltages (over v) are used and where the circuit is ect to surges and transients. Where sistors are used under adverse con-ns, some of their advantages must sacrificed for protection of the ipment.

• **Uniformity**—Tubes justly claim ormity and interchangeability as of their significant advantages. nsistor manufacturers admit that ormity of characteristics is hard to ntain. For critical applications, users forced to reject from one-tenth to half of production-run lots. Even elected groups, a 2 to 1 spread in is not unusual.

• **Power**—At the lower frequencies nc and down) tubes and transistors considered about equal. Tubes are e suitable at the higher power rat-. Power transistors sacrifice some antage with cooling measures.

There are perhaps just as many, or e, "tube" men as there are "tran-r" men. The rapid progress of elec-ics leaves no room for engineers or specification writers with prej-es and preconceived notions who there is only one way—theirs—to a job. The industry feels it can't d specifications calling for transis-ing at any price; neither can it d obsolete designs that use tubes because they were good enough last .

The strongest conclusion that can drawn from these "facts" is that ner tubes nor transistors can claim significant overall advantage over other—which goes back to the or-al statement that an intelligent de-n as to which to use must be based ntelligent appraisal of all the factors.

people

Louis N. Ridenour, Jr., vice president and general manager of Lockheed Aircraft Corp.'s Electronics and Avionics Division, died suddenly here last week. Death was from natural causes. He was 47 years old.

Dr. Ridenour had some to Washington to act as chairman of the National Aeronautics and Space Administration's Science Advisory Committee on Navigation, Guidance and Electronics. He presided at the two-day organization meeting.

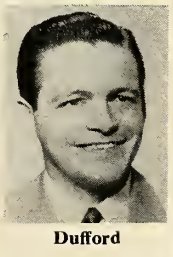
Ridenour

Internationally known for his work in both nuclear physics and electronics, Ridenour was a member of the Air Force's Scientific Advisory Board, heading up the electronics panel. He was first chief scientist of the AF. In 1950-1951, he headed a special committee which surveyed the AF's science and research effort. The report which bears his name was considered responsible for creation of the Air Research & Development Command and the organization of the deputy chief of staff (development). The report is also considered the basis for current attempts to revitalize ARDC.

During World War II, as assistant director of the Radiation Laboratory at Massachusetts Institute of Technology, he was instrumental in development of airborne radar and radar bombing systems. For this work, he received the President's Medal of Merit.

Ridenour was the author of a number of scientific books, as well as many technical and non-technical papers. He was a member of the American Physical Society, the American Association for the Advancement of Science, the Institute of Radio Engineers and the American Rocket Society.

Donald E. Dufford has been named head of applications engineering at Genesys Corp., manufacturers of digital process control computer systems. Dufford earlier was associated with Autonetics, Marquardt Aircraft, and previously the Telecomputing Corp.



Dufford

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

contract awards

NAVY

$11,000,000—**Remington Rand Univac, Div. of Sperry Rand Corp.,** for an advanced computer to be used aboard ship.

$800,000—**FXR, Inc.** Woodside, N.Y., for high-voltage supply for classified AN/SPG-55A shipboard radar set (subcontract from **Sperry Gyroscope Co.**).

$500,000—**Gladding, McBean & Co.,** Los Angeles, for production of ceramic radomes (contract awarded by **Raytheon Mfg. Co.**).

$292,431—**Loewy-Hydropress Div. of Baldwin-Lima-Hamilton Corp.,** New York, for services, labor and material to fabricate and test one complete warhead handling system, prototype for *Talos*.

$136,544—**McKittrick Construction Co.,** Huntington Park, Calif., for construction of technical services engineering facility at Point Mugu.

$64,560—**Hazeltine Corp., Electronics Div.,** Little Neck, L. I., N.Y., for 48 man months of field engineering services in the installation and operation of APA-127 and ASA-23 missile launching accessories in F3H-2 aircraft.

ARMY

$1,038,000—**North American Aviation, Inc., Rocketdyne Div.,** Canoga Park, Calif., for secret item for ARPA.

$977,941—**Cubic Corp.,** San Diego, for research and development for electronic measuring system.

$881,599—**Douglas Aircraft Co.,** for *Nike-Hercules* components, *Nike* repair parts and classified material (three contracts).

$513,248—**Ryan Aeronautical Co.,** San Diego, for research and development for target missile.

$455,237—**Western Electric Co., Inc.,** New York, for *Nike* spare parts and components, (three contracts).

$200,000—**California Institute of Technology,** Pasadena, for research and development to be performed at the Jet Propulsion Laboratory.

$173,238—**Rheem Manufacturing Co.,** Downey, Calif., for design and development work.

$164,703—**Bridgeport Brass Co.,** Riverside, Calif., for inside tube remover.

$125,000—**North American Aviation, Inc., Rocketdyne Div.,** Canoga Park, Calif., for missile spare parts.

$86,900—**Wiancko Engineering Co.,** Pasadena, for data systems components.

$85,809—**Wiancko Engineering Co.,** Pasadena, for eighteen items of oscillators, linearity controls and pressure pickups.

$75,470—**Allegany Instrument Co., Inc.,** Cumberland, Md., for multi-component static test stand.

$73,850—**The Firestone Tire & Rubber Co.,** for engineering services.

$71,174—**Gilfillan Brothers, Inc.,** Los Angeles, for engineering services and *Corporal* missile spare parts (two contracts).

$70,000—**Polytechnic Institute of Brooklyn,** for basic research on performance comparison of various system satellite re-entry.

$59,882—**Dow Chemical Co.,** Tulsa development of procedure for c ing *Jupiter* suction lines and tank

$51,565—**Consolidated Electrodyna Corp.,** Atlanta, for nine items of vanometers, CEC type.

$46,060—**Aerojet-General Corpor** Azusa, Calif., for study-process o hesive bonding.

$44,172—**Preshaw and Thompson,** Van Nuys, Calif., for spare parts.

AIR FORCE

$3,000,000—**International Business chines Corp., Military Products** for components of the AN/A bomb navigational system used o B-52G.

$2,500,000—**Melpar, Inc.,** Falls Ch Va., for flight simulators and re equipment.

$1,742,500—**General Electric Co.,** J son City, N.Y., for component automatic flight control systems the F-105D and the F-105E.

$470,000—**Curtiss-Wright Corp.,** S Barbara, Calif., for aerial t drones, launch rail adapters and equipment of the *GAR-8* missile.

$391,000—**Consolidated Systems C subsidiary of Consolidated Electr namics Corp.,** for propellant-uti tion-system exercisers to be use *Atlas* program at Vandenberg (subcontracts from RCA).

$233,099—**Block Associates, Inc.,** C bridge, Mass., for research dire toward the design, development testing of small rocketborne spe radiometer systems.

$233,000—**Leeds & Northrup Co.,** P delphia, for precision potentiom and accessories.

$215,000—**Gladding, McBean &** Los Angeles, for further research development on ceramic radome

$196,706—**Convair Div. of General namics Corp.,** San Diego, for pr PR 59-1131, SA #7. This is an crease in funds.

$76,631—**J. W. Frecker, Inc.,** Pittsbu for equatorial table to be use support of project 5177.

$76,253—**Consolidated Controls C** Bethel, Conn., for miscellan switch-pressure consolidated contr

$63,000—**Kuthe Labs., Inc.,** Newark, N for electron tubes.

$53,669—**Olin Mathieson Chemical C Chemicals Div.,** Baltimore, for n tethyl hydrazine for testing and ev ation in support of Weapon Sys 138A.

$53,667—**Tektronix, Inc.,** Portland, O for miscellaneous oscilloscopes, amplifiers, tubes and standard spa

$51,525—**Westinghouse Electric Corp.,** mira, N.Y., for miscellaneous elec tubes.

$40,243—**Grand Central Rocket Co.,** lands, Calif., for rocket motors t used in support of Project 7850.

The Marquardt Corporation's AST Div. has been awarded a prime cont for expansion of its efforts on Pr *Pluto*. (Amount not disclosed).

opulsion engineering

Vary the thrust to get optimum performance from a nuclear ket, say C. J. Wang, G. W. Anthony and H. R. Lawrence of Space nology Laboratories in the current (May) *ARS Journal*. They the thrust should be variable, and programmed, to take advant- of partial molecular dissociation and then recombination of gase- propellants. Dissociation drastically increases specific heat which gives an I_{sp} greater than normally expected by using the square- -of-temperature law.

There is "an optimum way of programming the thrust to fulfill articular mission" of a nuclear rocket, the Space Technology a says. Dissociation characteristics of gaseous propellants now idered potential nuclear rocket propellants are such that this ossible: At a given temperature, decrease the operating pressure, consequently the thrust, and you will increase the specific impulse.

'Energy communicated to the rocket at burnout of the total gy injected into the rocket system" is a maximum under their d theory. Wang, Anthony and Lawrence discuss a case where ciation of the gaseous propellant was taken into consideration, a program of varying thrust was designed. Their conclusion: e optimum thrust program results in much better performance the usual constant thrust operation."

Another unconventional propellant situation is analyzed in detail he same *ARS Journal*. A team formerly with Food Machinery Chemical outlines all the important physical properties for the gen tetroxide-nitric oxide system from minus 100°F to 0°F. This ne of the systems most highly touted to become an important izer in prepackaged, storable liquid engines. Presented for the time: Vapor pressure, density, viscosity, surface tension. To e the data more valuable to designers of rockets and equipment, as taken on *commercial grades* of the mixed oxides. For workers want it, Donat B. Brice, now with The Fluor Corp., and man Fishman, now at Stanford Research Institute, include de- d drawings of their apparatus.

Trapped free radicals will give up all their secrets, or at least National Bureau of Standards will make every effort to force them at the Fourth International Symposium on Free Radical Stabili- on late this summer. Theme of the meeting, to be held Aug. Sept. 2 at NBS in Washington, is "Trapped Radicals at Low Tem- atures." Deadline for preregistration forms was March 25, however . 1 is the deadline for getting a short communication into the ussion part of the program. Nature of these brief reports should ent to Dr. A. M. Bass, National Bureau of Standards, Wash- n 25, D.C. So far, the program includes tours of NBS labora- s participating in the free radical work, and these discussion cs: Low-Temperature Chemistry, Method of Production of pped Radicals and Physical Properties of Radical-Trapping Solids, tity and Concentrations of Trapped Radicals, Future Trends in e Radical Stabilization, Interaction of Free Radicals with Solids.

Shape of refractory plugs influences their durability, a Russian ker notes. Not a surprising conclusion, but I. Sh. Shvartsman ls this out in detail in *Ogneupory*, Vol. 22, No. 4. He says longi- nal cracks develop in screw plugs with thick-walled spherical parts. s does not happen in the case of bolt plugs with thinner, lighter erical parts, he reports.

Low-cost corrosion inhibitor for refrigeration and cooling systems be sodium molybdate, now that the price barrier has been crashed research. Sodium molybdate always has been an excellent— expensive—corrosion inhibitor in these systems. Climax Molyb- um chemists now say it can be mixed with very small amounts orthophosphate to achieve full inhibiting action. Result: A ller amount goes a longer way.

letters

Optik Goes to London

To the Editor:

I have read with much interest in the April 27 issue of M/R the proposal for standardization of velocity terms in astronautics and the suggestion of "Optik" put forward by Major Mannix.

This is to advise you that at the IAF Congress to be held in London in September this year, I will raise this important question.

Meanwhile, I have prepared a memorandum which I intend to discuss with Mr. (Andrew G.) Haley, President of IAF, at the end of this month, when he will be in Rome.

Glauco Partel
President
Terminology and Classification
Committee
IAF
Rome, Italy

Praise for Optik

To the Editor:

Cheers for Major William C. Mannix on his new proposal for a space velocity unit in the April 27 issue! Already the aerodynamicists have almost captured the field with their thoroughly incongruous unit of "Mach Number" based on the velocity of sound in air. This term obviously has no meaning in free space and worst of all is utterly dependent on the temperature of the medium. While its use is admittedly of value in aerodynamic problems, it is practically worthless in kinematic analyses or ballistic problems.

We should act quickly and energetically to adopt a unit of absolute velocity to alleviate somewhat the hopeless situation which has developed in English-speaking countries in regard to dimensional units.

For example, engineers use a horrible conglomeration of units, horsepower, slugs, foot-pounds, pounds-force, pounds-mass, BTUs, cu. yards, rods, miles, yards, acres, sq. mi., knots, kilowatts, gals. (both U.S. and British), feet/sec., m.p.h., Mach No., tons (short and long), barrels, fathoms, bushels, etc., ad infinitum, ad nauseum.

The wonder is that British and U.S. engineers have ever been able to develop anything with such a hodge-podge of units. How many hours are wasted in tedious conversions?

Scientists generally use the metric system although even here the physicist uses the centimeter-gram-second system while the meteorologist uses the meter-kilogram-second system. There are other variations in use. Perhaps the engineers and the scientists would work more closely together if their systems of units were made more nearly uniform.

Take the matter of charts used for navigation and aerial flight. Long distances are usually in nautical miles, short distances in yards, heights in feet, and depths in fathoms. The units now employed for velocity are as numerous as there are combinations of units for length and time.

The unit of "Optik" proposed by Major Mannix fulfills the requirements suggested by Messrs. A. Hurlick and E. B. Bell at the Second Symposium on Hypervelocity Impact Effects in 1957. It is referenced to a natural phenomenon and one as nearly absolute in a quantitative sense as is possible. Furthermore, the subdivision of making the basic unit one-millionth of the velocity of light permits the statement of all velocities in convenient quantities.

The name itself, "Optik," is a natural. Since the world is becoming smaller and people closer together, because of the increase in velocity of travel, the word should be one easily recognizable in all languages.

Certainly the final "k" is a small concession to be ask of English-speaking peoples. Names such as "Roemer" should be avoided. This name is at home only in German-speaking countries. With all due respect, the choice of "Roentgen" for a unit of ionizing effect of high-energy radiation is unfortunate because of the difficulty of pronunciation by non-German-speaking peoples. In sum, the name "Optik" not only denotes its origin, but should be easily transcribed and pronounced in any language on earth.

I vote loudly for the adoption of the term and its definition by all engineering and scientific professions.

John O. F. Dorsett,
Captain, USN (Ret.),
Johns Hopkins University,
Operation Research Office

'Furlong per Fortnight'

To the Editor:

In response to the recent proposal by Major William C. Mannix (M/R, April 27), concerning a unit of velocity, I suggest that we bestir ourselves now, while on the threshold of the Space Age, and adopt a different unit for velocity. It is the "furlong per fortnight." Although the unit appears to be somewhat illogical, I believe it will satisfy our need for having the largest of everything (somewhat lacking in satellites of late).

Thus, our satellites will be reported as having an orbital velocity of 47,000,000 furlongs per fortnight as compared to the insignificant 18,000 mph.

John R. Osborn
1409 Center Street
Lafayette, Ind.

'Back to Newton'?

To the Editor:

In connection with the April 27 c
(Dr. Edward Teller proposes test of
stein Theory), it would be quite a
able, for everyone who likes to i
tigate so-called "relativistic theories,"
to study quite carefully the book of
Georges de Bothezat, "Back to New
(available in libraries).

Prof. Bothezat, formerly of Princ
University, a great scientist, mathe
tician, author of many books and
ventor, may give *the proper directio*
evaluating the *fallacies* of relativity th

Victor A. Ivanoff,
Research Engineer
524 E. 5th Street
New York 9, N.Y.

Lunar Bases

To the Editor:

I have just read the April 20
of M/R and note on page 48 a refer
to articles written by Dr. Castrucci
the "strategic advantages of lunar b
and on lunar power supplies using
energy. I am very much interested
obtaining copies of these articles
would appreciate any information
could offer as to how I might o
copies and/or references to where
articles appeared.

L. Reiffel
Director of Physics Resear
Armour Research Foundat
Illinois Institute of Techn
Chicago

Stock Slip

To the Editor:

In your May 25 issue, part o
article on missile financing said th
firm obtaining equity capital from
SBIC is required "to buy stock in
SBIC up to 2 per cent of the loa
$50,000, whichever is less."

The law reads that a borrowing
pany must purchase stock in the
from 2 to 5 per cent, depending
the amount of capital it borrows.
SBIC not using Government funds f
financing may issue such stock wi
repurchase option for the borrowe

I hope you will include a corre
of this error in a subsequent issue, c
wise missile firms might be under
apprehension as to Small Business
ministration financial policies and
lations.

Arthur Hachten
Director
Office of Information
Small Business Administra

viet affairs

by Dr. Albert Parry

In what patents can we find descriptions of fuels needed in ketry? Who in the world is making a carburetor for a certain fuel? What metal alloy is necessary for this or that machine that the machine or a vital part of it would work well under n conditions? Man should be able to get quick and complete wers to such questions by just telephoning a central office where ecial machine would have the solutions to all the problems which e been solved anywhere on earth. The need for such an "inform- n machine," to be built on the latest findings and inventions in tronics, is discussed at length in *Izvestia* by Professor L. enmakher.

He points out that the limit of human absorption can be reached a man if he reads 12 hours a day for 50 years at the speed of words per second, finally totaling 18,000 books of 300 pages n. Yet the already-accumulated printed works of mankind are e than 50 million titles. Patents registered in all the world's ntries exceed 5 million. The world's annual output of books and nals is nearly 200,000 titles. Scientific, engineering and technical rmation on hand is growing at a terrific rate, thanks to the in- ant work of the world's 500,000 scientists and many millions engineers and technicians.

The world's treasury of all this information is "more valuable n any reserves of gold, diamonds, or uranium," the Soviet pro- or declares. The problem of its proper utilization is far more plex than any problem of ore mining, he continues. Scientists adays know more and more about their steadily narrowing cialties, and "the ever-expanding terminology of these narrow ls separates experts of adjacent fields even more than any such sion can be caused by foreign languages."

The Soviet scientist proposes that in the future whatever gets ted be simultaneously processed electronically into capsules for new information machine. The Soviets must lead the world once e, by being first to build this information machine, the Russian fessor insists. He writes: "If the creation of ordinary writing and invention of the printing press served as the foundation of contemporary civilization, then the future invention of what may called machine writing will be characteristic of the epoch of mmunism."

Steps necessary for the creation of such a machine were dis- sed recently at a nationwide Soviet conference on problems of chine linguistics, attended by Russia's outstanding specialists in tronics, mathematics and languages. Present also were a few ntists from Red China and Czechoslovakia who read reports on chine linguistics in their countries. In giving details of this con- nce, L. Voronkova in the Moscow *Trud* makes it clear that ingrad was chosen as the site of the conference because that is fast becoming the Red empire's foremost center of such erimentation. She claims that the world's first subdivision of thematical linguistics and experimental laboratory of machine nslation were established at the Philology Department of the Uni- sity of Leningrad.

The laboratory is now working to evolve 17 systems which the ssians define as "alogorhythms," and among which the Soviet ntists have already included the Indonesian, Burmese, Arabic l other Oriental languages. The inclusion of these and other tern tongues for machine translation and "information machine" erimentation shows Moscow's conviction that the time is not far when scientists of the Orient will increasingly contribute to the rld's storehouse of modern knowledge.

west coast industry

by Fred S. Hunter

In this initial-conscious age, Lockheed hopes its selection of name for the new Lockheed Electronics and Avionics Divis (LEAD) turns out to be prophetic. It may well be.

At the annual meeting of shareholders, Chairman Robert E. Gr said Lockheed was starting the new electronics enterprise with modest capital outlay. It is spending approximately $400,000 in furbishing the former Constellation subassembly plant in southe Los Angeles for a headquarters and manufacturing facility. Lockhe already owned the property.

Gross also said the division will grow "slowly and soundly." this writing, the payroll numbers 27 persons. The employment p jection is for 450 by the end of this year.

In its first year, Lockheed's Missile Systems Division had sa of $7.2 million, but, barring a windfall, LEAD's first-year revent will be substantially less. In 1954, the new missile division, th located wholly at Van Nuys, was given a head start by the trans of the *X-7* test vehicle program from the California division. LEA is starting from scratch, with no diversions from other divisions, a its primary objective right now is to establish its capabilities.

Initially, Lockheed is preparing 163,000 square feet of a to plant area of approximately 380,000 square feet for occupancy the new electronics division. New walls have been installed to sl off engineering, manufacturing, shipping and receiving and oth areas. "They're moveable—we can expand in any direction," s Russell C. Galbraith, the former director of financial operatic for the California division, who came over to fill the No. 2 execut post as assistant general manager of LEAD.

The plant—first occupied temporarily during World War II the production of P-38 assemblies and then, after a lapse of 10 yea purchased in 1955 to expedite Super Constellation subassembly wo —is to be a permanent manufacturing facility for LEAD. H quarters here for the general office and engineering staffs will temporary. Lockheed has its eye on a site in the Newport Bea area, where it plans a new facility specially designed to house t administrative and engineering staffs.

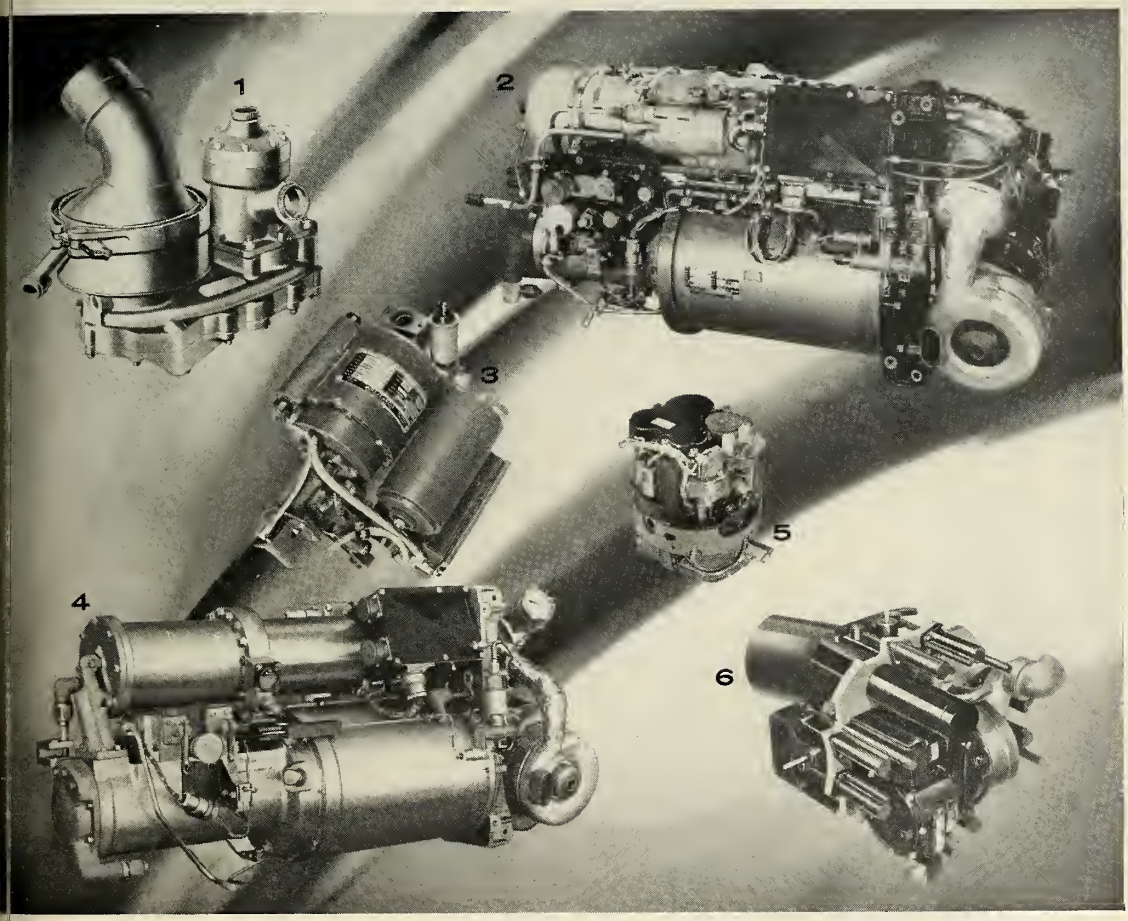
Lockheed is in the hardware business in all its divisions a LEAD will be no exception. This means it will be striving for co petence in the production of systems. Its first efforts will be in strumentation and subsystems useful principally for military systen but it will also investigate the possibilities of entering industrial a commercial markets. "We have no aspirations in the consumer fiel said Stephen J. Jatras, acting director of marketing.

Lockheed has started on the job of staffing the new divisi across the board—engineering, manufacturing, administrative. "W must have men who stand at the top of their fields," said K. Kiddoo, who worked on personnel procurement for Lockheed wh it established its missile division and is now doing the same thi for the new electronics division.

Some of the key jobs will be filled by people drawn from oth divisions of the company, but others will come from outside. "It w depend upon where we find the capabilities we require," said Howa S. Hagen, director of industrial relations.

By June 15, Lockheed expects to have procured a number of t people it needs. By the same time, it will be ready to start movi in some of its machines. It will then be in a position to step to the production development stage.

DELIVERED—thousands of missile APUs



olid propellant—hydraulic output **2.** *Liquid propellant—hydraulic and electric output* **3.** *Solid propellant—electric and mechanical drive output*
4. *Liquid propellant—hydraulic and electric output* **5.** *Solid propellant—hydraulic and electric output*
6. *Solid propellant—hydraulic, electric and steering outputs*

Research has designed, developed, nufactured and delivered thousands o missile accessory power units. Ex- mely reliable and lightweight, these rious solid and liquid monopropel- t APUs are completely self-sustain- within the missile system. Designed minimum space and weight require- nts, they are built to withstand high loading and severe temperature e remes.

The several units pictured above provide hydraulic, electrical and/or steering surface control depending on the customer's requirement. Delivered horsepower ranges from 1.2 to 35 h.p. over hot gas operating durations from 30 seconds to 20 minutes. Electrical regulation is maintained as closely as ±½%. A significant advance in missile APUs is unit #6 pictured above. This package represents the first integrated hydraulic and electrical power unit providing a steering surface actuation system.

These tailored systems utilize the extensive hardware experience and complete laboratory, test and production facilities of AiResearch needed for quick and efficient quantity production of complex APU systems. AiResearch is the world's largest and most experienced manufacturer of lightweight turbomachinery—the key component of its APU systems. Your inquiries are invited.

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Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

when and where

JUNE

Institute of Radio Engineers' Professional Group on Microwave Theory & Techniques, National Symposium, Harvard University Cambridge, Mass., June 1-3.

Armed Forces Communications and Electronics Association, 13th National Convention, Sheraton Park Hotel, Washington, D.C., June 3-5.

Institute of Radio Engineers' Professional Group on Production Techniques, Third National Conference, Villa Hotel, San Mateo, Calif., June 4-5.

The Pennsylvania State University's Missiles System Engineering Seminar, University Park, June 7-13.

Aero Club of Michigan, Industry Missile and Space Conference, Sheraton-Cadillac Hotel, Detroit, June 8-9.

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

American Society of Mechanical Engineers, Semiannual Meeting, Chase-Park Plaza Hotel, St. Louis, June 14-18.

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

Michigan Aeronautics and Space Association, Industry Missile and Space Conference, Sheraton-Cadillac Hotel, Detroit, June 16-17.

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

Institute of the Aeronautical Sciences, National Summer Meeting, Ambassador Hotel, Los Angeles, June 16-19.

Institute for Practical Research on Operations, The University of Connecticut, Storrs, June 21-July 3.

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

Nuclear Industry Division, Instrument Society of America, Second National Symposium, Idaho Falls, Idaho, June 24-26.

Institute of Radio Engineers' Professional Group on Military Electronics, Third National Convention on Military Electronics, Sheraton Park Hotel, Washington, D.C., June 29-July 1.

Pennsylvania State University, Summer Seminar on Plastics—Its Mechanical Properties, Design and Applications, University Park, June 29-July 3.

JULY

Tenth Annual Basic Statistical Quality Institute, University of Connecticut, Storrs, July 12-24.

Radio Technical Commission for Aeronautics and Los Angeles Section of the Institute of Radio Engineers, Third Biennial Joint Meeting, Ambassador Hotel, Los Angeles, July 16-17.

Second Annual Institute on Missile Technology, Chief of Research and Development, U.S. Army, University of Connecticut, Storrs, July 26-Aug. 7.

The Denver Research Institute of the University of Denver, 6th Annual Symposium on Computers and Data Processing, Stanley Hotel, Estes Park, Colo., July 30-31.

AUGUST

Institute of Investigation of Biological Sciences, sponsored by Air Force Office of Scientific Research-Aeromedical Div., World Health Organization and United Nations Educational, Scientific and Cultural Organization, Montevideo, Uruguay, Aug. 2-7.

William Frederick Durand Centennial Conference, Problems of Hypersonic and Space Flight, Stanford University, Stanford, Calif., Aug. 5-7.

Institute of Radio Engineers, Western Electronic Show & Convention, Cow Palace, San Francisco, Aug. 18-21.

International Astronautical Federation, 10th Annual Congress, Church House, Westminster, London, Aug. 31-Sept. 5.

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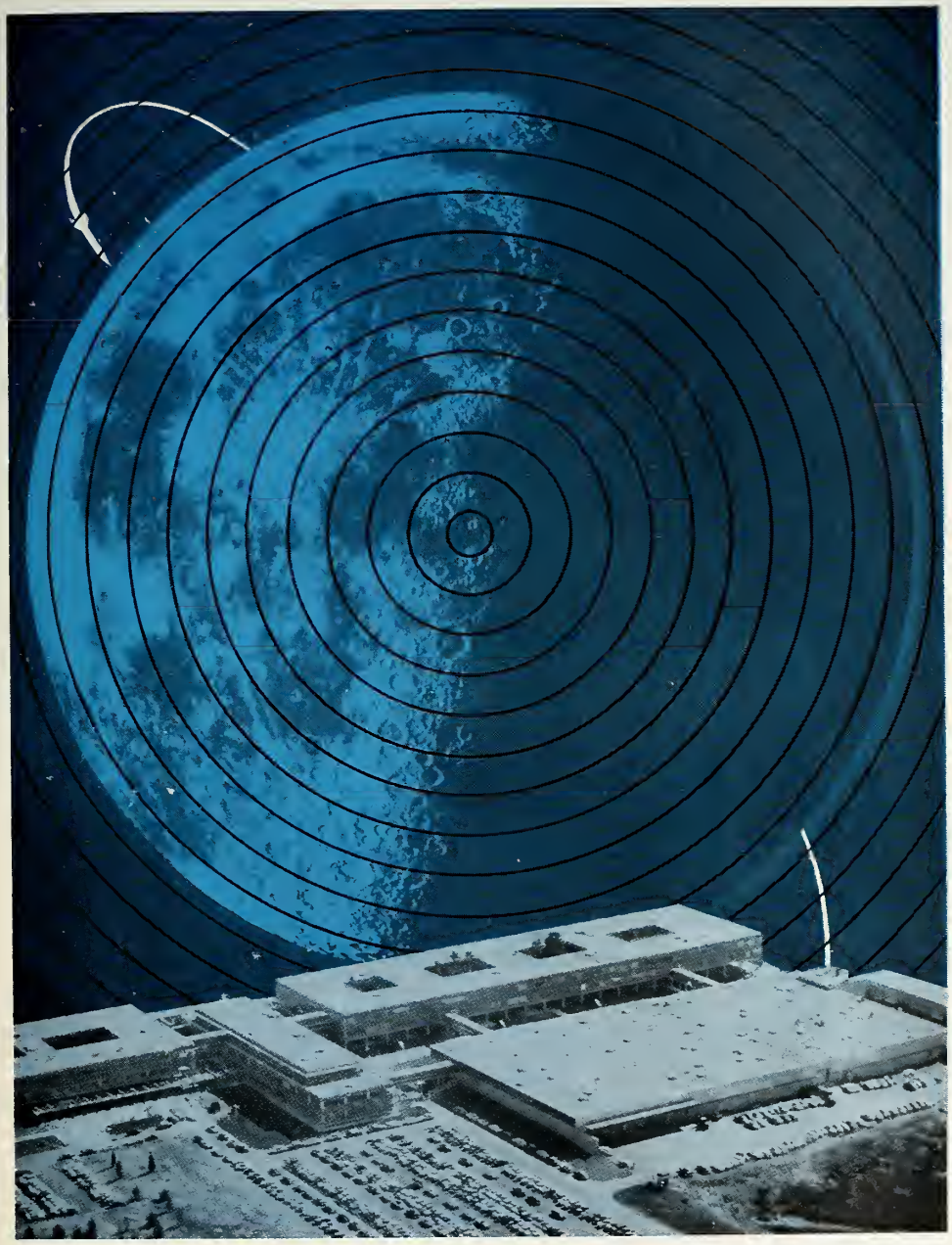

Space age research gets a new headquarters—One of the largest and best-equipped research facilities in the nation is the new 16-million-dollar Avco Research Center at Wilmington, Massachusetts. Here, research and development in space age technology is already being conducted In areas ranging from missile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

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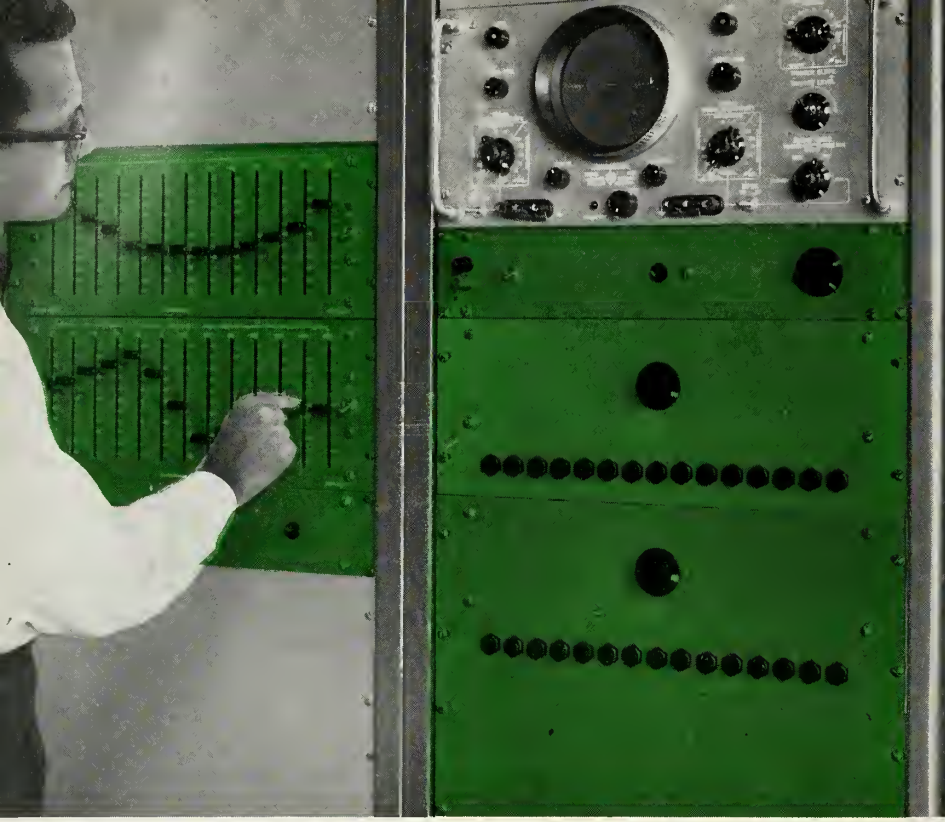

ESD-20
Spectral Densi
Equalizer
(left panel)
allows rapid, accurate equalization of vibration and high-intensity sound systems for random testing. Adjustments can be made during testing at any vibration level.

ASD-20
Spectral Densi
Analyzer
(right panel)
generates a continuous power spectral density plot of a random wave vibration signal for display on a cathode ray oscilloscope.

Ling announces a major breakthrough in random wave equalization and contr

New Spectral Density Equalizer/Analyzer System

...for continuous and parallel observation and control of test spectrum in vibration and acoustic testing programs

Announcing another Ling first—the new Spectral Density Equalizer/Analyzer System! This new system allows *continuous, parallel* observation and control of the entire spectrum of energy distribution during random wave vibration or high-intensity sound testing.

The Ling ESD-20/ASD-20 System reduces peak and notch filter set-ups...eliminates tedious adjustments for system response uniformity...makes continuous, accurate equalization possible at any vibration level.

In the Ling Spectral Density System, the random source output is divided into 26 frequency bands—each independently controlled by a simple vertical attenuator. Outputs from all 26 bands are rapidly and sequentially sampled and displayed on a cathode ray oscilloscope to provide the operator with a continuous view of the spectrum during the test. This new equalization system may be added to existing random wave vibration test systems...or incorporated in any new Ling random wave system. Available *only* from Ling Electronics.

5 Major advantages of new Ling ESD-20/ASD-20 Syst

1 **FASTER**—Reduces set-up time to a few
2 **MORE ACCURATE**—Permits continuous, observation and control of entire spect Load shifts during test can be detected corrected immediately.
3 **BETTER EQUALIZATION**—Compensates a non-linearities in specimen or system co
4 **EASIER TO OPERATE**—Operator has cont picture of shaker vibration spectrum on o ...makes corrections with simple level adjustments of filter attenuators.
5 **BETTER SPECIMEN PROTECTION**—New L system prevents over stress of specime set-up stages.

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