

JULY 13, 1959



HONEST JOHN IN ITALY

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

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AN AMERICAN AVIATION PUBLICATION



STEPS IN THE RACE TO OUTER SPACE

Nuclear Rocketship

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

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

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

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

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

Inertial navigation systems will play an increasing role in the exploration of outer space. **ARMA**, now providing such systems for the Air Force ATLAS ICBM, will be in the vanguard of the race to outer space. **ARMA** . . . Garden City, N.Y. A Division of American Bosch Arma Corp.

AMERICAN BOSCH ARMA CORPORATION

Where can Rubberized Fabric save for you?



Need strength, flexibility and portability in one lightweight material? Goodyear Rubberized Fabric may be your answer.

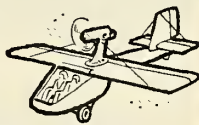
INFLATABLE, PORTABLE

Air Mat Fabric provides excellent insulation against heat, cold, vibration. Ideal for personnel shelters, portable scaffolding, shock cushioning. Beams made of this unique rubber-coated inflatable material have highest strength-to-weight ratio known.



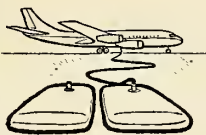
INFLATOPLANE

—another ingenious application of Air Mat Fabric. Pilot simply unfolds it, inflates it—and *flies away!* Do your plans call for a lightweight structural material that can be moved easily, occupies a bare minimum of storage space, can be erected quickly?



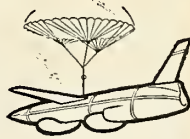
LOOK! COLLAPSIBLE FUEL TANKS

that unroll like a rug—can be set up, filled and pumping 45 minutes after delivery. Eliminates need for bulky, hard-to-handle metal drums. Designed for use wherever temporary or emergency storage of gasoline, oil, water—any bulk liquid—is required.



WANT TO BRING A MISSILE BACK?

Goodyear Recovery Bags—made of tough, rubberized fabric—fold into test missiles, inflate on way down to cushion ground impact. Saves the missile for firing another day, eliminates cost and weight of electronically operated conventional landing gear.



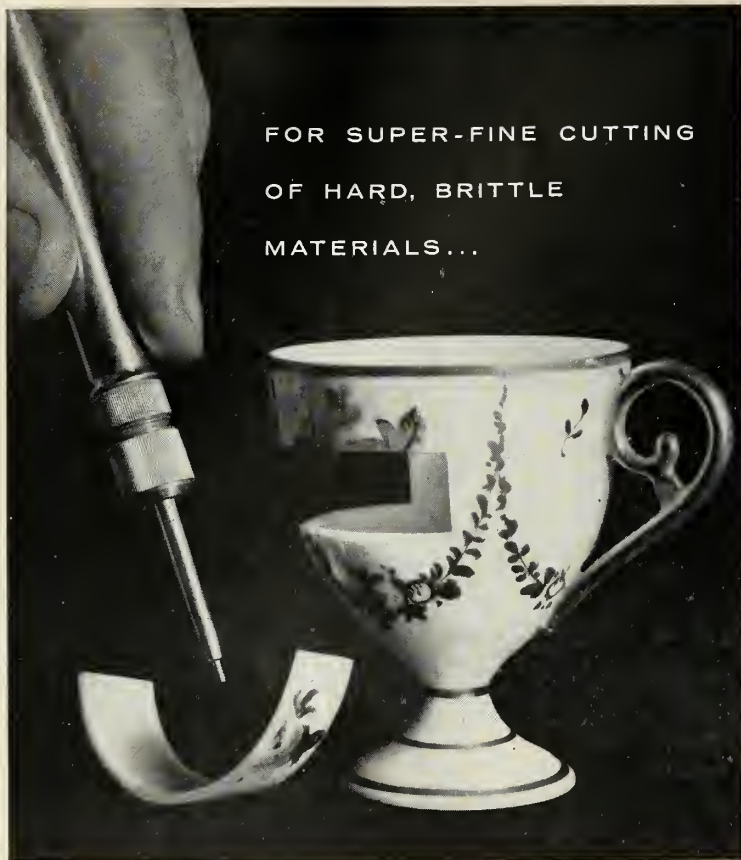
FOR DETAILED INFORMATION on rubberized fabric—and how it can save for you—write Goodyear, Aviation Products Division, Akron 16, Ohio, or Los Angeles 54, California.

AVIATION PRODUCTS BY

GOOD YEAR

Inflatoplane—T. M. Goodyear Aircraft Corporation, Akron 15, Ohio

RE AIRCRAFT LAND ON GOODYEAR TIRES, WHEELS AND BRAKES THAN ON ANY OTHER KIND
iles and rockets, July 13, 1959



FOR SUPER-FINE CUTTING
OF HARD, BRITTLE
MATERIALS...

THE *S.S. White* Industrial Airbrasive Unit

We don't recommend slicing up the family's fine Limoge China, but this does illustrate the precisely controlled cutting action of the S. S. White Airbrasive Unit. Note how clean the edge is, and how the delicate ceramic decoration is unharmed.

The secret of the Airbrasive is an accurate stream of non-toxic abrasive, gas-propelled through a small, easy-to-use nozzle. The result is a completely *cool* and *shockless* cutting or abrading of even the most fragile hard materials.

Airbrasive has amazing flexibility of operation in the lab or on an automated production line. Use the same tool to frost a large area or to make a cut as fine as .008"!...printed circuits...shaping and drilling of germanium and other crystals...deburring fine needles...cleaning off oxide coatings...wire-stripping potentiometers...engraving glass, minerals, ceramics. Jobs that were previously thought impossible are now being done.

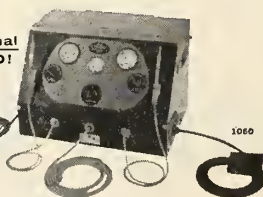


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Model D!

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missiles and rockets, July 13, 19

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS



COVER: the *Honest John* is now in the hands of Italian NATO troops. U.S. soldiers remain in that country to operate two *Corporal* battalions (see p. 15).



BOSTON area is booming with plants like these, especially along Route 128, the "Golden Industrial Semicircle." M/R survey of dramatic growth begins on p. 12.



CHECKING electronic equipment of the new Armstrong Whitworth *Flutter Dart*, a British rocket test vehicle for investigating aircraft wing flutter (p. 18).



PRINTED circuit's original artwork is checked by a Ryan technician. An M/R survey shows big advances in technique (p. 22).

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Zippered nose cone cover foils moisture, dust, abrasion

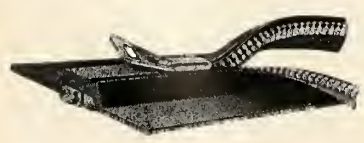
To protect the polished finish of missile nose cones from assembly to countdown, B.F. Goodrich fabricated unique zippered "all-weather" Nose Cone Covers for Avco's Research and Advanced Development Division.

Made from neoprene coated nylon fabric, this shipping cover has non-rigid neoprene ribs and spacers that keep it from riding down on the cone. Special B.F. Goodrich Pressure Sealing Zippers provide easy access and removal—yet seal positively against dust, dirt, grime, damaging impact.

B.F. Goodrich was asked to engineer this special project because of its widely-known ability to manufacture coated

fabrics to any shape or size—as in aircraft baggage pants. In addition, the space-saving B.F. Goodrich Zipper—used widely for air ducts, inspection ports, access doors, and aileron gap seals—withstands any pressure up to the maximum strength of the zipper itself. And it, too, can be fitted to complex contours.

Tricky sealing problems like this one are just part of today's work at B.F. Goodrich. Next time you have such a problem and need an answer—fast—write or call B.F. Goodrich Aviation Products, a division of The B.F. Goodrich Company, Dept. MR-79, Akron, Ohio.



B.F. Goodrich *aviation products*

Washington Countdown

IN THE PENTAGON

A Lockheed *Polaris* . . .

is expected to be launched from a surface ship sometime within the next six weeks. The launching from a tube aboard the *Polaris* Test Ship Observation Island in the Atlantic probably will be preceded by the launching of a *Polaris* from a sea motion simulator at Cape Canaveral.

. . .

Meantime, wider use for *Polaris* . . .

is being stressed by Navy officials—apparently with an eye to hit at AF proposals to incorporate the *Polaris* system in SAC. Navy officials note *Polaris* subs will be able to perform patrol and ASW jobs while on station. Also, they plan to be able to launch *Polarises* from surface ships such as the new nuclear-powered cruiser Long Beach.

. . .

Two new Army missiles . . .

Davy Crockett and Convair's *Red Eye*, are reported being sought by the British Army. Both are light nuclear-warhead hurling weapons designed for the use of troops in the field.

. . .

A top-level Air Force committee . . .

is studying ways to tighten up the weapon system concept of management. The committee is particularly looking for ways to improve programming and possibly slow down the rotation of project officers.

. . .

Curtailed of operations . . .

at the sizable U.S. missile tracking base on Fernando Noronha Island off Brazil is reported to be in the works. Reason: Not enough data collected to justify the high cost.

. . .

Pentagon R&E Director Herbert York...

is trying to avoid some of the inter-service knife play that helped undercut onetime Missile Czar William Holaday. The ex-czar had only one military adviser representing all three services. York has appointed one military adviser from each service.

ON CAPITOL HILL

A major public airing . . .

of repeated delays in the nuclear-powered aircraft program is the goal of the Joint Atomic Energy Research Subcommittee's forthcoming hearings. The two-day open hearings—first on the ANP program since it began more than a decade ago—are expected to start about July 22. Subcommittee members are expected to charge the Administration with setting back three years the development of a nuclear-powered aircraft—a potential principal carrier of ALBM's.

. . .

The Hébert Subcommittee . . .

has called in a team of experts to compile results of its questionnaire poll of retired military and Federal civilian officials employed by defense contractors. Results are expected to begin to show up when the subcommittee calls in a parade of ex-military brass later this month.

. . .

The Martin Mace-B . . .

is now expected to survive the congressional ax after all. Language in the Senate version of the defense appropriations bill would permit the Air Force to get new funds for *Mace* under a general money transfer clause permitting the switching of money from other projects. The House probably will go along.

. . .

AT NASA

Little Joe, the poor man's *Atlas* . . .

will be tested later this month at NASA's Wallops Island Test Center. *Little Joe*, which costs a sixth as much as an *Atlas*, is a cluster of six solid-propellant rockets capable of boosting a Project *Mercury* man-in-space capsule to a speed of about 4000-miles an hour for testing escape equipment.

AROUND TOWN

Some of the reports . . .

that are being passed as the "latest" in the nation's capital:

. . . Congressional Democrats are feeling the pinch of Democratic Advisory Committee demands for billions more for defense.

. . . The French are planning to build a huge missile range—probably in French West Africa.

. . . Some top Pentagon officers are warning that development of manned space vehicles is a life-or-death race with Russia.

A UNIQUE APPROACH TO INFRARED GUIDANCE

This precision spherometer measures a unique material developed at Hughes for infrared guidance. It can measure the curvature of the dome's surface to an accuracy of 10^{-6} meters. The material tested is unique in that it is completely opaque in the visible region, yet transmits very well in the infrared. First application of this material to military equipment requirements was carried out at Hughes.

This project is just one of the advanced studies in all phases of radar, inertial and infrared guidance currently underway at Hughes Research & Development Laboratories.

Assignments in missile guidance now open include:

Physicists to conduct Radiation Detector Studies

E.E.'s for Experimental Circuit Design

E.E.'s for IR Systems Studies

E.E.'s for Servo Analysis and Simulation

Optical Designers

The salary structure for the above positions reflects the advanced nature of the assignments. Please inquire by writing directly Dr. Allen Puckett, Assoc. Director, Hughes Systems Development Laboratories.

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Industry Countdown

All signs continue to point . . .

to **Boeing** as winner of the *Dyna-Soar* contract despite Air Force decision to delay making award. Indications are that the "further studies of various aspects of the program" announced by Air Force involve strong political pressure for greater spreading out of the big money package—particularly to firms that have suffered cutbacks in other programs.

STRUCTURES

France is cutting off . . .

production of **Sud Aviation 4200** and **4500** ground-to-ground missiles and concentrating on development of a ground-to-ground ballistic missile. Work will be done at Sud's Cannes plant. Sud also is researching a strategic ballistic missile to be developed by SEREB.

Raytheon Hawks . . .

will be in large-scale production shortly. Assembly of the Army's operational anti-aircraft missile will begin late in the summer at the Red River Arsenal, Texarkana, where major components will be shipped from all over the nation. Guidance packages will come from **Raytheon's** Andover, Mass., plant; solid-fueled motors from **Aerojet-General's** Sacramento facility; frames from **Northrop Aircraft**, Anaheim; warhead from Iowa Ordnance Depot; and missile shipping containers from the **Williamson Co.**, Madison, Ind.

Production of advanced Terriers . . .

is under way at the **Convair**-operated Naval Industrial Reserve Ordnance Plant at Pomona, Calif. The new solid two-stage *Terriers* will be a major weapon in the Navy's missile arsenal. The new guided missile frigate *Dewey* will get it first.

Air Force now setting up . . .

precision calibration laboratories at many of its bases. About \$6 million has been allocated for equipment and contracts have been let. Aim is for 168 of the labs ultimately. They will be utilized chiefly for maintaining accuracy of measurement for extremely close-tolerance missile components.

Under \$2 million AF contract . . .

Lockheed Aircraft will build four 1400-mph F-104 jet fighters as missile target drones.

Navy interest in explosive forming . . .

of refractory metals is increasing. BuAer has awarded **Chromalloy Corp.** substantial contract to develop new techniques and practices in producing complicated shapes.

ELECTRONICS

Missile site survey unit . . .

is being formed by the Air Force at Orlando AFB to establish exact location of ICBM, IRBM and space vehicle launching. Data will be used to increase accuracy of plotting trajectories—and aid in predicting missile impact.

Funding for Midas and Sentry . . .

in Fiscal 1960 is now set. AF is putting \$19.1 million into *Midas* ballistic missile early warning satellite and \$4.45 million into *Sentry* recon satellite. *Midas* facilities are to be situated in remote area of the United Kingdom. **Convair Atlas** boosters will be used to put both systems in orbit.

PROPULSION

Avco Lycoming Division has won . . .

\$6 million **Aerojet-General** contract to make second and third stage *Minuteman* motor chambers, and chambers for *Polaris*.

Theoretical studies . . .

of propellant sloshing and dynamic propellant tank deformation is part of a \$1 million research assignment handed the Army Ordnance Missile Command by NASA. AOMC also will investigate celestial mechanics of missile and space vehicle trajectories and ablation effects.

More monopropellant research . . .

will be undertaken by **Stauffer Chemical**. Navy contract for \$100,000 is third awarded the company by the services in high-energy field.

SPACE MEDICINE

Two-man space cabin simulator . . .

will be delivered in October to the new \$10 million Air Force School of Aviation Medicine at Brooks AFB, San Antonio. School personnel are now in process of moving from old quarters across town at Randolph AFB.



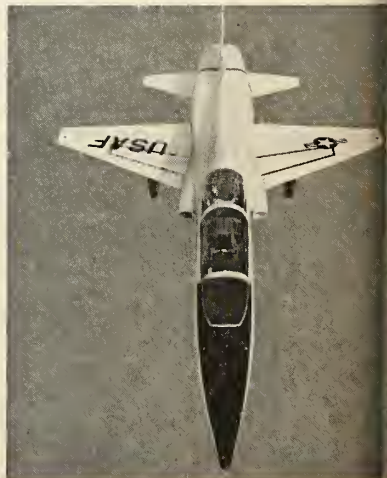
...NEWS IS HAPPENING AT NORTHROP

AIRBORNE...NEW USAF T-38 TALON!

The T-38 Talon fills a vital requirement of the Air Training Command. It is a lightweight, low-cost aircraft in which our new generation of space age airmen can safely master the art of supersonic flight.

Pioneering a new Northrop family of economical manned aircraft for the space age, the Talon is a direct result of teamwork between Norair and suppliers. This T-38 Team that made the trainer a reality is now producing it under USAF contract at Hawthorne, California. Soon to follow is the N-156F multi-purpose fighter, American-designed for our free-world allies.

The T-38 Talon stands as the latest airborne evidence of Norair capability and production know-how. Norair's creative management further adds to the accomplishment by trimming production costs with methods that include PACE — the unique Performance And Cost Evaluation program; new and superior quality controls; and Norair-conceived, years-ahead production techniques.



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NASA Braces To Fight Cuts

by Paul Means

WASHINGTON—Two Russian dogs named Snowflake and Daring, and an unnamed Russian rabbit could be NASA's best bet to rejuvenate Congress's flagging interest in space research.

The latest Soviet space experiment came after the House lopped \$68 million from NASA's supplemental FY '59 and FY '60 budgets, just before the Senate began its deliberations.

Congress leaped into action after Russians orbited *Sputnik I* in November of 1957, claiming that the administration had been stingy with research money. NASA hopes the latest Russian experiment will sharply shake Congress out of its current lethargy.

What could happen—If the space agency has to make do with \$68 million less, it may mean that the whole NASA schedule for space research, including Project *Mercury's* attempt to send the first man in space, will have to be revised.

Schedules for the big space boosters, such as *Vega*, *Centaur*, *Nova*, and *Saturn*, will have to be lengthened so they do not run out of money. The firings of *Vega*, expected in late 1960, may have to be delayed.

The cut will also mean less space research, without the insurance in some form of back-up shots in case the experiment fails.

One-two punch — The House's tight-fist on money for space research culminated last week when the House Appropriations Committee voted to cut the NASA budgets by \$500,000. Committee member Representative Thomas (D-Tex.) defended the move by stating that NASA had more money than it could spend wisely.

Adding to space agency's woes was a technical point of order raised by H. R. Gross (R-Ia.) which eliminated what was left of the \$48,354,000 in the NASA FY '59 supplemental. Gross pointed out that a recently passed law forbids the House to appropriate money for NASA not "hereafter" authorized by the House Committee on Sciences and Astronautics. The committee had authorized the supplemental before the passage of

the law (P. L. 8645) not "hereafter" as the language of the law requires.

The House then salvaged \$18 million of Project *Mercury* R&D funds in the supplemental by tacking them onto FY '60 budget. Lost was \$22,725,000 for construction and equipment, bringing the total loss to the NASA budget to \$68 million.

NASA officials are confident that the House space committee will either re-authorize the funds kicked out by Rep. Gross's technicality, or amend P. L. 8645 so that the words "hereafter" do not apply to their earlier authorization of this money.

• **The real danger**—What they are worried about is the \$45,500,000 cut, which NASA Administrator Dr. Glen-nan warns will cripple efforts to establish U.S. leadership in space research.

NASA spokesmen point out that the \$35,145,000 cut in R&D funding would severely cut into the funds available for the development of advanced systems, such as *Vega*, *Centaur*, *Nova*, and *Saturn*. They point out that \$310 million of the \$354 million NASA asked for in R&D money goes for fixed costs required to continue contractual obligations started in 1959, and to pay for operational costs of already ordered items.

To cut \$35,145,000 out of the R&D budget—as the House has done—leaves NASA with only \$8,305,500 for development of advanced systems. In order to re-balance the program, NASA scientists say they will have to delete scheduled space flights, slow down procurement of equipment for these flights, and delay important elements of the NASA flight program.

Such delays could have international repercussions as well as denying NASA scientists needed knowledge. The cut in Project *Mercury* R&D funds in the FY '59 supplemental by 10% will mean according to NASA spokesmen, a slowing down of the program, thereby jeopardizing the U.S.'s chance of being the first nation to place man in orbital space flight.

Other important programs, such as the meteorological and communications satellite programs, and nuclear engine research under Project *Rover*, may have to be delayed.

• **Tracking threatened** — Another cut NASA officials say the program

cannot sustain is the \$7,325,000 slash in the construction and equipment allocation. If the funds trimmed out by Rep. Gross's technicality are included, NASA's construction and equipment budget would be cut by \$30,050,000.

Much of this money is needed for the Project *Mercury* tracking range, without which the astronauts cannot take their first ride into space. The importance of the new tracking facilities was underlined recently when NASA attempted to award the contract for construction and integration of the range by July 1.

The House cut also reduced the NASA proposed salaries and expenses budget by \$3,030,000, which will deny the use of 100 new employees to the space agency. Many of the new NASA employees were to man the expanded worldwide tracking and observation installations.

• **Rock bottom**—NASA had pretty well wrung its budget dry before submitting it to Congress. In fact, some observers had felt that the NASA budget was too small, and that the space agency would have to ask for more funds later in the year. (See M/R, April 20, page 24.) Dr. Glen-nan admitted as much in criticizing the House cut, stating that the Space Agency had learned that money for certain projects did not go as far as its had originally seemed it would.

NASA hopes for restorations of the House cuts rest first with the Senate Appropriations Committee, chair-manned by Sen. Carl Hayden (D-Ariz.) If the space agency gets by this hurdle, then action by the Senate as a whole and the Senate-House Conference will decide the budget's fate.

• **Friend in power**—A strong ally on the side of the space agency should be Senate Democratic Leader Lyndon Johnson of Texas, chairman of the Senate Aeronautical and Space Sciences Committee, which has already authorized the NASA budget in total, and an advocate of space research since the launching of *Sputnik I*.

If the majority leader can swing the support of his party, then prospects are good that the NASA budget cuts will be restored. In the House, the Republicans in general favored the total NASA budget and the Democrats favored the cuts.

Boston—'Hub' of Space Research

*Tracing the development of a proud city's leadership
in many fields of the space race; a look at the famous
'Golden Semicircle'—second in a series of regional surveys*

by William E. Howard

BOSTON—Few cities physically show the nation's explosive growth in missile/space manufacturing and research more than Boston—a culturally endowed community which long ago laid claim to being the "Hub of the Universe," and where industry today is in the process of making this extravagant boast come true.

The entire metropolitan area is rapidly emerging as the country's leading research center. Scientists in hundreds of laboratories are conceiving and putting together the sophisticated offensive and defensive weapons of tomorrow. And they are responsible for much of the brainwork going into astronautic systems which one day will enable man to explore space.

Nowhere is the magnitude of this fast-expanding activity more eye-arrestingly apparent than along a 65-mile stretch of superhighway skirting the city from north to south in a great arc. Down the length of this busy artery there already are more than 200 modern plants employing more than 30,000 persons.

This is Route 128—Boston's "Golden Industrial Semicircle." Less than 10 years ago, it did not exist. Route 128 was only a country road meandering through meadows and woods, and connecting suburbs.

Where there were pig farms only a few years ago, today "industrial parks" are springing up. Once-quiet towns are the scene of more development. Industrial brick and mortar investment alone is estimated at \$140 million. The entire complex—including business and home development—is valued at more than \$500 million, and the figure is increasing.

Land values have shot up from

\$1000 an acre to as much as \$26,000—with plenty of takers. All segments of industry are represented in this booming new area. But electronics is far and away the most predominant.

• **Key to growth**—Originally, conversion of Route 128 into an expressway was conceived primarily as a way to divert traffic around Boston's congested streets. But by the time it was opened in 1951, developers were already making plans to attract new industry. Electronics manufacturers just beginning to open a vast new market were the first to see its advantages for locating efficient one-story plants—with the highway affording quick transportation and the historic old towns offering pleasant living.

Gravitation to Route 128 was slow at first. Then research took over, mushrooming the growth of the electronics industry and forcing the construction of new plant facilities. Concurrently, in the early '50's, came the development of missiles with their heavy electronic requirements.

One after the other, **Raytheon Mfg. Co.**, **CBS Electronics**, **Sylvania Electric**, **Avco** and other well-known companies moved out to the new highway.

Paving the way for the migration were such real estate developers as the Boston firms of Cabot, Cabot & Forbes and R. M. Bradley & Co. They were the ones that launched the industrial park plan, offering in one package a ready-prepared site, well-located, and engineering facilities to design any type of plant for purchase or lease. Both firms are credited with contributing greatly to the orderly development of Route 128.

Thirteen industrial parks are either completed or in final construction stages and three more are being started.

These parks are absorbing, too, an ever-mounting number of new jobs spawned in the dawning of the Space Age.

Illustrative of what is happening is the case of **Itek Corp.** Founded just two years ago by four Boston University engineers, Itek now has more than 700 employees engaged in classified work. In quick order it bought a plant on 128, leased 65,000 square feet of the **Waltham Watch Co.** works and is planning to build a laboratory on a 43-acre site in Lexington near the "Golden Semicircle." Incidentally, Itek also has a new West Coast installation.

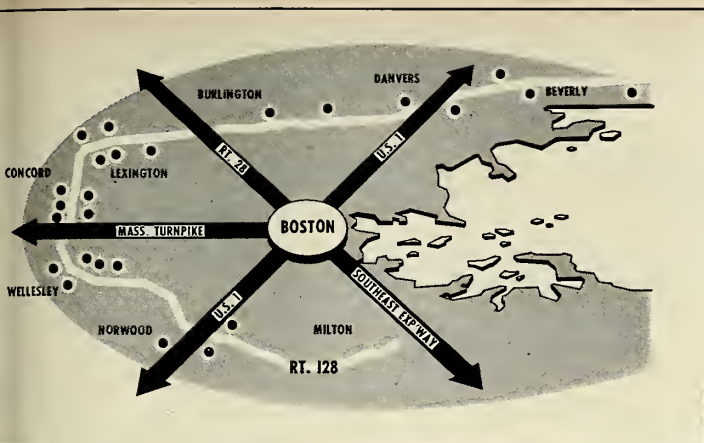
Another spectacular example is **Transitron**. Founded six years ago with eight employees, it now has 3000 and is the second-largest semiconductor producer in the nation.

In the past two years more than \$52 million has been poured into plants along Route 128—and engineers feel there is room to double the present total. Visibly supporting this optimism, the fabulous expansion keeps on accelerating.

• **Air Force millions**—Perhaps the biggest single contributor to the building boom—not only along 128 but elsewhere in the metropolitan area—is the Cambridge Research Center of the Air Force's Air Research and Development Command. CRC has been steadily funneling millions of dollars into research.

As of May 31, CRC had outstanding 1199 contracts totalling \$320 million. Millions more in contracts—production and research—are being poured into the area by the AMC, NASA, ARPA, the Army and Navy, and the private industry as well.

• **The MIT influence**—Hanging over the area is the MIT influence in missiles and rockets, July 13, 1958



OF the Boston area shows some of the towns where many missile/space plants sprung up. More than 30,000 persons are employed along Route 128 alone.

with CRC as a font of new ideas, ledge—and industrial talent—is Massachusetts Institute of Technology. Scores of firms owe their existence to MIT, through its creation of productive fields of research and education of brains to work them.

Harvard and other Greater Boston institutions also are producing a continuous stream of technical talent.

In September, the **Mitre Corp.**, a non-profit organization which takes its name from MIT, will move into a \$10 million plant at Bedford along Route 128. Mitre, under a contract with MIT, serves as the technical staff for the Air Defense System Integration program working on correlating activities of human operators with the computerized electronic gear of SAGE.

Mitre, which has H. Rowan Gaither as chairman of its board, expects to add to a \$5 million facility and usually employ 1500 to 2000. The company is presently located in Lexington, and ironically, the liberty of the navy was once entirely in the hands of

human operators. On the village green 77 Minute Men armed with muskets fired on the British in 1775 in the first conflict of the Revolutionary War.

MIT made history at its Lincoln Laboratory along Route 128 by bouncing a signal off of Venus in February, 1958, when it was 28 million miles from earth, with a 90-ton radar telescope. It took a year to decipher the data, and the feat was disclosed only a few months ago.

From MIT's Instrumentation Laboratory, headed by Dr. Charles S. Draper, has come the all-inertial guidance system for *Titan*, which is being manufactured by A. C. Spark Plug Division of **General Motors**, and many more important contributions to the defense effort.

• **Within a decade**—Greater Boston Chamber of Commerce officials estimate there are more than 430 missile, electronics and nucleonics-connected industries—almost all founded within the past decade. These are scattered throughout the area. At last

count, however, 63 were situated along Route 128.

One of the oldest research firms is the **Arthur D. Little Co.** of Cambridge, which among other items is deep in cryogenics and is preparing the design and specifications of MSE for fueling *Atlas* and *Titan*. **National Research Corp.**, also of Cambridge, has just come up with a new cryogenic storage vessel which has insulation improved by a factor of 15 over conventional devices.

At Waltham, **Infrared Industries** is producing missile guidance devices; at Lawrence, missile-carrying cases are being made by **Craig Systems**; and at Burlington, **Dynometrics Inc.** is hard at work on an Avco subcontract making measuring devices for *Titan* nose cones.

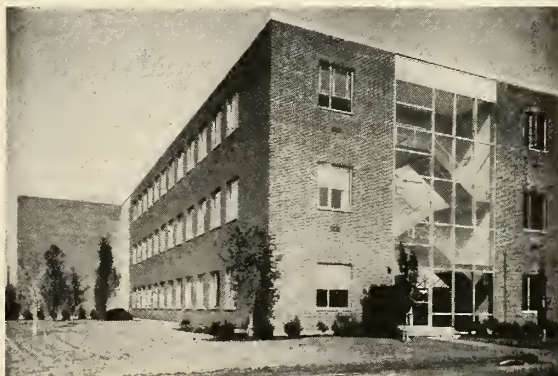
The activities of Greater Boston firms go into virtually every missile/space system, either as components or—as in the case of Raytheon, which has the prime contract for *Sparrow* and *Hawk*—the entire system.

The business scene shifts continually. **Bomac**, producer of Klystron tubes at Beverly, Mass., at the northern end of Route 128, recently merged with **Varian** of Palo Alto, Calif. **Texas Instruments** of Dallas has acquired **Metals & Controls Corp.** of Attleboro—the nation's first privately-owned nuclear fuel manufacturer.

Bostonians are looking to at least three firms to put them in the forefront of the space race. Avco at its new \$23 million laboratory in Wilmington is working on interplanetary shock-wave research and developing space systems. At the new **Goodrich-High Voltage Astronautics Inc.** in Burlington, work is being launched in development of ion propulsion engines. And at Raytheon engineers are working on a "sky station" which would hover miles above the earth in a fixed position—powered by microwaves beamed from the ground.



WALTHAM Research & Development Park. Thirteen industrial buildings are either finished or in final construction stages.



BUILDING AT the Arthur D. Little, Inc., West Cambridge Research Center, heavy in both cryogenics and major MSE.

First Things First— A Formula for Reliability

*An expert decries our misplaced
emphasis on perfecting assemblies
and urges priority for materials*

by John N. Dick
(Colonel USAF, Ret.)*

WASHINGTON—A new word has made its way to the top of the vocabulary of modern weapon systems—the word RELIABILITY.

The concept of reliability as applied to military materiel is not new, of course, but with the coming of everyday missile firing and the approach of manned space travel, the word has assumed new importance. Contributing to awareness of the vital importance of component reliability have been:

- Serious and substantial failures of critical aircraft, rocket and missile missions, including some repeated failures of missiles considered to be operational.

- Recognition that the failure of one small and perhaps inexpensive part can abort a mission costing millions of dollars.

- The tremendously high costs of modern systems and equipment, including both astronomical initial cost and continuing high costs of maintenance.

Recognition of the necessity for reliability goes beyond the military, of course. Intense national interest has developed as a result of some spectacular and highly publicized missile failures, and as a natural by-product of the international race in space travel. As a result of this interest, accompanied by some concern and doubt as to our scientific and production capabilities, Congress has looked into these areas.

As their awareness of the critical nature of component reliability has grown, military materials suppliers have come to recognize reliability as a functional responsibility of organization.

Although reliability problems have been better defined and some praiseworthy efforts made to solve them, on the whole these efforts have been too sophisticated for complete success. The basic flaw is that the primary effort to insure reliability is applied at the wrong end of the complex weapon system program. Too much engineering time and attention have been devoted to perfecting an assembly of complicated components, and not enough to perfecting individual parts and—even more important—the basic materials themselves.

How effective is it to require 100% testing of component parts for reliability without fully appreciating and perfecting the specifications of the basic materials from which they are produced?

- **Misplaced emphasis**—Because of the knowledge, ability and experience of topflight aeronautical designers, the emphasis in missile design has been on sophisticated performance of very complex systems; not enough attention has been given to development of materials capable of such performance. A by-product of this misplaced emphasis is that much research and development effort is expended not in the laboratory but on the shop or factory floor—the least efficient and most expensive place for research and development.

Despite the excellent technical advice and assistance which commercial suppliers can provide the military in areas of metals, ceramics, chemicals and other materials and services, the systems designer and operator often have the impression that they must work only with whatever materials are in being. Except in the laboratories of some progressive suppliers, the concept of vigorous and thorough basic R&D

of new materials, designed for specific and exacting performance requirements is not well-established. The result is a "fire-fighting" system of stamping weaknesses and "crash programs" directed at troublesome areas boost materials costs and subtract from overall quality which could be obtained with available funds.

If a broad solution to the problem is to be found, policy thinking at defense will have to be re-oriented. Basic research will be required to get a better perspective on the system for the future.

- **Present and future**—Immediate solutions to the practical problems of reliability will demand more attention (and surely more funds) for:

- More thorough study of the materials now in use in systems and components.

- Determination of their strengths and weaknesses, their full capabilities and their shortcomings.

- Determination of the present qualities required to make the materials more useful and the systems more reliable.

- Determination of which materials are most likely to succeed as hardware and fuel in the Space Age.

- An aggressive research program in those most likely to succeed, flexible enough to change direction and emphasis in the future.

Future solutions will require:

- Constant review of weapons defense systems—those in being, those in design and even those that are a wild gleam in some designer's eye.

- Determination of extreme requirements of environment, involving temperature, stress, erosion, corrosion, radiation, shock, friction, acoustic elements and expectable life of materials.

- Continuous review of all known materials which show promise of solving any of the problems raised by these environmental factors. Major search effort should be applied in this direction.

- A wedding of materials research with fabrication research in order to achieve maximum results in both areas.

- Prospecting for new areas of materials research, keeping uppermost in mind the environmental problems and the directions of progress indicated by accomplished research.

By putting first things first, by orienting our thinking to give a priority to basic materials research should eventually make it possible for the systems designer to specify his materials requirements and fabrication methods, and incorporate these into the materials he made materials into his gimmick tomorrow with a much higher degree of reliability than he can achieve today.

*Washington District Manager
Allegheny Ludlum Steel Corporation

Missile Troops in Italy

by Clarke Newlon

The following dispatch was sent Italy by M/R's Executive Editor, pouring Europe.

CENZA—The Western World's army missile command is stationed as part of NATO-earmarked forces are armed with obsolete weapons recently reduced in strength by and still a potent force because "mystery of atomic power."

The missile unit is part of the Western European Task Force (SETAF) and operates under the command of Col. Melville B. Coburn. Until June of this year it had been with the *Corporal* missile and *Honest John* rocket, both with nuclear warheads. On June 30—by coincidence, perhaps, the end of the U.S. year—the two *Honest John* battalions were formally turned over to the Italian army, which had been training to use them since Jan. 1. Simultaneously, the command's personnel cut in half, from 4000 to 2000. "The fact that we have obsolete weapons is not important to the people of Italy," Coburn said. "To them SETAF is a demonstration that there is an atomic force in Italy and that it is here to use it. It is a part of the mystery of atomic power."

Coburn recalled that last October his command loaded an *Honest John* on two USAF planes—a C-124 and a C-130—one carrying the rocket and the other support equipment, and flew to Salonika, Greece. There they fired the only a conventionally-loaded *Honest John*—at a target on the hillside.

"We had no right to be that accurate," said Coburn, "but we hit the target dead center. The Greeks were tremendously impressed that in just four hours we had flown in and fired an atomic weapon. And when they saw us unload the rocket from the plane they were not at all sure it wasn't really atomic."

SETAF itself is under the command of Maj. Gen. John P. Daley and is located in Verona, some 33 miles from Vicenza. In addition to the 1st Army Missile Command, it includes the SETAF Logistical Command and the 2nd Army Missile Command.

Organized in 1955—In the spring of 1955 it became apparent that the peace negotiations were headed for success, which meant the withdrawal of Allied troops from Austria.

Thus NATO moved to create a new American military command in Italy as a defensive move to fill the void created by the neutralization of Austria, and SETAF came into being on Oct. 25, 1955.

The Missile Command still operates two battalions of *Corporals*, sky cavalry which would drop reconnaissance teams behind enemy lines in time of war, an engineering battalion and a signal company. It works with Italian forces to carry out atomic demolition. The area covered by the command is 175 miles broad and 100 miles deep, all of it roughly north of Vicenza.

Facing this area are the six passes over the Alps through which enemy invaders traditionally come. They are, from north to south, Resia, Brenner, Dobbiacs, St. Croce, Tarvisio and Gorizia. The latter leads from the famed Ljubljana plains of Northern Yugoslavia.

In event of war, one of several major jobs facing the missile command would be demolition of these passes by atomic blasts. The Italians have the actual responsibility for destroying the passes, or making them impassable, but the missile command has control of the atomic demolition packages and the job of getting the Italian forces and the nuclear explosives to the scene.

To do this, the command has worked out three teams of three helicopters each. The first would carry the atomic store. This, it was revealed, weighs 1500 pounds, the same weight as the warhead of the *Corporal* and *Honest John*, regardless of what force

the atomic blast may be. The second helicopter carries equipment and the third personnel.

The Italians are expert, Col. Coburn said, in the art of destroying tunnels, bridges and roads. By boring a "room" some 40 feet into the side of a mountainside at just the right place to strike a "fault," they can, with the force behind an atomic blast, bring down the entire mountainside. Asked if they would close all the passes in the event of war, Coburn said, "Yes, if we were so directed."

• **Living by mobility**—The colonel feels that if war comes the primary job of his command is to stay alive by mobility. He said his force has shown that it can move the huge carriers of the *Corporal* and *Honest John* around the mountain roads of the extremely rough terrain of the area. In combat, the units would fire from one prelocated position and race to another, never firing twice from the same place.

Coburn said that each of the battalions turned over to the Italians was equipped with 254 *Honest John* rockets, but did not say whether all were nuclear-armed. The solid-fueled rocket weighs 5900 pounds; in a demonstration, an Italian Army team trucked one up, transferred it to the firing platform and theoretically fired it in about 10 minutes. It is fairly accurate at its 15.8-mile range.

The *Corporal*, two battalions of which the missile command retains, is fueled with nitric acid, aniline and compressed air. It is guided to the target by radar and has a range of 80 miles.

"The *Corporal*," said Col. Coburn, "is either extremely accurate or horrible. And we're never quite sure which it will be."

Col. Coburn would like to have the *Sergeant*, a follow-on to the *Corporal* which is solid-fueled and much less complicated in its guidance system. In the event of war each of his battalions could get off four *Corporals* on the first day, if all went well, but only one each 12 hours thereafter, largely due to the preparation-for-firing complications.

• **Waiting for Pershing**—In addition to the *Sergeant*, which the colonel isn't counting on getting any time soon, he also has a great yearning for an 800-mile missile—typified perhaps by the *Pershing*, now under development by the Army, although its range will probably be more in the neighborhood of 500 miles at first.



MISSILEMEN of U.S. Army's 1st Missile Command, Southern European Task Force, supervise an Italian Army cadre servicing the *Honest John* solid-fueled rocket.

ARPA Seeks 'Blue Sky' Defense Against Russian Missiles

**More than \$208 million has already been
spent or earmarked for Project Defender—
the search for something better than Zeus**

by James Baar

*"Come, we shall have some fun now!"
thought Alice. "I'm glad they've begun
asking riddles . . ."*

—*Alice's Adventures in Wonderland*

WASHINGTON—Scratch a military man and he will tell you that sooner or later a relatively cheap and workable defense is found for every new weapon.

This is the faith that led the United States, through the Pentagon's Advanced Research Projects Agency, to put up \$80 million in FY 1959 for research aimed at trying to find a "blue sky" defense against Soviet ICBM's.

The same faith encouraged the United States through ARPA to plan to throw another \$128 million into the same program in FY 1960. As of now more than 30 private companies and institutions are taking part.

The program—called *Project Defender*—is of such fantastically increasing complexity that it makes such medieval problems as counting angels on the heads of pins appear easy by contrast. It involves study of such possibilities as death rays, anti-gravity machines and magnetic walls.

The glittering goal of the entire effort is the development of an ICBM defense that would be both much better and much cheaper than the Army's *Nike-Zeus*—the multibillion-dollar system being developed by Western Electric and Bell Telephone Laboratories.

The *Zeus* program is considered to be America's first chance to have an AICBM within the next eight to 10 years. It is scheduled to be operational in 1963.

• **In the dark**—"Maybe *Zeus* is the best kind of thing we can ever

get," one top Pentagon scientist said recently. "But we feel there must be something else.

"We're like men in a pitch-black hallway looking for the key to a locked door. Maybe in the end we'll find there is no key at all. Or, maybe we'll find it in one of our pockets."

He shrugged and stared at a blackboard partly covered with half-erased formulas and sketches.

"You know, we really know so damn little about ICBM phenomena," he said. "That's what this research is all about. We're trying to find out more about it."

• **The fat pitch**—In its simplest form, the ICBM defense problem involves one nuclear-tipped ICBM hurtling toward you at a speed of Mach 24.

Let us say this ICBM is fired at you from Russia at 7 A.M. EST almost any day in 1961 as you sit down to eat breakfast in New York. It will arrive about 7:30, giving you hardly enough time to have a second cup of coffee.

However, you are not incapable of coping with this kind of threat to your breakfast and all future ones besides.

BMEWS, the huge radar system being constructed in Alaska and Greenland, is designed to alert you that an ICBM is on the way. Thanks to BMEWS, you would have about 20 minutes to do something about it.

If you had *Zeus* handy, which you won't in 1961, you could pick up the ICBM when it was about 10 minutes away with the powerful *Zeus* tracking radar.

The radar would feed tracking data into the big *Zeus* computer. That, in turn, would calculate the ICBM's trajectory, launch a *Zeus* at the cor-

rect moment and direct it to an interception point.

You may now go finish your coffee. But you won't do it in peace. You have too much to worry about. The ICBM threat is certain to get much more complex.

• **Complications**—Russia is expected to have the capability to launch a devastating ICBM attack on the United States about 1962. Moreover, this capability is expected to increase and not just in numbers and reliability. If the United States puts an operational *Zeus* in the field in 1963, Russia is expected to be able to reply by making the game a lot tougher.

Five or maybe 10 ICBM's could be fired at a target. Also, the situation could be further confused by several decoys of varying degrees of sophistication.

For example, the ICBM casing and engine can be blown up after its propellant is exhausted, leaving dozens of objects that will travel with the warhead along the same trajectory.

Some weight can be sacrificed that balloons or somewhat heavier-like decoys can be separated from the payload and follow the same trajectory.

All of these would begin to reduce their efficacy upon re-entry. But more weight could be sacrificed to provide heavier decoys which would delay warheads re-entering the atmosphere.

Also, it may be possible to develop weight decoys capable of simulating a warhead both beyond and within the atmosphere.

Nor is this all.

• **And more complications**—The payloads could be designed to

missiles and rockets, July 13, 1959

staff to confuse tracking. Warhead could be sacrificed to install types of electronic counter measures equipment capable of jamming and further confusing radar. And type of radar shielding or absorber material may be developed.

inally, warheads can be divided into—and possibly their course can be altered. Instead of five or 10 warheads flashing toward a target, you could have 50 or 100 warheads packed in a single payload. The A-bombs that devastated Hiroshima and Nagasaki.

There then is the full threat: Space warheads are crowded with hundreds of thousands. All are flying the same ballistic path at Mach 24. Many possibly on the same course. Score on score of them are decoys. Dozens more contain various types of anti-radar equipment. Somewhere in this mass are scores of nuclear warheads.

This pattern of attack would occur simultaneously over not one or two SAC bases or industrial sites, but everywhere.

ARPA contends an attack of this type is fully possible by 1969—only a few years away. It contends many of them are possible before then. Such an attack would confront a defense system with the extremely difficult triple job of:

1. Fighting off the electronic countermeasures.

2. Detecting which among thousands of speeding objects are heading in which target.

3. Discriminating among all objects heading for a particular target to determine which are warheads that must be intercepted.

The only active defense alternative is playing this vast game of "warhead-who-has-the-warhead" to prevent all of them from getting through.

Many Pentagon experts agree that ARPA could handle the early stages of the threat with reasonable if costly measures. Army officials also contend that Zeus is flexible enough so that as the threat becomes more and more complex Zeus can be improved to meet it. But here there is disagreement.

Something else—A number of Pentagon scientists believe that there is a point beyond which the Zeus computer system can not be appreciably improved and the continued use of Zeus would involve astronomical costs. Therefore, they think something else is needed. Here ARPA's Project Defender begins.

Project Defender, which absorbs about 10% of ARPA's annual effort, is headed by Harold N. Beveridge, formerly of the Aerophysics Development. Dr. Edward Holbrook has been serving

as assistant chief of ARPA's scientific missile defense branch while on leave from the Rand Corp. The program, in turn, is divided into seven areas including radar, interception, discrimination and advanced programs.

At present, the project's main work is to collect and evaluate large amounts of data on ICBM flight phenomena.

One way that this is being done is through minute observation of ICBM and IRBM flights from the Atlantic and Pacific Missile Ranges. ARPA maintains ships for this purpose off both the East and West Coasts.

Another way is through minute measurements of launchings of a special six-stage missile developed for ARPA by the National Aeronautics and Space Administration. It is capable of launching at relatively low cost a payload that re-enters the atmosphere at the speed of an ICBM. Launchings are being conducted at NASA's Wallops Island Test Center.

"We are looking for vulnerability," an ARPA official explained. "Where can we get at those warheads? How?"

• **Spending**—The 1959 ARPA budget provided \$25 million for the study of missile flight phenomena. The 1960 budget provides \$44,650,000.

Here are the budget figures for the program's three other major categories:

Identification and kill—\$10,000,000 in FY '59, \$17,600,000 in FY '60; radar and computing—\$23,000,000 in FY '59, \$35,250,000 in FY '60; exploratory research—\$22,000,000 in FY '59, \$30,600,000 in FY '60.

One of the most intriguing exploratory research projects is GLIPAR—the Guide Line Identification Program for Anti-Missile Research.

The first phase of the program—\$1.5 million worth of contracts spread out among 12 firms—calls for thinking

up and studying any "blue sky" idea that might lead within the next 20 years to an anti-missile weapon. The firms are to try to prove that the ideas are not feasible because they violate natural laws or some other permanent factor. Anything not rejected on these grounds will be considered for future investigation.

Meantime, ARPA has been conducting research and exploratory studies on such proposed anti-missile weapons as:

• **Death Rays**—The intense concentration of beams of electromagnetic radiation, causing incineration. A big drawback would be cost.

• **Anti-Gravity**—The search for some means to reverse the effect of gravity on an incoming ICBM. The missile and all other incoming objects would be hurled harmlessly into space.

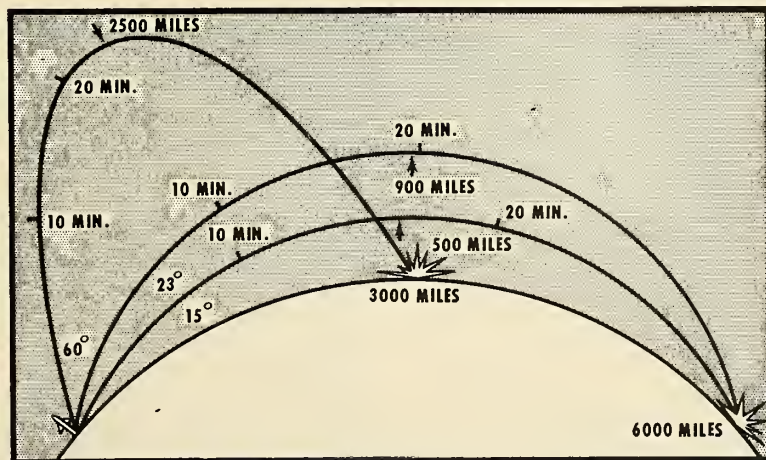
• **Giant Shields**—The creation of a magnetic shield through which warheads and decoys could not pass.

• **AICBM Spacecraft**—The stationing in orbit of a manned spacecraft from which ICBM's would be intercepted shortly after they are launched—when they are extremely vulnerable.

"Money is very important in all this," an ARPA official said. "We want something that costs us no more to use against an ICBM than it cost the enemy to launch the ICBM against us. Otherwise, if it costs us a million every time he spends \$100, he'll ruin us."

Obviously the most desired goal is to find something that costs a lot less than the enemy must spend.

"Put it this way: We want something simple and cheap," one official said. "Ideally, if we could have a bunch of monkeys armed with .22's sitting around the enemy's ICBM bases waiting for launching, we'd be all set."



AN ICBM with a range of 6000 miles could have any one of these trajectories. Trajectories show amount of reaction time available for interception by AICBM.

BRITISH ASTRONAUTICS

- **Armstrong Whitworth's Flutter Dart**
- **Rocketdyne's Dixon on storable propellants**
- **Astronautical conferences coming up**

by G. V. E. Thompson

LONDON—A rocket test vehicle that offers substantial economies in the investigation of aircraft wing flutter has been developed by **Sir W. G. Armstrong Whitworth Aircraft Ltd.** of Baginton, Coventry. Named the "*Flutter Dart*," this test vehicle was exhibited at the International Transistor Exhibition held in London recently. The vehicle shown had been recovered after a test flight.

Armstrong Whitworth carrying out research into the problems of supersonic airliners, decided that a method of studying wing flutter cheaper than wind tunnel testing was needed (A.W.'s high-speed tunnel costs about \$300 an hour to run). Another advantage of the *Flutter Dart* is that the speeds which the missile can attain enable the wings to be tested to destruction.

The vehicle carries strain gauges, equipment for measuring movements of the wing and control surfaces at supersonic speeds, and transistor amplifiers. The performance data are radioed to the ground. The illustration shows *Flutter Dart's* electronic equipment being checked at the Company's laboratories.

● **Storable propellants**—T. F. Dixon, Chief Engineer of the **Rocketdyne Division of North American Aviation**, addressed the Royal Aeronautical Society on storable propellants recently. He said that while most of the liquid fuels in current use—alcohols, hydrocarbons, amines and hydrazines—were stable and easily handled, the oxidants did not comply with the definition of a storable propellant—one which can be continuously stored in a missile in a state of instant readiness for relatively long periods of time without evaporating or corroding the containing structure.

The fuel with the highest performance per unit mass—liquid hydrogen—also did not meet these requirements and special equipment was needed for its liquefaction, storage and transportation.

Storable propellants in use or under development had sea level specific impulses of 263-294 sec., but this should be raised to around 380 sec. in the next five years.

The present importance of storable

propellants lay in the necessity for keeping ballistic missiles in a state of instant readiness for operational use. Their importance to astronautics would grow in the future: space vehicles undertaking flights of some duration and needing to use rocket engines to alter course would have to be fitted with efficient storable propellant systems.

● **Mk. 2 Thunderbird—English Electric's** Mk. 1 *Thunderbird* (M/R, June 29) is vulnerable to radar countermeasures. As reported earlier, a more advanced Mk. 2 missile is under development. This will probably be fitted with constant-wave radar guidance, making it practically immune to these countermeasures.

Other advantages of constant-wave over pulse radar are the reduction in signal-to-noise ratio, greater range, greater accuracy, and ability to deal with low-flying targets. Constant-wave guidance may also be used with the **Bristol/Ferranti** Mk. 2 *Bloodhound*, now being developed.

● **British Commonwealth Spaceflight Symposium**—When last summer the British Interplanetary Society agreed to organize the Tenth International Astronautical Congress of the IAF (to be held in London, 31 August to 5 September) it was realized that the presence of delegates from the various coun-

tries of the British Commonwealth would make it possible for them to and discuss astronautical matter common interest. The BIS then decided to precede the IAF Con with a short Commonwealth Space Symposium.

The decision of the British Government a few weeks ago to institute a spaceflight programme has naturally increased the interest in this symposium, particularly as both industry and the BIS consider that this programme is not ambitious enough. So many papers have been received from the aircraft and missile industry that it proved necessary to extend the symposium to three days (27-29 August).

At present the programme includes six papers from the Hawker-Siddeley Group (**Armstrong-Whitworth**, and **V. Roe**), two from the Indian Aeronautical Society, and one each from **Bristol/Aerojet**, **de Havilland Propellers**, **Jodrell Bank Experimental Station**, **Pye Ltd.**, **Normalair Ltd.**, **The Financial Times**, **University College London**, the College of Aeronautics, and the Weapons Research Establishment (Australian Ministry of Supply). Other contributions are expected from Canada and New Zealand, and there will be a guest speaker from the U.S.

● **Missile salesmanship**—An editorial in the *London Daily Herald*, a paper of the British Labour Party, criticized the country's missile aircraft sales methods. It said despite British achievement claimed by Western experts at the Air Show, "firms could not compete against America's 'salesmen in uniform' and at the same time fight the aircraft that the British Government and treaty top brass show towards will new orders."

The U.S.A.F. produced a "Strike Force" at the show complete with command post, white-belted military police and massive equipment to American aircraft and missiles. In contrast, Britain sent a Royal Air Force captain and six gunners to demonstrate the English Electric *Thunderbird* only when the firm had agreed to all the soldiers' expenses for the show.

Few orders came to British but U.S. sales were good.



CHECKING electronic equipment of the **Armstrong Whitworth Flutter Dart**.

missiles and rockets, July 13,

To further serve the diversified missile industry

MINNESOTA MINING and MANUFACTURING COMPANY
announces and offers the services of its

MISSILE INDUSTRY LIAISON



More than 27,000 products are manufactured by Minnesota Mining and Manufacturing—the 3M Company. Every day, more and more 3M products are playing important parts in missile and space operations.

The technical and sales staffs of some fifteen 3M divisions, subsidiaries and groups make daily contacts with missile manufacturers and subcontractors. Their efforts are implemented by 22 divisional and four staff research laboratories.

However, like the missile industry, the 3M Company is a growing *and a diversified* operation. The use of 3M products and capabilities increases every day.

To further serve this growing, diversified industry, 3M has formed the Missile Industry Liaison. This group, staffed by technical personnel experienced in rocket propulsion and other phases of space technology, is well qualified to translate your *problems* to those 3M specialists in your field of interest. Too, information on all 3M Company products—or interests applicable to missile research, development or production—is thus available to you through one convenient source.

For a cross-section view of 3M Company products for the industry, send for your free copy of the brochure "Products and Capabilities." Write: Missile Industry Liaison, 402 McKnight Road, St. Paul 6, Minnesota.

The Missile Industry Liaison is associated with these 3M divisions and subsidiaries:

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Chemical Division
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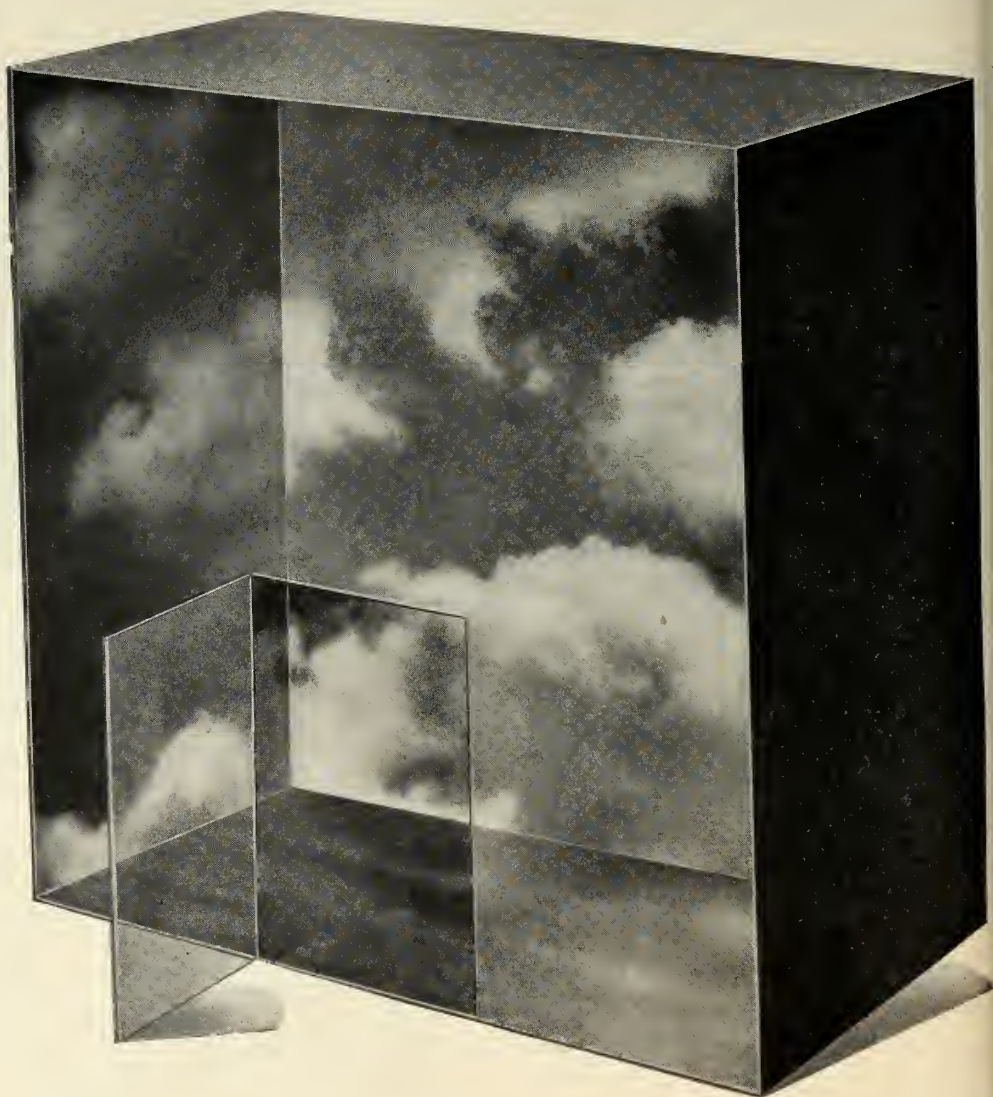
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The AF's 'Integration' Approach

How the Aeronautical Systems Center moves into responsibility for management of a weapon system after a decision is reached putting it into production

by Betty Oswald

WASHINGTON—"Integration," a word frequently in the news, has a very special meaning in the Air Force. It is not with race relations but with an equally difficult job of fitting together all of the jigsaw pieces of a weapon system. It deals also with the welding into a smooth-running whole all of the divergent interests which must be considered in converting a weapon system into an operational weapon in the hands of the troops.

We have seen in earlier M/R stories that the instrument of integration is the Weapon System Phasing Group and the Weapon System Project Office, created in its early phases by Air Research and Development Command and in later stages by the Aeronautical Systems Center of the Air Materiel Command.

• **Enter ASC**—ASC comes into the picture as manager of the integration not only when a decision is made that the weapon system has reached a point warranting a production order. The relatively new organization, ASC is the operating arm of Air Materiel Command in all areas except ballistic missiles.

This means it handles management of the weapon system during the period of production for inventory. In the earlier phases, when ARDC has executive management responsibility, the Air Force agency is still responsible for procurement. The key man during this time is the contracting officer responsible for the contract—how it is written and what it contains. He is assigned to the weapon system project.

In some cases, the prime weapon system contractor is made responsible for certain subsystem development or production. In such cases ASC may propose subsystem sources, set up a subcontract advisory panel, to give maximum consideration of the experience and technical programs of the AF and industry. Review involves such questions as the technical capability of the subcontractor; management approach to development and test; production capabilities and facilities; performance in meeting schedules;

quality control; overall company management structure and costs.

• **AF control**—AF reserves the right to reject the contractor's recommendations. As soon as possible, a decision is reached on so-called "make or buy" plans which involve such questions as maximum utilization of available industry capacity; minimum acquisition of new Government facilities; maximum use of specialized industries; maintenance, if possible, of a healthy basic aeronautical industry; maximum competition; utilization of small business to the greatest extent practicable; maximum use of standardized components, and elimination of unnecessary duplication of development. After they're agreed on, these plans can't be changed without prior AF approval.

Once this is done, AF keeps its finger in day-to-day management of the project. Each contract is assigned to an administrative contracting officer who—in the case of a major contract—will normally be in an AF plant representative office at the contractor's plant, to which specialists in cost analysis, quality control, production, property administration and audit are assigned.

His link at headquarters is the Weapon System Project Office at ASC. Headed by Maj. Gen. Beverly H. Warren, the organization is composed of seven directorates: contract support; logistic support; strategic systems; air defense systems; tactical and support systems; equipment and services, and the directorate of resources.

In addition, Gen. Warren has under his command the Aircraft Production Resources Agency on which representatives of the Army, Navy and AF serve. This agency's job is to schedule production of what have been termed "aircraft common components" and to be sure that the necessary materials are available.

Also part of Warren's organization are a program and analysis office and an office which provides management services.

• **How it's divided**—Under the directorate of strategic systems are weapon system project offices for the B-52H, the B-58, and the KC-135

tanker, for which ASC has executive management responsibility. In addition, there are Weapon System Project Offices for the B-70, for which ARDC is responsible, as well as undescribed advanced systems, strategic missiles (air breathers) and the GAM 77/72—*Hound Dog* and *Quail*.

Weapon System Project Offices reporting to the directorate of air defense systems include: F-106, F-101, F-108, *Bomarc* and drones. In the directorate of tactical and support systems, there are Weapon System Project Offices for the F-105 Thunderchief, transports, trainers, F-104, Star Fighter, tactical missiles and helicopter liaison.

The directorate of equipment and services is divided into divisions including accessories, weapons guidance, propulsion, communications and reconnaissance, specialized procurement, and Government-furnished aircraft equipment (GFAE).

The directorate of resources is responsible for industrial facilities, manufacturing methods (breaking the productivity barrier) and materials control.

• **Beefing up**—Actually, the idea of the Weapon System Project Office is not new. What is new is the way that the office has been beefed up in importance to serve as a focal point in the cradle-to-grave support of the weapon system.

This means among other things that while the program is in its research and development phase, as well as in the production phase, such requirements as maintenance and supply, along with training and operations, are cranked into the Weapon System Project Office—to provide an operational system which is entirely maintainable at the earliest possible time.

It also means that when the weapon system finally passes through production and the problems are only those of logistic support and maintenance, executive management responsibility moves out of Dayton to one of the Air Materiel Areas which have been given responsibility for support (spares, etc.) and maintenance of the weapons.

Even then, ASC and ARDC handle such questions as product improvement and technical failures.

Printed Circuitry Pays Dividends

An M/R survey finds missile business has helped to spur rapid growth of circuits that enhance reliability, cut assembly costs and permit fast repair

by Charles D. LaFond

WASHINGTON—The growing trend toward miniaturizing and modularizing electronic equipments, particularly in the missile industry, has brought rapid development of small, highly compact wiring assemblies, known throughout the industry as printed or etched circuits.

Although these circuits were not originally developed for direct application to missiles, certainly the missile business has provided a goodly share of the incentive needed to promote their growth.

The need for lightweight, extremely compact electronic equipment in miniature and subminiature assemblies called for something other than heavy bundles of inter-connecting cables and wires. New techniques have evolved better products, and new equipment for the production of printed circuits has resulted from this increasing effort throughout industry. Along with the increasing need for microminiaturization, industry has kept up with its small printed circuit cards.

The use of printed circuits has aided equipment design improvement and has greatly helped to increase reliability and cut assembly costs of complex equipment. At the same time, the new and equally complex packaging has contributed to improved component mobility. In addition, of course, modularization simplifies maintenance, increases equipment flexibility through rapid interchangeability of units, and in general permits rapid repair in almost any system.

Besides its other physical attributes, probably one of the strongest arguments for the use of printed circuitry in missiles and rockets is its inherent ability to withstand heavy vibration and shock. A most troublesome area

in conventional wiring is separation of soldered joints under an environment of high vibration or sudden shock. With the passage of time and the normal acquisition by manufacturers of increased experience, quality products are now available that employ almost unheard-of tolerances. New techniques permit high reproducibility, faster and cheaper.

MISSILES AND ROCKETS recently conducted an industry survey to determine progress in the field of printed circuitry in the past year. Here are some of the highlights of the survey returns.

• **Printed circuit usage**—Burroughs' Military Electronic Computer Division, a prominent manufacturer and user of printed circuitry, produces between 30,000 and 40,000 circuit boards per month. This is extremely high volume production, yet Burroughs maintains that to date they have not had to replace a printed circuit card in any device now in use in the field.

An indication as to just how much

printed circuitry is in use is revealed by Burroughs's estimate of 95% for the equipment they produce. A company spokesman said, "We range from the AN/FST-2 in SAGE, which has about 65% printed circuits, to the ground guidance computer which employs about 95%.

"In some equipment, the circuitry is entirely by printed boards. Some of our basic design equipment does not contain printed circuit cards, but new models do, as well as the peripheral devices linked to them."

• **Microminiaturization**—Although actual application is still highly classified, Burroughs Research Center in Paoli, Pa., has indicated that it is using microminiaturized blocks extensively in research and development and expects to make heavy use of equipment reduction techniques in the future. One spokesman went so far as to say, "in ten years, you won't find anything but micromodularization in electronic equipment."

The company's new packaging technique, which increases a module capacity to 300 components per cubic inch, was revealed here last week at the Institute of Radio Engineers' 1959 Military Electronics Conference. The high-density packaging achieved through "macro-modularization" of components already miniaturized.

The new stacking technique, which decreases total packaging volume available surface areas, provides immunity to thermal and physical stress in environmental conditions. The company has also indicated that along with these attributes circuit interconnections and power input requirements have been controlled in equipment design.

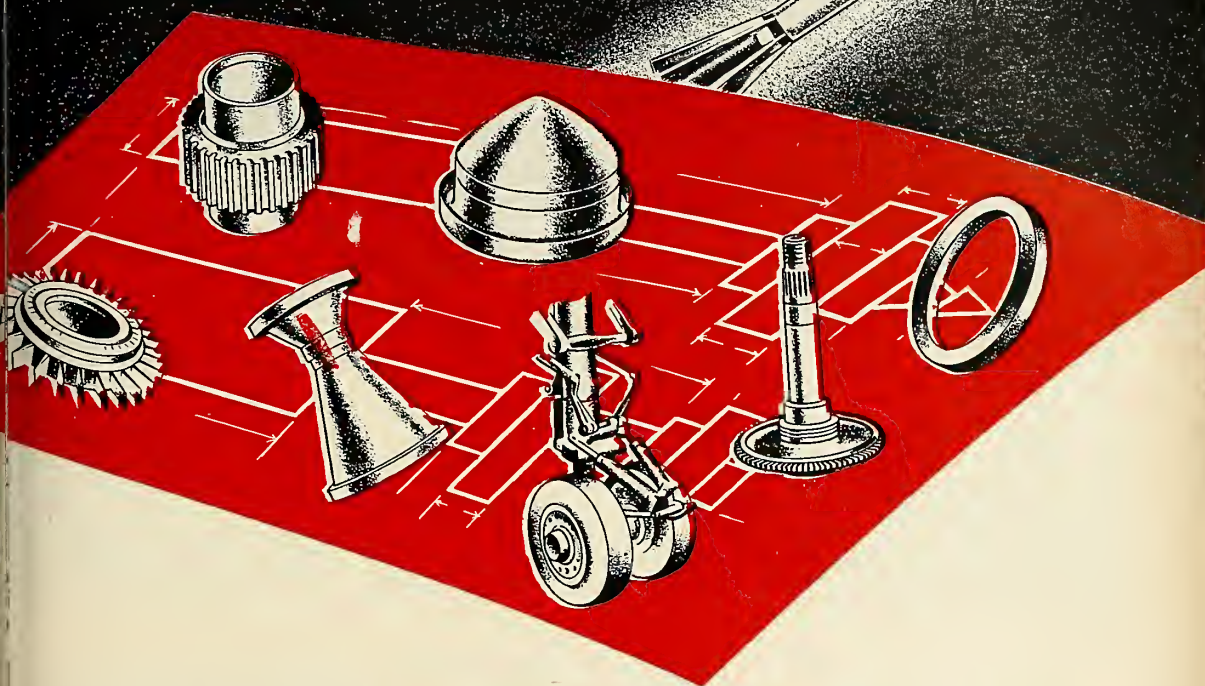
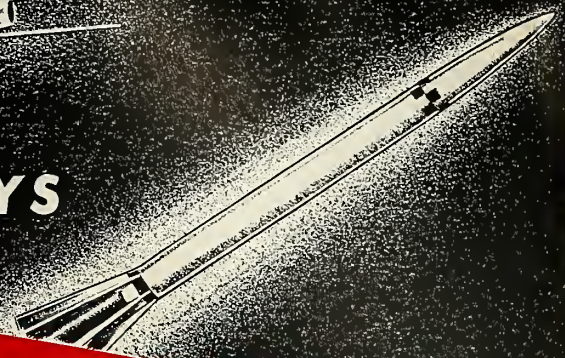
In Table 1, comparative specifications for three recent data processor



NEW TECHNIQUE by Burroughs Corp. in micro-miniaturization of electronic components. The small wafer was miniaturized from a printed circuit board some 20 to 30 times larger.



MIDVAC SUPER ALLOYS



SOLVING MODERN DESIGN SPECIFICATIONS

Parts for Missiles—Rockets—Jet Engines are constantly calling for newer alloys to operate at higher temperatures. Alloys made by the Midvac process of consumable electrode melting are currently answering these needs and new ones are being developed in anticipation of more critical operations.

Midvac Alloys insure increased tensile and impact properties, improved stress rupture strength at elevated temperature, and longer fatigue life.

Standard commercial alloys can also be made with increased cleanliness resulting in higher properties than have been available under conventional means.

Offered in ingots, billets or forgings for the production of missile combustion chambers, tail cone assemblies, jet engine parts, aircraft landing gear components or any other parts requiring properties beyond the capabilities of conventional steels.

MidVac Steels

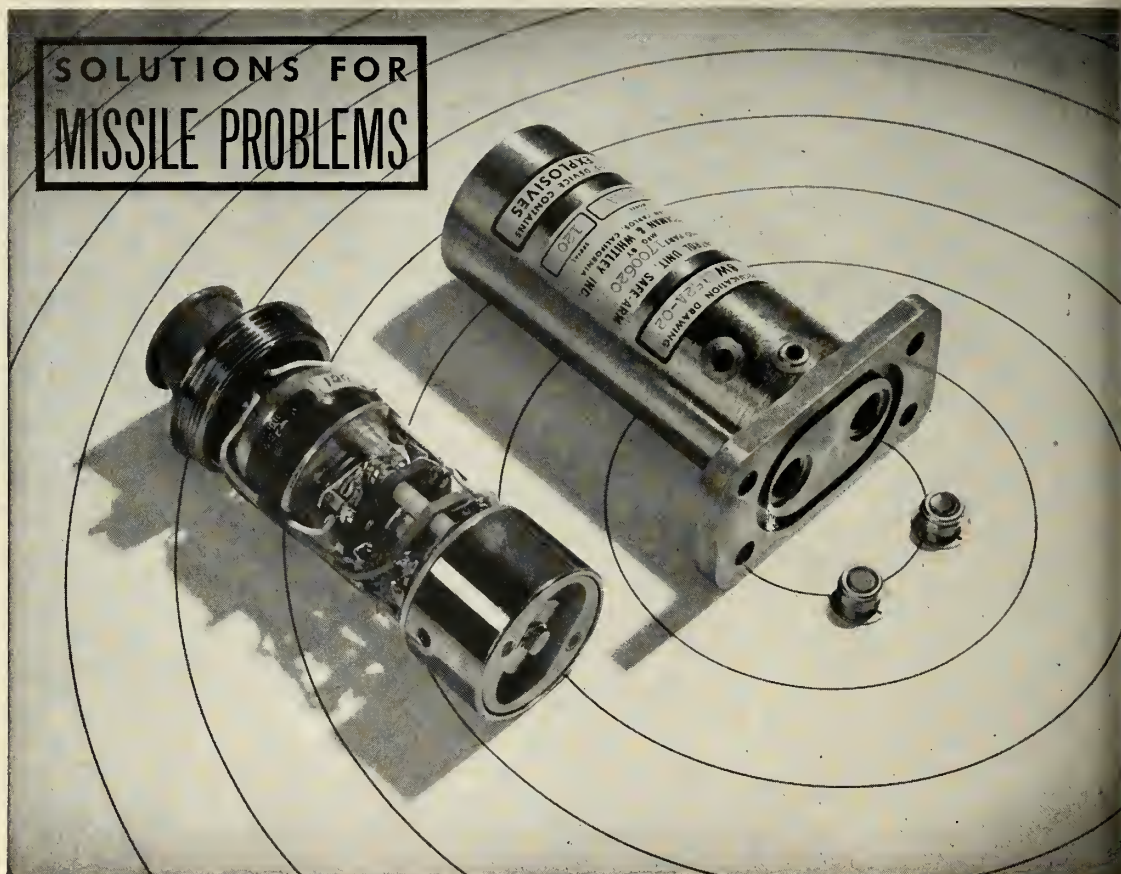
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SOLUTIONS FOR MISSILE PROBLEMS



safe/arm initiators

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

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

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

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

Just tell us your problem.

Beckman & Whitley INC.

SAN CARLOS 16, CALIFORNIA

ariety of approaches

developments at Burroughs are shown to illustrate the evolution in miniaturizing systems. Note that the temperature rise from 55°C to 100°C was accompanied by a power increase from 10 watts to 2200 watts.

To achieve 100°C operation, silicon transistors were employed effecting a power input rise. At the same time power dissipation increased, volume decreased (it should be noted that the increased concentration of power dissipation per cubic foot was solved in this instance by integrating an efficient heat exchanger into the overall equipment design).

A basic design philosophy held by the company is that the circuit must be built essentially in two dimensions, with the system being in the third dimension. In the macro-module technique, the true two-dimensional form is easily maintained. As components and circuitry become smaller, this interconnection technique may prove to be the principal element in a given complex assembly. By retaining the third dimension for the system, with continuing miniaturization, this dimension becomes largely available for system wiring.

As a result of the macro-module technique, they have achieved a quick production capability, principally because the design permits the acceptance of components from many vendors. These components can be tested prior to assembly into circuits and the circuits can be assembled prior to final assembly. The final assembly then can be tested before the complete unit is mated.

• **ITT's approach**—Another pioneer in the development of miniaturized systems employing printed circuits is the International Telephone and Telegraph Laboratories. Since missile payloads require extensive weight and size reduction in electronic units, this company has taken the approach that components, because of microminiaturization, will have to be produced with improved ability to withstand high temperatures. The smaller size for heat dissipating components such as resis-



ORIGINAL artwork for printed circuits in sub-miniature assemblies is drawn twice desired size, reduced photographically. Ryan technician checks camera.

tors implies a need for materials having greater heat stability.

ITT believes that the increased use of small semiconductor devices because of their very rapid development has gone far ahead of the normal evolutionary size reduction of resistors, capacitors, etc. The problem is that these components are still scaled and sized to accommodate vacuum tubes.

Based on their early experience with small printed circuit amplifiers for time proximity fuses, the ITT Missile and Space Systems Laboratory has been employing similar techniques to develop printed circuits, and small components for use with them, to a point of reliability and practicability acceptable for missile and space usage.

The Lab chose as its starting point its DOVAP telemetering sub-carrier oscillator. This is a transponder in wide use in missile testing as a doppler-measuring, projectory data-gathering system. The resulting metamorphosis in the sub-carrier oscillator from the conventional wire version to the final sub-miniature printed component device

that has resulted from their efforts is shown in the photo at top of page 26.

To achieve this great reduction in size, new equipment for the production of carbon composition printed resistors had to be constructed. Work is still continuing at the Laboratory in developing techniques for the practical fabrication of printed subminiature circuits.

Because resistors constitute more than 50% of the circuit components in general, a major effort has been assigned to the area of subminiature carbon composition and metal film resistors. There are other attributes of printed resistors beyond that of mere size reduction. Resistors in a similar range can be printed several at a time. They need not be inserted into a circuit and the size may be almost a strict function of dissipation required. The lab also believes that printed resistors offer maximum potential for completely automated production. In addition, printed resistors need not be handled—a primary reason why, in their opinion, conventionally designed small resistors do not enjoy wide application.

• **High-quality production—Avion-Alexandria**, a division of ACF Industries, Inc., has had its own printed circuit facility in operation for four years. Of prime concern to the company has been development of processes aimed at producing unusually high quality etched boards.

To achieve this, the company has developed what it believes is better-than-usual processing equipment. The results are best shown by an example of the tolerances achieved in production: spacings ± 0.001 in. conductor widths and lengths ± 0.002 in.; registry front and back ± 0.002 in.

In addition to normal printed circuit boards and assemblies, the company has developed high-quality printed circuit techniques for rf stripline components including filters, couplers, and power dividers.

• **Advanced facilities—Ryan Aeronautical Company's** latest—and most modern in equipment—is a new photographic facility designed and equipped especially for manufacturing printed circuitry.

Since printed circuits must be treated, by means of photographic processes, to enable the narrow silver-plated lines to conduct electric currents, Ryan considers the new photographic unit a necessity for its missile subsystems. The facility was planned and equipped for the express purpose of manufacturing etched boards with the greatest dispatch and accuracy.

Highly compact, the photographic unit covers only 364 square feet of space. Windowless, to eliminate drafts and dust and to keep out the fluorescent

COMPUTER SPECIFICATION	I	II	III
	No. of Components 32,559 Volume 500 Cu./Ft. Power Required 1 K Watt Operating Temp. 24°-27° C Clock Rate 210 KC Add Time 50 Micro Sec. Multiply Time 512 Micro Sec.	39,809 13 Cu./Ft. 850 Watts 55° C 1.4 mc 25 Micro Sec. 75 Micro Sec.	30,000 Approx. 3.5 Cu./Ft. 2200 Watts 100° C 1.3 mc 10 Micro Sec. 40 Micro Sec.

innovations in materials . . .

light of the adjoining electronics laboratory, the unit is air- and temperature-conditioned. Its construction is such that hallways and shielded doors completely screen off light and activity in one room from light-sensitive work going on in another room. The whole facility is operated as a "clean" room.

The precision photography applied to intricate miniature boards is achieved with a select collection of equipment—\$7000 worth of the finest industrial photographic apparatus, according to the company.

In addition to three major electronic projects—automatic navigator, helicopter hovering device and missile guidance systems—Ryan has more than a dozen others under development, each calling for subminiature electrical assemblies based on printed circuitry. The program places great emphasis on the need for an integrated, modern facility for supplying precision-built circuits on a production line basis. Already set up to turn out a board a minute as a one-man operation, Ryan believes that printed circuit photographic units can easily increase this rate.

A new and highly versatile equipment that appears to be an asset to printed circuit production, has been revealed by the **Fuller Brush Company** of Hartford, Conn. Called a printed circuit pumice scrubber, the unit scrubs, rinses and dries printed circuits and laminates in one operation. The machine will also prepare items for masking, etching and soldering in less time than by conventional means, Fuller says. Operating at a rate of 5 to 15 feet/minute, it will: (1) remove all surface dirt and oxide; (2) with a dip,



CONVENTIONAL wired subcarrier oscillator is shown at rear, printed circuit chassis in the middle, and a subminiature printed component device at front.

remove all photo-resists after etching; (3) prepare plates for more effective soldering; and (4) deliver plates clean and dry.

• **New material**—Another recent innovation in printed circuit development is the use of a new material developed by **Corning Glass Works** at Bradford, Pa. Copper metalized printed circuit boards made of high-strength, high-temperature Fotoceram have been produced by the company for high-reliability military applications for missile guidance and communication systems.

Automatically produced by a chemical machine process which permits extreme accuracy, the boards are capable of continuous operation between minus 55°C and 250°C. Through-hole plating is standard and

repeated resoldering does not result damage on circuit runs, according Corning.

Fotoceram is a crystalline variety of Corning's Fotoform glass and has a flexural strength of 25,000 ksi.

In processing, the original photosensitive glass is exposed through negatives to ultraviolet light and board holes are then etched out subsequent heating and immersion in a dilute hydrofluoric acid. Finally, additional heating converts the glass to a crystalline state and the circuit pattern is applied to the board.

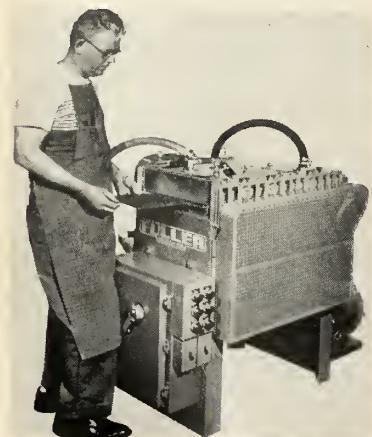
The company has said that in addition to its high thermal endurance, Fotoceram board will not bow, bend, warp, or burn and is impervious to solvents.

Vibration tests recently performed on the boards indicated that they will withstand more than 60 g when properly mounted.

In tests performed on Fotoceram circuits components have been hand resoldered to the same circuit run more than 50 times without indication of failure. To test solder-heat resistance the circuit boards have been floated or immersed in 565°F molten solder for over five minutes without evidence of any blistering or lifting of circuit runs, a company spokesman said.

• **Plated-through holes**—A significant controversy has arisen among manufacturers of printed circuit boards who feel that eyelets and plated-through holes cause unreliable assemblies. **Packard Bell**, for example, prefers to use soldered leads inserted through holes in the boards.

In the July 27 issue of *M/R*, we will present a defense of the use of plated-through holes based on the results of a test program performed by **Motorola's Military Electronics Division**.



PRINTED-circuit band scrubber developed by Fuller Brush Co., Hartford.



PHOTOSENSITIVE glass is processed at the new Corning Glass Works plant at Bradford, Pa. Each rectangle will be a printed circuit board for high temperature

missiles and rockets, July 13, 1964

THE BOEING IM-99 BOMARC... is a long range, extremely high altitude supersonic missile designed to intercept and destroy enemy aircraft and missiles. In full production, it has a greater range than any other air defense missile.



STRUCTURAL EFFICIENCY CONTRIBUTES TO GREATER PERFORMANCE

The airframe of the Bomarc reflects a successful solution to structural and fastening design problems typical to high performance missiles and aircraft. The airframe combines high strength with high temperature resistance, without adding unnecessary weight which could effect performance.

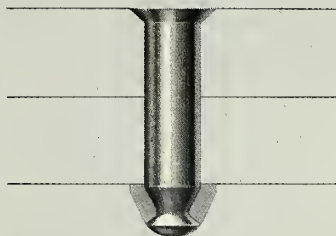
Three different fastener problems in the Bomarc are solved by stainless steel Hi-Shear fasteners. Hi-Shear Rivets are used in structure subjected to engine and rocket boost heat... Hi-Torque Bolts fasten removable panels and the nose section where heat, surface smoothness and ease of removal are factors. Blind Nuts eliminate hole/nut coordination problems in congested areas.

Continuing fastener environmental studies are being conducted at the Hi-Shear Test and Research Laboratories in a variety of strength and temperature resistant material combinations for advanced structural requirements.



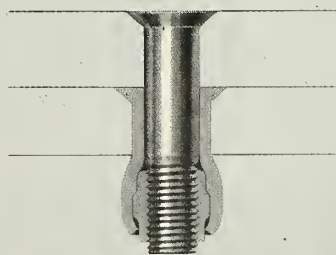
HI-TORQUE BOLT

IDEAL FOR FASTENING STRESSED ACCESS AND CLOSE-OUT PANELS. ITS UNIQUE SHALLOW RECESS LOCKS THE DRIVER INTO IT WHEN A HIGH TORQUE LOAD IS APPLIED DURING INSTALLATION OR REMOVAL.



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HAS THE LIGHTEST STRENGTH-WEIGHT RATIO, LEAST PROTRUSION AND LOWEST COST OF ANY SWAGED TYPE FASTENER. INSTALLED WITH STANDARD RIVET GUNS OR SQUEEZERS FITTED WITH HI-SHEAR RIVETING SETS.



BLIND NUT

FOR BLIND OR OPEN APPLICATIONS, THE BLIND NUT CUTS PRODUCTION COSTS BY USING ONE HOLE INSTEAD OF THE NORMAL THREE REQUIRED FOR NUTPLATES. INSTALLATION SPEED IS ABOUT TEN PER MINUTE BY ONE MAN USING A LIGHTWEIGHT, HYDRAULICALLY OPERATED GUN.

U.S. PATENT PENDING. FOREIGN PATENTS GRANTED AND PENDING.

"HI-TORQUE" TRADEMARK REGISTERED IN U.S. PATENT OFFICE.
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U.S. PATENT PENDING.

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U.S. PATENTS NO. 2,355,579; 2,355,580; 2,355,581;
OTHER U.S. AND FOREIGN PATENTS PENDING.



hi-shear RIVET TOOL COMPANY

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Space Transports are under development now, capable of transporting a pilot and 1000 pounds of payload or three passengers—equipped to work in space—to an orbit of 1000 miles altitude. Indications are that an operational vehicle will be feasible and practical in the 1965 period.

PROJECTS

FOR FUTURE DECADES IN SPACE... *another Lockheed Progress Report to Engineers*

Plotting the nation's future space exploration projects requires the capabilities of a forward-looking company; one with vision, superiority in technical skills and advanced facilities. Lockheed, Burbank, long a leader in extending the science of flight, is placing its vast resources and accumulated knowledge into programs designed to provide major breakthroughs in the fields of: Basic and applied research; manned aircraft of advanced design; missiles and spacecraft. Shown here are artists' renderings of a few of these important projects. Such project diversification calls for high-level technical skill, offers genuine challenge to experienced engineers. At Lockheed these varied projects require engineers in many fields. Take advantage of this need. Go forward with a forward-looking company: Lockheed, Burbank.

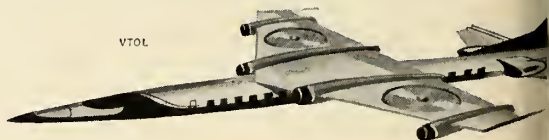
SUPERSONIC TRANSPORT



Supersonic Transports—have held an important place in our thinking for the past several years. Extensive wind tunnel tests have been conducted on many design concepts, supplemented by exhaustive laboratory and structure studies. Lockheed is prepared to build an airliner that will travel at speeds in excess of Mach 3 at an altitude of 75,000 feet.

Infrared Systems studies are being conducted using an advanced method of detecting fast-moving missiles and high aircraft. A new facility, which includes an advanced laboratory with an infrared tunnel, for basic research and development of prototype equipment in this expanding field, has been set up at Lockheed, Burbank, to the forefront in infrared studies.

VTOL



Vertical Take-off and Landing Projects—Lockheed, Burbank, is engaged in exploring the potential of projects on a very broad scale. Different VTOL features are being studied in each proposal. Considerable emphasis is being placed on VTOL "air recovery" vehicles, designed for air rescue and missile recovery missions.

Solar Radiation Studies—are being conducted at Lockheed's flight test radio station at Briar Summit, California, with particular emphasis on solar flares as our contribution to the International Geophysical Year. We have already accumulated more than a quarter of a million images of the sun's surface. In cooperation with other companies, we are determining the processes by which solar energy is released.

High caliber scientists and engineers are invited to take advantage of Lockheed's outstanding career opportunities. Fields now exist in: Electronics; aero and thermodynamics; propulsion; servo-mechanisms; materials and processes; structural analysis; operations research; research in optics, infrared, acoustics; magnetohydrodynamics, instrumentation, mechanics and hydraulics; mathematics; and in all phases of design. Write to Mr. E. W. Des Lauriers, Manager Professional Placement, Dept. 1707, 2400 North Hollywood Way, Burbank, California.

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Welding Process Gives Good Control

A new welding process, called "Short-Arc," welding has been developed by Linde Company, Division of Union Carbide Corporation. It permits manual and mechanized welding of thin material with excellent control of the weld puddle.

The outstanding feature of this new inert-gas consumable-electrode process is the ability to make manual fusion welds in the range of thickness of .001- to .100-in. of all common metals, such as carbon steel, stainless steel, aluminum (.040 in. minimum), copper, and titanium, in all positions and types of joints. The "Short-Arc" process exhibits inherent advantages over other welding methods for welding sheet metal by providing a more-readily-controllable welding process at high welding speeds, easier production of fillet welds, ability to weld in all positions, and—of significant importance—the ability to weld sheet metal in a range of thicknesses heretofore not considered readily weldable by any process.

Successful operation of the process depends on the development of several key factors: proper power source, selection of shielding gas, and apparatus for feeding small diameter wires. Normal fusion welding operations using conventional type power supplies with either covered electrodes or inert-gas shielded processes, give too much heat and cause uncontrolled melting

when making butt, lap, or fillet welds in thin gauge material. The Linde "Short-Arc" process has been made possible by the use of constant potential power supplies incorporating a drooping characteristic.

With the development of this new type of power supply it was found that surge currents could be controlled to limit the time duration of arc outages, prevent wire ejection, and produce a stable buzzing type of arc. This arc, operating in the range of 30 to 125 amp., 14 to 19 volts, short circuits dozens of times per second.

This produces a small cold puddle pinpointing the location of the arc heat and enabling the welding of thin materials in all positions. It is used primarily with .030-in. diameter wire, although .020-in. diameter hard wire works well on material in the very low end of the thickness range.

Considerable study has been given to evaluating shielding gases and mixtures and selecting the best in each instance. Argon has been found suitable for most metals such as aluminum, copper, and Everdur. For stainless steel and carbon steel, argon-oxygen and argon-carbon dioxide mixtures are finding wide acceptance.

Pure carbon dioxide is being used for some steel applications, but it produces somewhat more spatter and poorer head formation. The use of

argon-carbon dioxide mixtures provides many advantages over either argon or straight carbon dioxide on carbon steel. Their use provides superior wetting action with the minimum amount of deposited metal resulting in a vastly improved bead contour. An approved mixture is now commercially available.

A key factor in the success of "Short-Arc" welding was the development of both manual and mechanized equipment to feed wires as small as .020- or .030-in. diameter.

The process is easy to use. Very little training is required for adaptable personnel. Manual welds can be made readily in all positions on most commercial light-gauge materials.

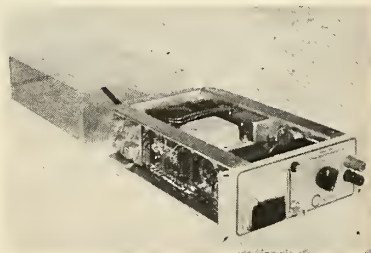
The Linde "Short-Arc" process makes high quality welds quickly and economically in carbon steel, stainless, aluminum and other metals. Distortion is minimized due to the pinpoint-type arc and there is little or no post-weld cleaning. Joints with poor fit-up are easily accommodated with manual welding. For example, 1/4-in. gaps on 14-ga. carbon steel have been bridged with ease.

Circle No. 238 on Subscriber Service Card.

Solid State Power Supply Is Short Circuit Proof

Electronic Research Associates, Inc., announces new model additions to their Magitran line of solid state power supplies which combine the characteristics of magnetic and transistor regulators.

These new units are intermediate current types, and like the high current units of the line, offer full automatic



protection against all types of short-circuits or transients, either on an intermittent or continuous basis, with instantaneous recovery.

Other advantages include fast transient response, transistor dissipation independent of line voltage variations, close regulation, low ripple content,

... new missile products

continuous wide-range adjustable output, instant warm-up time, and many other features.

These units are of the space-saving type, with panel dimensions which are multiples of the standard 19-inch relay rack, and two units may be mounted horizontally in the standard rack dimension. These models are intended for all types of laboratory and equipment applications.

In these new designs, the properties of a special magnetic control are combined with the fast transient characteristics of the transistor regulator. Pre-regulation and line transient protection is achieved by the magnetic controller.

This component is also designed in a manner so as to provide zero output in the event excessive current flows due to overload or short in the external circuit. The transistor regulator accommodates all fast line or load variations and transients, as well as providing for ripple reduction. This combination results in minimum heat dissipation for all transistors independent of line voltage variations.

Under short-circuit conditions zero voltage appears across the transistors and thus complete protection is obtained under the most extreme conditions. Other design features include the use of differential dc amplifiers, compensated zener references, silicon rectifiers, and conservatively rated transistors and components. Despite the advantages of the design, units are conservatively priced.

The new models have been given the model designations of 202M and 203M.

The Model 202M provides adjustable output over the range 10-150 VDC at 0-200 milliamperes, and the Model 203M has an output adjustable over the range 10-300 VDC at 0-200 milliamperes.

Other specifications common to both models include input, 100-130 VAC, 60 cps; line and load regulation, within 0.05%; ripple, less than .005%. Units are for bench or sub-relay rack mounting, and panel dimensions are 3½ x 9½ inches.

Circle No. 239 on Subscriber Service Card.

Miniaturized Choppers Have Varied Uses

A series of general-purpose miniature choppers, designed for aircraft and line frequencies, has been developed recently by **Collins Electronics Mfg. Corp.**

The choppers are now available in single-pole double-throw, or double-pole double-throw types, 60 cps or 400 cps, in both make-before-break or break-before-make designs.



Miniaturized for space and weight economy, they are hermetically sealed and drygas filled for operation in any known climate. To make insertion and removal simplified, as requested by field servicing firms, these Collins units have connections brought out through the base.

Maximum noise created is 450 microvolts across 1 megohm at 400 cps. They have been designed to meet all applicable military specifications.

Circle No. 240 on Subscriber Service Card.

Thin Gaged, Large Sheet High Alloys Available

Haynes Stellite Company, Division of **Union Carbide Corporation**, has just announced the availability of several high-temperature alloys in wider cold-rolled thin-gage sheets than were previously available. Sheets measuring 0.010 in. thick, 36 in. wide, and 96 in. long are now being rolled as a result of recent refinements in technique at the Company's expanding wrought alloy facilities.

This development, virtually an industry "first," opens new markets for high-alloy sheet where size limitations were an intolerable restriction to its consideration for certain applications.

Several companies are now investigating the use of large thin sheet as outer skin material for space craft.



shrouding for hot sections of conventional jet aircraft, or facing sheets honeycomb constructions.

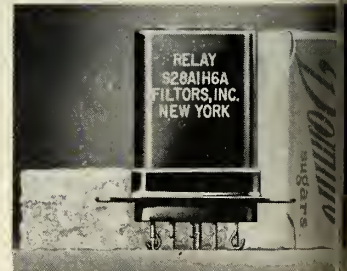
Alloys currently available in form are "Haynes" alloy No. "Multimet" alloy, "Hastelloy" a R-235, "Hastelloy" alloy X, and **General Electric's** "Rene 41" alloy. These alloys are among the leading materials in the field of high-temperature metallurgy.

Circle No. 241 on Subscriber Service Card.

Current Sensitive Relay Can Withstand 100 G's

A current sensitive relay of "Pemite" micro-miniature relay series has been produced by **Filtors, Inc.**

Known as the "S" type, this addition to the rotary "Powrm" series meets shock tests of 100 g for 11 milliseconds and vibration tests of 10-55 cps @ .06 double amplitude, 55-2000 cps @ 30 Gs.



Other specifications: contact arrangement: 2C (DPDT); ambient temperature range; -65° C. to 100° C. dielectric test: (at sea level) 100 (750 V. between open contacts); contact rating: 2 amps resistive; pulse time: 5 milliseconds maximum; 0.5 maximum weight. Coil resistances from 185 to 10,000 ohms are available standard values.

Circle No. 242 on Subscriber Service Card.

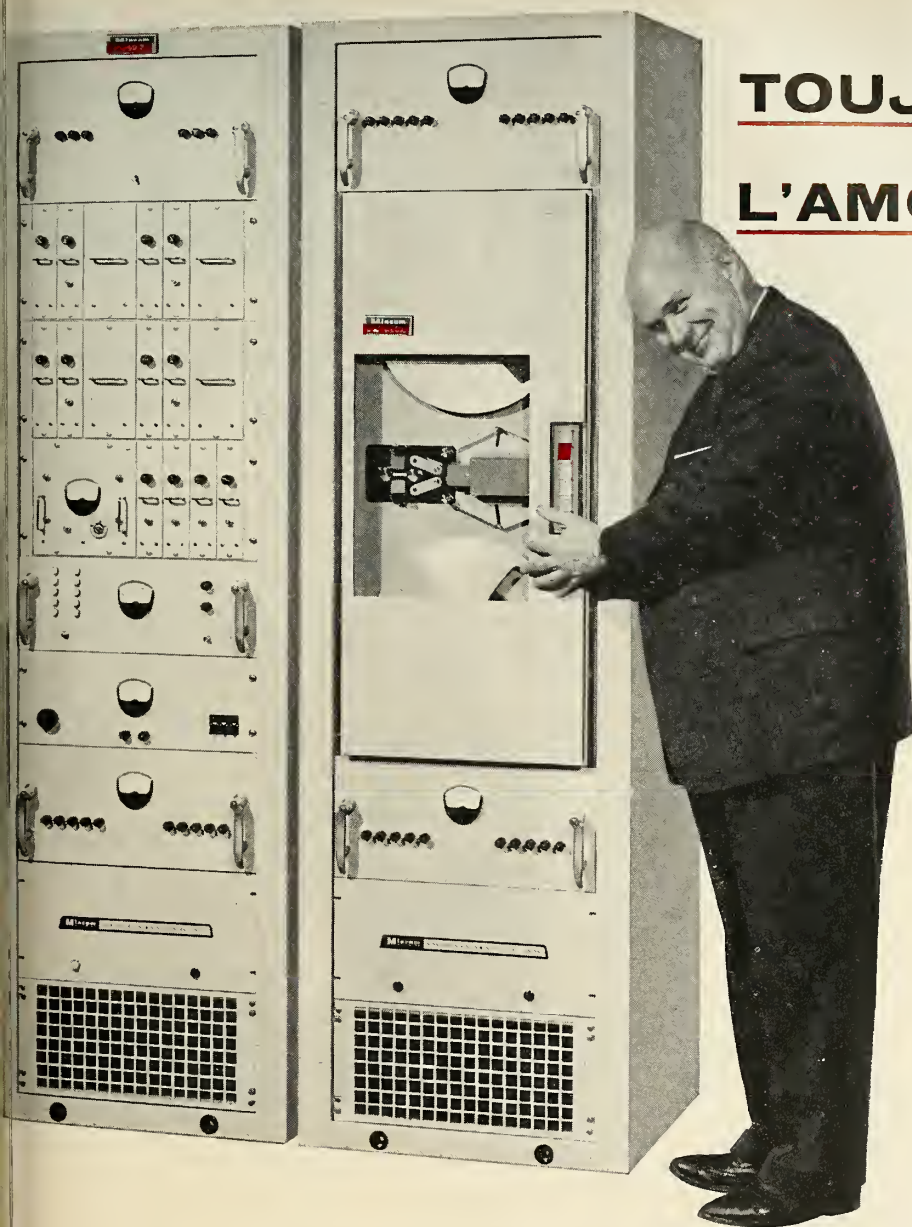
Marking Method Speeds Identification of Bearings

A new method of speedy, infallible visual identification for tiny instrument bearings—overcoming a long standing problem of the industry—is currently being introduced by **New Hampshire Ball Bearings, Inc.**

Specifications occasionally call for bearings about the size of the period at the end of this sentence. The outer and inner rings of the bearing, therefore, do not allow much room for identifying markings.

New Hampshire Ball Bearings, Inc. solved this problem through a relatively simple but effective method.

TOUJOURS L'AMOUR



Seven 1-megacycle video channels on a single half-inch tape — that's why there's an affectionate reaction everywhere to the new **Mincom Model CV-100 Video Band Magnetic Recorder Reproducer**. Tape speed of 120 ips, plus special recording and playback heads, produces reliable frequency response from 400 cycles to 1.0 megacycle (each track). Only 12 moving parts, four simple adjustments. Only 0.1% flutter and wow. No mechanical brakes. All plug-in assemblies, carefree maintenance. Interested? Write for specifications.



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... new missile products

Sets of double lines, either 120° or 180° apart, applied to one face of the outer ring, supply three important pieces of information at a glance.

First, the marks indicate whether the bearing is made of Stainless Steel (120° apart) or Chrome Steel (180° apart). Second, that the precision instrument bearing is ABEC 7 tolerances, or better. And, third, for inventory and specification purposes, that the bearing is made by New Hampshire Ball Bearings, Inc.

The new method of marking was introduced after careful analysis proved that it produced no change in dimensions, no distortion, or destruction of surface finish, and does not affect mounting or performance of the bearings. This is because the marks are applied on the outer ring by impact before grinding and heat treating.

Circle No. 243 on Subscriber Service Card.

4-Stage Amplifier Claimed To Be World's Smallest

What is said to be the smallest 4-stage amplifier ever constructed is now available in production quantities from Centralab, a division of Globo-Union, Inc.

Measuring only 0.531" in diameter and 0.228" in height, including the hermetically sealed case, the unit contains 12 resistors, 5 capacitors, and 4 transistors. It weighs 1/16 of an ounce. According to Walter E. Peek, Centralab's General Sales Manager, this means that the amplifier has a component



density of well over half a million components per cubic foot.

Mr. Peek emphasized that this is not a developmental unit or laboratory curiosity, but is in actual production, and is now being delivered to a number of leading manufacturers. It has

application in hearing aids, computers, missiles, and a variety of other military electronic devices.

The new unit is known as the TA-12, Mr. Peek said. Prior to its development, the smallest available 4-stage amplifier was Centralab's TA-11, which measures 1.175" long x .250" wide x .665" high.

The TA-12 has a gain of 73 to 78 db at 1 KC with 1000 ohm load. Its nominal input impedance is 2000 ohms. Signal to noise ratio is 42 db below 1 volt. Supply voltage is from a 1.3 volt mercury cell; current drain is 2.1 milliamperes maximum. At 300 CPS the frequency response is down 6 ± 3 db; it is down 4 ± 2 db at 3000 CPS. Load impedance is 1000 ohms inductive load with 400 ohms maximum d.c. resistance. According to Mr. Peek, these standard performance limits may be modified for special applications.

Circle No. 244 on Subscriber Service Card.

Tiny Vanguard II Motor Commercially Available

Inside *Vanguard II*, the weather satellite which is expected to be orbiting for several hundred years to come, is a tiny two-ounce motor, installed to drive a miniature tape-recorder. In size, it is the only one of its kind, but it was manufactured by the A. W. Haydon Division of Consolidated Electronics Industries Corp. for the Army Signal Corps as a scaled-down version of the Company's standard DC model.

This sub-miniature motor enabled the weather satellite to respond to interrogation, on command from certain of Earth's monitoring stations, 152 times during its first 211 cycles before the transmitters ceased operating, according to the National Aeronautics and Space Administration. *Vanguard II* was launched on February 17, 1959.

Less than one inch in diameter and only 1 3/8 inches in length, the Haydon Company's sub-miniature motor operates on only a tenth of a watt of power. Thirty of these motors would use no more than the same amount of power as an everyday household clock, or seven of them would require the same power as a two-cell flashlight bulb.

The parts in the orbiting satellite's adaptation of the motor are all one-half of regular dimensions. It runs with a speed of 2,500 revolutions per minute, has a permanent magnet within the rotating coils, and is equipped with ball bearings.

The A. W. Haydon engineers are certain that tooling can be obtained



promptly for production of the miniature motor to meet such major demands as may develop.

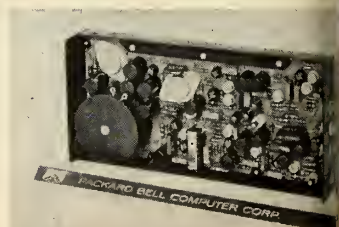
Circle No. 245 on Subscriber Service Card.

New Line of Solid State DC Amplifiers Marketed

Packard Bell Computer Corporation has announced a new line of solid-state DC amplifiers designed to meet an urgent need for wide-band, highly accurate amplification where reliability is of prime importance. This is the first available line of low-noise, complete solid state amplifiers with transistor choppers.

Because of the rapid development of new weapons and numerous testing requirements, instrumentation reliability is a prime factor. Normally, equipment can be tested only once because of the complexity and cost of such tests.

One of the basic pieces of equipment required to take measurements is an amplifier. It is used to amplify signals for processing into data logs



equipment for later evaluation. A major weakness in today's amplifiers is the use of mechanical choppers which tend to be unreliable and cause a significant failure rate.

To alleviate this condition, a line of amplifiers which use all solid-state circuitry, including the chopper, has been designed and is now available for application in systems. With this radical design, amplifier reliability, system reliability, is increased at least one order of magnitude.

Wide-band differential, operational and potentiometric amplifiers—all utilizing completely solid-state circuitry—are offered by Packard Bell under

exclusive arrangement with REDCOR, to meet the diversified need for a line of instrumentation amplifiers.

Differential amplifiers have many applications in the data reduction field. Wherever a low level signal of undetermined reference is measured, a means of isolating it and recovering low amplitude signals from high noise levels is required. The low-level, wide-band, low-noise differential amplifier has been designed to meet most of these requirements. This is the first such differential amplifier offering input impedances up to 10,000 megohms, noise in the microvolt range and a common mode rejection of 120 db at dc.

Operational amplifiers have many uses in data handling systems. They are used most commonly to provide impedance matching and signal inversion.

Potentiometric amplifiers are primarily used as a buffering device to isolate the source of the measurement from the measuring device.

The three types of amplifiers described here offer bandwidths at -3 db of 200 KC. Gain accuracies, linearity and drift figures are better than .002% on most models. The units are extremely small, measuring 8" by 4" by 1½", and all have self-contained power supplies.

This line of completely solid-state amplifiers, for which Packard Bell Computer Corporation has exclusive rights, reportedly makes the amplifier one of the most reliable pieces of equipment in the data logging field.

Circle No. 246 on Subscriber Service Card.

New Low-Current Thermal Relay Available

A low-current, sub-miniature thermal relay with a firing sensitivity of only 0.2 amps is announced by Networks Electronics Corp.

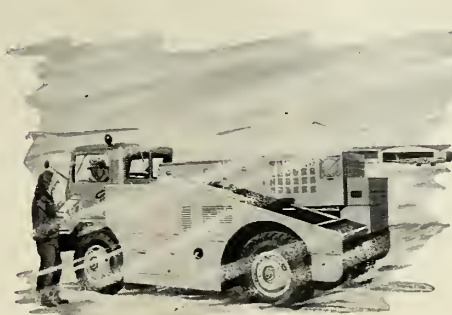
Relay is hermetically sealed by an exclusive method of bonding metal leadwires to high thermal-shock resistant glass housings. The use of a transparent glass case permits visual inspection of all working parts.

This tiny unit measuring only .65" dia. x .550" length, meets all

pertinent military specifications . . . operates under vibration of 20 to 2000 cps at 15 g, with a shock rating of 10 g. The temperature range extends

missiles and rockets, July 13, 1959

HEAT in military applications



HUNTER ENGINE HEATERS

starting aids for internal combustion engines

Hunter Engine Heaters, designed and manufactured in conformity with military requirements, are standard winterization gear for engines in military vehicles, hydraulic test stands, battery starting carts, generator sets, compressors, other ground support and special purpose equipment, etc. They burn any type gasoline or JP-4 fuel, with cold starts as low as -65°F. Input ranges from 30,000 to 90,000 BTU/Hour.

Both uncontaminated and exhaust heat is utilized. Compact, light-weight, high capacity units, they deliver high temperature, high volume air as required for specific applications.



MODEL UH-86 This heavy-duty model has 90,000 BTU/Hr. input for delivery of high volume, high temperature air against extreme resistances to the engine, battery and lubricating oil • starts to -65°F under the most extreme conditions • used on PE-90, PE-150 and PE-200 Engines employed in ground support equipment such as C-26, MD-3A, MA-3, hydraulic test stands, battery starting carts, etc. • weighs 38 pounds, less than 27" long, 8" diameter • burns ¾ gal. fuel per hr., any grade gasoline or JP-4 fuel.



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Explore new areas at IBM in



Information retrieval is a major area of study at IBM. Current investigations may lead toward such benefits as the instant accessibility to knowledge in the Library of Congress—or toward a system which can translate any of the earth's languages into English in real time.

Problems in information retrieval have defined entirely new concepts for the design of storage, input-output and "memory" units—achieving far greater capacities than any known today. These facilities will provide for the handling of the tremendous amount of updated information needed by business, science and government. With extremely rapid accessibility to vast amounts of information electronically stored, industrial and research efforts can be materially expedited. IBM needs engineers and scientists with the vision and the ability to pave the way to tomorrow.

You will enjoy unusual professional freedom and the support of a wealth of systems know-how. Comprehensive education programs are available plus the assistance of specialists of many disciplines. Working independently or as a member of a small team, your individual contributions are quickly recognized and rewarded. This is a unique opportunity for a career with a company that has an outstanding growth record.

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Applied mathematics & statistics	Operations research
Circuit design & research	Optics
Component engineering	Programming
Human factors	Real-time engineering
Inertial guidance	Semiconductors
Information theory	Solid state development
Logic	Systems analysis & design
	Transistor device design

QUALIFICATIONS

B.S., M.S., or Ph.D. in Electrical or Mechanical Engineering, Physics or Mathematics—and proven ability to assume a high degree of technical responsibility in your sphere of interest.

SOME TYPICAL ASSIGNMENTS

704 PROGRAMMER ANALYST to study data flow diagrams and write differential equations of a circuit diagram; to investigate analog and digital real-time control systems, using high-speed electronic digital and/or analog computers. Must be familiar with variable length alphabetic data, transforms, numerical analysis.

RETRIEVAL

COMPUTER OR SYSTEMS ENGINEER, MATHEMATICIAN OR PHYSICIST to design advanced computer, and work on development of new information retrieval program. Must have strong interest in transistor circuit design or in logical or systems applications of solid state circuitry.

MATHEMATICIAN to do programming of information retrieval research and plan construction of advanced systems. Will play an active part in automatic programming techniques, numerical analyses, criteria selection, probability and game theory.

SENIOR ENGINEER, MATHEMATICIAN OR PHYSICIST interested in systems; experienced in operations research, communications, missiles or radar.

For details, write, outlining background and interests, to:

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New York 22, N. Y.

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from -100°F to 400°F . Unit is SPST-NO, with a contact rating of 1 amp. Normally-closed operation is provided in a somewhat larger unit.

Designated Series M555, relay will handle a continuous fuse current of .120 amps max., and a firing current of .180 amps min. Fuse resistance is 15 ohms $\pm 15\%$.

The original design of this unit is based on the "fuse burnout" principle, and provides wide latitude in systems design. Manufacturer states that there has been no failure in 1,000,000 delivered units. Relay can be used as a low-current sensing device, or as overload protection in missile circuitry and other complex electronic equipment. Complete data will be sent upon request.

Circle No. 247 on Subscriber Service Card.

Micro Miniature Relay Has All Welded Construction

Contact contamination—one of the greatest problems in achieving relay reliability—has been significantly reduced by the use of all-welded construction in a new **General Electric** micro-miniature relay.

Solder flux has been one of the primary causes of relay contact contamination. The new four-pole, double-throw relay is assembled—without using solder—by an inert arc welding process which hermetically seals the header to the can.

Weighing about one ounce, the relay is rated two amperes at 26.5 volts



dc or 115 volts ac, and is dc operated using a highly efficient E-type magnet.

For application in a wide variety of equipment, including aircraft and missile electronic systems, the relay is well suited for high-temperature installations. The internal structure includes ceramic actuator and ceramic coil

... new missile products

spool. The relay is rated from 160 degrees C continuous ambient down to -65 degrees C.

Circuitry is symmetrical and wiring has been simplified, according to General Electric engineers. Socket mounted units may be turned end-for-end and cannot be plugged incorrectly. No polarizing pin is needed. The relay may be mounted directly on a printed circuit board or on a chassis.

Dimensions conform to standard grid patterns utilized by many electronic and component manufacturers. Terminals are on 0.2 inch centers and mounting holes are on 1.2 inch centers.

Knife edge armature bearing and other proven design features combine to yield a mechanical life of over ten million operations, according to General Electric engineers. Electrical life of the relay at rated load is in excess of 200,000 operations.

Operate and release times are six and four milliseconds respectively, including bounce. Pickup power is 400 milliwatts.

The relay withstands vibration tests to 2000 cycles per second at 30 G's and shock tests at 50 G's for 11 milliseconds.

Circle No. 248 on Subscriber Service Card.

Test Set Provides Both Swept and CW Signals

A new type of test set, which provides both swept and CW signals in a single compact instrument, is finding widespread use as a general-purpose laboratory and production-line tool.

Designated as the Model 303 Test Set by the maker, **Telonic Industries, Inc.**, the new unit contains three separate oscillators, all operating in the 20-40 mc range. Output of the three oscillator circuits is 1 volt RMS into 50 ohms. Each output is separately

metered and may be attenuated from 0 to 140 db in 1 db steps, using toggle-switch attenuators.

To maintain an overall accuracy of attenuation of better than 0.5 db, hermetically sealed, deposited carbon resistors with an accuracy of 1/2% are used. A vernier attenuator covering a 0-10 db range is also provided. Extremely close control over RF radiation in the design and construction of the instrument allows accurate attenuation to output values as low as 0.1 microvolts.

The two CW oscillators are individually tunable by dials on the instrument panel calibrated in megacycles. In addition to the megacycle markings, a 0-100 logging scale with a 10:1 vernier is provided. The tuning-knob mechanism provides a choice of 1:1 or 50:1 rotation.

The CW oscillator outputs may be used directly as test signals for the measurement of gain and similar circuit characteristics, or they may be used as extremely accurate, variable markers for the swept signals produced by the third oscillator.

The center frequency of the swept output may be turned across the full range 20 to 40 mc, and the width of the signal may be varied from 0.05 to 40% of the center frequency. At maximum sweep width the signal demonstrates a flatness of better than 0.25 db, achieved by an internal AGC circuit acting on the B+ input to the oscillator. As a result, any departure from flatness in the demodulated signal is the result of the frequency response of the circuit under test and not accountable to the original test signal.

Sweep rate of the Model 303 Test Set is line frequency, 50 or 60 cps, with the oscillator turned off during the return sweep to provide a zero base line. Source VSWR of the instrument is below 1.2:1. An external signal of approximately 0.1 volts may be used to produce a "birdy" type marker on the oscilloscope trace at any desired frequency. Telonic produces crystal-controlled markers for this purpose. Harmonic markers that produce birdies at 1.0 mc intervals across the entire band are generally included with the instrument as standard equipment.

As in all Telonic sweep generators, Model 303 markers (including the two CW outputs when used as markers) are added to the signal after it has passed through the circuit under test, thus preventing any distortion of the measured result. The "Birdy-By-Pass" marker system is an innovation developed by Telonic Industries.



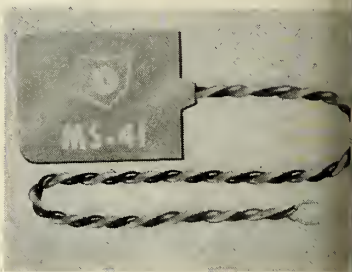
The Telonic Model 303 Test Set already in use as a production-line test instrument in plants where a major missile guidance system is now in volume production.

Circle No. 249 on Subscriber Service Card.

Magnetic-Field Sensitive Resistor Now Available

Ohio Semiconductors, Inc., announces the commercial availability of its recently developed semiconductor device, the Magnetoresistor.

The type MS-41 Magnetoresistor, a semiconductor in which the electric resistance is a function of an applied magnetic field. It features a 10 to



change in resistance with an applied field of 10 kilogauss. Greater change can be achieved at fields greater than 10 kilogauss with a linear dependence. At lower magnetic field densities the Magnetoresistor obeys an approximate square function. Important features of the MS-41 are low noise (on the order of Johnson noise) and fast response time. The theoretical response is limited only by the relaxation time of the charge carriers. In practice the lead inductance and capacitance sets the limit.

Non-inductive design with "thinner than a dime construction."

The MS-41 Magnetoresistor is made possible by the commercial development of new compound semiconductors by Ohio Semiconductors, Inc. O. S. is a pioneer and leader in the field of compound semiconductors for infrared, thermoelectric and electronic applications.

The compound—InSb, indium antimonide, is utilized in the MS-41 Magnetoresistor. The magnitude of the magnetoresistance effect is related to the mobility of charge carriers (electrons) within the solid. InSb displays the highest known electron mobilities.

Fully developed and ruggedly packaged, the MS-41 permits the use of the magnetic gaps. It is designed to satisfy many different applications.

Circle No. 250 on Subscriber Service Card.

A Big Step in Digital Telemetry

Space Electronics Corp.'s DIGILOCK system offers advantages of digital techniques minus some of its disadvantages for missile system development

by Hal Gettings

WASHINGTON—A new telemetry system just off the board shows promise in answering many of the problems plaguing this most important aspect of missile development. The system, named DIGILOCK by its developer, Space Electronics Corporation, combines many of the advantages of digital techniques and overcomes some of its disadvantages. It offers flexibility, accuracy, and small size.

The ideal telemetering system would require nothing, take no space, require no bandwidth, have unlimited sophistication as to selection of data, transmission accuracy and power, and be at least 100% reliable. It would consume no power and cost nothing.

The DIGILOCK system is, of course, not the ideal. It does, however, approach the maximum communication efficiency possible under information theory, and has several features previously available.

Digital systems—Digital techniques are generally accepted for a number of reasons as being superior for communications. Primary is the inherent accuracy of a digital system. Once above threshold, the output signal-to-noise ratio is independent of the carrier S/N; if any information is received at all, it is correct information. In analog systems, noise can vary the information modulation to cause errors in the received data.

Digital offers other advantages—speed and capability, bandwidth, and relative signal power required. A comparison of some of these parameters has been made by L. C. Watson and M. Goldstein of Texas Instruments in a paper presented at the 1959 National Telemetry Conference. A summary of their comparison is shown in the table (Fig. A).

The main objection to digital telemetry has been the large amount of hardware that must be carried in the

vehicle. Complicated coders and multiplexers with their attendant power supplies and accessory items not only add to space and weight but compound the reliability problem. Furthermore, existing ranges are instrumented to handle only analog (FM/FM, etc.) data; a change to digital would require extensive and expensive modification.

The first problem has been improved by development of transistorized units and advanced packaging techniques. The only complete digital (PCM) system in use today—developed by Radiation, Inc., for the Holloman AFMDC rocketsled track—has an entire "airborne" package in about one cubic foot.

The answer to the second problem lies in integrating "compatible" digital units into existing analog systems, to provide the desirable features of digital along with the economies of using present equipment. The DIGILOCK makes use of these principles and requires only the addition of a decoder, sync

generator, and detector to the conventional analog ground equipment. If desired, the quantized data can be stored on magnetic tape for direct entry into a digital computer.

The DIGILOCK system was developed as a result of a study made by Space Electronics Corporation under contract to Jet Propulsion Laboratory. This study showed that an "orthogonal" telemetering system was the most efficient, based on the bandwidth and power required per bit of information transmitted. Both analog and digital systems were compared on an analytical basis and assigned relative figures of merit. Some of the results of this comparison are shown in the graph (Fig. B).

A second part of the contract work was to design and test the most promising result of the study.

The analysis showed that for the best telemetry system a modulation subsystem must have these features:

- Good communications efficiency

Summary of Parameters for Analog and Digital Modulation

Parameter	FM/FM	PAM/FM	PDM/FM	PCM/FM
Number of Data Channels	18	18	18	18
Q	4000	4000	4000	4000
RMS Error	—	± 0.5%	± 0.5%	± 0.4%
Output S/N Ratio	42 db	46 db	37 db	—
Video Bandwidth	80 kc	28 kc	114 kc	28 kc
RF Bandwidth	440 kc	224 kc	228 kc	57.6 kc
Deviation Ratio	1.5	1.1	0.6	0.6
Carrier Deviation	125 kc	31 kc	69 kc	16.8 kc
Threshold S/N Ratio	9 db	9 db	9 db	9 db
$\frac{S_p}{K}$ = Relative Required Signal Power $\times 10^{-3}$	3450	1760	1790	453
$\left(\frac{S_p}{K}\right)$ db	8.8 db	5.9 db	6.0 db	0 db
$\left(\frac{S_p}{K}\right)$ db (PCM)				

FIG. A—Digital systems provide speed and capability, bandwidth and signal power.

nearing the limit of efficiency . . .

- Variable data rate
 - Variable accuracy
 - Digital data transmission
- **Orthogonal systems**—The development of the DIGILOCK, undertaken to meet these requirements, was described in a paper by A. W. Newberry at the Semiannual meeting of the American Rocket Society in June. Newberry said the family of orthogonal systems closely approaches the theoretical limit of communication efficiency, as illustrated in the graph.
- An "orthogonal" system is defined as one for which N messages can be transmitted, each of which consists of N degrees of freedom. Encoded messages are all equally different or equally spaced in an N dimensional space. The

system possesses N matched filters at the receiver, one for each possible transmitted signal.

The signals and corresponding matched filters are chosen so that the outputs from all but one matched filter are zero after the signal is received.

• **Desired characteristics**—It has long been considered desirable in telemetry design to make a system as sophisticated, or "intelligent," as possible consistent with weight and space requirements. Ideally, a system would be able to choose only pertinent information and transmit it at selected times, thus saving considerably in bandwidth and power. The complexity of such an intelligent system, however, has precluded its use up until this time.

To this end, the DIGILOCK equipment has incorporated both variable accuracy and variable data rate. The features offer considerable economy and provide a more intelligent system.

In the first place, it is very inefficient to transmit information with precision beyond the meaning of the data. It would be wasteful, for instance, to transmit continuous precise data when simple presence-absence or even per-unit-time information would be sufficient. The available information could better be reserved for measurements where greater precision is required.

Variable data rate offers, primarily, power economy. An example would be a system alternately turned on and off. When on, the data rate is some nominal maximum; when off, the rate is zero. By controlling the on-off time, the effective data rate can be varied over a wide range. If the meaningful data is properly encoded and stored, a worthwhile saving in power is provided.

But intermittent operation does not provide all of the desirable features without some additional change, the maximum communication range remains a fixed function of transmitted power, transmission bandwidth, and effective ground station sensitivity. The possibility of variable transmission bandwidth is a feature inherent in DIGILOCK and offers greater advantages. Variable transmission bandwidth can result in the adjustment of data rate to match a specific mission requirement. Even more important, a justment can be made during a transmission interval, allowing the decrease of data rate with increasing communication range—thereby making possible an operating link at distances otherwise impossible.

• **DIGILOCK operation**—DIGILOCK is a pulse code (PCM) system and, therefore, a time-division multiplex system. Primary operation consists of sampling an input data source, quantizing the data sample, transmitting a coded representation of the quantized data sample, receiving and decoding the data, and either storing or displaying a measure of the information received (Fig. C).

In an orthogonal system, messages must be encoded so that they are all equally different or equally spaced. Also, each message must be recognizable by its own matched filter. The matched filter decoder is therefore the heart of the system and its operation must be understood if the operation of the complete system is to be understood.

• **Delay line**—The principal element in the matched filter decoder is a multiple-tapped magnetostriction delay line, which provides a means of storing many bits of information

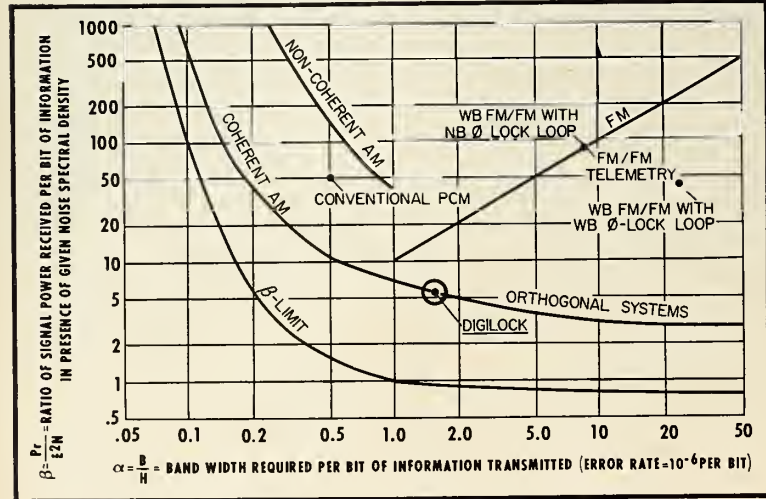


FIG. B—Comparison of the communication efficiency of various systems.

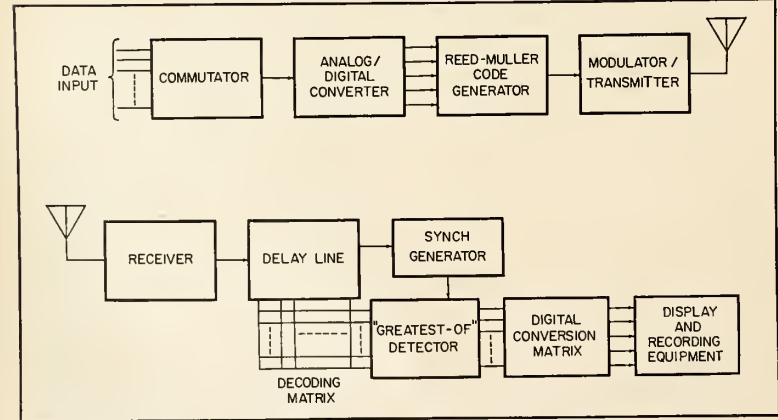
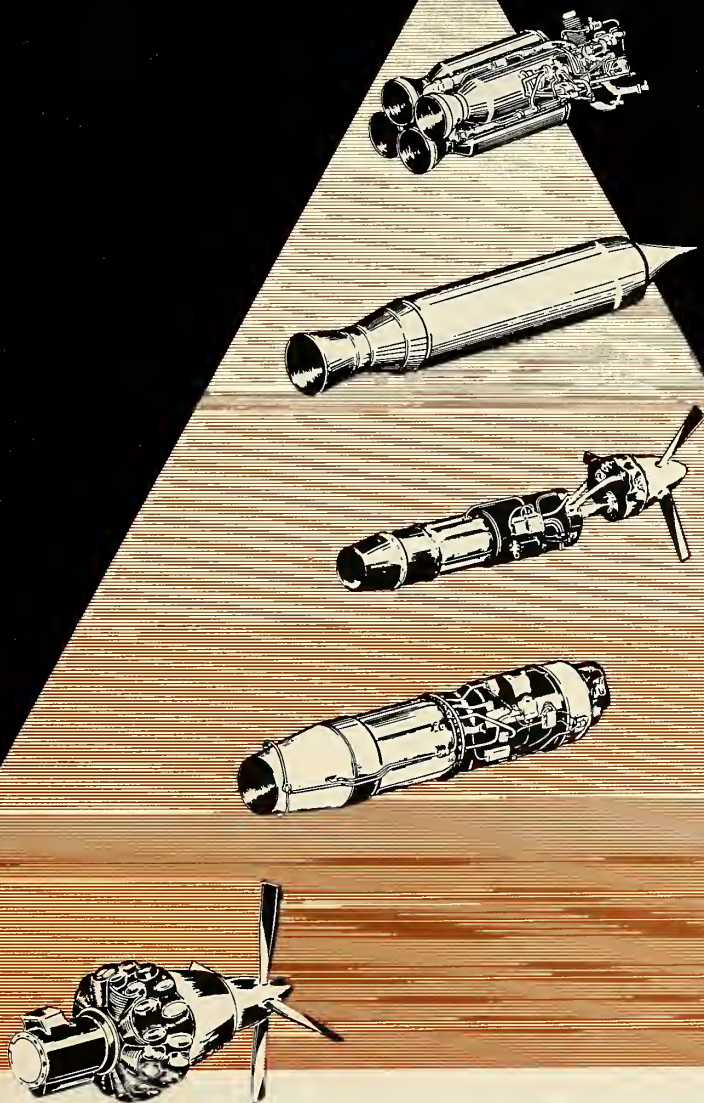


FIG. C—A block diagram of the workings of the DIGILOCK pulse code system.

CONTROLS

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BENDIX PRODUCTS DIVISION **SOUTH BEND, IND.**

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valuable for near-future missiles?

ceived in time sequence, yet allows continuous nondestructive readout of information stored on the line so that a succession of events or a succession of bits of information can be simultaneously compared.

The line used in the DIGILOCK decoder has a nickel alloy ribbon as its magnetostrictive material. It has a characteristic propagation velocity of approximately five microseconds per inch, exhibits a linear input/output characteristic over approximately a 40 db range, and has a half-power bandwidth of approximately 400 kc centered at 500 kc. Typical lines are several feet in length and pickoffs or taps can be positioned several to the inch if desired. This element, therefore, provides a convenient means of correlating events separated in time by intervals up to several hundred microseconds.

• **Summing matrix**—A summing matrix associated with a set of systematically located taps can "recognize" a discrete pattern of pulses or otherwise coded information bits. Moreover, a large number of summing matrices properly "matched" with coded messages can individually recognize a large number of multiple-digit code transmissions. Hence, the magnetostriction delay line is a very versatile element for this application; it leads to variable data rate because if the pulse code transmission is "slowed down," this simply means adjusting the taps to be farther apart. It provides an extremely important characteristic common to most correlation detection systems—that of summing systematic events while tending to cancel random events.

This last effect is obviously of primary significance because a cancellation or decrease of random noise means a lower system threshold and, consequently, a greater communication range with a given amount of transmitter power.

• **Detector**—The best detector to use with a matched filter decoder is one that simultaneously compares all outputs and determines which filter output is greatest. This approach has been mechanized in the DIGILOCK system by connecting each filter output to a transistor operated in the emitter-follower configuration with all emitters tied to one common resistor. The transistor realizing the "greatest" signal at its input is turned on, developing a voltage across the common resistor which in turn causes all other transistors to be back-biased with resultant low conduction on all but the one "greatest-of" output bus.

Basic Reed-Muller Codes—(16-Bit)

UNITS	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
4	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
8	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
16	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1

E.G. CODE #27

1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1
8	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
16	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1

1 0 0 1 1 0 0 1 0 1 0 0 1 1 0

TO OBTAIN CODE FOR ANY 5-BIT DATA POINT, ADD APPROPRIATE CODES (BINARY ADDITION)

FIG. D—Summary binary scaler outputs.

After detection, the information can be directed to a conventional decommutator and analog display system, or it can be identified and stored as quantized information on magnetic tape in a format compatible with a digital computer.

• **Encoder**—The function of the encoder is simply to determine which of the codes from the set representing all possible data values best represents the value of a data sample—and to cause this particular code to be transmitted. The particular code group chosen for use with the DIGILOCK system is a "maximum redundancy Reed-Muller" group which, for this system, consists of 32 different codes, each 16 digits long.

This code set has orthogonal properties and can be formed by systematically summing the outputs of a binary scaler as shown in the table (Fig. D). Quantization to 32 levels must be accomplished by the analog-to-digital converter, which establishes a discrete set of commands controlling the generation of the code corresponding to the level established in the quantization process.

The 32-level quantization implies that each data sample contains five bits of information and that this information can be encoded in a 5-digit binary code. A simple binary code, however, does not possess orthogonal characteristics. The 16-digit code can be detected at a lower signal threshold than could the 5-digit code, even though both might be allotted equal transmission power and the 16-digit code would require 16/5 the bandwidth of the 5-digit code. This is an example of increased efficiency resulting from bandwidth expansion techniques.

• **Timing and rate control**—A timing and data rate control system, consisting of a crystal oscillator and a binary scaler of several stages, allows the timing system to be "slowed down" by

factors of two simply by position one switch. The analog-to-digital converter uses a "stairstep" voltage generator and a comparator amplifier.

In operation, the timing system sends a 5-stage binary scaler through 32 possible states while a stairstep voltage being generated. When the comparator amplifier indicates that the stair-voltage first exceeds a data sample, inhibit signal stops the scaler, stores a binary measure of the data sample. The specific on-or-off state of the state of the binary scaler is used as command information to simple digital logic in the form of "AND" gates and EXCLUSIVE OR circuitry to generate one desired of the 32 possible codes which can be formed by the binary addition of outputs from binary scaler stages.

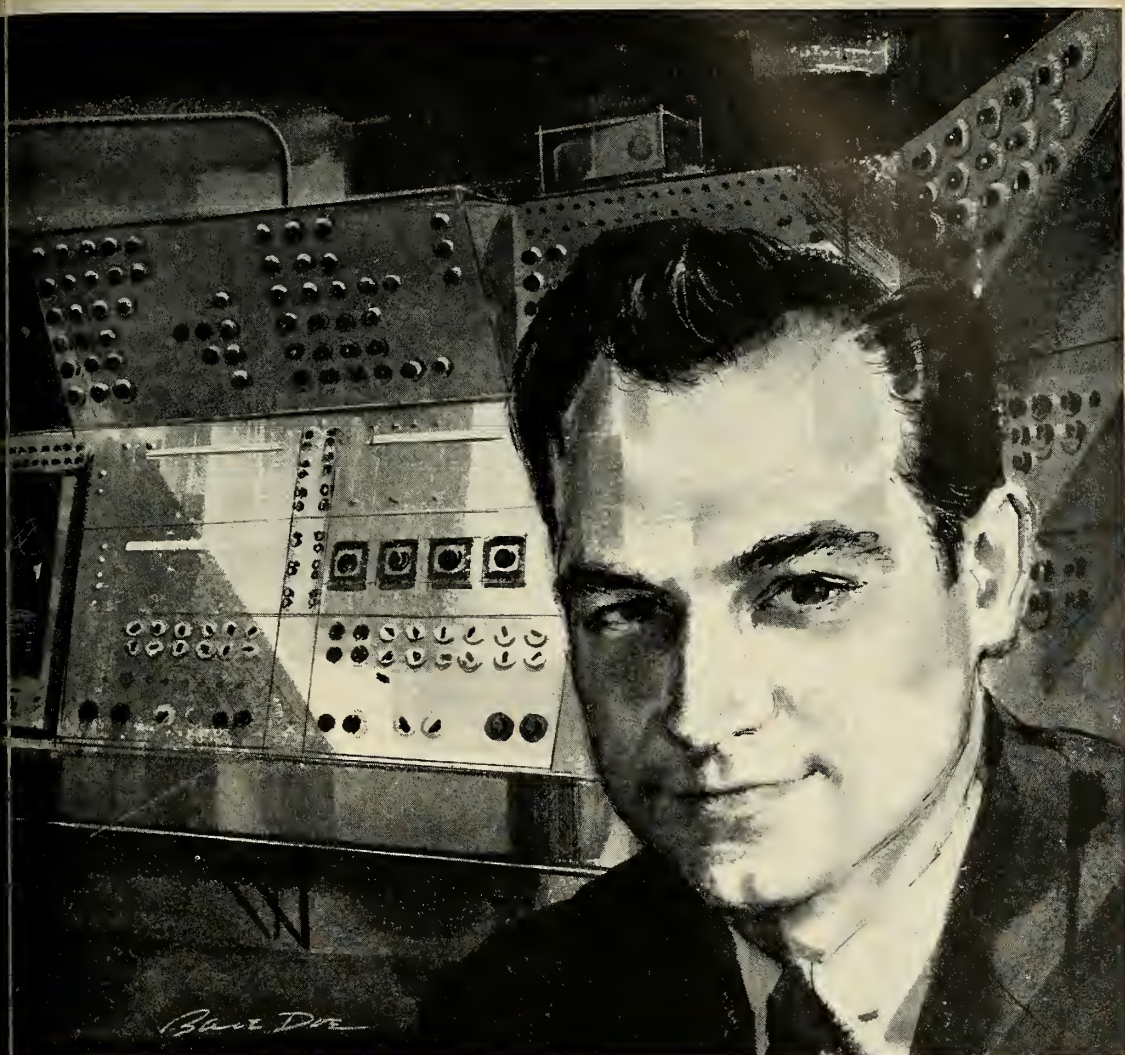
In operation, the system will use storage registers in the analog-to-digital conversion system; one will control code generator to transmit a code representing a data sample quantized in preceding period while the second register is in process of storing a new quantized value. At the end of each word, simple logic reverses the function of the two storage registers. This approach results in nearly a 100% duty cycle transmitted information.

• **Synchronization**—System operation depends of course on proper synchronization of the decoder with airborne encoder. This is accomplished by a special code transmitted at systematic intervals, recognized by a matched filter and detector and used in a phase-locked flywheel sync system to generate a gate signal. This signal enables the "greatest-of" detector during a short period surrounding match interval for each code transmitted.

• **Prototype evaluation**—First measurements of DIGILOCK operation reportedly showed results within 3 db of that predicted. Several elements of the system are not entirely new—in fact they are commercially available. This means that application of the system early missions would not require complete replacement of all components, for example, a world-wide ground station network.

The airborne system particularly lends itself to simple transistorized circuitry and extremely low operational power requirements. The complete airborne system weight, excluding transmitter, is about 5 pounds.

Study of the system as designed indicates that maximum data rates such that one DIGILOCK system provide information bandwidth equivalent, for example, to several typical FM/FM systems and, therefore, be of extreme value in near-future missile system development program



C. L. Hampton

Computer expert Chuck Hampton is a man with problems. As head of our Avionics Division's Computer Applications section, Hampton pits his analog and digital computers against the mathematical intricacies of infrared research, optics, spectral background studies, feedback control, and weapon system design.

At thirty, with a BSEE from the University of Illinois,

Chuck Hampton is a Senior Engineer. He typifies the progress made at Aerojet by younger men of technical distinction, in electronics and many other areas.

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J. Donald Rauth, 41-year-old general



RAUTH

manager of The Martin Co.'s Nuclear Division, was elected vice president of the company, retaining his post as general manager of Martin-Nuclear. Rauth, who joined Martin in 1940 as a draftsman, served in turn as a group engineer, project engineer on the *Gorgon IV* drone program, assistant chief project engineer for the company, and as manager of the Engineering Projects Division. He holds several patents for engineering inventions.

The Marquardt Corp. has established a Marketing Div. and Administration Div. in its Power Systems Group. **Paul J. Papanek** has been appointed director of Marketing and **Richard A. Davis**, director of Administration.

The two new divisions join the other three that make up the Power Systems Group at Van Nuys plant—Propulsion, Controls and Accessories, and Test. Customer Relations, Contract Administration, Marketing Planning, Proposals and Publications fall under the New Marketing Div.

In other personnel changes, **L. E. Dunn**, former chief engineer, has been appointed Test Division director; **R. K. Wead** replaces Papanek as manager-Customer Relations; and **F. M. DeLaval** has been named manager-Marketing Planning.

The new divisions are part of a long-range organizational realignment which began in January.

Robert Beagles has joined Packard



BEAGLES

Bell Electronics Corp. as chief engineer-advanced development, Technical Products Div. Beagles has been associated with RCA, Bendix and North American Aviation during the past 18 years in radar and missile electronics. He comes to Packard Bell after six years with RCA, where he was responsible for systems engineering activities in airborne radar, electronic warfare, and airborne communications and navigation.

Coleman Engineering Co., Inc., has formed a wholly owned subsidiary, Coleman Electronics, Inc., to manufacture the company's "Digitizer" and related automatic data handling and control systems. **T. E. Coalson** has been elected vice president and will serve as general manager of the new subsidiary. **T. C. Coleman** will act as president of both companies. Cole-

man has also promoted **C. A. Brosterhous** to chief engineer and named **R. D. Farnham**, former Eastern manager of the company, director of Customer Relations.

James R. Black has been appointed manager of the Microelectronics Laboratory in the Solid State Electronics Department of Motorola's Military Electronics Division. Formerly an associate professor in Electrical Engineering at the University of Michigan, Black will be responsible for research and development in microelectronics and applications to microminiaturized and integrated function circuitry.

William D. Caffin is contract administrator for the Electromechanical Division of Bowmar Instrument Corp. He was formerly assistant sales manager of Daystrom Transcoil Div., where he served in management and engineering capacities.

Transval Electronics Corp. has appointed



CAMPBELL

Jack Campbell director of government contracts. The appointment reflects the broadening scope of the company's activities in past months in the field of missile, aircraft and drone electronics. Campbell came to Transval from Hayes Aircraft, Birmingham, Ala., where he was project engineer on the C-119 program.

James O. Seamans, new *Sparrow III* program manager for the Missile Systems Division of Raytheon Co., was formerly *Sparrow III* technical director at the Bedford Laboratories, where engineering of the weapon is carried on. Seamans joined Raytheon in 1951 as senior engineer responsible for flight testing after leaving the Western Electric Co. in Winston-Salem.

George S. Schairer was elected vice president for research and development at Boeing Airplane Co.

Adolph Vlcek, Jr., has been named



VLCEK

director of manufacturing at Martin's Baltimore Division, succeeding **Vernon R. Rawlings**, general manager of Martin's newly created Activation Division. Vlcek joined Martin as a metal bench helper in 1930 at the age of 16 and worked his way up to Quality Control manager, tooling manager, and Manufacturing, Engineering and Research manager before promotion to his new position.

Benjamin O. Delaney has been named to the new position of assistant manager for Missile Operations under the Tech Operations Manager at Vitro Laboratory, Silver Spring, Md. Delaney, former head of the Missile Projects department, held several engineering positions, served with the rank of commander in U.S. Navy prior to joining Vitro in 1951.

Dr. Frank E. Swindells has been



SWINDELLS

named to manager of research for photodetectors and chemical search for the Electronic Tube Division of Allen B. Mont Laboratory, Inc. He was formerly manager of chemical research with emphasis on phosphors, after coming to Du Pont from the Photo Products Dept. of E. Du Pont de Nemours & Co.

Leang P. Yeh, telecommunications engineer specializing in communications missiles, satellites and space vehicles, joined Page Communications Engineering Inc., as consultant to the vice president and director of Engineering. Yeh also serves as technical advisor on Pakistan international projects now underway in Libya, Greenland, Iceland, England, and the Pacific Ocean area. Before joining Page, Yeh was with the General Electric Co., and previously spent three years with Westinghouse Electric Corp.

John C. Pitchford, recently retired from the Air Force as a colonel, has been named project manager at Benson-Led Corporation, Los Angeles manufacturer of data processing equipment. He is studying future developments of the company's standard product line. Pitchford's last service assignment was Project Officer for the deployment of IRBM's to NA.

John B. Rittenhouse, Research Group Supervisor in Chemistry at California Institute of Technology's Jet Propulsion Laboratory, was named recipient of award by the American Society for Testing Materials for a paper he wrote on chemical effects of certain acids on metals used in rockets.

Monogram Precision Industries, Inc., has named **Victor Gehrig** and **Robert Lehman** senior vice presidents. Gehrig formerly vice president-production, in charge of Monogram's customer product divisions in Culver City. Lehman, who was general manager of the electronic divisions in Los Gatos, Calif., now heads the proprietary products divisions in company's San Fernando Valley facilities.

Electronic Employment up 50%

Missile electronics are continuing to grow in Florida. A new State Department Commission survey shows the industry now has 15,000 employees compared to 10,000 only a year ago. Total sales are estimated at upwards of \$200 million with annual payrolls totaling about \$60 million.

One of the nation's fastest growing electronic centers, Florida during the past 12 months added 10 new plants and there were 10 major expansions. The survey, incidentally, excludes work being done at Cape Canaveral and Eglin AFB.

Optimistic officials are predicting expansion will continue and that the state's electronic output may triple in five years. **Martin-Orlando**, which has operations only a little over a year ago, now has 6500 employees and is the state's largest single manufacturing employer.

Air Force TIF Being Distributed

The new Air Force missile/aircraft support equipment "Technical Information File" is now being distributed to contractors. First issue of TIF (M/R June 15 p. 21 and M/R June 22 p. 13) contains more than 1500 items which can be used by missile system designers. The first of the catalogue, which will be expanded, is to obtain maximum standardization and minimum duplication of equipment. It may be the forerunner of service-wide TIF.

The 1st National Guard Squadrons at Fort Monmouth, N.J., and the 2nd at Fort Belvoir, Ill., are being equipped with the new **Philco-General Electric**-produced Sidewinder air-to-air homing missiles. The Sidewinder is being installed on F-100 Mustangs flown by the three squadrons.

W. H. Chemical is producing 5000 pounds of high-temperature lubricants for the Air Force. The two polyphenyl ether-bis (phenoxyphenyl) ether and bis (phenoxyphenoxy) benzene will be produced by Wright Air Development Center for engine usage. Production is being handled by the Midland, Mich., plant.

Pioneering cryogenic manufacturer **Cambridge Co.**, Lowell, Mass., has been acquired by **Standard Steel** Corp., from the **Carrier Corp.** . . . For the **Apco Group** West Coast Division, **Thompson Ramo Wooldridge** is plan-



FULL-SCALE model of Project Mercury antenna fairing under test by Collins Radio engineers. Complete communication system, scheduled for delivery this month, is being built by Collins for McDonnell Aircraft. It consists of 14 electronic subsystems providing pilot voice communication during orbit; command functions within capsule for all phases; telemetry during all phases; tracking during orbit; voice communication and beacons for recovery/rescue; plus antennas.

ning a \$2 million plant at Anaheim, Calif. Work will start in September on the facility which will produce hydraulic hardware and other precision missile/aircraft components. . . . Just opened—a 129,000-square foot addition to **Motorola's** Semiconductor Production Division in Phoenix. Company says it's just the beginning of growth pattern for its Arizona operations. . . . In

Mountainside, N.J., the **Cross Co.** of Detroit has acquired **Stephen F. Malaker Associates** and formed **Cross-Malaker Laboratories Inc.** to combine nuclear and electronic sciences "into an overall, integrated, automation concept." . . . On the West Coast: **Electric Steel Foundry**, a missile contractor supplier, has purchased **Pacific Alloy Engineering Corp.** . . . In **Polaris** speed-up **Lockheed Aircraft** is setting up within its Missiles and Space Division a new unit headed by Arthur L. Hubbard. Purpose is to consolidate missile modification and checkout functions for test operations at Santa Cruz and Long Beach and for **Polaris** assembly at Sunnyvale. . . . **Hardesty Research and Development**, producer of filament-wound plastic rocket cases and pressure vessels, is expanding into a 100,000-foot plant at Santa Ana.

USAF Eyes AA-5103

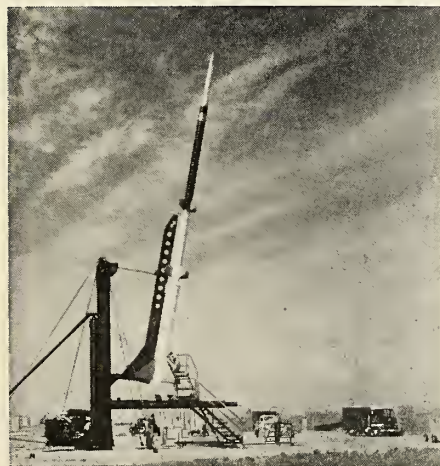
An air-to-ground version of **Nord Aviation's** AA-5103, a two-stage solid-fueled missile controlled by radio link along its entire flight path, is reported under evaluation by USAF.

Nord Aviation has just made a deal with **Bolkow-Entwicklingen** of Germany to manufacture the air-to-air version of the 295-pound missile.

Astrodyne Control Shifts

North American Aviation is acquiring full ownership of **Astrodyne, Inc.**, McGregor, Tex., which it founded jointly with **Phillips Petroleum Co.**, in February, 1958, to produce, research and develop high-energy rocket fuels. Terms were not disclosed.

NASA's Novel Rocket



SIX-STAGE ROCKET designed by the National Aeronautics and Space Administration to test re-entry friction. Unlike other rockets, the stages are phased 1, 2, 3, 6, 5 and 4. The first three boosters send the vehicle up to about 200 miles, while the last three send the vehicle hurtling towards earth at 16,000 m.p.h. The re-entry trail—to the point where the final stage is consumed by friction with the air—is followed by radars and radio receivers.

GUIDANCE

■ As systems manager for such major projects as the Navy POLARIS FBM; DISCOVERER Satellite; Army KINGFISHER; Air Force Q-5, X-7 and X-17; Lockheed Missiles and Space Division is deeply involved in improving existing guidance systems and designing solutions to new problems.

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propulsion engineering

Heat and mass transfer . . .

as they apply to missiles and aircraft are thoroughly covered in a new Air Force bibliography available from the Commerce Department's Office of Technical Services. The 172-page book is not only a bibliography of work in heat transfer and mass transfer, but also a volume of abstracts dealing with specific problems. W. J. Christian and T. H. Schiffman, Illinois Institute of Technology, compiled the volume for Wright Air Development Center. They split the volume into three parts: Local and average mass transfer from surfaces under isothermal and non-isothermal conditions; local and average heat transfer from pertinent airfoil surfaces; and correlations between heat and mass transfer. It's available from OTS at \$3.00. (Order PB 151517.)

Low humidity storage containers . . .

can substitute for some types of dehumidified warehouse storage, says an Army Ordnance research team. Sprayable, strippable plastic containers in which it's possible to maintain low humidity statically or dynamically are reviewed in another Commerce Department, OTS, publication—"Standardization Study of Long-Term Storage Process: Strippable Film Containers," by W. J. Shields and W. F. McTeague, Frankford Arsenal. The 20-page study concludes that the plastic containers "are suitable substitutes for dehumidified warehouse storage of assembled, irregularly shaped material." Essentially, they are simply coatings sprayed on material requiring storage. Advantages: low cost of fabrication and maintenance, mobility of stored wheeled items, light weight, ease of removal.

Storage, without warehouse, up to two years . . .

is possible with the coatings. Storage of more than 10 years is possible with top coatings of mastic, or with mastic and aluminized paint. The report compares adhering and nonadhering film materials and discusses maintenance requirements, cost, and durability of one to three coats. Some industry people have been thinking about these coatings in terms of solid propellants. The report is available from OTS at 75 cents (order PB 151295.).

Astrodyne's insulation . . .

for solid-propellant motors may soon find some non-missile civilian uses. At least that's the hope of Astrodyne officials who say one firm already is interested. Astrodyne will not name the firm, its field of operations, or its possible use for the rubber and asbestos material described in this column July 6. Officials say that in the meantime prospective users of the material probably still have to be defense contractors, but "the situation hasn't come up yet." The insulation itself is not actually classified, but Astrodyne and the Navy are guarding details of its composition. Possible civilian uses—Astrodyne will neither confirm nor deny any of these—include insulation for high-temperature reacting vessels or combustion chambers; packaging; railroad refrigerator car and reefer truck liners.

Beryllium patent is available . . .

for public use. Patent number 2,872,363 has been released by the Atomic Energy Commission. It is for a "Method of Working Beryllium." A beryllium billet is sheathed with a jacket of copper or stainless steel. It can then be worked by drawing or similar means at 570°F to 750°F. Another patent just released by AEC (No. 2,872,310) is for producing a binary zirconium antimony alloy which is extremely hard and corrosion-resistant.

els' 'Zoonik' Launching uses Calm Speculation

WASHINGTON—Russia's announced launching of two dogs and a rabbit has raised more speculation than an.

Radio Moscow began excitedly and gratefully to announce the launching of the "zoonik" July 6—four days after it took place.

The Russians said the dogs—Otvazhnaya and Snezhinka—and an unidentified rabbit were boosted to a great height" by an IRBM and successfully returned to earth.

The payload weighed more than 100 pounds. The Russians said it was



THESE dogs, shown training in rocket launch, may have taken latest flight.

heaviest ever hurled into space. (M/R Oct. 20, 1958)

No figures were released on how long the dogs and rabbit traveled.

The Russians said the launching preceded Otvazhnaya's third trip into space. It came six weeks after the first launch of Monkeys Able and Baker in the nose of a *Jupiter* and successfully recovered them more than 100 miles down the Atlantic Missile Range.

The Russians said instruments aboard the dog and rabbit flight telegraphed information on the ionosphere, air streams and the ultraviolet part of the solar spectrum.

The Russians attempted to make the most of the launching. Radio Moscow interrupted a broadcast of a football match to announce the four-day news. The bulletin then was announced repeatedly and Soviet academicians hailed the event as "another triumph of Soviet science."

Soviet commentators declared that the missile that launched the "zoonik" was the most powerful single-stage

booster ever launched to date. They said it was "much stronger than anything the Americans have."

However, the Russian boasts brought little of the alarm previously produced by Soviet space feats.

Despite the Soviet boasts of paving the way for space flight, the "zoonik" was nothing particularly new. Russia has announced repeated launching and recovery of dogs. The United States has recovered two monkeys.

Moreover, the announcement followed more than six months of Russian silence. Not since the sensational launching of *Lunik* have they indicated activity in space exploration. And U.S. scientists have been expecting the worst—an announcement that Russia has put a man into orbit.

The reaction is speculation as to whether Russia's space program may—for some unknown reason—have slipped.

Missile Designed for Firefighting

SAN DIEGO—Solar Aircraft Company has devised a new guided missile fire fighter that is launched like a rocket and hovers like a helicopter.

Conceived by Solar engineers, and dubbed the "Firefly," it will reportedly fly anywhere within five miles in 40 seconds, just a fraction of the time required by conventional firefighting equipment. It is fired and guided by push buttons to its destination, an air crash or other site of potential fire.

After reaching a crash scene, the unmanned craft turns into a helicopter and hovers over the area. The remote operator can then flip a switch releasing more than a ton of extinguishing liquid over the danger area.

According to Solar engineers, the *Firefly* does not require any new technology, but can be built by perfecting existing systems.

With helicopter blades in its tail and a fire nozzle in its nose, the *Firefly* looks like a small jet aircraft. A solid propellant rocket under the fuselage shoots the missile into cruise altitude. When in flight, Solar reports, the bird operates as a fixed wing aircraft.

The three rotor blades are locked back to serve as tail surfaces. It is transformed into a helicopter by unlocking its rotors and firing up small

rocket motors in each rotor blade tip.

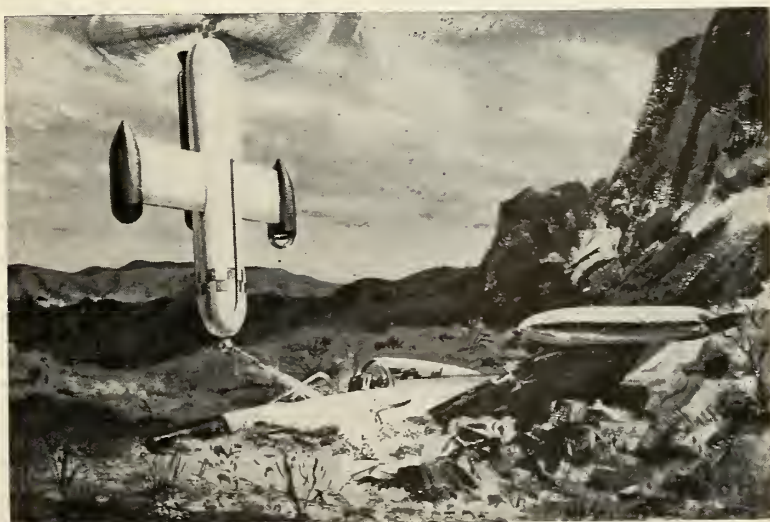
Solar engineers report that the missile-helicopter reaches its goal in three flight stages: 1) a ballistic trajectory, 2) powered level flight and glide and 3) deceleration and hovering.

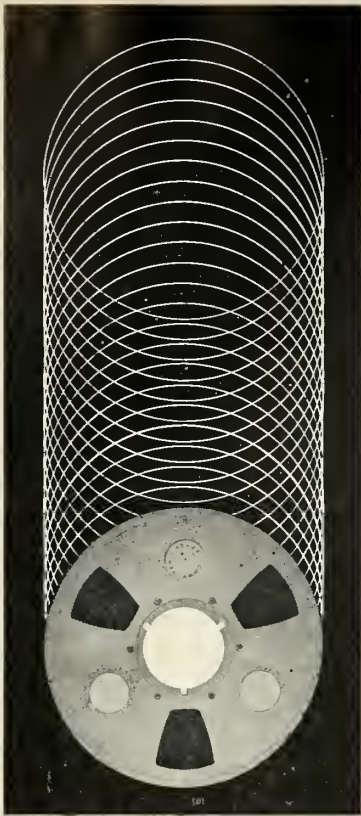
The bird picks up commands from a remote operator through an electronic "brain," and translates these into mechanical control of its devices. Radar and electronic sensing devices in the vehicle enable the operator to discover where and how severe a fire is and where and how much fire extinguishing fluid to release.

Mounted on a launcher which has a quick-opening metal-ribbed plastic housing for protection against inclement weather, the *Firefly* would be placed opposite a control tower near landing strips of an airfield.

Ground controls, consisting of a console and radar panel, would be located in the airfield's control tower. The radar can be tied in with equipment already present at most military and commercial airfields, Solar says.

The *Firefly's* body, exclusive of rotors and dispensing nozzle, is some 16 feet long, and its wing span is about the same. It weighs about 5000 pounds, including its payload of extinguishing fluid.





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west coast industry . . .

By FRED S. HUNTER

Someone said recently, "You can't fire unemployment statistics at the Russians." This seems to us to be a reasonably sagacious observation on the political byplay going on between the congressional delegations from New York and California over the distribution of defense contracts. There's no argument about California having a disproportionate share of present defense contracts. But there's also no argument about California having the research capabilities, the test centers, the manufacturing facilities, the trained personnel and the overall know-how to do the weapons job. You can't change these factors by legislation.

Keeping factory doors open in a phase . . .

of defense procurement which the various military services have to take into consideration. You'll recall the hue and cry that went up in California when the Air Force cancelled out the *Navaho* intercontinental missile and **North American Aviation** promptly began laying off employees. Then, a little later, North American picked up two juicy contracts, one for the F-108 and the other for the B-70, and a lot of people were surprised because the B-70 contract didn't go to **Boeing**, the Strategic Air Command's specialist in big bombers. So what happened? Boeing became a partner for development and assembly of the wing and is in the B-70 program in a big way.

Invitations to submit proposals for the missile . . .

carrier for the *Eagle* project have been issued by the Navy to several of its experienced prime contractors, such as **Chance-Vought**, **Douglas-El Segundo**, **Grumman**, **McDonnell** and **North American-Columbus**. We'll venture a prediction that the manufacturer capturing this plum will be Chance Vought. Our reasoning takes into consideration the cancellation of the *Regulus II* and the F8U-3. We're assuming, of course, that there will be little to choose between designs submitted and that all will meet requirements.

First blasts from the X-15's rocket engines . . .

will be echoing in the upper altitudes over Utah and Nevada by the end of this month or early in August with the first powered flight of the research craft. Of comparable significance is the fact that the No. 3 aircraft has been turned over to the flight test group, completely finished as far as manufacturing is concerned. This is the vehicle in which the big 60,000-pound-thrust engine being specially developed by **Thiokol's Reaction Motors Division** will be installed first. Later on, the No. 1 and No. 2 planes will be retrofitted. North American has a group test engine at Edwards Air Force Base now and is scheduled to get a flight engine before long.

Research activities keep right on . . .

becoming more diverse and complex in the missiles and rockets industry. **North American's Rocketdyne Division** recently found it advisable to reorganize its research department into two groups, one a physical sciences section, the other an engineering sciences section. Under physical sciences come physics and mathematics, combustion and heat transfer, electrical propulsion and a chemical group comprising theoretical chemistry and chemical engineering. Under engineering sciences come propulsion devices and systems, experimental instrumentation, research design and a special-products group made up of igniters and special devices, igniter fabrication and solid propellant process development.

Peter Masefield, Bristol Aircraft managing director . . .

evoked an appreciative laugh at the recent IAS session with this observation: "The principal function of an advanced design department nowadays is to keep up with the public relations department."

missiles and rockets, July 13,

contract awards

NAVY

\$6,000—Newport News Shipbuilding and Dock Co., Newport News, Va., for construction of two nuclear-powered submarines that will carry *Polaris* missiles.

\$1,541—Electric Boat Div., General Dynamics Corp., N.Y., for construction of a nuclear-powered submarine that will carry *Polaris* missiles.

\$1—Hazeitine Electronics Div., Hazeltine Corp., Little Neck, L.I., N.Y., for design, development, testing and production of one intercept tracking and control group AN/SPA-43.

\$0—Massachusetts Institute of Technology, Cambridge, for conducting a feasibility study encompassing those aspects fundamental and applied research needed for the evaluation of a high-speed computer system.

\$16—Heintz Div., Kelsey Hayes Co., Philadelphia, for FFAR rocket head.

\$47—American Machine & Foundry Co., Palo, for warhead, MK37-0.

\$8—Raytheon Manufacturing Co., Waltham, Mass., for investigation of methods improving the operation of cross-field electron beam devices.

\$0—North American Aviation, Inc., Missions, Downey, Calif., for conducting an engineering study of the application of sandwich and/or other lightweight structural design and/or combination thereof, to the hydrofoil and struts of Sketch PD 4374. Titanium skins to be used.

\$7—Philco Corp., Philadelphia, for variable type oscilloscopes.

\$—Cooke Engineering Co., San Mateo, Calif., for assembly and check-out of missile tracking units.

\$—Whirlpool Corp., Saint Joseph, Mo., for developing, testing and furnishing Type I thermoelectric temperature-controlled chambers including control circuitry and power supplies.

\$39,085—Sperry Rand Corp., Sperry Gyroscope Co., Div., Sunnyvale, Calif., for research and development of missile-aircraft interference study.

\$36,004—Nuclear Electronics Corp., Philadelphia, for radiac computer-indicator (Scaler) CP-297.

AIR FORCE

\$6,000,000—Avco Corp., Lycoming Div., Stratford, Conn., for production of missile rocket chambers for second- and third-stage chambers of "second generation" Minuteman ICBM.

\$2,000,000—Westinghouse Electric Corp., for manufacture of experimental "hardware" for infrared, reconnaissance, communications, telemetry, flight control and other military applications, using molecules as building blocks.

\$1,500,000—Telecomputing Corporation, Los Angeles, for the manufacture of spare valve components.

\$810,000—Massachusetts Institute of Technology, Dept. of Aeronautical Engineering, Instrumentation Laboratory, Cambridge, for study, design, fabrication and test of advanced inertial navigation system.

\$800,000—The W. L. Maxon Corporation, N.Y., for fabrication and testing of a flyable model of the AN/APS-99 (XY-1) radar.

\$796,664—Thiokol Chemical Corp., Utah Div., Brigham City, for 88 M-16E-1 rocket engines for the Mace missile.

\$500,000—American Electronics, Inc., Los Angeles, for design and manufacture of tactical ground support equipment for the B-58 "Hustler" jet bomber program (subcontract from Convair Div. General Dynamics Corp.).

\$439,986—Aeronautical & Instrument Div., Robertshaw-Fulton Controls Co., Anaheim, Calif., for helium pressure regulators for use on the Titan ICBM (subcontract from The Martin Co., Denver).

\$331,416—Sperry Rand Corp., Sperry Gyroscope Co., Div., Great Neck, L.I., N.Y., for microwave command guidance system operation and support.

\$192,000—Sperry Rand Corp., Sperry Phoenix Co., Div., Phoenix, Ariz., for guidance data transponder set.

\$191,227—Motorola, Inc., Chicago Military Electronics Center, for electron tubes.

\$159,940—Wentworth Institute, Boston, for research directed toward physical and chemical properties of the upper atmosphere.

\$90,000—Stanford University, Stanford, Calif., for continuation of research on "Microwave Solar Radiation."

\$50,301—Eitel-McCullough, Inc., San Carlos, Calif., for various electron tubes.

\$42,079—Littion Industries of California, Beverly Hills, for continuation of research on "Electromagnetic Acceleration of Gas Plasmas."

\$38,574—University of Illinois, Urbana, for investigation of the use of internal friction techniques in the study of diffusion and phase changes in metals.

\$35,000—The Catholic University of America, Washington, D.C., for continuation of research on "Studies of Molecular Physics."

\$30,000—University of Western Ontario, London, Canada, for research on gas scintillations from ionizing radiations.

\$28,980—Mass. Institute of Technology, Cambridge, for continuation of research on "Fracture under Plastic Flow."

ARMY

\$60,159,214—Western Electric Co., N.Y., for work on the Nike-Hercules system, including missiles, ground equipment, repair parts, engineering services and improvements on the system (five contracts).



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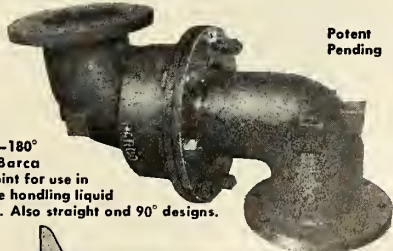
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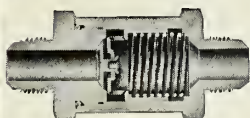
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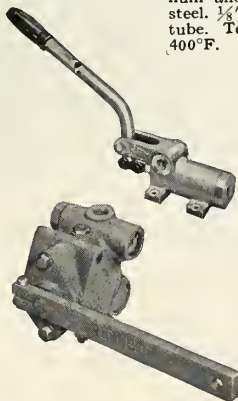


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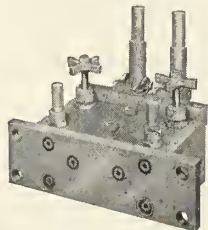
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contracts

- \$13,235,000—Food Machinery & Chemical Corp., N.Y., for construction, and test operation of a Chemical Corps production facility near Newport, Ind. (Prime contractor, The Lummus Company).
- \$13,141,192—Chrysler Corp., Detroit, for repair parts on the missile program.
- \$8,295,767—Raytheon Co., Waltham, Mass., for ground equipment support equipment and engineering services for the missile (four contracts). Contractor has subcontract work for the following and desires that subcontractors be located in the Northeast area: Drafting services, specifications and technical, manual preparation.
- \$6,938,450—Blaw-Knox Company, Pittsburgh, Pa., for construction of six Atlas launching complexes at Forbes AFB, Topeka, Kan.
- \$4,800,000—Western Electric Co., N.Y., for research and development study for a universal integrated communications system (Unicom).
- \$1,572,334—Independent Contractors & Engineers, Dallas, for construction of launch operations buildings, complexes A, B and C near Forbes AFB, Topeka, Kan. No subcontracts open.
- \$1,415,169—Henry George & Sons, Spokane, Wash., for operations buildings, site and utilities for SM-64 missile complexes A, B and C, near Fairchild AFB.
- \$1,000,000—General Electric Co., for outdoor substations and switchgear for the AF Ballistic Missile Early Warning System at Thule, Greenland (subcontract from Greenland Contractors, Trenton, N.J.).
- \$430,080—Ampex Corp., Los Angeles, for recorder/reproducer.
- \$385,411—C. H. Leavell & Co., El Paso, Texas, for missile assembly building at White Sands Missile Range, N.M.
- \$320,169—Rheem Manufacturing Co., Downey, Calif., for development of warheads.
- \$254,460—M.B. Electronics, Inc., New Haven, Conn., for an integrated complex wave vibration testing system.
- \$219,652—Western Electric Co., Inc., N.Y., for Nike spare parts and components (six contracts).
- \$170,632—Consolidated Electrodynamics Corp., Pasadena, Calif., for oscillographs (two contracts).
- \$167,694—Douglas Aircraft Co., Inc., Santa Monica, Calif., for parts and launching area items (three contracts).
- \$157,558—B. B. Saxon, Port Walton Beach, Fla., for construction of two Model IV B launcher shelters for G/M launch 11 at EST site, Santa Rosa Island, Eglin AFB, Fla.
- \$105,728—Douglas Aircraft Co., Inc., Charlotte, N.C., for spare parts and components (three contracts).
- \$84,289—ARF Producers, Inc., Raton, N.M., for three missile indicator ground stations.
- \$66,854—Mandrell Industries, Burbank, Calif., for airborne instrument system.
- \$61,690—Cooper Development Corp., Monrovia, Calif., for 32 motors, 32 window darts, 62 pyrotechnic fuses.
- \$50,893—Dana Corp., Toledo, Ohio, for power take-off.
- \$46,800—Dynamics Research, Inc., Los Angeles, for liquid nitrogen converter.
- \$43,118—Anderson-Nichols & Co., Boston, for development and construction of one data recorder reproducer instrument.
- \$35,878—Goodrich-High Voltage Astronautics, Inc., Burlington, Mass., for research on detailed technical scope of first demonstration of thrust.
- \$35,175—Union Carbide Corp., National Carbon Co., Div., N.Y., for power pack Y-155 for M31 rocket.
- \$25,726—Beckman & Whitley Inc., San Carlos, Calif., for streak camera with accessories.

BIDS

- U.S. Army Engineering District, Detroit, Corps of Engineers, 1101 Washington Blvd., Detroit 31, Mich.—Construction of tower, including all related work necessary and appurtenant thereto at Selfridge Air Force Base, Mt. Clemens, Mich.—IFB Eng-20-064-59-99. Bid opening 16 July 1959.
- Dayton Air Force Depot, Gentile Air Force Station, Dayton, Ohio—Directorate of Procurement and Production. Tube electrode type 5957-E-37B in A/W Spec MIL-E-1011A (sig) dated 1958 and MIL-E-1D dated 31 March 1958 S/N 5960-581-9958 each—IFB 33-604-59-779B. Bid opening 28 July 1959.
- Directorate, Procurement and Production, Middletown Air Materiel Area, Olmsted AFB, Pa. 9135-305-8199 (GSSF) propellant dimethyl hydrazine in accord with Spec MIL-D-25604B dated September 1958. Delivery to be made in contractor-furnished returnable drums or Government-furnished drums at the option of the Government (to be packed 350 lbs. per 55-gal. drum). Indefinite quantity. IFB 36-600-59-480. Bid opening 15 July 1959.
- Electronics Supply Office, Great Lakes, Ill. Tube, electron: type 6249AA, MIL-E-1D, QFL, FSN N5960-543-1143—200 Alternate A—300 each; alternate B—400 each. Estimate each. IFB 126-1283-59B. Bid opening 21 July 1959.

missiles and rockets, July 13,

when and where

JULY

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.

American Rocket Society, Propellants and Combustion Committee, "Propellants, Thermodynamics and Handling Conference," Ohio Union, Ohio State University, Columbus, July 20-21.

10th Annual Institute on Missile Technology, Chief of Research and Development, U.S. Army, University of Connecticut, Storrs, July 26-Aug. 7.

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

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AUGUST

Institution of Investigation of Biological Sciences, Sponsor: Air Force Office of Scientific Research, Aeromedical Div., World Health Organization, Montevideo, Uruguay, Aug. 2-7.

Association of the U.S. Army, Annual Meeting, Sheraton-Park Hotel, Washington, D.C., Aug. 3-5.

American Astronautical Society, Second Annual Western Regional Meeting, Ambassador Hotel, Los Angeles, Aug. 4-5.

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

Institute of Radio Engineer's Professional Group on Ultrasonics Engineering, First National Ultrasonics Symposium, Stanford University, Stanford, Calif., Aug. 17.

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

American Rocket Society, Gas Dynamics Symposium, Northwestern University, Evanston, Ill., Aug. 24-26.

Institute of the Aeronautical Sciences' National Specialists Meeting, A Symposium on Anti-Submarine Warfare, (classified), San Diego, Aug. 24-26.

Army-Navy Instrumentation Program, Annual Meeting, Symposium and Industry Briefing, Statler Hilton Hotel, Dallas, Aug. 31-Sept. 2.

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

SEPTEMBER

Air Force Office of Scientific Research and General Electric Company's Missile and Space Vehicle Department, Conference on Physical Chemistry in Aerodynamics and Space Flight, University of Pennsylvania, Philadelphia, Sept. 1-2.

University of California, 1959 Cryogenic Engineering Conference, Berkley, Calif., Sept. 2-4.

Air Force Association and Panorama: send Reservations to AFA Housing Bureau, P. O. Box 1511, Miami Beach, Sept. 3-6.

AFOSR/Directorate of Aeronautical Sciences, Office of Naval Research, National Science Foundation, Sixth Midwestern Conference on Fluid and Solid Mechanics, University of Texas, Austin, Sept. 9-11.

Institute of the Aeronautical Sciences, Western Regional Meeting on Frontiers on Science and Engineering, Los Angeles, Sept. 16-17.

Standards Engineering Society, Boston Section Eighth Annual Meeting, Hotel Somerset, Boston, Sept. 21-22.

Instrument Society of America, Conference and Exhibit, Chicago, Sept. 21-25.

Industrial Nuclear Technology Conference, sponsored by Armour Research Foundation of Illinois Institute of Technology, Nucleonics Magazine, and Atomic Energy Commission, Morrison Hotel, Chicago, Sept. 22-24.

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Components Reliability: What's Needed?

The velocity of change in the exploding fields of missiles and their related technology is so great that each day's effort brings new concepts, new designs and new developments.

Still there apparently never seems to be a lack of such choice phrases as: "Let's advance the state-of-the-art," or "We have to beat them to . . ." (and you name the astronautical position), etc.

This is all well and good because this nation advances when there's a sense of urgency in the prodding. But it occurs that there's still lethargy in one important area; components reliability.

On page 14 of this issue of M/R, a guest writer makes the point that "too much engineering time and attention has been devoted to perfecting an *assembly* of complicated components, and not enough to perfecting individual parts and—even more important—the basic materials themselves." He says that a by-product of this misplaced emphasis is that much R&D effort is expended not in the laboratory but on the shop or factory floor—the *least efficient and most expensive place for R&D*.

To this we would like to add another tragic fact: Too many thousands of components going into missile systems are *not designed specifically* for the particular missile involved. In far too many instances they're off-the-shelf components usually designed for a variety of applications which too often are either modified or put beyond their performance parameters to fit into a missile system. Missile failures frequently are the costly result.

Let's cite some statistics pertaining to the *Nike-Hercules*. The system consists of approximately 1,500,000 individual parts, ranging in weight from the smallest fraction of an ounce to hundreds of pounds. It contains one quarter of a million feet of wire, two thousand vacuum tubes, and a host of functional components, such as gyroscopes, servo-mechanisms, and electronic computers. Approximately 80,000 engineering drawings are required to depict the system on paper. The prime contractor utilizes 3300 subcontractors and suppliers scattered across the country. The system alone uses—directly or indirectly—practically every raw material used by American industry, and provides work to some extent for nearly every type of industry in the country.

With so many subcontractors and suppliers it is virtually impossible for the prime, military or major subs, to specify in precise detail the performance

parameters for *each* component. What usually happens is that in known critical systems areas, great reliability attention is paid to some components, while other components that might be subjected to the same vibration, shock and g-forces go practically unnoticed. The choice phrase—"random" failure is then offered to the public.

There is the argument that missile systems would be priced out of the pocketbook of the American taxpayer if each component were designed for a *specific* missile application. Components manufacturers themselves are reluctant to fire up assembly lines and produce for a *specific* application. "Why should we," many say, "when we can make one item and sell it to *many* customers?"

But as man prepares for space, government and industry are becoming more cognizant that he is too valuable a commodity to risk on a 98.2% reliability factor. More will be required to satisfy an American public which will become irate and aroused when the first life is lost.

Won't it be a little bit too late then to explain why more emphasis was not placed on this field? This fact should be told now: the reliability standards necessary for man in space will entail far more government action and fund support than has ever been evidenced in the past decade of missile development.

To say that it will be costly is an understatement. But you don't build a high-speed racing car that wins high-performance races by revamping an existing 65 hp engine. In the same way, you don't develop highly reliable spacecraft by using the same parts that are in the home television set.

What do we do about all this? First, it will be up to government to strengthen its present, mostly inadequate reliability requirements to such a par—as the enviable standards being achieved with fuzing and arming. Next, government must furnish the financial incentive for components manufacturers to start designing parts from the ground up. We must insure that components are given the most thorough testing in the laboratory—not in the shop or at a firing range—before they are wedded into the subsystems picture.

Then and only then will we see a *marked* improvement in reliability. Maybe then the scientists can quit sending up missiles with just prayers and hopes. We'll have something we *know* will work. This is as the science of rocketry should be.

Don Perry

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NEW PRODUCT BRIEFS

TUBE. An advanced type of intensifier tube that can "see" the faintest star or the faintest atom developed by the Westinghouse Electric Corp.'s electronic tube division. The new tube amplifies the light from one end to produce an image as much as 3000 times brighter than the fluorescent screen at the opposite end. The most important use of the new tube is expected to be in the nuclear field where it will permit photographic recording of atomic particle reactions. Two members of the Michigan Physicists, Marshall and Lawrence W. Jones, have used the tube in a luminescent system to produce photographs of the path of a single particle. Pictures can be taken of the tube of the minute light scintillation that occur when certain materials are struck by nuclear particles produced by "atom smashers." The nature of these fleeting scintillations gives information on the nuclear reactions being observed. In astronomy, the tube can further intensify the light from giant telescopes when viewing distant stars, or it could be used in the future to obtain pictures of far distant galaxies. The tube can amplify its own output simply by reflecting the light output back through the tube with a system of mirrors. Four tubes feeding into each other would be able to produce the output of a single photoelectron.

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NEUTRON TUBE. A new high-sensitivity neutron counter tube, WL-7243, designed to detect thermal neutrons in a range from 8×10^{-3} to 8×10^3 counts/cm² per second is now available from Westinghouse Electric Corporation. Consisting of an aluminum body, the tube consists of three individual neutron counters; each one inch in diameter and 10 1/2 inches long and filled with BF₃ enriched to 96 per cent with ¹⁰B. Operating at room temperature, the sensitivity of the WL-7243 is approximately 13 counts/neutrons/cm². Pulses arising from incident neutrons are sufficiently small to be processed out by suitable discrimination circuitry.

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PULSE GENERATOR. A completely transistorized battery or ac operated pulse generator has been announced by Solidyne. The unit features a design allowing versatile operating characteristics without the penalty of size, weight and heavy power drain usually associated with such units. Compactness and low power drain (less than 2 watts) are accomplished by unique transistorized circuitry. Short-circuit proof 15-volt positive and negative pulse outputs are provided with separately controlled amplitudes. Pulse width can be varied from 0.5 to 100 microseconds with a rise time less than 0.1 microsecond. Repetition rate can be continuously varied between 20 and 5000 pps and provision for an external sync. source is featured. Output pulse delays of up to 100 microseconds and anticipation up to 10 microseconds, relative to sync. output, are also included.

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MIDGET RELAYS. Kurman Electric Company, a subsidiary of Crescent Petroleum Corp. has introduced the Series 51C Midget Relay; the smallest, lightest plate circuit relay offering self-wiping contacts, dc operation only. Standard adjustment—10 milliwatts. (51CB44D factory adjusted for 5 milliwatt operation—others can be field adjusted—1 amp contact rating.) Adjustable 2 amp SPDT screw contacts. New rigid front pile-up. Variations—including 5 amp contact, H. S. Military relays coils to 20,000 ohms available. Mounting 2 #6-32 tapped holes on 0.437" centers.

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OHMMETER. A new technique for accurately measuring low resistances (milliohms) has been devised by Electro Instruments, Inc. Possible applications include measuring the resistance of fuses, conductors and transformer windings. The new instrument will measure resistance to an accuracy of ± 1 milliohm over the full range of 1 milliohm to 9999 milliohms. Sensitivities of 100 microhms are available at slightly reduced accuracy. Scanning and print out modules can be added to form automatic component testing systems.

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MISSILE LITERATURE

PRESSURE SWITCHES. Consolidated Controls Corporation, a subsidiary of Consolidated Diesel Electric Corporation, has issued a new condensed catalog covering airborne pressure switches. The catalog lists general-purpose pressure switches, including pneumatic and hydraulic types, high vibration models and differential pressure units. In addition, special application units, such as altitude switches, high-temperature (650-degree Fahrenheit) models and pressure ratio switches, and aircraft gauges are discussed.

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FERRITE DEVICES. Two new catalog sheets summarizing data on coaxial ferrite isolators and "Tee" ferrite circulators have been made available by Sylvania Electric Products Inc. Sylvania is a wholly-owned subsidiary of General Telephone & Electronics Corporation. Twenty-three types of coaxial ferrite isolators are shown on one of the sheets, covering frequencies from 1 to 11 kilomegacycles. Available units cover an octave of bandwidth over this range. The units offer isolation between 10 and 35 db with 1 db of insertion loss. Any of them can be delivered with up to 80 db isolation, according to Thomas D. Fuller, marketing manager of Sylvania's Special Tube Operations. "Tee" ferrite circulators as small as one-fourth the size of conventional circulators are described on the other sheet. The miniaturization has been achieved in part by designing the units in a shunt T configuration. One of the new units described, the broadband FD-TC501, offers 20 db isolation at 0.3 db insertion loss from 5.925 to 6.425 kilomegacycles.

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THYRATRON. A new technical bulletin from CBS-Hytron, tells how Thyatron tubes differ from conventional amplifier types. In it, author Bud Tomer explains the mechanism of ionization, describes the "critical characteristic" curve, and discusses the effects of temperature on ionization time and tube life. Installation precautions are also given.

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GENERAL CATALOG. The Electro Mechanical Instrument Division of Consolidated Electrodynamics Corp. announces the availability of its new General Catalog. The divisions's entire line of dynamic-measuring and recording instruments including oscillographs, data amplifiers and bridge balances; vibration measuring equipment; and power supplies is described. A summary of specifications for CEC standard galvanometers is also included.

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BROCHURE. A brochure has been released by M. Ten Bosch, Inc. describing three basic Force Balance Pressure Transducers; Static Pressure, Pressure Ratio, and Pressure Difference. Transmission of computed quantities by means of electrical servo loops permits remote indication and tie-in with navigational computers, autopilots and other systems for aircraft and missile control are described.

Circle No. 204 on Subscriber Service Card.

WELDING MANUAL. The American Welding Society has announced publication of an Arc Welding Manual specifically designed for teachers and instructors of manual arc welding. Contents include welding processes and recommended safety practices, the metal-arc process, arc exercises in arc welding, arc equipment, identification of metal metals and their structure. Prolustrated, the manual contains drawings, halftones and tables. Material was prepared in response to requests from schools and industry for a training manual of basic arc information which would be a guide for instructors and a reference for students. Fifty pages are devoted to arc exercises and the various techniques to be mastered by following the instructions.

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CATALOG. Will Corp.'s latest supplement describes the new "StereoZoom" microscopes with interrupted, continuously variable magnification and the 1959 Precision Ovens with electronic temperature control and higher heat range. Of interest is the newly-designed constant Temperature Circulator-rer, pump and temperature controller in one unit. The CTC is housed compact and shock resistant chamber is equipped with a transistor circuit for precise control of temperatures. Other items include temperature determination, direct-reading thermometer that simplifies dry'n wet times, and flexible, waterproof, tapes which won't burn out end are for heating large bulky containers conducting pipes.

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RECTIFIERS. A handbook on rectifiers has been issued by Electric Co. This book, which should be of interest to all design engineers, contains basic information on the products and design characteristics. It details all rectifier components manufactured by GE, contains application work circuit information, cooling, and insulation techniques.

Circle No. 207 on Subscriber Service Card.

BULLETIN. A new four-page technical bulletin, No. 2024, describing a range frequency converter for 15,000 cps inputs is now available from Cox Instruments Division of General Nankervis Company. The Cox T-Frequency Converter described in the literature is designed to meet requirements in laboratory and applications. It is readily adapted to all types of pulse generating transducers. Applications include recorders, computers, digital indicators, millivoltmeters and data handling equipment. Conversion application specifications are given in the bulletin discussion and data, including frequency range, linearity at various output ratios, signals required; output current; linearity; accuracies; time constants; power requirements; and price list for standard and modified versions.

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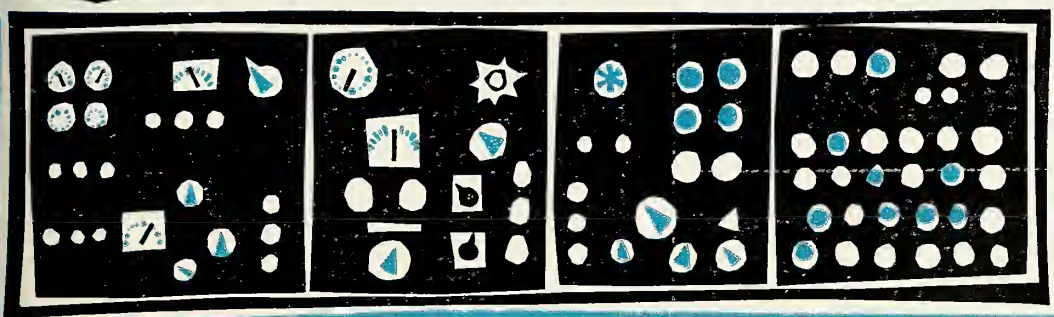
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