JULY 13, 1959

HONEST JOHN IN ITALY

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

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 ta on the craft and larger payloads.

Inertial navigation systems will pla increasing role in the exploration of o space. ***ARMA***, now providing such tems for the Air Force ATLAS ICBM, be in the vanguard of the race to o space. ***ARMA*** . . . Garden City, N A Division of American Bosch Arma C

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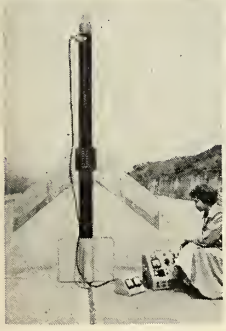
ABC AUDITED PAID CIRCULATION NBP READERSHIP Eastman RESEARCH

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).

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

JULY 13 HEADLINES

ASTRONAUTICS ENGINEERING

ASTRIONICS

MISSILE SUPPORT

NEW MISSILE PRODUCTS

THE MISSILE WEEK

DEPARTMENTS

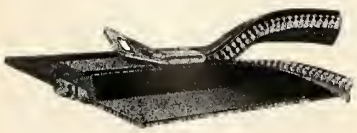
Zippered nose cone cover foils moisture, dust, abrasion

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 pa In addition, the space-saving B. F. Goodrich Zipper—u widely for air ducts, inspection ports, access doors, and aile gap seals—withstands any pressure up to the maxim strength of the zipper itself. And it, too, can be fitte complex contours.

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



B.F.Goodrich ***aviation produc***

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.

• • •

Curtailment 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 advan nature of the assignments. Please inquire by writing directly Dr. Allen Puckett, Assoc. Director, Hughes Systems Deve ment Laboratories.

the West's leader in advanced electronics **HUGHES** *Hughes Aircraft Company, Culver City 54, California*

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.

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.

NORAIR Hawthorne, California
A Division of ***NORTHROP CORPORATION***

NASA Braces To Fight Cuts

by Paul Means

VASHINGTON—Two Russian dogs ed Snowflake and Daring, and an med Russian rabbit could be A's best bet to rejuvenate Con-'s flagging interest in space re-ch.

The latest Soviet space experi- came after the House lopped 68 million from NASA's supple-tal FY '59 and FY '60 budgets, just before the Senate began its erations.

Congress leaped into action after Russians orbited *Sputnik 1* in ber of 1957, claiming that the inistration had been stingy with e research money. NASA hopes the latest Russian experiment will arly shake Congress out of its ent lethargy.

• **What could happen**—If the space cy *has* to make do with $68 mil-less, it may mean that the whole A schedule for space research, in-ng Project *Mercury's* attempt to the first man in space, will have e revised.

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

he cut will also mean less space re-h, without the insurance in some of back-up shots in case the experiment fails.

• **One-two punch** — The House's t-face on money for space re-h culminated last week when the e Appropriations Committee d to cut the NASA budgets by 500,000. Committee member Rep. rt Thomas (D-Tex.) defended the by stating that NASA had more ey than it could spend wisely.

dding to space agency's woes was chnical point of order raised by H. R. Gross (R-Ia.) which elimi-d what was left of the $48,354,000 he NASA FY '59 supplemental. Gross pointed out that a recently d law forbids the House to appro-e money for NASA not "here-" authorized by the House Com-e on Sciences and Astronautics. Committee had authorized the lemental 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. Glennan 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 fore funds later in the year. (See M/R, April 20, page 24.) Dr. Glennan 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, chairmanned 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 ever-mounting number of new spawned in the dawning of the Age.

Illustrative of what is happeni the case of **Itek Corp.** Founded two years ago by four Boston U sity engineers, Itek now has more 700 employes engaged in classifie connaissance satellite and other work. In quick order it bought plant on 128, leased 65,000 squar of the **Waltham Watch Co.** works is planning to build a laboratory 43-acre site in Lexington near "Golden Semicircle." Incidentally also has a new West Coast install

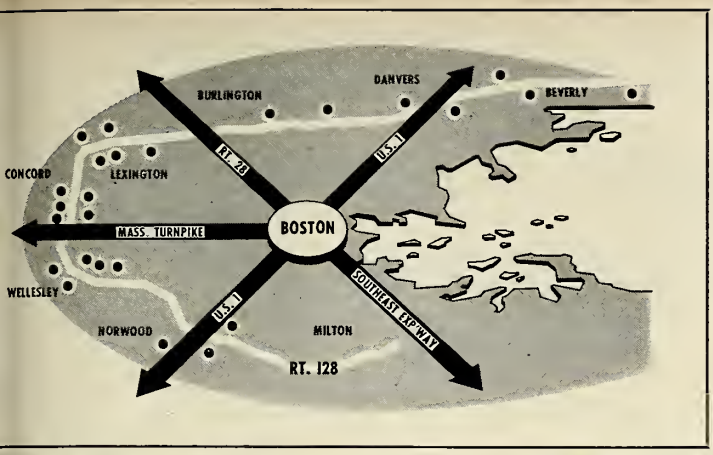
Another spectacular examp **Transitron.** Founded six years ago eight employes, it now has 3000- is the second-largest semicond producer in the nation.

In the past two years more $52 million has been poured int plants along Route 128—and opers feel there is room to doub present total. Visibly supporting optimism, the fabulous expansion keeps on accelerating.

• **Air Force millions**—Perha biggest single contributor to the ing boom—not only along 128 elsewhere in the metropolitan ar the Cambridge Research Center Air Force's Air Research and De ment Command. CRC has beer still is funneling millions of dollar research.

As of May 31, CRC had out ing 1199 contracts totalling $32 lion. Millions more in contracts duction and research—are being p into the area by the AMC, N ARPA, the Army and Navy, an vate industry as well.

• **The MIT influence**—Han



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 Tech- y. Scores of firms owe their exist- to MIT, through its creation of productive fields of research and sion of brains to work them. arvard and other Greater Boston utions also are producing a con- us stream of technical talent. n September, the **Mitre Corp.,** a n-profit organization which takes ame from MIT, will move into million plant at Bedford along e 128. Mitre, under a contract MIT, serves as the technical staff ie Air Defense System Integration ion working on correlating activi- f human operators with the com- electronic gear of SAGE. litre, which has H. Rowan Gaither airman of its board, expects to d to a $5 million facility and ually employ 1500 to 2000. The presently is located in Lexington, ironically, the liberty of the na- vas 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.

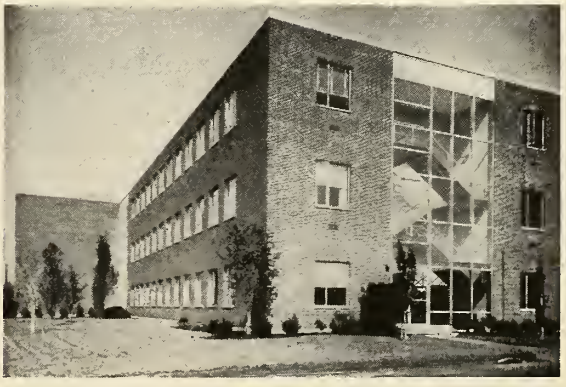
At Waltham, **Infrared Industries** is producing missile guidance devices; at Lawrence, missile-carrying cases are being made by **Craig Systems;** and at Burlington, **Dynametrics Inc.** is hard at work on an Avco subcontract making measuring devices for *Titan* nose cones.

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 shockwave 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.

THAM Research & Development Park. Thirteen industrial 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 spe and exacting performance requireme is not well-established. The resul "fire-fighting" system of stamping weaknesses and "crash programs" rected at troublesome areas boost terials costs and subtract from overall quality which could be obta with available funds.

If a broad solution to the prob is to be found, policy thinking al defense will have to be re-orier Basic research will be required to a better perspective on the system the future.

• **Present and future**—Immec solutions to the practical problem reliability will demand more atten (and surely more funds) for:

• More thorough study of the terials now in use in systems and c ponents.

• Determination of their stren and weaknesses, their full capabil and their shortcomings.

• Determination of the pre qualities required to make the mate more useful and the systems more liable.

• Determination of which mate are most likely to succeed as hardv and fuel in the Space Age.

• An aggressive research prog in those most likely to succeed, fle enough to change direction and em sis in the future.

Future solutions will require:

• Constant review of weapons defense systems—those in being, t in design and even those that are a wild gleam in some designer's eye

• Determination of extreme quirements of environment, invol temperature, stress, erosion, corro radiation, shock, friction, acous elements and expectable life of terials.

• Continuous review of all kn materials which show promise of solving any of the problems raise these environmental factors. Majo search effort should be applied in direction.

• A wedding of materials rese with fabrication research in orde achieve maximum results in both a

• Prospecting for new areas of terials research, keeping uppermo mind the environmental problems the directions of progress indicate accomplished research.

By putting first things first, by orienting our thinking to give a priority to basic materials research should eventually make it possible the systems designer to specify his terials requirements and fabric methods, and incorporate these ta made materials into his gimmick o morrow with a much higher degre reliability than he can achieve toc

*Washington District Manager Allegheny Ludlum Steel Corporation

Missile Troops in Italy

by Clarke Newlon

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

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

ıe missile unit is part of the ern European Task Force AF) and operates under the and of Col. Melville B. Coburn. ıtil June of this year it had been with the *Corporal* missile and *onest John* rocket, both with nu- warheads. On June 30—by coin- e, perhaps, the end of the U.S. year—the two *Honest John* bat- were formally turned over to ılian army, which had been train- use them since Jan. 1. Simul- ısly, the command's personnel ut in half, from 4000 to 2000. he fact that we have obsolete least obsolescent weapons is not tant to the people of Italy," Co- said. "To them SETAF is a estation that there is an atomic in Italy and that it is here to It is a part of the mystery of power."

e recalled that last October his command loaded an *Honest John* wo USAF planes—a C-124 and 30—one carrying the rocket and her support equipment, and flew Salonika, Greece. There they fired th only a conventionally-loaded ad—at a target on the hillside.

Ve had no right to be that ac- ," said Coburn, "but we hit the dead center. The Greeks were ndously impressed that in just ours we had flown in and fired omic weapon. And when they us unload the rocket from the they were not at all sure it wasn't ningly atomic."

TAF itself is under the com- of Maj. Gen. John P. Daley and ated in Verona, some 33 miles Vicenza. In addition to the 1st Army Missile Command, it in- the SETAF Logistical Command rona.

Organized in 1955—In the spring 55 it became apparent that the an peace negotiations were headed l success, which meant the with- l 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, Tarviso 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 'copter carries equipment and the third personnel.

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.

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.

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 only 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 correct moment and direct it to an i ception point.

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

• **Complications**—Russia is pected to have the capability to la a devastating ICBM attack on United States about 1962. More this capability is expected to incre and not just in numbers and relial

If the United States puts an o tional *Zeus* in the field in 1963, R is expected to be able to reply by ing the game a lot tougher.

Five or maybe 10 ICBM's cou fired at a target. Also, the sitt could be further confused by se along decoys of varying degre sophistication.

For example, the ICBM casing and engine can be blow after its propellant is exhausted, viding dozens of objects that w with the warhead along the sam jectory.

Some weight can be sacrific that balloons or somewhat heavie like decoys can be separated fro payload and follow the same traje

All of these would begin t their efficacy upon re-entry. But more weight could be sacrificed t vide heavier decoys which would late warheads re-entering the a phere.

Also, it may be possible to d low weight decoys capable of si ing a warhead both beyond and atmosphere.

Nor is this all.

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

naff to confuse tracking. Warhead
it could be sacrificed to install
us types of electronic counter
ures equipment capable of jam-
and further confusing radar. And
type of radar shielding or absorb-
naterial may be developed.
inally, warheads can be divided
ght—and possibly their course can
tered. Instead of five or 10 war-
flashing toward a target, you
have 50 or 100 warheads pack-
actional yields all still more pow-
than the A-bombs that devastated
hima and Nagasaki.
ere then is the full threat: Space
ky are crowded with hundreds of
ts. All are flying the same ballistic
at Mach 24. Many possibly
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is pattern of attack would occur
aneously over not one or two ci-
AC bases or industrial sites, but
eds.
RPA contends an attack of this
is fully possible by 1969—only
ears away. It contends many
s of it are possible before then.
ch an attack would confront a
se system with the extremely dif-
triple job of:
Fighting off the electronic count-
sures.
Detecting which among thou-
of speeding objects are heading
hich target.
Discriminating among all objects
g for a particular target to de-
e which are warheads that must
ercepted.
he only active defense alternative
aying this vast game of "war-
warhead who has the warhead"
prevent all of them from getting
gh.
any Pentagon experts agree that
could handle the early stages of
hreat with reasonable if costly
s. Army officials also contend
Zeus is flexible enough so that
threat becomes more and more
ex *Zeus* can be improved to meet
t here there is disagreement.
Something else—A number of
gon scientists believe that there
point beyond which the *Zeus*
computing system can not be
eably improved and the con-
use of *Zeus* would involve
omical costs. Therefore, they
d something else is needed. Here
's Project *Defender* begins.
efender, which absorbs about
of ARPA's annual effort, is
Harold N. Beveridge, formerly
erophysics Development. Dr.
rd 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.

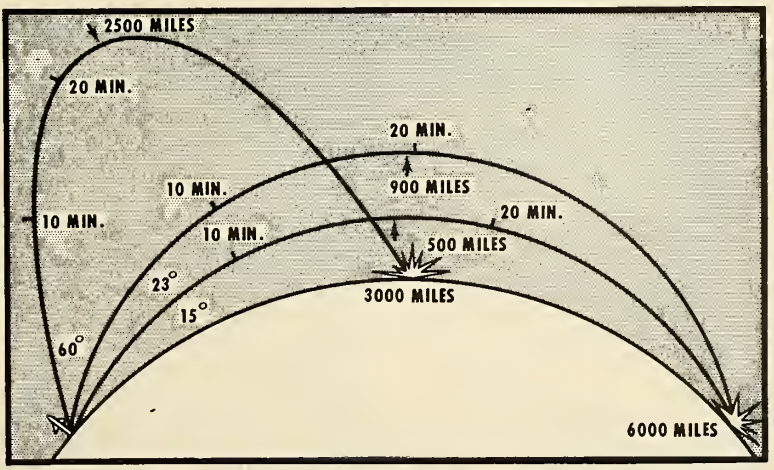
• Giant Shields—The creation of a magnetic shield through which warheads and decoys could not pass.

• AICBM Spacecraft—The stationing in orbit of a manned space craft 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 propellents**—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 propellent—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 countries of the British Commonw would make it possible for them to and discuss astronautical matter common interest. The BIS ther decided to precede the IAF Con with a short Commonwealth Space Symposium.

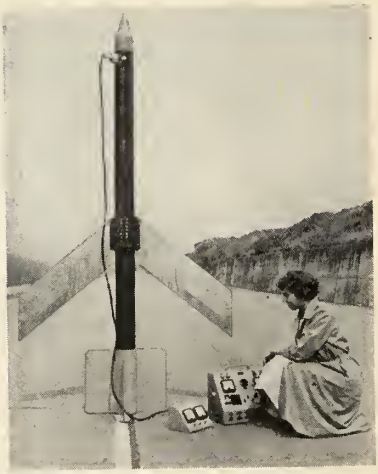
The decision of the British Go ment a few weeks ago to institu spaceflight programme has natu increased the interest in this sy sium, particularly as both industry the BIS consider that this progra is not ambitious enough. So man pers have been received from the craft and missile industry that i proved necessary to extend the posium to three days (27-29 Aug

At present the programme inc six papers from the Hawker-Sid Group **(Armstrong-Whitworth,** an **V. Roe),** two from the Indian A nautical Society, and one each **Bristol/Aerojet, de Havilland Pr lers,** Jodrell Bank Experimental St **Pye Ltd., Normalair Ltd.,** *The F cial Times,* University College Lo the College of Aeronautics, anc Weapons Research Establishment tralian Ministry of Supply). Other tributions are expected from C and New Zealand, and there wi a guest speaker from the U.S.

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

The U.S.A.F. produced a Force" at the show complete command post, white-belted m police and massive equipment to American aircraft and missiles. In trast, Britain sent a Royal Ar captain and six gunners to demon the English Electric *Thunderbir* only when the firm had agreed t all the soldiers' expenses for the

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



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

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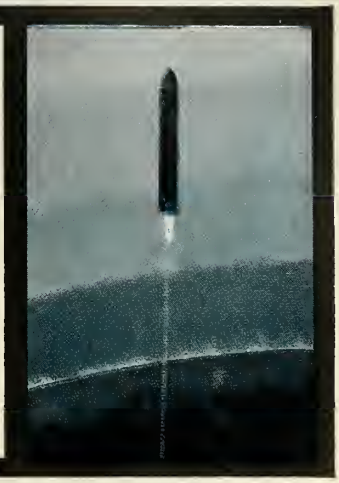

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MISSILE INDUSTRY LIAISON

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 quently in the news, has a very ial meaning in the Air Force. It s not with race relations but with equally difficult job of fitting to- er all of the jigsaw pieces of a on system. It deals also with the of welding into a smooth-running all of the divergent interests h must be considered in converting eapon system into an operational on in the hands of the troops.

We have seen in earlier M/R stor- hat the instrument of integration is Weapon System Phasing Group and Weapon System Project Office, aged in its early phases by Air arch and Development Command in later stages by the Aeronau- Systems Center of the Air Ma- l Command.

• **Enter ASC**—ASC comes into the re as manager of the integration t only when a decision is made the weapon system has reached int warranting a production order. latively new organization, ASC is operating arm of Air Materiel mand in all areas except ballistic iles.

This means it handles management e weapon system during the period production for inventory. In the er phases, when ARDC has execu- management responsibility, the r agency is still responsible for urement. The key man during this e is the contracting officer respon- for the contract—how it is writ- and what it contains. He is as- d to the weapon system project e.

n some cases, the prime weapon m contractor is made responsible certain subsystem development or production. In such cases ASC ws proposed subsystem sources, g a subcontract advisory panel, to re maximum consideration of the rience and technical programs of AF and industry. Review involves questions as the technical capa- y of the subcontractor; manage- t approach to development and test; luction 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 producibility 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 interchangability 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 the AN/FST-2 in SAGE, which about 65% printed circuits, to the ground guidance computer which ploys about 95%.

"In some equipment, the circuit are entirely by printed boards. Some our basic design equipment does contain printed circuit cards, but new models do, as well as the peripl devices linked to them."

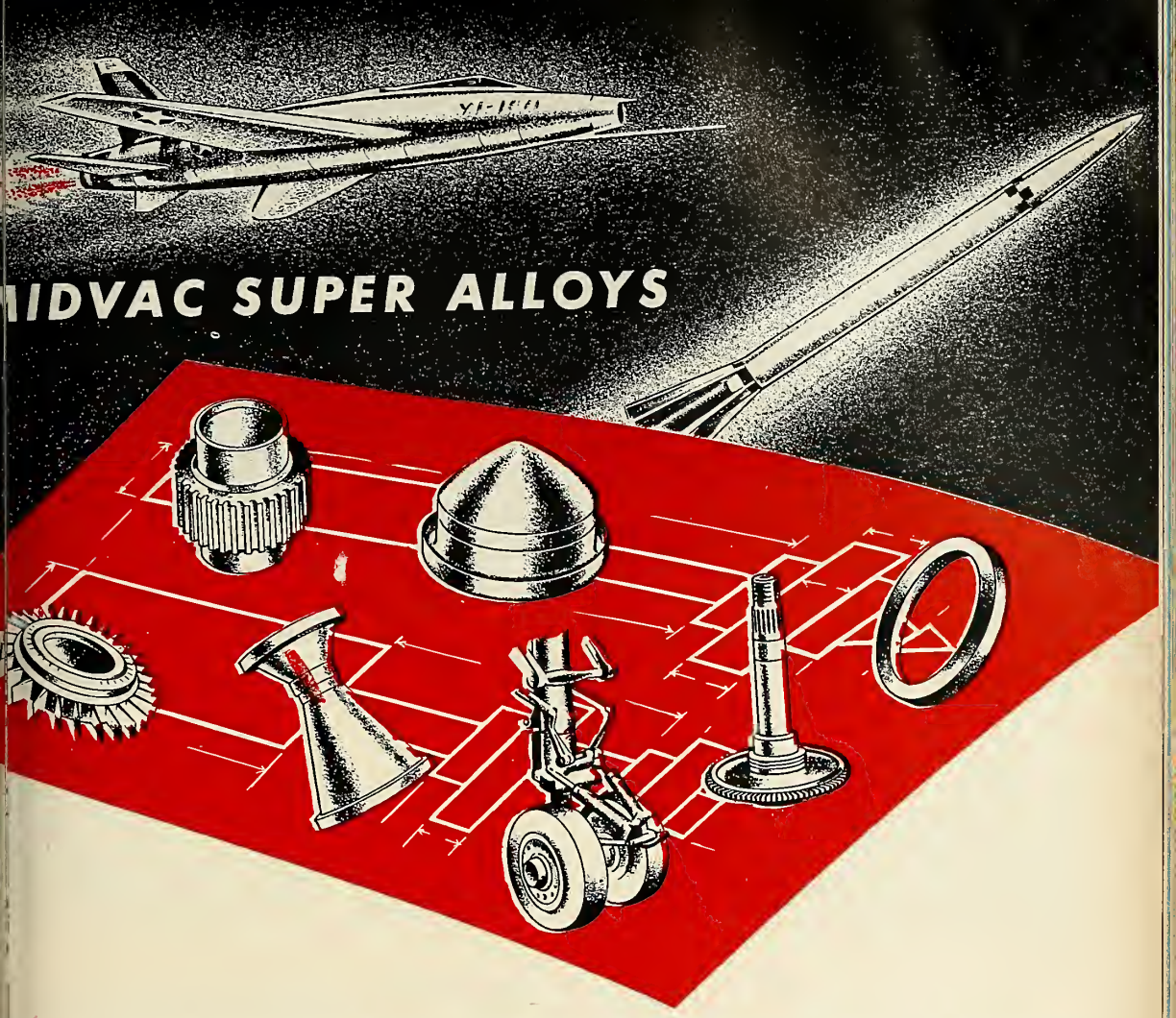
• **Microminiaturization**—Alth actual application is still highly cl fied, Burroughs Research Cente Paoli, Pa., has indicated that it is microminiaturized blocks extensivel research and development and ex to make heavy use of equipment reduction techniques in the future. One spokesman went so as to say, "in ten years, you won't anything but micromodularization electronic equipment.

The company's new packaging t nique, which increases a module ca ity to 300 components per cubic i was revealed here last week at the stitute of Radio Engineers' 1959 tary Electronics Conference. The roughs high-density packaging achieved through "macro-modula tion" of components already mi miniaturized.

The new stacking technique, w decreasing total packaging volume available surface areas, provides munity to thermal and physical sh in environmental conditions. The c pany has also indicated that along these attributes circuit interconnec and power input requirements been controlled in equipment des

In Table 1, comparative specif tions 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.



OLVING 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.

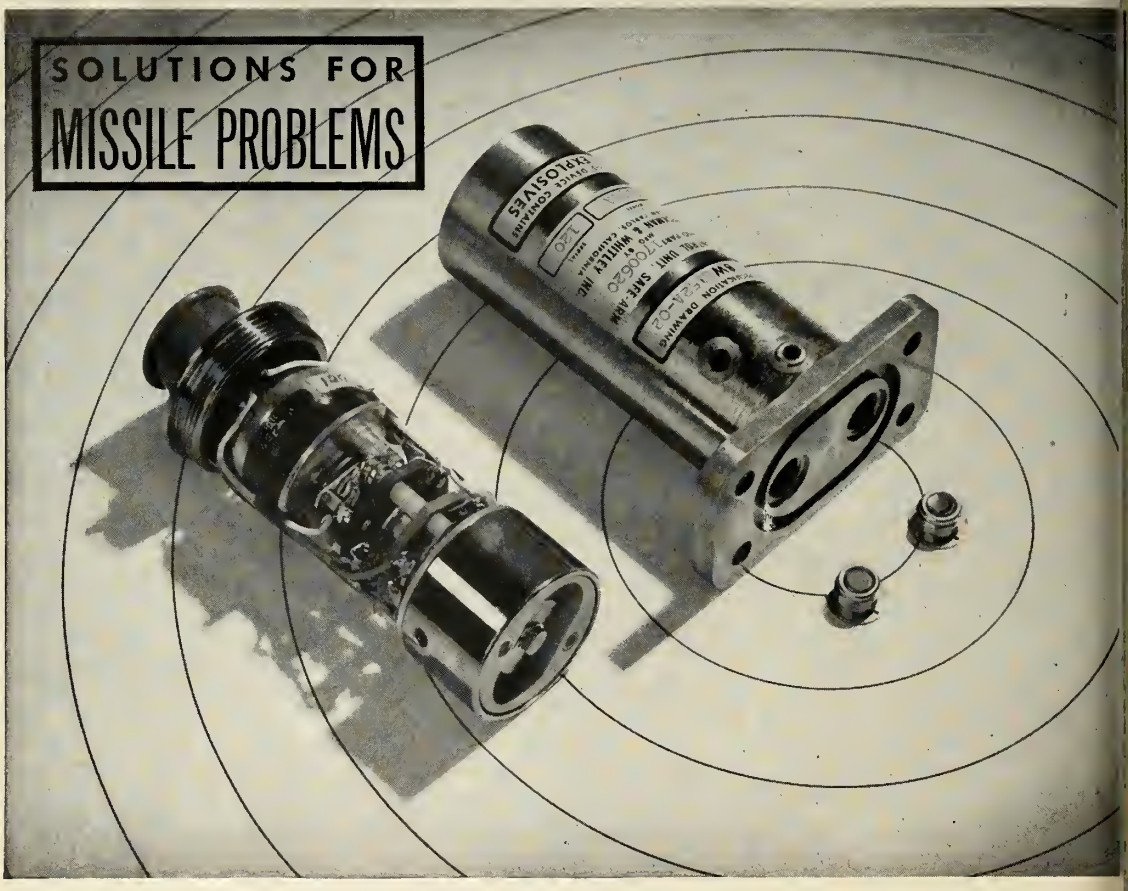
Offered in ingots, billets or forgings for the production of missile combustion chambers, tail cone assemblies, jet engine parts, aircraft landing gear components or any other parts requiring properties beyond the capabilities of conventional steels.

MidVac Steels

MIDVALE-HEPPENSTALL CO., NICETOWN, PHILADELPHIA 40, PA.

Subsidiary of HEPPENSTALL COMPANY, Pittsburgh, Pa.

Circle No. 6 on Subscriber Service Card.



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 1¾ 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

lopments at Burroughs are shown to ustrate the evolution in miniatur- ng systems. Note that the tempera- re rise from 55°C to 100°C was ac- mpanied by a power increase from 0 watts to 2200 watts.

To achieve 100°C operation, sili- n transistors were employed effect- g a power input rise. At the same ne power dissipation increased, vol- ne decreased (it should be noted that e increased concentration of power ssipation per cubic foot was solved this instance by integrating an effi- nt heat exchanger into the overall uipment design).

A basic design philosophy held by e company is that the circuit must be ilt essentially in two dimensions, with e system being in the third dimen- n. In the macro-module technique, e true two-dimensional form is ughly maintained. As components d circuitry become smaller, this in- -connection technique may prove to the principal element in a given com- x assembly. By retaining the third mension for the system, with con- uing miniaturization, this dimension comes largely available for system ring.

As a result of the macro-module chnique, they have achieved a quick oduction capability, principally be- use the design permits the acceptance components from many vendors. ese components can be tested prior assembly into circuits and the cir- its can be assembled prior to final sembly. The final assembly then can tested before the complete unit is aled.

• **ITT's approach**—Another pioneer the development of miniaturized stems employing printed circuits is e **International Telephone and Tele- aph Laboratories.** Since missile pay- ads require extensive weight and e reduction in electronic units, this mpany has taken the approach that mponents, because of microminiatur- ation, will have to be produced with improved ability to withstand high mperatures. The smaller size for heat ssipating 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 subminiature 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	39,809	30,000 Approx.
Volume	500 Cu./Ft.	13 Cu./Ft.	3.5 Cu./Ft.
Power Required	1 K Watt	850 Watts	2200 Watts
Operating Temp.	24°—27° C	55° C	100° C
Clock Rate	210 KC	1.4 mc	1.3 mc
Add Time	50 Micro Sec.	25 Micro Sec.	10 Micro Sec.
Multiply Time	512 Micro Sec.	75 Micro Sec.	40 Micro Sec.

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

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

• **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 vari of Corning's Fotoform glass and a flexural strength of 25,000 ksi.

In processing, the original pho sensitive glass is exposed through ne tives to ultraviolet light and board holes are then etched out subsequent heating and immersion a dilute hydrofluoric acid. Finally, ditional heating converts the glass i a crystalline state and the circuit p is applied to the board.

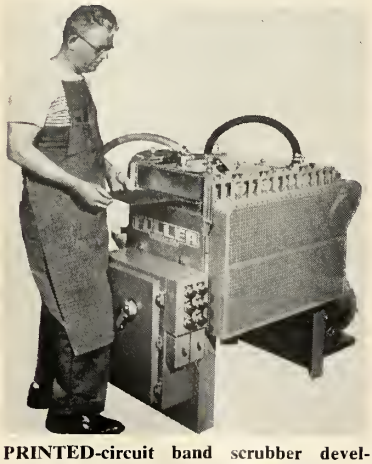
The company has said that in ad tion to its high thermal endurance, Fotoceram board will not bow, be warp, or burn and is impervious to s vents.

Vibration tests recently perform on the boards indicated that they w withstand more than 60 g when pr erly mounted.

In tests performed on Fotocera circuits components have been ha resoldered to the same circuit run m than 50 times without indication failure. To test solder-heat resistan the circuit boards have been floa or immersed in 565°F molten sol for over five minutes without evide of any blistering or lifting of circ runs, a company spokesman said.

• **Plated-through holes**—A sn controversy has arisen among ma users of printed circuit boards w feel that eyelets and plated-throu holes cause unreliable assembl **Packard Bell,** for example, prefers use soldered leads inserted throu holes in the boards.

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



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

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

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

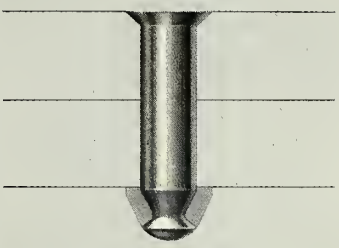
The airframe of the Bomarc reflects a successful solution to structural and fastening design problems typical to high performance missiles and aircraft. The airframe combines high strength with high temperature resistance, without adding unnecessary weight which could effect performance.

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.

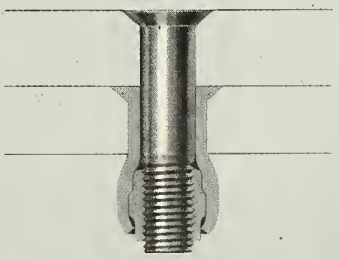
HI-TORQUE BOLT

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.



HI-SHEAR RIVET

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.

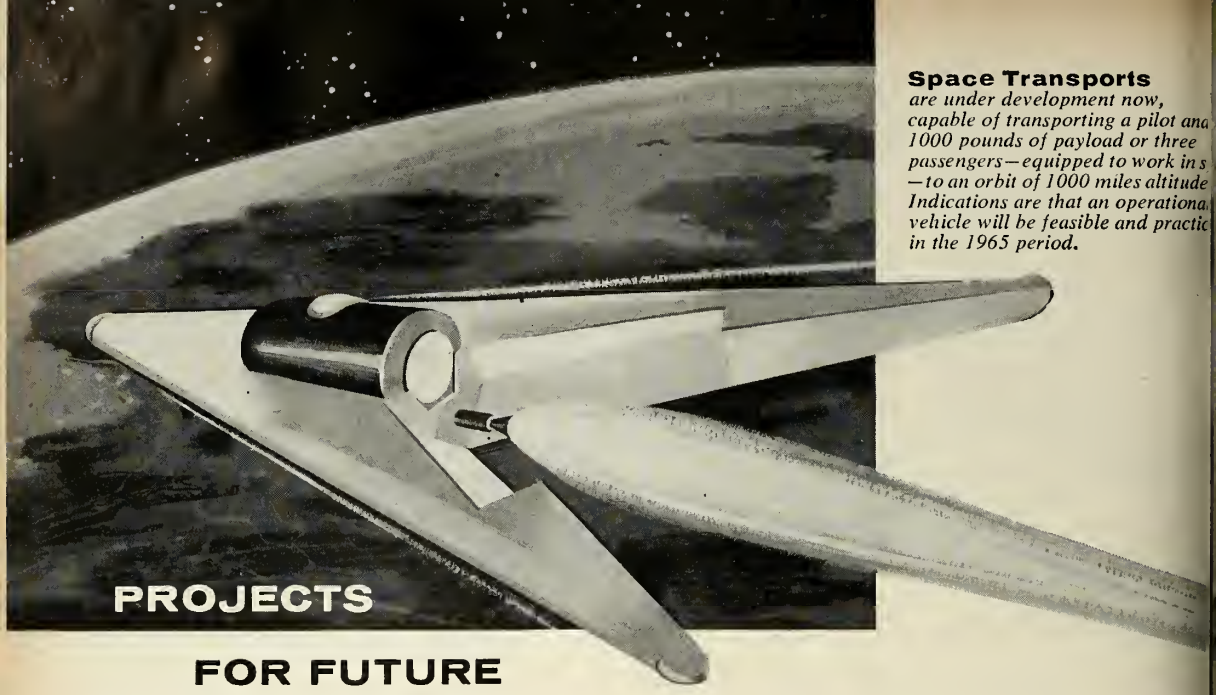
U.S. PATENT PENDING. FOREIGN PATENTS GRANTED AND PENDING.

"HI-TORQUE" TRADEMARK REGISTERED IN U.S. PATENT OFFICE.
U.S. PATENTS NO. 2,677,985; 2,745,120 AND 2,782,039.
U.S. PATENT PENDING.

"HI-SHEAR" TRADEMARK REGISTERED IN U.S. PATENT OFFICE.
U.S. PATENTS NO. 2,355,529, 2,355,580; D-138,579;
OTHER U.S. AND FOREIGN PATENTS PENDING.

hi-shear RIVET TOOL COMPANY

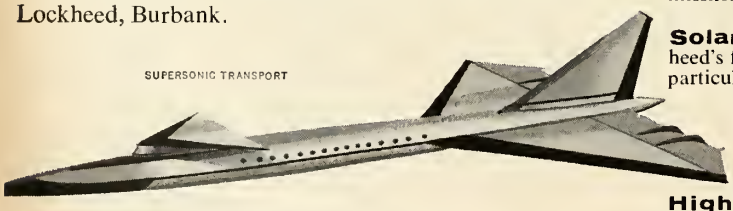
2600 WEST 247TH STREET, TORRANCE • CALIFORNIA



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

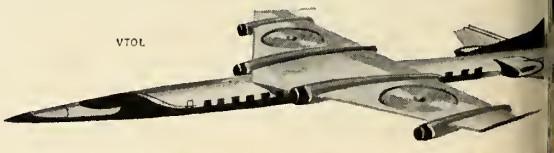
FOR FUTURE DECADES IN SPACE... *another Lockheed Progress Report to Engineers*

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 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 us advanced method of detecting fast-moving missiles and high aircraft. A new facility, which includes an advanced labor with an infrared tunnel, for basic research and developm prototype equipment in this expanding field, has been set push Lockheed, Burbank, to the forefront in infrared stud



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

Solar Radiation Studies—are being conducted at heed's flight test radio station at Briar Summit, California, p particular emphasis on solar flares as our contribution to the national Geophysical Year. We have already accum more than a quarter of a million images of the s analysis. In cooperation with other companies, v determine the processes by which solar energy is re

High caliber scientists and engineers are invited t advantage of Lockheed's outstanding career opportunities. ings now exist in: Electronics; aero and thermodynamics; p sion; servo-mechanisms; materials and processes; structur stress; operations research; research in optics, infrared, acc magnetohydrodynamics, instrumentation, mechanics and h lics; mathematics; and in all phases of design. Write tod Mr. E. W. Des Lauriers, Manager Professional Placement Dept. 1707, 2400 North Hollywood Way, Burbank, Califo

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elding Process Gives Good Control

A new welding process, called ort-Arc," welding has been deoped by **Linde Company,** Division **Union Carbide Corporation.** It pers manual and mechanized welding hin material with excellent control he weld puddle.

The outstanding feature of this new t-gas consumable-electrode process he ability to make manual fusion ds in the range of thickness of 0- to .100-in. of all common metals, h as carbon steel, stainless steel, minum (.040 in. minimum), copper, t, in all positions and types of joints.

The "Short-Arc" process exhibits rent advantages over other welding hods for welding sheet metal by viding a more-readily-controllable ing process at high welding speeds, er production of fillet welds, ability weld in all positions, and—of sigant importance—the ability to weld t metal in a range of thicknesses tofore not considered readily weldby any process.

Successful operation of the process ended on the development of several factors: proper power source, ction of shielding gas, and appas for feeding small diameter wires.

Normal fusion welding operations g conventional type power supplies either covered electrodes or inert-shielded processes, give too much 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.

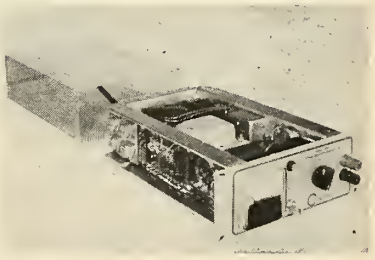
The Linde "Short-Arc" process makes high quality welds quickly and economically in carbon steel, stainless, aluminum and other metals. Distortion is minimized due to the pinpoint-type arc and there is little or no post-weld cleaning. Joints with poor fit-up are easily accommodated with manual welding. For example, ¼-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,

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 application.

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.

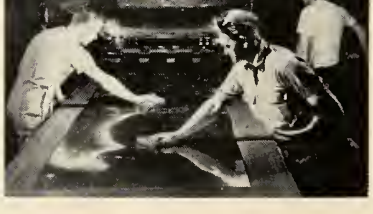
Circle No. 240 on Subscriber Service Card.

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 for honeycomb constructions.

Alloys currently available in sheet form are "Haynes" alloy No. 25, "Multimet" alloy, "Hastelloy" alloy 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 "Pc mite" micro-miniature relay series been produced by **Filtors, Inc.**

Known as the "S" type, this addition to the rotary "Powrm series meets shock tests of 100 for 11 milliseconds and vibration t of 10-55 cps @ .06 double amplitu 55-2000 cps @ 30 G8s.

Other specifications: contact rangement: 2C (DPDT): ambient t perature range; −65° C. to 100° dielectric test: (at sea level) 10((750 V. between open contacts): tact rating: 2 amps resistive; pul time: 5 milliseconds maximum; 0.5 maximum weight. Coil resistances f 185 to 10,000 ohms are availabl standard values.

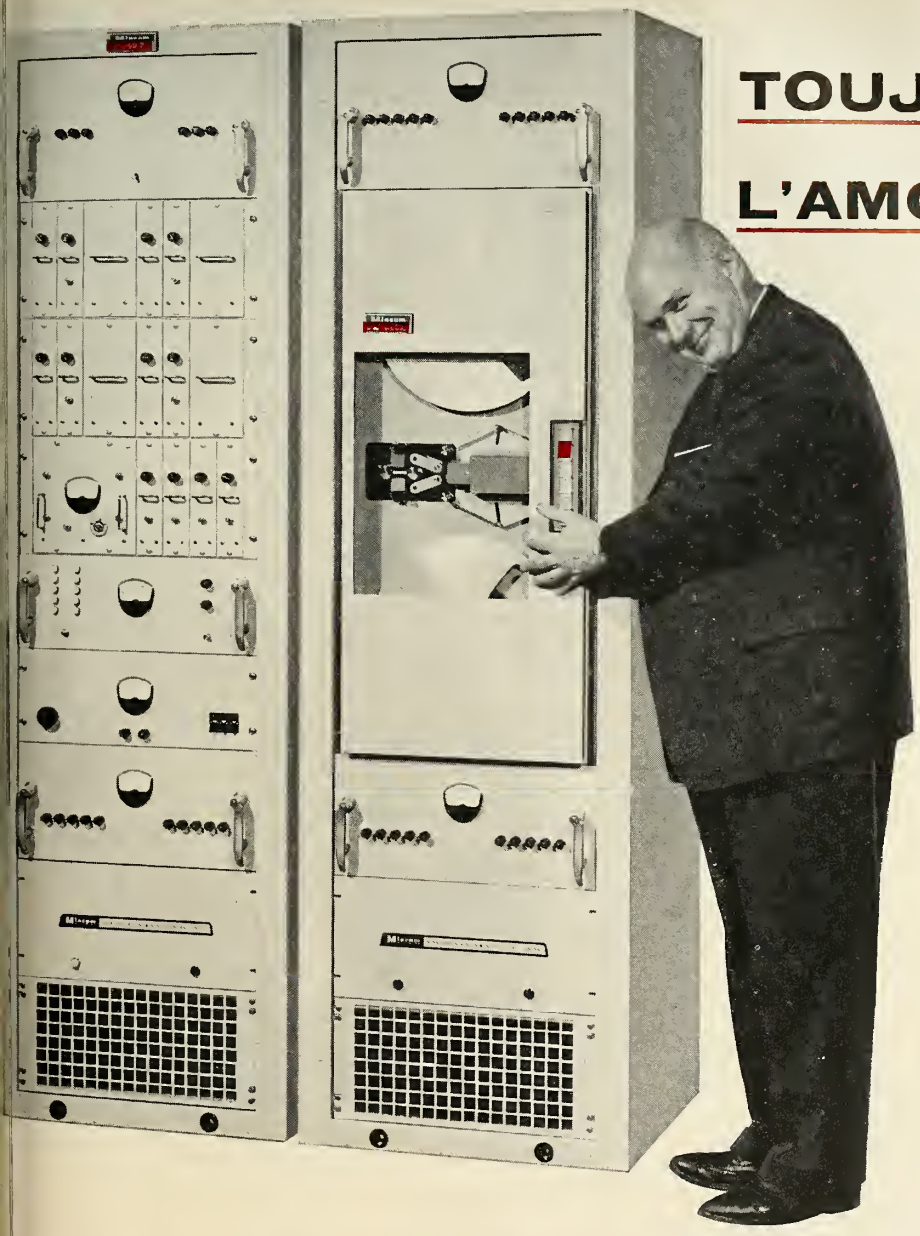
Circle No. 242 on Subscriber Service Ca

Marking Method Speeds Identification of Bearing

A new method of speedy, infal visual identification for tiny instrur bearings—overcoming a long stan problem of the industry—is curre being introduced by **New Hamps Ball Bearings, Inc.**

Specifications occasionally call bearings about the size of the pe at the end of this sentence. The o and inner rings of the bearing, th fore, do not allow much room identifying markings.

New Hampshire Ball Bearings, solved this problem through a ra 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.

3M COMPANY ... WHERE RESEARCH IS THE KEY TO TOMORROW

MINCOM DIVISION MINNESOTA MINING AND MANUFACTURING COMPANY

2049 SOUTH BARRINGTON AVENUE • LOS ANGELES 25, CALIFORNIA

Circle No. 10 on Subscriber Service Card.

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 s
miniature motor to meet such mai
demands as may develop.

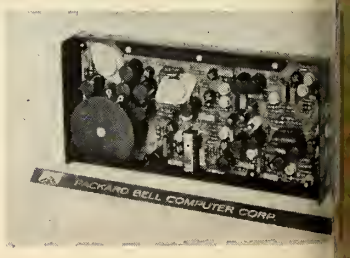
Circle No. 245 on Subscriber Service Cor

New Line of Solid State DC Amplifiers Marketed

Packard Bell Computer Corporat
has announced a new line of solid-s
DC amplifiers designed to meet
urgent need for wide-band, highly
curate amplification where reliabi
is of prime importance. This is the
available line of low-noise, comple
solid state amplifiers with transi
choppers.

Because of the rapid developm
of new weapons and numerous tes
requirements, instrumentation relia
ity is a prime factor. Normally, eq
ment can be tested only once bec
of the complexity and cost of such t

One of the basic pieces of eq
ment required to take measurem
is an amplifier. It is used to amp
signals for processing into data log



equipment for later evaluation.
major weakness in today's amplifie
the use of mechanical choppers w
tend to be unreliable and cause a
nificant failure rate.

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

Wide-band differential, operati
and potentiometric amplifiers—all
izing completely solid-state circuit
are offered by Packard Bell under

xclusive arrangement with REDCOR, o meet the diversified need for a line f instrumentation amplifiers.

Differential amplifiers have many pplications in the data reduction field. Vherever a low level signal of unde- ermined reference is measured, a neans of isolating it and recovering ow amplitude signals from high noise evels is required. The low-level, wide- and, low-noise differential amplifier as been designed to meet most of hese requirements. This is the first such ifferential amplifier offering input im- edances up to 10,000 megohms, noise n the microvolt range and a common node rejection of 120 db at dc.

Operational amplifiers have many ses in data handling systems. They re used most commonly to provide mpedance matching and signal in- ersion.

Potentiometric amplifiers are pri- arily used as a buffering device to olate the source of the measurement rom the measuring device.

The three types of amplifiers des- ribed here offer bandwidths at –3 db t 200 KC. Gain accuracies, linearity nd drift figures are better than .002% n most models. The units are extreme- y small, measuring 8" by 4" by 1½", nd all have self-contained power sup- lies.

This line of completely solid-state mplifiers, for which Packard Bell Com- uter Corporation has exclusive rights, eportedly makes the amplifier one of ne most reliable pieces of equipment n the data logging field.

Circle No. 246 on Subscriber Service Card.

New Low-Current Thermal Relay Available

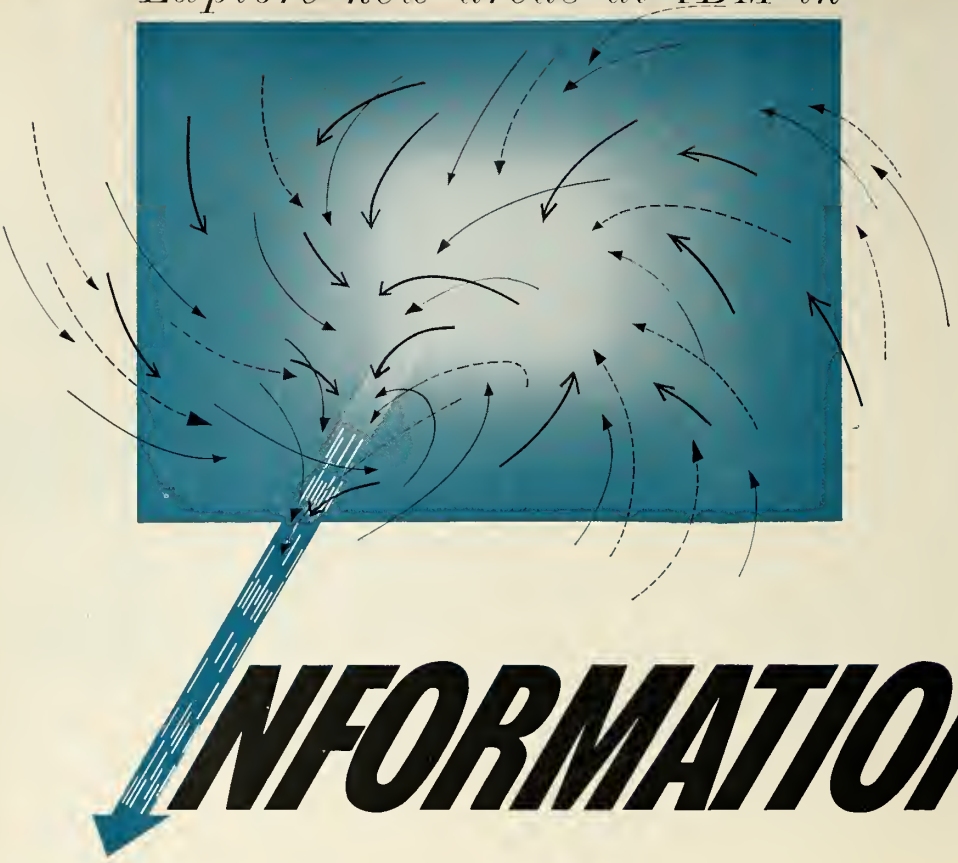
A low-current, sub-miniature ther- al relay with a firing sensitivity of nly 0.2 amps is announced by **Net- orks Electronics Corp.**

Relay is hermetically sealed by an xclusive method of bonding metal eaders to high thermal-shock resistant lass housings. The use of a transpar- nt glass case permits visual inspection f all working parts.

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

ertinent military specifications . . . perates under vibration of 20 to 2000 ps at 15 g, with a shock rating of 0 g. The temperature range extends

Explore new areas at IBM in



INFORMATION

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.

. . . new missile products

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 ± 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

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.

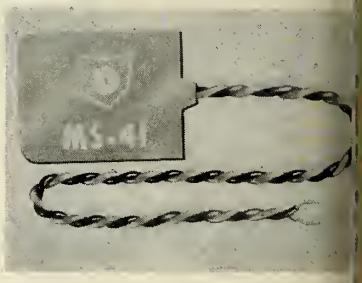
The Telonic Model 303 Test Set already in use as a production-line te instrument in plants where a major m sile guidance system is now in volun production.

Circle No. 249 on Subscriber Service Card.

Magnetic-Field Sensitive Resistor Now Available

Ohio Semiconductors, Inc. a nounces the commercial availability its recently developed semiconduct device, the Magnetoresistor.

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



change in resistance with an applie field of 10 kilogauss. Greater chang can be achieved at fields greater tha 10 kilogauss with a linear dependenc At lower magnetic field densities th Magnetoresistor obeys an approxima square function. Important features the MS-41 are low noise (on the ord of Johnson noise and fast response tim The theoretical response is limited on by the relaxation time of the charg carriers. In practice the lead inductan and capacitance sets the limit.

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

The MS-41 Magnetoresistor is mad possible by the commercial develo ment of new compound semiconducto by Ohio Semiconductors, Inc. O. S. is a pioneer and leader in the field compound semiconductors for infr red, thermoelectric and electronic a plications.

The compound—InSb, indium ant monide, is utilized in the MS-41 Ma netoresistor. The magnitude of the ma netoresistance effect is related to th mobility of charge carriers (electron within the solid. InSb displays the hig est known electron mobilities.

Fully developed and ruggedly pac aged, the MS-41 permits the use of th magnetic gaps. It is designed to satis 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 of 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 weigh nothing, take no space, require no bandwidth, have unlimited sophistication as to selection of data, transmission accuracy and power, and be at once 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 not 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 the 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—in 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 Telemetering 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 Bandwith	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 x 10^{-3}	3450	1760	1790	453
$\frac{\left(\frac{S_p}{K}\right)\text{ db}}{\left(\frac{S_p}{K}\right)\text{ db (PCM)}}$	8.8 db	5.9 db	6.0 db	0 db

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.

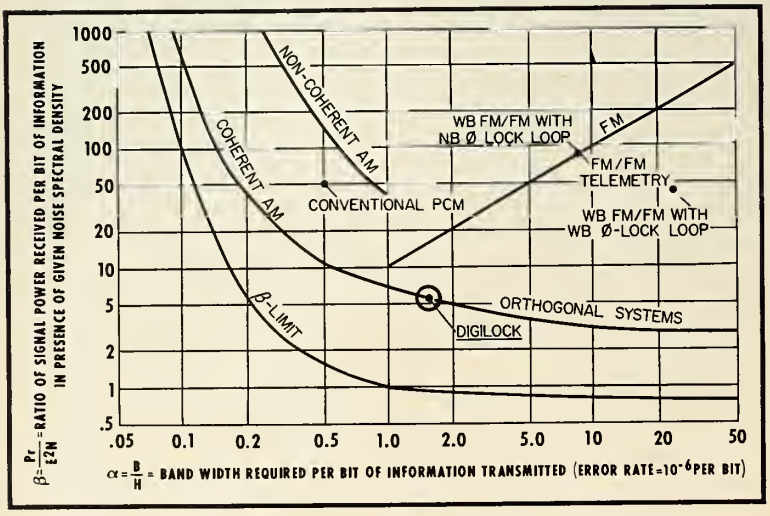


FIG. B—Comparison of the communication efficiency of various systems.

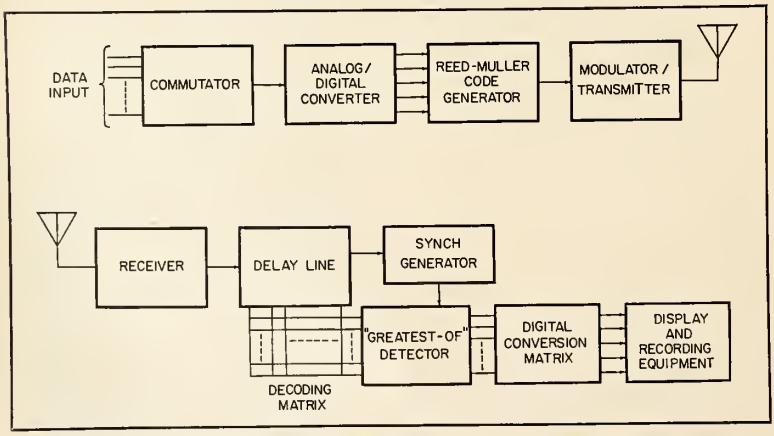


FIG. C—A block diagram of the workings of the DIGILOCK pulse code system.

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

In the first place, it is very in ficient to transmit information wi precision beyond the meaning of t data. It would be wasteful, for instanc to transmit continuous precise da when simple presence-absence or even per-unit-time information would sufficient. The available information b could better be reserved for measur ments where greater precision is r quired.

Variable data rate offers, primaril power economy. An example would a system alternately turned on and o When on, the data rate is some nomin maximum; when off, the rate is zer By controlling the on-off time, the e fective data rate can be varied over wide range. If the meaningful data properly encoded and stored, a wort while saving in power is provided.

But intermittent operation does n provide all of the desirable feature without some additional change, t maximum communication range r mains a fixed function of transmitt power, transmission bandwidth, and e fective ground station sensitivity. T possibility of variable transmissio bandwidth is a feature inherent DIGILOCK and offers greater a vantages. Variable transmission ban width can result in the adjustment data rate to match a specific missio requirement. Even more important, a justment can be made during a tran interval, allowing the decrease of da rate with increasing communicatio range—thereby making possible operating link at distances otherwi impossible.

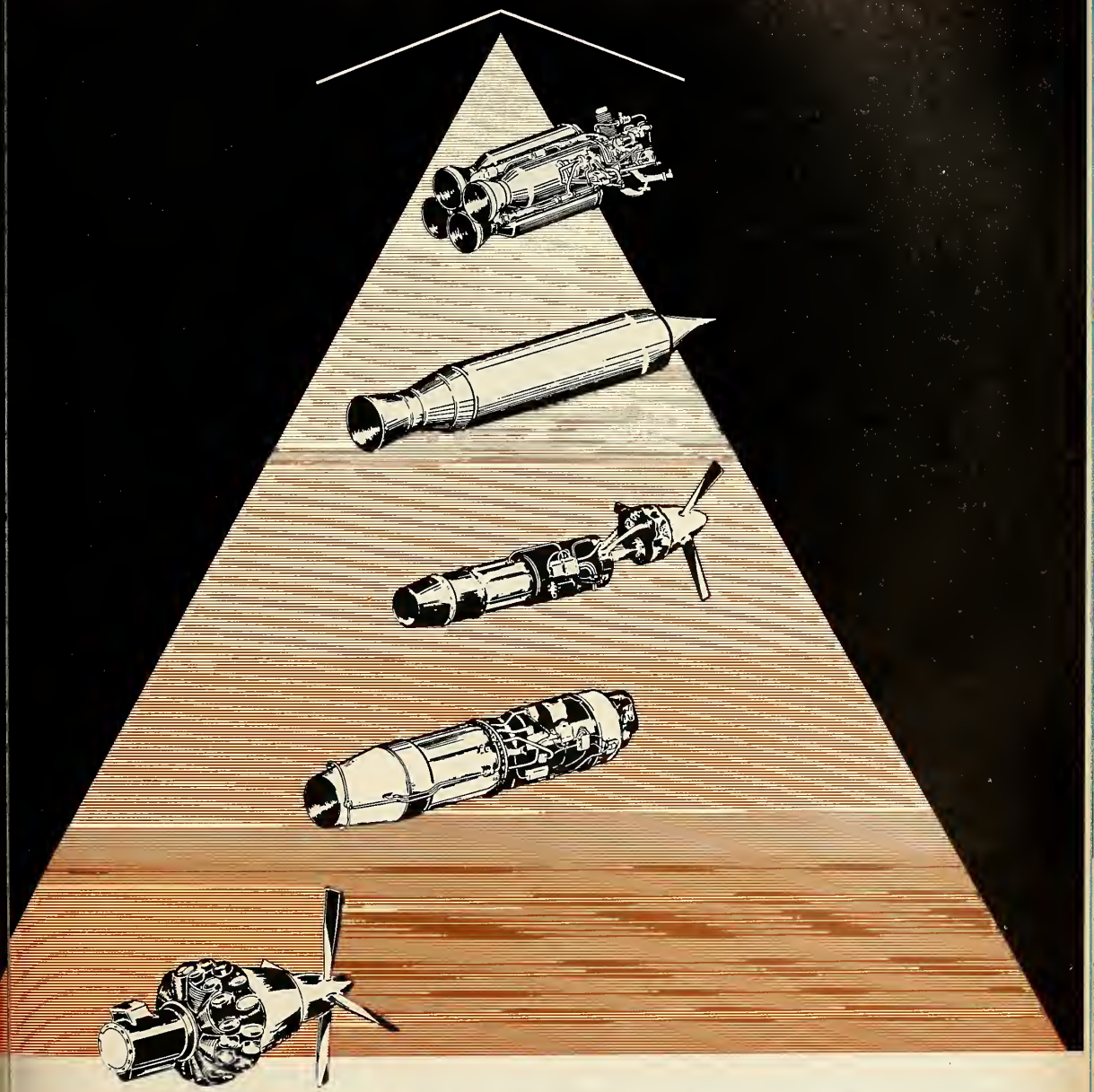
• **DIGILOCK operation**—DIG LOCK is a pulse code (PCM) syste and, therefore, a time-division mult plex system. Primary operation co sists of sampling an input data sourc quantizing the data sample, transm ting a coded representation of t quantized data sample, receiving ar decoding the data, and either storin or displaying a measure of the info mation received (Fig. C).

In an orthogonal system, messag must be encoded so that they are equally different or equally space Also, each message must be recognize by its own matched filter. The matche filter decoder is therefore the heart the system and its operation must l understood if the operation of t complete system is to be understood

• **Delay line**—The principal el ment in the matched filter decoder a multiple-tapped magnetostriction d lay line, which provides a means storing many bits of information r

CONTROLS

FOR THE FULL SPECTRUM OF PROPULSION SYSTEMS



Bendix* has long been a leader in supplying controls and fuel systems for all types of aircraft engines. Today, Bendix is proving to be a natural for new challenges in related missile fields—on ram jets, rockets, nuclear power, and other advanced propulsion systems. So, when it comes to controls, remember that Bendix has the background—and is anxious to share it in solving your problems. *REG. U.S. PAT. OFF.

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

Bendix AVIATION CORPORATION

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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
2	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
8	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1
16	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
E.G. CODE #27															
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	1	1	1	1	1	1	1
8	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1
16	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
	1	0	0	1	1	0	0	1	0	1	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 positio one switch. The analog-to-digital c verter uses a "stairstep" voltage ge ator and a comparator amplifier.

In operation, the timing system s a 5-stage binary scaler through 32 j sible states while a stairstep voltag being generated. When the compar amplifier indicates that the stair voltage first exceeds a data sample, inhibit signal stops the scaler, sto a binary measure of the data sam The specific on-or-off state of the st of the binary scaler is used as c mand information to simple digital l in the form of AND gates and CLUSIVE OR circuitry to generate one desired of the 32 possible co which can be formed by the bi addition of outputs from binary sc stages.

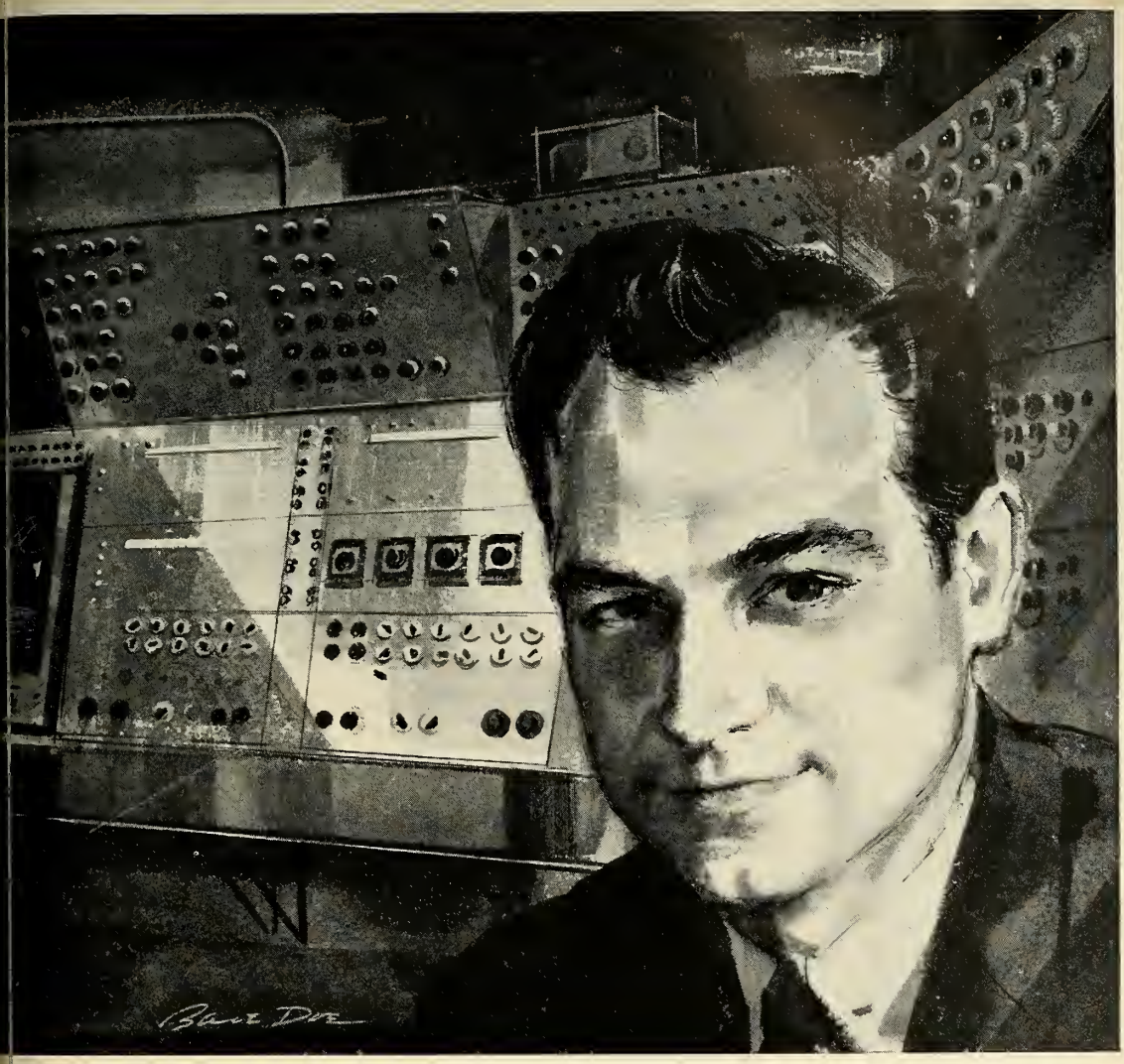
In operation, the system will use storage registers in the analog-to-dig conversion system; one will control code generator to transmit a code re senting a data sample quantized in preceding period while the second re ter is in process of storing a new q tized value. At the end of each w simple logic reverses the function the two storage registers. This appro results in nearly a 100% duty cycl transmitted information.

• **Synchronization**—System op tion depends of course on proper chronization of the decoder with airborne encoder. This is accomplis by a special code transmitted at s matic intervals, recognized by matched filter and detector and in a phase-locked flywheel sync sys to generate a gate signal. This si enables the "greatest-of" detector ing a short period surrounding match interval for each code t mitted.

• **Prototype evaluation**—First n surements of DIGILOCK operation portedly showed results within 3 dl that predicted. Several elements of system are not entirely new—in they are commercially available. means that application of the syste early missions would not require c plete replacement of all components for example, a world-wide ground tion network.

The airborne system particul lends itself to simple transistorized cuitry and extremely low opera power requirements. The complete borne system weight, excluding transmitter, is about 5 pounds.

Study of the system as designe dicates that maximum data rates such that one DIGILOCK system provide information bandwidth eq lent, for example, to several ty FM/FM systems and, therefore, be of extreme value in near-future missile system development progra



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.

We think the challenge is imposing, the opportunity impressive. May we see *your* resume? AEROJET-GENERAL CORPORATION, Box 296J, Azusa, California or Box 1947J, Sacramento, California. Attn: Director of Scientific and Engineering Personnel.

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THE GENERAL TIRE

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RAUTH

J. Donald Rauth, 41-year-old general 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.


BEAGLES

Robert Beagles has joined Packard 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. Coleman 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 Transicoil Div., where he served in management and engineering capacities.


CAMPBELL

Transval Electronics Corp. has appointed **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.


VLCEK

Adolph Vlcek, Jr., has been named 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 na to the new position of assistant man for Missile Operations under the Techr Operations Manager at Vitro Laborato Silver Spring, Md. Delaney, form head of the Missile Projects departm held several engineering positions served with the rank of commander in U.S. Navy prior to joining Vitro in 1


SWINDELLS

Dr. Frank E. Swindells has been moted to man of research for p tosensitive dev and chemical search for the E tronic Tube Divi of Allen B. Mont Laborato Inc. He was merly manager chemical resea with emphasis transparent and black background sc phosphors, after coming to Du M from the Photo Products Dept. of E Du Pont de Nemours & Co.

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

John C. Pitchford, recently ret from the Air Force as a colonel, has b named project manager at Benson-Le Corporation, Los Angeles manufact of data processing equipment. He study future developments of the c pany's standard product line. Pitchfo last service assignment was Project Of for the deployment of IRBM's to NA

John B. Rittenhouse, Research Gr Supervisor in Chemistry at California stitute of Technology's Jet Propul Laboratory, was named recipient of award by the American Society for T ing Materials for a paper he wrote on chemical effects of certain acids on m used in rockets.

Monogram Precision Industries, has named **Victor Gehrig** and **Robert Lehman** senior vice presidents. Gel formerly vice president-production, i charge of Monogram's customer prod divisions in Culver City. Lehman, was general manager of the electro divisions in Los Gatos, Calif., now h the proprietary products divisions in company's San Fernando Valley facili

ida Electronic
loyment up 50%

Missile electronics are continuing om in Florida. A new State De- ment Commission survey shows ndustry now has 15,000 employees npared to 10,000 only a year ago. ory sales are estimated at upwards 200 million with annual payrolls ng about $60 million.

s one of the nation's fastest grow- lectronic centers, Florida during past 12 months added 10 new s and there were 10 major expan- The survey, incidentally, excludes of the work being done at Cape veral and Eglin AFB.

ptimistic officials are predicting expansion will continue and that tate's electronic output may triple ve years. **Martin-Orlando,** which g operations only a little over a ago, now has 6500 employees and state's largest single manufactur- mployer.

Force TIF
ig Distributed

he new Air Force missile/aircraft rt equipment "Technical Informa- File" is now being distributed to actors. First issue of TIF (M/R 15 p. 21 and M/R June 22 p. 13) more than 1500 items which can sed by missile system designers. t of the catalogue, which will panded, is to obtain maximum ardization and minimum duplica- of equipment. It may be fore- r of service-wide TIF.

ir National Guard Squadrons at on, Albuquerque and Windsor cs, Conn., are being equipped with *inder* air-to-air homing missiles. **Philco-General Electric**-produced on is being installed on F-100 sabres flown by the three squad- n

ow **Chemical** is producing 5000 ds of high-temperature lubricants e Air Force. The two polyphenyl hs—bis (phenoxyphenyl) ether and phenoxyphenoxy) benzene will be ated by Wright Air Development r for engine usage. Production is ows Midland, Mich., plant.

ioneering cryogenic manufacturer **Cambridge Co.,** Lowell, Mass.— een acquired by **Standard Steel** from the **Carrier Corp.** . . . For apco Group West Coast Division, **pson 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 Product Division in Phoenix. Company says its 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* speedup **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.

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.

ls' 'Zoonik' Launching uses Calm Speculation

Vashington—Russia's announced e launching of two dogs and a it has raised more speculation than an.

Radio Moscow began excitedly and atedly to announce the launching he "zoonik" July 6—four days t it took place.

The Russians said the dogs—Otnaya and Snezhinka—and an unified rabbit were boosted to a at height" by an IRBM and successfully returned to earth.

The payload weighed more than 0 pounds. The Russians said it was

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

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

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

The Russians said the launching ked Otvazhnaya's third trip into e. It came six weeks after the y launched Monkeys Able and r in the nose of a *Jupiter* and successfully recovered them more than 50 miles down the Atlantic Missile ge.

The Russians said instruments rd the dog and rabbit flight telered information on the ionosphere, treams and the ultraviolet part of solar spectrum.

The Russians attempted to make nost of the launching. Radio Mosov interrupted a broadcast of a footal match to announce the four-day news. The bulletin then was anced repeatedly and Soviet academians hailed the event as "another iph of Soviet science."

Soviet commentators declared that missile that launched the "zoonik" 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.

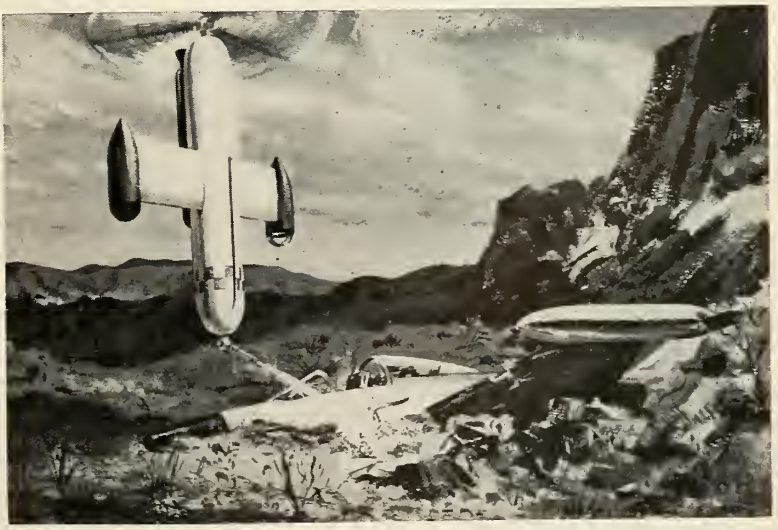
Solar engineers report that the missile-helicopter reaches its goal in three flight stages: 1) a ballistic trajectory, 2) powered level flight and glide and 3) deceleration and hovering.

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.



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."

NAVY

6,000—Newport News Shipbuilding and dock Co., Newport News, Va., for con-ıction of two nuclear-powered subma-es that will carry *Polaris* missiles.

1,541—Electric Boat Div., General Dy-nics Corp., N.Y., for construction of a lear-powered submarine that will y *Polaris* missiles.

01—Hazeltine Electronics Div., Hazel-Corp., Little Neck, L.I., N.Y., for gn, development, testing and produc-of one intercept tracking and con-group AN/SPA-43.

00—Massachusetts Institute of Tech-gy, Cambridge, for conducting a feasi-ty study encompassing those aspects fundamental and applied research re-ed for the evaluation of a high-speed puter system.

16—Heintz Div., Keisey Hayes Co., adelphia, for FFAR rocket head.

47—American Machine & Foundry Co., falo, for warhead, MK37-0.

86—Raytheon Manufacturing Co., Wal-n, Mass., for investigation of methods improving the operation of cross-field ntrant beam devices.

0—North American Aviation, Inc., Mis-Division, Downey, Calif., for conduct-an engineering study of the applica-of sandwich and/or other light-ght structural design and/or combina-thereof, to the hydrofoil and strut ion of Sketch PD 4374. Titanium skins l be used.

7—Philco Corp., Philadelphia, for vari-type oscilloscopes.

0—Cooke Engineering Co., San Mateo, f., for assembly and check-out of mo-missile tracking units.

0—Whirlpool Corp., Saint Joseph, n., for developing, testing and furnish-five Type I thermoelectric tempera-ture-controlled chambers including con-trol circuitry and power supplies.

$39,085—Sperry Rand Corp., Sperry Gyro-scope Co., Div., Sunnyvale, Calif., for re-search and development of missile-aircraft interference study.

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

AIR FORCE

$6,000,000—Avco Corp., Lycoming Div., Strat-ford, 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, communica-tions, 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 Tech-nology, 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 fly-able model of the AN/APS-99 (XY-1) radar.

$796,664—Thiokoi Chemical Corp., Utah Div., Brigham City, for 88 M-16E-1 rocket en-gines 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., Ana-heim, Calif., for helium pressure regula-tors for use on the *Titan* ICBM (subcon-tract from The Martin Co., Denver).

$331,416—Sperry Rand Corp., Sperry Gyro-scope Co., Div., Great Neck, L.I., N.Y., for microwave command guidance system op-eration and support.

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

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

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

$90,000—Stanford University, Stanford, Calif., for continuation of research on "Micro-wave Solar Radiation."

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

$42,079—Litton 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 fric-tion techniques in the study of diffusion and phase changes in metals.

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

$30,000—University of Western Ontario, Lon-don, Canada, for research on gas scintil-lations 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, includ-ing missiles, ground equipment, repair parts, engineering services and improve-ments on the system (five contracts).

contracts

$13,235,000—**Food Machinery & Chemical Corp.**, N.Y., for construction, and test operation of a Chemical Corps proc facility near Newport, Ind. (Prime contractor, The Li Company).

$13,141,192—**Chrysler Corp.**, Detroit, for repair parts on the missile program.

$8,295,767—**Raytheon Co.**, Waltham, Mass., for ground equi support equipment and engineering services for the missile (four contracts). Contractor has subcontract worl for the following and desires that subcontractors be loca the Northeast area: Drafting services, specifications v technical, manual preparation.

$6,938,450—**Blaw-Knox Company**, Pittsburgh, Pa., for consti of six *Atlas* launching complexes at Forbes AFB, Topeka

$4,800,000—**Western Electric Co.**, N.Y., for research and de ment study for a universal integrated communications (Unicom).

$1,572,334—**Independent Contractors & Engineers**, Dallas, fo struction of launch operations buildings, complexes A, B 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 gear for the AF Ballistic Missile Early Warning System near Thule, Greenland (subcontract from Greenland Co tors, Trenton, N.J.).

$430,080—**Ampex Corp.**, Los Angeles, for recorder/reproduce

$385,411—**C. H. Leavell & Co.**, El Paso, Texas, for missile as building at White Sands Missile Range, N.M.

$320,169—**Rheem Manufacturing Co.**, Downey, Calif., for desig development of warheads.

$254,460—**M.B. Electronics, Inc.**, New Haven, Conn., for an grated complex wave vibration testing system.

$219,652—**Western Electric Co., Inc.**, N.Y., for *Nike* spare and components (six contracts).

$170,632—**Consolidated Electrodynamics Corp.**, Pasadena, Cali 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**, Fort Walton Beach, Fla., for constr of two Model IV B launcher shelters for G/M launch f 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 miss di indicator ground stations.

$66,854—**Mandrell Industries**, Burbank, Calif., for airborne 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 ni converter.

$43,118—**Anderson-Nichols & Co.**, Boston, for development construction of one data recorder reproducer instrument.

$35,878—**Goodrich-High Voltage Astronautics, Inc.**, Burli Mass., for research on detailed technical scope of first demonstration of thrust.

$35,175—**Union Carbide Corp., National Carbon Co., Div.**, N.Y power pack Y-155 for *M31* rocket.

$25,726—**Beckman & Whitley Inc.**, San Carlos, Calif., fo streak camera with accessories.

BIDS

U.S. Army Engineering District, Detroit, Corps of Engi 1101 Washington Blvd., Detroit 31, Mich.—Construction of tower, including all related work necessary and appurt 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, Attn: Directorate of Procurement and Production. Tube el type 5957/E-37B in A/W Spec MIL-E1/1011A (sig) dated 1958 and MIL-E-1D dated 31 March 1958 S/N 5960-581-9956 each—IFB 33-604-59-779B. Bid opening 28 July 1959.

Directorate, Procurement and Production, Middletown Air Ma Area, Olmsted AFB, Pa. 9135-305-8199 (GSSF) propellan dimethyl hydrazine in accord with Spec MIL-D-25604B dat September 1958. Delivery to be made in contractor-furn returnable drums or Government-furnished drums at the o of the Government (to be packed 350 lbs. per 55-gal. dr Indefinite quantity. IFB 36-600-59-480. Bid opening 15 July

Electronics Supply Office, Great Lakes, Ill. Tube, electron: type 6249AA, MIL-E-1D, QPL, FSN N5960-543-1143—200 Alternate A—300 each; alternate B—400 each. Estimatec each. IFB 126-1283-59B. Bid opening 21 July 1959.

—when and where—

JULY

o Technical Commission for Aeronautics and Los Angeles Section of the nstitute of Radio Engineers, Third iennial Joint Meeting, Ambassador otel, Los Angeles, July 16-17.

American Rocket Society, Propellants nd Combustion Committee, "Propelnts, Thermodynamics and Handling onference," Ohio Union, Ohio State niversity, Columbus, July 20-21.

id Annual Institute on Missile Techology, Chief of Research and Delopment, U.S. Army, University of onnecticut, Storrs, July 26-Aug. 7.

Denver Research Institute of the niversity of Denver, 6th Annual ymposium on Computers and Data rocessing, Stanley Hotel, Estes Park, olo., July 30-31.

AUGUST

Institution of Investigation of Biological Sciences, Sponsor: Air Force Office of Scientific Research, Aeromedical Div., World Health Organization, Montevedio, 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.

Advertisers' Index

CLASSIFIED

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, servomechanisms, 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

I TUBE. An advanced type of itensifier tube that can "see" ng atom or the faintest star e developed by the Westing- ectric Corp.'s electronic tube r The new tube amplifies the ering at one end to produce an much as 3000 times brighter orescent screen at the opposite st important use of the new expected to be in the nuclear vere it will permit photographic f atomic particle reactions. Two y of Michigan Physicists, Mar- l and Lawrence W. Jones, have used the tube in a luminescent system to produce photographs from the path of a single perticle. Pictures can be taken tube of the minute light scin- that occur when certain ma- re struck by nuclear particles l by "atom smashers." The na- these fleeting scintillations gives formation on the nuclear re- ing observed. In astronomy, the ube cen further intensify the f giant telescopes when viewing et stars, or it could be used in to obtain pictures of far dis- s and galaxies. The tube can y its own output simply by the light output back through with a system of mirrors. Four ubes feeding into each other es would be able to produce of e single photoelectron.

N 225 on Subscriber Service Card.

N:R TUBE. A new high-sensitivity nal counter tube, WL-7243, de- o detect thermal neutrons in range from 8×10^{-3} to 8×10^{5} r/cm²/ second is now available th Westinghouse Electric Corpora- Ctaining an aluminum body, the 24 consists of three individual nal counters; each one inch in et and $10\frac{5}{8}$ inches long and vh BF, enriched to 96 per cent B on-10 isotopy. Operating et ves, the sensitivity of the WL-7243 pximately 13 counts/neutrons/ T pulses arising from incident na photons are sufficiently small based out by suitable discrimina- ir try.

N 226 on Subscriber Service Card.

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 emplitudes. 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 end 5000 pps and provision for en 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.

Circle No. 227 on Subscriber Service Card.

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 operetion—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.

Circle No. 228 on Subscriber Service Card.

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 or ± 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.

Circle No. 200 on Subscriber Service Card.

FERRITE DEVICES. Two new catalog sheets summarizing data on coaxial ferrite isolators and "Tee" ferrite circulators have been made aveilable 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.

Circle No. 201 on Subscriber Service Card.

THYRATRON. A new technical bulletin from CBS-Hytron, tells how Thyratron 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.

Circle No. 202 on Subscriber Service Card.

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.

Circle No. 203 on Subscriber Service Card.

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 A
Welding Society has announ
publication of an Arc Welding
Manual specifically designed f
ers and instructors of manual
welding. Contents include weldi
esses and recommended safet
tices, the metal-arc process, ac
exercises in arc welding, arc
equipment, identification of me
metals and their structure. Pro
lustrated, the manual contains
drawings, halftones and tables.
terial was prepared in respons
quests from schools and indu
a training manual of basic arc
information which would be a
instructors and a reference to
Fifty pages are devoted to arc
exercises and the various techni
be mastered by following the
tions.

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CATALOG. Will Corp.'s latest
supplement describes the new
"StereoZoom" microscopes wi
terrupted, continuously variable,
fication and the 1959 Precisio
Ovens with electronic temperat
trol and higher heat range. Of
interest is the newly-designed
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rer, pump and temperature c
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ance that simplifies dry'n wei
tines, and flexible, waterproof,
tapes which won't burn out end a
for heating large bulky contain
conducting pipes.

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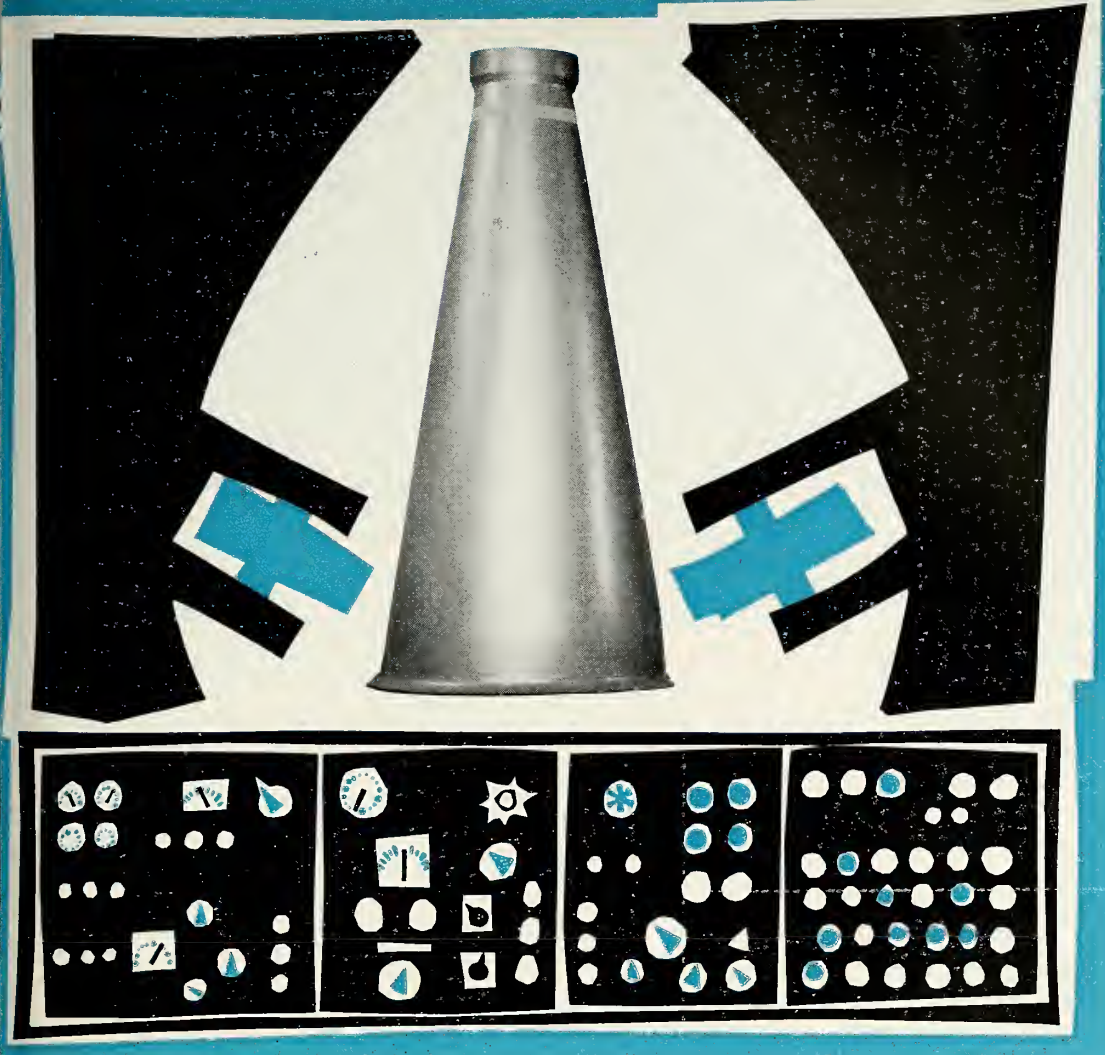
RECTIFIERS. A handbook on
rectifiers has been issued by
Electric Co. This book, which sh
of interest to all design enginee
such rectifiers, contains cons
basic information on the producti
and design characteristics. It d
all rectifier components manuf
by GE, contains application work
circuit information, cooling, and
cation techniques.

Circle No. 207 on Subscriber Servi

BULLETIN. A new four-page t
bulletin, No. 2024, describing a
range frequency converter for 15
000 cps inputs is now availabl
Cox Instruments Division of Ge
Nankervis Company. The Cox T
Frequency Converter described
literature is designed to meet
requirements in laboratory and
applications. It is readily adapt
all types of pulse generating tr
ers. Applications include recorde
puters, digital indicators, milli
and data handling equipment. C
application specifications are pr
in the bulletin discussion and
data, including frequency rang
linearities at various output ratio
signals required; output current
ious linearities; accuracies; f
time constants; power requireme
closures; and price list for stand
modified versions.

Circle No. 208 on Subscriber Servi



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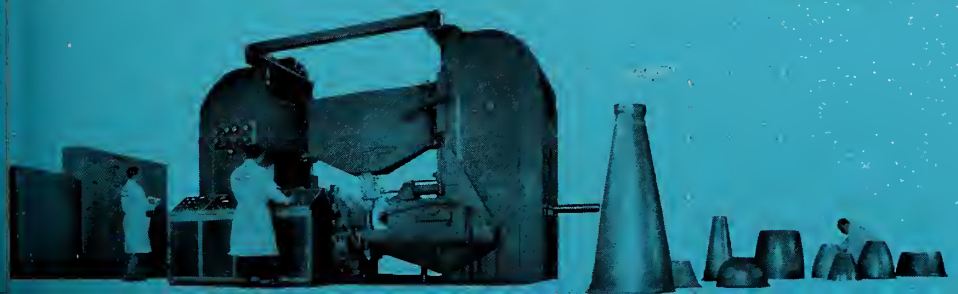

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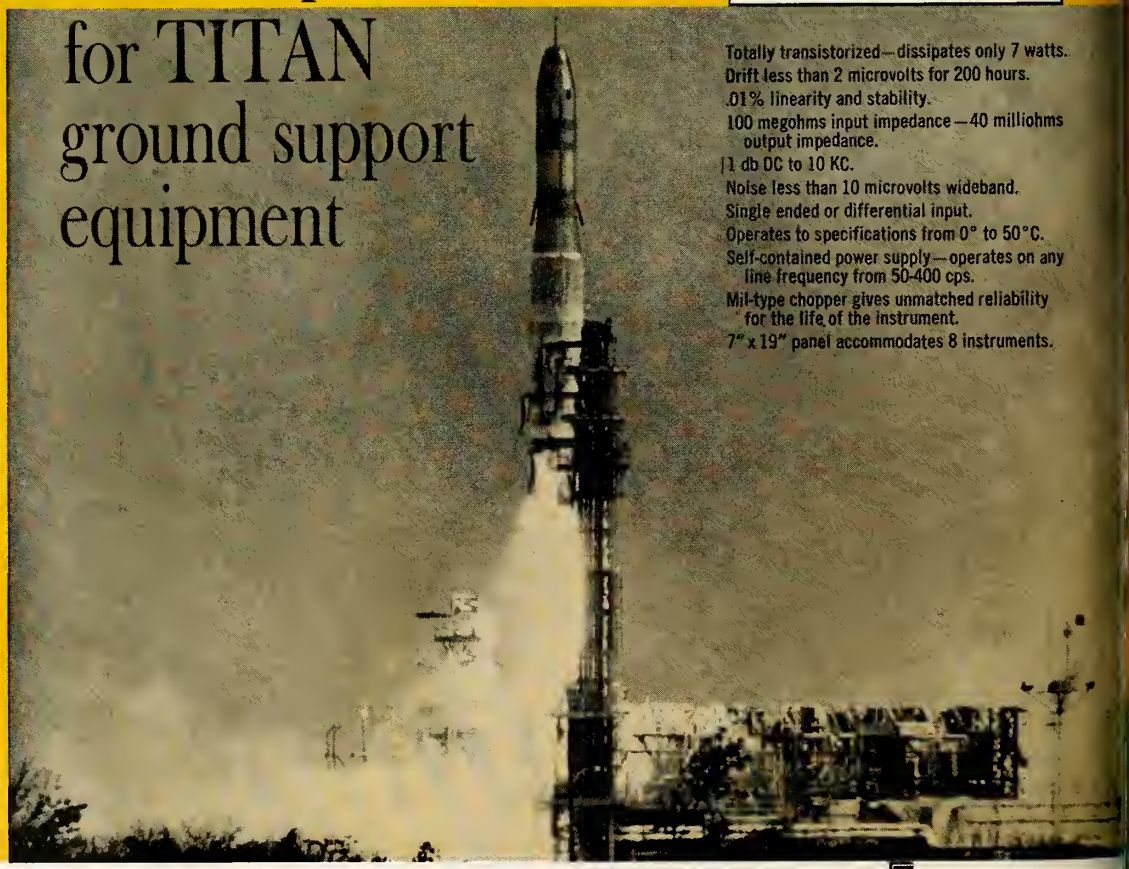

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