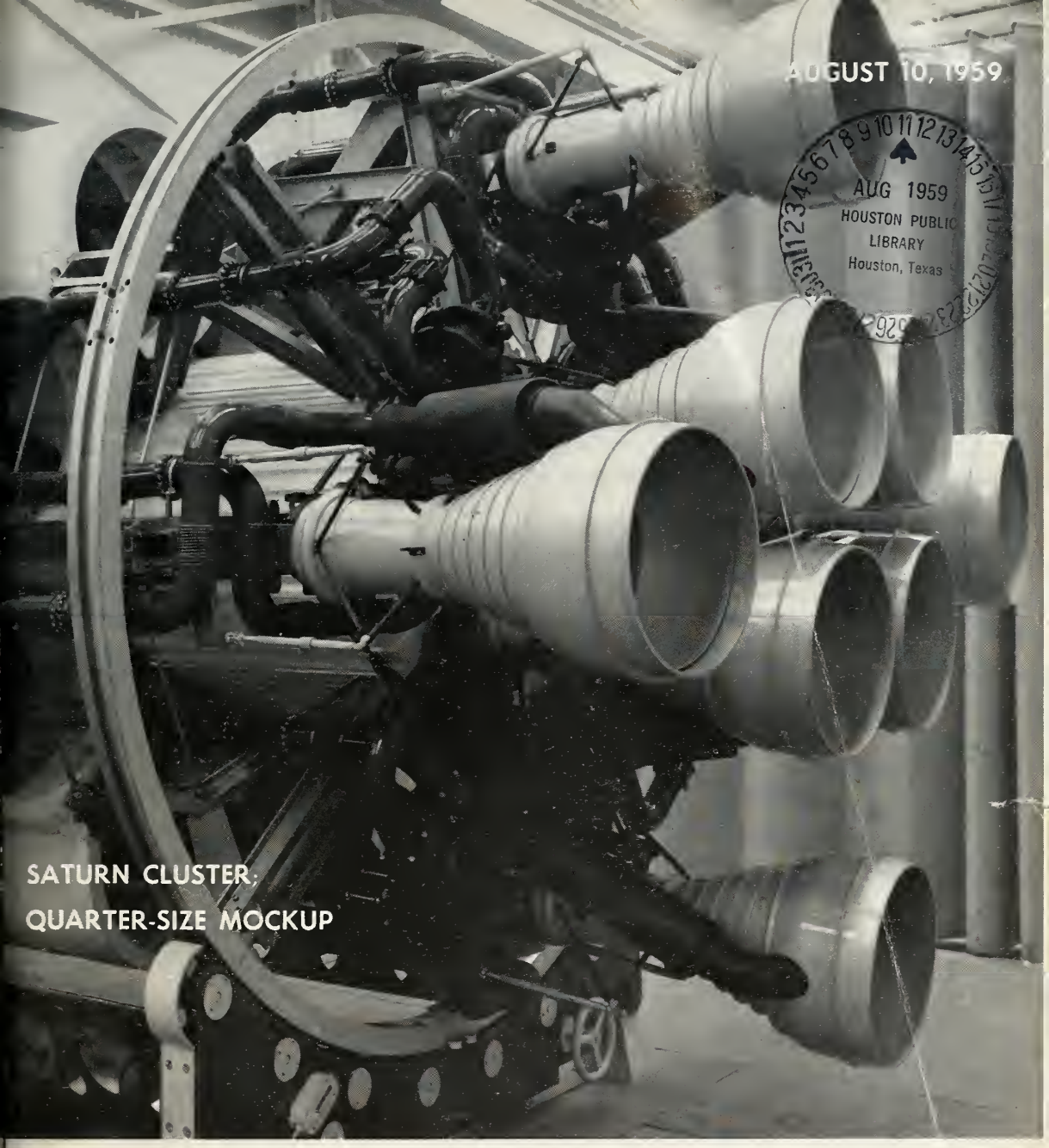


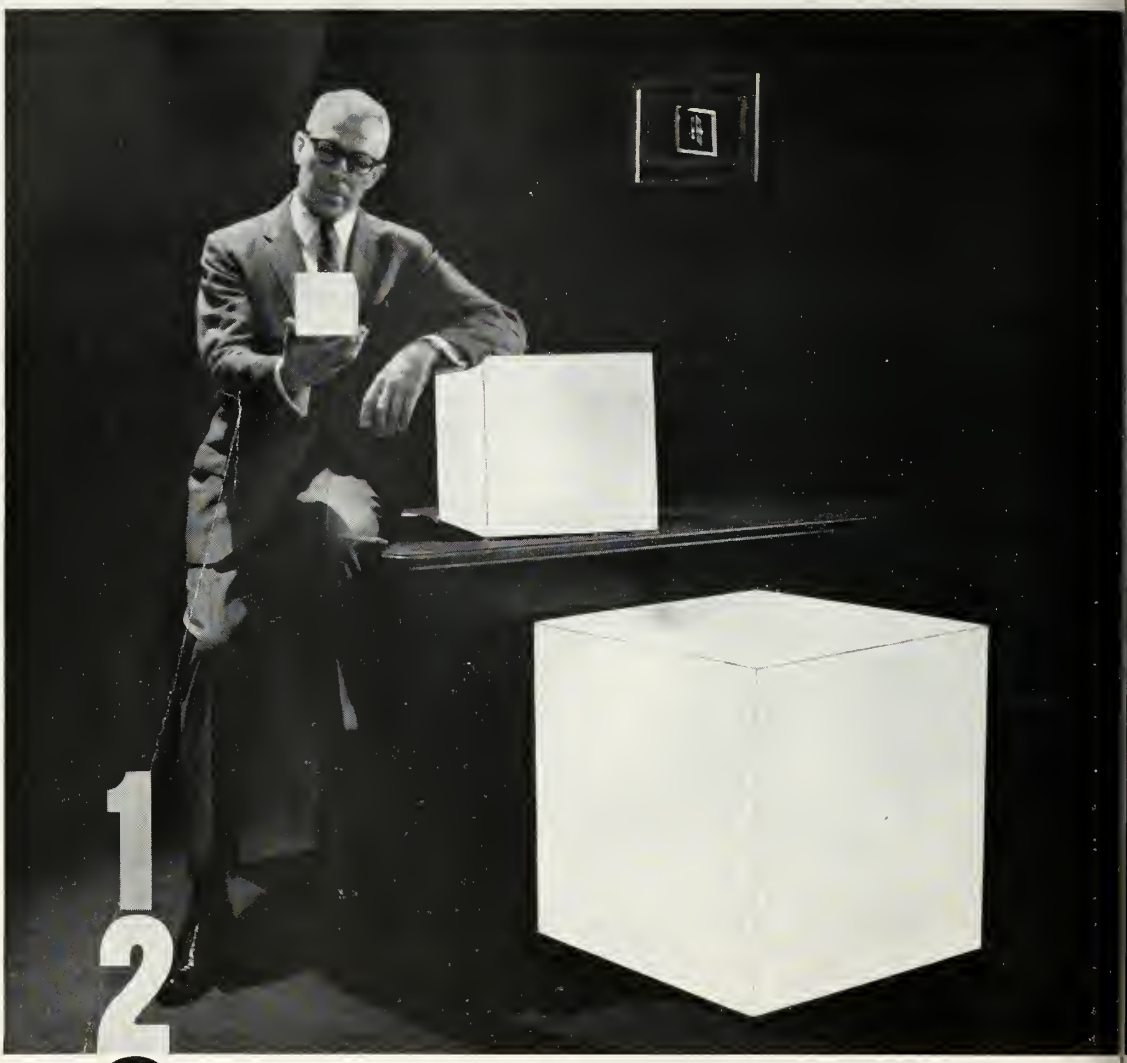
AUGUST 10, 1959

SATURN CLUSTER:
QUARTER-SIZE MOCKUP

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION



3 generations of airborne digital computers (but we can't show you their configurations)

In the photo above, the three ARMA computers have been intentionally deleted. But the cut-outs accurately represent the relative size of the three generations of ARMA airborne digital computers.

The larger size has been *in production* since 1957. The middle-sized one (a quarter the size of today's) will be in production in 1960. And the micro-miniaturized version in the engineer's hand will be operational in 1962—only .3 cubic feet in volume.

A production line unit of ARMA's curren model has operated in excess of 4000 hour without a component replacement. And th 1960 and 1962 versions will have reliabilit factors at least equal to this.

With this program of miniaturization ARMA has made the digital computer truly airborne. ARMA . . . Garden City, Nev York. A division of American Bosch Arma Corporation.

693

We invite you to visit our booth at the Wescon Show, San Francisco.

AMERICAN BOSCH ARMA CORPORATIO

• GUIDANCE
• NAVIGATION
• BOMBING

So Flexible, *it can be adapted to various type missiles, manned or unmanned aircraft — use star-field pattern for matching interplanetary guidance —*

So Uncanny, *it can be launched from barren areas where there are no fixed ground reference points and strike a precise target thousands of miles away —*

So Pinpoint Accurate, *it can hit its objective with a single missile — rather than needing a salvo.*

Pinpoint

PRIME CAPABILITY OF

GOODYEAR AIRCRAFT

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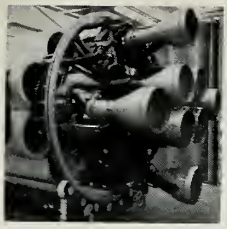


COVER: Quarter-size mockup of ABMA's *Saturn* cluster. For report on clusters technology on this vehicle and plans for the *Nova*, see story on page 24.

SOMETHING more than just size is required in antennas technology. There are still close tolerance manufacturing criteria and maintenance problems under environmental conditions. See report on page 18.

DESTINED to be as big in money expenditures as missiles and space is the challenging field of Under Sea Warfare. Read the special 10-page staff report beginning on page 24.

ASW is a big part of the USW picture and the Red missile submarine threat is bigger than their ICBM's. See story on page 32.

missiles and rockets ®

MAGAZINE OF WORLD ASTRONAUTICS

AUGUST 10 HEADLINES

ASTRIONICS

ASTRONAUTICS ENGINEERING U. S. Reg. Pdg.

M/R SPECIAL REPORT ON UNDER SEA WARFARE

MISSILE SUPPORT U. S. Reg. Pdg.

THE MISSILE WEEK U. S. Reg. Pdg.

DEPARTMENTS:

NEXT WEEK:

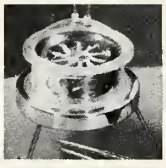
Propulsion Control Systems—New Art Needed
APU and Batteries—What's the Market?
Part I, Special Survey of Middle Atlantic States Missile Industry

Materials Memo

3M reports on SNAP III . . . heat reflective tape . . . adhesive welding

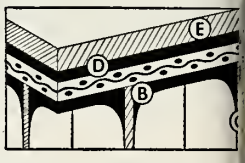
Many of the 27,000 different products manufactured by Minnesota Mining and Manufacturing—the 3M Company—have proved valuable in missile manufacturing and space research. Here is information on newer products . . . and up-to-date ideas and applications for some established products:

■ **SEEBECK & PELTIER, 1959:** Over 100 years ago, in 1829, the German physicist, Thomas Seebeck, discovered that heat applied to one junction of two dissimilar metals in a circuit would produce an electrical potential. The reverse of Seebeck's effect was discovered in 1834 by Jean Peltier when he found that a current passed through the junction of two dissimilar conductors caused heat to be absorbed or given off. Because of the poor conversion efficiencies of available materials, applications of these principles have, until recently, been limited to temperature measurements. But about 10 years ago, a major breakthrough led to the development of new and more efficient conductor materials. Now the Seebeck Effect is headline news: The 1959 development of the first working thermoelectric generator, SNAP III, designed and built by 3M for the Martin Company and the AEC. This unit directly converts heat of radioactive material into electrical energy. Depending on the isotopes used, a 5-lb. generator could provide 5 watts of electricity for one to many years. For comparison, 1,500 lbs. of batteries would be needed to supply 5 watts for one year. Peltier's principle, on the other hand, has led to development of a new 3M Heat Pump. Because of the wide-spread interest in these materials, we now offer a test kit that will let you experiment with heat pumps yourself. Kit contains an assembled Model E-8 heat pump; four extra "P" type elements; four extra "N" type elements; complete instructions—is available for $75. Send your purchase order to Electrical Products Division, 207-1, Dept. 1442, 3M Co., 900 Bush Ave., St. Paul 6, Minn.



■ **HOT TEMPERED TAPE:** One of the latest of the more than 370 pressure-sensitive "SCOTCH" Brand Tapes has unusually good heat-reflective properties. No. Y-9014 can protect plumbing and other hardware from high intensity radiant heat; protect thermally sensitive materials from 5000° F. radiation for short periods. Basic construction is glass cloth laminated to highly-reflective aluminum foil, with a specially compounded pressure-sensitive silicone adhesive. It stands up well under continuous duty at 500°. (Under development: Tape that will withstand 800-850° F.!) You can find this tape liberally applied in engine compartments of some of our big-birds. And wouldn't it be useful in and around high-temp air-breathing jet airplane engines? For complete information on this, or any of the other "SCOTCH" Brand Tapes, call yo 3M Industrial Tape salesman, or write: Missile Indust Liaison at the address below.

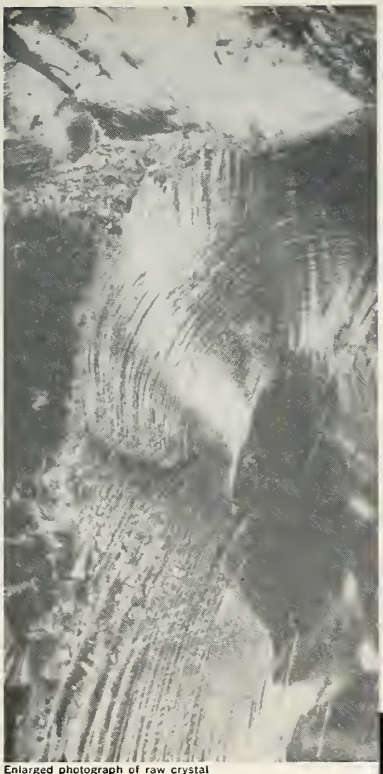
■ **SPACE AGE ADHESIVES:** The last 10 years ha seen adhesive technology move a long way from anim glue and gooey surgical tapes. Today adhesives are i creasingly regarded for structural joining. As example Today most helicopter blades are fabricated with structur adhesives. Intricate castings are now being made in sever simple parts which are then bonded together to form t whole. Advanced aircraft and Missiles are built with a hesive bonded honeycombs. And 3M research has led t way in these new advances in adhesive technology. Yo 3M AC&S salesman will be glad to give you the comple story. "AC&S", incidentally, means "Adhesives, Coatin and Sealers." There's more to the operation than just sticking things together!



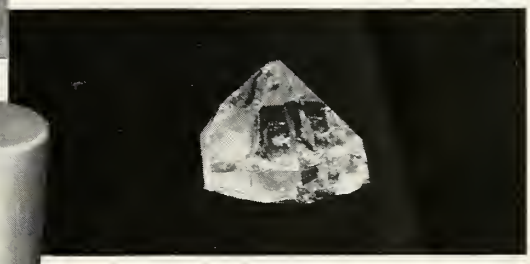
GREATER BOND AREA: One side of "3M" Composite Adhesive Film (a) is coated with dry filleting epoxy (b). Under heat, this epoxy turns liquid, wets deep into t honeycomb (c), then cures chemically to a high-streng solid fillet. Elastomeric adhesive (d) on the opposite si of film, bonds firmly to skin material (e). Sandwich bo has controlled thickness; is tougher and far less mes than previous sandwich construction adhesives.

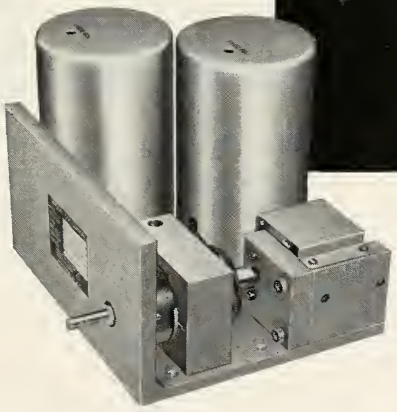
■ **ABOUT "MIL":** 3M's Missile Industry Liaison is service staffed by technical personnel experienced in rocl propulsion and other phases of space technology. Th job is to translate problems of the aerospace industry those 3M specialists best qualified to solve them. If y have questions on any of the items mentioned here, would like to know what else 3M makes—or **could** ma —for your needs, write: 3M Company, Missile Indus Liaison, St. Paul 6, Minn., Dept. VAA-89.

DESCRIPTIVE BROCHURE shows cro sample of 3M Products for missile a space uses. For free copy, write: 3M C Missile Industry Liaison, St. Paul 6, Min Dept. VAB-89.



Enlarged photograph of raw crystal





BULOVA CRYSTAL CONTROLLED ULTRA-STABLE SHIFT OSCILLATORS

Bulova shift oscillators are all that any electronics engineer could ask for in miniature crystal controlled packages!

Consider this new Bulova custom designed 18.5mc shift oscillator. Here's an assembly of two oscillators operating at 18.5mc. One is fixed, with a 1 pp 10^7 stability. The other is a variable with equal stability, 1 pp 10^7. The shift is accomplished by means of a variable air capacitor. However, the same shift, at the same frequency, can be affected with a varicap.

This new ultra-stable shift oscillator is only one of many recent advances made by Bulova Electronics. For information on these specific units, or on how Bulova experience, in mastering component and system reliability, can help your program, write—

Department A-1361, Electronics Division, Bulova, 40-06 62nd Street, Woodside 77, New York

BULOVA

Visit Our Booth #2518, Wescon Show, San Francisco, California

GROUND SUPPORT EQUIPMENT

A Proven Kearfott Capability – Kearfott's prominence in the design and production of ground support equipment is a result of 15 years' experience in producing precision servo systems, computers, gyro reference systems and inertial guidance equipment. Kearfott test equipment is designed on modular principles which increase flexibility and economy and eliminate the obsolescence factor since modules can be readily modified or replaced. Modules are designed to be compatible with one another, thus providing test capabilities for a wide variety of applications.

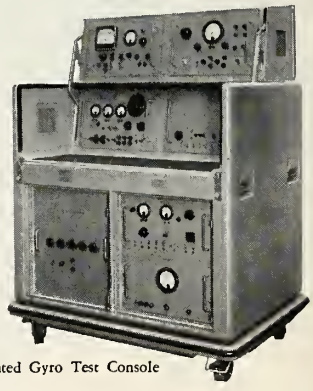
Inertial Guidance System Test Console

IN-PLANT TEST EQUIPMENT: Rack-mounted modules comprise the necessary metering circuits, signal generators and power supplies, switching circuits and junction boxes to perform the following tests on inertial reference systems:

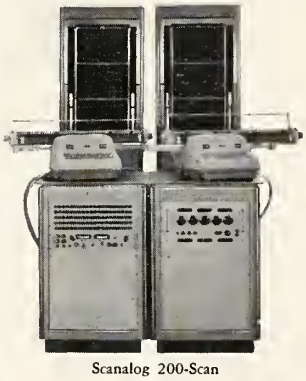
Voltage and phase • Current • Heating cycle checks • Verticality of platform in ground erection mode • First order erection time in ground erection mode • Measurements of platform roll and pitch output angles in ground erection mode • Measurements of free drift of platform in azimuth in ground erection mode • Measurement of azimuth gyro torquer scale factor in ground erection mode

FIELD-TYPE TEST EQUIPMENT: Modularized, self-contained unit that provides all power and signal voltages to operate, test or trouble-shoot a gyro. All inputs to and outputs from the gyro are accessible at convenient jacks where connections to measuring equipment can be made, thereby enabling operator to evaluate gyro performance completely. Modules are slide-mounted for ready access if repair, modification or product improvement replacement are required. This portable equipment performs these basic tests:

Insulation resistance • Warm-up time • Torquer scale factor measurement Gyro transfer function • Free drift • Gimbal offset drift • Continuity Signal Generator Null • Phasing • Gyro drift • Fixed torque restraint



Floated Gyro Test Console



Scanalog 200-Scan
Alarm Logging System

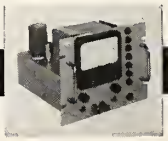
GENERAL PURPOSE DATA PROCESSING: This data handling system provides a reliable, precise means of monitoring, logging and performing an alarm function of up to 200 separate temperature, pressure, liquid level or flow transmitters. Manual controls are provided for scanning rates, automatic or manual logging, data input relating to operator, time, day, run number and type of run. 200 numbered lights, corresponding to specific points being maintained, provide a visual "off normal" display for operator's warning. This system has growth built in and can be expanded in capacity to 1024 points and in scanning rate to 2000 points per second.

Write for complete information on Kearfott's ground support equipment.

Engineers: Kearfott offers challenging opportunities in advanced component and system development.

VTVM-PSVM

High-Speed
Precise Angle
Indicator Module



Automatic
Ohmmeter
Module

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Washington Countdown

IN THE PENTAGON

Put *Polaris* in cruisers . . .

This is a Navy battlecry that you can expect to hear increasingly in the months ahead. The Navy believes firing the **Lockheed** missiles from cruisers would be easier to do than firing them from submarines. And it feels that *Polaris*-packing cruisers would be a natural strategic partner to the underwater fleet of *Polaris* subs.

• • •

Two types of rocket belt . . .

may be adopted by the Army. One—a light model that can be strapped around the waist—would be used for short jumps over obstacles. The other—a more elaborate harness with bigger rockets—would be used for longer one-man hops.

• • •

An anti-submarine satellite . . .

is under study by the Navy. Details of the project are highly classified. However, the satellite undoubtedly is being looked at as a means to solve the tough detection problem. (See page 24)

• • •

Number of *Lacrosse* battalions . . .

in FY '61 is very iffy with numbers being tossed all over the park. It's definitely decided, however, to equip eight battalions this year. Two more are to be activated before December and one battalion in March, April, May and June.

• • •

Navy also requires *Mauler* . . .

and, sources say, wants to put funds into its R&D. (See p. 13)

• • •

Army's new "vest pocket" system . . .

for tactical air defense probably will soon go to NATO forces as well as U.S. units in Europe. The Army can be expected to seek at least another 30 of the mobile **Hughes** units in the not too distant future to go with missile batteries already in the field. (See page 45)

ON CAPITOL HILL

American missile shipments . . .

to NATO forces will not necessarily be cut during the next year because of congressional multi-million dollar slashes in the foreign aid program. The Administration can probably find elsewhere in the big program the $302 million it planned to spend on missiles for NATO in FY '60.

• • •

Congressmen remain pessimistic . . .

about the chances of the Administration taking up Congress' desire for ordering eight more squadrons of **Convair** *Atlases* this year. The House and Senate have made an $85 million down payment on the extra squadrons available. But the Administration has made clear that it has no intention of making the $800 million commitment for the squadrons unless the international situation should change for the worse.

AT NASA

With one *Vanguard* . . .

attempt yet to go, fairly complete figures indicate that the "work good when it works" bird costs $3 million per shot.

AROUND TOWN

Watch for Japanese . . .

to make an official protest to the Soviet Union about Red missile firings passing over Japanese territory. The Japanese are already irritated about the Russian action several years ago banning their fishing ships from the Sea of Okhotsk and parts of the Bering Sea, claiming them to be contiguous to Russian territory. Japanese sources say that Russian missiles are landing in these waters, and that longer range missiles are passing over Japan itself.

Other reports . . .

. . . Some military and space planners are worried that Soviet Premier Khrushchev's forthcoming U.S. visit may take a lot of the starch out of U.S. missile-space efforts . . . On the other hand, Russia could decide that now's the time to announce another spectacular Soviet space achievement.

. . . The Air Force is considering establishment of a Ground Electronics Systems Center to control development of electronics systems in all AF weapons. This would split the weapon system concept.

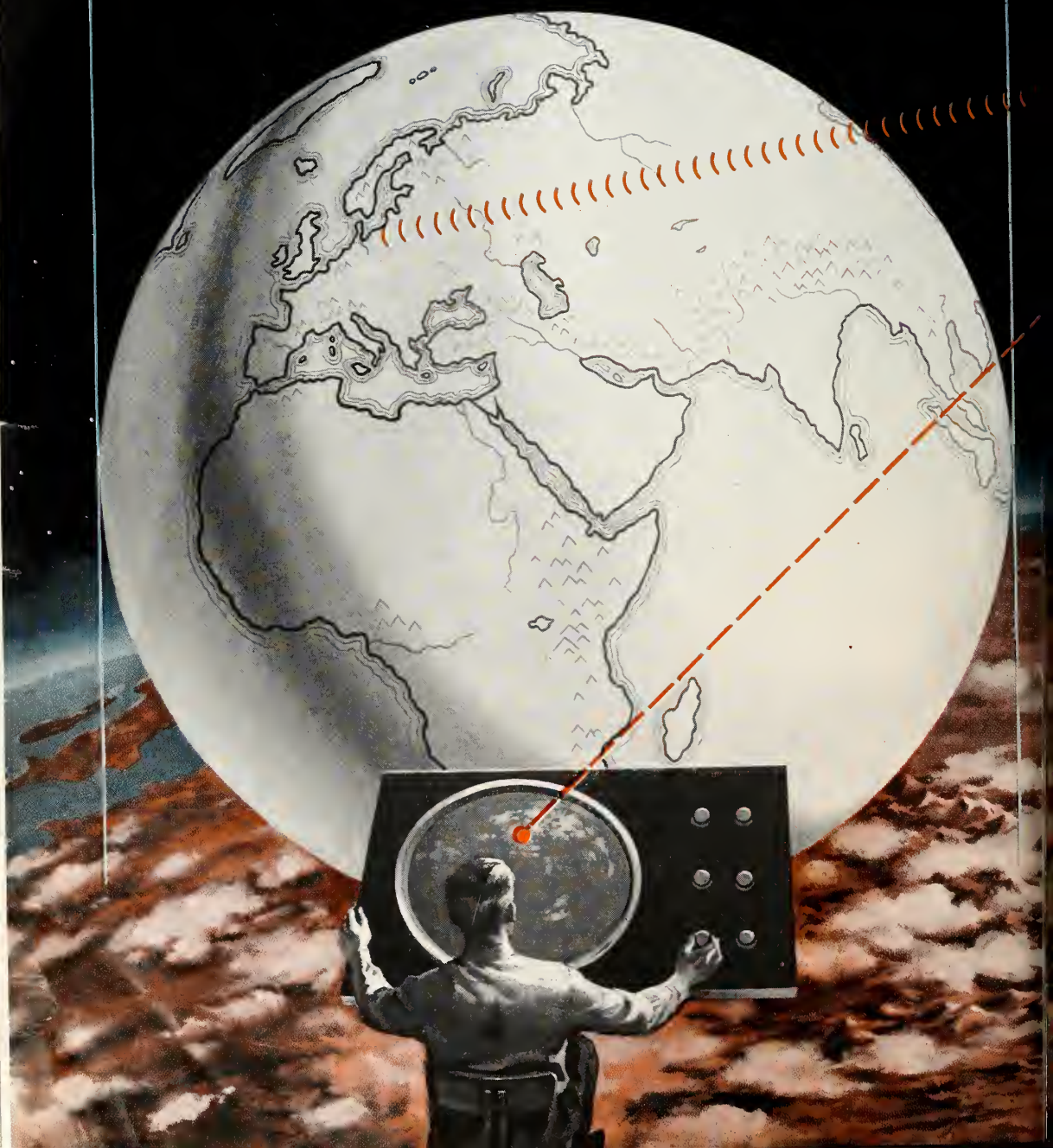
. . . Vice President Nixon will work behind the scenes for more money for the U.S. space program in the '61 budget.

Marquardt

ADVANCED SIMULATOR-TRAINING SYSTEMS

FOR AIR AND SPACE

UNIQUE MARQUARDT CONCEPT SHRINKS EARTH TO 14-FEET



Advanced land mass simulation concept demonstrates Pomona Division capability in realistic simulators for lower-cost training of America's air and spacemen.

IN DEVELOPMENT:

A Marquardt-conceived land mass simulation system that shrinks the map scale factor to 1:3,000,000, while enabling the operator to distinguish landmarks smaller than a football field from any altitude! Application today: ground-training airmen for intercontinental missions at great savings in cost — using a single 8-foot map to realistically simulate the radar reflectivity and shadow effects of a 4,000-mile mission. Application tomorrow: training the free world's first space explorer for his safe return to earth.

IN PRODUCTION TODAY:

Pomona Division's AN/GPS-T4 Radar Signal Simulator, a relatively low-cost training system that is simple, compact, flexible and realistic; producing synthetic target and IFF video information for radar display. Current mission: training USAF aircraft controllers to direct interceptor missions. Ready adaptability will permit the T4 to simulate missiles, radar surface targets and sonar targets.

IN THE U.S. DEFENSE INVENTORY:

The USAF's AN/APQ-T1, AN/APG-T1A, AN/APQ-T2 and T2A, and AN/APQ-T3 simulator-training systems, plus the USN's 15WV-2 AEW/CIC trainer system — all developed and manufactured by the Pomona Division and its predecessor companies. Numerous sub-systems, up-dating modification kits, adapters, spares, and a worldwide field service section add to the organization's total experience.

POMONA DIVISION of The Marquardt Corporation is an able and experienced organization with demonstrated capability in advanced research, design, development and production. The result is reliable hardware which provides solutions to the problems of training military operational personnel.

Drawing on the Corporation's overall management-engineering skills, additional facilities and financial support, Pomona Division now offers industry and the Armed Forces a unique and proven ability to get the job done—delivering vital simulator-training system both on-time and at minimum cost.

OPERATIONS AT:
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Pomona, California
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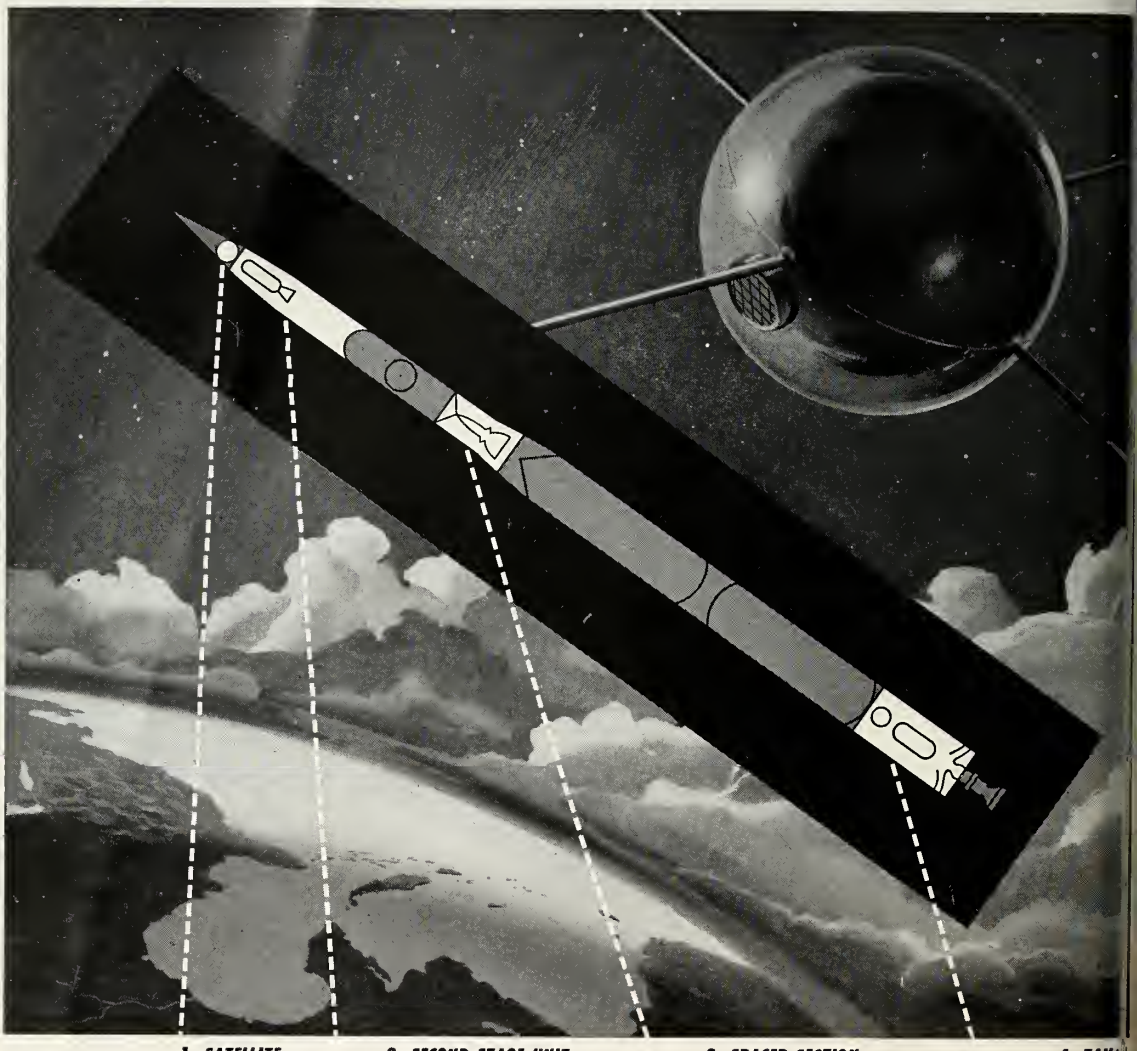
SUBSIDIARY:
Cooper Development
Corporation,
Monrovia, California

THE Marquardt
POMONA DIVISION CORPORATION
2709 No. Garey Avenue, Pomona, Calif.

Engineers and scientists capable of contributing to advances in state-of-the-art are invited to write to: Dr. Wendell B. Sell, Vice-President.



1. SATELLITE
The rigid external skin of the weather satellite is made of magnesium alloy, AZ31B. It is plated with gold and other materials to reflect heat.

2. SECOND-STAGE UNIT
The skin is made of HK31A, magnesium-thorium alloy sheet. This elevated temperature alloy must withstand temperatures of 700° F. and above.

3. SPACER SECTION
The skin is formed of AZ31B magnesium alloy sheet. Magnesium was selected for its light weight and high strength-to-weight ratio.

4. TAIL
Again AZ31B magnesium alloy chasen because it is the world's ligh structural metal.

LIGHTWEIGHT MAGNESIUM SPEEDS WEATHER ROCKET FOUR WAYS

The shell of the satellite and several parts of the Vanguard Rocket are made of standard magnesium-aluminum-zinc and magnesium-thorium alloys. Why was magnesium chosen for this project? Because it is the lightest commercially available metal that could be easily fabricated—one with a high strength-to-weight ratio and able to withstand elevated temperatures encountered during flight. Magnesium alloys met these demanding requirements, as pro by tests conducted by the Naval Research Laboratory Washington, D. C.

Write today for new illustrated brochure on aircraft, m siles and rockets. Contact the nearest Dow Sales Office write to THE DOW CHEMICAL COMPANY, Magnesium Produ Sales Dept., Midland, Mich., Dept. MA1302CL8-10.

THE DOW CHEMICAL COMPANY · MIDLAND, MICHIGA

Industry Countdown

MANUFACTURING

***Missile A* competition . . .**
winner announcement is to be announced momentarily. Prime contract will go to **GE's Missiles and Space Systems Division.** Funding decision confirms M/R story (March 30, p. 13). While no official announcement has been made, sources inform M/R that **Convair** has go-ahead on the *Mauler* competition, an infrared homing missile for use against low-flying aircraft. *Missile A* is 65-70 mile range solid propelled successor to the *John* family.

Labor demands for coming year . . .
will include: equal pay for equal work; severance pay; per diem and expenses when relocating to another plant (now included in a **Lockheed** contract) and 15 cents more an hour.

• • •

Look for new IAM-UAW coalition . . .
to campaign for some kind of contract protection against surprise cancellations of missile/aircraft work. In forthcoming negotiations union bargainers may ask for job security provisions against sudden layoffs.

• • •

Single collective bargaining . . .
pact worked out last week by IAM-UAW will be tried out first in negotiations with **United Aircraft's Pratt & Whitney Division.** Contract expires in December; most other major contracts are up for renewal in the first half of 1960.

• • •

Keep an eye on $100 million . . .
oceanographic research program recommended by National Academy of Sciences National Research Council. It could be another good market for missile, rocket and spaceflight knowhow. Ten-year project would entail direct procurement of deep (18,000 feet) and mid-depth submarines, 36,000-foot bathyscopes and a great variety of other instrumentation akin to missile/space requirements.

PROPULSION

Best analysis . . .
of **Phillips Petroleum** withdrawal from its **Astrodyne** partnership with **Rocketdyne** is that Phillips decided small government contract profit didn't offer as good a percentage return on investment that could be obtained in normal commercial operations.

• • •

Latest model Rocketdyne X-1 . . .
from which company has developed all its liquid rocket engines now has only two basic components—turbopump and combustion chamber. A couple of years back there were 10 times that number of components.

• • •

Navy will use $3.5 million . . .
order of **Thiokol** Guardian II rocket motors for off-the-shelf stock as well as propulsion system for supersonic target drone being developed by **Temco.**

• • •

First silo shot . . .
of **Boeing** *Minuteman* with first stage solid-fueled **Thiokol** engine is due shortly at Edwards AFB. Engine will be scaled-down prototype with very limited thrust. Shot primarily will be test of configuration of the 100-foot silo.

ELECTRONICS

Uninterrupted telemetry . . .
transmission during atmospheric re-entry reportedly has been developed by **Avco** scientists. Hush-hush method penetrates ionized layer which builds up around re-entry vehicle and heretofore has blacked out radio signals.

• • •

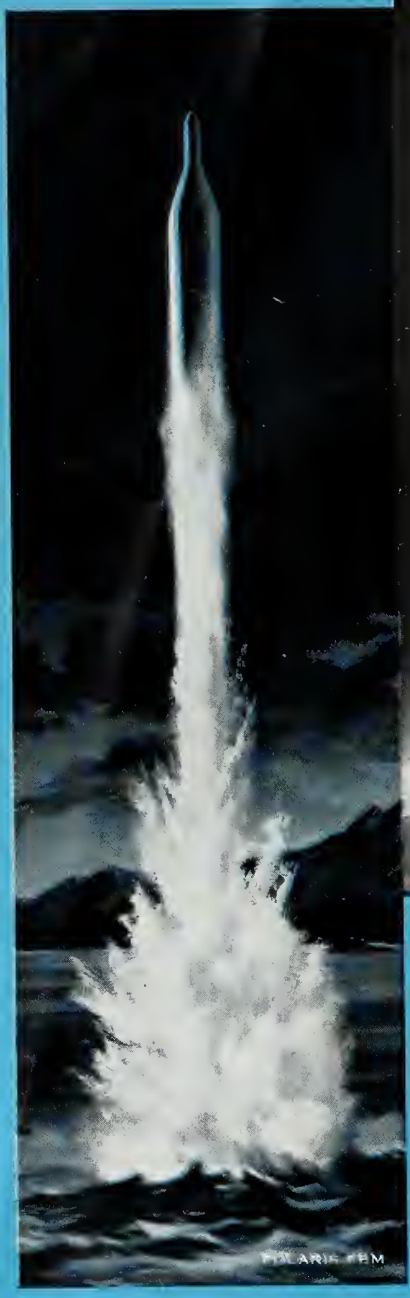
Big problem in engineering . . .
Mercury "satellite clock" programmer is gravity. **Waltham Precision Instrument Co.** must design it to operate in space where there is no gravity, and this means developing entirely new means to achieve zero gravity conditions on earth to test the device before it is sent aloft.

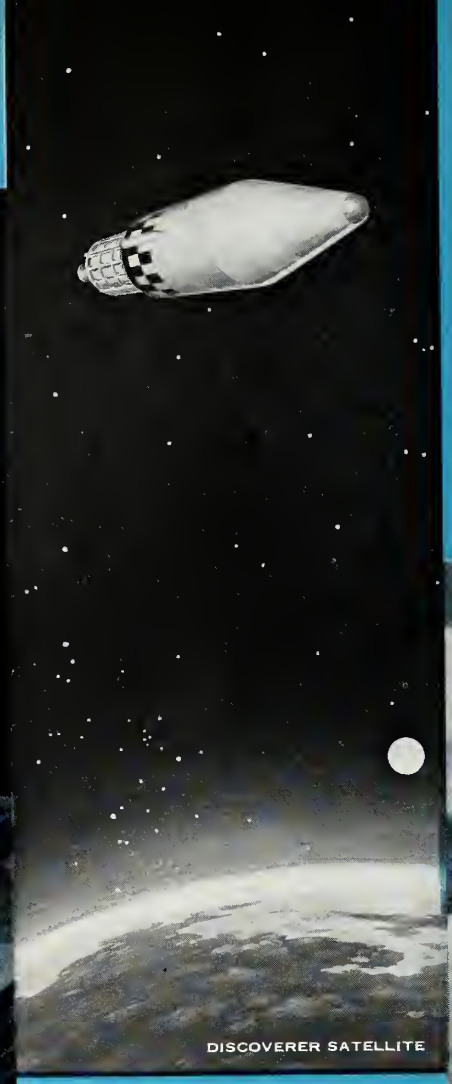
WE HEAR THAT—

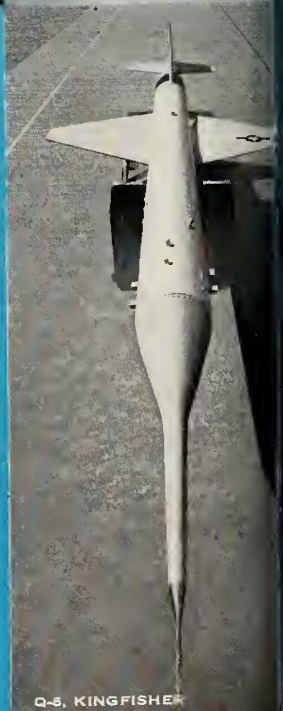
Underground missile sites . . .
are being sought by British Air Ministry geologists for *Bluestreak* IRBM squadron—and perhaps for *Titan.* Trouble to date has been in finding militarily suitable locations which have proper subsoils . . .

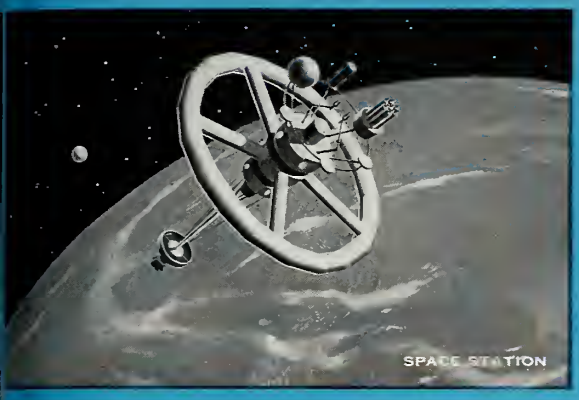
Richard Boutelle, former president of **Fairchild Engine & Airplane Corp.,** now is reported to be a consultant to **AC Sparkplug Division** of **General Motors** . . . Merger of **Victoreen Instrument and Tenney Engineering** will produce one company with combined annual sales of $15 million . . .

Restraint reel and harness systems for *Mercury* astronauts are under development by **Hardman Tool & Engineering Co.,** Los Angeles . . . Hardware for Naval Research Laboratory sun flare investigation consists of 12 **Cooper Development** *Aspan* rockets which weigh 1760 pounds apiece and can boost a 50-pound payload to 150 miles. They require only a 60-second countdown . . .




DISCOVERER SATELLITE


Q-5, KINGFISHER



EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

■

ADVANCED PROJECTS AT LOCKHEED

POLARIS FBM—Lockheed is missile systems manager for the Navy POLARIS Fleet Ballistic Missile, under the cognizance of the Special Projects Office of the Bureau of Ordnance. Submarine-launched, the POLARIS will travel through three mediums in a single flight: water, air and outer space. With three-quarters of the earth's surface being water, practically no target in the world is outside its range. The solid-propellant POLARIS was *designed with the future in mind*—an approach that the Navy states has cut nearly two years from the original timetable.

DISCOVERER SATELLITE; MIDAS; SENTRY Designed and built by Lockheed Missiles and Space Division, the first of a series of DISCOVERER satellites was successfully placed in orbit in February. The Division has also been assigned the responsibility of systems manager for PROJECT MIDAS – an early warning system against ballistic missile attacks. The project will investigate the use of infrared sensors for detecting aggressor missiles at the moment of launch; and PROJECT SENTRY—an advanced satellite reconnaissance system. DISCOVERER, MIDAS and SENTRY are programs of the Advanced Research Projects Agency under the direction of the Air Force Ballistic Missile Division.

X-17—The nation's first successful reentry tests were conducted by the Air Force with the three-stage, Lockheed X-17 solid-propellant ballistic missile. The X-17 has pioneered many new techniques and the valuable experience gained from this program has facilitated development of other, inter-service projects, including the Navy POLARIS FBM. The Navy's history-making, 300-mile-high, Project Argus radiation explosions featured the X-17 as the vehicle.

Q-5, KINGFISHER—Developed for the Air Force, and currently being manufactured for the Army, the Kingfisher is designed to simulate enemy attacks to test the efficiency of our various defensive weapon systems. It is equipped with extensive instrumentation to register "kills" without itself being destroyed and can be recovered by parachute and landing spike to be used again, with marked savings in cost.

X-7—Lockheed's X-7 recoverable ramjet-engine test vehicle, developed for the Air Force, has established speed and altitude records for air-breathing vehicles and is also recoverable for re-use following flight.

SPACE STATION—An orbiting research facility, to serve as an advance base for space exploration, has been proposed in practical detail by Lockheed's research and development staff. The station would carry a 10-man crew. Prefabricated compartments for the rim of the wheel, the spokes, and the three hubs would be launched separately by means of ballistic missiles and guided into a cluster on the same orbit.

The successful completion of projects such as these requires a bold and imaginative approach to entirely new environments. Lockheed's programs reach far into the future. It is a rewarding future which scientists and engineers of outstanding talent and inquiring mind are invited to share. Write: Research and Development Staff, Dept. H4-29, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

Lockheed / **MISSILES AND SPACE DIVISION**

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO • HAWAII

Pick Your War – Then Plan for It

Pentagon's new instruction on industrial readiness planning leaves it up to individual services to choose type of war and make industry gear to match decision

by James Baar

WASHINGTON—The Defense Department is dramatically demonstrating once again its inability to answer the multi-billion dollar mlitary question: What kind of war should the nation prepare for in the Missile Age?

The demonstration is made for all to see in the Defense Department's new Instruction on Industrial Readiness Planning—a detailed outline of how the three services should go about making industrial war mobilization plans.

The multi-billion dollar missile-space market is caught directly in the middle.

In brief, the Pentagon has three obvious choices on which to base war mobilization planning:

- Total all-out war. This would begin with a catastrophic exchange of nuclear weapons and could be expected to conclude shortly thereafter.
- Limited war. This would be another Korea-type war—a war fought for a relatively short period in a limited area for limited objectives.
- General war fought without the big warheads. This would be a long war involving only conventional and possibly small fractional-yield nuclear weapons.

The United States could prepare to fight all three kinds of war. That is what Russia has done. Or, the United States could make a clear-cut decision on one or even two types.

But the Pentagon and the Administration have decided against taking either course at the present time. Instead, the Pentagon has clearly decided to let the decision continue to ride.

In effect, the new Defense Planning Instruction tells each of the three services to make industrial plans for whatever kind of war each believes would be the correct one to plan for under the present circumstances—budgetary and strategic.

As a result, the Air Force can be expected to proceed with its present policy of planning strictly for all-out nuclear war. This means little or no industrial war planning.

On the other hand, the Army and Navy can be expected to continue to proceed with their present policies of planning for limited and general wars fought without the big nuclear weapons. This involves millions each year.

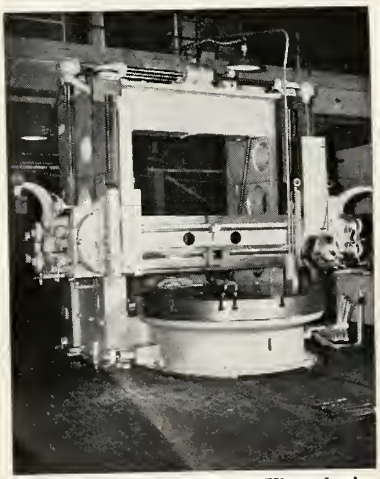
- **How it started**—Industrial war planning dates back to the early years after World War II. The governme decided that it would never again caught in the state of industrial unp paredness for war that it was in af Pearl Harbor.

Therefore, the government began vast program of stockpiling critical w materials. The services also put ir effect industrial preparedness and pla ning programs involving projects rar ing from drawing up paper mobili tion plans to mothballing factories.

The United States today has a st tegic material stockpile involving penditures and obligations totali nearly $6 billion. These include so 75 materials running from aluminu to manganese to zinc—not to for wattle and waterfoul feathers. All stored at some 216 depots and oth facilities throughout the nation.

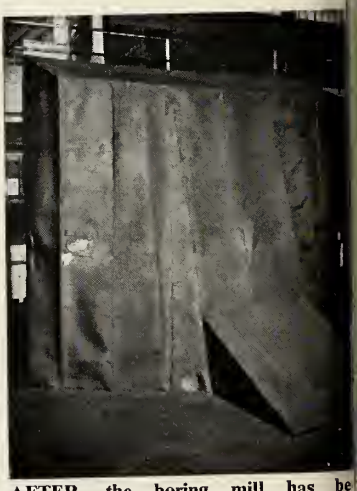
Purchases of a number of items continuing. However, for most ite both basic and maximum objectiv have been achieved.

The Army has in reserve 73 plan for mobilization purposes—38 inacti and 35 active to varying degre Thirty-five are ammunition plan Twenty-six others for some type ordnance. Five of these are in the Arr missile program.



BEFORE mothballing, a King boring mill awaits joining machine tool reserve.

PART WAY, the boring mill is covered with protective paper and frame.



AFTER, the boring mill has be shrouded with heavy protective materi

The Army also is maintaining more han 169,000 items of war production quipment in storage. About 60% of hese items are part of plants in the rmy industrial reserve. Some are tored in big Atchison cave in Kansas.

The proposed Army budget for FY 50 provides $76 million for its in- ustrial mobilization program. But this s not a true picture of Army expendi- ures in this field. Many costs are scat- ered elsewhere.

The Navy is spending about $110 to 120 million a year on its mobilization rogram. However, the Navy is spend- ng only about $12 million on industrial obilization planning. The bulk of the oney goes for purchase of mobiliza- ion stocks and maintenance of the big othball fleet.

The mothball fleet today is made up f nearly 1400 ships of all types. These nclude 47 carriers, 15 battleships, 54 ruisers, 121 destroyers and 44 sub- arines.

The Air Force now is doing prac- ically no industrial mobilization plan- ing except for a number of very lim- ed programs. However, the new Air orce budget includes $40 million for ar readiness material. Most of this is or such rapidly consumed items as uxiliary fuel tanks for tactical jet ircraft.

• **Clarification overdue**—These learly divergent programs and the asic policies behind them has made it bvious for sometime in industry and ilitary circles that clarification of entagon policy on industrial war plan- ing was much overdue. Naturally, ny such clarification would also in- olve clarification of Pentagon policy n the far broader issue of limited vs. otal war.

But Pentagon officials faced great ifficulties in doing any such thing.

Money, of course, was and still is the main stumbling block. If there is enough cash, you can plan for all kinds of wars. But, when you have to operate under a $40 billion annual ceiling, you have to make some tough decisions.

The Air Force theory has been that the most likely war would be a total war no matter how it started. Therefore, it has argued that its limited funds should be spent on building and maintaining the most powerful force-in-being possible.

This policy is based on the conclusion that in any total war only the forces that the United States can bring into action at the beginning would have any meaning.

There would be no time to take plants, machine tools and ships out of mothballs. There would be no time to begin producing thousands of new missiles. There would be no time to order the manufacture of 50,000 planes.

Moreover, an all-out nuclear attack would make rubbish out of most advance planning along with much of the nation's industry and huge strategic stockpiles.

The Army and Navy have countered that limited wars similar to the Korean War and smaller are far more likely than total war. Therefore, industrial mobilization planning, stockpiling and mothballing of equipment are vital.

The Air Force reply is that it is not opposed to planning for such wars. But it argues that first the Defense Department should come up with an overall plan of what kind of limited war to plan for and someone should provide the money.

In any assessment of all of these arguments, it must be remembered that the Administration policy continues to be preparation for total war.

The Army's high-readiness reserve factories can be operating within three to four months. But the Army itself is not designed to meet the vast armies of Communism in any sizeable land war fought with conventional weapons.

After extensive review of all this, the Defense Department came up with its new War Planning Instruction—a broad compromise.

• **Possibilities**—The new instruction offers seven broad possibilities:

• Acceleration Planning. This is aimed at having current producers increase their rate of output in conflicts short of general war.

• Conversion Planning. This involves arrangements under which a manufacturer plans to produce in an emergency products that he does not normally produce.

• Compression Planning. This involves increasing a current contractor's normal production inventory so that in a national emergency he can complete a maximum number of finished products on a crash basis. The assumption in such planning is that all sources of supply have been destroyed.

• Subcontract Planning. This involves elimination of delays in an emergency.

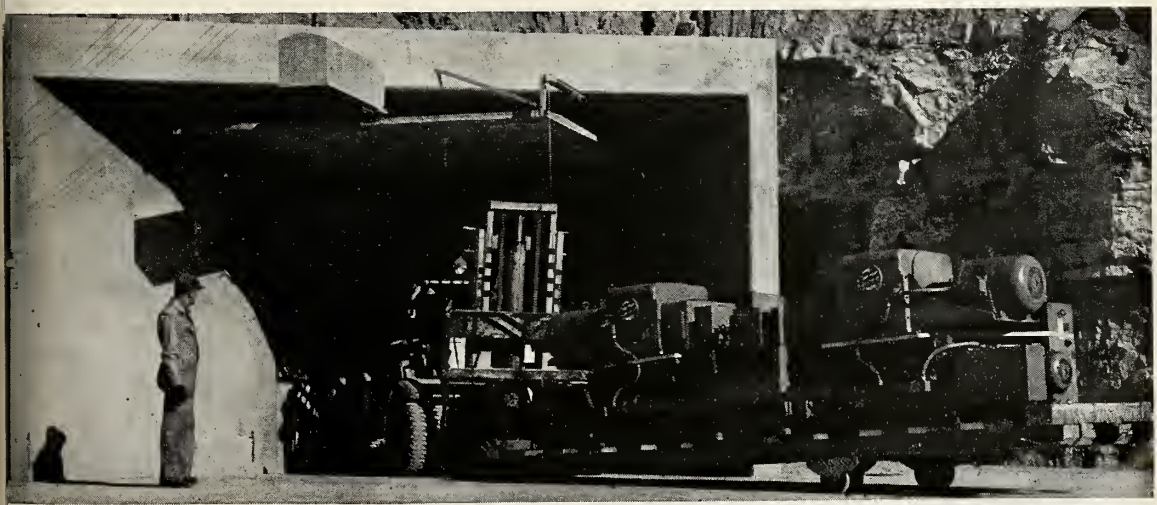
• Supplier Planning. This is aimed at production of normally commercial items that have a military application.

• Industry Preparedness Measures. This ranges from surveys of possible production problems to operation of pilot assembly lines.

• Special Studies. These are such things as broad surveys that might be needed from time to time.

Finally, the Defense Department left open the possibility of approving any other type of planning that any of the services might believe desirable.

In other words, pick your war and plan for it.



UNDERGROUND in huge Atchison Cave near Atchison, Kansas, the Army stores part of its big mobilization stockpile.

Antennas: There's a Limit in Size

What's needed is the ability to manufacture dishes and maintain them in an exposed environment to the close tolerances required

by Hal Gettings

WASHINGTON—What's needed in antenna design and fabrication to meet the extreme range requirements of missiles and space vehicles?

For example purposes, let's cite a 600-foot monster antenna now being constructed near Sugar Grove, W.Va. Costing $60 million and scheduled for completion in 1962, the Naval Research Laboratory facility will be able to look 38 billion light-years into space.

But the design of this unit merely serves to point up the emphasis being given to the extreme range requirements necessary for tracking. Boiled down, it means antennas must become bigger—because gains require larger apertures. And they must be better—because there appears to be a limit to bigness and advancement must also come in other areas.

Long-range communications can be improved by increases in three areas, under the present state-of-the-art: transmitter power, receiver sensitivity, and antenna gain.

Higher transmitter power is being obtained with new tubes and techniques. Receiver sensitivity is being increased with MASERS and parametric amplifiers. And antenna gain is being increased by larger and more precise reflectors.

But one of the primary limitations to larger reflectors is the ability to manufacture the dishes and maintain them in an exposed environment to the close tolerances required. Accepted practice calls for a reflector surface accuracy of better than 1/16 the wavelength from the focal point to any point on the reflector. (For a 60′ paraboloid with a 25′ focus at 2000 mc this would mean ± 1/6″ deflection).

These extreme accuracies even put a strain on present instrumentation to measure conformance. However, **General Bronze** has devised a special microwave interferometer to measure accuracies within one-tenth of an inch.

• **Design problems**—Several other problems have had to be overcome in the design and construction of large reflectors. Wind and weather loads, for instance, are tremendous. These are compensated for in several ways: counter-balancing sails, spoilers, and even, in case of the BMEWS for example, by covering the entire structure with a 140′ diameter radome.

Goodyear has just announced a new seamless hypalon-coated nylon radome which, it is claimed, will withstand wind velocities up to 150 mph and temperatures from −65 to +135°F.

Mechanical requirements, too, impose serious problems. Tracking accuracies demand extreme tolerances in the azimuth and elevation mechanisms and the servo drives. **General Electric's** precise *Atlas* command guidance antenna requires a tolerance of 0.000050″ on the bearing race of the 2½-ton azimuth pedestal. Other parts are built to within 0.00001″. Such precision is usually found only in fine watches and delicate instruments.

It is interesting that, so far as is known, Russia has made no effort to develop giant antennas. They reportedly use a series of medium-size interconnected "orange-peel" types, similar to our height-finders, for long-range tracking and telemetry reception.

Conventional mechanical scanning systems are made somewhat obsolete in the massive antennas. Rotating the mass of a mechanical scanner suspended 25′ from the dish, for example, would require prohibitive construction to contain the vibration and moments generated.

This problem was solved neatly b **Radiation, Inc.** in the case of the 6(Atlantic Missile Range tracking an tennas by using a rotating dielectri lens in the feed system. This applica tion was used also in the modifie multi-frequency diversity feed for th Jodrell Bank antenna.

One recent development by Ger eral Bronze goes around some of thes limitations by using an entirely new ap proach. This is an improved "end-fire element array which, it is claimed, i superior in gain, lighter in weigh smaller and cheaper than equivaler parabolic reflector types. In addition, single array can contain as many a three different antennas with negligibl interaction.

The largest movable antenna in us to date is the 240′ radio telescope a Jodrell Bank, England. Several 8(parabolas are in use and 60-footers ar almost common.

Narmco, with its "tension-truss" de sign, claims feasibility of 120′, an larger, diameter parabolas with les than 1/8″ deflection.

• **Big business**—Due to the ir creased emphasis on space communica tions, antenna design and manufactur has become a big and booming bus ness. Among the leaders in this field i **D. S. Kennedy & Co.,** which last yea did almost $14 million worth of bus ness. General Bronze reports a tota yearly volume of $10 million. **Blaw Knox's** share ran $8-10 million, an Radiation, Inc. $2 million. Goodyear' portion of the BMEWS contracts run to several million but no exact amount have been released.

Other important firms in the an tenna field include **Narmco, W. I Maxson, Philco, and Avco**—several o whom are working on classified de velopments on which no details o money amounts are available.

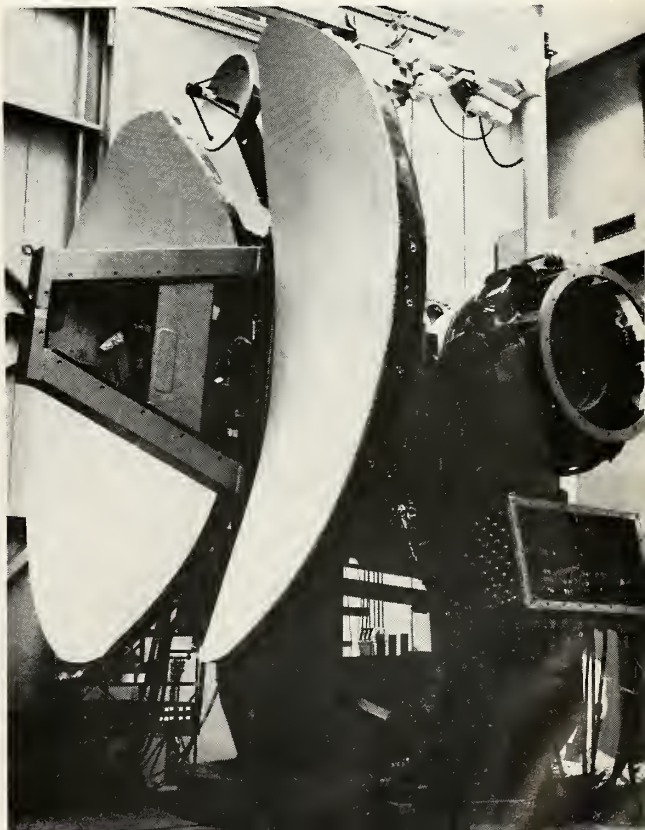
D. S. KENNEDY & Co.'s 120 ft. reflector swings continuously in azimuth at speeds up to six rpm.

ENERAL BRONZE's SVE tri-band tracking telemetering ntenna provides three simultaneous coincident beams on one edestal.

GOODYEAR'S BMEWS tracking antenna has spherical radome 140 ft. in diameter.

RADIATION/KENNEDY CO. TLM18 automatic tracking telemetry antenna has rates of over 7°/sec.

GE's high-precision *Atlas* tracker theoretically is accurate enough to measure an angle of one foot at 25 miles.



WESCON Trying New Method for Papers

SAN FRANCISCO—This year's Western Electronic Show and Convention—scheduled for the Cow Palace, August 18-21, promises to maintain its record as an interesting and progressive technical meeting and showplace for new developments in electronics.

Technical presentations will differ from the usual in two ways. First, each technical session will be limited to three outstanding papers in each classification. Second, each session will include a panel with several authorities on the subject being discussed plus authors of the three selected papers. The panel will comment on the papers presented, question the authors, and stimulate discussion with the audience.

Another innovation is an industrial design competition which will honor outstanding examples of electronic industrial design. Such a competition, it is hoped, will help design and packaging engineers to break away from the conventional "relay rack concept" and incorporate human engineering and visual appeal in their designs.

Not new—but unusual in such a convention—the third annual Future Engineers show will exhibit some 30 examples of outstanding work in electronics and allied sciences by high school students. These exhibits, representing nine western states and Hawaii, are selected by IRE sectional committees as the best in their respective areas. The students will compete for $2500 in scholarship awards.

To augment the technical sessions, a number of field trips to area facilities has been scheduled as part of WESCON. Selected on the basis of IRE professional group classifications, these include visits to **Dalmo-Victor, IBM's** San Jose computer center, **Hewlett-Packard, Eitel-McCullough, Lockheed, Ampex, Stanford Research Institute, Varian Associates,** and **Stanford's Biophysics Laboratory.**

A highlight for electronics industr management men at WESCON will b the annual meeting of the Weste Electronics Manufacturers Associatio The Wednesday luncheon meeting expected to attract about 350 weste industry leaders. P. E. Haggerty, pres dent of **Texas Instruments,** will be th featured speaker at the session.

An elaborate closed-circuit telev sion paging system will cover th entire Cow Palace and adjoining buil ings to carry messages and announc ments to the participants. Twelve more TV monitors will be installed i strategic locations to handle the mas ive problem of communication.

Program and arrangements for th show and convention—jointly sponsore by WEMA and the Los Angeles an San Francisco sections of IRE—ar handled by 15 voluntary committe made up of members of western ele tronics technical and business organiz tions. These committees operate und the direction of H. Myrl Stearns, chai man of the WESCON board, an B. M. Oliver, chairman of the executiv committee.

Plane-Wave Tubes Study High-Intensity Sound

ANAHEIM, CALIF.—The completion of a new series of plane-wave tubes for studying the effects of high-intensity sound on small electronic equipment has been announced by Altec Lansing Corporation. The 155-db 8-inch plane-wave tube is designed specifically to observe and determine electronic equipment malfunctioning in missiles and jets. The device is employed in establishing sensitive planes within equipment that might dictate particular mounting and location requirements. Also, support equipment, externally mounted devices, and support personnel are exposed to high-intensity noises under conditions similar to that of a free field; the plane wave tube is ide for studies of response of these el ments.

The wall of the tube confines th energy from a loudspeaker to a fr field in depth. By this energy co finement, the loudspeaker is require to generate much less energy than otherwise would have to develop establish a given energy level in a anechoic chamber.

According to Altec, these plan wave tubes are energized by compre sion type driver units. Two driver typ currently can be used interchang ably—the model 2801 high-pow unit for midfrequency testing and th model 288B driver for tests up to frequency of 15,000 cps.

ALTEC LANSING Corp. has developed a 155-db 8-inch plane-wave tube to observe and determine electronic equipment malfunctioning in missiles.

Automatic Sequencer

NEW YORK—A completely stat sequencer for control of the *Polar* missile countdown, capable of trigge ing 60 checkout operations per minut has been developed by **Magnetic Am lifiers, Inc.** of New York.

Constructed for the Missile an Space Division of the **Lockheed Ai craft Corporation,** the device is use to provide overall control of oth missile ground checkout equipment. issues its commands consecutivel compares information received in r sponse to its orders and verifies a curacy of test results.

Clustering: Big Payloads Quickly

These engines will add a greater degree of safety and reliability to manned space flight than the comparable single engine boosters

by Paul Means

WASHINGTON—The large boosters eeded to launch heavy payloads into ace during the next decade will be veloped by the technique of clus- ing.

Clustering is the method of mating isting reliable rocket engines into lger single stage with a much higher ust level. For a space program des- rately in need of larger engines, clus- ing produces the largest feasible oster in the shortest time.

But clustering is not just a stop-gap asure. Because it can perform mis- ns or abort under guidance after lure of one or two of its engines, e clustered engine adds a greater gree of safety and reliability to nned space flight than would a com- rable single engined booster.

The concept of clustering is not w. When it became unfeasible to ild larger ship or airplane engines, ater power was produced by com- ing the efforts of more than one gine. And, as in the case of the clus- ed rocket booster, multiple engined ps and planes have a greater degree safety and reliability in that they n still operate after the failure of e engine.

• **First is** *Saturn*—The first large stered rocket engine will be *Saturn*, itiated by the Army at ABMA in rd-1958, and accepted as a project the Advanced Research Projects ency in August, 1958.

The *Saturn* booster, whose eight werful H-1 engines developed by the **cketdyne Division of North Ameri- n Aviation** will produce a combined ust of 1,500,000 lbs., has a diame- t of 22′ and a height of 5′. It is pable of boosting such sophisticated ace experiments on their way as the st-landing of a one ton payload on t moon.

Static tests of this first clustered oster will take place in December, d the first flying tests will be initiated sometime next year. The completed space vehicle, with the **Martin Co.'s** *Titan* as the second stage and a **Pratt & Whitney** liquid hydrogen engine as the third stage, could be ready in approximately two and a half years.

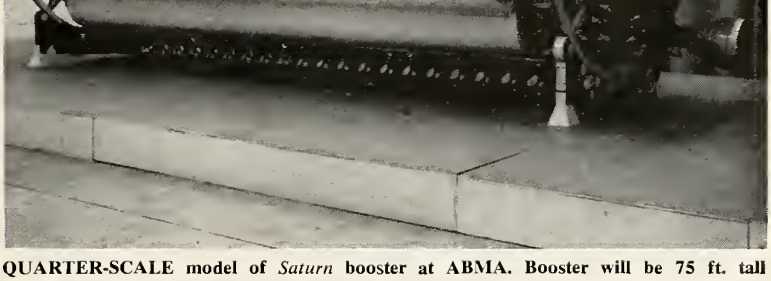
The eight H-1 engines are repack- aged, uprated, and simplified versions of the 150,000 IRBM engine currently in use in the *Jupiter* and *Thor*. This engine has been under development by Rocketdyne since its grandfather was used in the *Navaho*, and is also used in the *Atlas* and *Redstone*. It is the most reliable engine currently avail- able. (See M/R, July 20, page 53.)

Each engine operates independently with its own gas generator and turbo- pump. The propellant tankage is a common source for all engines. The eight outer tanks are of *Redstone* di- ameter (but not of *Redstone* length) and are clustered around the inner tank which is of *Jupiter* diameter.

Each of the eight engines operate independently, with the four outer engines movable so that they direct the course of the vehicle. They are mounted on gimbals, a part of their assembly, and have a six degree free- dom of movement on response from the guidance system.

Inertial guidance will be used, and the system will have the capability of automatically compensating for devia- tions resulting from loss of thrust should one engine fail to function. The guidance may also be able to operate step-wise shut down of the engines, allowing for a more accurate timing of first stage burnout.

• **Second is** *Nova*—The second large clustered booster will be *Nova*, whose million pound engines are cur- rently undergoing development by Rocketdyne for NASA. Initial designs cluster four of these large engines, but the payload penalty in case of an engine failure indicates that the final



QUARTER-SCALE model of *Saturn* booster at ABMA. Booster will be 75 ft. tall and 22 ft. in diameter, giving 1.5 meg thrust.

clustering: big payloads quickly . . .

configuration will use at least six engines. No firm date has been given for the completion of this booster.

The three distinct advantages of a clustered vehicle: (1) the ability to build a large thrust vehicle in a short time; (2) the reliability and safety advantages for manned flight; and (3) the great flexibility and flight control that can be maintained.

Engine development for space vehicle use operates in a cycle. The immediate need for a higher level of thrust is satisfied by clustering an existing engine of proven reliability. This can be done in a fraction of the time necessary to scale up to a single engine developing the higher level of thrust.

So a cluster of the smaller engines is used until the larger engine is developed and demonstrates a high degree of reliability. Then the larger engine is clustered, providing a booster with a higher thrust level which will be used until a still larger engine is developed, which after it achieves a high degree of reliability will be clustered . . . etc.

Therefore, at any given stage of engine development, the booster providing the highest thrust level would in all probability be a cluster.

• **More applications with cluster**—But what if it were possible to build the larger single engine in the same amount of time it took to cluster the smaller existing engines? Most rocket experts agree that the clustered engine would still have more applications because of its greater safety, reliability, and flexibility.

If, for example, one of *Saturn's* eight engines failed after launch, the following four options are available: (1) the booster could complete the mission on the seven engines with a payload that had been originally been reduced by 1/8 of full capacity; (2) the mission could be completed if part of the payload is jettisoned, (after 30 or 40 seconds of burning, the payload penalty is very small); (3) the mission can be aborted under power and guidance making possible recover of vehicle and payload (this is possible with the failure of two or more engines); and (4) the vehicle can continue into space to perform an alternate, less demanding mission.

None of the above options are available upon failure of a single engine booster. Unless the payload has an escape rocket system, both the booster and payload would be lost.

The clustered booster also achieves a greater reliability in the area of thrust decay. The characteristics of each engine may not be the same, but you can predict closer the mean value of the thrust decay of eight engines than the variance of thrust decay of one engine on a given flight. Because of this, and also the possibility of a step-wise shutdown of the engines, the clustered vehicle allows for a greater predictable accuracy from the propulsion system.

Because of the individual compartmenting of the cluster's engines, engine failures can be kept from spreading except for the rare "bomb" type of explosion.

• **Limitations**—There are limits as to how many or how few engines can be feasibly clustered. Because of the intricate relationship between the various components of a cluster, 10 or 12 engines is thought to be the largest feasible cluster. Because of the payload penalty incurred when too few engines are clustered, six is considered by some to be the minimum feasible cluster.

Saturn, whose booster clusters eight times the thrust level, must accept a payload penalty of only 12% to allow for the failure of a single engine. A booster clustering only four times the thrust level would have to accept a 25% payload penalty.

Clustering large boosters out of existing engines is not merely just clustering missiles. The parts of the missile must be fully redesigned before they go into the cluster. Many components must be reinforced because of the greater stress and pressure. Nozzles must be redesigned so that th are very short, and *Saturn's* 16 suctic lines will have to be flexible for gir balling.

Many of these problems are n within the present state-of-the-art, a must be solved through new enginee ing. The biggest problem is simplific tion of parts.

The telemetry system must have t capability of providing data insta taneously so that the vehicle aft engine failure can be kept in the m sion trajectory or switched to the abc trajectory. In a clustered engine, t guidance carries the thrust vect through the center of mass by adjusti the outer control engines.

As in all multiple fuel systems, clu ter designers must make sure that of the propellant is used up so th part of the payload does not becon unused propellant.

Clustering of the upper stages of space vehicle is slightly less desirab than clustering boosters because the is less chance of engine failure a therefore less need for multi-engine liability.

Upper stage clustering would al raise the problem of how to get f thrust from all engines instantaneous at ignition. This is done with boost clusters by clamping them down un full thrust is achieved.

• **Doubtful in solids**—Though clu tering has applications in the advanc space engines of tomorrow such as t ion, plasma, and nuclear engines, it doubtful that the principle will ev be used in solid rocketry.

One major problem with a sol cluster is that the electrical wiri together of the engines would ta place with the propellant in place. short in any of the electrical pa could mean a catastrophe.

Another problem with solid clu tering is control or determination thrust. This could be accomplished designing a grain with a small e plosive film lamination that wou rupture the propellant grain and te minate thrust. The problem with th method is that the rocket could n be restarted unless the ignition devi would also be located in the grai

The third problem with clusteri solids is that a single solid grain th could develop a million pounds thrust would probably have to be ma at the launching site because of t possibility of damage to such a lar grain during shipment.

Rapid advancements in the field solid rocketry could overcome ma or all of these objections, but prese indications are that the large space v hicle boosters of the next decade w be clustered combinations of liqu rocket engines.

ARTIST'S concept of clustered *Nova* vehicle and its support equipment.

автоматический перевод
вычислительные машины
способствуют исследова-
нию языков

AUTOMATIC TRANSLATION

Computing machines aid language research at Ramo-Wooldridge

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Apart from the question of translation itself, electronic computers are invaluable for language research. The expansion of existing knowledge of the rules of language, through statistical analysis, is made practical by mechanized procedures. A clear symbiosis between linguistics and computer technology has emerged.

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USW: A $4-Billion Yearly Market

Many missile companies are realizing that this great technological challenge is as important as space flight and in the next few years will be just as expensive

by The M/R Staff

WASHINGTON—Missiles are—among other things—a matter of markets. And one of the most demanding and untapped missile markets today is USW (Under Sea Warfare). It already accounts for $4-billion a year in Navy spending—including some $2-billion in direct procurement and 85% of the cost of fleet operations.

Proportionately, over the next decade the USW market will grow as much, if not more than the spaceflight market. And, that growth will draw heavily on missile, rocket and spaceflight technologies—as many companies are beginning to realize.

Though at the opposite end of the altitude spectrum, USW is every bit as important as space flight, and, over the next few years, it will become every bit as expensive. Probing the depths of Earth's oceans is no less a technological challenge than reaching up into depths of solar space. The nuclear-powered deep-diving submarine poses the same problems of closed self-sufficient environment as does the interplanetary space ship.

As an environment for missiles, the same basic problems exist: High velocity flight—200-to-300 knots; complete three-dimensional maneuverability; greater and greater operational depths (altitudes); missiles that operate entirely in the water realm; missiles that go from water to air, from water to air to surface, from water to air to underwater; underwater missiles to intercept and destroy other underwater missiles; missiles that decoy attacking missiles away from their targets; drones that are used for practice and training; unmanned advanced warning, detection and tracking units, etc., etc.

• **What USW includes**—USW now includes strategic bombardment of land targets, anti-surface ship activities (both merchantmen and military ships), and, most important of all, ASW—Anti-Submarine Warfare. In fulfilling these missions, use is made of aircraft, surface vessels, other submarines, and weapons—in being or planned. T mention a few:

Polaris, Subroc, Asroc, Weapo Alfa, Mark 37, Mark 39, and *Mark 4* torpedoes, *Regulus* I, missile min and depth charges.

However, the ocean is a strange an mysterious place. We know less abou its depths than we do about the surfac of the moon. Yet it poses as great threat to our national security as do space—perhaps even greater. And i turn, knowledge and supremacy of th oceans demands many of the sam technologies as does the conquest c space.

The submarine first started in Nav service 58 years ago. And even throug World War II it was essentially a su face vessel which could submerge t make its attack. Otherwise, it was surface vessel. Its hull was efficient o the surface; inefficient underwater. It powerplant was designed primarily fc surface operation. On the top of th sea it ran on diesel engines. Under water it ran on batteries—which ha

Market Needs in USW

—Submarines capable of 50-to-60-knot underwater speeds.

—Torpedoes and missiles able to go at least five times that fast in submerged pursuit of their prey.

—Sub-carried anti-missile-missiles to intercept 200-knot torpedoes and other high-speed ASW weapons.

—45-knot hydrofoil ships for high-speed ASW search within 200 miles of the coastline.

—High-speed missiles designed specifically to destroy hydro-foils—a kind of Hawk concept that breaks out of the water, gains altitude and then seeks the target by radar, heat, etc., from above.

—Drone helicopters that range and search and fire their ASW weapons without the benefit of direct manned control.

—Submarine-launched anti-aircraft missiles.

—Submarine-launched tactical amphibious assault support rockets.

—Anti-Polaris missiles designed to shoot down submarine-launched ballistic missiles soon after they brea through the water.

—Long-range anti-submarine weapons—includin an extended range SUBROC and adaptations of th Polaris—launch a pattern of ASW missiles just befor impact (probably employing recovery gear to slow ther down). This weapon could be fired from thousands o miles away.

—Podded Polaris and other missiles that can b anchored to the ocean floor to be launched later b remote control or by automatic sensing.

—Air and sea launched high-speed missiles tha seek out and destroy undersea craft.

—Both submarines and weapons capable of operat ing at depths of 10,000-to-20,000 feet.

—Diversionary missiles designed to draw an attack ing missile from its intended target.

—High-speed underwater drones for test, practic and maneuver.

) be charged periodically.

Today's modern submarine is nu-lear-powered, whether surfaced or sub-nerged. Its hull is designed to ignore ow-wave problems. It's faster under-ater than it is on the surface. And its nderwater speed is more than twice ne World War II's surface speed. Sud-enly it has become at home in the eep—out of its element when wallow-ng in the surface waves.

• **USW arriving in fact**—Undersea arfare has been around a long time n theory. But only recently has it nally arrived in fact. And with this rrival has come a whole new family f concepts and requirements. The rctic ice cap, once a forbidden land as suddenly become playground and nctuary.

Whole packs of submarines, either ussian or American, can lurk in eadiness indefinitely under the protec-ve layer of ice above. Where a 300-ot depth was a dangerous limit in Vorld War II, today's submarines dive adily to a depth of 1000 feet, and oats capable of operating effectively nd safely at 3000 feet are now under onstruction. Research vessels to go own three miles or more are on the rafting boards.

These are precursors of submarines nat will be at home and fight to the reatest depths of the world's oceans—hich include depths of 30,000 feet or ore, where the crushing pressure of ne waters above exceed 10,000 pounds er square inch.

Today, however, the attack capa-lities of submarines are moving ahead r more rapidly than are our capa-lities of submarine defense. For this ason the bulk of our undersea war-re efforts are devoted to ASW. Sur-ce ships, submarines, helicopters, air-anes and missiles whose sole mission to kill other subs are being bought volume. And, in turn, the Navy, ving to look ahead, is already design-g weapons to counter the weapons ey're buying now to kill subs.

But out of it all, a full spectrum of eapons emerges. Some are already thorized for procurement. (See box, larket Needs in USW) Some are tually on order. Others beg for "pro-sals with promise" from industry. ver the next decade, they add up to multi-billion-dollar market.

• **Need electronic backup**—But the rformance capabilities of these new eapons will be useless unless they ve adequate electronic backup. rgets must be detected, located, entified and tracked over great dis-nces and with great accuracy.

Currently the only operational derwater detection and tracking sys-ms rely, one way or another, on

PODDED *Polaris* **missiles that can be anchored to ocean floor and launched later are a future requirement in USW.** →

sound. And this is limited on all counts. Detection is possible at great distances, particularly with recent developments in very low frequency (below the level of human hearing) sonar equipment.

However, direction and ranging over more than a few miles are virtually impossible. Thus, so is tracking. You can tell if "something is out there," but that's about all. You don't know how far or in what direction.

Not only that, but underwater devices are growing more and more silent. Contrarotating propellers have reduced high-speed hydrodynamic noise to a heretofore unachieved low. The French use rubber propellers to minimize transmission of engine noise—very high in fast nuclear submarines—and similar developments are believed to be underway in the U.S.

Work by **Coleman Engineering Company** on the West Coast on special boundary layer control skins for underwater vehicles has reduced drag (and cavitation noise) from fast-moving underwater bodies by 65%—with 85% theoretically possible.

• **The complaints**—A major complaint of every naval officer connected with USW is that attack capabilities are moving ahead at a far faster rate than ASW's ability to counter them. This is especially true in the realm of detection, identification, location and tracking. Underwater vehicles are becoming more silent at a more rapid rate than the range, sensitivity and accuracy of tracking gear.

A really noisy beast like the nuclear-powered submarine Nautilus on a high-speed underwater run can be heard thousands of miles away. It's a detection, but that's all. No range. No bearing.

Effective, operational detection of submarines is good only over a few dozen miles—even with the latest gear. And then, distance and direction readings are only probable—due to the ever-present salinity and temperature gradients that lace the ocean and bend sound waves over considerable angles.

Current efforts to make up for the low effective range of sonar detection take two directions:

One involves development of sonars with a greater range coupled with employment of vehicles able to cover a lot more territory in a given period of time. Helicopters, airplanes, blimps,

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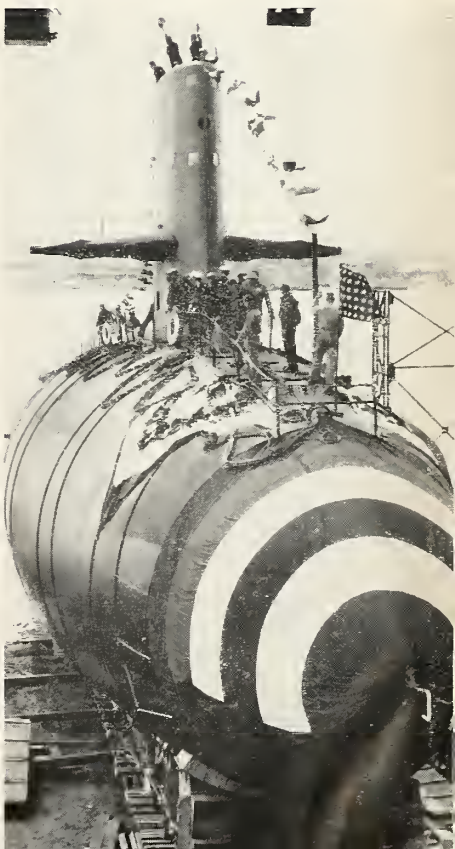
SKIPJACK, U.S.'s fastest submarine will be outmoded in a few years with the requirement for 50-60 knot underwater speeds.



USW: $4-billion market . . .

and fast surface ships such as destroyers, destroyer escorts, and various smaller ships.

Important to remember is the fact that aircraft (airplanes, helicopters and blimps) are only effective in finding surfaced or (sometimes) snorkling submarines. Their main piece of detection gear is radar. Magnetic detection gear is limited only to a few hundred yards and cannot begin to cope with the great expanses of ocean involved.

• **Hydrofoil to be funded**—Scheduled for funding during the current fiscal year is a hydrofoil—length, 115 feet; displacement, 100 tons; speed 45 knots; armament, twin ASW torpedo tubes, stern depth charge racks and twin 50-caliber machineguns—one escort research ship, a special hull configuration that is expected to do for surface ship design what the Albacore did for underwater hull design, and incorporating the latest in both long-range and variable depth sonar detection gear.

New long-range sonar is reported to have an effective range five times anything now operational. Variable depth (dunking) sonar equipment is designed to permit surface vessels to see below the thermocline—a layer of water a few hundred feet down where the temperature changes rapidly with depth-below which submerged submarines have been virtually free of detection. Presumably the variable depth sonar can be towed at whatever depths are required.

The other major approach to ASW rests in pure weight of numbers—an approach, incidentally, by which we cannot possibly afford 100% assurance of safety from underwater attack. Towards this end, however, (and this will give you a partial idea of the mounting size of this market) the fiscal 1960 Navy budget provides for two Dealy class DEs (destroyer escorts), eight ASW DDs (destroyers); one MSS (minesweeper special); three ASW submarines (Thresher class); three guided missile frigates (7500-ton displacement compared to 4000 for a destroyer)—totaling some $494.4-million for ASW ships, not including modernization of existing vehicles. An ASW submarine now under development, the Tulibee, will have a depth capability of 3000 feet.

In addition, the 1960 budget provides for 26 **Lockheed** P2V-7 Neptune ASW aircraft; 36 **Grumman** S2F Attackers; 70 torpedo and detection gear-carrying helicopters; and the first of the modified Lockheed Electra P3V-1 new-generation ASW aircraft—a total of over $400-million for ASW aircraft, if you include aircraft modernization.

Add to this some $160-million for Continental U.S. and ocean ASW sonars, radars, electronic countermeasures, etc., plus $174.7-million for ASW research, development, test and evaluation, plus a large portion of the $516-million request for procurement of ordnance and ammunition, plus nearly $300-million in ASW-related construction . . . and this market begins to take on an appreciable size.

• **Capricious sound**—The only signal that man knows can travel through water is sound, and while it travels faster and farther in water than it does in the air, it is capricious at best.

In an effort to beat the limitations of sound, the Navy is spending considerable amounts of money on a large variety of underwater detection tracking and communications projects that do not involve sound phenomena.

These, lumped together, bear the unofficial title of *Project Unsound*—including efforts to find a window in the ocean for electromagnetic waves, the study of electrical phenomena, such as the motion of the ionized particles in the ocean; to see if the underwater wake of a submarine can be tracked by a homing device; investigation of both magnetic and gravitational disturbances due to the presence of metal, etc.

The cost of completely covering the coastal waters of the U.S. by present methods would be absolutely prohibitive. And, the expense of trying to patrol the oceans of the world, including those lying under the polar ice pack, would be proportionately greater. In a word, by present methods—namely, sonar—it is not possible to establish an effective anti-submarine defense. Another principle of detection capable of great accuracy and very long ranges must be developed. The Navy would pay well for such a discovery.

Meanwhile, every effort is being made to do with what's on hand. A major portion of the Navy's R&D budget is being expended on two-way communications between submerged submarines—over both close and long ranges; communications between surface ship and sub; between aircraft and sub; long range communications with shore stations.

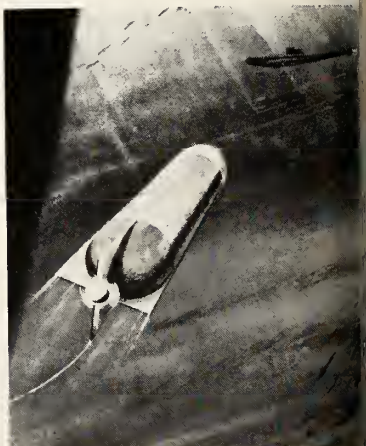
Specifically, current effort is being directed toward further procurement and development of single sideband techniques for tactical communications between widely dispersed task force units; ultra-high-frequency double sideband techniques for line-of-sight communications; fast frequency chang equipment; ionosphere scatter; an Moon relay.

For the future, there is a windo in the ocean for infrared transmissio over considerable ranges, but which so far impracticable. Also, there tantalizing evidence of an electr magnetic phenomena that is effectiv to a considerable depth (normal atter uation of low frequency waves is som 90% in 300 feet) which is "somewh less than well understood . . ."

In a word, there are hints of breakthrough, but the "actual" has y to be achieved.

• **Computers important**—Also in portant in the ASW electronics mark are computers for firing underwat missiles at high-speed targets. Prob lems not only include calculation c firing time and angle (in three dimer sions), but en route arming, so that th torpedo's (missile's) acoustic homin device is activated only when a saf distance from the launching vessel. A example of this kind of equipment the *Mark 112* Torpedo Fire Contr System being produced by **Sperry Gy roscope** under a $12-million contract.

USW divides into two basic cat gories: Attack and defense. For th moment, attack includes standard ant surface ship operations and strategi land bombardment with ballisti *(Polaris)* or air-breathing *(Regulus* missiles. Defense includes everythin else, and accounts by far for the bul of USW expenditures. And of thi submarine detection, location, identif cation and tracking is the major prob lem. Until this is solved satisfactorily submarine destruction is an importan but still secondary problem.



MARK 39 wire guided underwater m's sile may have 60-knot speed but in 197 period torpedoes will require 200-30 knots.

• **Submarine attack capabilities**—The submarine attack capability against surface ships has improved materially in the 14 years since World War II's end. Whereas surface ships were faster (18 knots for merchantmen, about 30 knots for Naval warships vs. the submarines 12-to-15 knots short duration submerged speed), submerged submarines are now faster than most surface vessels (30-to-40 knots vs. the still-the-same 18-to-30 knots for surface ships). This means that submarines now chase, overtake and attack vessels that before they had to intercept or lay in wait for. For anti-surface ship attack, torpedoes have increased range, higher speeds and better homing guidance.

The *Polaris* system is designed to attack major strategic land targets. With its range due to increase from 1200 to over 1500 nautical miles, it is capable of attacking all of the Russian land mass except for a small 100-mile square in the Siberian heartland. A small increase in range will readily bring this, too, under potential submarine attack.

• **$612 million for** *Polaris*—In fiscal 1960, the Navy has asked for $611.6-million to support the *Polaris* Weapon system program. Of this, $220-million is for research, development, test and evaluation.

Other *Polaris* spending includes: ships and facilities, $16.3-million; servicewide operations $3-million; shipbuilding and conversion, $54-million; procurement of ordnance and ammunition, (including *Subroc* procurement for tactical defense) and military construction, $4.2-million.

Included in these figures are pipeline, shake-down and flight test for *Polaris* missiles; production engineering and tooling; special training equipment; pop-up test devices; R&D on reentry bodies, guidance, structures, controls, systems integration, command communications systems, etc.

Currently there are six *Polaris* submarines under construction. Three more starts are planned during the current fiscal year, plus placement of initial orders for long lead time equipment for three more to be started in 1961. The missile itself may yet achieve operational status during 1960, as has been forecast, but only with a 1200-mile range—compared to the 1500-mile original target.

• **Assault and logistical supply**—Work is already underway on the development of undersea craft for landing troops for amphibious assault work and for the supply of overseas bases with operational essentials such as fuel, food, weapons, etc. This involves not only large troop carriers but cargo "tracker-trailers," as well. In the latter category, **Goodyear** is working on a rubber, wormlike petroleum transporter that can be towed behind a submarine. This would have practically no drag and would be almost 100% transparent to the effects of underwater blasts. In line with this is thinking and planning for undersea-launched tactical missiles to lend the same kind of close support to amphibious troops as is now supplied by aircraft.

And, as always, for every system of weapons, there must be counter-weapons. There will be a need, for example, for land troops to be equipped with effective mobile ASW weapons to fire back at this kind of underwater artillery.

• **ASW warfare** — With current technologies and physical equipment, it is not possible to spot more than a small percentage of any fleet that might be lurking off our coast. It is impossible now to detect either one or a whole fleet of atom-submarines lurking under the Polar ice pack. And even if they could be detected, they would be very difficult to attack.

It's a standard rule of thumb that torpedoes should be five times as fast as the submarine they are attacking. This means that a torpedo should have a speed of 200 knots to attack a 40-knot submarine. They need this extra speed to make up for time lost in following sound twisted and turned by ocean conditions.

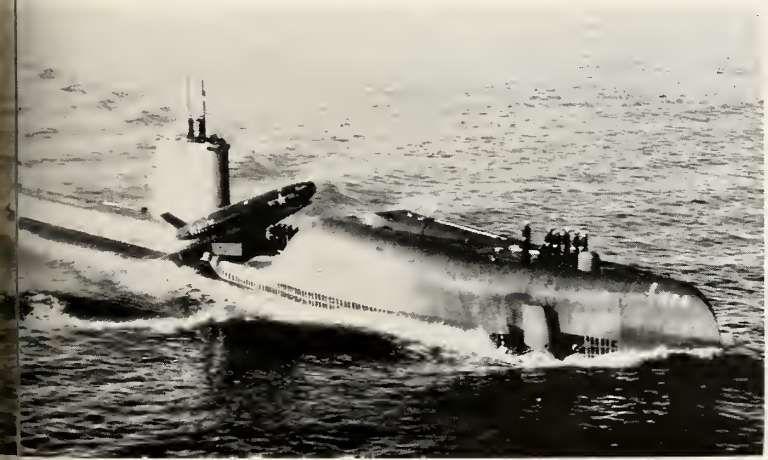
Not only must it be this fast, but its self noise must not be so great as to interfere with its own sonar homing gear. Such a torpedo is a requirement still, and not an achievement. Even though the speeds have been attained using both rockets and lithium-fueled hydroducts, noise due both to cavitation (boundary layer separation) and the propulsion unit itself has made them worthless as weapons. Current West Coast efforts to develop an underwater body skin system to provide boundary layer control show some promise and may provide a partial answer to this problem.

• *Subroc* **purpose**—A major purpose of *Subroc* is to make up for the torpedo's lagging speed capabilities, as well as to extend the submarine's effective attack range. However, once back in the water on its final target run, *Subroc* will suffer from the same speed limitation as an unboosted torpedo, unless a break-through is made in quieting down torpedo propulsion or coming up with homing systems other than sonar.

Nearly everything the Navy is developing is designed to make up for the lack of range of both detection devices and weapons. The hydrofoil is designed to cover great areas in a minimum of time—like the airplane, only the hydrofoil will search with sonar as well as radar. Similarly, both manned and unmanned helicopters can cover considerable distances during a single flight, using sonar equipment dropped into and dragged in the ocean.

DD's, DE's, frigates, etc., though not capable of the other crafts' speeds can carry much heavier search equipment, which have a much greater range. The same basic approach is also true of ASW submarines, though these have the added advantage of being able to operate in the submarine's natural submerged environment. The submarine is, perhaps, the most effective ASW weapons system, and is certainly the most feared by another submarine.

And these are being designed to go faster and deeper. Current depth limit of operational submarines is about 1000 feet. Craft now on order will be capable of diving to 3000 feet. Research models are already funded capable of going down 10,000 feet and better.



SS GRAYBACK and *Regulus I*. **The 1970 submarine will have ability to launch anti-aircraft missiles and tactical amphibious assault support rockets.**

$$$—Biggest Barrier to Effective ASW

But industry hits other factors: Lack of single ASW group in Navy; lack of consistency in requirements; and difficulty in getting state-of-the-art information

by William E. Howard

WASHINGTON—Top Navy and industry ASW experts agree the biggest barrier existing today in developing an effective counter to the Soviet submarine-missile threat lurking beneath the sea is plainly—money.

Unless more basic research is funded soon—and in large amounts—there is serious doubt that the United States ever will achieve in time an ASW system capable of defending its cities from submarine-launched missiles, or keep vital sea lanes open in a limited war.

Anti-submarine techniques—particularly in the area of long-range detection—lag woefully behind rapidly advancing submarine technology. Nuclear subs, as made painfully clear by this country's own Nautilus and Seawolf, can out-dive, out-race and outsmart every ASW detection system in existence today.

What is urgently needed to close this gap are breakthroughs to new methods of detection—something which, unlike indiscriminate sonar, will home-in only on submarines and at great distances. And these breakthroughs can be achieved only at tremendous research cost.

That Congress and the Administration have failed to realize fully the scope of the problem and furnish more money dismays many persons in the ASW field. For they consider ASW equal, if not more important to the nation's security than space research. However, the chances of having ASW funds increased by any significant amounts this year or next are rather dim.

In 1959, ASW appropriations for research, development, test and evaluation amount to about $174 million. For the 1960 FY they are expected to be about the same level under the $40 billion budget ceiling.

• **Need $100 million more**—Actually, the Navy feels an additional $100 million should be spent on ASW R&D in 1960. Vice Adm. J. T. Hayward, deputy chief of naval operations for R&D, says the extra $100 million was needed this year. And for lack of it "many new ideas which were of a high risk nature have been left unfunded."

Points out Hayward: "It is entirely possible that one of these new ideas could hold the secret to a real successful improvement in ASW."

As programmed now, there may be a slight step-up in ASW R&D aimed principally at active and passive systems for detection, localization, classification and kill of all types of enemy subs—including the quiet deep-running nuclear boats. The Navy is asking for $27.9 million for sonar development and $5.2 million for oceanography. In the latter area, Russia has devoted a major part of its International Geophysical Year program.

MARK 44 torpedo, new ASW weapon, can be launched from ships or aircraft.

The Navy today feels that ASW is its prime mission. Says Rear Adm. Howard A. Yeager, acting ASW readiness executive, "ASW is practically Mr. U.S. Navy right now." It cuts across the function of practically every Navy division and bureau, from aircraft carriers to *Polaris* submarines.

Actively working on various phases of ASW is the office of the Chief of Naval Operations headed by Adm. Arleigh Burke, BuOrd, BuShips, BuAer, the Naval Ordnance Laboratory, Navy Research Laboratory and the Office of Naval Research.

But, by and large, almost all of this activity is of an operational or an applied nature that basically is no different from what the Navy was doing in World War II. As one expert puts it, "All our carriers, destroyers, blimps, submarines and helicopters today are still just as ineffective against modern Red subs as they were against German U-boats. What we need are brand new ASW techniques—and the only way to find them is through basic research."

• **Industry survey**—The Navy by saying its overall mission is ASW is distracting attention from the primary problem, in the opinion of several experts. They firmly believe that instead of allowing BuAer, BuOrd and other agencies to dabble in ASW, the Navy should set up one main ASW bureau or division to push basic research—chiefly in the all-important area of detection/identification.

Until the entire emphasis shifts to finding the answers to a foolproof detection system, the feeling in industry is that progress will be haphazard and the necessary breakthroughs won only by luck.

A confidential industry survey which will appear in the September issue of ARMED FORCES MANAGEMENT, an American Aviation publication, pinpoints these industry-Navy problem areas:

OTS-developed *Weapon Alfa* is one of the oldest ASW weapons in use y fleet. *Subroc* will largely make the weapon obsolete.

• Lack of sufficient ASW R&D unds.

• Lack of a single ASW group in ne Navy.

• Lack of consistency in Navy SW requirements.

• Difficulty in obtaining need-to-now and information about the cur-ent state-of-the-art.

• Failure to expedite field testing f R&D items.

Industry, through the National Se-urity Industrial Association, today is ying to overcome many of these dif-culties. NSIA established an ASW dvisory Committee a year ago headed y Fordyce Tuttle of **Eastman Kodak,** hich is developing infrared detection nd film data processing systems for SW. Eighty companies and more than 00 individuals—all ASW experts—re on the committee.

An NSIA official explains that the ommittee's job is basically to "make possible for industry to become ware of what is going on in ASW." he NSIA group is dedicated to pro-ding the technical assistance and in-rmation machinery to further a close orking relationship between industry nd the Navy. Problems it submits to ne Navy are in the form of recom-endations only, and it does not have ything to do with the actual placing contracts for hardware.

• **Shipboard visits** — Committee embers maintain close liasion with e Navy's "HUK" hunter-killer groups lfa and Bravo now at sea. "We go oard ship," says one, "to talk to the aman third class who is actually op-ating the equipment to find out how od it is and how it can be improved."

Chairman Tuttle spends more than 0% of his time on the move, as do any other members. All of this ac-ity is company-funded.

Major interest of the NSIA com-ittee is in the detection and classifica-n area, where a 50-member sub-committee headed by R. A. Wilson, vice president of **Daystrom Inc.,** is probing into electro-magnetic effects, environmental effects, acoustics and nuclear effects.

Other committee interests include: evaluation of sonar, wire, radio and data handling, greater depths for submarines, propulsion systems, submerged navigation, oceanographic research, weapons and fire control.

• **Company research**—Private industry long has been acutely aware of the Red submarine menace. For years —despite the lack of military funding—many companies such as **General Dynamics, General Electric, Chance Vought, Lockheed, Magnavox, Motorola, American Machine and Foundry, DuMont Laboratories, Yardney Electric, Westinghouse, Grumman Aircraft, Sparton Electronics, Acoustica Associates, ACF Industries, Goodyear Aircraft, ITT Laboratories, Western Electric, DuPont, Raytheon** and others have been maintaining ASW R&D out of their own pockets in addition to working on Navy contracts.

"They haven't been looking for profits, either," says "Red" Yeager. "These companies have made important contributions right down the line to ASW and I don't know what the Navy would have done without them.

"They have been acting as citizens —for the country's welfare. And what they are producing on their own may mean the difference in keeping the peace."

General Dynamics for some time has been moving ahead in ASW with a company-wide "task force" which is headed by Lawrence B. Richardson, engineering senior vice president. One of its divisions, Stromberg-Carlson, presently is building a $250,000 underwater acoustic laboratory.

At Lockheed Aircraft there is another intra-company ASW "task force" called LAWSO (Lockheed Anti-Submarine Warfare Systems Organization.) The company is working now on a pre-production contract for engineering design data for a model P3V-1 and holds contracts for other ASW aircraft and airborne systems.

Lockheed, whose LAWSO operation is headed by E. M. Davis, has 3700 employees engaged in ASW work —and more than 850 in ASW engineering. The company says it has devoted almost 250,000 man hours to anti-submarine operations research and more than 15 million man hours of engineering effort has gone in design of ASW aircraft.

Nearly all ASW work—from detection to weapons—is heavily classified. But some noteworthy developments have become known recently.

Vitro Laboratories, developer of the wire-guided *Mark 39* torpedo is working on a unique underwater television device *SOLARIS* (submerged object locating and retrieving/identification system) which has possible ASW detection applications. The ball-shaped apparatus is designed for retrieving missile nose cones, experimental torpedos and other objects from the ocean floor—but also might be used to sweep areas of the sea for hostile submarines.

Chance Vought reportedly is hard at work developing an advanced detection system without sonar.

A nuclear depth bomb—*Betty*—is under development by American Machine & Foundry.

At Acoustica Associates engineers are perfecting *SEFAR* (sonic end-fire for azimuth and range) acoustic transducers which will permit the design of extremely long range sonar systems at deep depths.

Grumman Aircraft now is flight testing a "futuristic" S2F-3 tracker plane, an improved version of presently operational anti-subtrackers which have hunt-kill capability in one plane.

Now operational with the Navy is the air-launched target-seeking electrically propelled *Mark 44* torpedo which was developed by GE and the Naval Ordnance Test Station, Pasadena. The Navy also recently unveiled two mines, *Mark 52* and *Mark 55*, which can be dropped from high speed aircraft.

• **What's ahead?**—Industry experts believe a big shift is on to adapt aircraft techniques to both the operation of submarines and in fighting them. Along this line, the **Electric Boat Division of General Dynamics** recently was awarded a contract to devise a submarine which would operate with a small crew. Concept may embrace the creation of whole squadrons of "fighter subs" which could patrol great areas of the sea at high speed and fight like aircraft interceptors.

Torpedoes—Neglected Factor in ASW

They'll have to be vastly more sophisticated and reliable if they are to be equal to their mission in coping with missile submarine threat

by Hal Gettings

WASHINGTON—"We forget too quickly between wars!" That's how one ranking Navy officer sums up today's widespread apathy and neglect in development of torpedoes—the first guided missiles and the number one weapon in antisubmarine warfare.

While the torpedo undoubtedly is the most universal and flexible weapon in our arsenal, their detection and running ranges must be increased. While they can be launched from the air (by blimp, helicopter or airplane), from a large or small surface ship, or from under the sea, and against either submerged or surface targets—they still must run faster and deeper to cope with future undersea targets.

First developed almost a century ago, the torpedo has progressed relatively slower than most of its contemporary weapons. Until recently, advancement has been primarily in improvement of range, speed, and accuracy.

In the last few years more significant steps have been taken with the development of rocket-powered units (*Rat* and *Asroc*) and the hybrid water-air-water missile (*Subroc*). The major effort today, however, is toward improvement in propulsion systems, target detection, and greater range and speed.

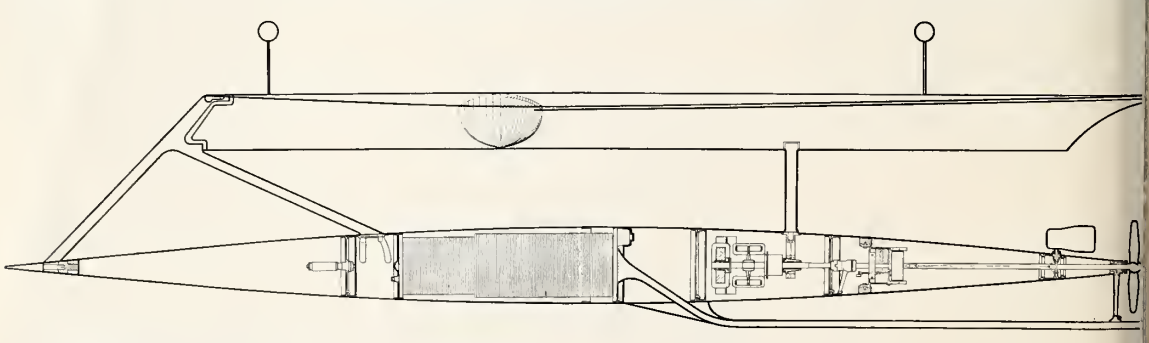
Many problems have plagued torpedo development. First, of course, has been lack of money and general apathy and neglect between wars.

• **Propulsion**—Methods for propelling torpedos have gone through several cycles of trial and error development. The first "successful" method was electric power supplied from ship or shore

CURRENT TORPEDOS

MODEL	MANUFACTURER	DESCRIPTION	STATUS
Astor	Westinghouse	Wire-guided antisub	Development
Asroc	Minneapolis-Honeywell	Antisub Rocket*	"
Subroc	Goodyear	Water-air-water missile*	"
Mark 35	GE	First production target-seeker	Operational
Mark 37	Westinghouse	Acoustic-homing	"
Mark 39	Vitro	Wireguided	"
Mark 43	Clevite	. . . . .	Obsolescent
Mark 44	GE	Antisub acoustic-homing	Operational

SIMS-EDISON TORPEDO (circa 1880)



The Sims-Edison electrical fish torpedo probably represents **General Electric's** *initial entry in the field of underwater ordnance.*

It was described as an "indestructible" copper float about 20' long, supporting a copper torpedo that varied in length from 28 to 31' and in diameter from 18 to 25". On the float's deck, two vertical rods topped by balls, flags, or lights showed the operator the path of the torpedo.

A sharp steel blade that caused the unit to dive under cables or friendly vessels protected both hull and float.

The bow section carried a 200-pound dynamite charge. The center section contained a coil of cable and the motor. Total weight was 1½-2 tons.

The torpedo was driven by an electric motor powered by a generator on shore or aboard ship through a cable 1-2½ miles long. Steering was controlled by an operator from a small keyboard. The charge could be exploded by the operator or by contact.

The speed of early models was 10-11 miles per hour; later units reportedly traveled at 20 knots.

The unit shown in the drawing was probably the successor to the one developed by the **Sims Electrical Fish Torpedo Company.** *Sixty tests were made on the unit in 1880 at the Army Torpedo School, Willet's Point, N.Y.*

hrough a cable paid out as the tor-
edo moved toward its target. Since
his method had its obvious limitations,
he next step was a battery carried in
he torpedo.

But the conventional lead-acid bat-
ery was found to have too many short-
omings. It didn't have enough power
nd the hydrogen gas given off pro-
ided some spectacular explosions—
ometimes even before the torpedo was
aunched. Acid splashed around during
aunching was apt to have deleterious
ffects on wiring and homing equip-
nent.

Battery, steam, and air-powered
nits all saw service during World War
I. All worked with more or less suc-
ess but had many undesirable char-
cteristics.

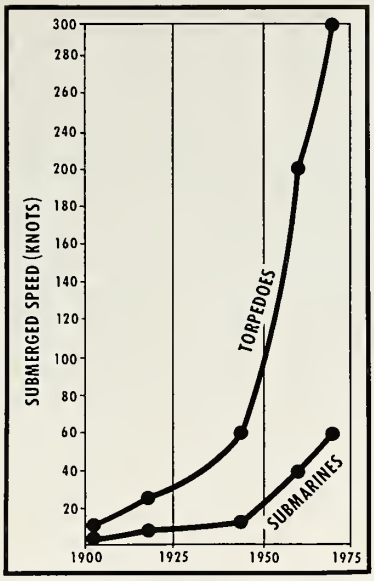
The problems of the lead-acid bat-
ery have already been mentioned. The
lcohol-burning steam generator and
he compressed-air types were short on
ange and long on malfunctions. Of
ourse, the availability of alcohol "tor-
edo juice" was considered by many
ubmariners to be an important morale
actor. The battery was sufficiently im-
roved toward the end of the War to
urn in an impressive record when com-
ared to the earlier score of the steam
orpedo.

Probably the greatest improvements
n batteries was the development of the
eawater battery (SWB) after WWII.
eawater, scooped into the battery after
aunch, serves as the electrolyte in
lace of acid. The battery is therefore
ry until the instant of use and poses
o problems in storage and handling.
he unit is approximately five times
s powerful and one-tenth as heavy as
n equivalent lead-acid type. It does
ave disadvantages—principally in cost
$6000-8000 each)—but is far supe-
ior to the old unit in most respects.

• **Rocket propulsion**—The trend to-
ay is to use rocket power for torpedo
ropulsion. Several projects using solid
ropellants are in development (*Asroc*
nd *Subroc*, for instance) but work is
o classified that no results are avail-
ble. The *Rat* (rocket-assisted torpedo)
as developed and test-fired, then
cratched.

• **Aerojet-General** has a Bureau of
rdnance contract for close to $30
illion for a torpedo development—
robably a solid-propellant type—but
ot even the model designation has
een released to date.

• **Guidance**—Torpedo guidance de-
elopment has traveled full cycle. The
ims-Edison was guided through a cable
y an operator on board the launching
hip who visually tracked the progress
f the missile toward its target. Now,
he latest operational unit—the *Mark*
9—is also wire-guided. Such a system
virtually immune to countermeasures



BASED on requirement that torpedo must be five times as fast as its target.

and evasive action.

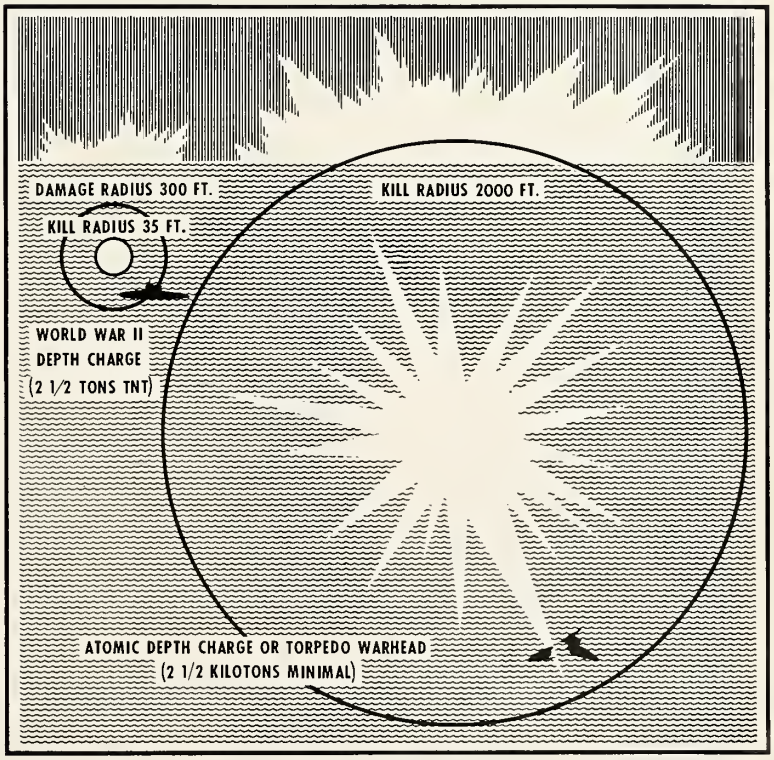
In the interim, various types of gyro mechanisms—the first inertial guidance—controlled the torpedo on a preset intercept course. The target-seekers are guided by target noise or returned sonar echoes.

• **Dynamics and construction**—The modern torpedo is an extremely complex mechanism. It not only is a combination of systems itself, but is part of a larger and complex weapons system. It is subject to long storage, shock, extreme environmental changes, and must perform a difficult and complicated task. Reliability must be as close as possible to 100%.

Modern instrumentation methods and equipment have been an important factor in torpedo progress. Engineers can tell exactly how a torpedo has reacted and performed throughout its run and test evaluation becomes more precise. With accurate test results, areas of weakness can be improved and the entire system made more efficient and reliable.

The target seeking torpedo brought its own problems. One writer has compared the detection problem to that of trying to locate a black cat in a dark room with a rapidly-failing flashlight. The floor and ceiling are covered with mirrors at crazy angles and the walls are indefinitely located. And . . . the cat may have a flashlight, too.

• **Echo return drawbacks**—Present methods use both passive and echo-return sonar. As described in the fore-



KILL RADIUS of submarines has greatly increased since World War II when a depth charge with 2.5 tons of TNT could inflict damage to 300 feet.

torpedoes—neglected factor . . .

going analogy, however, sonar return is subject to any number of erratic conditions such as bottom or surface bounce, fish noise, temperature gradients, or other presently unexplainable phenomena. In addition, the target-seeker can be fooled by countermeasures. And, of course, there is always the possibilty that the homing torpedo may turn and attack its launcher.

The *Subroc* has a reported range of 30 miles and the *Mark 39* five miles. These distances are far beyond the effective range of sonar, however, and there is some question as to the merit of range capabality so much greater than detection capability.

Much effort is being directed toward improvement in this area, but little is known publicly as to direction and success of present research. It is generally assumed that inherent limitations of acoustic methods make necessary breakthroughs in other techniques to obtain any significant progress.

• **Future**—One company official, queried as to research in torpedo improvement said ". . . work being done to improve torpedo characteristics cannot be described in detail without giving aid and comfort to the enemy and valuable data to our competitors."

Future undersea targets are going to run faster and deeper and torpedos must be built to meet these new requirements. Detection and running ranges must be increased. Higher speeds are a necessity and better target acquisition and classification are vital.

In short, tomorrow's torpedos must be vastly more sophisticated and reliable if they are to be equal to their mission. Significant breakthroughs are demanded.

M/R SPECIAL REPORT

Soviet Subs Bigger Threat than ICBM's

Intelligence reports assume Reds converting to nuclear and deep diving boats armed with KOMET III IRBM. Red China now third biggest submarine builder

by James Baar

WASHINGTON—The Soviet submarine fleet is a gun pointed at the head of every American.

In a total war, Red submarines can smash nuclear-tipped missiles into any part of the United States without warning. In a limited war, they can reach for the jugular vein of ocean commerce that links America to its worldwide alliance.

These are considered to be the Red submarines' capabilities today. Tomorrow they are expected to be much greater.

One glance at any map of the world shows America's vulnerability to the submarine. The United States is a continental island. The front door for any all-out attack is across the Arctic. The cellar door is beneath the sea.

Soviet submarines armed with 1500-mile missiles could hit any part of the United States from beneath the Atlantic or Pacific Oceans. Top U.S. officials say it would be foolish to doubt that Russia already is capable of doing this.

Russia's specific missile capabilities aren't known. However, the Russians have had a long head start beginning in 1945 with full access to German Peenemunde plans for the *V-3* (an encapsulated *V-2* to be towed under water by submarine to enemy shores) and to data on experiments with underwater deck-launched solid propellent rockets.

The Soviet submarine fleet of some 450 boats is reported to include some 100 "W" class and some 60 "Z" class types. The big "Z" class submarines are considered capable of launching missiles from inside tubes as U.S. *Polarises* will be launched. The "W" Class is considered capable of launching air-breathing type missiles from its deck.

• **Building nuclear boats**—Russia also is reported to be building at least three to five nuclear-powered submarines. A number of them are expected to be missile launchers. And Red China has become the world's third biggest builder of submarines.

Moreover, the Russians have turned over some of their latest model subs to both China and Egypt. Also, Red submarines based in Albania may in fact have been turned over to them. This means Russia now has a number of countries to do her undersea dirty work for her in the event of any more "local" wars.

Finally, recent intelligence reports note a sharp cutback in Russian submarine building activity. The official assumption is that this is for purposes of converting to nuclear-powered craft with all their advantages of speed and underwater endurance. Simultaneously the Reds are known to be building deep-diving submarines.

All of this, combined with an effective fleet of ballistic missiles, can pose a bigger threat to U.S. security than the Red ICBMs.

• **Two series of Red missiles**—The Russians have been developing two series of missiles for their submarines. The *Golem* and the *Komet*.

The *Golem I* is a two-stage liquid missile similar to the Soviet *T-2* IRBM. Both are direct descendents of the German World II *V-2*. Its range is estimated at 400 miles.

The *Golem II* is a two-stage liquid missile with a range of 1200 to 1500 miles. The *Golem III* is a two-stage solid equivalent of the Lockheed *Polaris*. Its range is estimated at between 1500 and 2000 miles.

All three *Komets* have solid motors. *Komet I* has a range of about 100 miles. *Komet II's* range is about 500 to 600 miles, and may be capable of being fired from underwater. The two-stage *Komet III*, which is reported to be still under development, has a rang

more than 1500 miles.

These weapons coupled with the ussian "Z" and "W" Class submarines ve Russia the capability of striking crippling blow against the United ates at any time.

The *Golems* and *Komets* probably ould not be used against U.S. cities it rather against bases of the Strate- c Air Command.

This is certain to be Russia's first al in any all-out war: An attempt rough surprise to catch SAC on the ound. Then DA—the Soviet inter- ntinental bombers—and the Soviet BM's would be loosed on U.S. cities d industry.

Submarines slipping through the st oceans of the world have much ore chance of reaching the North merican coasts unobserved than would viet bombers and later missiles pass- g through the gauntlet of the U.S. rctic warning nets.

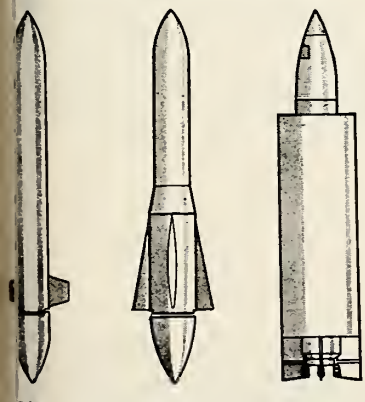
Nor does the submarine threat in- lve only all-out missile attack. In y future limited war, the sea lanes the world must be kept open for e United States and its Free World lies to supply any defense effort.

Even today in the North Atlantic one 2000 merchant ships are at sea any average day of the year. An- her 16,000 are scattered in ports on the other seas of the world. Ships avelling the sea lanes to and from the nited States carry nearly 99% of U.S. overseas tonnage.

• **Would cut sea lanes**—In time of ar, the Russian submarine fleet would empt to cut these sea lanes as Ger- any did in World War II. Only, while itler began World War II with only out 60 U-boats, Russia would have ore than 450.

The Navy faces twin challenges:

• It must hit Russian submarines fore they launch their missiles.



OLEM-1 GOLEM-2 GOLEM-3

ED submarine missiles include the *olem* and *Komet* series.

• It must wreck wholesale destruction on the Soviet submarine fleet.

The principal problem is detection and identification. Once found a whole series of new weapons such as the nuclear *"Betty"* depth charge and the *Mark 44* torpedo have made the kill of a submarine not too difficult. But each year the finding becomes a tougher job.

The North Atlantic alone comprises 12 million square miles of ocean surface. The floors of the world's oceans are mostly unexplored. The enemy can hide anywhere.

In World War II, radar could be used for locating submarines when they surfaced to get fresh air and recharge their batteries. Now, only the wastebasket-size snorkel, has to be exposed. And soon the Soviet nuclear-powered subs with their ability to remain submerged almost indefinitely will be introduced.

• **Special ASW group**—The United States has designed a special hunter-killer task group to meet the challenge. The first of these is Task Group Alfa. The second is Task Group Bravo. Each group is comprised of a carrier, eight destroyers, two hunter-killer submarines, land and carrier-based planes and helicopters.

At the same time, the Navy is attempting to push forward rapidly with new means of detection from planes, ships and by the creation of some form of underwater DEW line.

In all, the United States also has 300 ocean escorts and 720 ASW aircraft at present to meet the Soviet submarine threat. It also has about 80 anti-submarine submarines—the bulk of the U.S. underwater fleet.

At the height of World War II the Allies had about 930 ocean escorts and about 2200 ASW aircraft. Germany had a maximum U-boat strength of 440—only a few less than Russia has today.

This force in time of war would strike first at the submarine ports and the narrow seas. Russian submarines would have to run a gauntlet in order to reach the open North Atlantic.

Those that made it would face the hunter-killer groups as well as the ASW submarines which include the fast *Polaris* types.

Russia might try to avoid running such a gauntlet by deploying her submarines in open water before the outbreak of war. But such a mass deployment would also carry the disadvantages of giving warning.

Of course, for an underwater missile attack no mass deployment would be necessary. Only a relative handful of "Z" Class subs could destroy much of America.

Milestones in Torpedo History

1864—*First ship (Union Sloop* Housatonic*) sunk by moving torpedo.*

1864—*Robert Whitehead began experiments*

1869—*First torpedo station founded (Newport, R.I.)*

1870—*First production units of Whitehead's torpedo (11-foot, compressed air unit. Speed 6 knots; range 200 yards)*

1872—*Electric drives first appeared*

1879—*Lay cable-controlled torpedo used by Peru against Chile. No success*

1880—*Sims-Edison electric fish torpedo developed (see sketch)*

1898—Howell torpedo, *using flywheel power and stabilization, obtained range of 800 yards and speed of 38 knots*

1903—Whitehead torpedo, *improved with a gyro and Curtiss turbine, launched (300 ordered by Navy in 1905)*

1915—*U.S. Navy began work on electric torpedo*

1917—*Germans developed electric torpedo*

1928—*Navy electric finally tested but sank in process*

1931—*Navy abandoned electric torpedo*

1941—*U.S. entered war with five types of torpedoes:* Mark 8 *and* 15 *(surface ship);* Mark 13 *(aircraft);* Mark 10 *and* 14 *(submarine). Electric torpedo work reactivated*

1942—Mark 24 *airborne target-seeking torpedo qualified and put into production. Several thousand built and credited with stopping German submarine threat*

1943—Mark 18 *battery-powered torpedo (speed 40 knots, range 4 miles) turned over to fleet where it gradually took over from steam torpedoes*

1943—*Germans began use of "intelligent" (Noise-homing) torpedo*

1945—*Work begun on "universal"* Mark 35 *(air, surface, or submarine) acoustic homing torpedo. (Modified units, less air-launch capability, went into production four years later)*

1948—*Development begun on* Mark 41, *air-launched version of* 35.

1950—*Work begun on lightweight, small, target-seeking* Mark 43

1958—*Wire-guided* Mark 39—*an "underwater guided missile"—introduced*

1959—*Surface or air-launched* Mark 44 *introduced.*

Servovalves Need Fresh Approach on Temperature

Moog Valve believes 1000 F reachable by using acceleration switching servos

by Jay Holmes

EAST AURORA, N. Y.—How would you like to be the largest stockholder in a company that doubles its sales every year?

William C. Moog, a development engineer formerly with Cornell Aeronautical Laboratory in nearby Buffalo, was in this happy position from 1951 until 1957. His **Moog Valve Co.,** now **Moog Servocontrols Inc.,** had $200,000 sales in its first year and approached $9 million six years later. After a recession dip in fiscal 1958, the company set another record of more than $10 million in the year ended June 30.

Moog, while employed by the Cornell Lab, invented an advanced and sophisticated servovalve of a type requested by the military for service in the rugged environments anticipated for guided missiles. When **Bendix** ordered four of the valves for use on a defense job, the lab gave Moog the order. The Cornell lab is set up for research alone and is not interested in production contracts.

• **Manufacturers decline**—He inquired of several manufacturing companies but none of them thought the market was large enough for them to go into it. And so he decided to take six months' leave and do it himself. Moog found a machine shop willing to make the valves and to wait for its money until Bendix paid. The first valves were assembled in his basement.

At about this time, **Philco** ordered 75 units for $30,000. With this encouragement, Moog decided to incorporate. He has never had reason to regret it. The market has been growing steadily almost all of the time since then.

What is a servovalve? It is an automatic error-correcting device for critical flight applications, foremost of which is controlling the flight of aircraft and missiles. When the attitude changes from that prescribed, an electronic sensor transmits the change to the servovalve, which then adjusts the flow of oil through an actuator po tioning a control surface or engi Sophisticated controls of this type fi became necessary when aircraft spee reached the neighborhood of that sound and it was no longer possib for human pilots to make correctio fast enough.

After a while, Moog began man facturing servoactuators which cor bine the valve, cylinder and feedba device in one mechanism.

Missile and aircraft servovalves a incredibly small for the work they pe form. The first Moog valves weigh about a pound, with dimensions about 2″x2½″x1½″. Later mod have been reduced to about a ha pound. William Thayer, Moog's chi engineer, says a servovalve has two di tinctive features: high power contr from a low power signal and contin ous control that can change the dire tion of output in two directions. Th contrasts with a thermostat, for e ample, which can increase temperatu but cannot decrease it.

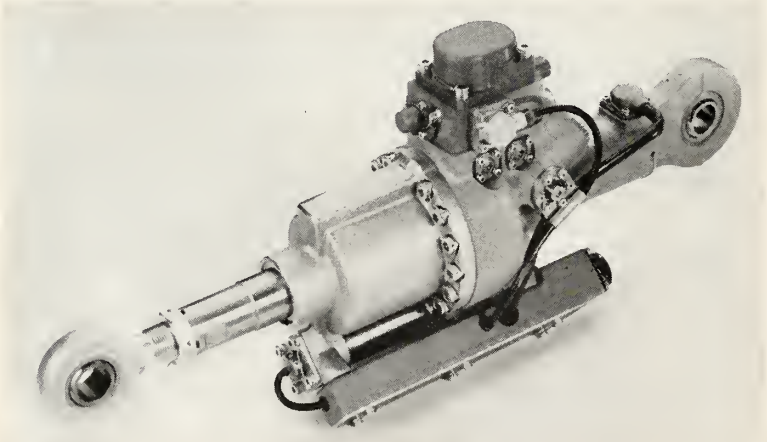
• **Musical valves**—A servoval can accept an input on the order 50 milliwatts and regulate an outp of many horsepower—a power gain the order of 10^7. It acts rapidly, a most as fast as an electric current. Th signal from a phonograph needle ca be fed into a servovalve and somethi recognizable as music will come out.

Servovalves in use at present w operate within a temperature range –65° to 500°F. The most importa new requirement is for an increase i the upper temperature limit. Models i development will bring this to 700°F but Moog says a fresh approach needed for an attack on the next ten perature barrier, 1000°F.

One possible solution is the use acceleration switching servovalve Basically, the difference between suc a valve and the earlier types is tha the valve force motor operates on simple on-off basis, rather than b graduated variation of signal strengt

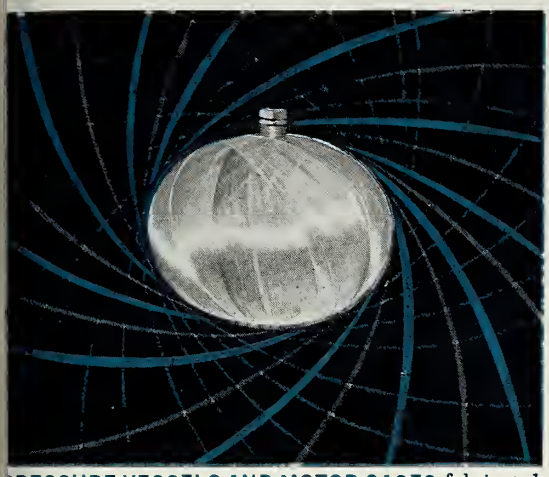
Under such an arrangement, elec trical hysteresis does not affect opera tion and it is possible to use plain cold rolled steel for the motor magnetic cir cuit. Theoretically, it would be pos sible to operate a switching valv motor to temperatures well abov 1000°F—possible to almost 1400°– with acceleration switching.

On a rocket, servovalve system are used to actuate control surfaces on-off switching of control engines an thrust-vector controls. With a four nozzle solid-fuel engine, adjustment o the four can control pitch, roll an yaw. With a single-chamber liquid-fue rocket, this is accomplished by swivel ing the entire engine.

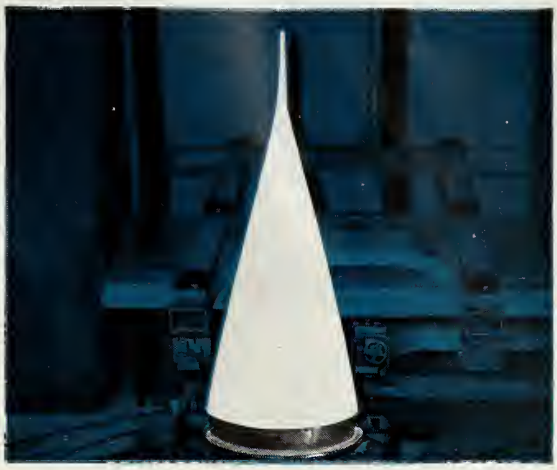


TINY SERVOVALVE can accept input near 50 milliwatts and regulate an output of many horsepower—a power gain on the order of 10^7.

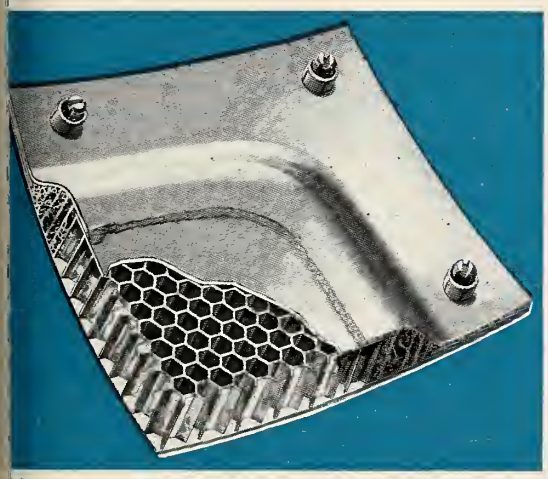
Brunswick technology leads the way in three critical space-age components



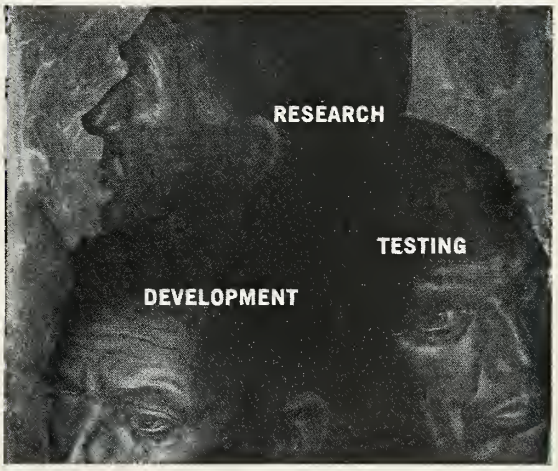
PRESSURE VESSELS AND MOTOR CASES, fabricated by Brunswick's exclusive Strickland "B" Process, now have the highest strength-to-weight ratio ever obtained in filament-wound components. Brunswick is *now* producing these virtually leak-proof pressure vessels. Brunswick also fabricates motor cases capable of withstanding extremely high pressures and temperatures.



RADOMES AND NOSE CONES, created by Brunswick's outstanding research and development efforts and filament winding process, are being used on supersonic aircraft such as the advanced Convair F-106 and McDonnell F4H, as well as on missiles such as the Boeing Bomarc, Lockheed Q5 and similar missiles. And, of course, Brunswick capabilities include complete electronic design and test facilities.



HONEYCOMB ASSEMBLIES, now developed by Brunswick can support two million times their own weight. Brunswick research has created honeycomb assemblies of paper, fiber glass, aluminum and stainless steel as well as conventional forms. Using the most advanced adhesive systems, these assemblies can be formed in compound curvatures with extremely close tolerances.



RESEARCH, DEVELOPMENT AND TESTING—carried on by Brunswick teams have contributed heavily to space-age technology . . . most notably in solving problems of increasingly high operating temperatures (600°—4,000°F.) for critical components and new heights in strength-to-weight ratios. For full information on how this leadership can help you, write or call Brunswick today!

BRUNSWICK

DEFENSE PRODUCTS DIVISION • 1700 MESSLER STREET • MUSKEGON, MICHIGAN

missile support

Air-Supported Space Platform Is Advocated

ARTIST'S conception of air-supported space platform structures.

BUFFALO—The first space platform will be an air-supported structure, a Buffalo manufacturer predicts.

Walter W. Bird, president of **Birdair Structures Inc.,** maintains that light weight, portable plastic housing is ideal for the first habitable satellite, since the rockets carrying such materials into orbit will have very small payloads.

The housing could be built in units carried into orbit on successive flights, Bird said. Air could be carried up in liquid form and boiled into the structure to inflate it.

Bird is well qualified to discuss the building of large, inflatable plastic structures. His company manufactures the Pentadome, a missile maintenance shelter 150′ in diameter and 85′ high with four smaller auxiliary domes, for the Army. The Pentadome maintains its shape without rigid supports, poles or frames—just with constant low pressure, high volume air supplied by motor driven blowers.

The center dome of the Pentadome consists of five sections that have to be joined together. This makes it easier to handle the dome in erection, dismantling, packing and shipping operations. However, Bird said it would be possible to make a housing in one piece for space use.

Many types of material are used in Birdair structures. The Pentadome consists of 18,000 square yards of vinyl-coated nylon. The central dome material weighs 24 to 25 ounces per square yard. The smaller domes, 100 in diameter and 50′ high, weigh abou 18 ounces per square yard. The struc ture is designed to withstand a con stant wind load of 70 miles per hour It has a safety factor of 3 to resis gust loads of greater velocity. Th fabric is designed to retain its flexibil ity at –40°F. The material is designe to carry full loads up to 160°F.

What about meteorites and micro meteorites in space? Bird asserts tha a resilient plastic material will with stand such blows better than rigi structural materials. Some particles tha would penetrate a firm jacket, he says would bounce off or be absorbed by resilient material.

The Pentadome, which stands 8½ stories high, can serve as a protectiv cover for a *Jupiter* missile while it i being readied for firing. Smaller plasti covers are used to protect other mis siles. In come cases, a missile is fire after a quick release, sometimes on th order of 1½ seconds. In other case the missile is fired through the dom

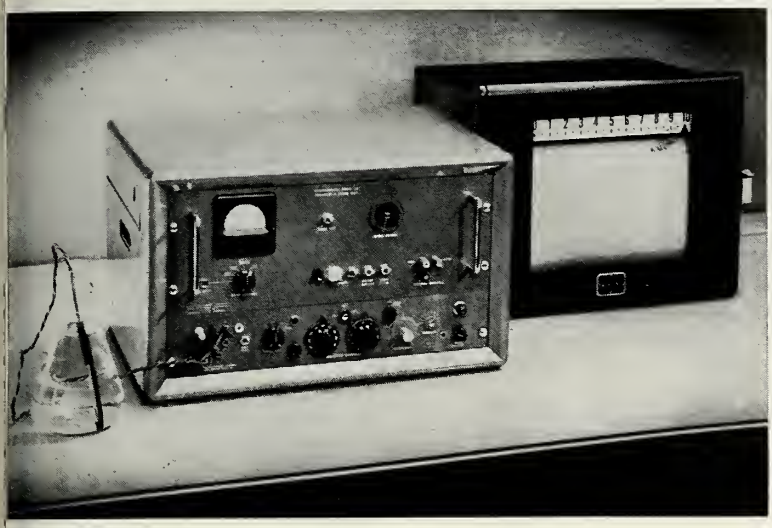
Bethlehem Research Center Going Up Despite Strike

BETHLEHEM, PA.—Foresight i stocking structural steel has enabled contractor to maintain construction o a **Bethlehem Steel Co.** research cente despite the steel strike.

Turner Construction Co. of Ne York is the general contractor for th multi-million-dollar center for metal research and development. The firs buildings are to be completed nex year.

Bethlehem is building the center o a 50-acre site high atop South Moun tain in Bethlehem, near the campus o Lehigh University. When it is complet several years from now, about 40 will be employed.

The center will provide facilities fo work in process metallurgy, mechani cal engineering, physical metallurg mechanics, chemical engineering ceramics, chemistry, physics an nuclear engineering.



Corrosion Now Measured Automatically

Automatic corrosion measurements are now possible, using a new servo-controlled corrosometer manufactured by **Crest Instrument Div., Magna Products, Inc.**

The Model L-2 corrosometer is capable of detecting as little as one millionth of an inch of corrosion on a routine basis and one billionth of an inch in some special applications. It automatically "tracks" corrosion as it occurs, providing a permanent record of the total thickness of metal corroded. This record is presented as a function of time which is quickly converted to the rate of attack.

In the laboratory, the Model L-2 corrosometer greatly simplifies the job of evaluating the effects of corrosion inhibitors on the resistance of various metals to known corrosive conditions. The pattern of corrosion differs from metal to metal, and the Model L-2 eliminates the tedious, point-to-point plotting required when the timing and extent of the initial attack is unknown.

A single Model L-2 may be used to monitor up to twelve individual tests by adding additional measuring units. A single multipoint recorder can be used to record data from these tests being run in parallel at the same time.

The Model L-2 also finds use in oil refineries and chemical plants, where it detects the change in corrosion rate resulting from the addition of inhibitors or from changes in process conditions. The effect on the corrosion rate may be immediate, or it may extend over a long period, and again the Model L-2 saves time and trouble over point-to-point plotting.

In the case of inhibitors, the instrument may be used to evaluate various proprietory compounds under actual plant conditions, or it may serve as part of the plant's basic instrumentation system, telling operating personnel exactly when corrosion has reached a dangerous level and new inhibitor should be added to the process stream.

Like other corrosometer instruments manufactured by Crest, the Model L-2 detects corrosion by measuring the ratio of resistance between exposed and protected metal elements mounted on a "probe" that extends into the corrosive medium or sample. As the exposed metal is corroded, the resistance ratio between the two elements increases. This increase is a direct indication of corrosion. Since both elements are mounted together, resistance changes due to temperature fluctuations have no effect on the readings.

In the Model L-2, the two metal elements in the probe form two legs of a bridge circuit, with a servo-driven potentiometer acting as the automatic balancing mechanism. The position of this potentiometer is a direct measure of corrosion. The gear train connecting the servo motor and the balancing potentiometer also drives the recorder output potentiometer.

The tracking "range" of a probe is typically divided into one thousand corrosion units, each unit being one microinch. Corrosion totalizer dials on the face of the instrument indicate how many micro-inches of corrosion have occurred. The recorder, on the other hand, swings full scale with only 10 microinches change, thus providing a high level of resolution.

Circle No. 225 on Subscriber Service Card

Miniature Servo Picked for *Pershing* Guidance Unit

The heart of the inertial guidance system for the new Pershing IRBM—a miniature servo-package—will be produced by the **Bowmar Instrument Corporation.**

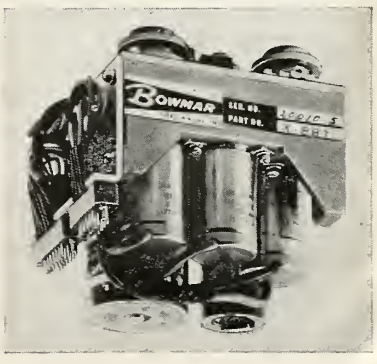
Edward A. White, Bomar president, said that the firm has been awarded $65,000 in contracts for the manufacture of an initial order of the units.

The new unit is a program transmission servo-package which plays a key role in the ST-120 air bearing gyro stabilized platform. It transmits tilt program pulses from a programming tape to the Pershing steering mechanism, in a smoothly changing voltage, that corrects for course deviations.

To meet size and weight requirements, Bowmar engineers had to reduce the package to one-third of its standard dimensions, producing a package 2½ x 2¼ inches and weighing less than 34 ounces.

Housed in the package are essentially two systems, each performing a function in the overall control and guidance of the missile. The first system consists of a stepper motor, dual cams and microswitches, synchro control transmitter and gear train. It ultimately indicates the position of the synchro control transmitter of this first system via a signal proportional to its shaft angle.

The second system of this assembly consists of a motor rate tachometer, synchro control transformer, synchro control transmitter, one dual and one single cam and microswitch together with separate gear trains between the motor tachometer and first synchro, the first synchro and the dual cam-



microswitch and the second synchro and the cam-microswitch. From the second synchro to the single cam-microswitch is 1:1 gearing. This second system ultimately indicates the position of the synchro control transformer and transmitter.

Backlash between synchro control transmitter and synchro transformer of the second system portion measured at the synchro control transmitter of the first system is 3 minutes maximum. Backlash between the motor and the synchro control transformer is 30 minutes maximum. Basically, four different gear reductions are included in the entire package. Reduction between the stepper motor and the synchro control transmitter is 9:1 and reduction between the motor rate generator and synchro transformer is 100:1. Reduction from the synchro transformer of the first set of cams and microswitches is 3:1 and reduction from the first set of cams and microswitches to the synchro control transmitter is 40:3. A ratio of 1:1 exists from the synchro control transmitter and the single cam and microswitch.

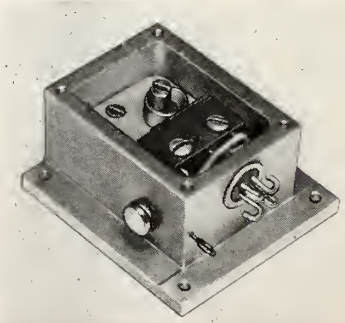
The housing of this package is of clean anodized aluminum and bearings are ABEC Class 5 or better. Gearing tolerances are Class 2 or better. The entire unit is designed for operation in ambient temperatures of −55°C to +100°C. Unit construction was designed to withstand environmental conditions as generally specified in MIL-E-5272.

Circle No. 226 on Subscriber Service Card.

Tiny Mechanical Timer Weighs Less Than 4 oz.

The nation's smallest mechanical timer (fits into 1 cubic inch of space) is now in production at **Timech Corp.**

Weighing less than 4 ounces, Model TMC-50 timers are available over a time range of 1 to 20 seconds with accuracies of 3% and 5%. Designed primarily for use on missiles and target drones, the new mechanical timers are used as events programmers and timers, and to release recovery parachutes.



An unusually rugged device, capable of withstanding all of the environmental hazards of missile operation, the new Timech timer performs its function with extreme reliability. It is engineered to perform reliably in ambient temperatures from −65°F to +250°F; Shock of 300 G's-millisecond duration, and vibration of 25G's from 25 to 2,000 cps. The Model TMC-50 mechanical timer is also built to meet the standards of MIL-STD. 202 and MIL-E-5272A.

Circle No. 227 on Subscriber Service Card

Delay Relays Feature Adjustable Timing Ranges

Two new lines of time delay relays, with guaranteed accuracy ratings of 10% to 5%, have been announced by **Tempo Instrument Inc.**

These units are said to be the only known adjustable time delay devices that meet all the accuracy and reliability requirements of high performance electronic systems, particularly for airborne and ground support missile applications.

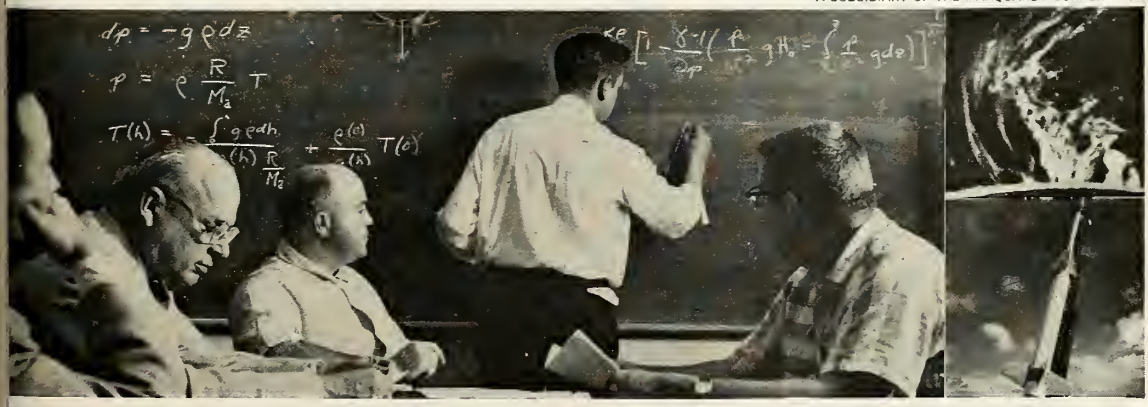
The new Tempo units, of subminiature size and weight, include provision for simple, quick field adjustment of the time delay period. Adjustment may be accomplished with a precision potentiometer located remotely from the unit, or with a stable fixed resistor wired directly across the terminals provided on the unit. A standard calibration table is supplied showing the resistance value required to result in a given time delay period.

Six basic units are available, with overlapping time delay ranges—each is capable of a 20 to 1 adjustment range as follows: .050 to 1.00 seconds, .5 to 3.00 seconds, .750 to 15.0 seconds 3.00 to 60.0 seconds, 9.00 to 18 seconds, 15.0 to 300 seconds.

By stocking only 6 units, the user has immediately available a wide range of highly accurate time delays, from

Southern California opportunity for creative rocket systems scientists, engineers. CDC's current expansion has created several key openings. Specialist in complete rocket systems, CDC offers you opportunity to join the team that has helped orbit America's satellites...to contribute to upper-atmosphere and space research programs like Explorer, Vanguard, Sunflare, Eclipse and Project Mercury. Rewards are high if you can generate original ideas and take responsibility on your own shoulders. A subsidiary of The Marquardt Corporation, CDC assures you outstanding career stability. High-level Engineering Writer. Capable of assuming responsibility for creative engineering writing on preliminary design concepts. Aerodynamicist. B.S. in A.E. Familiar with drag prediction in subsonic and supersonic flows. To perform drag and stability analyses on rocket motors. Physicist. Ph.D. or M.S. preferred. Experienced in research and analytical studies in upper atmosphere physics. Knowledge of meteorology helpful. Instrumentation Engineer. B.S. in M.E., E.E. or physics. Experienced in development of instruments and instrumentation systems. Electronics Engineer. Experienced in transistor theory, instrumentation, and telemetering systems. Project Engineer. B.S. in physics, M.E. or A.E. Familiar with sounding rockets, aerodynamic heating problems and stress. Experienced in organizing a project. Senior Systems Analyst. M.S. or Ph.D. To head group. Experience in propulsion, guidance, instrumentation, aerodynamics, thermodynamics preferred. Senior Mechanical Engineer. To head mechanical development group. Experience in rocket vehicles, mechanical auxiliaries, ground handling equipment, and rocket launchers desirable. Systems Engineers. B.S. or M.S. Broad systems knowledge. To work in field of design concepts. Live and work in Southern California, a healthful, year-around vacation land. Call or write Ben Hedding, Personnel Director, immediately. Cooper Development Corporation, 2626 South Peck Road, Monrovia, California, MUrray 1-5664

A SUBSIDIARY OF THE MARQUARDT CORPORATION



.050 to 300 seconds in missile testing and checking operations.

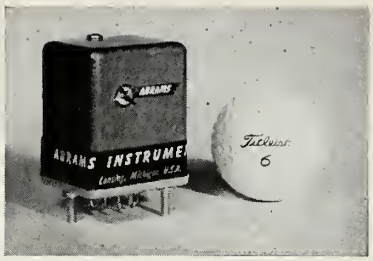
The rated accuracies, either 5% or 10% of nominal time delay, are guaranteed under any combination of environmental and operating conditions including input voltage variations from 18 to 31 vdc, temperatures from −55 to +125°C, vibration to 20 g's, 2,000 cps., shock to 50 g's, 11 milliseconds, acceleration to 20 g's.

Circle No. 228 on Subscriber Service Card

Accuracies of .025% Provided by Transistor

The Abrams Instrument Corp. has announced the development of transistor, crystal controlled dc inverter to 400 cycle ac output with frequency accuracy of .025% through a temperature range of −60°F to +165°F.

The time base comprises a crystal controlled oscillator, transistor divider and output amplifier. For even greater accuracy, the unit can be furnished with a crystal oven at slightly higher cost and current requirement. Dip potted, the unit withstands high acceleration, vibration and shock. Input dc



voltage can vary as much as ±25%.

Encapsulated in a dustproof stud mounted relay case approximately 1 9/16 x 1 3/8 x 2 1/8; the inverter weighs approximately 4½ oz., and has enough power to drive a synchronous motor with a .002 inch oz. torque. By increasing the power amplifier at some sacrifice in size, larger torque motors or multiple synchronous motors can be used with the same accuracy of output.

The Model DB-1 time base for a synchronous motor, makes possible a multitude of applications in the airborne timing and control field where only dc voltage or unregulated ac is available. The advantages of extreme accuracy (.025%), no radio noise interference from motor brushes to filter, extreme environmental capability and maintenance free motor life, (well over 10,000 hours); are the answers to previous major design problems.

Circle No. 229 on Subscriber Service Card

New Comparison Bridge Model Features Simplicity

Southwestern Industrial Electronics Co., a division of **Dresser Industries, Inc.**, has announced the introduction of its new-series model E-2 Comparison Bridge.

A replacement of a previous SIE model of the same number and type designation, the new model is said to encompass ranges from 1 ohm to 5 megohms resistance, 500 mmf to 2000 mf capacitance and 3 milli henrys to 10,000 henrys inductance at accuracies from 2.5% to 0.1%.

Advantages of the new model are said to be increased accuracy, a reduction of component selection time, minimal operator fatigue, a simplicity which allows unskilled operators to obtain 0.1% accuracy and to detect component differences as small as one part in ten thousand.

Circle No. 230 on Subscriber Service Card

"Multi-Zone" Platecoil Cuts Heat-Up Time 17½%

Improved performance resulting from a change in product design has been proved by **Tranter Manufacturing Inc.**, in a test of its new multi-zone platecoil heat transfer unit under actual operating conditions.

The test was performed in a rinse tank at the **Ideal Finishing Co.**, where the original header-type Tranter platecoil had been used for several years for heating up the water in the rinse tank. The tank has 600-gallon capacity and the desired operating temperature is 200°F.

With steam at 15 psi, the old style platecoil heated the water from 60°F to 204°F in 182 minutes. With the same steam pressure, the multi-zone platecoil heated the water from 60°F to 203°F in only 150 minutes—a saving of 32 minutes, or more than 17½ percent faster, to reach the desired temperature.

The tests were run under identical conditions, with the old coil being removed from the tank after the first test and the multi-zone platecoil being placed in exactly the same position.

The units are two embossed sheets of metal, welded together to form channels for the passage of heating or cooling media, such as steam or water. In the old style header platecoil, one common header extended the width of the unit, feeding all of the lateral passages that carried the steam across the unit to the common condensate return.

In the multi-zone platecoil, the steam inlet header is divided into three branches so that steam is carried directly to all areas of the platecoil simultaneously. In effect, the new unit provides three platecoil units in one.

Circle No. 231 on Subscriber Service Card

Oil-Damped Transducer Withstands Rocket Blast

Statham Instruments, Inc., announces the P285TC miniature pressure transducer developed for use in rocket engine test environments.

Because it is oil-damped, the P285TC withstands the violent pressure transients generated in shock tubes or transmitted from firing chambers. In addition, the high natural frequency of undamped miniature flush-diaphragm instruments is retained.

The P285TC measures pressure from 0-50 to 0-1000 psi with the operational, environmental and service life advantages of unbonded strain gage transducers. Case length: 49/64". Width (between hexagonal sides): 1.0". Weight: approximately 3 ounces.

Output approximately 28 millivolts full scale open circuit at 7 volts (AC or DC) excitation. Non-linearity and hysteresis not more than ±1% of full scale.

Circle No. 232 on Subscriber Service Card

propulsion engineering . . .

By M/R STAFF

Liquid oxygen-ozone mixtures . . .
containing up to as much as 30% ozone can be safely used as a rocket engine oxidizer for gaseous hydrogen if the temperature is controlled properly. National Aeronautics and Space Administration researchers have used the combination successfully in carefully-designed engines, and have determined the limits of brisant detonability. Riley O. Miller of NASA's Lewis Research Center, Cleveland, described O_3-O_2 experience to the American Rocket Society's propellant thermodynamics and handling conference in July.

Ozone handling apparatus and procedure . . .
can now be specified for many use and handling situations, thanks to Miller's work. He attempted detonations of ozone-oxygen in various sizes and shapes of stell and glass tubes. Some were triggered by an initial pure ozone detonation, others by direct spark. The degree of fragmentation was one measure of brisance. Miller reports that a steady-state Chapmen-Jouguet detonation propagates from a spark in liquids containing 50% to 100% ozone. From 50% down to about 35% ozone (by weight), it is still possible to achieve detonation if it is initiated by a 100% ozone booster charge. At 35% or less ozone, no brisant propagation is obtained.

Safe mixtures may not stay safe . . .
if they are improperly handled, Miller points out. The biggest ozone handling worry is that, due to O_3's physical properties, ozone can be concentrated inadvertently. Miller points out these three ways this can happen:

(1) High concentration liquid ozone may condense from a dilute gas.

(2) Dilute liquid ozone may lose some of its diluting oxygen if the temperature increases.

(3) There is a two-phase region which is dependent on temperature and composition of the liquid mixture. In this area, the liquid separates into two phases, one more concentrated than the other.

Propellant tank was mixing bowl . . .
in the NASA experimental ozone rocket. "The required liquid O_3-O_2 mixture was prepared directly in the propellant tank," Miller reports. "Specially purified oxygen was passed through a specially cleaned ozonator . . . into the bottom of the refrigerated propellant tank where the ozone and all or part of the oxygen were condensed." All components that contacted the mixture were refrigerated. Liquid nitrogen was used when the ozone concentration was to be only 2%, but liquid oxygen was used as the refrigerant when higher ozone concentrations were used.

Few unexpected problems came up . . .
when Miller ran the engine. Runs were 3-seconds each, with continuous spark ignition. Miller found that the oxidant inlet valve should not be refrigerated when *gaseous* ozone-oxygen was passed through. Small amounts of ozone would condense on it and detonate, breaking up the Teflon packing. The result was leakage and Teflon fragments in the system.

A brisant detonation occurred . . .
in the line between the oxidant control valve and the oxidant tank at the start of one run. Tubing and flowmeters were fragmented, Miller says. Heavy forged valve bodies were split. The refrigerant trough was torn into several pieces and scattered "with considerable velocity." Miller says the detonation appears to have been initiated by a low energy source, away from the rocket combustor. That explosion, Miller says, emphasizes the need for careful consideration of all operations before they are tried.

WHO READS MISSILES AND ROCKETS?

Well, for instance ... ENGINEERS AT WESTINGHOUSE DEFENSE PRODUCTS

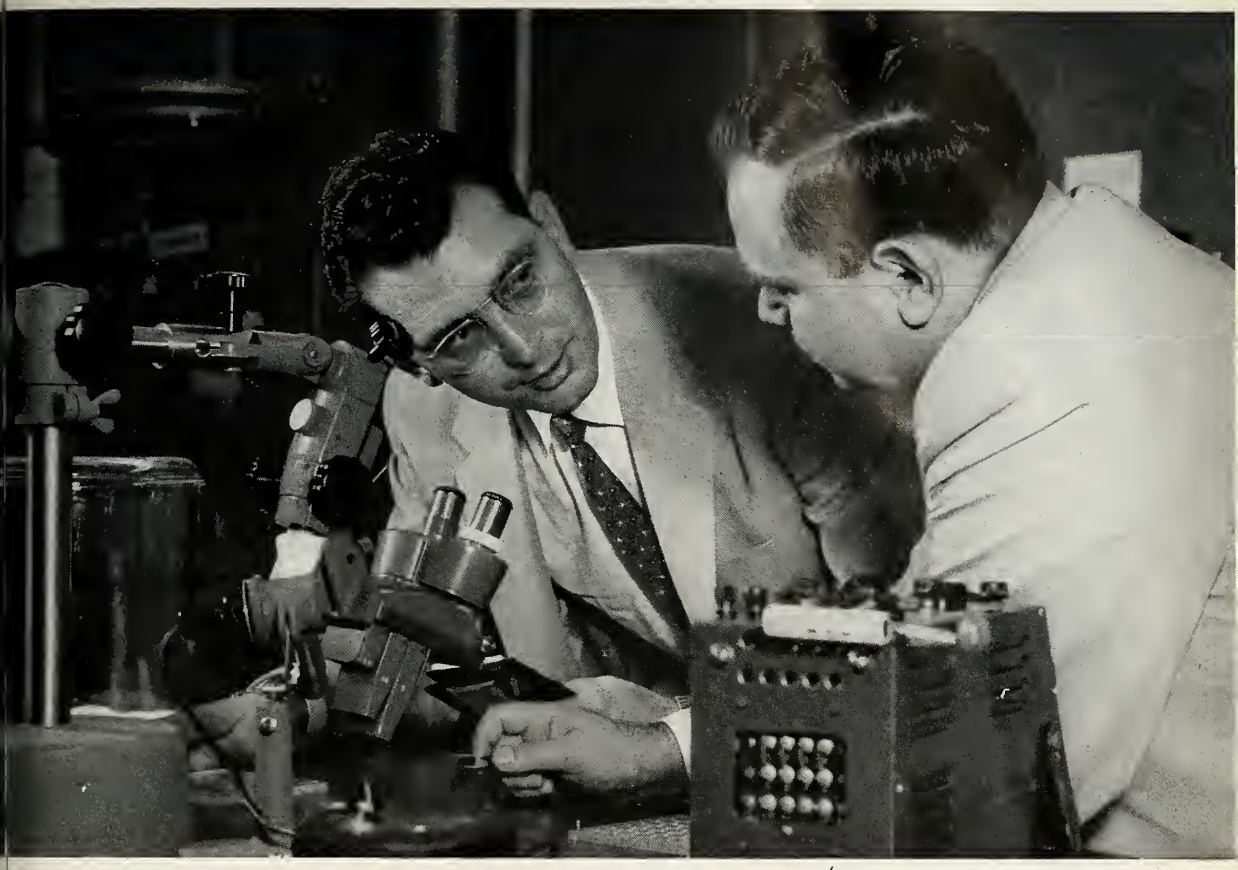
Molecular electronics—a technological breakthrough at Westinghouse—is producing electronic systems *1,000 times smaller and lighter* than anything now in existence.

Through molecular electronics, drastic reduction in weight, size, power and heat dissipation requirements will permit space vehicles and satellites to perform a greater number and wider range of tasks. Greatest advantage is the vastly improved reliability achieved by the replacement of numerous components by a single solid state unit.

Recently, the Air Research and Development Command of the U. S. Air Force awarded a development contract to Westinghouse as a part of a broad program effort in this new electronic area. Experimental "hardware" is being fabricated by Westinghouse for infrared, reconnaissance, communications, telemetry, flight control and other military applications.

"Missiles and Rockets deals exclusively with astronautics. Spawned by aviation, missilery and outer space exploration today is an industry by itself." — George Shapiro (right), Fellow engineer of the Westinghouse Astronautics Institute, located at Air Arm Division.

"One company can't build the entire bird ... it takes thousands of p and scores of companies. Missiles and Rockets keeps us informed of products and capabilities of the other companies throughout the in try — a most definite aid in selecting contractors." — Harvey Sa (right), Manager, power systems, Westinghouse Advanced Syst Planning group.



Gene Strull (right), Manager of the Semiconductor Divi-
's Solid State Advanced Development Laboratory at the
tinghouse Air Arm Division, discusses molecular elec-
ics with Charlie LaFond of the editorial staff of Missiles
Rockets magazine. Westinghouse engineers have devel-
. on a single semiconductor wafer, a system that performs all the functions of much larger conventional and transistorized electronic systems. Typical application is a tiny light sensing device for satellite telemetry less than ½" in diameter and 1/100th of an inch thick, one of several subsystems including pulse generators and multiple switches, already built and demonstrated by Westinghouse.

Many Missile Programs Changed by Congress

by Betty Oswald

WASHINGTON—Major revisions of missile programs were recommended by Congress in approving defense appropriation of $39.2 billion for FY '59-60. Funds do not include an additional $1.3 billion for construction of missile bases and other military installations, a separate appropriations act.

While Congressional emphasis, centered on ballistic missiles and strategic weapons, there were signs of a growing concern over the capability of the U.S. and particularly the Army to handle a limited war. There were also indications Congress would take more of a hand in actual programming of military production if the Secretary of Defense did not take a firmer stand to eliminate interservice rivalries and what Congress considers duplicate development of equipment.

Some $1,407,300,000 was provided the Army for procurement of missiles and other equipment. Of this total, Army was ordered to take at least $100 million which had been made available for *Nike-Hercules* to make a start on Army modernization. Originally, the House provided the Army with $1,232,300,000 for procurement which the Senate boosted to $1.45 billion.

Navy will have $3,860,063,000 for procurement of missiles, aircraft, ships, and other hardware items. This includes $1,961,644,000 for missiles and aircraft; $1,330,700,000 for shipbuilding, including *Polaris* submarines and $35 million for planning for a second nuclear powered carrier; and, $567,-719,000 for procurement of ordnance and missiles (other than those used in aircraft).

Air Force will have $7,934,800,000 in new procurement money. Of this, $2,540,550,000 is for missiles, with the strong recommendation that the number of missile squadrons be increased and *Minuteman* be accelerated.

Actually, this could be increased if DOD decided to act. The Appropriation Act provided that the Secretary may take unobligated balances previously provided for aircraft and other procurement to boost ballistic missile programs. This is about $60 million under the budget.

Aircraft procurement money totals $4,284,000,000. This includes funds for armament, specialized handling equipment of the ground variety and other specialized equipment, including machine tools which may be needed. This account may also be boosted by use of previously appropriated but unobligated funds.

For research, development, test and evaluation a total of $3,165,615,000 was made available in new money to Army, Navy and Air Force. Of this, Army gets $1,035,715,000; Navy $970,000,000; and Air Force $1,159,-900,000.

Advanced Research Projects Agency gets an additional $455 million as requested by the President, and the Secretary of Defense's emergency fund of $150 million.

Defense Department has already changed some of the programs for which these funds will be used. Out of Army funds, $137 million will be used for preproduction preparation for *Nike-Zeus* missiles and equipment.

Nike-Hercules program has also been changed. A total of $10.8 million originally planned for research, development, test and evaluation won't be used under changed air defense plans. In addition, some $100 million of *Nike-Hercules* production funds will be used for Army modernization.

Air Force *Bomarc* program is also being reduced sharply under the so-called "master plan." The House originally took a little more than $162 million out of the *Bomarc* program. DOD asked a return of $129.9 million for *Bomarc* installations on the east and west coast. Senate provided about $80 million of the amounts which DOD asked to be returned. The Appropriations Act as it went to the President was a compromise giving the Air Force a little more than half of what the Pentagon had asked.

Congress made it clear that it didn't like either the *Bomarc* or *Nike* programs. Secretary McElroy is barred, by legislative history of the Appropriations Act of using any part of the emergency fund for *Nike-Ajax, Hercules* or *Bomarc*. And there is a strong suggestion, in addition, that the Secretary of the Army ought to start phasing out *Nike-Ajax*.

Plans to buy *Mace*, will have to be sharply revised. Originally $127.5 million was requested by DOD. The House knocked the entire fund out. However, the Senate gave the program a reprieve. It did not restore the money, as requested by the Pentagon, but provided that if the Secretary of Defense really wants the missile, he can take the money out of "maintenance and operation procurement and research and development funds in his discretion—."

Radar improvement programs of the Air Force were also cut slightly, hitting the SAGE project.

Simulator Delivery

Minneapolis-Honeywell Regulator Co. will deliver an 8 x 12-foot space flight simulator to the Air Force School of Aviation Medicine late next month. AF pilots are being screened for two volunteers to spend 30 days in the chamber. The eight-ton device includes air and water recycling devices. Solid wastes will be burned in an incinerator with gases disposed by afterburner. Environmental system will permit the volunteers to smoke cigarets and listen to recorded music.

Boeing has awarded RCA "Multi-million dollar" contract for command and information networks for *Minuteman* launch-control system . . . $1.9 million follow on for more *Minuteman* telemetry equipment has been ordered from **Radiation Inc.** by Boeing. Earlier contract was for $4 million . . . **Bell Aircraft** has picked up three AF R&D contracts totalling $575,000—one of them for development of a storable propellant flow system.

Corps of Engineers will soon ask bids for construction of *Nike-Hercules* bases at Barksdale AFB, La.; Dyess AFB, Tex.; Bergstrom AFB, Tex. Walker AFB, N.M.; Offutt AFB, Neb. Schilling AFB, Kan.; Robins AFB Ga.; Lincoln AFB, Neb. and Turner AFB, Ga.

DOD also has okayed construction of *Bomarc* bases at Camp Adaire, Ore. Paine AFB, Wash.; Vandenberg AFB and Travis AFB, Calif.

Aerojet-General Corp. is donating $400,000 to California Institute of Technology for construction of a new research laboratory. The lab will be named in honor of Dr. Theodore von Karman, who found Aerojet back in the late 1930's.

Boeing Proposes New Vehicle

Boeing Airplane Co. is advancing nd "interplanetary reconnaissance ve- icle" proposal that is a very blue-sky ntity with very real technical appeal.

According to the company's de- cription of the manned orbital- nterplanetary system, it would be apable of:

- Transport between planets by eactor-powered plasma jet;
- Reconnaissance of the orbited lanet by means of a "Boeing Martian xplorer" carried within and dis- atched from the main vehicle;
- Housing shuttle vehicles for per- onnel movement of vehicular service;
- Releasing personnel via self- ontained individual *Mercury* type scape and re-entry capsules.

The principal structure would be a 0x74-foot spherical-ended cylindrical shell. The interior would be divided into two ellipsoids independently pressurized and separated by a hanger deck.

Capable of being fully assembled in outer space, seven levels would be provided within the capsule. Nylon nets would compartmentize various levels.

The power plant would be separated from the habitated area by a truss structure and shadow shield. Communication to earth would be by paraboloidal reflectors and a solar-optical transmitter.

Study Shows Obsolescence

A **Johns Hopkins University** study for the Army labelling 75% of U.S. manufacturing facilities obsolete may increase chances for Congressional approval of changes in current tax depreciation rules.

Fast tax write-offs of equipment and facilities (amortization within 5 instead of 20-30 years) is due to end this year unless extended by Congress. The program was started during the Korean War and in the past few years has been reduced to mostly R&D for missiles and space systems.

Venus' Atmosphere Poses Entry Problem

Tests conducted in shock tubes by **Lockheed Missiles and Space Division** scientists indicate that for vehicles approaching Venus aerodynamic heating may be 50% higher than re-entry into the earth's thinner atmosphere.

AUSA Unveils New Army Missile Equipment

WASHINGTON—The Army last week elebrated the annual meeting of the ssociation of the U.S. Army by un- eiling a series of new Missile Age de- elopments ranging from a GI rocket elt to a "vest pocket" mobile air de- nse system.

The "vest pocket" system is con- dered capable of development as a eld anti-missile missile system.

Gen. Lyman Lemnitzer, Army chief f staff, set the tone of the meeting y warning that the Cold War is rapidly eaching the point of nuclear stalemate.

"The situation will then mean real- tically that the other components of ur power will play the vital role in pping with the tactics and strategy f Communism short of the threat of eneral nuclear war," he said.

He made clear that "the other com- onents of our power" meant very uch a missile-packing modern Army.

The Army disclosed that a soldier such an Army will be equipped with ich weapons as:

- Rocket belts of various sizes— ne belt under development by **Thiokol** ould give a GI up to 50 feet of boost om five solid rockets. Another bigger pe under development by **Aerojet- eneral** is capable of taking a man 200 feet into the air in 20 seconds.
- Rocket foxhole diggers—The ouble-tubed device is designed to dig foxhole by firing two rockets into the round.
- *Redeye*—The Convair anti-air- aft missile that can be handled by ne or two men in the field. It weighs ly about 20 pounds. (m/r Aug. 3)

The new **Hughes** "vest pocket" air defense systems are designed to semi-automatically direct the fire of from one to eight batteries of anti-aircraft missiles—*Hawks* and *Nikes*. They replace much manual operation.

The systems are comprised of from two to eight two-and-a-half ton trucks crammed with electronic equipment. The equipment—much of it modular—has been installed and designed to withstand travelling at high speeds over rough terrain.

One truck in each system serves as operations central. It detects and tracks attacking aircraft and routes the information to the appropriate coder-decoder truck. The coder-decoder truck in turn automatically routes the information to its battery.

The mobile systems already are being deployed with U.S. troops in Germany. In all, Hughes will manufacture 29 five-truck systems under a $30 million contract.

The cost of additional systems is estimated at about $500,000 each.

"VEST POCKET" DEFENSE against enemy jets is provided by the Army's new mobile tactical air defense system. The system—developed by Hughes Aircraft—is capable of semi-automatic direction of the firing of from one to eight Army anti-aircraft and missile batteries. Several of the five-truck systems are already in the hands of U.S. troops in Europe for use with Western-Electric *Nikes* and Raytheon *Hawks*.


HAMMER

Recent appointment of Brig. Gen. **Stephen R. Hanmer** as Deputy Chief of Engineers for Military Operations has been announced. Gen. Hanmer, who has been Assistant Chief of Engineers for Troop Operations, will have supervision over the Corps' military activities, including training and assignment of Engineer personnel, and research and development of missile ground support equipment and techniques.


CAIRELLI

C. P. Cairelli, new chief engineer of M. H. Rhodes, Inc., Hartford, Connecticut, has been with the company for three years as design engineer. He will direct Rhodes' expanded engineering program.

Irving H. Young has been named manager of engineering administration at Litton Industries' Maryland Division. He formerly was an engineer with General Electric's aircraft nuclear propulsion department in Cincinnati. **Fred E. Burnham** assumes position of manager, antenna and microwave section at Litton after ten years with Wright Air Development Command. He was assistant chief of the antenna techniques and applied research section.

William James Weaver takes over as product specialist at F. J. Stokes Corp., Philadelphia. He was formerly with Air Products, Inc.


SOLARI

Sterling Precision Corp. has announced election of **Joseph Solari,** vice president, as a director of the corporation. Solari has also been elected to the board of American LaFrance, Yawman and Erbe, Prescott, Alf-Herman, Weck and Wood and Brooks. He will continue responsibility on the operation of the Instrument Division at Port Washington, New York; the Inertial Navigation Division at Cambridge, and the Weck Division in Brooklyn.

France's Nord-Aviation has named **Leon Beaussart** as vice president (technical) of their Missiles Department. **Roger Chevallier** is promoted to chief engineer of the target missiles section; **Jean Guillon** chief engineer of the autorotating missiles and **Roger Fleury,** chief engineer, for missile development and support equipment.


ROSS

Harvey M. Ross, chief engineer of Motorola's Defense Systems Laboratory has been named manager of Program Development, a new position "reflecting the continued expansion of Motorola's military activities in Phoenix." He joined Motorola's Communications and Electronics Division in 1948 and was promoted to department head in the Military Electronics Division.

Paul R. Ellis, former manager of ACF Industries, South Albuquerque Works, has been promoted to manager of the division.


DUNCAN

Dr. Donal B. Duncan, 34, has moved to Aeronutronic, a Division of Ford Motor Co. as assistant general operations manager of Space Technology Operations. He was manager of Advanced Engineering at Autonetics, a Division of North American Aviation Inc.

Barnett Pomerantz takes over as project engineer at Bulova Research and Development Laboratories, Inc., for aircraft altimeter development and production programs. Pomerantz came to Bulova a year ago, from Swivelier, Inc. where he was chief engineer.


SILK

C. Earnest Silk heads development of solid propellants and explosives operations of the Energy Division, Olin Mathieson Chemical Corp. and will be responsible for development operations at East Alton, Ill., and Ordill, Ill. Silk, who joined the then Olin Industries in 1930, and has worked in research, manufacturing and engineering phases of the business, holds patents for explosive processes.

west coast industry . . .

By Fred S. Hunter

Ryan Aeronautical Co. keeps pushing . . .

toward higher altitudes with its *Firebee* jet target missile. When Ryan first started drawing lines on paper for the XQ-2 in 1947, it was to meet a requirement for 15,000 feet of an anti-aircraft target. Its newest model, the Q-2C, has achieved a record of 59,500 feet and, in addition, has set a duration record of 77½ minutes above 50,000 feet. Next step will be a supersonic *Firebee*. Ryan, says Frank Fink, vice president-engineering, is thinking in terms of Mach 1.5 and then going on from there.

First objectives in Ryan's program . . .

to provide supersonic capabilities in the *Firebee* may be met with a two-stage version of Continental's J69-T-29 engine which powers the Q-2C. This would increase the Dash 29's 1700-pound thrust rating by approximately 50%. Ryan's own engineers are working on the development of an augmentation system for this same engine. This would be in the form of a simplified afterburner which could be cut in after the drone is on station. Cost of a current *Firebee*, including augmentation and scoring equipment, comes to $50,000 or $60,000. A supersonic *Firebee* probably would cost twice as much. But higher and higher performance target systems have to be developed to meet the requirements of advances in weapons systems. And Ryan's people make a cogent point—often the cost of the munitions (rockets) used up in a target mission exceeds the cost of the recoverable *Firebee*.

Steel strike may affect missile industry . . .

on the labor front as well as in the supply of material. Roy M. Brown, International Association of Machinists general vice president for the southwest area, made this observation at the recent western states conference of the IAM in San Diego: "What happens in steel will affect negotiations in other industries, including contract talks coming up in the aircraft and missile fields next spring."

NASA will come into the X-15 flight . . .

program at an early date. Immediately upon conclusion of proving flights, **North American Aviation** will turn the No. 1 aircraft over to NASA for test by its pilots. With two B-52s available for mother ships, North American will continue with its program on the No. 2 aircraft. A major change in flight technique will take place with the entrance of the No. 3 aircraft into the program. Interim engines in the No. 1 and No. 2 aircraft will be lighted after the rocket plane is dropped from the mother B-52. The big 60,000-pound thrust rocket specially developed for the X-15 will be lighted just before the aircraft is released.

How big is the missiles and rockets business . . .

getting to be? Well, **Aerojet-General** says at Sacramento it has the largest telephone switchboard west of the Mississippi and is expanding it. The company's telephone bill is $85,000 a month. And if the stock market is your barometer, consider, then, in the last 18 months, prices of shares of **Ampex** and **Hoffman Electronics** have increased more than fourfold, **Hewlett-Packard** and **Stratham Instruments** more than threefold . . . J. E. Rheim, **Rohr Aircraft** president, says the next two or three years should be "the best we've ever had." Rohr has $150 million of business lined up already for fiscal 1961.

Transfer of satellite launchings from . . .

Vandenberg Air Force Base to the Navy's Point Arguello will probably become effective after January 1, 1960. The switch is purely in the interest of geographical efficiency. There's nothing between Arguello and the South Pole except ocean.

—contracts—

AIR FORCE

Radio Corp. of America has received a "multi-million dollar" major research and development contract for work on the sensitive-command and support information networks of the *Minuteman* launch-control system. (Subcontract from **Boeing Airplane Co.**)

$83,966,000—**Pan American World Airways, Inc., N.Y.**, for increased funds for services and material for management, operation and maintenance of the Atlantic missile range facilities and related activities of the AFMTC. (Two contracts.)

$1,900,000—**Radiation Inc.**, Florida Div., for the ground portion of the PCM/FM telemetry equipment for the *Minuteman* ICBM. (Subcontract from **Boeing Airplane Co.** and is in addition to an earlier $4,000,000 contract.)

$1,000,000—**The Garrett Corp., AiResearch Div.**, Phoenix, for vent and relief valves and high pressure regulators for the *Titan* ICBM. (Subcontract from **The Martin Co.**)

$575,000—**Bell Aircraft Corp.**, Buffalo, N.Y., for development of a storable propellant flow system for rocket engines; feasibility study for the electrostatic suspension of accelerometers, and a method of determining the effect of structural flexibility on the stability and control of hypersonic air vehicles. (Three contracts.)

$450,000—**Consolidated Diesel Electric Corp., Aircraft Equipment Division**, Stamford, Conn., for transformer-rectifier type power supplies.

$36,000—**Traid Corp.**, Encino, Calif., for 16mm hi-speed camera.

$30,530—**Boeing Airplane Co.**, Pilotless Aircraft Div., Seattle, for technical data for IM99A missile components.

$20,000—**Southwestern Industrial Electronics Co., Div. of Dresser Industries, Inc.**, for electronic instrumentation Model K-1 microsource.

NAVY

Contracts totalling $12,000,000 have been awarded **Sperry Gyroscope Co.**, Great Neck, N.Y., for the development of the Mark 112 Torpedo Fire Control System, an electronic "brain" that controls torpedos even after they are fired. The first will be installed on the *Polaris*-launching submarine, the USS George Washington.

$1,920,000—**Ryan Aeronautical Co., Electronics Div.**, for additional spare parts and other support equipment for the Model APN-122(V) Doppler Radar Navigator.

$425,000—**Elgin Micronics, Div. of Elgin National Watch Co.**, Elgin, Ill., for the production of safety-arming devices used in the *Sparrow* missile.

$330,000—**Brubaker Electronics, Inc.**, Culver City, Calif., **Div. of Telecomputing Corp.** of Los Angeles, for the manufacture of complex radar test equipment and spare parts.

$225,000—**Vitro Laboratories**, Silver Spring, Md., **Div. of Vitro Corp. of America**, for the expansion of services in the field of weapon system simulation and training devices. (Four contracts.)

$134,000—**Packard Bell Computer Corp.**, Los Angeles, for data gathering system.

$71,876—**Bendix Computer Div.**, Los Angeles, for digital computing system.

$61,840—**Avion Div., ACF Industries, Inc.**, Paramus, N.J., for radar beacon assembly.

ARMY

$9,950,000—**Western Electric Co., Inc.**, N.Y., for *Nike-Zeus* industrial planning program.

$3,023,204—**Chris Berg. Inc.**, Seattie, Wash., for construction of tracking and data acquisition station at Donnelley Flats, near Fort Greeley, Alaska.

$2,500,000—**North American Aviation**, Canoga Park, Calif., for design and development.

$2,358,670—**HRB-Singer, Inc.** and the **Singer Manufacturing Co.**, a joint venture, State College, Pa., for infrared surveillance system.

$1,934,519—**Hazeltine Electronics, Div. of Hazeltine Corp.**, Little Neck, N.Y., for radar set An/TPS-25.

$803,452—**Ford Instrument Co., Div. of Sperry Rand Corp.**, L.I., N.Y., for airborne guidance receiver transponder.

$800,000—**ITT Laboratories, Div. of International Telephone & Telegraph Corp.**, Nutley, N.J., for three ground stations for *Courier* communication-satellite systems.

$700,000—**Philco Corp.**, Philadelphia, Pa., for *Courier* communication satellites, shrouds, code tapes.

$440,000—**The Trustees of Columbia University**, N.Y., for research and experimental work in the continued investigation of electromagnetic spectrum, together with technical reports. (Two contracts.)

$420,315—**Firestone Tire & Rubber Co.**, Los Angeles, for engineering services.

$350,000—**Union Carbide Development Co., Div. of Union Carbide Corp.**, N.Y., for research in physical and chemical principles affecting high temperature materials for rocket nozzles.

$349,403—**Gilfillan Brothers Inc.**, Los Angeles, for engineering services.

$340,948—**Ford Instrument Co.**, L.I., N.Y., for eight sets of modified *Redstone* guidance and control components.

$226,021—**Collins Radio Co.**, Dallas, Texas for microwave relay for wide band telemetry, White Sands Missile range, spare parts list.

$179,364—**Radio Corp. of America, Defense Electronic Products**, Moorestown, N.J., for investigation into requirements of special test equipment for cross section measurements, design, fabricate and installation of necessary special test equipment determined to be applicable.

$139,000—**Bulova Research & Development Labs., Inc.**, Woodside, N.Y., for study, design and fabrication of nine prototype accelerometer monitors and mico-miniaturized three-speed synchro assemblies utilizing size eight synchros for the ground equipment to be used in the *Jupiter* guidance system and for study and development of basic research tool applicable to gun launchable guidance systems. (Two contracts.)

$81,950—**Defense Electronic Products**, Camden, N.J., for investigation studies pertaining to advance development of microwave radio relay systems together with technical reports.

$65,060—**Atlantic Research Corp., Alexandria**, Va., for one design and test plan for radiosonde AN/DMQ-6 and subsequent delivery of 15 development and 50 engineering test models.

$53,720—**Wild Heerbrugg Instruments Inc.**, Port Washington, N.Y., for modification of government-owned ballistic cameras.

$51,539—**University of Wisconsin** for research work for 24 months to conduct surface wave antenna and microwave filter engineering study and technical reports.

$42,736—**University of Pittsburgh**, for basic research related to low energy nuclear and electron physics and research and development entitled "The Reactivity and Molecular Constitution of Some Metal Hydridies in Solution."

$40,182—**Western Electric Co.**, N.Y., for *Nike* spare parts and components.

$38,000—**Litton Industries**, San Carlos, Calif., for magnetron tubes.

MISCELLANEOUS

$794,000—**Applied Science Corp.** of Princeton, N.J., for digital data transmission systems for the Eglin Gulf Test Range. (Subcontract from **ITT Laboratories**, a division of **International Telephone & Telegraph Corp.**)

$350,000—**Consolidated Avionics Corp.**, subsidiary of **Consolidated Diesel Electric Corp.**, Westbury, N.Y., for automatic test equipment for testing electronic missile components and circuits. (Subcontract from **General Electric Co.**)

$75,000—**Consolidated Avionics Corp.**, Westbury, N.Y., for data reduction system. (Subcontract from **Boeing Airplane Co.**)

BIDS

U.S. Army Engineer District, Pittsburgh, Corps of Engineers, New Federal Bldg., Pittsburgh, Pa.: Construction of ground-air transmitter and receiver facility for the *Missile Master*, Pittsburgh Defense Area, Collier Township, Allegheny County, Pa. Bid sets available after 24 July 1959. Completion 165 calendar days—Job—IFB Eng-36-058-60-1B—Bid opening on or about 25 Aug. '59.

—letters—

Reliability Interest

To the Editor:

I have read with interest the articles written by Managing Editor D. E. Perry and Col. J. N. Dick, USAF, Ret., in the July 13 issue of MISSILES & ROCKETS and was prompted to reply with some thoughts of my own. The fact notwithstanding that new materials and components will be required for future equipments, I question how much we know about the reliability attributes of those presently available.

It is my belief that our knowledge is inadequate and our needs are immediate. Further, that we are actually attempting to design reliable equipments without sufficient reliability information concerning the parts from which they are to be constructed. With sufficient component reliability data available to the design engineer at the time that he is building his dream, there should be marked decrease in the number of nightmares that occur in test and production.

To stress my point, let us suppose that the designer had a reliability requirement in addition to accuracy, altitude, size, etc. A rather unsophisticated technique for a rough computation could be explained to him. Suppose further that some of these computations require the data that associates failure rate, temperature and electrical stress (voltage, wattage, etc.) for the various components that he is to use. Where does he obtain this information concerning either new or relatively new components. It appears that he doesn't unless either his company has been funded for a large components evaluation program or has access to data from another company or a government agency.

To gather these types of data through testing program is a costly process for any company, but it could be done on a national scale at Government expense. Dissemination of these design data could be either upon request or included with the documents associated with an equipment specification.

Considering military component specifications for a moment and the fact that they contain certain requirements for size, rating, etc., should they not contain reliability requirements as well? It would seem that we are not exploiting to best advantage those components that are in and today because of the lack of sufficient information concerning their reliability attributes.

This does not mean that we cannot expect to require new component types to meet the demands of future equipments. However, suppose that the suggestions made by Col. Dick are accepted and new materials are developed. Will we know any more about their failure rates in equipment application than we now about those that we are using today? Certainly not, if the developmental investigations are conducted without forethought for the reliability data required to make use of them.

In summary, and as Col. Dick's article suggests, let's really put "first things first" and find out what our components will do in a reliability sense. If we are able to accomplish this, we should be able to design reliability into equipment just as any other design requirement. Reliability is no longer an art but a science; therefore, there is a need for scientific information in its aplication.

E. G. Lebre, Manager
Reliability & Specification
Compliance Department
Raytheon Manufacturing Co.
Maynard, Mass.

—when and where—

AUGUST

Metallurgy Division, Denver Research Institute, Eighth Annual Conference on Applications of X-Ray Analysis, Stanley Hotel, Estes Park, Colo., Aug. 12-14.

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.

AFOSR/Propulsion Research Division, Directorate of Aeronautical Sciences Office of Naval Research, Office of Ordnance Research & National Aeronautics and Space Administration, Symposium on "The Dynamics of Ionized Cases," Northwestern University, Evanston, Ill., Aug. 24-25.

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, Calif., Aug. 24-26.

International Commonwealth Spaceflight Symposium, Church House, Westminster, London, England, Aug. 27-29.

Army-Navy Instrumentation Program, Annual Meeting, Symposium and Industry Briefing, Statler Hilton Hotel, Dallas, Texas, 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, Berkeley, 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.

New York University's College of Engineering, Titanium Metallurgy Conference. For information: Dr. Harold Margolin, New York University, University Heights 53, New York, Sept. 14-15.

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.

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

Navy Fails to Solve ASW Problem

It is basic military doctrine that close behind any new offense will appear a defense. The time and the effectiveness vary but historically the doctrine has proven itself, the world has watched this spectacle of defense and offense leap-frogging each other over the war-marked centuries.

It is in the periods when the development of the defense lags unduly that nations find themselves in the greatest danger, whether the weapon be the phlanx, the catapult, the long bow or the satellite missile-firing platform.

The United States today finds itself facing such a problem in not one but two fields. The first is the anti-ballistic missile missile. The second is in anti-submarine warfare. Of the two the second seems to us to be much the more dangerous for two reasons.

First: despite a great deal of talk about the "missile gap," the probability is that both the United States and the Soviet Union will actually perfect long range ballistic missiles in roughly the same time period. Any advantage the Russians may have for a short time will be offset by the Western Allies long range bomber force. These factors seem likely to prolong the same sort of stand-off under which the world has been living, perhaps indefinitely.

Second: No such equality of force exists between the Soviet and U.S. submarine fleets. It is true that we have the first atomic submarines and are building more, and that their feats have been spectacular. But indications are the Russians will not be far behind with their own atom-powered subs. Certainly their accomplishments in the reactor field in other endeavors can leave little doubt that they have such a capability.

The more important fact is that the Russians have a huge fleet of some 500 submarines as opposed to 113 in operation by the United States (five nuclear).

Times and tactics have changed a great deal since World War II. Then the submarine was intended and directed to operate exclusively against other ocean craft. Today the submarine has the capabality of operating not only against shipping but against the cities and military installations of the enemy as well.

In the first instance, in the words of Rear Admiral John S. Thach, commander of the Navy's Task Force Group ALFA;

"Hitler started his war with about 60 U-boats, the old fashioned kind that could submerge only temporarily, and he nearly strangled us. The Russians have eight times that many right now. Most of them are new. They're fast. Snorkels are standard equipment. Nuclear propulsion is only a matter of time." Admiral Thach is one of the Navy's sailors responsible for building a submarine defense. He will admit that in war games his own opposing snorkel subs confound his defenses all too frequently.

Even if we ignore the possibility that the Red subs might throttle the sea lanes, concentrating on the theory that the next war will be short, if unhappy, and that supplies can be handled via the air, this does nothing to dispose of the missile-throwing sub which could operate in the Atlantic, the Pacific and the Gulf.

Since we have not and probably will not have for some time a defense against a ballistic missile—certainly not against one fired from short range—then the problem here is exactly the same as the problem of protecting shipping. The only defense is to get the submarine itself. And a conventional sub can toss a missile just about as well as a nuclear sub.

Industry, which has been working fitfully on this problem for some years, details two main obstacles they have run into—and many responsible Navy officers agree. These are:

Lack of money—The price of one carrier, for instance, would go far toward the solution.

Concentration of effort—Instead of scattering the responsibility between The Bureaus of Ordnance, Ships, Aeronautics and the Office of Naval Research.

A poll of more than a score of companies who have worked on the ASW problem, including putting their own funds into it, has revealed almost an unanimity of response on the latter fact. Almost invariably it went like this:

"One of our greatest problems in dealing with the Navy on ASW is that there is no single group within the Navy Department responsible for the entire anti-submarine field and, therefore, it is difficult for a contractor to anticipate or, indeed, discover the total needs of the service in this area."

And another, from a company which had spent $100,000 of its own funds:

"The most difficult problem encountered to date in conjunction with ASW is the lack of consistency among many Navy agencies as to what the requirements of the Navy really are in the ASW area."

It seems to us that the conclusion is inevitable. There are many precedents in the Services for establishing a special group—task force, division, command, call it what you will—to concentrate the best skills of the Navy and industry toward solving one of the most dangerous threats which the country faces. It should be done quickly. And it should be given a priority on money and manpower to be successful.

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ITIVE FUSE. A current-sensitive having a functional reliability of % is announced by Networks Elec- Corp. Glass-enclosed and hermet- sealed, the fuse is 100% humidity , and guaranteed to meet any ied resistance to atmospheric con- s. Unit has excellent environmental cteristics, withstanding tempera- from −100°F to +400°F . . . ion of 10 to 500 cps at 15 G's ium, and shock of 50 G's for 11 conds. Fuse is dimensioned to dis- heat produced by the maximum current under any special blowing and temperature conditions. Fast, m or slow burning-operating time vided. The slow-burning fuses have h time-lag, with standing heavy ; and instantaneous peaks, but g quickly in response to short cir- Units are filled with nitrogen or specified gases. Outside ends of rminals are flexible copper alloys straight cutoffs, or flattened-and- d lugs. Fuses can be designed and ged to customer specifications.

No. 245 on Subscriber Service Card.

OTEST CONSOLE. Solartron, Inc. a new console providing a con- t housing for selected items of est equipment, plus working sur- for use as a plotting desk or as d for units under test. The con- was designed to house Solartron nents such as its low frequency e oscillator, low frequency resolved onents indicator, Solarscope, con- s, sub-sonic power amplifier and nical reference generator. How- the manufacturer also suggests cer- ther instruments as being applic- n the servotest field.

No. 246 on Subscriber Service Card.

SDUCER. Astra Technical Instru- Corp., is now marketing a tung- resistance thermometer having a tless connector of 2 ounces. These possess the high accuracy and wide rature ranges characteristic °F to +2000°F) of the com- standard laboratory probes. lucers feature body rotation inde- nt of leads for ease of installation, re extremely rugged to withstand ibration and shock.

No. 248 on Subscriber Service Card.

PLANETARY MIXER-DISPERSER. A heavy-duty vertical planetary mixer, only 14 feet tall and powered with a four-speed, 20 horsepower, explosion-proof motor, has been produced by the Bramley Machinery Corps. Mixing is performed in the 250 gallon, stainless steel, mixing chamber by means of specially designed, wedge-proof paddles, one stationary paddle and one rotating paddle moving on its own axis in a planetary orbit. The paddles intermesh, thereby performing a continuous and quicker kneading and squeezing action between the paddles. The mixing chamber is jacketed around the periphery, including the bottom, for either cooling or heating, with an allowable internal working pressure of 50 PSI. A separate hydraulic system raises the mixing chamber and holds it to the head, to permit the mixing operation to be conducted under high vacuum.

Circle No. 249 on Subscriber Service Card.

DIFFERENTIAL. The Dynamic Gear Co. has introduced a miniature, precision three-gear differential for application in the fields of electronic computers and fire control systems. Designed, manufactured and available from stock, this differential has a backlash of only 8′ of arc and breakaway torque of .3 oz. in. Tumbling circle is 1.380″. Maximum recommended load at 2500 RPM is 75 oz. in. Featuring 6 precision bearings, this solid shaft differential is entirely constructed of 303 stainless steel—except the spider gear, which is 24 St aluminum. Overall length of the differential proper is 1.888 and shaft diameter is .1847. Shaft lengths are available up to 4″.

Circle No. 250 on Subscriber Service Card.

PROPELLANT TESTER. A "drop-weight tester" developed by the Olin Mathieson Chemical Corp. for impact testing liquid propellants and explosives is offered by Technoproducts Inc., exclusive licensee. The test method, developed by Olin Mathieson in a five year cooperative government and industry program aimed at standardization of propellant testing, has been accepted as a Recommended Test by the Joint Army-Navy-Air Force Panel on Liquid Propellant Test Methods.

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51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

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200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

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225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
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CIRCLE NUMBERS BELOW FOR INFORMATION ON PRODUCTS, LITERATURE OR ADVERTISEMENTS

• **Advertisements**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

• **Missile Literature**

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

• **New Missile Products**

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

For Other Information Give Page Numbers: ....

MISSILE LITERATURE

SURFACE COATINGS. A chart providing thermal, physical, chemical and electrical characteristics of HumiSeal protective surface coatings for electronics applications is now available from the Columbia Technical Corp. Prepared so that all characteristics can be seen at a glance on one side of the sheet, the chart covers the ten HumiSeal types broken down by the A.I.E.E. thermal classification as well as 47 other specific characteristics for each type. The reverse side has a selector table which enables the user to select the HumiSeal type best suited for the property most desired for his application.

Circle No. 200 on Subscriber Service Card.

A. C. TIMING MOTORS. The A. W. Haydon Company has released a Bulletin—AWH MO-807—describing a line of compact, reversible AC Timing Motors. These motors are supplied with built-in gear trains offering speeds from 450 RPM down to 1/4 RPM. Identified as the 26100 Series, these motors were designed specifically for applications where ease of reversing is the main requirement, and where small size and light weight is necessary. The synchronous characteristic of these hysteresis type motor assures an accuracy on the same order as the power source. Operation can be on single phase supplies, using a phase shift network supplied with one winding, or on two phase supplies. Reversing is accomplished rapidly and conveniently with a single-pole double throw switch.

Circle No. 201 on Subscriber Service Card.

SENSITIVE DETECTOR. Technical bulletin no 91411 describes the theory and operation of a visual phase sensitive detector manufactured by Boonshaft and Fuchs Inc. This test instrument is used in the performance evaluation of a-c servo amplifiers and mechanisms. Other applications are also listed. Block diagrams, waveforms, and test setups are shown in the bulletin, as well as a chart illustrating the demodulation of various carrier signals of different phase relationships.

Circle No. 202 on Subscriber Service Card.

TRANSFORMER. A "do-it-yourself" transformer, called the Flexiformer packaged transformer primary, which makes stocking of many fixed-ratio transformers unnecessary, is described in a bulletin released by the Superior Electric Co. Essentially, a Flexiformer is a self-contained toroidal primary coil consisting of a strip-wound silicon steel core having a coil of 400 turns of #24 B&S guage copper wire. When used as a source of a-c voltage, simply hand-thread the proper number of secondary winding turns through the center opening to obtain the desired output voltage. Input rating is 120 volts, 50/60 cycles, 1-phase and output is 150 VA. When used as a current transformer, the Flexiformer winding becomes the secondary winding with the current induced by a wire passing through the center opening. Used with a 0-1 ampere ammeter, currents up to 400 amperes can be measured with an accuracy of 1% at 60 cycles.

Circle No. 203 on Subscriber Service Card.

GAS REGULATORS. A new line of industrial gas regulators without g[...] is described in a data sheet now [...] able from Linde Company, Divisi[...] Union Carbide Corp. The new gau[...] regulators eliminate the costly an[...] noying problem of gauge breakag[...] replacement. Designed for use wit[...] gen, acetylene or propane on cyl[...] or manifolds the new Oxweld regu[...] are designated the R-550 (Oxyge[...] 551 (Acetylene) and the R-552 [...] pane). Complete specifications an[...] erating data on the new large-cap[...] single-stage regulators are includ[...] the data sheet. The new regulato[...] extremely valuable on jobs where [...] lators are subject to rough handli[...] switched from cylinder to cylinde[...] quently. Use of an absolute mi[...] number of parts in the gaugeless [...] lators reduces the number of part[...] ject to wear. It is rarely necess[...] replace parts other than the stem [...] of diaphragm.

Circle No. 204 on Subscriber Servic[...]

PUBLICATION. The first issue of [...] Tech Notes, a 4-page publication [...] ing with analog computer tech[...] and applications, is now available [...] Donner Scientific Co. Subject of th[...] issue is "How to Simulate a Non-[...] Control System with an Analog [...] puter". Diagrams of a typical [...] system and plots showing respon[...] the system at various points with [...] ent parameters are included.

Circle No. 205 on Subscriber Servic[...]

SPACE HANDBOOK. Those inclir[...] brag of having "the world in [...] pockets" should check Space Techi[...] Laboratories, Inc. STL has manag[...] effect, to shrink our solar system [...] handy "pocket size." Produced [...] form of a computer, the device [...] matically computes time, distanc[...] the earth's rotation in regard [...] other planets. With minor position[...] cardboard dials, the "Planetariur[...] cates exact planet positions durir[...] hour of the day, for all twelve [...] of any year for the next ten yea[...]

Circle No. 206 on Subscriber Servic[...]

INTERNATIONAL INCH. Pratt & [...]ney Company, Inc., announces th[...] lication of a new booklet that dis[...] on a practical commonsense bas[...] various problems a manufacturer [...] expected to encounter as a re[...] America's change-over to the I[...] tional Inch on July 1 of this year. "The New International Inch . . [...] How It Will Affect Your Opera[...] the booklet explains that a majo[...] plants will not be affected to any [...] ficant degree by the adoption [...] new inch—but warns that each [...] facturer should make a careful [...] tion of his own machining and [...] ing operations before deciding w[...] or not the 2-millionths-per-inch [...] ence between the old and th[...] measurements should be taken in[...] count. To simplify the job of [...] this necessary evaluation, Pratt & [...] ney states that the boklet prov[...] questions-and-answers section de[...] to cover the more immediate poin[...] will concern most manufacturers.

Circle No. 207 on Subscriber Servic[...]

B.F.Goodrich

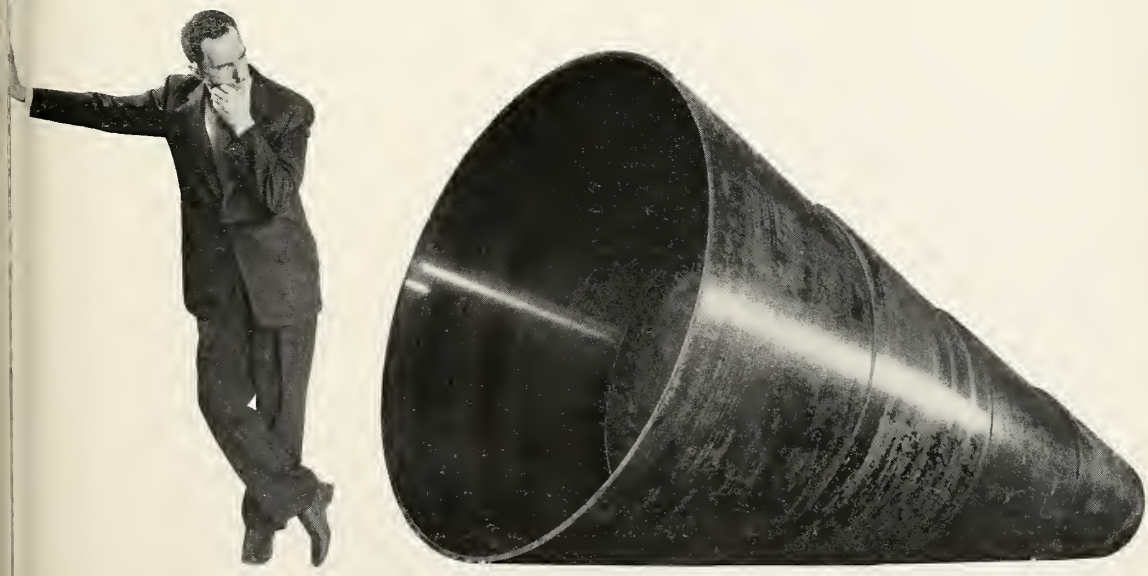
WHAT IS IT? Probably the biggest homogeneous void-free laminate ever built . . . a B. F. Goodrich ablation shield for an experimental re-entry vehicle designed and built by General Electric to be test flown on an Air Force Atlas ICBM.

Fabricated by a special B. F. Goodrich winding technique, the shield contains about five miles of high-temperature resin tape. This fabricating technique, which is also being used for many other specialized B. F. Goodrich products of various types and sizes, completely eliminates precision matched metal molds, cuts tooling costs by hundreds of thousands of dollars, and saves plenty of lead time. Autoclave curing replaces massive high pressure presses.

Throughout the construction of this re-entry vehicle shield, B. F. Goodrich maintains constant quality control of resin content and residual volatiles. Modern radiological facilities are used for final checking.

The fabrication and curing of such huge void-free parts illustrates the advances made by B. F. Goodrich in producing high-temperature, reinforced plastic products. So if you're up in the air and want down-to-earth answers on plastic laminate constructions, contact *B. F. Goodrich Aviation Products, a division of The B. F. Goodrich Company, Dept. MR-89, Akron, Ohio.*

B.F.Goodrich *aviation products*



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Electro Instruments Model A12 D.C. Amplifier

Totally transistorized—dissipates only 7 watts.
Long term drift less than 2 microvolts.
.01% linearity and stability.
100 megohms input impedance—40 milliohms output impedance
1 db DC to 10 KC.
Noise less than 10 microvolts wideband.
Single ended or differential input.
Operates to specifications from 0° to 50° C.
Self-contained power supply—operates on any line frequency from 50-400 cps.
Mil-type chopper gives unmatched reliability for the life of the instrument.
7" x 19" panel accommodates 8 instruments.

Plug-in attenuators of the A12 provide convenience, flexibility and economy. Special variations, gain settings, etc., can be tailored to your system at no extra cost.

FULLY TWO YEARS AHEAD of the FIELD!

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