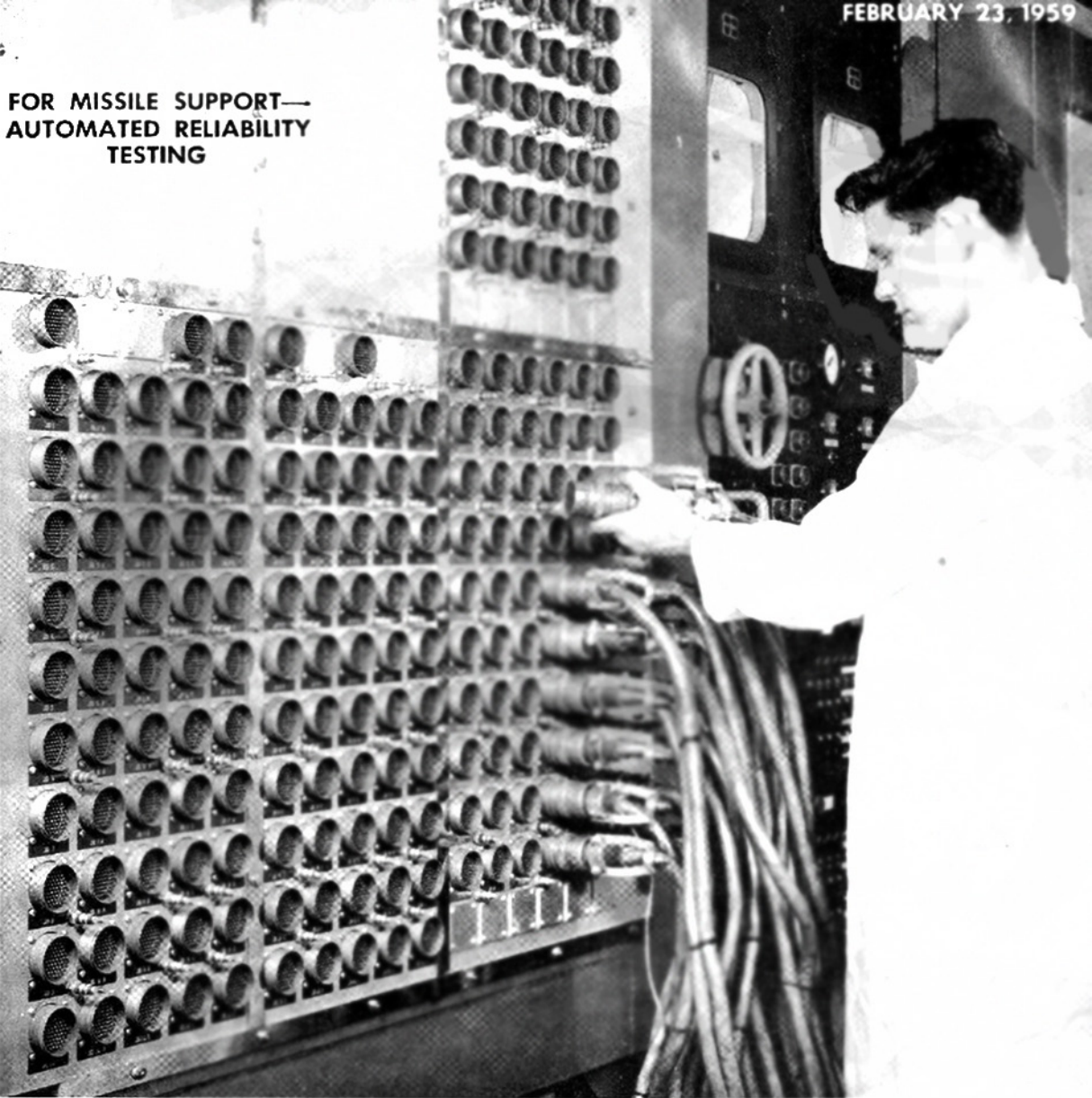


FEBRUARY 23, 1959

FOR MISSILE SUPPORT—  
AUTOMATED RELIABILITY  
TESTING



# missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

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AN AMERICAN AVIATION PUBLICATION

# Transistorized NLS M-24 Selected for Missile Checkout System



Analog to digital conversion in Nortronics' Universal Datico is accomplished by the ultra-reliable NLS M-24, the transistorized Digital Volt-Ohmmeter that automatically and accurately measures and displays AC and DC voltages, voltage ratio and resistance.

In Datico, program control is performed by a punched paper tape. Test stimuli are automatically controlled by Datico and output signals (voltage, voltage ratio, and resistance) from the system under test are automatically selected and fed to the NLS M-24. The M-24 digitizes the system outputs to 0.01%, and provides numerical data to the indicator and control chassis for distribution to the data recorder, digital comparator, and visual display on a special NLS in-line readout.

The tape also establishes the go-no-go limits for comparison with the M-24's digital output. It then directs the system to the next channel to be measured.

Operation of the NLS M-24 in this system is completely automatic . . . the instrument is remotely operable, does not require zero setting, and is extremely stable over very long time periods. Over-all system speed is not compromised by analog to digital conversion time, the M-24 making each measurement in just 330 milliseconds.

The NLS M-24 meets the unusually great reliability demanded of automatic test equipment for modern electronic weapons systems. This reliability is assured by transistors, mercury-wetted contact relays (rated at 10 billion measurements), advanced circuit design, and thorough production and field testing.

Proved in the field in a variety of applications, the NLS M-24 Digital Volt-Ohmmeter is in production and ready to go to work for you. Write today for detailed information concerning this outstanding example of NLS leadership in the development and manufacture of digital instruments. A complete catalog of NLS instruments will be sent upon request.



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**NLS — The Digital Voltmeter That Works...And Works...And Works!**



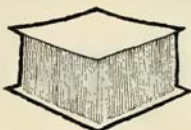
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missiles and rockets, February 23, 1959



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missiles and rockets Vol. 5, No. 8, Feb. 23, 1958

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missiles and rockets, February 23, 1958



# missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

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**COVER:** Cook Electric has 14 test chambers such as this for reliability testing. (p. 24)



**LATEST** in company team efforts is the *Hilo* drone by Bendix, Republic and Marquardt (p. 21)



**NEW** "sagging method" was used by Corning in making large telescope mirror. (p. 29)



**SOLIDS** mixer by Baker Perkins is boosting propellant output for Thiokol Chemical Co. (p. 26)



**RECOVERABLE** Lockheed X-7 ramjet test vehicle has made 100 tests with 75% successful.

# A FORCE TO RECKON WITH

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Today, all branches of the Armed Forces continue to look to Rheem for leadership in Explosive Ordnance, Missile Warheads and Fuzes, and Basic Research. A partial list of current projects underway at Rheem includes:

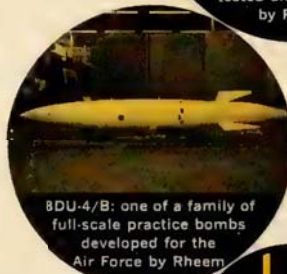
- MINES, GRENADES, PRACTICE BOMBS
- NON-NUCLEAR WARHEADS
- WARHEAD ADAPTION KITS
- FUZES AND SAFETY AND ARMING DEVICES
- EXPLOSIVELY ACTUATED VALVES, SWITCHES, SEPARATION DEVICES
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Advanced warhead for Hercules: developed, tested and produced by Rheem

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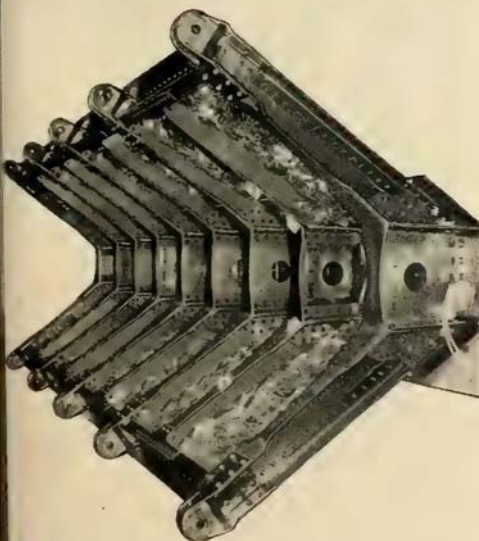
## \* X-15 .. A CHALLENGE FOR FASTENERS

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HI-SHEAR™ TRADEMARK REGISTERED U.S. PAT. OFFICE. U.S. PATENTS 2,355,579; 2,355,580; D-138-579; OTHER U.S. AND FOREIGN PATENTS PENDING.



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# HARD

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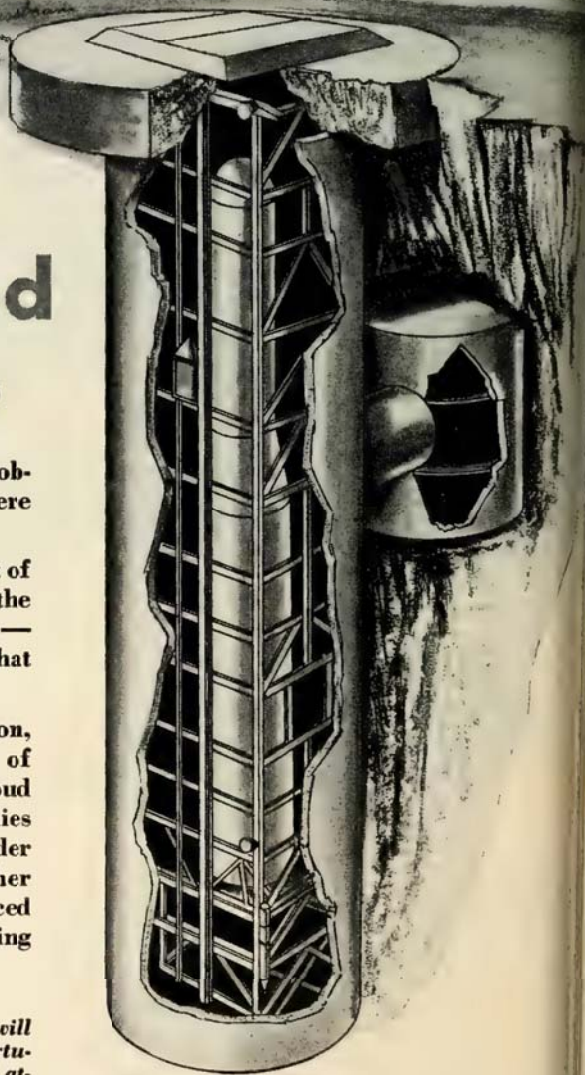
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Thanks to the Air Force's development of *hard-based* missile systems, we have the means to counterattack effectively — *within minutes* — from installations that are virtually invulnerable.

AMF's Greenwich Engineering Division, as the foremost designer-developer of hard-base missile installations, is proud to have helped make the original studies to evaluate these systems, and prouder still of its designs for the Titan and other programs. AMF is the most experienced contractor in the complex and exacting field of hardness engineering.

*Missile support specialists will find challenging job opportunities with AMF at several attractive locations — on both coasts!*



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# The New Line-up in Space

Defense Secretary Neil H. McElroy took a first step toward clarifying the nation's murky space projects picture when he straightened out some of the lines of authority in his Pentagon infield, although there is still some doubt as to who calls the play—Holaday, Johnson or York.

Before Congress, in a press release and by directive, it was spelled out something like this:

Dr. Herbert York is the boss of Defense Research and Engineering and, for the first time, McElroy seems to have given him some of the authority that Congress unquestionably intended he should have when it passed the law establishing his position. Two very important items in his charter say he is specifically delegated authority to:

"Issue instructions and one-time directive-type memoranda appropriate to carrying out policies approved by the Secretary of Defense for his assigned fields of responsibilities.

"Approve, modify or disapprove programs and projects of the military departments and other Department of Defense agencies in his assigned fields to eliminate unpromising or unnecessarily duplicative programs, and initiate or support promising ones for research and development."

That's a lot of authority if Secretary McElroy really means it and will back York up in getting the money he will need.

Roy Johnson's ARPA is the operating agency to carry out the directions of Dr. York, Congress was told. Here Secretary McElroy made his greatest concession to unified control. Before the Congressional appearance both he and Johnson had been adamant and emphatic that Johnson report to McElroy and McElroy only. Now, in research and development matters he reports to Dr. York. Queried as to the reason, one associate of the office said:

"Some of the people in the Pentagon were getting as tired of the confusion as some of you outside."

William M. Holaday, whose continued presence anywhere in the scientific space business puzzles a great many of his colleagues, remains there nevertheless as Special Assistant to his fellow-Ohioan, Secretary McElroy. Holaday was formerly Director of Guided Missiles. Before that office was absorbed by Dr. York's, he became Chairman of the Military

Liaison Committee with the National Aeronautics and Space Administration—a \$20,000-a-year position which he still retains.

In his new job, it has been explained, Mr. Holaday additionally will be the production expeditor. After Dr. York has decided upon the project and Mr. Johnson has carried forward the research and development, Mr. Holaday will clean up the problems of getting the project into production and hardware. He does not draw two salaries.

This clarification will meet the approval of all of us who want an orderly national program of space development. But there are other clouded areas which can be accepted only on faith.

For instance, the other day ARPA's Roy Johnson startled even his own staff members by declaring in a conference called to discuss the power plant for a new space project that ARPA could do nothing about it (ARPA is the sole agency managing military space projects) because in the future NASA will develop all space engines. This, he said, was an agreement he had made with Dr. T. Keith Glennan, head of NASA.

Now that the implications of this startling fact have finally filtered through to the military services, emotions are mixed. For in final delineation it means that a civilian agency will be writing the specifications for the engines around which the services must build military space machines. This concept of separate design for the component parts of a weapon system had long ago been abandoned, if it ever was really accepted. The engine and the machine now have a loving courtship, not a shotgun marriage.

It takes a lot of faith indeed to accept this situation. With NASA it may work (although one wonders if this test of faith is really necessary) because NASA is built on the old foundation of the NACA—an organization which for years worked in the closest harmony with the military. It will be a sad thing if that same cooperation does not continue, that is, if NASA does not utilize military skills and does not make military needs a prime requisite in any power-plant project.

Peaceful space exploration is both good and important, but we would like to point out again that unless the free world's military can guarantee our unmolested presence there we won't be doing any exploring in space, peaceful or otherwise.

CLARKE NEWLON





## fast-maturing TI infrared systems advance IR early warning, reconnaissance, tail-warning...

ALL-OUT DEVELOPMENT of the precocious infrared sciences at Texas Instruments has brought this versatile field to new levels of sophistication — a maturity that spells design simplicity in complex systems, and permits expert use by inexperienced personnel. The keys to this new status for infrared are *new optical materials, new materials/systems/application matching techniques, advanced detector cells, and low-noise transistorized circuitry* — all pioneered by Texas Instruments.

This experience can work for you immediately, whether your particular interest is reconnaissance, distant detection, early warning, tracking, tail-warning, or merely curbing a heat-seeking missile's tendency to chase the sun. To obtain IR technical services, backed up by the capacity to produce in any quantity the systems you require, properly cleared military or industrial personnel contact **SERVICE ENGINEERING DEPARTMENT:**

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FRANK TINSLEY '58

## STEPS IN THE RACE TO OUTER SPACE

### *Assembling a station in space*

This imaginative but technically accurate illustration shows a permanent satellite (center) being constructed in orbit around the earth. It generates its own heat and electricity from solar rays. Basic vegetation (such as algae) for oxygen as well as protein-rich foods are grown in hydroponic tubes in upper level "greenhouses."

New vistas in astronomy will be opened up by such a space station, because of perfect conditions for photography and spectroscopy. It will also provide unique conditions for ad-

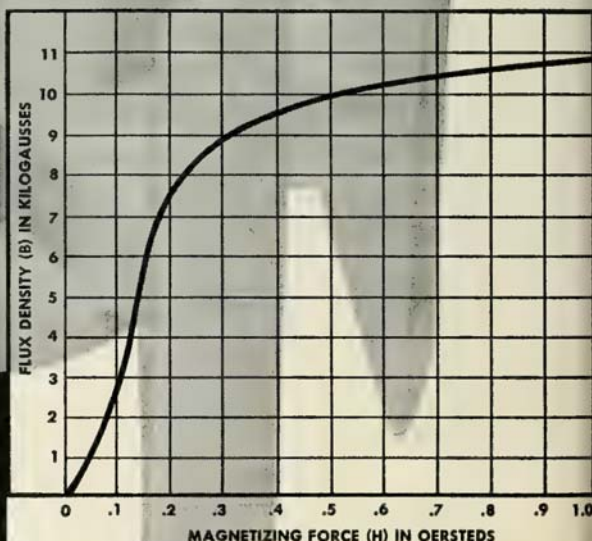
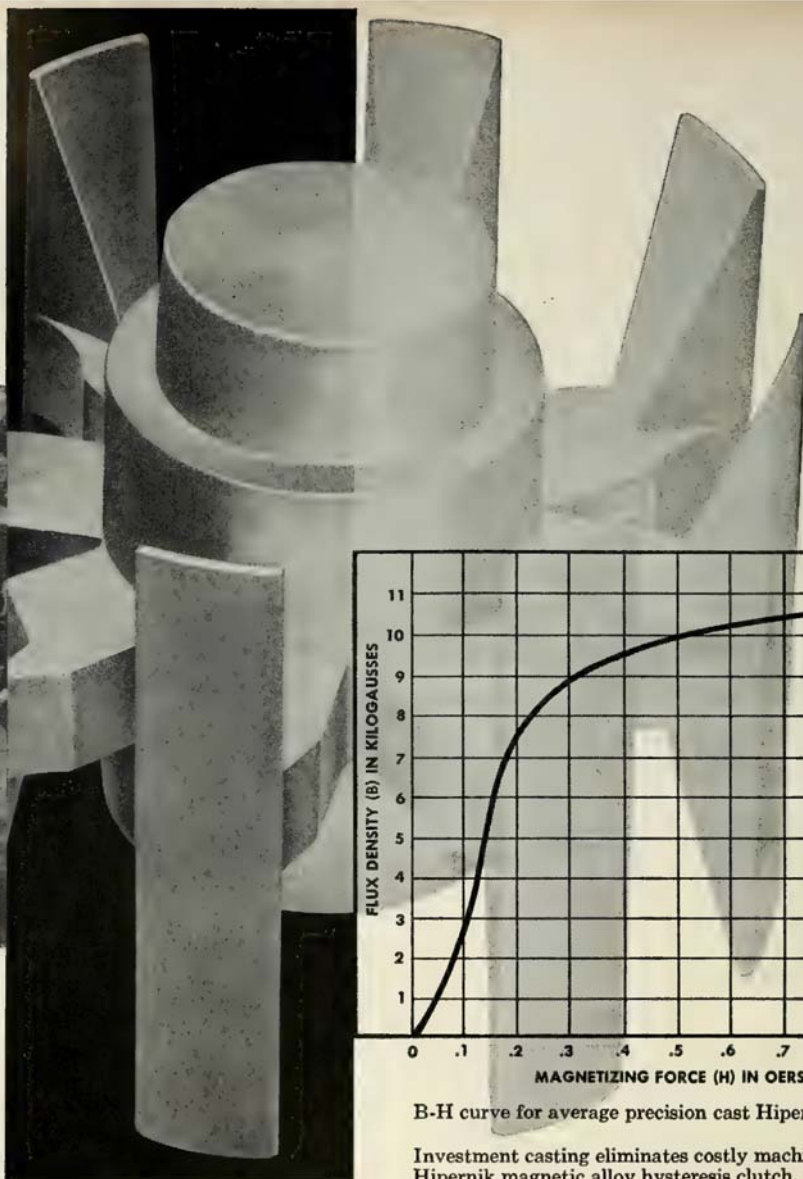
vanced research in physics, electronics, weather prediction, etc. Three such stations, properly placed, could blanket the entire world with nearly perfect TV transmission.

Atomic rocket vehicles with prefabricated skin layers (lower center) provide building materials for the station, then return (bottom) to earth. Similar craft will service an established station (lower right), docking by electromagnetic pull in lower section of station's axis.

#### ENGINEERS • SCIENTISTS

**ARMA** needs key men to augment a broad research program in missile guidance and space technology. As designer and developer of all-inertial navigation systems for TITAN and ATLAS ICBM's, **ARMA** provides a stimulating atmosphere where creative talents can develop. Write to E. C. Lester, Professional Placement, **MR-2 ARMA** Division, Garden City, N.Y. A Division of American Bosch Arma Corporation.

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The Westinghouse Metals Plant may be able to cut your costs by eliminating unnecessary machining, yet delivering to you a completely finished component ready for assembly. This modern metals plant can furnish strip, sheet and bar stock in other magnetic and high temperature alloys. Write to: Westinghouse Metals Plant, Blairsville, Pennsylvania. Our latest bulletin on Hipernik will be sent to you by return mail.

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missiles and rockets, February 23, 1959



## washington countdown

### There is now little hope . . .

of increased funding for *Nike-Zeus*. Dr. Herbert York told the House Space Committee that progress thus far was insufficient to warrant any "confidence" as to its operational capability. Present budget provides about \$300 million for accelerated research, development and test. However, no money is provided for production because, as Dr. York explains it, production at this time would get in the way of development. Army viewpoint is that *Zeus* is ready for production even though some modification and retrofitting would be required later.

### Chances are good . . .

that ARPA director Roy Johnson will buy a substantial part, if not all, of a proposal by Maj. Gen. John Medaris and Dr. Wernher von Braun for funding of Project *Saturn*. The proposal calls for building (probably at Redstone) 16 vehicles including the 1.5 meg rocket cluster and a second stage, and construction of launch pads at Cape Canaveral. Johnson approved the funding of the launch pads in two increments, out of fiscal 1959 and fiscal 1960 funds, for a total of about \$83 million. He has expressed some doubts as to the need for 16 vehicles but has given his blessing so far for four vehicles which may be upped to a minimum of eight.

### Recruiting of scientists . . .

for missile and space programs as well as for weapon system evaluation by the Institute for Defense Analyses, IDA will be investigated by the House Military Operations Subcommittee. Inquiry is scheduled to start about March 2. For contrast, the subcommittee will ask Vice Adm. Hyman G. Rickover how he put the organization together which successfully produced the *Nautilus*.

### A 10% increase . . .

in missile expenditures is forecast by chairman George H. Mahon (D-Tex.) of the House Military Appropriations Subcommittee. The \$700 million would be used to step up construction of *Atlas* ICBM's.

### Woomera rocket range . . .

is being extended for tests of ballistic missiles. Prototype *Black Knight* has been tested and preparations for testing the long-range *Blue Streak* are well advanced.

### U.S. Navy reportedly . . .

is dickering with Australia for an instrumentation facility for use by PMR on Manus Island. Negotiations also are going on between U.S. and Great Britain for another site in the Christmas Islands.

### Royal Navy has decided . . .

to adopt a short-range surface-to-air missile developed by Short Brothers and Harland known as the *Seacat*. Powered by a solid-fuel motor, it was developed from the *SX-45* research vehicle. Another version—*Tigercat*—is being designed for use by ground forces.

### AF has high hopes . . .

of getting substantial funding from Congress for its long-planned multi-purpose rocket test vehicle, *WS609A*, assigned to BMD. The four-stage solid rocket would be used for scientific payloads in excess of 50 pounds. AF Research centers needing space environmental data for such projects as *Dyna-Soar* and manned orbiting capsules could send up instrumentation without having to wait for miniaturization of instrument components. NASA has a companion all-purpose rocket vehicle in the works termed Project *Scout*.

### Negotiations for *Sidewinder* . . .

purchases have been completed by the Royal Swedish Air Force. The U.S. Navy-developed *Sidewinder* in "considerable numbers" will become standard armament in Sweden's J-32B Lance, J-35 Hawker Hunter, and the J-35 Dragon.

### Quality control . . .

program policies of DOD have been strengthened in a new directive, 4155.10, which is expected to promote better quality and reliability.



# B. F. Goodrich Unilock Rivnuts designed especially for aircraft and missiles

*New lightweight steel Rivnuts with thread-locking feature preserve structural strength...save assembly time and costs*

Ordinary anchor type fasteners used in aircraft and missiles require as many as three holes. And installation is made by two men who must have access to both sides of the work.

But new B. F. Goodrich Unilock Rivnuts can be installed by *one* man from *one* side of the work. Only one hole is needed. And the job can be done at any time during or after assembly.

This greater flexibility in manufacturing procedure means a substantial savings in cost. In addition, with only one hole required instead of three, greater structural strength is maintained.

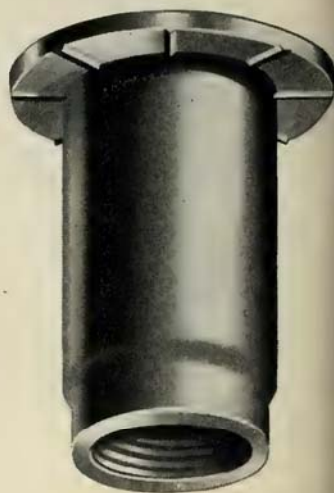
B.F. Goodrich Unilock Rivnuts, in fact, actually reinforce holes. That's because the equally spaced V-teeth under the Rivnut heads lock the Rivnuts to the

material in which they are installed. This eliminates the need for a key and keyway — elements which ordinarily set up points of stress concentration.

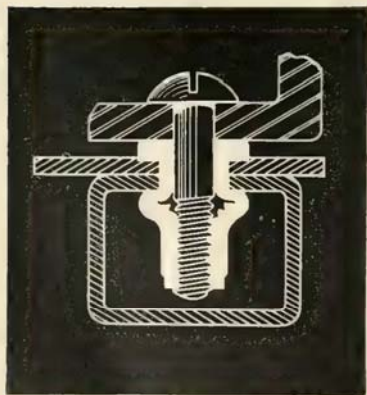
The thread-locking feature is a short crimp in the shank of B. F. Goodrich Unilock Rivnuts. This provides attaching screws with an all-metal interference fit that locks them securely in place.

Made from aircraft quality alloy steel, B. F. Goodrich Unilock Rivnuts are actually lighter than most anchor type fasteners. Yet they will meet strength and torque requirements of Military specification MIL-N-25027 for lock-type nuts.

B. F. Goodrich engineers will be happy to make recommendations concerning the use of Unilock Rivnuts in your products. For complete information write *B. F. Goodrich Aviation Products, a division of The B. F. Goodrich Company, Dept. MR-29, Akron, Ohio.*

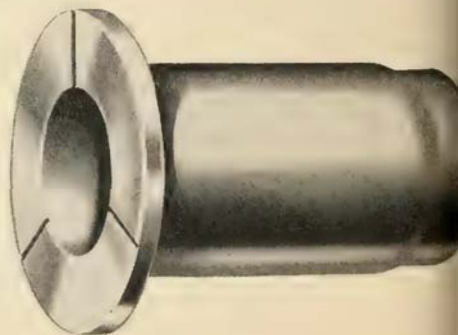


B. F. Goodrich Unilock Rivnuts are basically the same in appearance and function as regular type Rivnuts. However, the Unilock design is identified by the V-teeth under the head and the crimped shank end which provides the thread-locking feature. Radial marks on top of the head readily indicate grip range.



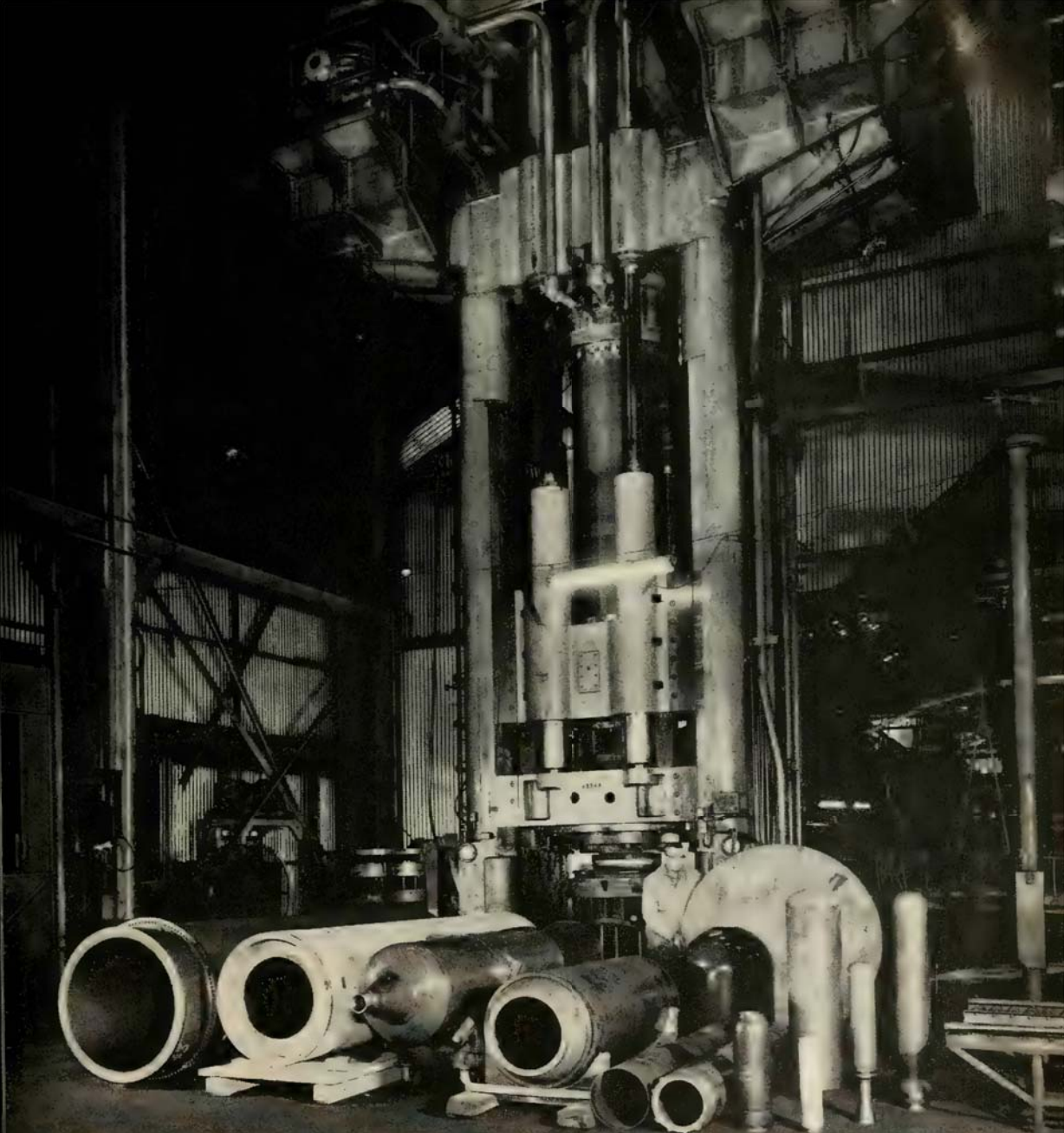
Typical Unilock Rivnut installation in blind application. Installation principle is same as for regular Rivnuts.

Equally spaced V-teeth, made as an integral part of the under side of the head, engage with surface of material in which the Rivnut is installed, thus providing high torque resistance and eliminating need for keyed head and slot.



## B. F. Goodrich *aviation products*





## CAPABILITY - MISSILE MOTOR CASES

Scaife's role in the missile field is best illustrated by the 10 missile items pictured above. These items range from 4½ inches to 45 inches in diameter and from 18 inches to 180 inches in length, and were manufactured by utilizing the fabricated and deep-drawn methods of construction for both R & D and Production programs.

Presses such as the 1500 ton triple action hydraulic press with 198 inches of stroke, shown in the background, together with the missile metal parts "know-how" acquired over nearly a decade, are available for application to your missile programs. For further information write today, or telephone EMerson 2-2100.

# SCAIFE

FOUNDED IN 1802 • OAKMONT (PITTSBURGH), PA. • A DIVISION OF WILSON BROTHERS  
PRODUCERS OF THE GREATEST NUMBER OF HIGH PERFORMANCE MISSILE MOTOR CASES IN AMERICA

Circle No. 14 on Subscriber Service Card.



130,000 pounds of liquid oxygen can be stored and transferred by this giant liquid gas container. The vacuum jacketed tank holds liquid at  $-297.4^{\circ}\text{F}$  with negligible losses. Designed and built by Cambridge Corporation, Lowell, Massachusetts, for Douglas Aircraft, the tank is used in fueling the Air Force Thor Ballistic Missile.

World's Largest Airborne Dewar, example of . . .

## **Improved Low Temperature Liquid Handling WITH CAMBRIDGE CRYOGENIC SUPPORT**

Cambridge Corporation offers the aviation and missile industry a unique single source of technical service and equipment for all types of low temperature liquid handling.

The liquid oxygen Dewar shown above is one example of this facility. Cambridge designs and builds a complete line of liquid gas storage vessels, truck transports, semi-trailers, and pumps for oxygen, nitrogen, argon, hydrogen and other cryogenic fluids.

New materials and techniques offer lighter weight and maximum dependability.

Missile fueling systems are available from Cambridge, including the ability to design and produce the vital components under one roof.

**Call for Cambridge Support to solve** your low temperature liquid handling problems. You'll be getting America's most complete cryogenic service when you do.



**CAMBRIDGE**  
CORPORATION  
SUBSIDIARY OF CARRIER CORPORATION

6 Industrial Ave., Lowell, Mass.



## industry countdown

### **Pershing vertical launch . . .**

facility at Cape Canaveral is underway with site clearing by Jacksonville District, Corps of Engineers. Facility will have a blockhouse, two launch pads, a nose installation building, and a mobile service structure servicing either pad. *Pershing* is being fabricated at Martin-Orlando. Firing team will be composed of ABMA personnel and Martin representatives.

### **Northrop has acquired . . .**

Page Communications Engineers, Inc. of Washington through an exchange of stock. The deal reportedly cost \$3,200,000 and is part of Northrop's expansion into the new field of advanced systems for long-range radio communications.

### **Total infrared volume . . .**

in early 1960's—both industrial and military—will be more than \$500 million. That's the estimate of Henry Blackstone, president of Servo Corp. DOD's Project *Midas*—detection of the heat of ICBM's over long distance by infrared—will figure heavily in funds for infrared R&D. Pentagon infrared research expenditures for Fiscal Year 1960 will be more than \$100 million.

### **Some 67% of voting stock . . .**

of Cribben & Sexton Co., Chicago appliance company, has been acquired by Waste King Corp., Los Angeles producer of missile components.

### **Multi-billion-dollar project . . .**

is how some AF officials describe a long-term program to expand the service's space-age communication requirements. AF has announced as a first step that International Telephone & Telegraph Co. and Radio Corp. of America will be awarded a \$3 million contract to assist in figuring out AF total communication needs through 1970 and beyond. Ultimately, RCA and ITT would be the service's manager and technical director. The two companies have indicated that Hughes Aircraft Co. and Hoffman Electronics Corp. would serve as contractors. The project is known as 380L.

### **Sylvania merger into . . .**

General Telephone Corp. should permit greater diversification of investment and increased R&D for General Telephone, plus an improved position for Sylvania to diversify and finance its future development. The merger—approved by directors of the two companies last November—will become effective about March 5. It has been predicted that the combined company will show operating revenues of over \$1 billion in 1959.

### **First all-ceramic radome . . .**

made on a production basis will be manufactured by Gladding, McBean & Co. of Los Angeles for *Sparrow III*. Radomes to be produced for Raytheon will be fabricated from high-purity ceramic oxides. The alumina radome's dielectric constant is 8.82 at 77°F and 9.73 at 1472°F. Its dissipation factor is .00022 at 77°F and .0015 at 1472°F. It reportedly can withstand temperatures up to 3000°F, and has flexural strengths exceeding 45,000 psi.

### **\$1,356,290,000 military building . . .**

authorization request has been made to Congress. Army wants \$231,252,000; Navy, \$195,284,000, and AF, \$872,761,000.

### **27¢ of the procurement dollar . . .**

in FY 1960 will go for missiles, Assistant DOD Secretary Wilfred J. McNeil has told Congress. Purchases for aircraft will dip to 45¢ of the dollar. In FY 1957, aircraft took 58¢ and missiles got 15¢.

### **Planned Army obligations . . .**

through FY 1960 for missiles, looks like this: *Nike-Ajax*, \$1,257,400,000; *Nike-Hercules*, \$1,882,800,000; *Nike-Zeus*, \$591.5 million; *Redstone*, \$513.2 million; *Sergeant*, \$257.5 million; *Corporal*, \$286.3 million; *Lacrosse*, \$270.9 million; *Honest John*, \$250.5 million; *Little John*, \$60.5 million.

### **Rare, tough and rough rhenium . . .**

is being commercially produced by Chase Brass & Copper Co. of N.Y. Fabricated forms include rod, wire and strip. Chase says that tests using rhenium for electrical contacts have shown a life expectancy 30 times greater than that of any material currently being used.

# Hughes in Southern California

announces the establishment of

a major new division . . .

the COMMUNICATIONS DIVISION

The growing importance of global and space communications, together with major contributions of the Hughes Communications Laboratory, such as the Long Arm and Quicksilver programs, has resulted in the creation of the COMMUNICATIONS DIVISION of the Hughes Aircraft Company. The new division is fully integrated and will be responsible for communications research, development, manufacturing and sales. Expansion plans are ambitious and aggressive, and the backlog of contracts already awarded promises an expansion consistent with the spectacular records established by the other major divisions of Hughes Aircraft Company.

The establishment of Hughes as a major factor in the communications industry has created many

openings for experienced electronic engineers in the following areas:

*Senior Staff Engineers*  
*RF Power Design*  
*Digital Data Processing*  
*Transistor Circuit Design*  
*Communication Systems Analysis*  
*Propagation Specialists*  
*Upper Atmosphere Physicists*

also

*Airborne Equipment Productizing Engineers*  
*Test Engineers*

For further information write Mr. John Melville at the address below.

**HUGHES**

COMMUNICATIONS DIVISION, P. O. Box 90-902, Los Angeles 3

missiles and rockets, February 23, 19



Now...because of new  
and expanded product lines,

## *Swedlow Plastics Company*

announces a change in name to...

# SWEDLOW Inc.

(EFFECTIVE FEBRUARY 1, 1959)



**ETCHED AND MONOLITHIC PLASTIC GLAZING** for aircraft windows and enclosures. Optically polished, tough, light weight.



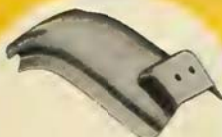
**HIGH TEMPERATURE WELDED AND ALUMINUM HONEY-COMB CORE.** For aircraft and missiles. Heat resistant, light strong.

Swedlow has long been well known as a leader in the development and fabrication of high quality Plastic Glazing for aircraft. Excellence in this field has resulted in demands for the same type of development and craftsmanship in additional products of fine quality, involving metals and many other materials.

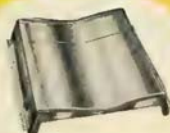
High temperature Welded Honeycomb Core in stainless steel and super alloys has become a very important part of our business, along with Aluminum Honeycomb Core, and the volume of these light weight, strong structural materials is growing rapidly to meet the increasing needs of aircraft, missile and other industries.

Swedlow products also include a wide variety of high heat-resistant reinforced plastics, utilizing fibre glass with silicone, phenolic and epoxy binders and metalized for extra heat protection.

This diversification and expansion makes the change to a more inclusive name desirable. In all of its products, the company will continue to adhere to the highest standards of quality and workmanship in the future.



**GOLD AND ALUMINUM METALIZED PLASTIC LAMINATES.** Minimum weight, minimum bulk, heat protection to 1650° F.



**HIGH TEMPERATURE REINFORCED PLASTIC LAMINATES** for sheeting and contoured parts in missiles and aircraft.



**PRIMARY SOURCE FOR CONTINUOUS AND PRESS MADE LAMINATES** for aircraft and industrial uses—fibre glass, cotton, nylon, etc.



**KEVINITE FLEXIBLE, DECORATIVE LAMINATE.** An all-paper, polyester, continuous laminate, available in many color and design combinations.

## SWEDLOW Inc.

LOS ANGELES 22, CALIFORNIA / YOUNGSTOWN 9, OHIO

PLEASE REFER TO DEPT. 21

Circle No. 16 on Subscriber Service Card.

## Raytheon Missile Projects



**SPARROW III**—the Navy's tenacious, lightning-fast, air-to-air missile—is intended for extensive use by Navy fighter aircraft in fleet air defense. Sparrow III is a Raytheon prime contract.



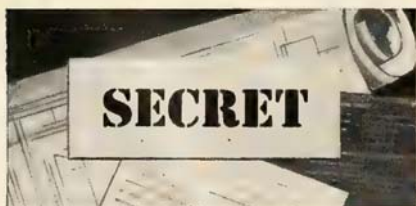
**HAWK**—the Army's defense against low-altitude attackers—carries out its destruction in the blind zone of conventional radars. Hawk development and production is under Raytheon prime contract.



**TARTAR**—A substantial contract for vital electronic controls for this Navy destroyer-launched missile is held by Raytheon. This equipment—a tracking radar and associated units—enables it to "lock on", cling to target's path, despite evasive tactics.



**ADVANCED PROJECTS** in aeronautical structures as well as missile guidance and control are now underway in Raytheon laboratories. New facilities are continually being added for this work.



**PRELIMINARY NEW DESIGNS** of tomorrow's missiles will result from the advanced work being done by today's missile engineers. Raytheon plays an important role in this area.

Raytheon diversification offers

## JOB STABILITY FOR CREATIVE MISSILEMEN

Here is an opportunity to free yourself of worry about a job that's here today, gone tomorrow.

**Diversified assignments**—only possible in a company with Raytheon's wide range of missile activities—means security not found in one- or two-project companies. You apply your creative energies to the many projects you work on, and they in turn are your "insurance" against falling into a rut.

**Individual recognition** comes quickly from Raytheon's young, engineer-management—men who are keenly aware of the engineer's needs and contributions to missile progress.

**Dynamic Raytheon growth**—the fruit of this management's progressive policies—is best illustrated by the fact that Raytheon is already the only electronics company with two prime missile contracts—Navy Sparrow III and Army Hawk.

**The next step is up to you.** Why not get frank answers and helpful information on the type of job suited to your background and talents, its location, salary and other important details. Write, wire or telephone collect: The number is CRestview 4-7100 in Bedford, Massachusetts. Please ask for W. F. O'Melia.

### **RAYTHEON OPPORTUNITIES NOW OPEN IN:**

**WEAPONS SYSTEM ANALYSIS • CONTROL SYSTEMS • PACKAGING • MICROWAVE • RADAR • SPECIFICATIONS • MISSILE AERODYNAMICS • WIND TUNNEL TESTING • AERODYNAMIC HEATING • ROCKET ENGINEERING • VIBRATION MEASUREMENT and DATA REDUCTION**

**RAYTHEON MANUFACTURING COMPANY**  
Missile Systems Division, Bedford, Mass.







GROUND-LAUNCHED *Hilo* hits transonic or supersonic speeds at high or low altitudes.

## Four Companies Producing Versatile Drones

**Bendix, Republic and Marquardt joined forces in designing ground-launched *Hilo*, providing a bomber-like radar im-**

**age. Bell worked with Bendix in developing *Penny*, air-launched to perform at high altitude and supersonic speeds.**

by Frank G. McGuire

WASHINGTON—Two new drone systems which apparently can handle any requirements set down for them, have been produced largely through the efforts of four companies—Bendix Aviation, Republic Aviation, Bell Aircraft and Marquardt Aircraft. The new systems are *Hilo* and *Penny*.

Details of the drones were discussed in Paris last week at an engineering conference sponsored by Bendix and attended by 800 European engineers and aviation officials.

• ***Hilo* described**—Republic Aviation and Marquardt worked with Bendix in developing *Hilo*, a ground-launched drone for operation at any altitude, and at transonic or supersonic speeds. The target features a single basic airframe unit and a ramjet powerplant for either transonic low-altitude operation or supersonic high-altitude operation. Standard off-the-shelf boosters are used to attain speeds where the 14-inch Marquardt ramjet takes over.

The basic aerodynamic design for use at low altitudes has a high fineness ratio and Hauck nose. Movable mid-wing panels provide longitudinal and roll control, as well as lift, while the vertical stabilizer remains fixed.

For high-altitude operation, fixed wing panels are added to the basic configuration to provide necessary wing area for efficient cruise. Movable panels then act as inboard trailing-edge elevons for the high-altitude wing.

*Hilo* is 21½ feet long, has a span of 38 inches, and a diameter of 14 inches. Its gross weight with full tanks is 778 lbs. and its empty weight is 472 lbs. It uses radar augmentation to provide an image resembling a large bomber.

• **Low-cost lens**—The Bendix lens used in the radar augmentation system is a small spherical plastic device providing both monostatic and bistatic enhancement. Where applicable, it is lower in cost than active devices, according to Bendix, and is smaller than devices used in passive techniques, such

as corner reflectors. In *Hilo*, the scorer, radar altimeter and beacons are located directly behind the lens.

A fiberglass skin is used in the airframe, and two propellant tanks are integral with the fuselage. Fuel flow is achieved through pressure from a fiberglass nitrogen pressure tank.

Command receivers and recovery parachutes are located in the tail of the vehicle. Wings and fins are made of solid magnesium die castings. All parts of *Hilo* are designed for quick assembly.

The guidance and control subsystem includes electric servos, a vertical gyro, a pitch program, a barometric sensor and a radar altimeter. It also uses a beacon to assist ground tracking and a receiver and decoder to accept control commands from the ground.

The *Hilo* target system, states Bendix, is completely mobile, and its equipment is adaptable to most military vehicles. The system uses two vehicles: a transport van carrying four assembled targets, and a launcher mounted on a



trailer bed. Fueling is accomplished with the missile on the launcher.

• **Penny savings**—Penny, a target drone system developed jointly by Bendix and Bell Aircraft, is described as "a high-altitude, supersonic drone designed specifically as a low-cost expendable target." It is an air-launched vehicle which any type of aircraft can carry. It achieves a good supersonic flight duration with its dual-chamber liquid rocket engine.

The drone's aerodynamic configuration embodies no moving control surfaces. The basic design features a high fineness ratio with small canard surfaces forward, a fixed wing aft and fixed vertical fins.

Penny is about 20 feet long and 13 inches in diameter, and has a total wing span of 64 inches. Gross weight with fuel is 950 lbs. and burnout weight is 438 lbs. Flight is pre-programmed into the guidance system.

Pitch control is governed by swiveling one of the two rocket engine exhaust chambers, and lateral control is

achieved by a combination of this exhaust-chamber-swiveling and roll jets mounted on the wings.

• **Advantages of simplicity**—The drone's airframe is built of seven sections which make the most of simple production, assembly and maintenance advantages. The forward section is reinforced plastic which doubles as a radome for the radar augmentation and scoring devices. Integral metal fuel tanks are used in the fuselage.

The main wing and tail surfaces are fabricated from magnesium die castings for minimum weight and cost. The after portion of the body is an aluminum shell containing guidance and control equipment. The rocket engines are housed in a reinforced plastic boat-tail.

Penny's guidance and control equipment is comprised of two primary sensors: a two-axis gyro and a pressure altimeter. A variety of mission profiles may be selected through use of a simple programmer, which may also be used to destroy the drone at the end of the flight. Both active and passive subsystems are incorporated into Penny for

radar augmentation, so that the bird may simulate a much larger aircraft. It uses the same type of system as *Hilo*, and an alternate infrared augmentation flare which may be adjusted for varying amounts of radiation.

Penny's electrical system includes a battery, transistorized inverter power pack and molded electrical harness connectors.

• **Bendix roles**—Most of Bendix's 25 operating divisions are in the missile field. Bendix Products Division is prime contractor for the *Talos* SAM. The Pacific Division and the Research Laboratories Division developed the guidance for *Sparrow II*. The Eclipse-Pioneer Division has guidance responsibility for *Pershing*. The Radio Division produces *Talos* guidance equipment and the radar units for missile and fighter control.

Other Bendix Divisions are working on computers, hydraulic systems, electrical systems, auxiliary power units and other components. Bendix is sharing with Grumman in the new AAM *Eagle*.

## Industry Briefs

**Additional contracts** totalling \$2,-100,000 for *Falcon* components have been received by Crosley Division, Avco Manufacturing Co. Work—which possibly will embrace stabilizers, flippers and other components—will be done in Richmond, Ind.

**First of B52G missile platform** bombers has been delivered to Travis AFB from Boeing's Wichita plant.

**New project name** for ARPA-Rocketdyne 1.3-million-lb. booster is Project *Saturn*.

**Study contract** for space vehicle terminal guidance methods has been awarded to International Telephone and Telegraph Corp. by ARDC. Astronics Lab of ITT in Fort Wayne, Ind., will do the research aimed at defining guidance systems, techniques and designs.

**Range Systems Division** has been formed by Chance Vought. It will design, develop, install, operate and maintain facilities and personnel for testing and evaluating missiles and space vehicles.

**New major data center** by Data-Control Systems, Danbury, Conn., has been delivered to ABMA for checking out telemetry links from missiles and satellites.

**More Hawk ground support** equipment and frame will be provided by Nortronics, which received a \$16,690,000 subcontract from Raytheon. Delivery will be through 1960. GSE includes mobile launchers, self-propelled loaders and loader attachments.

**Air Force will open** its 35,000-foot captive missile test track Feb. 25 at AFMDC, Holloman. The track will be used for testing warheads, missile guidance systems, flutter testing air foil sections and human tolerance programs. Original track constructed in 1949 was 3,500 feet.

**Proximity scorer device** which should save high-priced targets and missiles is under test at Eglin AFB. Mounted in either towed or free-flying targets, the 8½ pound scoring unit surrounds the target with electro-magnetic radiations. When the missile passes near the target, the reflected radiations trigger a relay that transmits miss-distance to the launch aircraft, target aircraft, or ground observers.

**Antisub Division** set up by Aerojet-General shows new management trend in the expanding anti-submarine warfare field. Aerojet has multi-million-dollar contract for development and production of an antisub torpedo.

## Vanguard II Big Step in Weather Reconnaissance

WASHINGTON—The first step toward a continuous satellite weather mapping system was accomplished last week with the successful launch of *Vanguard II*, a 21½ pound sphere containing two photocells which scan the clouds, sea and earth below.

Early computations placed the satellite's perigee at 335 miles and apogee at 2050 miles. The satellite's orbital period is 126 minutes and its inclination to the Equator is 34 degrees.

Indications are that the satellite will remain in orbit indefinitely.

The photocells are mounted behind circular, gridded windows which project from the satellite. Their reflections from the cloud, sea and land masses below will be translated into electrical impulses and then telemetered by tape recorder to ground stations.

One transmission will be sent on each of the satellite's orbits at command of the ground station.

Expected life of the cloud cover instrumentation (operating at 108.03 megacycles) is two weeks. The Mini-track transmitter (operating at 108.00 megacycles) is expected to last four weeks.

Life of the weather transmitter's mercury batteries was lengthened by tucking solar cells behind the two windows, which turn on the cloud-spotting cells only when the satellite is over sunlight portions of the earth.

The satellite should reveal cloud data over about 25% of the earth's sunlit surface in 600-mile-wide strips.





# Giant Mirror Created for NSF's New Observatory

Corning's reflector, largest built in 25 years, was made by 'sagging' and must cool for seven months.

by Donald E. Perry

CORNING, N.Y.—The heat treatment is over. Another giant eye for probing the universe is cooling—ever so slowly—as if in tribute to the six months of planning and engineering which went into its production.

This summer, Corning Glass Work's newest contribution—the largest glass telescope mirror blank since completion

25 years ago of the 200-inch disk for the Hale Observatory—will be shipped to Tucson. There the disk will be ground and polished and gently hauled to a 6875-foot mountain peak, site of another observatory to be constructed by the National Science Foundation.

This giant reflective piece has an

84-inch-diameter disk and weighs over 3500 pounds. Some 13 inches thick and with a 26-inch center hold diameter, it demanded a new process from skilled glass artisans, vital backbone of the missile-space industry. Outcome has been a new process—termed "sagging"—which is told pictorially by m/r.



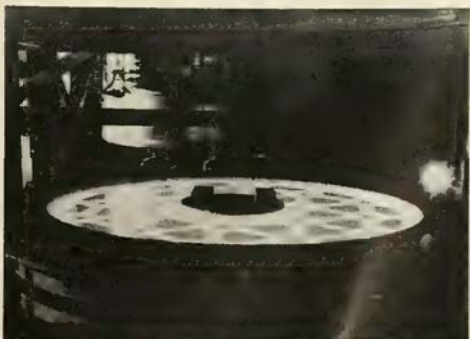
**CERAMIC CORES**—which had to hold their position under temperatures of about 2300° F—provided a ribbed, or honeycomb, design.



**THE FIRST** large-sized ribbed disk (84-in. diameter) is made by sagging. Scrubbed clean by sandblasting, glass is now ready for the melting furnace.



**MOLD'S CENTER** core had to be reinforced by a steel plate. One reason was this 2796-pound chunk of boro-silicate composition glass.



**MOLTEN BLANK**—weighing almost 4000 pounds—is moved from furnace to the annealing kiln where it will be slowly cooled for seven months.

# Cook Labs Do Mass Components Testing

Inland Testing engineers screen up to 100,000 parts simultaneously without damaging those that are acceptable.



A ROW OF Inland's environmental chambers with automation equipment in front of doors. Accuracy is closely checked.



COBALT 60 cells for radiation testing. A gate circuit is used to guard against loss of component identification.

MORTON GROVE, ILL.—While it is true that quality cannot be tested into a product, engineers of Cook Electric Co.'s Inland Testing Labs say that reliability can.

Leonard L. Schneider and Albert M. Lock contend that reliability of equipment can be upgraded by eliminating submarginal component items from a lot of parts before production. This is accomplished by subjecting all component parts to screening tests designed to identify and segregate parts which will exhibit marginal and/or abnormal performance under field service conditions.

These tests employ environmental, electrical and mechanical stresses to isolate component parts which are not members of a homogenous population, without degradation of acceptable parts. This is essentially a process of truncating a distribution.

Inland's experience with a quarter of a million parts subjected to screening, say Schneider and Lock, has indicated that from 0.1 to 10% of a lot of component parts can be rejected because of anomalous behavior of some characteristic.

• **A new concept**—Inland's approach is that, if screening tests are to be useful, they must be non-destructive—they must neither degrade performance or life expectancy of acceptable parts, nor physically alter the parts, which might make them unacceptable for production use. This type of large-quantity non-destructive testing calls for not only a new concept, but for unusual testing facilities.

Inland Testing Labs have these unusual facilities. Their reliability section can simultaneously test 100,000 components under programed humidity, temperature and power cycling. This chamber capability is accompanied by automated test consoles capable of performing measurements on resistors, capacitors, diodes and transistors at the rate of one measurement per second. Thus it is economically feasible for producers of high-reliability equipment to have their component parts 100% screened.

ITL's chamber facilities consist of 14 environmental chambers, each of 75-cubic-foot capacity. Since the door assemblies (see cover photograph) which may be inserted from the front of the chamber can be transported from one chamber to another, cooling is needed in only two chambers. With this combination, Schneider and Lock say they can accommodate almost any temperature-humidity cycle by appropriate scheduling.

• **Mounting a test**—The components are mounted between specially-designed spring clips which do not

missiles and rockets, February 23, 1959



deform the leads. These clips are insulated from anodized aluminum terminal boards by teflon inserts. Thirteen rows of 51 positions, uniquely identified, comprise a board, and two or four boards comprise a rack. The racks are inserted into a door assembly which in turn is inserted into a chamber. Placed on dollies, it can be rolled from one chamber to another.

All of the internal wiring from the terminals on the boards to the 52-pin AN connectors is teflon-insulated. When fully loaded, a door assembly will contain approximately 12,000 component parts, connected to the front panel through teflon-insulated cables terminating in 288 Amphenol 52-pin connectors.

To be effective, a screening test must discriminate among components on the basis of permanent changes in characteristics as a result of environmental and/or electrical exposure. Anything other than rapid automated measurement techniques is considered impractical.

The measuring consoles are equipped with cables, one end of each cable plugged into the front of the door assembly and the other end terminating on a scanner stepping switch. The stepping switch successively introduces components to be tested into a programmed test circuit. A digitizing voltmeter converts the desired information from analog to digital form and feeds into a card punch. The output of the punch constitutes a permanent data card which is fully identified and contains 4-digit readings of 17 components.

The resistor console is capable of making a total of 2550 resistance measurements without a change of cables and these can be accomplished in about fifty minutes.

• **System checks**—The reliability of the measurement equipment, incorporating many electro-mechanical devices, is in most cases lower than the reliability of the component parts being tested. Hence, the accuracy and functioning of the system must be checked. Before a readout is begun, the digitizing voltmeter or ohmmeter, card punch and associated circuitry are exercised.

The meter is connected across a variable resistor and made to read 00000, 11111, 22222, etc. through 99999. The exercise readings are punched on a card along with code information indicating the relationship of this exercise to the rest of the test program. Precision, pre-aged wire-wound resistors or voltages from standard cells are introduced into the measuring circuitry in the ranges in which component measurements will fall to provide a check on the calibration of the



**COMPONENTS ARE mounted on frames which are part of a chamber door assembly.**

digital meter. These calibration readings are recorded on a punched card with the exercise information and retained as a permanent reading.

A second exercise and calibration card is punched at the conclusion of a run to establish that the measuring equipment is functioning properly.

To further assure that the measuring consoles are performing properly, a dummy component is placed in the measuring console, protected from severe environmental conditions, to simulate the test component. The dummy is introduced into the measuring circuitry at 10-minute intervals during the course of a readout, enabling an engineer to ascertain that the equipment

is functioning properly.

• **Identification safeguard**—Electro-mechanical devices like those in the scanning circuitry are prone to malfunction—either failing to step or double-stepping—which could introduce serious error in data reduction due to false identification of parts. To guard against loss of component identification, a gate circuit is employed after measurements on each 51 components.

If the sequencing is proper, the scanner control relay is permitted to move to the next 51 components. If a scanning malfunction has occurred, the console will stop. The stoppage will be investigated, corrective action taken, the previous 51 components re-read and the operation continued.

At the conclusion of a run, the deck of cards is taken to the data reduction section where a 650 computer produces a tab run which identifies the positioning of the "bad" components. This data reduction is normally accomplished the same day as a measurement run is made and usually the rejected components are pulled from the door assembly within a few hours after a measurement run has been completed.

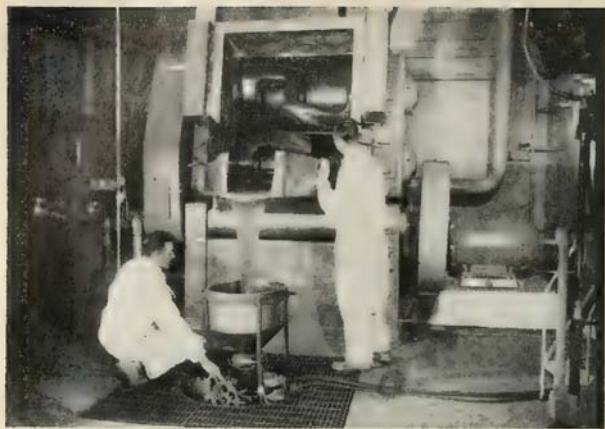
• **Missile work**—This describes the facility which Inland now has in operation. Current emphasis is on a program to test all the components going into the *Atlas* computer made by Burroughs. A previous large-scale program was carried out for Remington-Rand Univac. Inland now expects that it will be associated with the guidance program of an upcoming major missile, testing all components of the guidance and control system.

## Britain's Deadly Seaslug

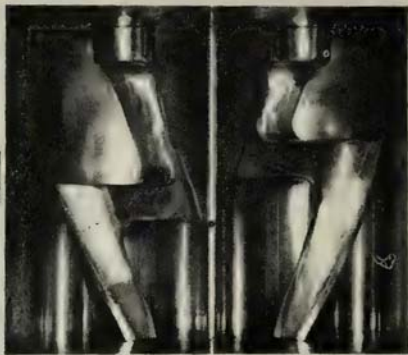


**THIS PHOTO** of England's *Seaslug* ship-to-air guided missile was released after a recent demonstration to NATO military personnel in Paris. The missile will be on four guided missile ships now under construction for the Royal Navy. Produced by three companies—Sir W. G. Armstrong Whitworth Aircraft Ltd., The General Electric Company, Ltd., and Sperry Gyroscope Company, Ltd.—it is intended for interception of aircraft at long range. In one firing of a salvo of two missiles, the first destroyed the target aircraft, and the second made a direct hit on the largest piece of the wreckage remaining.





AT THIOKOL's Huntsville plant, operators pour 200 gallons of molten rocket fuel from Baker Perkins mixer.



CLOSE-UP of cast stainless blade of the 17 TSE mixer. Smooth surfaces permit easy cleaning.

## Mixing Machines Boost Solid Fuel Output

WASHINGTON—A "growing pain" resulting from rapid expansion in production of solid rocket propellants—the necessity of obtaining a critical blending action of large batches in precise proportions—has been eliminated.

This has been accomplished by the development of large mixing machines equipped with special blades. Designed by Baker Perkins Inc., Saginaw, Mich., they are used in various plants of the Thiokol Chemical Corporation.

**•Solid advantages**—The many advantages of solid fuels have led to recent missile advances. Not only can the solid propellant charge be bonded to the chamber wall of the rocket motors but it can also be shaped into an "internal burn" propellant charge, making possible construction of extremely lightweight rocket motors with thin-walled combustion chambers.

These advantages have resulted in sharply increased production of the fuels. The original method of making small batches in any available equipment had to be abandoned. Both the actual volume of production required and the need for efficient operation in a competitive market have forced producers to turn to equipment designed specifically for rocket fuel requirements.

These fuels generally consist of a mixture of an organic fuel—a polysulfide material—and an inorganic oxidizer. Solidified into a desired shape, the charge must have sufficient flexibility and strength under temperature extremes to resist the shock of acceleration of the rocket, as well as the

shock of adjacent detonation. To meet military specifications, the charge must burn evenly and must not deteriorate during normal storage.

**•Mixing process critical**—All of these requirements are directly or indirectly affected by the nature of the mixing process. The inorganic oxidizer, ground to a critical particle size, must be blended with the polysulfide binder in a precise proportion.

In addition to the normal requirements for a mixing machine, the need to maintain the precise composition of the fuel demands extraordinary cleanliness. No corrosion of construction materials by the inorganic oxidizer or other matter can be tolerated.

Also, since different compositions of various propellants are prepared in the same mixers, it is essential to prevent particles from previous ingredients from mixing with the new batch and changing its composition even by a very small percentage.

**•Cast blades**—Because of these considerations, the mixing blades of the Baker Perkins mixers are made of cast stainless steel type CF-8M (Alloy Casting Institute designation).

As listed in the data sheets of the Alloy Casting Institute, type CF-8M has the following nominal composition: 19% Cr, 10% Ni, 2-3% Mo, 0.08% max. C. This iron-chromium-nickel-molybdenum alloy has excellent corrosion resistance and mechanical strength in a wide range of temperatures and corrosive environments.

The fact that this alloy is available in the cast form is particularly advan-

tageous in the complicated design of the blades, which would be extremely expensive to produce by any other method. Producing this blade from wrought shapes probably would involve welding, which would increase the corrosion problem, possibly to a prohibitive point. Also, casting allows the design of smooth contours, avoiding sharp corners and crevices which act as "traps" for contaminating materials and as focal points for corrosive action.

**•Practical design**—According to John Higginson, General Manager of the Thiokol Chemical plant at Brigham City, Utah, other types of equipment using plain carbon steel blades showed a great deal of corrosion when in contact with the propellant ingredients. When such blades were used, much hand cleaning was necessary between batches to avoid contamination.

For some very viscous fuel mixtures, such as those produced at the Utah plant, Thiokol is using vacuum mixers. Thus, while the materials are in a state of constant agitation, solvents or other volatiles can be vaporized. Also, oxidation of sensitive materials can be prevented by vacuum mixing, since occluded gases can be removed efficiently. In addition, air will not be worked into the mix during the operation. The mixer has a separate hydraulic pressure system which tilts the machine for discharge of the mixed batch.

Cleaning is accomplished by running through a mixture of sawdust, water and detergent.

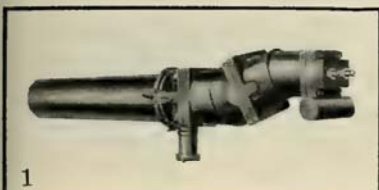


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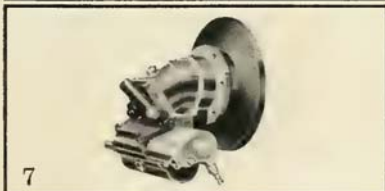
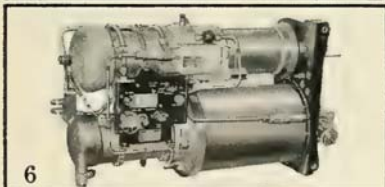
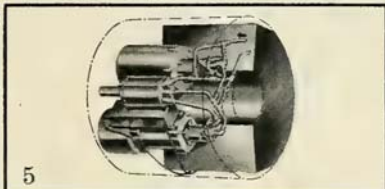
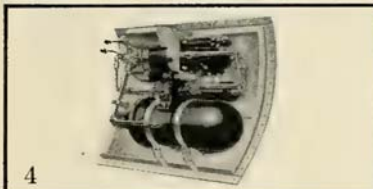
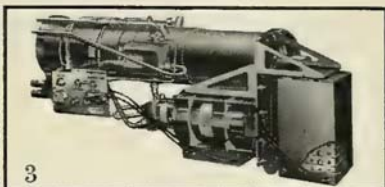
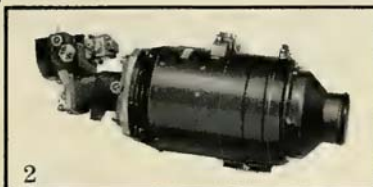


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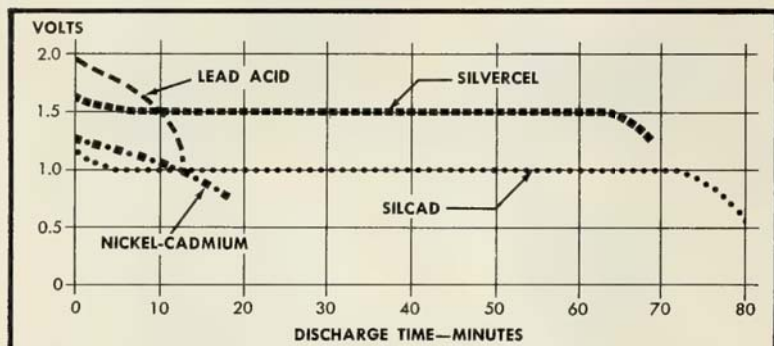
Engineers and Builders of Fluid Power Equipment Since 1921

Missiles and rockets, February 23, 1959 Circle No. 17 on Subscriber Service Card.

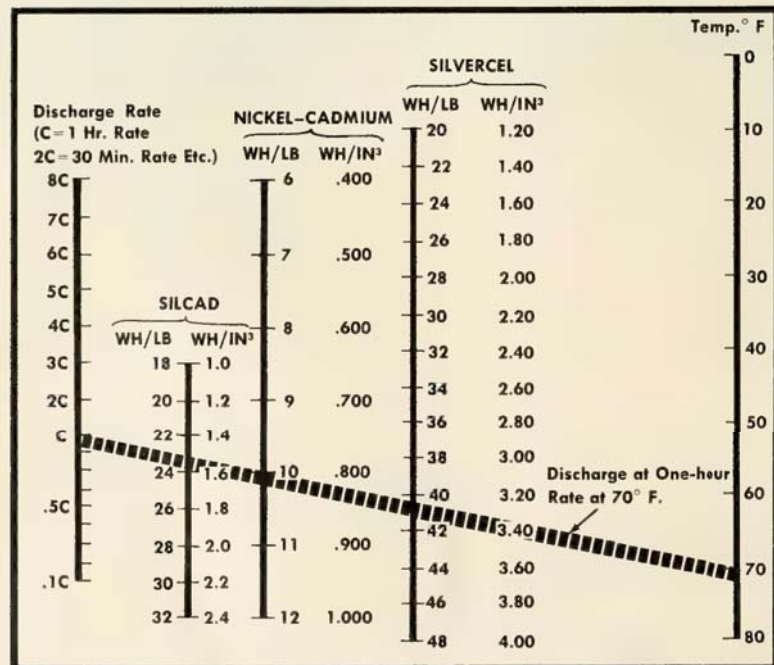
# Miniature Batteries Have Heavy Missile Use

Yardney's latest Silvercel may make possible more pre-flight tests for reliability. Early model saw service in *Viking*; many employed in today's birds.

by Donald E. Perry



DISCHARGE CHARACTERISTICS of several types of production rechargeable batteries of equal weight delivering the same current. Note the steady "plateau" voltage prevalent throughout most of the discharge of the batteries.



COMPARISON of specific energy of Silvercel, Silcad and Nickel-Cadmium systems.

NEW YORK—Speak if you wish of future "exotic" power sources for space vehicles, but don't discount the features of today's miniaturized rechargeable electrolyte batteries that are already proving their value in rocketry.

While the battery—unless it is solar-powered—may be considered by some as passé, Yardney Electric Corp. likes to cite present applications—use in *Titan*, *Pioneer* probes, *Bomarc*, *Atlas*, *Jupiter*, *Polaris*, *Snark*, *Redstone*, *Vanguard*, *Falcon*, *Goose*, *Aerobee* and drones.

Latest Yardney effort is a PM (reusable reserve primary) Silvercel battery in a missile model with an external feed line to fill the battery with electrolyte to activate it only minutes before the missile is fired.

The battery reportedly offers specific energy as high as 70 wh/lb and has been recharged as many as 15 times. This indicates that it would make possible many more pre-firing tests for reliability. The company says it can stay in a missile two months without losing its capacity. It uses a silver-zinc couple and, according to the company, can provide as much power as ordinary batteries five times larger and six times heavier.

The development cycle of the Silvercel is worth mentioning because of its use in early pioneering U.S. space experiments. Equipment in a *Viking* rocket was powered by the battery and photographed the earth from a 158-mile altitude.

The specific energy—under optimum conditions—of Yardney batteries can be compared this way:

	wh/lb	wh/in <sup>3</sup>	nominal cell volt.
Silvercel . . . . .	56	3.6	1.5
Silcad . . . . .	33	2.7	1.1
Lead-acid . . . . .	20	0.9	2.0
Nickel-Cadmium . . . . .	13	0.8	1.2



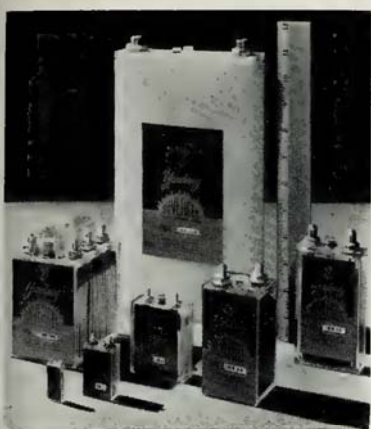


PHOTO SHOWS range of Silvercel sizes.

• **Uses in missiles**—The extent of battery applications for missiles and rockets is shown in the following breakdown by project, type of batteries used, and specific purposes of use. PA is for automatically-activated primary; HR is for high rate; and PM is for reusable reserve primary.

*Vanguard* uses Type 20xHR 20, 30-volt 20-amp. hour, and others, for telemetering, flight and guidance controls in the first and second stages. Soon there will be a package battery in a *Vanguard* satellite that is non-magnetic. It will operate minitrack, command receiver, magnetometer and telemetering.

The *Astor* torpedo uses a Mark 64, 250-volt 115-amp. hour for all electric power supply, including propulsion and homing devices.

*Falcon* uses Type 10xHR3, 15-volt 3-amp. hour for telemetering in all R&D tests.

*Bomarc* uses Type 30xHR 80, 38-volt 80-amp. hour to power a hydraulic pump motor. A double battery, Type 22xHR40-300 and 5xHR20-100 with 27.5-volt 40-amp. hour and 7.0-volt 20-amp. hour, respectively, supplies energy for electronic guidance equipment and telemetering instruments.

*Atlas* is a heavy user of the batteries. For guidance and controls, these types are used: Type 20xHR60, 30-volt 50-amp. hour; and Type 20xPM40, 30-volt 40-amp. hour. Range safety command utilizes Type 19xHR1, 28-volt 1-amp. hour. Telemetering uses include two double batteries. One set is Type 5xHR10, 6.6-volt 10-amp. hour and Type 18xHR15, 28-volt 15-amp. hour. The other double battery uses Type 9xHR15, 28-volt 15-amp. hour, and Type 5xHR10, 6.3-volt 10-amp. hour.

The *Mark 39 Torpedo* uses a Mark 5, 60-volt 100-amp. hour battery for all electric power supply, including propulsion and homing devices. Other

missiles and rockets, February 23, 1959



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## ... missile electronics

torpedoes and battery types are *Mark 32 Torpedo*, Mark 42, 43-volt 40-amp. hour; *Mark 43-1 Torpedo*, Mark 41, 26-volt 20-amp. hour; *Mark 43-3 Torpedo*, Mark 58, 26-volt 44-amp. hour.

*Snark*—for controls and instrumentation—uses Type 22xHR10, 30-volt 10-amp. hour.

Under the *Goose* program—now cancelled—two units of Type 22xHR3, 60-volt 3-amp. hour were put in series for controls and guidance in the R&D test program.

*Titan* will soon have Type 20xPA-50, 28-volt 50-amp. hour, and Type 19xPA3-1, 28-volt 3-amp. hour for telemetering, guidance and controls.

While specific battery information is not available for *Polaris*, use will be multi-purpose.

*Redstone* has a double battery, Type 20xPA19, 28-volt 19-amp. hour, and Type 19xPA30, 28-volt 30-amp. hour, for guidance controls and telemetering.

*Jupiter* also uses a double battery Type 20xPA8, 28-volt 8-amp. hour,

and Type 20xPA15, 28-volt 15-amp. hour, for guidance and controls. No specific information is available on battery use for telemetering.

Again, there is no specific information on the batteries used for the *Pioneer* shots. However, they will figure in the TV camera, satellite instrumentation and telemetering.

*Aerobee* uses Type 20xHR1, 30-volt 1-amp. hour; and Type 20xHR3, 30-volt 3-amp. hour, both for guidance, controls and telemetering.

Drones use Type 19xHR5, 28-volt 5-amp. hour; and Type 19xHR15, 28-volt 15-amp. hour for electronic apparatus power, including hit recording and data transmitting.

The following types are used for telemetering on nose cones of various missiles: Type 20xHR5 D. C., 28-volt 5-amp. hour; Type 20xHR20 D. C., 28-volt 20-amp. hour; Type 20xHR1 D. C., 28-volt 1-amp. hour; Type 20xHR40 D. C., 28-volt 40-amp. hour; and Type 4xHR5 D. C., 6-volt 5-amp. hour.

## Reds Say Lunik Made 'Comet'

by Frank G. McGuire

WASHINGTON—The Soviet Union has issued an explanation, published in *Pravda*, of the photograph of its *Lunik* taken Jan. 3, 1959. Considerable speculation had been voiced about the photograph for several reasons. The absence of stars in the photograph was questioned, and therefore, the ability of the Soviets to accurately pinpoint the artificial comet's location without stars as reference points.

According to the Russian account, given by I. S. Shklovskiy, Doctor of Physicomathematical Sciences, the weak stars surrounding the "comet" were not registered on the photograph because an interference light filter was used. The determination of the comet's location in the heavens was made through the use of "special reference marks"—presumably through a device in the photographic mechanism.

• **Troubles met**—*Pravda* cited difficulties in making the photo, principal among these being the weakness of the sun's reflection from the rocket at that distance. It was pointed out that *Sputnik III*, at a distance of 187 miles from earth, appeared as a star of the 4th magnitude. If this distance is increased to 187,000 miles from earth, or a distance 1000 times farther, the reflected sunlight drops to one-millionth because the reflectivity is inversely pro-

portional to the square of the distance.

This means that the satellite *Sputnik III* would appear, at 187,000 miles, as a star of the 19th magnitude. The 6th magnitude is the weakest visible to the unaided eye on a moonless night.

The Soviet author pointed out that the difficulty is even greater when the rocket must be observed and photographed against a bright background, since it would then be near the moon in its last quarter. Observations are possible, in this case, with only the largest telescopes.

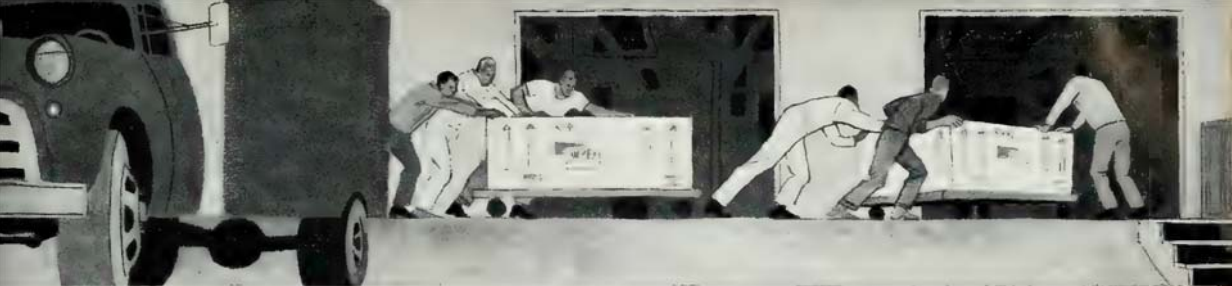
In addition, problems arise when attempts are made to photograph such a small object at great distances, using instruments having a small field of view under bright sky conditions.

• **Reported solutions**—"In these circumstances," Shklovskiy says, "the necessity of developing a method of increasing the brightness of the cosmic rocket many times, if only for a short period, arose. The idea for this method was prompted by nature itself through observations of comets whose brightness in some cases far exceeds that of stars.

"This brightness is the result of the capacity of gases associated with the comet to cause intense scattering of sunlight in separate spectral lines and bands. The bright yellow line of sodium is sometimes observed in their spectra."

Calculations made by the Soviet





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scientists showed that the mass of gas needed to make an artificial comet visible to the naked eye at a distance of 100,000 kilometers is one kilogram.

Sodium was selected because of its characteristic bright yellow line when emitted. The great advantage in this choice is that sodium scatters light strictly according to a wave length of 0.589 microns (the yellow-orange part of the spectrum)—thus making it possible, by using suitable light filters, to observe the cloud even against a bright background. Such light filters decrease the brightness of sky background intensely, while scarcely weakening the brightness of the sodium cloud.

Thus was an artificial comet created by the Soviet rocket. It was necessary to make certain that in a short period of time the sodium would be vaporized into its atomic state, because its molecules, compounds and ions cannot intensively scatter sunlight. The vaporizer for forming the cloud of atomic sodium utilizes thermite to accomplish vaporization, the thermite being ignited at a predetermined time through a programming device.

• **Wide visibility**—Preliminary testing of the vaporizer's operation was done with the aid of high-altitude rockets. The sodium vaporized in one of these experiments at 267 miles formed a golden-orange cloud that was said to be visible over a great part of the Soviet Union.

By analyzing the rate of dispersion of the cloud, the Soviet scientists determined the density of the earth's atmosphere at that altitude "with great accuracy." The obtained value of density was in close agreement with the value derived from analysis of the braking action on artificial earth satellites.

United States experiments on sodium vaporization in the atmosphere were begun in 1955 at altitudes of 43 to 87 miles to study the wind and the chemical reactions of gases in these atmospheric layers with sodium.

According to the Pravda article, special cameras were developed and produced for the observations involved in the Lunik program. Two series of cameras came from this effort, one photographic and one "electronotelescopic". They were equipped with high-quality light filters and located in various places in the USSR.

At the specified time—03:56:20 on Jan. 3, 1959—the artificial comet was created in several tenths of a second when the rocket was at an altitude of about 70,000 miles. The cloud of sodium was estimated to be 62 miles in size.

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## Airborne Converter Weighs Seven Pounds

A new airborne, electronic system that weighs only 7 lbs., and is slightly larger than a milk bottle has been developed by **C. G. Electronics Corp.**, a subsidiary of Gulton Industries Inc.

Known as the multi-channel analog-to-digital converter, Model CG591, the new system is purported to be the smallest completely solid-state airborne converter.

Applications include measurements for guidance and stability of flight vehicles such as satellites, missiles, drones and balloons, as well as high-reliability measurements in ground installations for data acquisition and reduction systems.

This completely transistorized converter contains an automatic error checking system and digital readout, and no function is sacrificed in spite of the system's low power requirements.

Utilizing the PCM method of operation, the new system attains accuracies of 0.2% and can be made compatible with any computer code because of its building block construction which uses modular techniques.

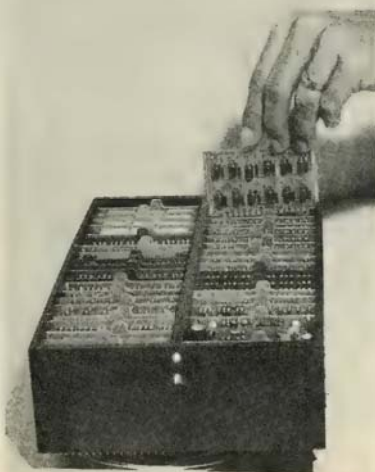
Featuring built-in transient surge protection, the converter is adaptable to on-line entry into digital computers which not only saves time, but eliminates errors encountered in the reduction of information.

Other features of the new system are: high accuracy, extreme reliability, low power consumption, small size and weight and modular construction which provides a high order of system flexibility.

Because of the modular construction, a relatively small number of subsystems can be combined to form many systems depending upon application. In effect, custom systems may be formed from standard subsystems.

The systems are formed from small, (2" x 3") plug-in, etched circuit cards which are easily installed or replaced and provide longer life and increased reliability. Outputs can be furnished for magnetic tapes, punched tapes, punched cards, nixie tube readout, or transmission over telemetry links.

Various combinations of circuits, such as flip-flops, mono-or bistable multivibrators, and, or, and not gates, and-emitter followers, comprise the desired subsystems. Sub-systems of decade counters, ring counters, command



units, parity checkers and the like, constitute the complete analog-to-digital converter.

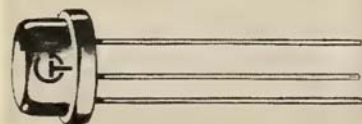
Normally designed to receive 12 inputs, 50 or more can be scanned depending upon the scan rate required. The binary coded decimal form of transmitting information requires only seven discriminators, independent of the number of transducers scanned. The scan rate ranges from 100 to 300 cps. with possible response rates as high as one megacycle.

Designed to measure analog voltages, the a to d converter has a volume of .17 cubic feet (7" x 3" x 14"). Read in sequence, the encoder converts each analog voltage to its digital equivalent which is translated into decimal form. Through the use of amplifiers or attenuators, voltage ranges other than those specified can be handled by the unit.

Circle No. 225 on Subscriber Service Card.

## Silicon Unit Produces High Speed, High Gain

A high-speed, high-gain, silicon PNP alloy junction transistor to meet



industrial and military needs has been developed by the **General Transistor Corp.** Now in pilot production, the unit will be commercially available in quantity by the spring of 1959.

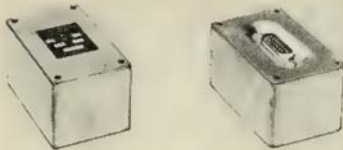
Good switching and gain characteristics, coupled with low saturation resistance, are predicted for the device, which will be packaged in a TO-9 case.

Development of the unit has significance beyond its use in dc amplifiers and other linear applications, since it will make the use of silicon possible in such further applications as direct-coupled and resistance-coupled transistors and other extensions of transistor logic.

Circle No. 226 on Subscriber Service Card.

## Oscillator Designed for Many Airborne Uses

**Data-Control Systems, Inc.** has announced the availability of its new model AOV-4S Airborne Voltage-Controlled Oscillator, which has the same



circuitry and performance as Model AOV-2S in a new physical configuration, compatible with many existing airborne packages.

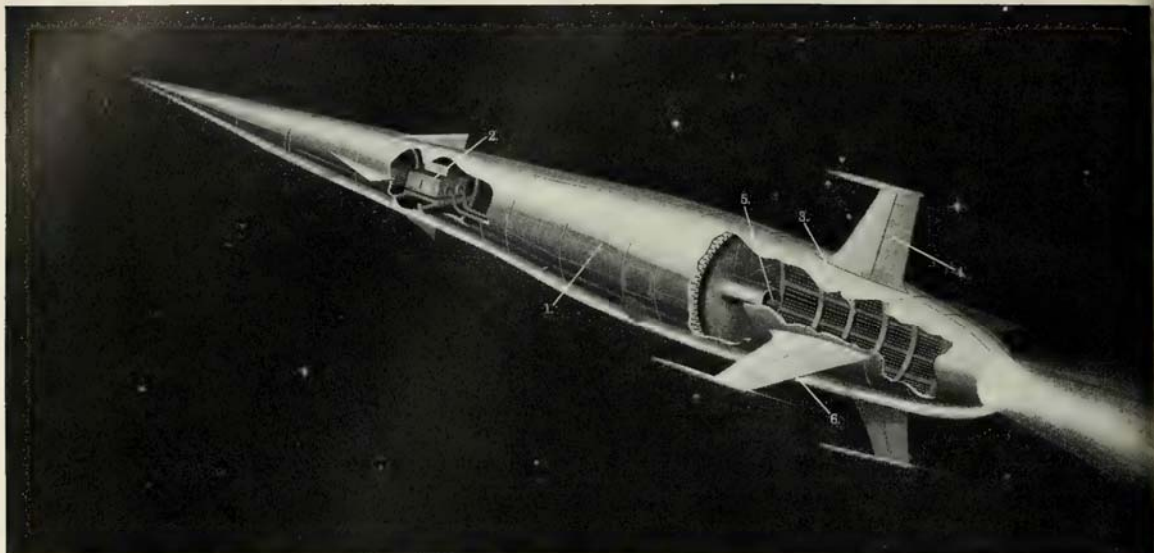
The unit has a silicon junction diode network and silicon transistors,

**NOTE:** For additional information about any product mentioned in this section of Missiles and Rockets use the attached prepaid reply cards. Circle numbers shown on the reply card that correspond with numbers appearing beneath items described. If no circle number accompanies the article or advertisement, give page number (and advertiser's name) on line provided at bottom of card.

Your requests for information will be forwarded promptly to the companies concerned.

The Editor





## THERMAL PROPERTIES OF LIGHTWEIGHT MAGNESIUM

offer advantages to  
missile men

Most engineers are aware of the advantages available to them when they combine magnesium's light weight with its good mechanical properties at elevated temperatures up to 800° F. There are, however, other advantages such as thermal properties that are less well known. They, too, can be of real value to missile designers. In many cases they will open new areas in design previously considered closed to magnesium.

Let's consider one of these, magnesium's high specific heat and its relationship to missiles. This can mean lower temperatures for given flight conditions. As a result magnesium can be used under very severe flight conditions for short time applications. (See Fig. 2.) This permits the use of magnesium in high speed missiles which are exposed to heat generating atmosphere for only a matter of a few

seconds. With magnesium acting as a heat sink it can result in reducing environmental temperature for electronic instruments.

Magnesium offers other thermal properties that are of value in aircraft and missile design. For example, the thermal diffusivity of magnesium-thorium alloys  $\left\{ \frac{\text{Thermal conductivity}}{\text{Specific heat} \times \text{density}} \right\}$  is high and remains fairly constant over a large temperature spread. Between 68° and 900° F. the thermal diffusivity of these alloys is in the range of 0.57 and 0.75 cm.<sup>2</sup>/sec. (2.2 and 2.9 ft.<sup>2</sup>/hr.)

For more complete data send for Bulletin 141-187 "Magnesium Alloys for Elevated Temperature Use." Contact your nearest Dow Sales Office or write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Department 1300CL2-23.

Design a missile with light, strong magnesium alloys.

1. SHEET for internal or external skins of body.
2. DEEP DRAWN HOUSINGS AND CASTINGS for guidance and other instrumentation.
3. CASTINGS AND EXTRUSIONS for body frame.
4. CASTINGS AND EXTRUSIONS for fin and wing construction.
5. ROUND EXTRUDED TUBING for integral body sections.
6. SHEET for external skins of fins, rudders and wings.

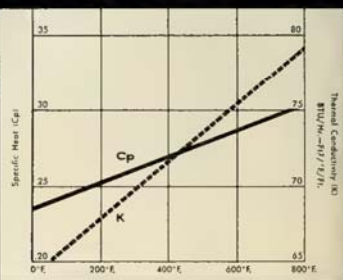


Fig. 1. Specific Heat and Thermal Conductivity of Magnesium-Thorium alloys.

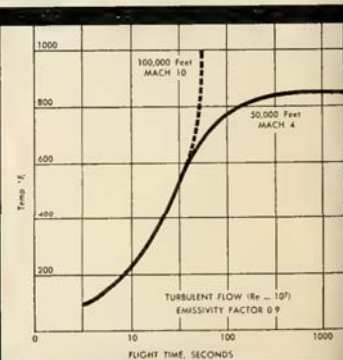


Fig. 2. Effect of Structure Temperature and Flight Time on Mg-Th Sheet Alloys at Mach 4 and 50,000 Feet and Mach 10 and 100,000 Feet.

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN



which permits use in ambient temperature to 125° linearity for the unit is  $\pm 0.5\%$  maximum deviation from best straight line and low power drain and high stability in cases of supply voltage variations. Dimensions of this miniaturized oscillator are 3" by 1.62" by 1.87".

Circle No. 227 on Subscriber Service Card.

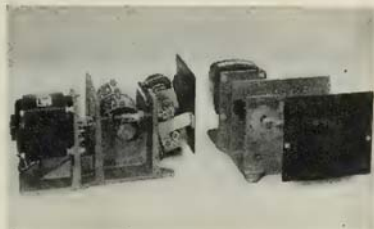
## Miniature Bellows Motor Works Around Curves

A powerful miniature, squib-actuated bellows motor which provides positive displacement for the performance of mechanical work has been developed by Atlas Powder Co.

The motor is .320-in. in diameter and 1-in. long. Actuated by as little as 100 ergs at 1.5 volts, or 0.3 amps, the motor is capable of providing 10 lb. of thrust over a 1-in. minimum stroke within an elapsed time of 1 millisecond. In addition, the bellows can be guided around a 90 degree curve.

limit stop mechanism positively eliminates damage to the balance potentiometers due to off-scale input signals.

This assembly, which includes a black fiberglass bezel for panel mounting, eliminates the necessity to spend valuable engineering time to package



this combination of electrical and mechanical components into a compact and proven configuration. Models are available with various full-scale range of counts and speed.

Circle No. 229 on Subscriber Service Card.

## Lightweight Calibration Unit Designed by Ampex

A fully portable, all semi-conductor device intended for precision alignment and calibration of electronics equipment such as FM record/reproduce systems has been introduced by Ampex Corporation's Instrumentation Division.

The new calibrator, designated TC-10, contains a voltage standard accurate to 0.01%. Working calibration voltages are available in nine steps, each adjustable over a range of 10%. Nine precision oscillators and seven binary dividers provide 63 accurate calibration frequencies ranging from 1012 cycles to 151.2 kc. These can be introduced into a system for discriminator alignment or for comparison with the output of a voltage-controlled oscillator.

According to Ampex spokesmen, the 25-pound, fiberglass-housed unit was especially designed to withstand the rigors of field use. They described its highly stable and accurate voltage system as "an important advance in test instrumentation."

Circle No. 230 on Subscriber Service Card.

## Oscillator Adjusts Against Crystal Aging

The Model RD-146, a new version of the Manson Laboratories' RD-140 one-megacycle high stability oscillator, contains a calibrated trimmer control for making accurate frequency adjust-

ments against crystal aging, on a daily, weekly or other frequent time period basis, without comparison to WWV or other standard.

Operation of the dial, which has a readability accuracy better than two parts in 109, may conveniently be related to the instrument's known drift rate, thus greatly extending the time interval for absolute re-adjustment to 1 mc. The dial is also useful in applications requiring a small range of tunability, as the output frequency may be varied and accurately set over 6 cycles.

The oscillator, employing a quartz resonator under proportional oven control, furnishes a 1 mc output stabilized to better than 1 part in 108 per day; extended usage results in even lower drift. External B+ and filament power are required, but the instrument's relatively high insensitivity to input voltage fluctuations permits the use of almost any unregulated power source of suitable capacity.

Circle No. 238 on Subscriber Service Card.

## Switch/Transducer Has Varied Missile Uses

Haydon Switch Co., has announced the 1500 series pressure switch/transducer. The new unit is designed to meet



the requirements of aircraft, missiles and rockets. Applications include lubricating, pneumatic, hydraulic, fuel, chemical and gas pressure systems.

All moving parts are contained in aluminum housing, environmentally-sealed by O-rings at each end. This assembly, weighing only 3 ounces, can sense pressure levels from 0.5 to 4000 psi merely by changing internal modular components. Eight switches will

The motors are extremely reliable. They will function properly from -65 to +165 F and will withstand 20,000 g's shock and acceleration. Shelf life is measurable in years.

Circle No. 228 on Subscriber Service Card.

## Servo Designed for Auto-Null Balance Systems

A new servo assembly is being offered by Datran Electronics for use by designers of automatic null balance systems.

The aluminum casting assembly includes a Holtzer-Cabot 4 pole 60 cycle servo motor, drive coupling, shaft, bearings and gear drive assembly, digital counters with automatic shutter action to indicate plus or minus digital output, and one or more balance or output potentiometers. Synchro output and/or a Coleman Decimal Digitizer is also provided as optional equipment.

An unusual and easily adjusted



...NEWS IS HAPPENING AT NORTHROP \



## FIRST LOW-COST SPACE AGE AIRCRAFT DEMONSTRATES NORAIR SYSTEMS MANAGEMENT CAPABILITY

The twin-jet T-38—America's first supersonic trainer—aptly demonstrates Norair's capability in systems management. Now in production under USAF contract, the T-38 Talon is the first member of a Northrop-conceived family of lightweight, low-cost space age aircraft.

Soon to follow: a supersonic counterair fighter, the N-156F—first weapon system designed in America for the specific tactical and economic requirements of those free allied nations most vulnerable to enemy attack.

Other important systems management achievements include the USAF Snark SM-62A and the F-89 Scorpion. Norair management of the Snark program produced the free world's

first operational intercontinental guided missile—delivered on time and at minimum cost.

In producing America's first nuclear-armed interceptor, Norair's weapon system management of the F-89 was marked by on-time delivery of more than 1,000 units throughout the program's life, and by a significant dollar underrun. A full ten years after its first flight, the Scorpion is still the USAF's most heavily armed interceptor—and a uniquely stable platform for air-launch of atomic rockets.

Norair's cost-proved record of effective management, integrated facilities, and available resources combine to demonstrate outstanding capability as a prime systems contractor.

**NORAIR** *formerly Northrop Division*  
HAWTHORNE, CALIFORNIA  
A DIVISION OF NORTHROP CORPORATION





## ... new missile products

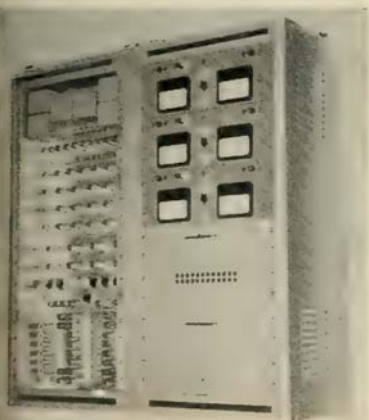
cover the complete pressure span. Exact calibration of each switch assembly is obtained by rotating the external pressure setting adjustment, which is then securely locked by two set screws.

The unit meets MIL-E-5272A specifications. The entire assembly is resistant to corrosive operating media, for example, water-alcohol solutions, nitric acid and hydrogen peroxide. An optional mounting bracket provides vibration isolation up to 2,000 cps and up to 50 g's.

Circle No. 231 on Subscriber Service Card.

## Automatic Electronic Unit Compares Input Signals

A new electronic unit which automatically compares two input electronic signals that consist of digital pulses, subtracts them, and presents an analog signal output representing the difference between the two has been produced by the **Computer Equipment Corp.**



The digital subtractor-converter combines analog and digital data processing techniques, using each method in areas known to be appropriate. Each of the two input channels will accept positive voltage pulses, zero to 30 volts in amplitude. Repetition rates of from zero to 4095 pulses per block or data word are accommodated, with 30 blocks per second handled by the system.

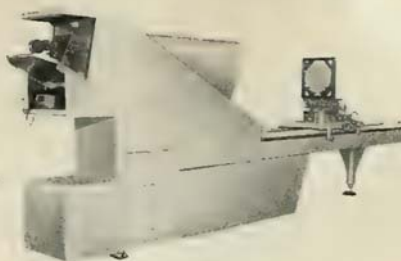
The analog output voltage, which may be used to operate servocontrolled pattern followers and precision positioning systems, performs digital null detection and program comparison, or in many other applications, is accurate to 12 bits of input information. The scale factor is 50 millivolts of output amplitude change for one bit difference between input channels.

In operation, Model DS-12-A accepts input pulse signals at bit rates ranging up to 250 kilocycles per sec-

missiles and rockets, February 23, 1959

*Presenting-*

## A VERSATILE OPTICAL BENCH FOR CHECKING BOTH VISUAL AND IR SYSTEMS



Davidson has added another timely development to its growing family of optical equipment with the new Infrared Collimator Bench, Model D-278. Equipped with a Barnes infrared source and a visible light source, the D-278 tests lenses and assemblies in both the visible and infrared wave length regions. Designed as a large reflective-type collimator, it emits a 15.5 inch diameter collimated beam with a maximum deviation from parallelism of 2 seconds of arc over the entire field of view. The collimated beam is projected parallel to the ways of a large, precision, optical bench. A nodal slide, which may be traversed along the rails of the bench, gives precise longitudinal, transverse, and circular movements. By this means, large optical systems may be set very precisely on their nodal points.

Every day Davidson's experienced engineers are assisting manufacturers to solve their optical tooling problems. Without obligation, let them help plan your optical tooling. Simply write or phone our Sales Engineering Department.

## DAVIDSON

MANUFACTURING CO. INC.

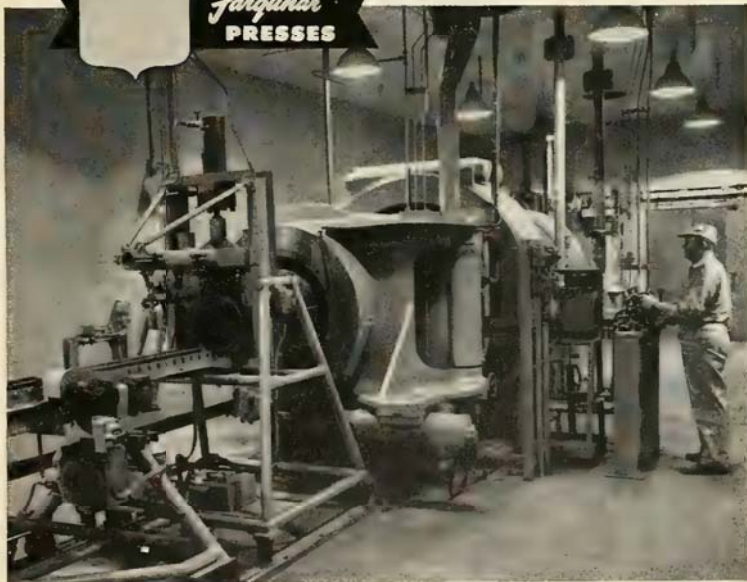
2223 RAMONA BLVD. • WEST COVINA, CALIF.

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Circle No. 22 on Subscriber Service Card.

**OLIVER**

*Farquhar*  
**PRESSES**



**A**t Astrodyne's plant in McGregor, Texas, this Oliver-Farquhar 2140-Ton Hydraulic Extruding Press does its work in the silence of its own cell, compacting today's powerful solid rocket propellents. All movements of this unique press are programmed and recorded in a central control bunker placed at a safe distance from the unmanned press cell.

Write, wire or phone for complete information or ask for our recommendations and proposals. The Oliver Corporation, A. B. Farquhar Division, Press and Special Machinery Departments, York 6, Penna.

Circle No. 23 on Subscriber Service Card.

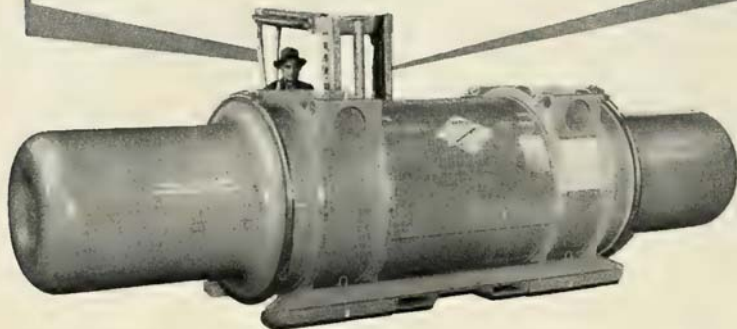


# fiberglass HARCO CONTAINERS

for  
transport, storage  
and ground  
handling of

in-flight refueling stores,  
missiles and rockets,  
jet engines...accessories

## 60% LIGHTER IN WEIGHT!



### HARCO CONTAINERS ARE THE ONLY

fiberglass containers approved by BuAer for handling in-flight refueling stores. Far lighter in weight than steel containers, they also transport the Harco developed ground handling trailer for moving of stores from container to aircraft. Type 1500 Harco Container is 18½-feet long, 4½-feet diameter. Unique design of end sections permits reversing and telescoping into center section for empty-return shipment, reducing length to less than 10-feet.



Harco Containers can be stacked three high for conservation of storage space; provision is made for sling or fork-lift-truck handling.



Note end sections reversed for empty shipment. Seven Harco containers with their integral ground handling trailers can be shipped in the same space required for three conventional containers.



write for literature and quotations on your container and ground handling equipment requirements.

## Harco Containers

A DIVISION OF HARBOR BOAT BUILDING CO.

258 CANNERY STREET, TERMINAL ISLAND, CALIFORNIA

### ... new missile products

ond at either or both of its high impedance inputs. These pulses may represent various quantized analog information; e.g., radar range, azimuth or elevation.

The inputs may be asynchronous, since the digital subtractor converter performs its subtraction only after each block of information is completely loaded. This makes the unit particularly useful where two separate, non-synchronized electrical signals exist, but whose characteristics with respect to each other must be known accurately at all times.

Circle No. 232 on Subscriber Service Card.

### Tantalum Capacitors Run 18,000 Hours

A series of extended life tests recently completed by P. R. Mallory & Co. Inc., have demonstrated the reliability of the company's high-temperature tantalum capacitors. Longest of



these tests, made on a group of 16 type XTL-125 capacitors (connected in parallel) ran for a total of 18,000 hours in the life test ovens. No failures occurred during this period. At completion, equivalent series resistance and capacitance were virtually unchanged from its initial value, while DC leakage current had dropped from 125 microamperes to 25 microamperes for the parallel connected package.

Extended life tests are used consistently by Mallory, not only to verify quality but also to correlate data from accelerated testing with actual life expectation.

In addition, all Mallory tantalum capacitors receive 100% inspection of basic electrical characteristics, and statistical sample quantities from every production lot are given tests for DC leakage, equivalent series resistance, capacitance at room temperature and at +175°C and -55°C, under MIL

missiles and rockets, February 23, 1959



# Autometric

CORPORATION

PARAMOUNT BUILDING, TIMES SQUARE, NEW YORK 36, N. Y. BRYANT 9-8700

PAUL RAIBOURN  
PRESIDENT

Eighteen months ago Autometric announced that it holds "proprietary rights in and manufactures apparatus for pre-programmed control of actual universes, particularly where wayward or inimical autochthons cause capricious responses to control stimuli."

This statement was an appeal to those scientists who recognized its precise technical language to join us. Their response was gratifying.

With their aid, Autometric's capabilities for getting answers simply and directly have been developed. These have been proven by numerous flights and by geophysical measurements which were then compared with the best previous work of many men with analogue and digital aids.

As a result, we now hold large prime contracts for geophysical work in partnership with several of America's largest corporations. We are being requested to become active in other projects of unusual size and significance. We face difficult practical problems of expansion.

In handling these masses of complex data, we have problems of rapid computation and of miniaturized storage and presentation of undigitalized information and abstractions therefrom.

Basically however, we are working beyond such problems since the tough practical decisions demanded by the work-a-day world seem invariably to present themselves in terms of conflicting and incoherent data. A best decision under such conditions is our goal.

We would like to hear from individuals and organizations whose capabilities and experience will be of help to us. Please write in confidence to Robert Dressler, Vice President. Your inquiry will receive personal attention. We are a family of people, not an institution.



The oxidizer that **STAYS** ready...

# Perchloryl Fluoride

## Stable, storable, superior performance

Pennsalt "PF"® (Perchloryl Fluoride— $\text{ClO}_3\text{F}$ ) delivers high oxidizing power when it's needed, today or years from now. It's stable, noncorrosive, hypergolic but not incendiary in ordinary handling operations... can be permanently stored in liquid form without refrigeration. "PF" is easy to handle without undue hazard to personnel or support equipment. It gives high specific impulse, superior performance with a wide variety of fuels. "PF" is available in ton quantities for shipment in the U.S.

### SPECIFIC IMPULSE

System	O/F (lb. per lb.)	Specific Impulse (second)	Condition
PF—Hydrazine	1.1	274	600# frozen
PF—UDMH	2.55	273	600# frozen
PF—JP4	4.03	255	600# frozen

Write for complete technical data on "PF"

Commercial Development Department 721, Technical Division  
**PENNSALT CHEMICALS CORPORATION**

Three Penn Center, Philadelphia 2, Pa.

Circle No. 25 on Subscriber Service Card.



**Pennsalt  
Chemicals**

ESTABLISHED 1850



### ... new missile products

specification C-3965B—after which they get a 2000-hour life test at 85°C and 175°C.

The Type XTL capacitors are part of a line of twelve different tantalum types made by Mallory. Included in this line are many models rated for temperatures as high as 200 C. These extreme temperature ratings, supplied only by Mallory, have been in commercial production since 1949.

Circle No. 233 on Subscriber Service Card.

### Miniature Coil Produces Full Range of Inductances

A new 11 miniature R. F. Choke Coil known as the wee-ductor has been announced by Essex Electronics.



The tiny new choke covers a full range of inductances from 0.10 uH to 1,000 uH, yet it measures only 0.150" in diameter by 0.375" long, occupying a volume of less than 0.0066 cubic inches. The wee-ductor design allows for a high current rating at 125°C operating temperature. Because of its unique new design construction which consists of a high permeability ferrite sleeve and core sealed in epoxy resin for moisture resistance to MIL-C-1505A, the new choke covers a wider range of inductances in a small package size.

Circle No. 234 on Subscriber Service Card.

### New Cathode Ray Tubes Have Varied Applications

Sylvania Electric Products, Inc. has announced the addition of nine multi-purpose cathode ray tubes for military, industrial and commercial applications. The additions include tubes for oscilloscope, materials processing and radar indicator applications.

Type 3RP1A is a flat face oscilloscope tube with electrostatic focus and

missiles and rockets, February 23, 1959



## Here is a man you should know he's a DELAVAN FUEL INJECTOR SPECIALIST

His name is Robert Ulrich. He's the Senior Project Engineer on Fuel Injector Development with Delavan. He's been with Delavan ten years, and has designed fuel injectors which are now standard on many of the world's most advanced jet aircraft and missiles. Men like Bob Ulrich, concentrating their considerable talents to fuel injector development, have made Delavan the world's largest nozzle specialist. They're the main reasons leading turbo-jet, rocket and APU manufacturers rely on Delavan for fuel injection problem solving.

If fluid metering and atomization are part of your product, take advantage of Delavan's specialized experience and proven ability to deliver aircraft quality. Send specifications to the address below for obligation-free recommendations.

# DELAVAN

*Manufacturing Company*

West Des Moines, Iowa

World's largest nozzle specialist

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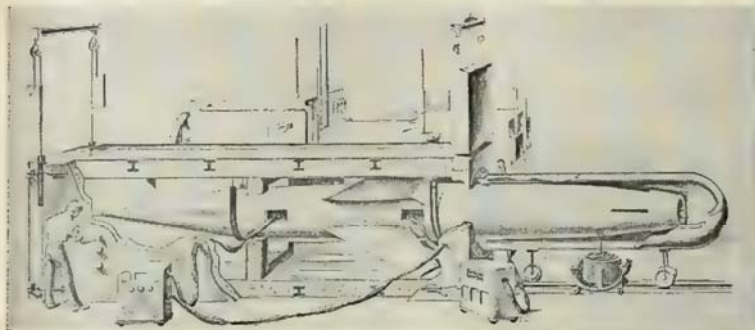


# ENVIRONMENTAL TEST CHAMBERS

FROM THE



FILE



## THE IDEA FROM THE CUSTOMER

From The Martin Company in Orlando came the design specifications for an environmental chamber required for missile testing. Drawing upon years of experience in this specialized field, and working closely with The Martin Company, Conrad developed the walk-in chamber illustrated below.

## THE RESULT FROM CONRAD, INC.

Delivered to The Martin Company recently, this 1200 cu. ft. Conrad chamber is sectionalized to produce high and low temperatures simultaneously. It consists of three units—main chamber, machinery, and instrument panel. The main chamber can be divided into two chambers with a pressure barrier separating the sections. Temperature range,  $-120^{\circ}\text{F.}$  to  $+650^{\circ}\text{F.}$ , altitudes in excess of 125,000 ft., capable of dissipating 40,000 watts at  $-100^{\circ}\text{F.}$



*For Complete Service in  
Planning and Building  
Environmental Test Chambers*



**HOLLAND, MICHIGAN**  
Subsidiary of Crampton Mfg. Co.

**FREE!** New chart of technical information  
and conversion data. Send for your copy.

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## ... new missile products

deflection. It uses a P1 phosphor with green fluorescence and medium persistence.

Type 5WP11 is an oscilloscope tube for visual or photographic observation. It has magnetic deflection and electrostatic focus.

Types 5AHP14, 5AHP14A, 5AHP19 and 5AHP19A are round glass type high resolution tubes which use electrostatic focusing and magnetic deflection. These tubes differ only in their screen phosphors.

Type 5ZP15 is a flat face high resolution tube with electrostatic focus and magnetic deflection designed for use as a flying spot scanner. It uses a P15 phosphor with blue-green fluorescence and extremely short persistence.

Type 5ZP24, designed for color flying spot scanning, has electrostatic focus and magnetic deflection. It has a clear non-browning faceplate and an aluminized screen. The tube's P24 phosphor is of blue-green fluorescence and extremely short persistence.

Type 7MP14 is a clear face, round glass, non-ion trap radar indicator tube with magnetic focus and deflection.

Circle No. 235 on Subscriber Service Card.

## Magnetic Amplifier Has Varied Missile Uses

A new Variable Output Magnetic Amplifier for aircraft and missile use has been developed by the Vap-Air Aeronautical Products Division of Vapor Heating Corp. It is purported to be the smallest in size and weight of any unit of this type available. It has an output of from 0 to 2000 watts.

The Variable Output Magnetic Amplifier can be used in many aircraft and missile systems including windshield temperature control, heater control, and motor speed control.

The reported advantage of the Variable Output Magnetic Amplifier over the on-off type is the modulating output, eliminating power surges in the aircraft or missile electrical system.

Combining the functions of these units into a single control eliminates, 1) extra AN Connectors and harness to tie them together, 2) moving electrical contacts in the control box and contactor, and 3) installing three units.

The controller also offers fail-safe features which will shut the controller off in the event of loss of power, pickup short, or pickup open.

In addition to these advantages, the Variable Output Magnetic Amplifier has the ruggedness which is characteristic of mag-amps. The unit will meet

missiles and rockets, February 23, 1959



(right) Part of giant capacitor bank used to fire "hotshot" tunnel. Bank is capable of 5 million kilowatt jolt.



(above) Lockheed's "Hotshot" tunnel — only one in private industry.

(right) Research and Development facilities in the Stanford Industrial Park at Palo Alto, California, provide the latest in technical equipment.



## THERMODYNAMICS

### Expanding the Frontiers of Space Technology

Lockheed capabilities in thermodynamics and gas dynamics are unsurpassed in private industry. Basic work is being performed on problems relating to missiles and spacecraft under simulated conditions of upper atmosphere and outer space. Studies include: boundary layer flow and heat transfer; cooling and insulation; thermodynamic instrumentation for flight test; design of rocket motor controls and nozzle structures; re-entry thermal protection; materials specification; and thermal environments of electronic, mechanical and hydraulic equipment. Also under study are new methods and improved techniques of thin film thermometry, measurements of dissociation and combination of nitric oxide and high-speed shock wave flows.

Equipment includes the fastest wind tunnel in industry, fired by 20 million kilowatts; a hydromagnetic tube which produces velocities of over Mach 250 and temperatures approaching 500,000°K; a "hotshot" tunnel for shock wave, gas and heat studies, capable of velocities of 16,500 mph and temperatures above 12,000°F; and a ballistic range on which projectiles are fired at speeds up to 20,000 ft/sec.

Scientists and engineers of outstanding talent and inquiring mind are invited to join us in the nation's most interesting and challenging basic research programs. Write: Research and Development Staff, Dept. C2-29, 962 W. El Camino Real, Sunnyvale, California.

*"The organization that contributed most in the past year to the advancement of the art of missiles and astronautics."* NATIONAL MISSILE INDUSTRY CONFERENCE AWARD

**Lockheed**

**MISSILES AND SPACE DIVISION**

SUNNYVALE, PALO ALTO, VAN NUYS,  
SANTA CRUZ, SANTA MARIA, CALIFORNIA  
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ALAMOGORDO, NEW MEXICO

# METALS FOR MISSILES...

## Armco PH Stainless Steels-

**PH 15-7 Mo**

**17-7 PH**

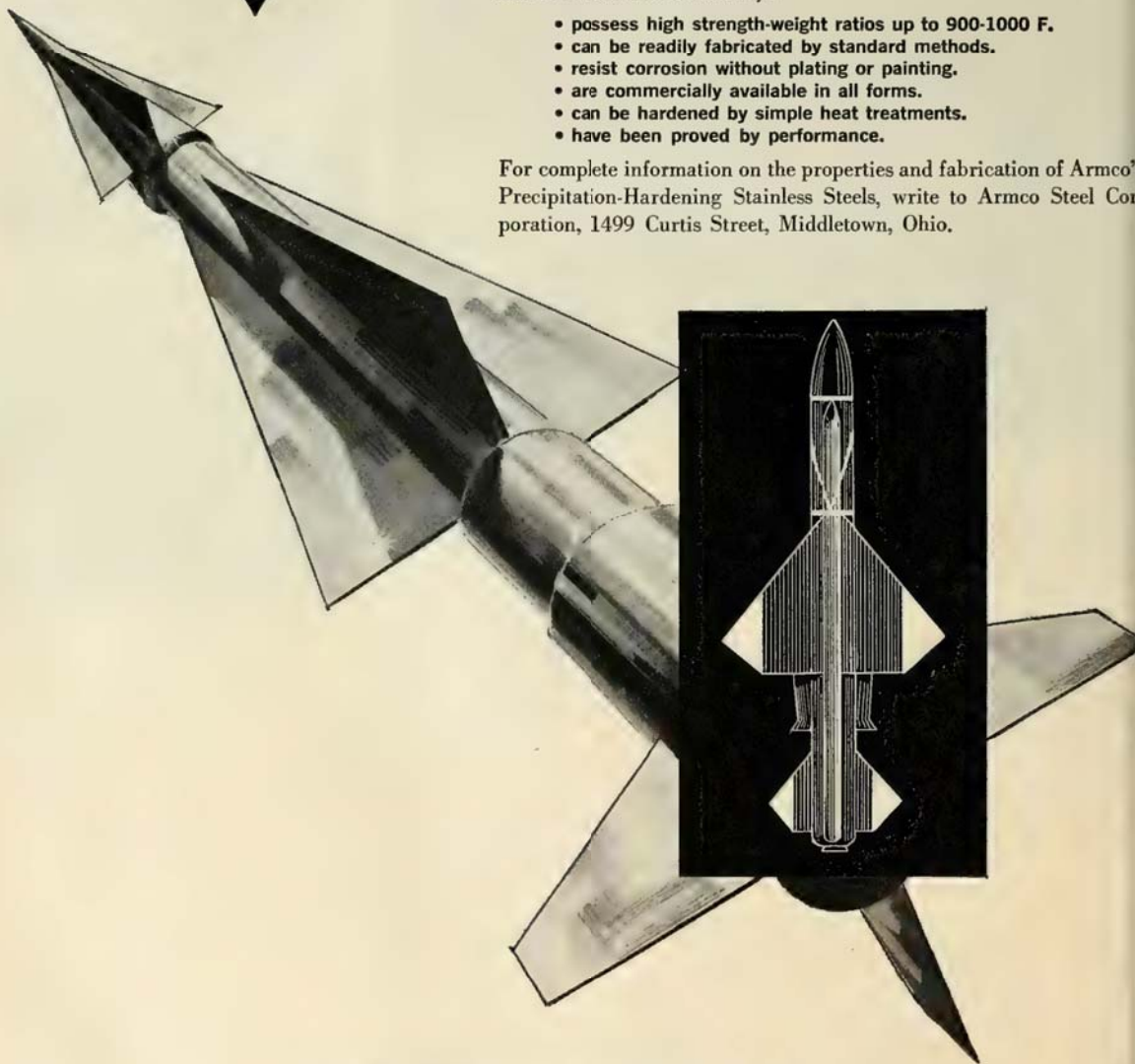
**17-4 PH**

New steels are  
born at  
Armco

These special Armco Stainless Steels, developed specifically for aircraft and missiles, are used for missile airframes, tanks, power plant and accessories because they:

- possess high strength-weight ratios up to 900-1000 F.
- can be readily fabricated by standard methods.
- resist corrosion without plating or painting.
- are commercially available in all forms.
- can be hardened by simple heat treatments.
- have been proved by performance.

For complete information on the properties and fabrication of Armco's Precipitation-Hardening Stainless Steels, write to Armco Steel Corporation, 1499 Curtis Street, Middletown, Ohio.



## ARMCO STEEL



Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation • Southwest Steel Products



the requirements of MIL-E-5272A, is adjustable over a wide range, has the built-in reliability which mag-amps offer, and features extreme accuracy and repeatability of operation in ambient of minus 65° to 200°F.

Circle No. 236 on Subscriber Service Card.

## Amplifier Permits Use of Only One Instrument

Development of a new low level DC amplifier that will permit the use of one instrument instead of many, has been announced by **Engineered Magnetics Division of Gulton Industries, Inc.**

The completely transistorized DC amplifier, Model EM-2000A, is a chopper amplifier not of the magnetic or mechanical chopper types. Designed for use with devices measuring low level phenomena, as for example, thermocouples and strain gauges, the new units are suited for airborne applications because of lightweight, ruggedness, high frequency response and a low power requirement of less than two watts.

Developed for use in systems where excellent sensitivity and frequency response are required, the new DC amplifiers are subminiature in their mechanical characteristics, occupying 27 cubic inches and weighing only 12 ounces.

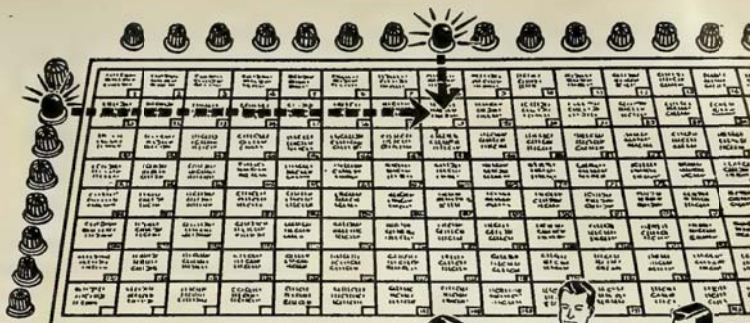
The unit has a higher frequency response (better than -3DB at 2,000 cps), and thus provides greater economy where larger band widths of low level data are to be amplified. With standard equipment, it is now necessary to amplify each low level signal before multiplexing into a common channel. With the new EM-2000A, DC amplifier, multiplexing may be done at the amplifier input, thus permitting the use of one amplifier instead of many.

The high sensitivity of the new amplifiers permits accurate temperature measurements as low as -95°C with the Iron Constantan thermocouples, and -122°C with Chromel-Alumel thermocouples. The new units are also compatible with strain gauge transducers for high frequency shock and vibration measurements.

Additional characteristics of the equipment include: input sensitivity, 0 to 5MV, + 2½MV, zero is adjustable over a 2.5 volt output range; linearity of + 0.5% from best straight line; gain stability + 1% full scale; floating input and output, and good long term zero stability. The gain is 1000.

Circle No. 237 on Subscriber Service Card.

missiles and rockets, February 23, 1959



# NOW! COMPLETE FACTS ABOUT EVERY CIRCUIT... RIGHT BEFORE YOUR EYES!



## DIT-MCO FAULT LOCATION CIRCUIT ANALYZER AUTOMATICALLY PLOTS TEST SEQUENCE... PINPOINTS, IDENTIFIES AND PATTERNS CIRCUIT ERRORS.

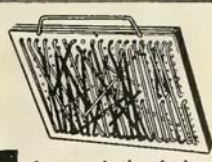
DIT-MCO's exclusive cross-reference Matrix Chart automatically pinpoints each circuit flaw and puts clear, concise test information directly in front of the operator! Horizontal and vertical indicator lights cross-reference on the matrix square corresponding to the circuit under test. This square details type of flaw, circuit number and exact error location. Once an error is detected, the operator immediately marks it on the matrix square, resets the Universal Automatic Circuit Analyzer and continues the test.

All corrections are made direct from the Matrix Chart after the test sequence has been completed. This saves up to 90% correction time by eliminating time consuming searches through diagrams, manuals or interpretive readout devices. Because the DIT-MCO Matrix Chart is a simple, concise representation of all test circuits, specifications, instructions and modifications, nothing is left to chance or guesswork! The comprehensive nature of the Matrix Chart system provides important data for statistical analysis and permits effective checks and balances... from the drafting board to obsolescence!

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## contract awards

### ARMY

\$1,650,000—**Telecomputing Corp.** of Los Angeles, for precision gyros for *Nike-Hercules* and *Nike-Ajax* missiles (add-on contracts from **Western Electric Co.**).

\$1,285,000—**Chrysler Corp.**, for additional *Jupiter* components.

\$1,000,000—**Rocketdyne Div.**, North American Aviation, Inc., for rocket engines for ABMA's clustering project.

\$596,369—**Radioplane Co.**, Van Nuys, Calif., for target drones.

\$264,680—**Harvey Aluminum**, Torrance, Calif., for engineering and fabrication.

\$243,980—**Western Electric Co.**, for R&D.

\$200,000—**The Conkle Construction Co.**, Rosamond, Calif., for G.E.E. maintenance building at Vandenberg AFB.

berg AFB.

\$164,647—**Gilfillan Bros.**, Los Angeles, for engineering services.

\$161,514—**Ford Instrument Co.**, Long Island City, N.Y., for development, engineering and design services on basic guidance and control design information.

\$152,927—**Magline, Inc.**, Pinconning, Mich., for *Redstone* missile shelters, lightweight system.

### AIR FORCE

\$949,000—**Autonics Div.**, Bell Aircraft Corp., for design, development, fabrication and testing of high-performance inertial navigator, The Hipernas II and applicable spare parts, technical reports and engineering data for use in Army surveillance drone program and AF satellite launch and space vehicle program.

\$877,430—**Sperry Gyroscope Co.**, for klystron tubes.

\$504,237—**General Electric Co.**, for thermocouple assemblies.

\$242,000—**Hughes Aircraft Co.**, Tucson, for additional facilities for *Falcon* production.

\$229,445—**Gilfillan Bros., Inc.**, for modified search antenna kit including circular polarization.

### NAVY

\$2,145,772—**Lear, Inc., Grand Rapids, Mich., Div.**, for controller assembly.

\$1,380,000—**Manderbach Construction Co.**, Glendale, Calif., for construction of maintenance hangar at Pt. Mugu.

\$729,662—**American Bosch Arma Corp., Chicago Div.**, for *Talos*, *Tartar* and other switchboards and FC switchboard section. (with electric devices and wiring deleted).

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## west coast industry

by Fred S. Hunter

Subcontracts are beginning to show up on the Nike-Zeus project. One of the stipulations laid down by the San Diego city council in approving Narmco Manufacturing Co.'s purchase of the first plant site in the city's new industrial park calls for construction of a 50,000-square-foot manufacturing facility upon receipt of a production contract from Western Electric. Narmco is one of a group of companies picked by Bell Telephone Laboratories to contribute to the development of a prototype of the Nike-Zeus guidance system. Others include Goodyear, Lear, RCA and Remington Rand.

Narmco, in its presentation to the San Diego authorities, indicated that its Nike-Zeus development could lead to a \$20-million production contract. The company, presently employing 1000 persons at plants in La Mesa and Costa Mesa, expects its payroll to grow to 5000 in five years. That's why it wants to consolidate manufacturing facilities in San Diego. Its purchase involves 14½ acres, with an option for 10 more.

California missile interests are more concerned over some of the governmental problems at local levels than those on a national scale. Legislation introduced at the current session of the state legislature includes increases in income and corporation taxes, a higher minimum wage, liberalization of unemployment insurance and various other bills which will increase the cost of doing business and threaten to put companies located in the state at a competitive disadvantage with companies located where the business climate is more favorable. Significantly, a New Mexico legislator announced a plan to introduce legislation to wipe out income and corporation taxes in the hope of luring defense business from California.

A. C. Esenwein, new executive vice president of Convair and formerly general manager of its Fort Worth Division, points out that if the Russians fly a nuclear-powered aircraft this year—as forecast—it would probably be three or four years, at our present rate of progress, before the United States could duplicate the feat. "Our program for nuclear flight has been one of the most undulating series of circumstances I have witnessed," Esenwein observed. It would be possible, he added, to modify present aircraft, such as the Boeing B-52, Convair B-36 or Douglas C-133 for nuclear flight, but this would cost as much as building a totally new aircraft.

Lt. Gen. Jimmy Doolittle, new chairman of Space Technology Laboratories, describes space flight as an "extension of conventional aviation." And, apparently, the noise will be extended, too. In a recent paper, Al Mayo, Douglas-El Segundo's chief of equipment and safety research, observed: "Takeoff noises of space vehicles might nonetheless cause a degree of dissatisfaction to be expressed by people living in the immediate vicinity of the early space-exploration launch sites."

Lockheed's Missile and Space Division calls on the high-speed cameras used chiefly to photograph engineering test work to help solve maintenance problems when machines that need repair operate too fast for the eye to detect what's amiss. These cameras record 100 to 9000 frames a second and slow-motion playback works for the repair crews just as it does for the test engineers.

Quantities almost invariably come under the heading of classified information, so some of those attending the press showing on the Thor IREM recently were surprised when they observed numbers conspicuously displayed on some of the units. No. 215 on a subassembly at Santa Monica, No. 198 on an assembled missile in the paint shop at the end of the final line, No. 141 on a test job on the launching pad at the Sacramento test facility. But Douglas missile people only grinned. The numbers, they declared, didn't mean a thing.

**MARMAN**

## Engineering Notes

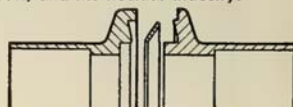


W. M. WILLIS

In looking at a finished product for the first time, one sees only the superficial aspects. At first glance it is difficult to visualize the intensive design effort, infinite refinements, and development engineering that

have led to the final product.

The Marman Conoseal is a typical example, reflecting the reduction of theory by empirical testing to ultimate simplicity in finalized design. From this point of view, it may be interesting to discuss some of the details that make this joint outstanding, meeting the extreme requirements for advanced missile systems, aircraft, and the nuclear industry.



In the sketch above, note the reverse position of the gasket and pilot length which demonstrate that an incorrect assembly is impossible. This was attained by correlating the gasket proportionate requirements of performance to the length of the pilot for assembly.

For preassembly, the angle of the gasket had to accommodate ease of installation yet accomplish closed radial forces sufficient to produce plastic flow at the gasket edges to achieve a seal of zero leakage under the most severe environmental conditions. The reposed angle of flanges also has a definite design objective which allows for ease of joint disassembly subsequent to providing a radial seal.

The sharp corners on gaskets combined with material hardness and strength as differentiated from the flanges allow unlimited usage of flanges with new gaskets.

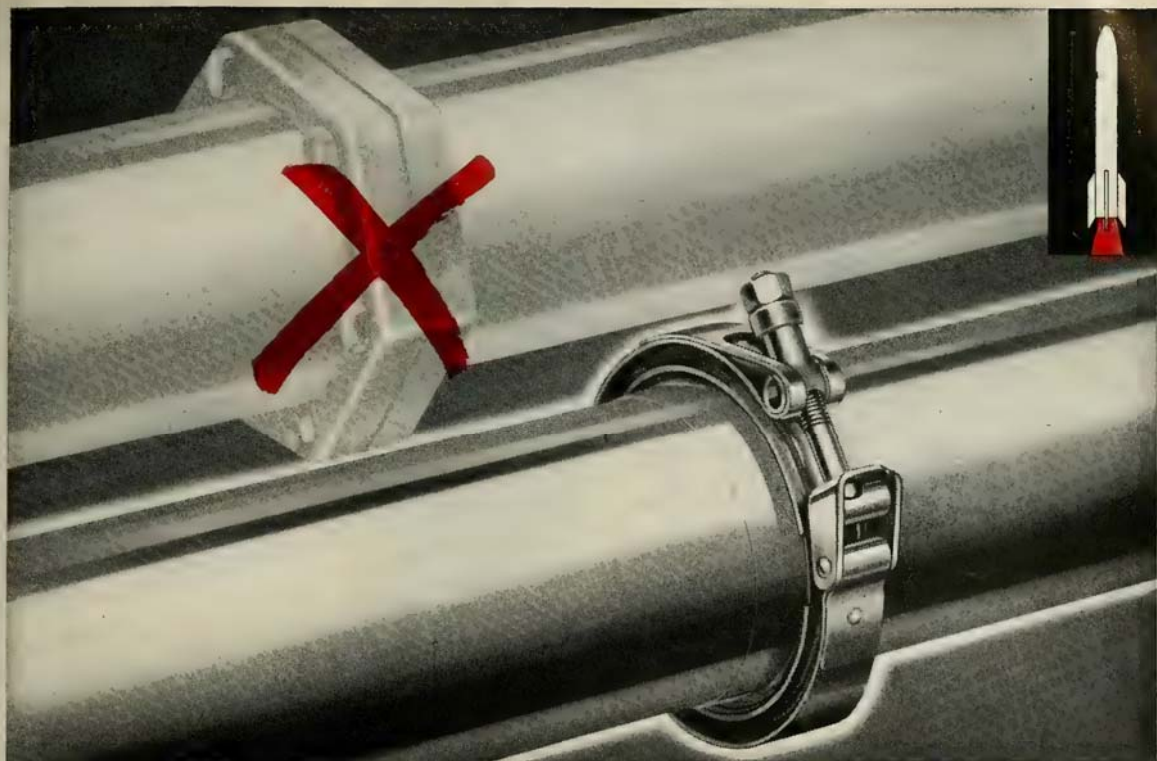
In order that the quality of the product be compatible with the performance of critical application areas, stringent quality control standards have been established for acceptance; 10% X-ray, 100% magnaflux, special forging temperatures which limit the grain size to a standard ASTM 5 to 6. One out of each heat batch of forgings is cut and severely etched, photomicrographed, and compared to the standard grain size. Vacuum melt or similar stock is specified to establish the dispersion of carbides into a very fine pepper pattern. This allows the customer, after welding flanges to this ducting system, to use the normal cleaning and pickling methods without destroying the surface.

The results of this five-year product development have culminated in coupled joints far exceeding the performance of bolted flanged per pound of weight.

Complete test reports are available upon request.

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Light Duty	-300 to +750	1500 psig
Medium Duty	-300 to +1250	3200 psig
Heavy Duty	-300 to +2000	6000 psig

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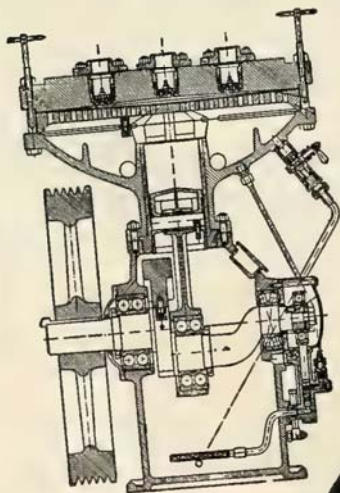
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### FEBRUARY

Heat Transfer Div. of American Society of Mechanical Engineers Third Annual Symposium on Thermal Properties, Purdue University, Lafayette, Ind., Feb. 23-26.

EIA Sixth Industrial Relations Conference, Chase-Park Plaza Hotel St. Louis, Feb. 25-27.

1959 Engineering Exposition, Balboa Park, San Diego. For information, contact exposition office at 422 Land Title Bldg., San Diego. Feb. 26-Mar. 1.

### MARCH

IRE, AIEE and Association for Computing Machinery, 1959 Western Joint Computer Conference Fairmont Hotel, San Francisco March 3-5.

Institute of the Aeronautical Sciences Flight Propulsion Meeting (classified), Hotel Carter, Cleveland March 5-6.

Second Western Space Conference and Exhibits, Great Western Exhibit center, Los Angeles, March 5-7.

Gas Turbine Division of the American Society of Mechanical Engineers, Turbine in Action, Cincinnati, March 8-11.

Third Annual Shock Tube Symposium, Old Point Comfort, Ft. Monroe, Va. For details: Armed Forces Special Weapons Center, Kirtland AFB, Albuquerque, N.M. Attn.: SWRS R. R. Birnkoff. March 10-11.

American Society for Metals, 11th Western Exposition and Congress, Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles, March 16-20.

The American Rocket Society, 1959 Sectional Meeting, Daytona Plaza Hotel, Daytona Beach, Fla., March 23-25.

Institute of Radio Engineers, National Convention, Coliseum and Waldorf-Astoria Hotel, New York, March 23-26.

Society of the Plastics Industry, 16th Annual Conference, Pacific Coast Section, Hotel del Coronado, San Diego, March 25-27.

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

missiles and rockets, February 23, 1959



# propulsion engineering

by Alfred J. Zaehring



Ultimate chemical system, hydrogen and fluorine, may be near actual rocket use in the USSR. A recent Russian book on rocket fuels pictures a liquid rocket of 6.3-ft. diameter and about 46.5-ft. length (without payload package). Small upper oxidant tank indicates liquid fluorine and very large fuel tank below stores bulky liquid hydrogen. In fact, this "research rocket" is in the size category of the last stage of the *Sputnik* or *Lunik* rockets. Thrust is estimated at about 99,000 lb. All dimensions are compatible with H-F propellant systems. Puzzler is that hydrogen is shown as the coolant for a regenerative engine. It is known that at  $-181^{\circ}\text{C}$  hydrogen has about 2.6 times the specific heat of water. If the Russians have learned to use liquid hydrogen as a coolant, it would be an accomplishment that the U.S. has not attempted.

Ejection of electrons from metals by bombardment of molecules moving at meteoric speeds is being studied by Soviet physicists. In an air stream moving at a speed of over six miles/sec., and colliding with iron, all air molecules are ionized. This phenomenon may be studied as a possible high altitude, high speed, satellite propulsion system.

New boron fuel entry is the award of a \$2-million Air Force contract to Stauffer-Aerojet. Facility is to be located at Aerojet's Sacramento facility. It will be a pilot plant with boron fuel capacity estimated at about  $1\frac{1}{2}$  tons per month. The Stauffer-Aerojet fuel is said to be less costly than either the Callery or Olin Mathieson fuel. Speculation is that some of the new fuels will be suitable for rocket propulsion. At any rate, it looks like a boron battle will begin to brew.

Solid propellant battle may also be shaping up. Hercules Powder (operator of Allegany Ballistics Lab) says that it has plunked \$5 million into its Bacchus, Utah, solid facility; employment there is expected to go up to an eventual 3000. Propellant testing, possibly for Air Force *Minuteman* project, is starting. Previous reports stated that Hercules had joined hands with the Naval Propellant Plant for work on *Minuteman*. Right now, Thiokol and Aerojet have major solid propellant work on the solid ICBM. A few days ago, Standard Oil Company of Indiana was awarded a R&D contract for work on a solid propellant auxiliary power system for *Minuteman*.

Perchlorates for propellants are perking. Sodium chlorate, basic intermediate for present ammonium perchlorate processes, is now being pushed by three firms. American Potash & Chemical will produce some 15,000 tons per year of sodium chlorate at its \$4.3-million plant at Aberdeen, Miss. Hooker Chemical's HEF subsidiary will complete its AP-LP plant at Columbus, Miss. Pennsalt is pushing its AP production at its Tacoma, Wash. plant. All in all, 1959 may see plenty of perchlorates available for the solid propellant people. Though overall AP production may double or triple, not much price change is expected. Until *Minuteman's* production is in the thousands, AP production will be relatively small compared to the high volume liquids such as LOX.

Other solid developments: Thiokol will add a quarter million dollar propellant development lab to its Brigham, Utah, facility. The Naval Propellant plant at Indian Head, Md., starts delivering solid rocket motors for the Martin-designed and developed *Bullpup* missile. Allegany Ballistics Lab did the design work on the rocket motors; initial deliveries will mean beginning of fleet evaluation for the bird.

missiles and rockets, February 23, 1959

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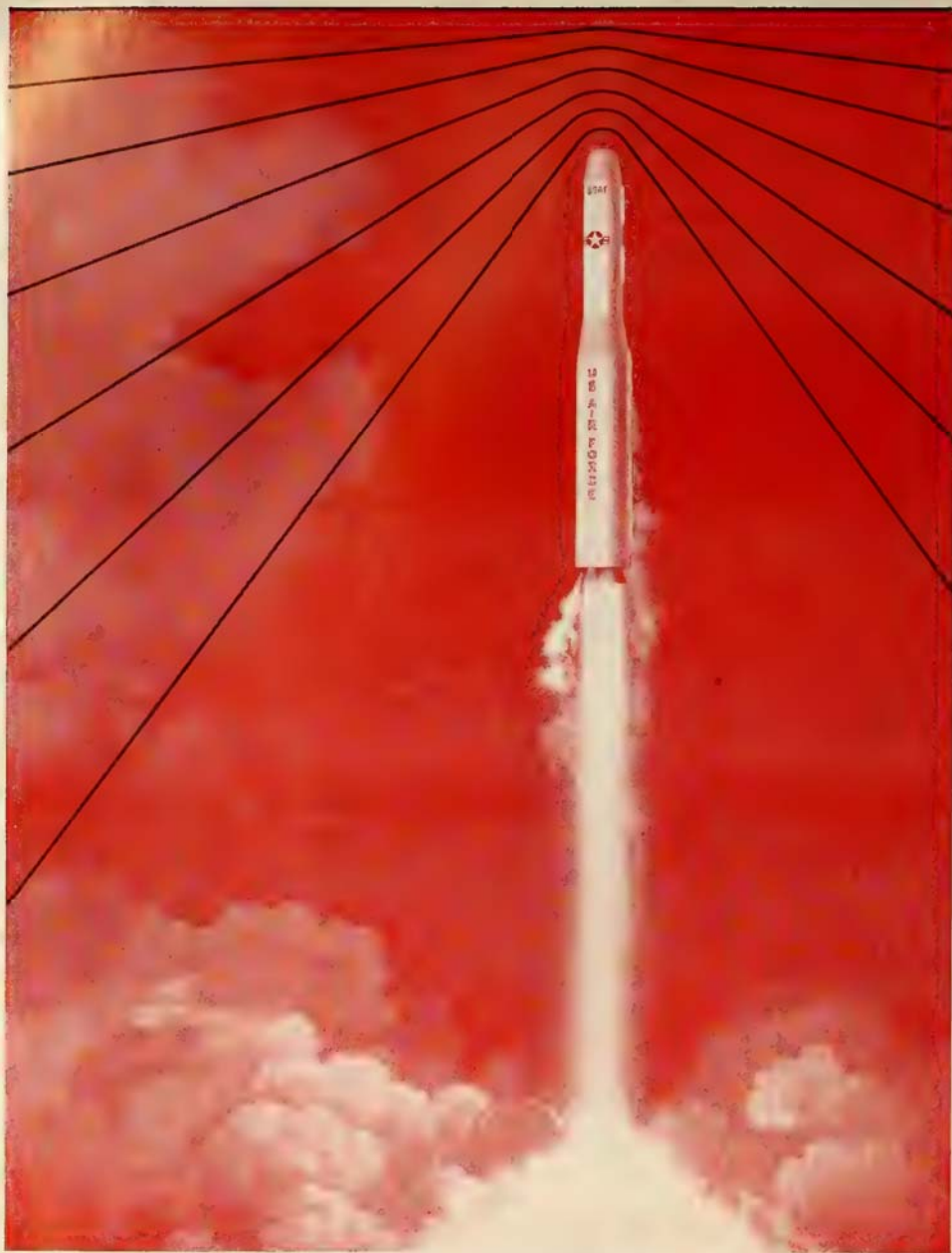
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## missile people

The University of Cincinnati has named the "fastest man on earth," **Col. John P. Stapp**, as part-time associate professor of industrial medicine. He will work with graduate students and physicians on the effects of velocity on the human organism.

Stapp, who is with the Air Research and Development Center at Wright-Patterson AFB, Dayton, Ohio, is noted for his research on the effects of acceleration and deceleration on man. He won the "fastest man" title in one of his rocket sled experiments when he was accelerated to 632 miles an hour in five seconds, then halted in one second.

**W. H. Jaeger** has been appointed as North American Aviation's corporate engineering and planning representative at Huntsville, for liaison with Headquarters, Army Ordnance Missile Command. Previously he was plant engineer at Rocketdyne's Neosho, Mo., *Jupiter* engine factory.

**Tom Courtney**, formerly chief project engineer, has been named program director for the *Corvus* air-to-surface missile system being developed by Temco Aircraft Corp. Courtney came to Temco last year from McDonnell Aircraft Corporation, St. Louis, where he was program manager for the *Green Quail* missile.

**Dr. Norman F. Jacobson** will head the newly-formed Reliability Section at California Institute of Technology's Jet Propulsion Laboratory. The section is charged with providing safeguards against environmental changes and establishing required reliability tests. Jacobson, 30, has been with JPL since 1956 and was responsible for "payload reliability" in connection with the building and launching of the *Explorer* satellites and the *Sergeant* weapons system.

**Dr. Douglas Duke**, formerly head scientist of the satellite tracking project (*Spacetrack*) at AFMTC, has joined Radiation, Inc. as a technical advisor in space technology. He has worked on various space projects with Convair Astronautics and the Navy Electronics Laboratory.

General Electric's Semiconductor Products Department has established a Rectifier Product Section with **C. Graydon Lloyd** as general manager. GE said the reorganization was necessitated by the department's expanding activities in the semiconductor components field. Lloyd was formerly manager of engineering for the Technical Products Department and general manager of General Electric's Specialty Electronic

Components Department in Auburn.

Another GE department, Heavy Military Electronics, has set up two new marketing units—Defense Industries Sales and Defense Industries Contract Administration—to serve the defense prime contractor market. **George D. Prestwich** was named manager of Defense Industries Sales, and **Fred Glickman** will head Defense Industries Contract Administration. The company said the new units would make available to major defense prime contractors technical know-how and facilities for designing and producing large, complex electronic subsystems.

**Richard E. Roberts** has been named chief of GE's newly-organized Instrumentation and Communication unit, part of the company's Missile and Space Vehicle Department.

**G. W. Trichel** has been appointed military advisor to **T. F. Morrow**, group vice president-defense and special products, Chrysler Corp. Trichel has been president of Chrysler's Amplex Division since 1956.

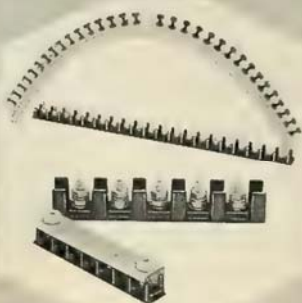
Beckman's Systems Division has organized a new Military Electronics Department to operate within the Systems Division. This group will be under the direction of **Kenneth F. Miller**, formerly with the Contract and Engineering Department of Beckman's Heliport Division.

Cook Electric Co. has named two new associate directors of its Research Laboratories Division: **Raymond O. Fredette** and **Alton D. Anderson**. Fredette formerly was assistant director of the laboratories and, as staff engineer and chief aerodynamicist, directed development of systems for recovering ballistic missile nose cones and recovering man from early space trips. Anderson, previously Lab assistant director, chief engineer and director of Cook's Systems Development Section, has worked on missile instrumentation and mine countermeasures systems.

Former general manager of IBM's Data Processing Division, **Charles J. Lawson, Jr.**, has been promoted to assistant director of manufacturing services. His duties include providing technical counsel to operating division managers. Lawson's successor as head of the Rochester plant is **Clarence E. Frizzell**, who was assistant general manager of IBM's San Jose, Calif., plant.

Borg-Warner Corp. has named **Tom G. Conway** vice president in charge of manufacturing of its Pesco Products Division. He will supervise the fabrication of aircraft and missile components.

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## Fuels Vaporization Study Contract Awarded by NSF

WASHINGTON—Formulation of an overall theory of the atomization and vaporization of liquid fuels in continuous-flow heterogeneous combustion systems will be attempted by three engineers of the University of Wisconsin's department of mechanical engineering.

Under a grant of \$57,600 from the National Science Foundation, the engineers will utilize a photographic technique to study vaporization in the simulated combustion chambers of rockets, ramjets and turbojet power plants.

The engineers, Profs. Phillip S. Myers, Otto A. Uyehara and M. M. El-Wakil, say present design approaches are based largely on trial-and-error. This applies to liquid fuel combustion chambers for both ramjets and reciprocating engines.

They point to the ever-increasing requirements for speed and power in propulsion and the need for development of a scientific basis for designs that will permit optimum efficiency.

The Foundation financed an earlier research project by the same engineers to develop a photographic technique which will be used in the new study. It is carried out by mixing fluorescent dyes with the fuel droplets to make them primary light sources under high-intensity light. Photographs of the vaporization taken in this way are sharper and do not have the defects encountered in other methods.

The engineers hope to test many different fuels under varying conditions, including some new high energy fuels, possibly fluorine.

## Digitronics Corp. Sells Two Component Divisions

WASHINGTON—The National Aeronautics and Space Administration has announced the appointment of Robert R. Gilruth as Director of Project Mercury's Space Task Group.

Assistant Director of the Group is Charles J. Donlan and Special Assistant to the Director is Paul E. Purser, according to the NASA announcement.

Charles W. Mathews, NASA said, will be director of the Operations Division of the Task Group; Maxine A. Faget, director of the Flight Systems Division; and Charles H. Zimmerman, director of the Engineering and Contract Administration Division.

The Task Group's headquarters will be at NASA's research center at Langley AFB, Va.



missiles and rockets, February 23, 1959



## book reviews

**THE ATOM AND THE ENERGY REVOLUTION**, by Norman Lansdell, Philosophical Library, Inc., New York, 1958, 200 pp., \$6.

This work is a study of the profound implications that atomic energy has for the world of tomorrow.

The military and economic applications of atomic energy are already being developed. But little has been written about the probable affects of the atomic era on the whole of human life and society. What will be its effect, for instance, on world trade, the relation of industry to the state, and on national sovereignty?

Lansdell's work is for the general reader who wishes to grasp the social and political implications of the atomic era, for the businessman who must adapt himself to the new economy, or for the specialist in any related field of inquiry. The book covers the potential uses to which the atom may be put; its exploitation by separate countries and by international bodies; and its impact upon the world.

**PHYSICAL LAWS AND EFFECTS** by C. Frank Hix, Jr., and Robert P. Alley; John Wiley & Sons, Inc., New York, 1958, 291 pp., \$7.95.

A good compilation, arranged in three cross-reference systems, of complete and convenient information on physical laws, both common and uncommon.

It is valuable as a quick reference for experienced engineers and scientists because each item is comprehensive, including further references to be consulted if necessary.

The book is arranged alphabetically by the names of the laws, alphabetically by the physical quantities involved and alphabetically by fields of science. The format includes a short description of each law, an illustration, an indication of the expected magnitude, and a list of references.

Highly recommended for use by anyone dealing with physical laws.

**COMPACT HEAT EXCHANGERS**, by W. M. Kays and A. L. London, McGraw-Hill Book Co., New York, 1958, 156 pp., \$6.00.

This work covers all types of heat exchangers in use today, including tube banks; plate-fin surfaces; finned tube surfaces; and screen and sphere matrix surfaces.

Basic heat transfer and flow friction data are presented for a total of 88 surface configurations. The book makes available to designers the results of experimental and analytical

work on compact heat-transfer surfaces.

One objective of the authors is "to give a common treatment to all surfaces considered, thus avoiding the confusion so often encountered with a large number of arbitrarily defined parameters."

**RADIOACTIVITY MEASURING INSTRUMENTS**, by M. C. Nokes, Philosophical Library, New York, N.Y., 1958, 75 pp., \$4.75.

A well-written work giving detailed instructions for making a number of simple radioactivity measuring instruments. The author, now with the Isotope Division, Atomic Energy Research Establishment, Harwell, England, was formerly Senior Science Master at Harrow School.

In the book's nine chapters, he covers Geiger-Müller counters and the phenomena in G-M tubes, various trigger devices, power supplies, rate meters, scalars, instruments and practical hints for constructing a measuring instrument.

One minor drawback: The author gives some idea of the cost of parts involved in building a radioactivity measuring device, but, despite the fact that American marketing for the book was arranged, prices are given only by the English currency standard.

**EFFECT OF SURFACE ON THE BEHAVIOUR OF METALS**; Institute of Metallurgists, 100 pp., \$10, Philosophical Library, New York.

A series of lectures delivered at the Institution of Metallurgists Refresher Course, 1957. Embodies the four papers presented during the series and covers topics of: Methods of Preparation and Examination of Surfaces; Influence of Surface Treatments on the Chemical Behavior of Metals; Relationship between Surface Condition, Friction and Wear; Influence of Surface on the Physical Properties of metals.

Included are 30 diagrams in the text and 10 pages of art plates.

### Fast Write-Offs

WASHINGTON—Office of Civil Defense Mobilization has granted five concerns fast amortization permits for tax purposes on expansion of missile and electronics research. Firms include: Hercules Powder, Motorola, Inc., Bendix Aviation Corp., Lockheed Aircraft Corp., and Sundstrand Machine Tool Co.

Hercules was allowed fast depreciation on 65% of the \$4,602,250 expansion cost of a solid propellant research facility at Bacchus, Utah. The cost of expansion for the other firms was under \$1 million each.

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## NEW PRODUCT BRIEFS

**ING MOTORS**—A new line of extremely thin synchronous timing motors 25, 50, or 60 cycle operation in five standard voltage ratings has been produced by A. W. Haydon Corp. Main features are extremely thin design with ample torque equivalent to much larger motors, and completely electrical operation. Only  $\frac{1}{8}$ " thick, these units are designed to occupy considerably less space than other available motors. The design has completely eliminated the need for mechanical devices to control the direction of rotation of the motor. Although mechanical devices have been used in the industry for years, they have many troublesome disadvantages such as being noisy and offering only limited life. Over 125 standard output speeds from 300 R.P.M. down to one revolution in six hours can be supplied with either standard or heavy duty motor trains. With a nominal 30 oz-in. starting torque at 1 R.P.M., these motors can be used in a wide variety of applications. Bulletin AWH MO-806 illustrates the motor, contains outline and mounting dimensions, charts, applicable industry specifications and completely describes these motors.

Circle No. 241 on Subscriber Service Card.

**WAVEGUIDE SWITCH**—The "Delta" micro-miniature waveguide switch, featuring extreme compactness and lightweight—0.37 lbs.—has been developed by the Lan Electronics Co. Designed for the "X" band—81.2 to 12.0 KMC—the "Delta" waveguide switch is remotely controlled to provide a highly reliable means of switching a single waveguide input to either of two outputs. RF switching under power, with a maximum S/R of 2.1/1.0 during the switching cycle, and 1.1/1.0 in either position over the entire frequency range is achieved by the unique design. RF power rating of the unit is equal to associated waveguide. Other features of the Delta micro-miniature waveguide switch include switching time of only .007 seconds and isolation of 50 db down minimum. The unit is priced at \$285, with quantity discounts available.

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**CIRCUIT BREAKER**. The Klixon D6760-5 is a metal-type, three-phase circuit breaker, a new model in the Klixon D6760 series with applications on aircraft and missile

ground support equipment where high voltage power is used, has been produced by Metals and Controls Corp. The -5 version is a modification of the basic design with greater electrical clearance between phases. The manufacturer says this internal redesign eliminates the possibility of arcing between phases on short circuit interruption.

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**QUARTZ CLOCK**. A quartz clock, which can be used both as a timekeeper (rate variation less than 1/100th of a second per day) and as a reliable frequency standard, has been made available by the Freeport Engineering Co. Manufactured by the Oscilloquartz Department of Ebauches S.A., Neuchatel, Switzerland, the B-288 quartz clock consists of six standard units mounted on slides in a sturdy metal case only 18" x 18" x 15". Compact and portable, the B-288 quartz clock is an exceptionally reliable frequency standard, Freeport says. It generates frequencies of 100 kc, 10 kc, 200 cps, 60 cps, and 50 cps, which can be distributed throughout of building without further amplification.

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**URETHANE FOAM PROTECTION**. Sensitive recording instruments carried in the nose cones of Thor and Atlas missiles are being packaged in urethane foam produced by DuPont. The sphere of foam, no larger than an oversized basketball, withstands impacts up to 45,000 times that caused by the force of gravity, DuPont says, and protects the equipment from vibration and shock from the launching to the time it is ejected and returned to earth. This cocoon of urethane foam consists of an outer shell of hard foam (20-lb density) containing a core of soft foam (6-lb density) in which are embedded the recording devices.

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**RECORDER**. An analog & operations recorder, developed to military requirements and specification has been developed by Brush Instruments, division of Clevite Corp. According to Brush, the new recorder permits simultaneous recordings of two types: analog recording of the dc to 100 cps range.

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## MISSILE LITERATURE

**MICRO VOLT AMMETER.** A bulletin released by the Keithley Instruments, Inc. describes the Model 150 micro volt-ammeter for measuring voltages as low as 0.03 microvolts and currents down to two micro-microamperes. The four-page bulletin gives a detailed description including circuit design considerations, schematic diagram and actual reproductions of stability performance tests. Also included are specifications, prices and ordering information. **Circle No. 200 on Subscriber Service Card.**

**CORROSION PREVENTION.** A bulletin describing techniques developed through use of treated pure metals which are firmly bonded to a steel base by Metallizing Engineering Co. These metal coatings assure protection against oxidation for 25 to 50 or even 100 years. In addition to describing the systems, the new bulletin pictures some typical applications on a broad range of equipment and structures. **Circle No. 201 on Subscriber Service Card.**

**CIRCUITRY.** A new booklet entitled "Notes on Transistor Switching Circuitry" is available from Navigation Computer Corp. The 16-page pamphlet covers the field of transistorized pulse handling techniques, and includes diagrams for programing pulses, delays, serial-to-parallel conversion (and vice-versa), ring counters, cycle distributors, binary counting, electronic switching, etc. **Circle No. 202 on Subscriber Service Card.**

**TESTING DELAY LINES.** A 35-page Mimeographed Manual on "Procedures For Testing Ultrasonic Delay Lines" is available from the Arenberg Ultrasonic Laboratory, Inc. The manual covers basic inspection, single-terminal impedance measurements, overall insertion loss, band width, ripples in the band pass, secondary signals, multiple travel signals, direct feedthrough, sum of secondaries, delay time, absorption in medium, temperature effects and other variables, such as military requirements. Applications to high speed computers, radar MTI and integration kits, as well as timing devices are considered. The techniques discussed will have bearing on all ultrasonic measurements. **Circle No. 203 on Subscriber Service Card.**

**TEFLON TUBING.** A Bulletin on the CDF line of flexible thin-wall paste-extruded tubing and spaghetti-extruded Teflon is available from Continental-Diamond Fibre Corp. Complete tables of sizes and tolerances are given. This 4-page, 2-color brochure also presents in tabular form lists of electrical and physical properties of the tubing. The test method is indicated for each property. **Circle No. 204 on Subscriber Service Card.**

**BROCHURE.** Space Electronics Corp. has released a brochure describing its facilities and capabilities in electronics techniques for missile guidance, control, instrumentation and communication, and ground support equipment. Accent is placed on R&D operations. **Circle No. 212 on Subscriber Service Card.**

**PRODUCTS.** Eastern Industries, Inc. has released a brochure describing its products for manned aircraft and missiles, including pumps and hydraulic power units, pressurization-dehydration

units, electronic liquid cooling, and refrigeration-type cooling packs, se valves and servo systems. Performance specifications, weights and dimensions and power requirements are given along with tables, graphs, and illustrations. **Circle No. 205 on Subscriber Service Card.**

**TAPE RECORDERS.** A new treatise discussing the fundamentals and chief applications of magnetic instruments recording is available from An Corp. From the introduction of magnetic recording devices in this country some 16 years ago, the booklet traces the need for more precise measurement, and points out how magnetic tape devices are suited to meet the need. The booklet includes discussion of principles of magnetic recording, physical elements of instrumentation corders, and the four major recording processes—direct, frequency modulation, pulse-duration modulation, digital. **Circle No. 206 on Subscriber Service Card.**

**TUBE HANDBOOK.** A 550-page Technician's Handbook describes over 100 receiving tubes and 330 picture tubes as well as data on transistors, triodes, diodes, and special-purpose tubes, produced by the Hytron Division of Columbia Broadcasting System. **Circle No. 207 on Subscriber Service Card.**

**MECHANICAL FILTERS.** A 16-page illustrated catalog describing the complete line of standard production Co Mechanical Filters has been issued Collins Radio Co. **Circle No. 211 on Subscriber Service Card.**

**TECHNICAL ARTICLES.** Articles of interest to engineers, designers and technical personnel concerned with structural construction, adhesive bonding, structural plastics are now available without charge in the bimonthly Narmco Engineering Topics. **Circle No. 208 on Subscriber Service Card.**

**NEW MANOMETERS.** A catalog recently made available by Trimco Instrument Co. illustrates and describes two manometers of new design. The company says the new units are presented in their accuracy. Design Models C-22 and C-12, their dramatic exterior design is highlighted by black scale with white numerals and increments. Cases of both are of extruded aluminum with gold anodized finish. Their wells differ—Model C-12 is a normal well type, while Model C-12 is a raised well type. Operational data are identical, with maximum operating pressures of 400 psig and range from 12 to 120 inches. **Circle No. 209 on Subscriber Service Card.**

**PORTABLE MEASURER.** An entire series of test instrument functions has been engineered into a single self-contained portable instrument for direct measurement of physical quantities. Telechrome Poly-gauge can measure pressure, load, force, displacement, strain when plugged in the appropriate transducer or strain gauge, according to its manufacturer, Telechrome Manufacturing Corp. It is powered by 1 volt AC, weighs 11 pounds and measures 15"x9"x6". **Circle No. 210 on Subscriber Service Card.**

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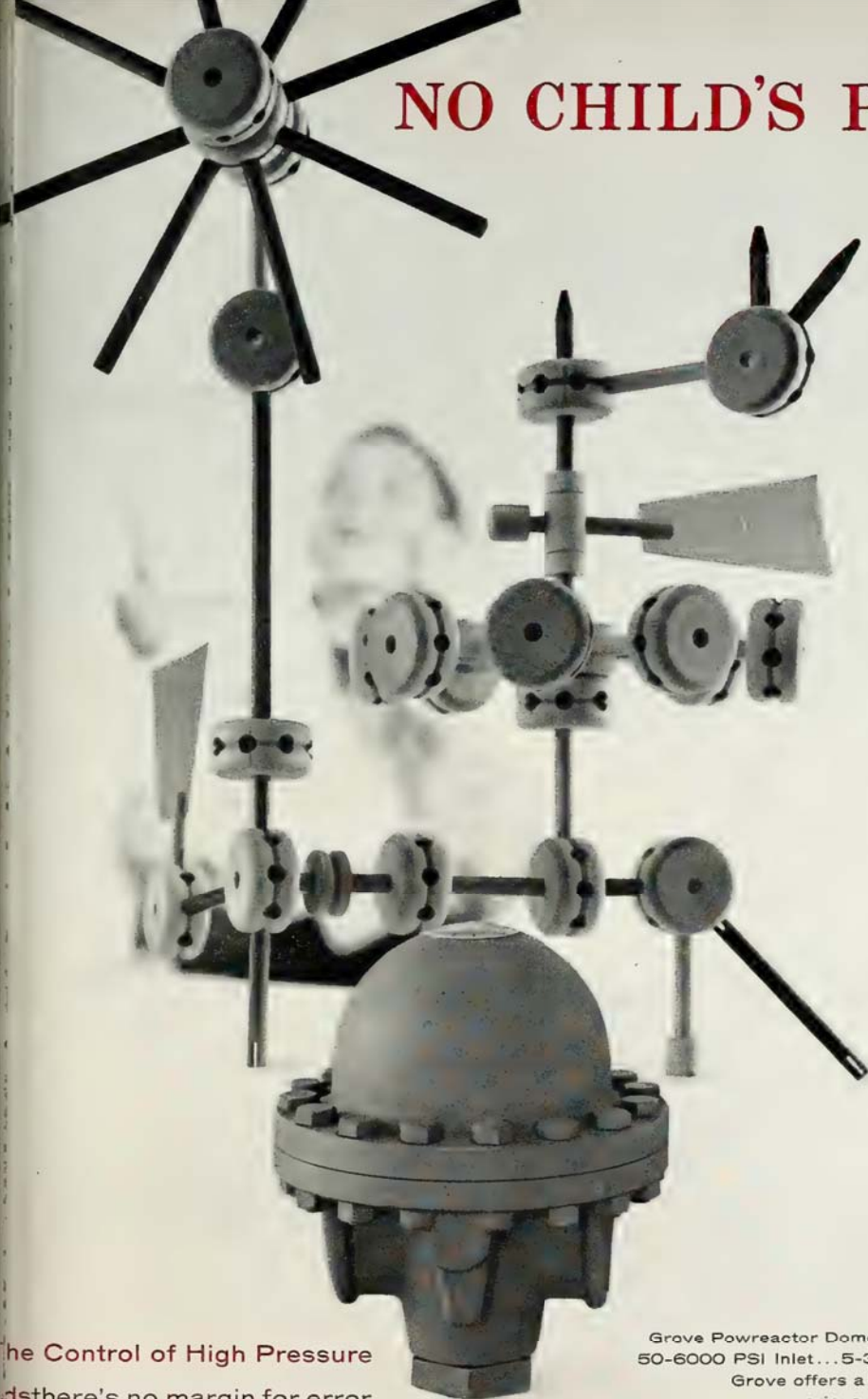
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