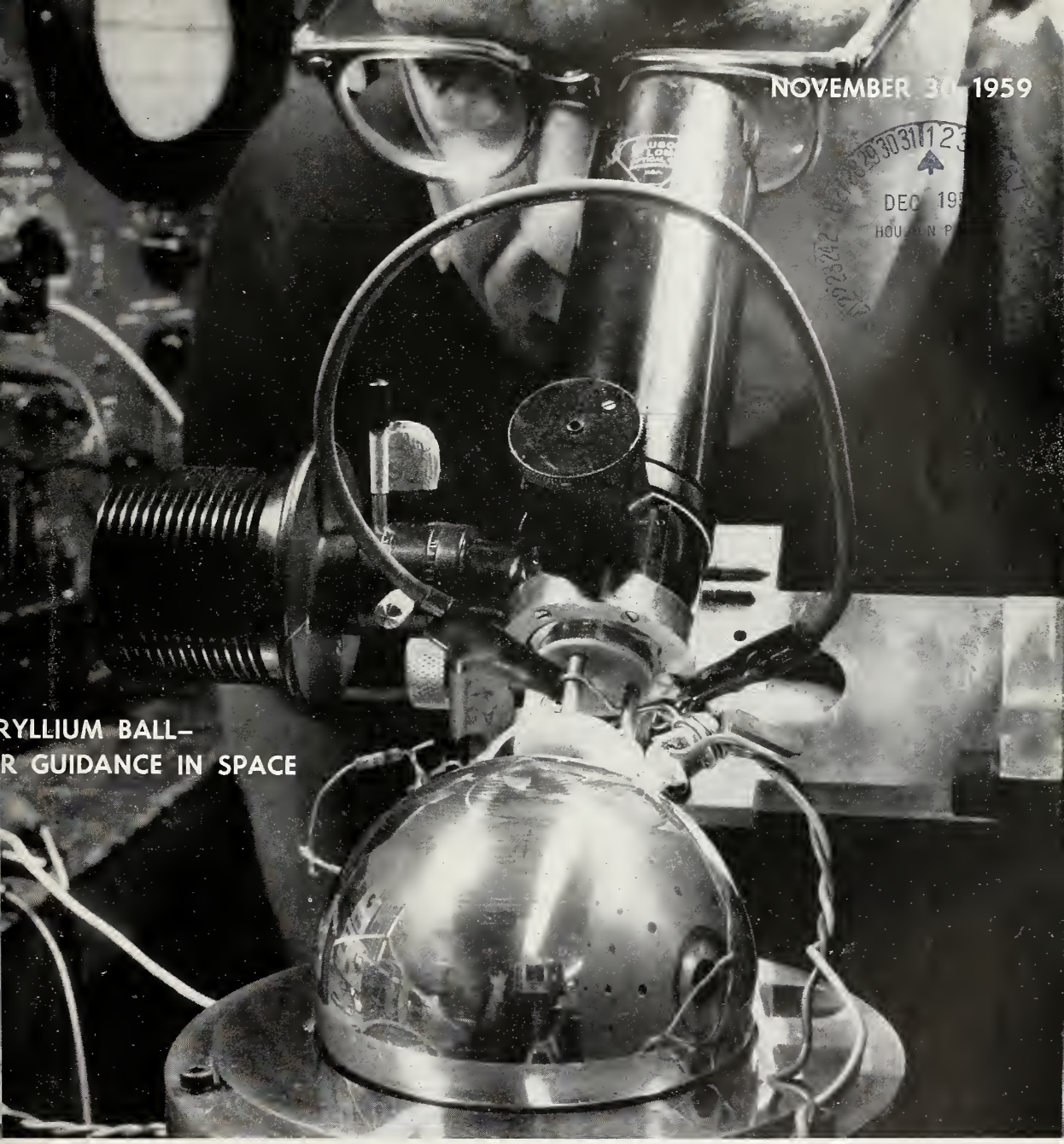
NOVEMBER 30, 1959

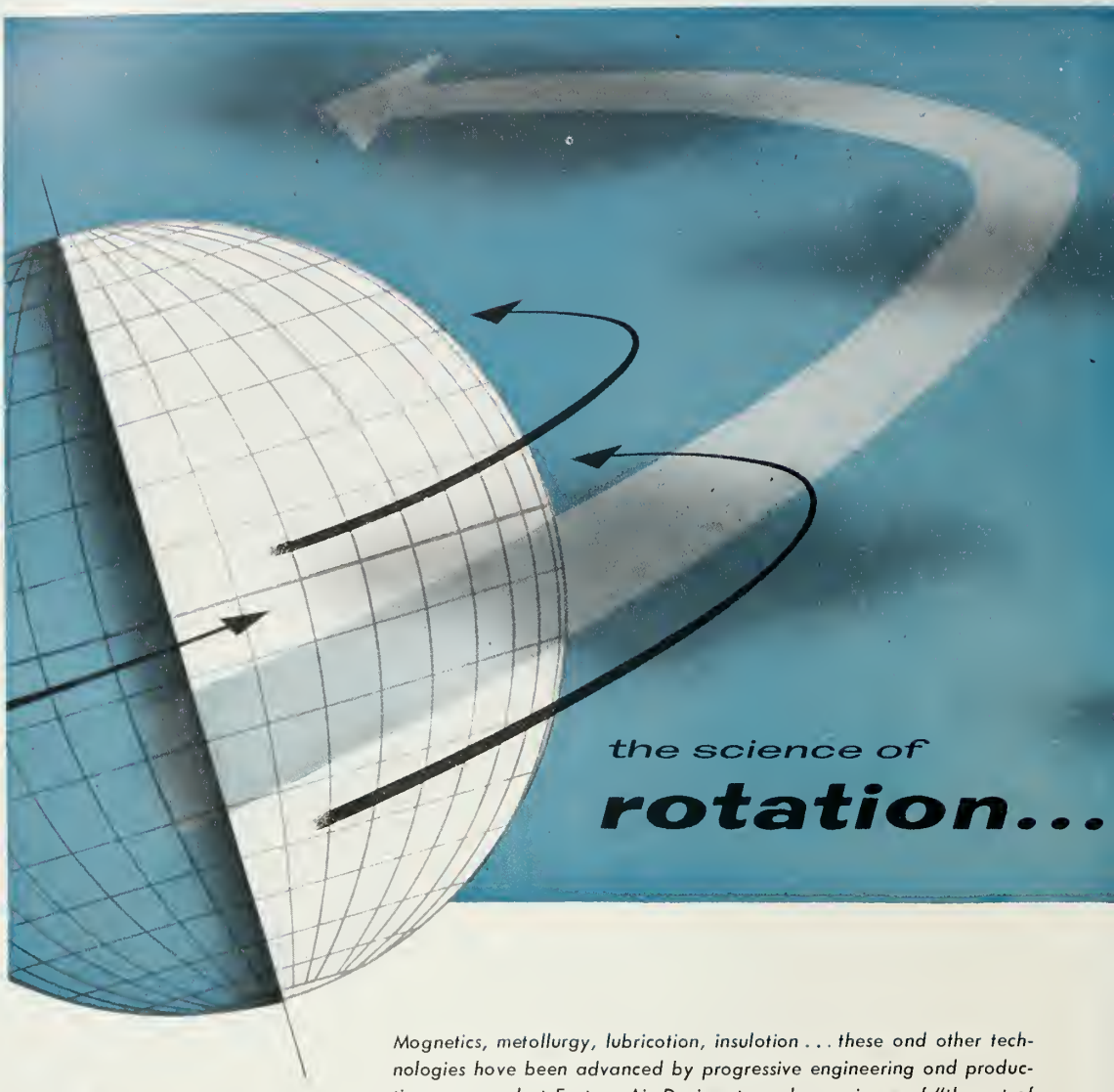


RYLLIUM BALL–
R GUIDANCE IN SPACE

missiles and rockets

MAGAZINE OF WO

AN AMERICAN AVIATION PUBLICATION



TYPE V1HJ-G8

Miniature Vane Axial Blower

Maximum air delivery in the smallest package

Combining a unique mechanical and aerodynamic design with EAD's standard, reliable 1" diameter motor has resulted in this extremely compact and efficient fan. In addition to the 2 pole characteristics listed below, EAD can supply 4 and 6 pole designs and models for operation from 1600-cycle and variable frequency power sources. Here is another development in the growing family of EAD V-Line vane axial blowers.

TYPICAL CHARACTERISTICS

115 Volt • 400 cycles single or three phase

19,000 RPM nominal

65 CFM at 0" SP

35 CFM at 2.3" SP

Life in excess of 1000 hours at 125°C.

1.5" total length

1.990" housing diameter

Available with:

1. Leads
2. Terminals on mounting flange
3. Terminals on housing

Write for complete technical data.

Magnetics, metallurgy, lubrication, insulation . . . these and other technologies have been advanced by progressive engineering and production personnel at Eastern Air Devices to make a science of "the art of turning." Since 1942, this scientific approach to the improvement and development of precision rotating devices has resulted in higher output efficiencies, reliable operation in higher ambients and superior performance characteristics under the most severe environmental conditions. In addition to continued product improvement, the application of this science has developed a number of firsts, including variable frequency motors, pure sine wave alternators and thermistor compensation of integrating tachometers. Combine this technical ability with high volume production, unsurpassed quality control, parts standardization for lower cost, and you can see why EAD has been specified by leading systems manufacturers for nearly two decades.

EASTERN AIR DEVICES, INC. EAD

Subsidiary of Norbute Corporation • Dover, New Hampshire

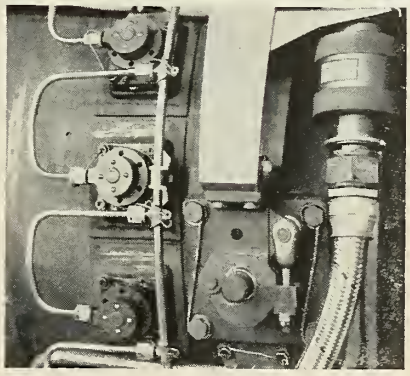
INDUCTION MOTORS • SERVO MOTORS • HYSTERESIS MOTORS
INTEGRATING TACHOMETERS AND MOTOR TACHOMETERS • BLOWERS
INERTIALLY DAMPED SERVO MOTORS • TORQUE MOTORS • FANS
DAMPING MOTOR TACHOMETERS • GEAR MOTORS • ALTERNATORS

Circle No. 1 on Subscriber Service Card.

Aeroquip Quick-Disconnect Couplings and Hose Lines of Teflon Speed 'Hound Dog' Handling

Hound Dog, the Air Force's new air-to-surface nuclear-armed missile, lengthens and strengthens the retaliatory arm of the Strategic Air Command. Designed and manufactured by North American's Missile Division, the GAM—77 Hound Dog is equipped with Aeroquip Hose Lines of Teflon and Quick Disconnect Couplings. Used on its internal hydraulic system and on ground service checkout equipment, these Aeroquip products speed handling and checkout of system components.

As the leading designer and producer of fluid line products for aircraft/missile systems, Aeroquip can offer complete engineering and manufacturing facilities to meet your fluid system problems. Mail the coupon below for specific product information, or outline your problem to our sales engineering department.



Aeroquip Hose of Teflon with potented* "*super gem*" Reusable Fittings and 3200 Quick Disconnect Coupling shown here on the Hound Dog Missile, are also used on the external check-out system.

Aeroquip

REG. TRADEMARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN
AEROQUIP CORPORATION, WESTERN DIVISION, BURBANK, CALIFORNIA
AEROQUIP (CANADA) LTD., TORONTO 19, ONTARIO
AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN CANADA, U.S.A. & ABROAD

AEROQUIP CORPORATION, JACKSON, MICHIGAN—PLEASE SEND LITERATURE AS INDICATED: M & R-11

1. Large diameter hose lines of Teflon for corrosive fluids. ☐
2. 6000 psi. pneumatic hose of Teflon for charging systems. ☐
3. 1500 psi. hose lines of Teflon for fuel, hydraulic and pneumatic systems. ☐
4. 3000 psi. hose lines of Teflon for hydraulic and pneumatic systems. ☐
5. Large diameter formed tubing. Fuel and oil quick-disconnect ☐
6. couplings in accordance with MIL-C-7413A. ☐
7. Precision tube and hose assemblies. ☐
8. 3000 psi. quick-disconnect couplings for pneumatic and hydraulic systems. ☐

68-page Catalog #104 covering Hose Lines of Teflon. ☐

NAME_____
TITLE_____
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"*super gem*" is on Aeroquip trademark. *U.S. Potent Nos. 2,833,567 and 2,731,279. Teflon is DuPont's tradename for its tetrafluoroethylene resin

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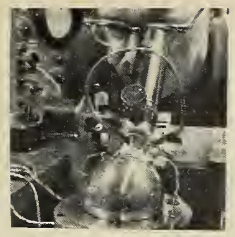
Missiles and Rockets Volume 5 Number 49

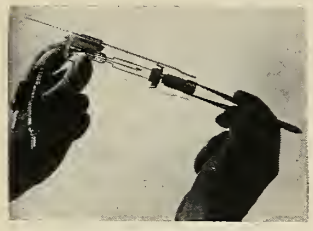
Published each Monday by American Aviation Publications, Inc., 1001 Vermont Ave., N.W., Washington 5, D.C. Wayne W. Parrish, *President;* Leonard A. Eiserer, *Executive Vice President & General Manager;* Fred S. Hunter, *Vice President & Editorial Director;* A. H. Stackpole, Eric Bramley, Robert R. Parrish, *Vice Presidents.*

Printed at the Telegraph Press, Harrisburg, Pa. Second class postage paid at Washington, D.C., and at additional mailing offices. Copyright 1959, American Aviation Publications, Inc.

Subscription rates: U.S., Canada and Postal Union Nations—1 year, $5.00; 2 years, $8.00; 3 years, $10.00. Foreign—1 year, $10.00; 2 years, $18.00; 3 years, $26.00. Single copy rate—$.50. Subscriptions are solicited only from persons with identifiable commercial or professional interests in missiles and rockets. Subscription orders and changes of address should be referred to Circulation Fulfillment Mgr., M/R, 1001 Vermont Ave., Washington 5, D.C. Please allow 4 weeks for change to become effective and enclose recent address label if possible.

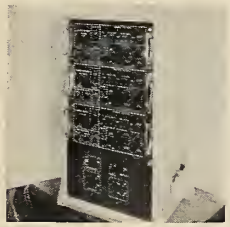


COVER: This shiny ball of beryllium is the heart of a new kind of gyroscope being developed by Minneapolis-Honeywell. It is designed to spin at high speed while held in position by electrical forces.



COLD-CATHODE electron tube under development by Westinghouse research laboratories uses silicon carbide (inside the cartridge) as emitter. A survey of semiconductor industry starts on p. 23.

MINIATURE tape recorder by Ampex recently survived in good working order after trip in instrumentation portion (similar to above) of missile nose cone. For the story, turn to p. 31.



RADAR simulator by Servonics is being used by Navy for simulating blips of attacking enemy. It may be used to train anti-missile batteries. See the report beginning on p. 37.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

32,200 copies of this issue printed

NOVEMBER 30 HEADLINES

ASTRONAUTICS ENGINEERING

U.S. Reg. Pdg.

ASTRIONICS

MISSILE SUPPORT

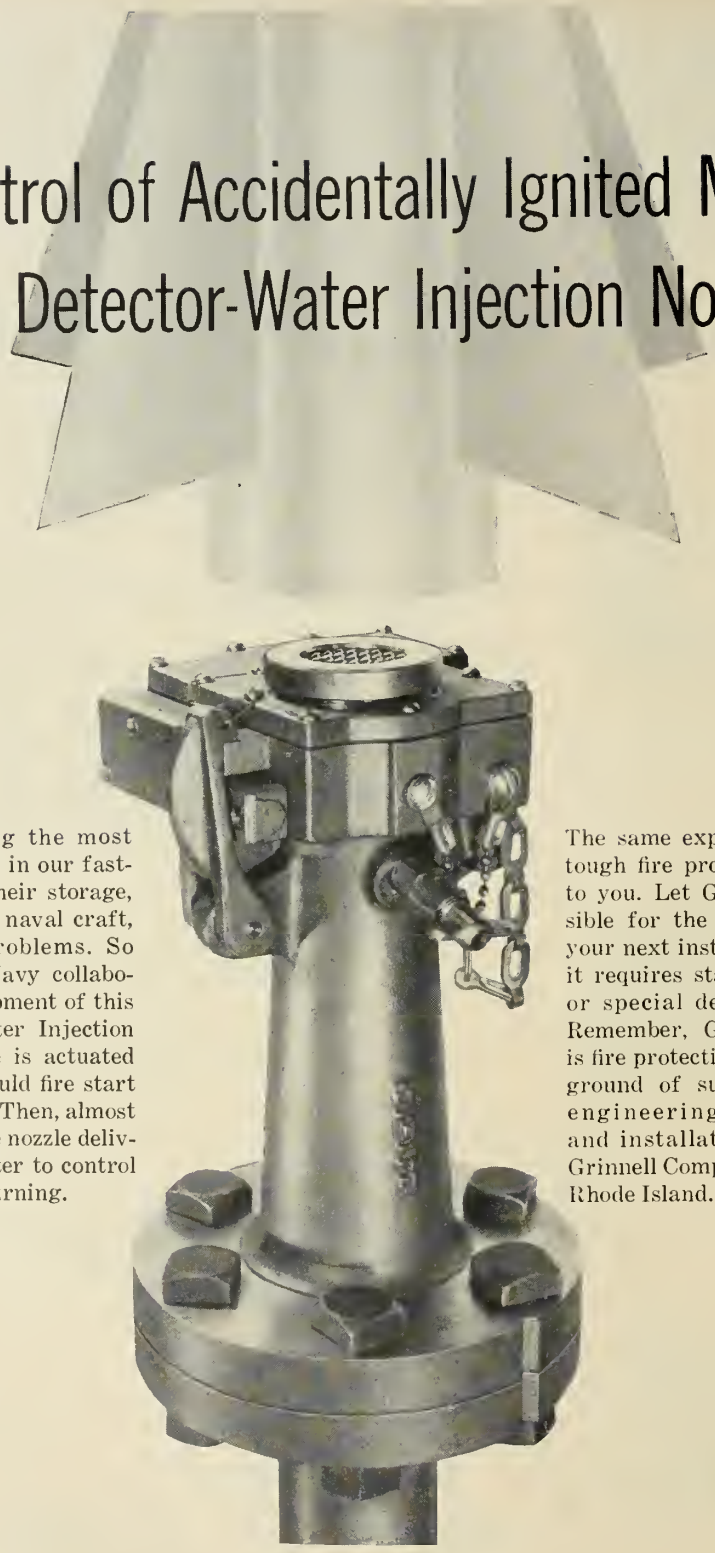
U.S. Reg. Pdg.

THE MISSILE WEEK

U.S. Reg. Pdg.

DEPARTMENTS

For Control of Accidentally Ignited Missiles ... Fire Detector-Water Injection Nozzle



Missiles are among the most destructive weapons in our fast-growing arsenal. Their storage, particularly aboard naval craft, creates critical problems. So Grinnell and the Navy collaborated on the development of this Fire Detector - Water Injection Nozzle. This device is actuated by shock waves should fire start in a missile booster. Then, almost instantaneously, the nozzle delivers a stream of water to control or extinguish the burning.

The same experience in solving tough fire problems is available to you. Let Grinnell be responsible for the fire protection on your next installation—whether it requires standard equipment, or special development work. Remember, Grinnell's specialty is fire protection . . . with a background of successful research, engineering, manufacturing and installation for 89 years. Grinnell Company, Providence 1, Rhode Island.

GRINNELL

Research, Engineering, Manufacturing and Installation of Fire Protection Systems since 1870

Circle No. 3 on Subscriber Service Card.

Seals With ± Zero Tolerance

SILASTIC® RTV
SILICONE RUBBER

Forms Airtight Weather-Proof Enclosure

Aircraft and missile engineers have found an effective material for sealing airframe members and other parts. It's Silastic RTV, the Dow Corning room temperature vulcanizing silicone rubber.

In the F-102 and F-106* canopies, for example, engineers at Convair Division of General Dynamics (San Diego), specified that the windows be "floated" in Silastic RTV. This window seal maintains cockpit pressure but resists cracking and checking and other effects of weathering and ozone. It remains pliant in spite of stratospheric cold.

And Silastic RTV seals are easy to form. Semi-fluid in nature, the RTV can be applied by caulking gun directly to the spot you want sealed. In a short time (you can vary the time from a few minutes to a whole day) the fluid sets up to a rubbery solid, and you have a seal with tolerances to ± zero. Other uses of Silastic RTV, aside from caulking and sealing, include potting of electronic gear and making of molds for prototype parts. Various consistencies are available for application methods other than caulking gun. For further information on this product, send for literature: "How To Use Silastic RTV." Address Dept. 7623.

*SHOWN: F-106 DELTA DART.

TYPICAL PROPERTIES OF SILASTIC RTV SYSTEMS

After Vulconizing (24 hours at 77 F)	*Fluid Grade*	*Caulking and Putty Grade*
Hardness, Shore A	30 to 65	20 to 55
Tensile Strength, psi	250 to 850	225 to 450
Elongation, percent	100 to 250	120 to 400
Brittle Point, degrees F	—100	—178 to —100
Shrink, linear, percent		
after 3 days* at 77 F	0.6	—
after 6 days* at 77 F	0.8	1.2 to 1.6
after 14 days* at 77 F	1.1	—
Water Absorption, percent after 70 hours immersion at 212 F	1.0	1.0
Working Time	10 min. to 3 hr	2 to 5 hr

Your nearest Dow Corning office is the number one source for information and technical service on silicones.

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

Circle No. 4 on Subscriber Service Card.

Kinetics design shrinks missile switch from 50 lb to 7 lb

As shown in this bottom view, the actual switch is much smaller than the bracket. Kinetics can put a 200-pole, double-throw switch in less than 200 cubic inches.

The original main power changeover switch in the Atlas missile that switched from ground supply to internal electrical supply just prior to launch weighed 50 lb. Now, thanks to the design ingenuity of Convair-Astronautics engineers who cut the number of circuits from 32 to 20 and to Kinetics Corporation engineers who provided a new design concept, the switch and bracket assembly weighs only 7 lb. Since a pound of savings in the missile-borne weight adds about a mile to the missile's range, this saving is truly spectacular!

The new Kinetics motor-driven switch is more rugged and reliable than previous designs and is impervious to shock and vibration. A typical Kinetics switch exhibits no contact chatter over the whole vibration spectrum, from 5 to 2000 cycles, 40 G's. The voltage drop across typical switch contacts is less than 10 millivolts at 22 amp.

The high-density design results in many circuits per cubic inch, saving space. There are no permanent magnets or springs, no latching devices. This is truly a motor-driven switch using no elements of relays. The switch can be transferred at 40 G's, 2000 cycles. Once it's transferred, no power is required to hold it in position, saving batteries. Write or phone for more information on how this switch can be adapted to your requirements. Kinetics Corporation, Dept. K-13, 410 S. Cedros Avenue, Solana Beach, Calif. SKyline 5-1181.

Circle No. 5 on Subscriber Service Card.

KINETICS
CORPORATION

ELECTRONICS · ELECTROMECHANICS

Washington Countdown

IN THE PENTAGON

Fate of *Nike-Zeus* . . .
in the FY 1961 budget appears dim as far as getting the more than $1 billion needed to begin production is concerned. Army officials are looking more hopefully at the idea of getting production money in a supplemental appropriation bill later next year for the big **Western Electric** AICBM.

• • •

Dyna-Soar money . . .
still left in the Air Force's pocket for FY 1960 is reported to total about $35 million. Some new word on contracts for the **Boeing-Martin** spacecraft is expected by Christmas.

• • •

Super Lockheed *Polarises* . . .
designed to travel 2500 miles are being proposed as a possible Navy answer to the Air Force's *Minuteman*. The *Polarises* would be deployed on fleet ballistic missile submarines larger than current models or on surface ships.

• • •

Air Force astronauts . . .
are being quietly trained for military space missions. The training program is generally similar to the one being undergone by the inter-service group of astronauts taking part in NASA's *Project Mercury*.

ON CAPITOL HILL

Space patent policies . . .
will get a second going over in less than two weeks. A House Space Subcommittee investigation of NASA patent regulations in early December will be followed by a Senate Monoply Subcommittee investigation of federal scientific patent policies in general.

• • •

Unfinished business . . .
that will confront Congress when it returns in January includes:

. . . Proposed bills that would further reorganize the Armed Forces in the direction of greater unification.

. . . An expected blistering report from the House Hébert Subcommittee's investigation of the "munitions lobby." The subcommittee plans to call for stricter legislation.

. . . Proposed bills that would strengthen the weapon system concept of developing defense projects.

. . . A rear-guard fight to strip the Armed Service Committees of power to authorize missile procurement programs beginning in 1961.

At NASA

Space budget problems . . .
for NASA include whether to go for a sizeable supplemental appropriation in January or lump all requests in its new budget for FY 1961. Speculation on how much NASA will seek for '61 is ranging between $750 million and $1 billion.

• • •

A "white paper" . . .
outlining U.S. national objectives in space is understood to be under preparation by NASA officials. It would be used to support NASA's space programs. However, NASA Chief T. Keith Glennan swears "up and down" that he knows nothing about the paper.

• • •

The Thanksgiving moon shot . . .
was dogged by difficulties. The *Able* stage of the *Atlas Able* rocket was damaged and NASA officials had to scrounge around for a substitute. (They took one scheduled for a *Tiros* shot next year.) And the *Atlas* adapter ring was bent twice—once each time an *Able* vehicle was hoisted into place.

• • •

No chances were taken . . .
that the *Atlas Able* finally assembled would blow up during a static test as the last one did in October. The solution was simple: NASA skipped the static test altogether.

AROUND TOWN

A huge red rocket . . .
may be under development despite Soviet denials. The sun shot forecast by Soviet Deputy Premier Mikoyan would have to be travelling at 25.5 miles/second at burnout—a feat requiring a new high energy fuel or a booster with upwards of a million pounds of thrust . . . or both.

• • •

***Lunik III* is doomed . . .**
to a short life because of orbit problems. Soviet Space Scientist Leonid Sedov told U.S. colleagues that torsional forces from the sun are pushing *Lunik III* closer and closer to the earth because of the high angle of inclination —70 degrees—of the space vehicle's orbit from the equator.

• • •

Other reports . . .
heard around the nation's capital:

. . . The Russians may hold a convention of Soviet rocket experts.

. . . *Jupiter* shipments to Italy are expected to begin early next year.

A SUBSIDIARY OF THE GENERAL TIRE & RUBBER COMPANY

Engineers, scientists—investigate outstanding opportunities at Aerojet. (Plants at Azusa and near Sacramento, Calif.)

Industry Countdown

MANUFACTURING

Underground silo launching . . .
for *Minuteman* is proving much tougher than anticipated. Initial tests have shown some radical new approaches are needed in the design of the silo to overcome destructive acoustics and heat generated at blast-off. The problem is so serious, the Air Force reportedly is considering switching *Minuteman* to an elevator type launcher similar to the one to be used by *Titan,* which raises the missile out of the silo for launching.

• • •

France holds poor market . . .
prospect for U.S. missile suppliers. The 1960 French defense budget earmarks only $22 million for development of a long range ballistic missile. About $66 million is allocated for three French Army *Hawk* anti-aircraft missile units. These are being produced jointly with Germany, Belgium, Holland and Italy under the system managership of a French firm—**Thomson-Houston Co.**

• • •

Dispersion of Snark . . .
missiles now "bunched up" at Presque Isle AFB in Maine is being proposed to improve their value as a deterrent weapon. Idea would be to scatter a squadron—putting two missiles to a "satellite site" consisting of a $250,000 tilt-up reinforced concrete building capable of withstanding 20 psi overpressures. A number of dispersed *Snarks* would be a cheap method, it is argued, of forcing up the cost to an enemy of knocking them all out.

• • •

Anticipating a boil-up . . .
in Congress, DOD is now moving to insure greater small business participation. It has invoked a mandatory program applicable to all procurement contracts over $1 million. The program replaces a voluntary one which resulted in only a slight increase in small business subcontracting in the first six months of this year.

• • •

New steel alloy . . .
packing about 7% more strength per weight unit than other structural alloy steels is claimed by **U.S. Steel.** Called "Strux," the alloy can be heat treated to develop tensile strengths of 280,000 to 300,000 psi for use in missile parts.

PROPULSION

Cermetic nozzle . . .
2-in. in diameter developed by **Nuclear Materials and Equipment Corp.** has withstood a 60-sec. blast of gases at over 4500°F. The alloy's composition has not been revealed, but it is said to be lighter than most used in R&D nozzles for the same temperature range.

• • •

Good stability and 255 I_{sp} . . .
are claimed for **Grand Central Rocket's** new "Nitrosol" solid fuel—a polymer based on nitrocellulose. Process and quality control are suited for mixing, casting and curing at launch site.

• • •

Rocket engines for autos . . .
are being developed at **Hagerty Research & Development Co.,** Tucson, Ariz. Fuel is nitrate and cellulose solid. Company claims when perfected, the engine can power a car for 10 hours on 50 cents worth of fuel. Speed: undisclosed.

ASTRIONICS

Little hope . . .
is held for thermomagnetic generation of power. Navy research shows the efficiency of such devices is too low.

• • •

Russians are recanting . . .
their reported claim of a breakthrough in thermoelectricity (M/R, Nov. 16, p. 11.) They admit the device which supposedly obtained a thermal efficiency of 182% doesn't exist and was, in fact, nothing more than an ordinary heat pump.

• • •

Look for NASA contract . . .
decision soon on Sunflower 1 (solar heat source) and Snap 8 (nuclear heat source). Contenders are **Thompson Products, Sunstrand, Allison** and **AiResearch Mfg.** Big requirement is 10,000-hour operational life.

WE HEAR THAT—

Unsuccessful bidders . . .
for NASA contracts soon may be told why they lost out—a new policy . . . The part **Bell Aircraft** may play in the Air Force *Dyna-Soar* program is still undecided . . . AiResearch Mfg. has come up with a 50-pound closed-circuit oxygen system for moon explorers . . . a copper-doped germanium crystal infrared detector has been developed by **Hughes Aircraft's** Santa Barbara Research Center which reported can track space satellites and ICBM's at extreme distances. Device is said to be six times as sensitive as similar-type detectors in 8-to-25 micron range . . . and **Summers Gyroscope** is discussing possible mergers with several companies.

More About the Missile Week on Page 41

FABRICATION TESTS SHOW...

New Titanium alloy takes th

...in strength...in weight...in reliability...in pri

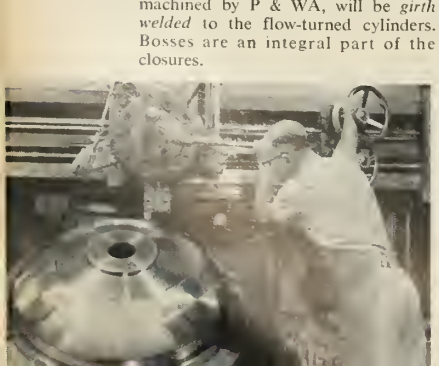
Titanium rocket-motor cases can be built at least 30 percent stronger (or lighter) than best available alternate metals; provide permanent corrosion resistance without protective coatings; withstand temperatures from −400°F to +800°F; will not absorb moisture which distorts critical parts in storage.

Completed assemblies give a spectacular two-way pay-off . . . immediately; provide a growth potential virtually unlimited.

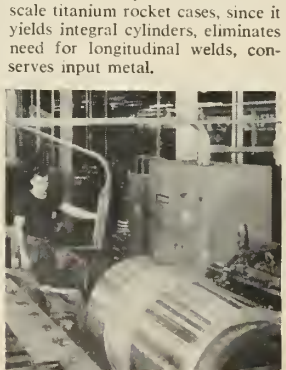
The alloy: Ti-13V-11Cr-3Al, the beta titanium alloy. Now available from Titanium Metals Corporation of America at commercial lead-times (billet, 2-3 weeks), beta may well become the metals story of the year.

Welding of titanium at P&WA is based on the company's experience in production of more than 5800 jet engines containing titanium parts. Weld strength of beta titanium alloy is considerably improved by cold working the weld.

End Closure Titanium Forgings produced by Wyman-Gordon Company and machined by P & WA, will be *girth welded* to the flow-turned cylinders. Bosses are an integral part of the closures.



Flow-turning from roll-forged rings, makes feasible production of full-scale titanium rocket cases, since it yields integral cylinders, eliminates need for longitudinal welds, conserves input metal.



Pilot rocket-motor cases manufactured by P & Whitney Aircraft from beta titanium a Ti-13V-11Cr-3Al have been consistently bu tested at levels in excess of 235,000 psi – a b strength/density ratio of 1,340,000.

So successful has been its titanium progr that Pratt & Whitney Aircraft considers production of full-scale titanium cases can easily realized. Estimated initial burst streng a conservative 180,000 psi – a burst streng density ratio of 1,000,000. Readily attainal 1,250,000.

Reasons for optimism, spelled out by P&W engineers are:

1. **"The welded beta titanium alloy is capable considerable plastic deformation prior to r ture. As welding has improved, the fail origins have moved into the thin wall (of case itself). With beta titanium, the case te but doesn't fragment.**

2. "We have successfully tested small scale titani cases with a steel equivalent yield strength w beyond the 300,000 psi point. Considering th the metallurgy of metastable beta titanium allo is not far beyond its infancy, conservatively c would predict strengths substantially higher th the 320,000 psi equivalent as being qu possible.

3. **"Beta titanium has to develop (only) 140,000 to be equivalent to 220,000 psi steel (which almost near steel's top limits). But titaniur great potential above other alloys is reflected the high figure for practical (based on 5 elongation) yield strength. At 180,000 be titanium is equivalent to steel at 280,000 psi; 200,000 psi, beta titanium is equivalent to steel 320,000 psi. 200,000 psi in beta titanium is pos ble, and obviously would mean substantially i creased payload to the moon or out into spac**

4. "Apart from the strengths attainable in the be titanium alloy, there is another property of co siderable significance. Like other titanium alloy it has excellent resistance to corrosion und normal atmospheric conditions, in salt water as well as in many other media.

"In considering the long time storage problen with rocket cases – a pit in a thin-walled casin can be catastrophic – we would regard the bet titanium alloy, as the outstanding materi under consideration."

ead in rocket case construction

PRATT & WHITNEY AIRCRAFT SURVEY OF ROCKET CASE MATERIALS

GENERAL PROGRAM

The goal: "A material capable of reaching 300,000 psi yield strength in steel, with a considerable development margin."

The result: "While this goal had to be modified for steel cases, we have successfully tested small scale titanium cases with a steel equivalent yield strength well beyond the 300,000 psi point."

Conclusions: 1. "By exercising reasonable care, the development of full scale (steel) cases at 240,000 psi is perfectly feasible.

2. "Small scale (titanium) cases have been burst at stress levels as high as 260,000 psi . . . we are convinced that reliable cases can be manufactured (from titanium) at yield strength levels of 180,000 psi and over . . . at 180,000 beta titanium is equivalent to steel at 280,000 psi.

"At 200,000 psi beta is equivalent to steel at 320,000 psi. 200,000 psi beta is possible and obviously would mean substantially increased payload to the moon or out into space."

SPECIFIC COMPARISON: Corrosion Resistance

Steel: "All of the low-alloy constructional steels which have been discussed are subject to general rusting and, far more serious, to pitting type corrosion during machining, welding, heat treatment, pressure testing and final storage. Corrosion pits can act as severe stress-raisers and, in conjunction with hydrogen, have been demonstrated to cause catastrophic failure. It therefore goes without saying that pitting corrosion is a serious hazard."

Titanium: "Like other titanium alloys, the beta titanium alloy has excellent resistance to corrosion under normal atmospheric conditions, in salt water as well as in many other media.

"In considering the long-time storage problems with rocket cases—a pit in a thin-walled casing can be catastrophic — we would regard the beta titanium alloy as the outstanding material under consideration."

SPECIFIC COMPARISON: Strength

Alloy	Density	Practical Yield Strength (5% elongation)
Ti-6Al-4V	0.161 = /in.³	155 ksi = steel at 270 ksi
Ti-13V-11Cr-3Al (Beta)	0.175 = /in.³	180 ksi = steel at 280 ksi 190 ksi = steel at 305 ksi 200 ksi = steel at 320 ksi

Burst Test Results show titanium has provided consistent burst strengths of 235,000 psi — a burst strength/density ratio of 1,340,000. Failure occurs in the wall of the case itself — not the weld zones. Titanium cases do not fragment.

• Reliability and growth . . . the parallel

Pratt & Whitney Aircraft data reveal rocket-cases can *now* be built from beta titanium at strengths 17 percent greater than alternate metals, with beta titanium's strengths bounding forward under a minimum of development.

A striking parallel exists in liquid-fueled rocketry where titanium alloy Ti-6Al-4V was selected for helium storage bottles in the Atlas missile because of its strength/density ratio. Airite Products, Inc., a leading supplier of the titanium vessels, reports:

"Minor modifications in processing techniques and continuous tightening of tolerances and other variables have shown an increase from the original 5400 psig average burst pressure to the present average which is in excess of 9000 psig.

"This has been done without increasing the weight of the article by one ounce. Weight of the unit, incidentally is controlled to a tolerance of plus or minus one-half pound, on a weight of 79 pounds, and volume is controlled and guaranteed to plus or minus one percent."

While the performance of the titanium pressure vessels has been almost doubled, the price has been reduced almost 50 percent — and the missile has become operational.

• When a case fails, so does the missile

The price of completed beta titanium rocket-cases is now estimated at 2½ times the price of other metals, with titanium cases virtually in their infancy. Should the titanium cost difference remain, the pay-off would still be two-fold:

1. **Cost:** engineering time, would be greatly curtailed; expensive fuels (for example, 30 pounds of fuel are required in earlier stages for each additional third-stage pound) would be saved.

2. **Reliability:** titanium cases simply will not pit, rust, deliquesce, or become hydrogen embrittled.

Added together, these elements mean feasibility—feasibility supported by the commercial availability of the metal itself. Beta titanium alloy Ti-13V-11Cr-3Al is available from Titanium Metals Corporation of America at these lead times: billet, 2-3 weeks; bar, 3-4 weeks; flat-roll, 5-6 weeks. TMCA's metallurgical experience with the alloy is yours for the asking.

For further information, write for TMCA Data Bulletin *All-Beta Titanium for Solid Rocket Pressure Chambers.* Extensive welding information is included.

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DECEMBER

Rocket and Missile Symposium, USAF Arnold Engineering Development Center and ARO, Inc., Arnold Air Force Station, Tullahoma, Tenn., Dec. 1-2.

Eastern Joint Computer Conference, Statler Hilton Hotel, Boston, Dec. 1-3.

National Conference on Application of Electrical Insulation, Sheraton-Park and Shoreham Hotels, Washington, D.C., Dec. 6-8.

American Institute of Chemical Engineers, 52nd Annual Meeting, Sheraton-Palace Hotel, San Francisco, Dec. 6-9.

American Management Association, Briefing Session on the Defense Market, Ambassador Hotel, Los Angeles, Dec. 7-9.

First Aerospace Finishing Symposium, sponsored by Southwest Society of Aircraft Materials and Process Engineers, and Dallas-Ft. Worth Branch of American Electroplater's Society, Hotel Texas, Fort Worth, Dec. 8-9.

Institute of Environmental Sciences, New York Metropolitan Chapter, Technical Symposium and Product Exhibition, Henry Hudson Hotel, New York City, Dec. 10-11.

1960

Sixth National Symposium on Reliability and Quality Control in Electronics, Statler-Hilton Hotel, Washington, D.C., Jan 11-13.

American Astronautical Society, Sixth Annual Meeting, New York City, Jan. 18-21.

Institute of Radio Engineers, 1960 Winter Convention on Military Electronics, Biltmore Hotel, Los Angeles, Feb. 3-5.

Engineering Materials and Design Exhibition and Conference, Earls Court, London, Feb. 22-26.

Univac Users Association, Semi-annual Meeting, Greenbrier Hotel, White Sulphur Springs, W.Va., Feb. 25-26.

American Rocket Society, Structural Design of Space Vehicles Conference, Biltmore Hotel, Santa Barbara, Calif., April 6-8.

American Welding Society, 41st Annual Meeting and Welding Exposition, Los Angeles, April 25-29.

National Association of Relay Manufacturers, Eighth Annual Conference on Electromagnetic Relays, Oklahoma State University, Stillwater, May 3-5.

Fourth Annual Summer Conference on Vacuum Metallurgy, New York University's College of Engineering, NYU University Heights Campus, (Bronx), New York City, June 2-3.

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Kearfott's rugged shaft position-to-digital converters are resistant to high shock and vibration and high and low temperature environments. Ideally suited for missile applications, these converters are available for many uses, including latitude, longitude, azimuth or conventional angular shaft displacement conversion and decimal count conversion. Exclusive drum design provides large conversion capacity in smallest size. Combination counter converter assemblies for both visual and electrical readout also available.

TYPICAL CHARACTERISTICS

Kearfott Unit No.	P1241-11A
Code	Cyclic Binary
Range	0-32,768 (2^{15})
Bits per Revolution	16
Revolutions for Total Range	2,048
Volts D.C.	10.5
Current (ma.)	20
Inertia (gm. $cm.^2$)	20
Unit Diameter (in.)	1 7/16
Unit Length (in.)	3
Life 10^6 Revolutions or 10^3 hours	
Static Torque (in.-oz.)	2 (break) 1 (running)
Weight (oz.)	5
Maximum Speed (RPM)	600

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This synchro, just one of a broad line offered by Kearfott, provides the extreme accuracy required in today's data transmission systems. Kearfott synchro resolvers enable system designers to achieve unusual accuracy without the need for 2-speed servos and elaborate electronics. By proper impedance matches, up to 64 resolver control transformers can also operate from one resolver transmitter.

TYPICAL CHARACTERISTICS — SIZE 25

	Transmitter	Control Transformer
Type Resolver		
Part Number	Z5161-001	Z5151-003
Excit. Volts (Max.)	115	90
Frequency (cps)	400	400
Primary Imped.	400/80°	8500/80°
Secondary Imped.	260/80°	14000/80°
Transform. Ratio	.7826	1.278
Max. Error fr. E.Z.	20 seconds	20 seconds
Primary	Rotor	Stator

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Kearfott integrating tachometers, special types of rate generators, are almost invariably provided integrally coupled to a motor. They feature tachometer generators of high output-to-null ratio and are temperature stabilized or compensated for highest accuracy integration and rate computation. Linearity of these compact, lightweight tachometers ranges as low as .01% and is usually better than ± .1%.

TYPICAL CHARACTERISTICS

	Size 11 (R860)
Excitation Voltage (400 cps)	115
Volts at 0 rpm (RMS)	.020
Volts at 1000 rpm (RMS)	2.75
Phase shift at 3600 rpm	0°
Linearity at 0-3600 rpm	.07
Operating Temperature Range	−54° +125°

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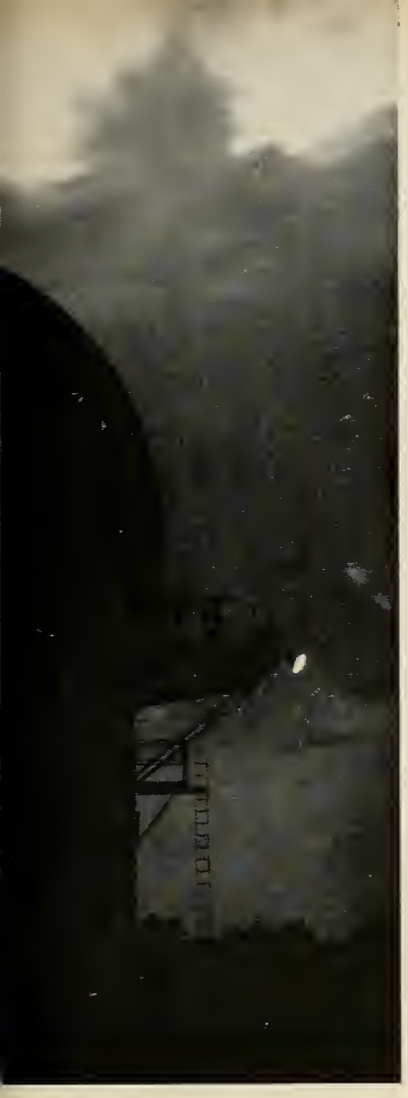
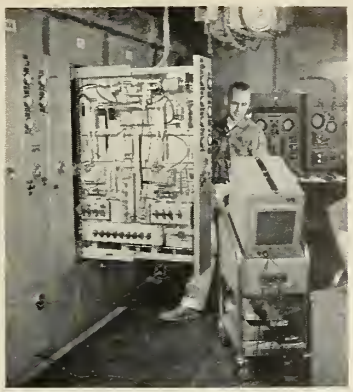
Westinghouse AN/FPS-27 Radar in operation at an Air Defense Command site

A single Westinghouse radar gets a 3-D fix on the enemy... dilutes his jamming ability

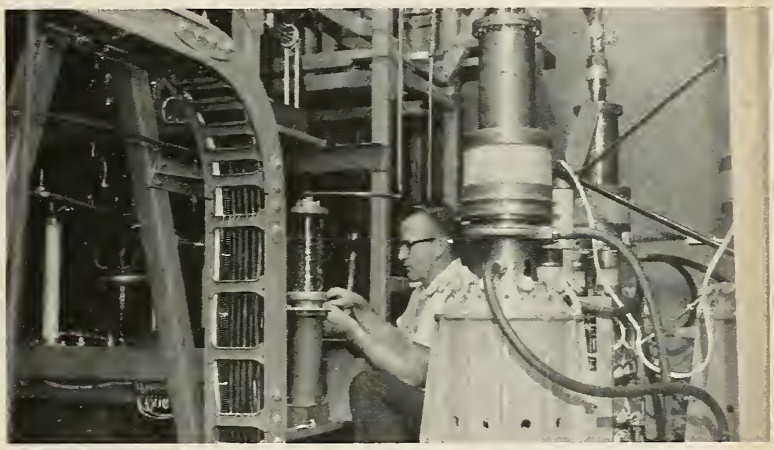
The AN/FPS-27, versatile 3-D radar designed by the Westinghouse Electronics Division for the Air Force's Rome Air Development Center, is achieving new standards of performance, reliability . . . and economy. Now under contract from the Rome Air Materiel Area, this high-power, stacked beam radar gathers range, azimuth and height data quickly and accurately while eliminating unwanted signals. These comprehensive functions in a single radar represent the application of the latest state of the art radar techniques to our nation's early warning defense.





MAINTENANCE EASE: AN/FPS-27 design stresses reliability and maintenance accessibility. A separate monitor console calibrates the receivers remotely. Equipment troubles are automatically indicated. Sub-assemblies can be replaced rapidly in case of circuit malfunction.

UNIQUE CONSTRUCTION DESIGN of the antenna system permits the inclusion of the latest 3-D height-finding techniques. Range, azimuth and height data can be automatically fed to a computer to form a composite picture of the air defense sector.



EASE OF OPERATION: One man operates the entire transmitter room. This is typical of the operational ease of the Westinghouse designed AN/FPS-27. A minimum team of six specially trained men can handle the operation and maintenance of the entire facility.

Here is the management team responsible for the development of the AN/FPS-27—within budget and on schedule. This team is typical of the Westinghouse practice of matching talent to the job.

The AN/FPS-27 is a part of a broad Westinghouse effort in shipboard, tactical and airborne radar. Current simulation studies at the Air Arm Division, utilizing the latest digital computer facilities (at right), hold promise for new approaches to the problem of long-range detection and tracking of aircraft and ICBM's.

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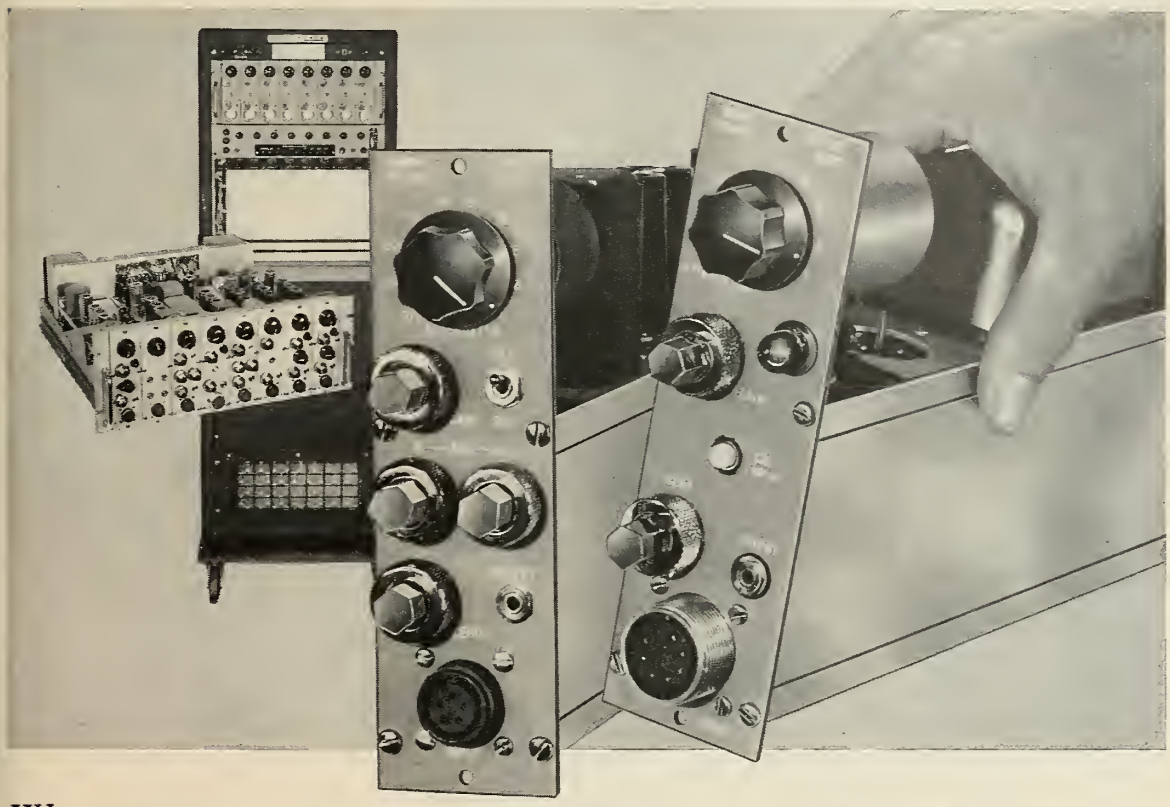

With the availability of these two new plug-in preamplifiers and associated MOPA, Sanborn 6- and 8-channel "850" oscillographic recording systems can now record an even *wider* variety of inputs — wherever *many channels* are needed in *minimum panel space*, with *no* sacrifice in system accuracy or reliability. The 850-1100A is a carrier amplifier-demodulator unit designed to work with resistance bridge, variable reluctance and differential transformer transducers. Attenuator, smooth gain, position and balancing controls are on the 2″ x 7″ front panel; input and output connections are provided at both front and rear. The 850-1500A is a chopper amplifier with floating input isolated from a floating output, capable of measuring low level DC-100 cps signals such as those from thermocouples and strain gage bridges. Design provides low noise operation, greater freedom from ground loop interference and high common mode rejection ratio. Required carrier excitation (2400 cps standard, 600, 1200 and 4800 cps optional) and chopper drive (440 cps) voltages are supplied by the 850-1900 MOPA, a dual-oscillator unit which can handle up to eight of each preamplifier.

SPECIFICATIONS

	850–1100A	850–1500A
Sensitivity	100 μv in gives 1 v at output	
Input impedance	approx. 2500 ohms	approx. 100,000 ohms
Output	±2.5v across 3300 ohms	±2.5 volts across 2500 ohms
Freq. response	−3 db at 20% of carrier freq.	0–100 cps, −3db
Linearity	±0.5% of full scale	±0.1% of full scale
Common mode performance		120 db for 60 cps, 160 db for DC with 5000 ohms unbalance in input
Noise		2 μv p-p over 100 cps bandwidth

(data subject to change without notice)

Ask your Sanborn Sales-Engineering representative for complete facts on all "850" system units — or write the main office in Waltham.

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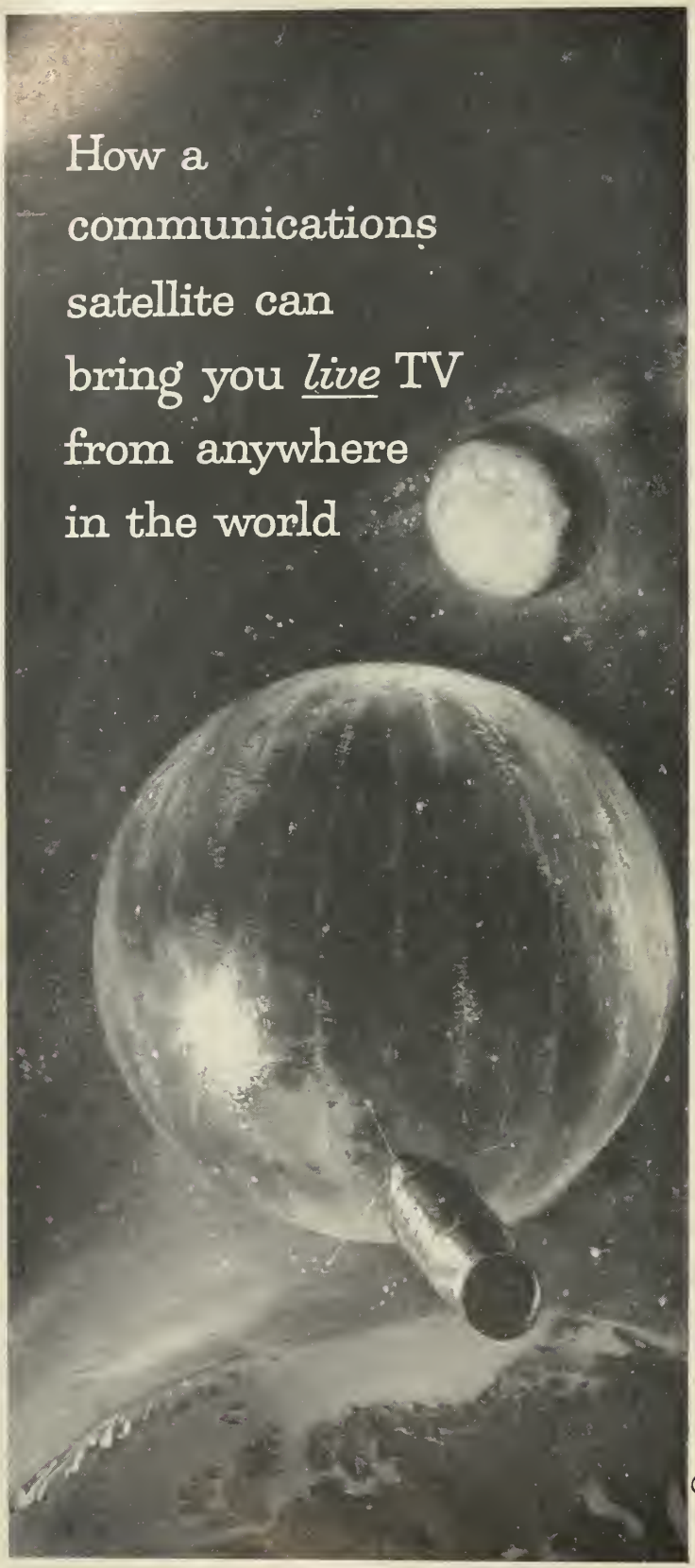

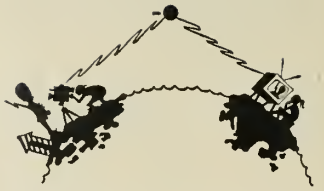

World-wide live TV, with no cable or radio relay costs, can develop from outer-space research by government and industry

Among the peaceful applications for scientific break-throughs being made in the study of outer space is a communications satellite.

Using inflated plastic satellites, boosted toward orbit by the Air Force *Thor* rocket, a global TV network could be established. TV signals would bounce to satellite and back to your station, giving you a front-row seat at events anywhere in the world. Cost should be a fraction of coaxial cables and microwave relays now used.

Practicality of *Thor* for this purpose is based on its demonstrated reliability. With Douglas responsible for airframe fabrication and assembly and test of the entire system, *Thor* has helped launch 84% of all payload weight put into space by the U. S.; is the key booster in the Air Force "Discoverer" firings; launched the first nose cone recovered at ICBM range.

Thor is another product of the imagination, experience and skills which Douglas has gained in nearly 20 years of missile development.

Foil-covered satellite, folded like a pocket raincoat, would balloon out in orbit as an inexpensive TV relay station

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AF Pushing for Big Solids

Industry expecting decision soon on feasibility contract for developing one-million-pound-thrust booster

by Jay Holmes

WASHINGTON—America may soon have a new entry in the race for space—a program for development of a million-pound solid-fuel booster rocket.

Maj. Gen. Victor R. Haugen, director of development planning, deputy chief of staff/development, U.S. Air Force, announced Nov. 5 that the Air Force plans "to let a contract very soon to demonstrate the feasibility of a rocket engine which will be twice as large as any other under development."

Thiokol's *Minuteman* booster is the largest solid rocket at present under development. Its thrust and other performance figures are classified. However simple physical calculations indicate that it could not be much less than 400,000 lbs. and might be more.

The *Nike-Zeus* booster, although not the largest rocket in size, is known to develop 450,000 lbs. thrust. Thus an engine twice as large as any other under development would have to approach the million-pound class.

Industry has greeted the development with enthusiasm. At least four major rocket companies have announced that they are capable of taking on the development of a motor of this size. It is believed that at least two other companies are interested. The "million-pound solid booster" was a major topic of conversation and conjecture in the industry suites at this month's American Rocket Society convention.

John Gustavson of the Advanced Concept Office, **Grand Central Rocket Co.**, outlined details for construction of a 2.4-million-lb.-thrust solid engine, which would burn 72 seconds at a thrust-to-weight ratio varying between 2.5 and 7.9. The booster, weighing 691,000 lbs., would be 90′ long and 12.5′ in diameter and would perform at a specific impulse averaging 265 seconds between sea level and the burnout altitude of the booster, he said in a paper read in the session on solid rocket technology.

Gustavson said six of these rockets, known as *Cronus*, could be clustered into a 14.4 million lb. booster, which he named *Novus*. The *Cronus* could operate, he said, with a second stage generating 650,000 lbs. thrust for 82 seconds and a third stage generating 100,000 lbs. thrust for 133 seconds. This configuration could lift a payload of 26,000 lbs. into a 300-nautical mile orbit, Gustavson calculated.

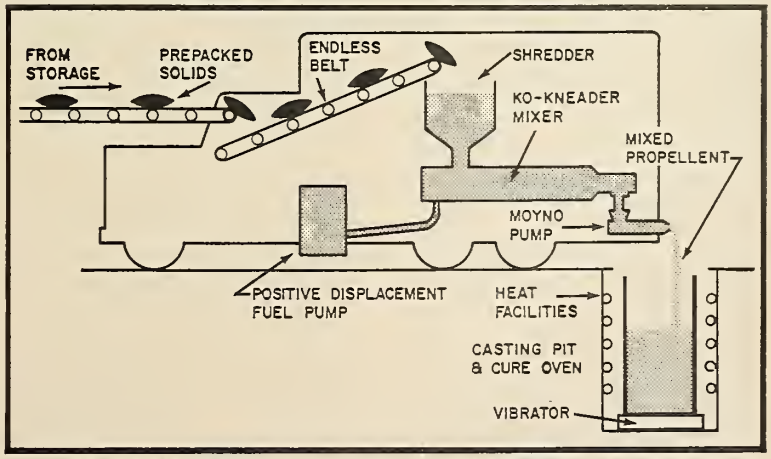
Thiokol, **Aerojet-General** and **Rocketdyne** also have indicated in recent weeks that they are capable of building boosters in the multi-million-pound range.

In comparing solid and liquid boosters, one must recall the much longer typical burning times of liquid-fueled rockets. For example, most large liquid rockets under development contemplate burning times of 180 seconds.

A truer measure of the size of a rocket is the total impulse, measured in pound-seconds. The Grand Central *Cronus* booster would have a total impulse of 172.8 million pound-seconds. This would compare in total impulse with a 180-second liquid rocket with an average thrust of 960,000 lbs.

At the Symposium on Advanced Propulsion Concepts, held in Boston last month by **Avco-Everett Research Laboratory** and the Air Force Office of Scientific Research, Dr. Harold Ritchey of Thiokol proposed a solid booster of 10 million lbs. thrust and 60 seconds duration. This would thus have total impulse of 600 million pound seconds, comparable to a liquid rocket generating 3 1/3 million lbs. thrust for 180 seconds.

Gustavson and other solid-fuel spokesmen maintain that a scaled-up booster can be developed in for less



CONTINUOUS MIXING process developed by Grand Central Rocket Co. for loading big solid-fueled booster rockets at the firing site.

time than required for liquids because solids have fewer parts. And, since development cost is largely dependent on the length of time involved, they argue that developing a large solid rocket is cheaper.

Last spring, the Air Force made a routine query of contractors as to what it would cost to demonstrate the feasibility of a million-pound solid rocket. The bids received varied from under $2 million to more than $6 million. M/R has learned that one of the under-$2-million bids contemplated a first static test 8½ months after the go-ahead.

However, the Air Force decided not to award any contracts at that time. Officially, the situation lay dormant until Maj. Gen. Haugen made his statement in a speech before the 12th annual national conference of the Public Relations Society of America at Miami Beach, Fla.

Gen. Haugen said the Air Force, which has been working with solid fuels since 1953, feels they "hold great promise for reduced costs" in addition to the often-cited advantages of instant reaction, long storage life and ease of maintenance.

• **Energy Rate**—Another advantage cited by the solid supporters is the higher rate of energy production in solid boosters, which enables them to better overcome the loss due to gravity. For example, in the Grand Central *Cronus* proposal, the thrust-to-weight ratio at takeoff would be 2.5. Subtracting the one G lost to gravity, the acceleration at takeoff would be 1.5 G, gradually rising to about 7 G just before cutoff.

The liquid rocket is limited by the weight of pumps and tanks to a maximum of 1.5, Gustavson declared. Thus the initial acceleration is less than 0.5 G. This gradually increases, he said, until its burnout acceleration is just equal to the burnout acceleration of the solid.

Thus, solid rocketeers assert, the total velocity increment is less for a liquid than a solid. They further maintain that this difference is sufficient to overcome the liquids' advantage in specific impulse and the somewhat lower dead weight of a liquid booster.

Thiokol's Ritchey maintains that the division of responsibility between solids and liquids for space now is just the opposite of what it ought to be, with boosters and lower stages liquid and solids in the upper stages.

Actually, he says, the higher specific impulse of liquid fuels can be used to better advantage in the upper stages, while in a booster specific impulse is not quite so critical a factor.

Ritchey points out that high-energy fuel systems and exotic case materials always are preferred, at least in early stages of their development, for upper-stage use. The same argument would lead to selection of high-energy liquid upper stages, he says.

Solid rocketeers concede the impossibility of turning their flames off and on again. But they say this is less important in a booster, which must lift a system into orbit before any other space mission can be performed.

The Air Force outlined its requirements for such a booster to contractors Nov. 10 at a meeting at Edwards Air Force Base, Calif. The meeting was attended by representatives of Thiokol, Aerojet, Rocketdyne, Grand Central, **Hercules Powder Co., Atlantic Research Corp.** and the **United Research Corp.**, a subsidiary of **United Aircraft.**

A key to the manufacturing of large solid-fuel rockets is the continuous processing of propellant. For a booster solid would be too big to transport by rail or truck to the site. Thus on-site loading seems a logical alternative. This would require on-site processing. At least six companies are working on development of continuous processing methods.

Rocketdyne disclosed some details of its method in a statement issued at the ARS convention. The North American division says its process, known as "Quickmix," is expected to provide a high degree of mobility for manufacturing in the field and loading into large motors. Rocketdyne is applying the process to several propellant combinations under contract with the Manufacturing Methods Division, Air Materiel Command.

A "Quickmix" pilot plant, which has a minimum capacity of 500 lbs. of propellant per hour, recently was loaded onto a 30' truck trailer and transported from California to Rocketdyne's solid propellant plant (formerly named Astrodyne) at McGregor, Tex.

In the process, ingredients are blended in a matter of seconds with only a small amount of material in the mixer at any given moment. The oxidizer is dried, sifted and ground before being dispersed in a liquid carrier.

Minor dry propellant ingredients are handled in a similar way. Liquid ingredients enter the system through a colloid mill for emulsifying with the liquid carrier. Where metallized propellants are required, the powdered metal also will be mixed with a liquid carrier, thus reducing the special hazards that come with handling of fine metal powders.

The streams of oxidizer and other ingredient in the liquid carrier are blended at high speeds in a small mixer. Because of the fluidity, mixing is accomplished rapidly with no appreciable heat buildup and a very low power requirement. The propellant forms immediately on contact of the binder droplets and oxidizer particles.

Rocketdyne says a Quickmix plant with a capacity of 5,000 lbs. per hour could be constructed and it would also be able to operate successfully at reduced rates. The plant and raw ingredients would be transported to the proposed firing site for the field loading of rocket motors larger than feasible to transport from plant to site.

• **Other methods**—Grand Central has developed a continuous mixer on a truck trailer. Propellant ingredients can be trucked to the site, mixed at leisure, loaded directly into the rocket case and stored until needed.

Thiokol, Aerojet-General, Hercules and **Olin Mathieson** are known to be developing continuous mixing processes. The problems have not all been solved. Several explosions have occurred in recent months during tests of these processes.

Next Week: Soviet Propulsion

Next week, MISSILES AND ROCKETS *presents another exclusive first—a complete and authoritative report on Soviet rocket propulsion systems.*

Donald J. Ritchie, one of America's top non-government experts on Soviet rocket and aircraft technology, gathered his material through a study of 120 textbooks and hundreds of periodicals in the Russian language. Ritchie, a project mathematician in the Research Laboratories Division, Bendix Aviation Corp., formerly was engaged in R&D work at Wright Air Development Command, Melpar Inc. and Crosley Division, Avco Corp.

Among the details outlined for the first time in Ritchie's comprehensive account will be the thrust level and other technical data for the Soviet ICBM's, Sputniks, Luniks and many smaller rocket systems.

M/R Surveys the Exploding Semiconductor Industry

Already a half-billion-dollar-a-year business, forecasts indicate the total will double in five years unless imports hit defense market . . .

by Charles D. LaFond

WASHINGTON—The semiconductor industry is experiencing a growth that resembles an explosion. Barely eleven years old, its future impact on the rest of the electronics industry cannot even be guesstimated. We are blinded by long-range market forecasts, business speculations, technological huckstering and research ballyhoo.

M/R estimates, based on an industry survey, indicate the total 1960 semiconductor market will approach $510 million: $295 million military; $215 million commercial. These figures represent a mean, for industrial estimates vary by about ±$4 million. But on one total—the 1965 estimated market—the figure was almost a unanimous $1 billion.

According to Dr. Frank Herman, **RCA Laboratories,** thousands of articles and responsible text books already have been published on semiconductor science and technology. Well over 150 commercial companies are now engaged in development and production of solid-state devices and more than 100 of these are American firms. (It has been estimated that nearly 35% of the world volume of currently published basic research in physics is in the solid-state area. Roughly, this is between 1500 and 2000 papers annually.)

He conservatively estimates that the total semiconductor-device output should overtake that of vacuum tubes by about 1962 in the United States.

• **The industry**—The accompanying chart contains most of the semiconductor manufacturers in the U.S. today and a list of the principal products of each by category.

For a rapid rundown of what some of the major producers are doing, the following summary has been prepared. The list is not intended to be complete, but it will indicate the trends of today—that is, the successful smaller companies are carefully expanding and the large manufacturers are engaged in an R&D marathon. Big or small, each is making technological headway.

Pacific Semiconductors, Inc., recently announced development of a "micro-micro diode" weighing 14.09 milligrams (a standard silicon diode weighs approx. 160 mg). According to PSI, the small size was achieved by a molecular bonding process. It was described as a chemical surface passivitation technique in which silicon crystal molecules are bonded with the protective-coating surface elements.

A relative newcomer to the field is **P. R. Mallory and Co., Inc.,** which will limit its efforts to single junction devices for the present. Developmental work and pilot production operations are nearly complete. Diffused junction silicon rectifiers will be marketed during 1960, but certainly growing pains will slow its mass entry into the field.

Philco Corp. is involved in almost all phases of semiconductor R&D and manufacturing; it has programs to develop packaging for severe environments, to increase power dissipation and increase maximum storage limit to 175°C, to improve fabrication techniques, to replace potting compounds in some devices with a process wherein no heat is developed.

According to a company spokesman, significant research is being directed toward new semiconductor materials which will make possible new physical phenomena. Magnetic-film memories for next-generation computers are being studied along with electroquenchable phosphors for low-cost computer elements.

Industro Transistor Corp., a manufacturer of high-quality PNP germanium alloy junction transistors only, expects to increase its product line considerably during the next six months with silicon mesa and power transistors, and silicon rectifiers. (It is interesting to note that Industro has experienced a management metamorphosis. Fiscal '58 and '59 showed successive deficits. During the last quarter of its current year, it has completely removed the deficit and showed an earning above taxes of $0.24 per share.)

Primary company research efforts are aimed at tunnel diode development and radical improvements in transistor environmental capabilities.

Transitron, Inc. has achieved a remarkable growth in the last few years. A manufacturer of semiconductor components only, it is currently a family-owned closed corporation. This December it will make a 1-million-share public stock offering.

Already a broad contributor to the semiconductor product field, **Raytheon Company** is investing much of its research in continued development of tunnel diodes and the avalanche mode transistor for high-speed switching.

The Semiconductor Div. of **Fairchild Camera and Instrument Co.** has concentrated on development and production of high-quality silicon transistors for ultra-high-speed switching. It recently introduced seven new types of transistors and some silicon devices for microminiaturized circuitry. Research programs are investigating new semiconductor materials, tunnel diodes, parametric diodes, microminiaturized

modules, and devices using intermetallic compounds.

Hoffman Electronics Corp.'s Semiconductor Div. recently announced success in one of its R&D programs. It has developed automatic test equipment that speeds up high-low temperature operating "run-in" tests on Zener diodes by 700%. (Tests are designed to insure maximum stability and reliability.)

Texas Instruments has a complete line of solid-state components. A pioneer in the field, it produced one of the first demonstration solid state functional circuits. TI uses diffusion techniques with photolithographic processes to produce circuit "components" in a single semiconductor crystal.

Westinghouse Electric Corp.'s Semiconductor Div. is engaged in a sizeable research program. A large semiconductor producer, it is pushing its efforts for a better understanding of molecular electronics. By modifying the properties of solid-state material through a control of crystalline structure, a desired function can be achieved by the researchers without the need for individual components.

Westinghouse believes only an approach such as its molectronics can achieve the desired reliability, ruggedness, and low power consumption necessary for tomorrow's missile/space system requirements.

For more conventionally sized circuits, the company has been investigating cold-cathode type electron tubes using various semiconductors for electron emission. It recently announced successful use of silicon carbide in such a "transistorized" electron tube. Power requirements are negligible; current flow is low but adequate (of the order of 1 microampere).

Radio Corporation of America, General Electric, and **Hughes Products** —Semiconductor Div. are all large producers of semiconductor devices. Accordingly, each maintains a broad research effort: molecular electronics and thin-film circuitry, exotic metals, and the whole gamut of conventional solid-state components. Each has had notable success in the development of tunnel-diode circuit applications.

• **Transistor prices**—To understand the steady downward trend of transistor unit prices, a study of the development and subsequent production record of transistors is most revealing.

Initially, development costs were high for the first year following the **Bell Telephone Labs** invention of the point-contact transistor. As costs began to decline, the zone-refining process evolved and the junction transistor was conceived. Development costs again rose sharply and continued until 1952. The first real production began in 1952. It has risen sharply and almost linearly ever since.

In 1955, with the birth of the diffusion process and the silicon transistor, developmental costs again rose sharply. Only recently have they begun to taper off somewhat. Bell Labs estimates that the total 1955 production of transistors was approximately 4 million units at an average unit price of four dollars.

By 1960, production will be well over 100 million units and the average price will have dropped below two dollars. Production may level off at around 750 million by 1970 with a unit price near $0.70 or less. Rapid development and application of tunnel diodes and future breakthroughs can completely alter these estimates. Only time will provide all the answers.

It is also interesting to note that as a result of advances in diffusion technology, the semiconductor diode market should eventually equal that for transistors. Many feel it may even exceed the transistor market because of the diverse applications for diodes.

Major U.S. Semiconductor Makers

	Transistors							Diodes			Rectifiers			Cells
	Germanium	Germanium Power	Photo	Silicon	Silicon Power	Switching	Tetrode	Germanium	Silicon	Zener	Germanium	Silicon	Solid State Thyratrons	IR Detector
Aeronica Mfg. Corp.														X
Allis-Chalmers Mfg. Co.											X	X	X	
American Elite, Inc.								X						
American Rectifier Corp.								X	X			X		
Amperex Electronic Corp.	X	X	X					X	X	X	X	X		
Arco Electronics, Inc.									X	X				
Audio Devices, Inc.									X			X		
Avion Div., ACF Ind., Inc.														X
Axler Associates														X
Barnes Eng. Co.														X
Basic Controls Corp.														X
Bausch & Lomb Optical Co.														X
Baird, Atomic, Inc.														X
Bendix Aviation Corp.	X	X		X	X	X						X		
Block Assoc., Inc.									X			X		X
Bogue Elect. Mfg. Co.	X			X	X		X	X	X		X	X		
Bomac Labs.									X					
Bradley Semicond. Corp.												X		
CBS-Hytron Div.	X	X			X	X		X	X					
Cartriseal Corp.								X	X					
Centronix, Inc.														X
Clark Electronics Lab.											X	X	X	
Clevite Corp.	X	X			X	X		X	X					
Columbus Electronics Corp.									X			X		
Crystalonics, Inc.				X										
Delco Radio Div.	X	X												
Delta Chem. Works								X	X					
Dynamic Electronics, Inc.														X
Eastman Kodak Co.														X
Emerson Electric Co.														X
Erie Resistor Corp.								X						
Fairchild Semicond. Div.				X	X	X								
Fansteel Metall. Corp.									X			X		
Farrand Optical Co., Inc.														X
Ferranti Elec., Inc.									X			X		
Finney Co.								X	X					
Electronics Corp. of Am.														X
Flame Research, Inc.														X
GB Electronics Corp.														X
Gates Electronic Corp.												X		
Gen. Electric Co.	X			X	X	X	X				X	X	X	X
Gen. Instrument Corp.								X	X	X	X	X		
Gen. Nuclear Corp.												X		
Gen. Transistor Corp.	X		X	X		X		X						
Great Eastern Mfg. Co.	X		X	X	X	X	X	X				X		
Gulton Ind., Inc.	X			X	X									
Hoffman Electronics Corp.				X	X				X	X		X	X	X
Hughes Semicond. Div.	X			X		X		X	X	X		X		X
Hycon Mfg. Co.														X
I.T.T. Corp.									X	X		X		X
Industro Transistor Corp.	X													
Intercont. Electronics Corp.	X							X						
Internat'l Electronics Corp.	X		X		X	X								
Internat'l Electronics-Mullard								X						X
Internat'l Rectifier Corp.									X	X	X	X		
Intimex Corp.			X											

• **Transistor imports**—At least one cloud exists on the transistor market horizon. Japanese imports have been increasing steadily. According to David R. Hull, president of the Electronics Industries Association, Japanese sales have hit the entertainment-type transistor field to the tune of 25% of the total U.S. business. There is one Japanese transistor import for every 3.6 units produced here, he said.

The danger, he pointed out, is that this is the market that has provided manufacturers with the funds to carry out R&D in other areas.

It is also obvious, he said, that if they can make inroads on the market to this extent in three years, it stands to reason that the defense market will also prove vulnerable.

• **Development**—Just in developing what we now have—that is, without considering advanced research aimed at further breakthroughs—what will the expected industry accomplishments be in the next few years?

Standardization of designs certainly will be a primary target for advance. Refinement, simplification, and reduction of designs for broad application will continue.

Manufacturing processes and techniques can be improved. Progress in automation has been made but to keep up with requirements—quality and quantity—large-scale advances are needed. Improvements are needed to protect semiconductor surfaces. Currently this is an expensive process necessary to obtain intrinsic reliability in bulk semiconductors.

A better understanding of the uses of semiconductor devices is mandatory. New circuit techniques will aid greatly the rapid application of such devices to a vastly greater number of different equipment.

To expand the range of available (or obtainable) electronic properties, other intermetallic compounds must be rigorously investigated and exploited. Others can be used to fill the gap in meeting more environmental requirements.

We need better methods of measurement and control of impurities when an order of magnitude of parts per million is considered. Until proper methods are devised, the semiconductor industry will be based more on art than exact science.

Improved or even new methods of attaching mechanical components to semiconductors are needed. Production type plating, welding, and soldering techniques in current use often introduce impurities and other degrading efforts into the finished product.

	Transistors								Diodes			Rectifiers			Cells
	Germanium	Germanium Power	Photo	Silicon	Silicon Power	Switching	Tetrode	Germanium	Silicon	Zener	Germanium	Silicon	Solid State Thyratrons	IR Detector
Isomet Corp.														X
Kellogg Switchboard & Supply Co.	X													
Kemtron Electron Prod., Inc.								X	X					
Leeds & Northrup Co.														X
Librascope, Inc.														X
Lindly & Co.														X
Litton Ind.					X									
Macarr, Inc.												X		
P. R. Mallory & Co., Inc.				X					X			X		
Marstan Electronics, Inc.														X
Microwave Assoc., Inc.									X					
Minneapolis-Honeywell	X				X		X	X						
Motorola, Inc.	X	X		X	X	X			X	X	X	X	X	
North American Electronics, Inc.									X	X		X	X	
North Hills Elec. Co., Inc.										X				
Nucleonic Prod. Co., Inc.								X						
Ohmite Mfg. Co.								X						
Opad Elect. Co.									X		X	X	X	
Pacific Semicond., Inc.				X	X	X			X	X		X		
Perkin Eng. Corp.											X	X		
Perkin-Elmer Corp.														X
Philco Corp., Lansdale Tube Co., Div.	X	X		X	X	X		X	X		X	X		X
Pyramid Elect. Co.												X		
Qutronic Semicond. Corp.	X	X	X				X	X	X					
RCA, Electron Tube Div.	X	X	X	X	X	X		X	X			X	X	
Radiation Electronics Corp.														X
Radiation, Inc.														X
Radio Dev. and Research Corp.	X			X	X				X					
Raytheon Co.	X			X	X	X		X	X		X	X		X
Rectico, Inc.												X		
Rheem Semicond. Div.				X	X	X			X			X		
Sarkes, Tarzian									X			X		
Semicon, Inc.									X			X		
Semi-Elements Inc.	X		X	X	X	X		X	X					X
Servo Corp. of Am.														X
Shockley Transistor Corp.									X					
Silicon Transistor Corp.				X	X	X			X			X		
Solid State Prods.				X	X	X							X	
Sperry Rand Corp.				X		X			X			X		
Sprague Electric Co.	X													
Sylvania Electric Prods.	X			X	X	X		X	X		X	X	X	
Syntron Co.									X			X		
Technical Apparatus Builders					X			X	X		X	X		
Texas Instruments	X	X	X	X	X	X	X		X	X		X		X
Thermosen, Inc.									X			X		
Thompson Ramo-Wooldridge	X			X										X
Topp Ind., Inc.	X													
Transitron Electronic Corp.	X	X		X	X	X		X	X	X	X	X		
Trans-Sil Corp.				X	X				X			X	X	
Tung-Sol Elect., Inc.	X	X			X	X			X			X		
U.S. Dynamics Corp.				X	X			X	X		X	X		
U.S. SemiCond. Prods. Div.									X	X		X	X	X
U.S. Semcor										X				
Vickers, Inc., Elect. Div.									X			X		
Warren Components Div., El-Tronics, Inc.								X			X	X		
Westinghouse Elect. Corp.	X	X		X	X	X		X	X		X	X	X	X
Workman TV, Inc.	X	X										X		

Huge Solar Converter Used To Open New Hoffman Plant

Los Angeles—Power from "Big Bertha," the world's largest solar energy converter, was used to open the doors to **Hoffman Electronic Corporation's** new Semiconductor Center at dedication ceremonies here last week.

The $2-million plant will be used to conduct research and development of solid-state material devices.

Described as the largest and most advanced of its type in the world, the Center is the first designed to mass-produce solar cells. The facility is reported to be able to produce semiconductor materials with a purity of 99.9999999%.

Hoffman's production capacity will be more than doubled by the new Center. Annual sales potential is increased to approximately $35 million. Employment at capacity will be an estimated 2000.

'Who Says There's A Space Race?'

Dr. Eberhardt Rechtin, Chief of the Telecommunications Division, Jet Propulsion Laboratory, NASA, recently delivered an address before the Electric Club of Los Angeles on the subject "Who Says There's a Space Race?" M/R reproduces it here in condensed form.—Ed.

A race has certain required elements. There must be a reward, a significant achievement and an interested audience. And there must be at least one participant, not necessarily two. We can all think of examples of a single participant who is racing against time.

This being true, then there most certainly is a space race since we have one highly demonstrative participant, the Russians, and ample evidence of the achievements, rewards, and interest to the audience.

Let us then consider the race from the point of view of the Communist government and society of the USSR. They want a strong Russian Communistic society. They want to expand their sphere of influence. And they want an increasingly favorable economic situation for Russia.

There is not much question that the original Soviet missile program was a direct consequence of a military need to counter our Strategic Air Command. According to the Soviet scientists, it was no simple task for them to get their space program started. As a matter of fact, it apparently took several years.

According to one possibly apocryphal story, a very serious question was raised in the upper Soviet government circles as to whether or not the Soviets should launch space vehicles at all. Certain members of the Soviet government were very seriously concerned that such space activity might trigger the United States into engaging in this race of missiles and space.

• **The payoff**—Probably neither the Russians nor the Americans remotely guessed the prizes which the Russians would pick up as a result of their success.

Some of the prizes can be valued in cold cash. The Russians probably spent on the order of $500 million to launch the first several *Sputniks*. As a direct result, the Russian technical prestige took a large discrete jump upwards in the world market. Conservatively, this jump, based upon the size of the world market and the size of various governmental expenditures, meant a return on the world market on the order of $5 billion.

To illustrate:

Suppose that you were a civil servant in South America or in Asia choosing a contractor to build a bridge.

We will consider two cases. First, go back to 1954. You would probably consider obtaining your bridge from the United States, the United Kingdom, or perhaps, West Germany. It is unlikely that you would consider a Russian contractor too seriously. Now, let's go to 1958. The countries which immediately come to mind are Russia and the United States.

Well, the prize of technical prestige in obtaining more of the world market is relatively obvious. Another prize, very easily overlooked by us, is an advantage which is probably of even greater value to the Russian Communist leaders—the fact that the Russian people are understandably and justifiably quite proud of their new technical achievements.

It is probably no coincidence that the Russians began mentioning (and we began considering) coequal summit meetings just after the launchings of the *Sputniks*. It is now no longer Russia, Great Britain, and the United States as the three great powers, it is now Russia verses the West, even up.

• **What next?**—The Russians will most certainly continue in the space race, since this race very well meets the overall objectives of the Russian Communist society.

From the economic standpoint, it can be shown that certain types of space vehicles will more than pay for themselves. Both communication and weather satellites can be used to make money. The Russians, could, for example, set up a world-wide communication system considerably better and more reliable than our high frequency radio system in use today—then rent and control this system.

• **What to do?**—The United States at the moment is neither in nor out of the space race. We have made no declaration to accept the Russian challenge. We have no programs whose avowed intent is to close the gap between ourselves and the Russians. We have one or two programs whose hopeful intent is to try to keep the gap from getting wider. At the present time, one of the most remarkable features of the U.S. position is the almost complete lack of urgency in the space program.

The NASA budget is now somewhat less than what the United States pays to ship and store surplus wheat. Our space program is less than two percent of our defense budget. The space program costs less than ten dollars per year per U.S. adult or roughly one evening's entertainment per year.

On the other hand, we have not declared ourselves *out*, either, although in the last two years we have dropped six months to a year further behind in the process of organizing, re-evaluating, carving out paper empires, and fighting over who is going to be the boss to tell the professional what to do.

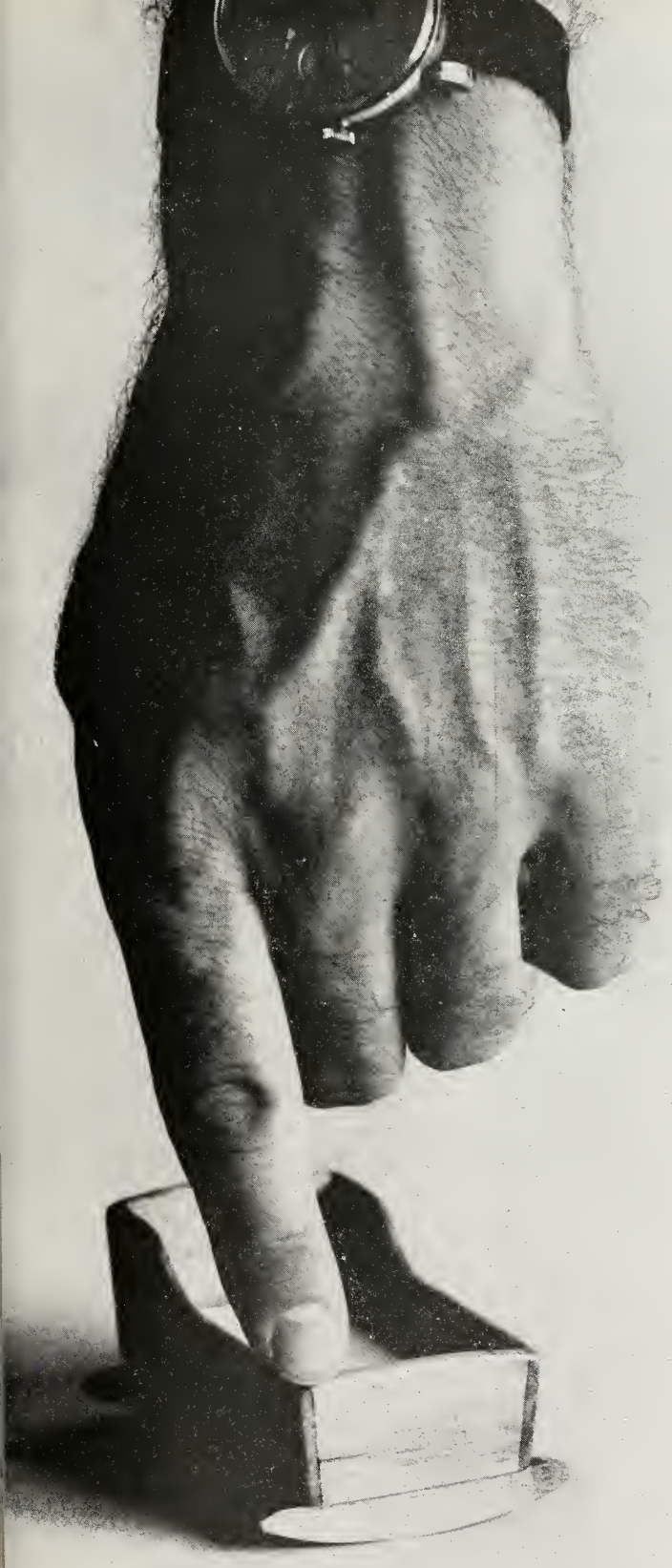
The results of continuing as we are were illustrated the other day in a meeting at JPL in which we were attempting to plan the missions for a set of space vehicles in 1961 and 1962. We went through the process of setting up a logical and technically sound program, only to be shocked at the end of our efforts to find that the first half of our fine program had already been done by the Russians.

A colleague last week remarked that the closer you get to the space program, the more of a sinking feeling you get.

Putting it in somewhat different words, continuing at the present level is largely a waste of money. At the moment, we are paying for the privilege of being the perfect straight man for the Russians. As Dr. Glennan has stated, "we cannot run second very long and still talk of leadership."

In a perfectly objective way, we should therefore consider the results of declaring ourselves out of this game. We might well save ourselves a great deal of embarrassment. We would have to yield the field to the Russians and admit that they are highly successful. What would hurt is that we would have to admit by inference that their reason for success, namely the Communist Society, might also be true.

We should also consider the results of declaring ourselves *in* the space race. It will certainly cost us more money than we are presently spending. We are going to need clearly defined goals, specifically, whether or not we intend to accept the Russian challenge. We will need facilities and priorities. We need a very hard-boiled look at past performance and a willingness to let the finally chosen professionals run their own race.



He kept the crib from rocking

For accurate firing, Titan and its subterranean steelwork crib must be kept in absolute alignment with the earth's center despite natural movements of the crust or nuclear shock. This AMF production engineer's problem was to build the shock absorbers AMF designed for the job. These are massive, pneumatic cylinders constructed of precision-fabricated, precision-fitted steel parts.

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Here's what he did: He put down heavy steel tracks for a series of wheeled carts. He mounted the tubes on carts, adjusted position... and, slid them together.

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- *Undersea Warfare*
- *Radar*
- *Automatic Handling & Processing*
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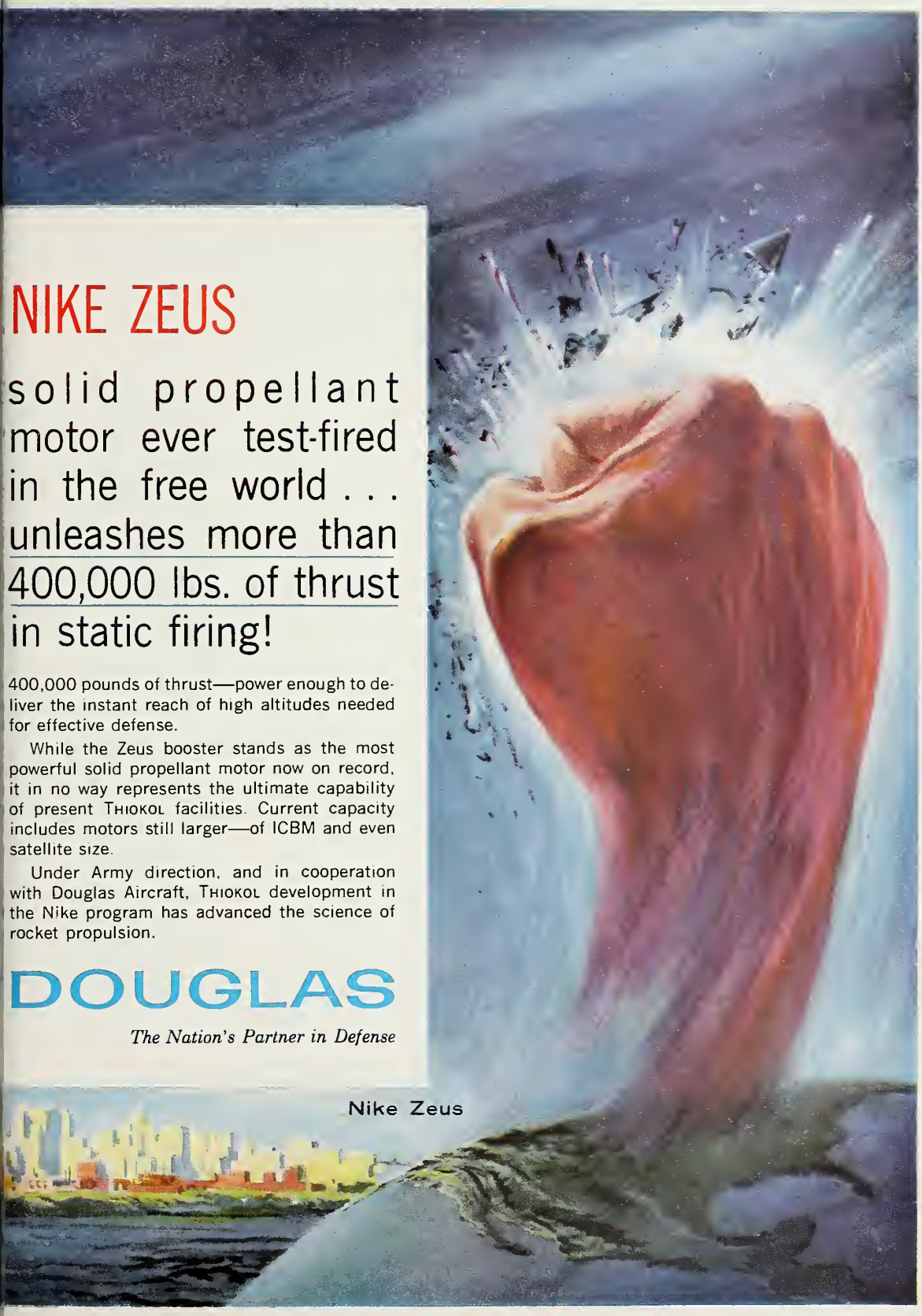
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Under Army direction, and in cooperation with Douglas Aircraft, THIOKOL development in the Nike program has advanced the science of rocket propulsion.
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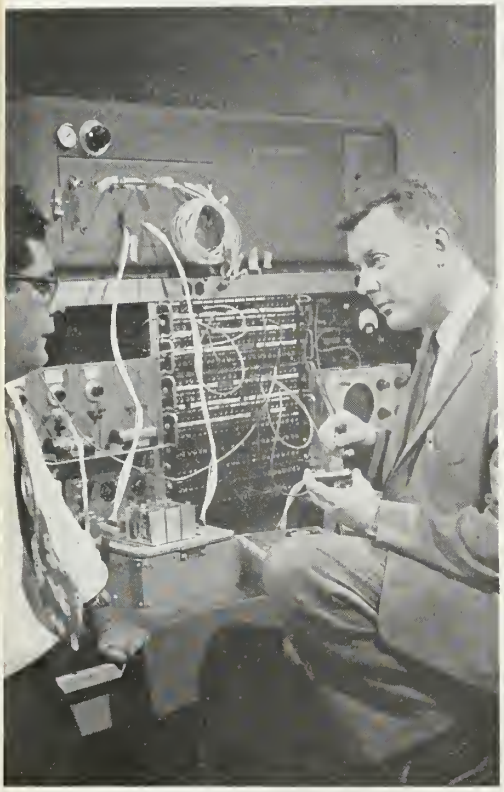
Nike Zeus

FLIGHT CONTROLS

Expanding the Frontiers of Space Technology



Transistorizing missile flight control systems by Lockheed scientists has meant significant reductions in weight and space requirements.

Flight Controls offers one of the most challenging areas of work at Lockheed's Missiles and Space Division.

From concept to operation, the Division is capable of performing each step in research, development, engineering and manufacture of complex systems. Rapid progress is being made in this field to advance the state of the art in important missile and spacecraft projects under development at Lockheed.

Flight controls programs include: analysis of flight data and sub-systems performance, design and packaging of flight control components, development of transistorized circuits, operation of specialized flight control test equipment, and fabrication of flight control prototypes. Other work deals with the design, development and testing of rate and free gyros; accelerometers; programmers; computer assemblies; guidance control systems; circuitry; and hydraulic systems and components.

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Lockheed Missiles and Space Division is systems manager for such major, long-term projects as the Navy POLARIS FBM; DISCOVERER, SENTRY and MIDAS; Army KINGFISHER; Air Force Q-5 and X-7; and other important research and development programs.

ENGINEERS AND SCIENTISTS

Lockheed Missiles and Space Division programs reach far into the future and deal with unknown environments. Exciting opportunities exist for engineers and scientists to contribute to the solution of new problems in these fields. If you are experienced in one or more of the above areas or have background in related work, we invite your inquiry. Write: Research and Development Staff, Dept. K-29, 962 West El Camino Real, Sunnyvale, California. U.S. citizenship required.

Pre-flight check-out on final assembly on X-7 missile. The X-7 holds free-world's speed and altitude records for air breathing missiles.

One of Lockheed's test stands with dynamic thrust mount to simulate flight environment.

Lockheed **MISSILES AND SPACE DIVISION**

Systems Manager for Navy POLARIS FBM; DISCOVERER, MIDAS and SAMOS; Army KINGFISHER; Air Force Q-5 and X-7.

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Recorder Passes Flight Test

Miniature Ampex unit survives trip on missile and nine days in ocean; performs perfectly when retrieved

REDWOOD CITY, CALIFORNIA—A miniature tape recorder survived an Air Force missile flight and 9 days in the Atlantic Ocean, yet performed perfectly when retrieved from the water and tested with a new tape and tape turntable.

The recorder, Model MR-100, developed by **Ampex Corporation,** was enclosed in a plastic sphere on a *Thor-Able* carrying an instrumented nose cone. The recorder was thrown free before the cone struck the ocean. The plastic was strong enough to protect the recorder, yet light enough to allow the capsule to float in the water.

During its recording periods, all data telemetered from the nose cone during flight is stored. Temperature, pressure, stress, acceleration, and deceleration information is included.

The system contains two separate assemblies and weighs 20 pounds. The tape transport assembly contains the magnetic record heads, tape drive system, and system control circuitry. The electronics assembly contains the record and reproduce amplifiers and a reference oscillator used for timing. An interconnecting cable is used between the two assemblies. The entire system rides in a **General Electric**-developed instrumented sphere, 18 inches in diameter, made of polyurethane foam with a cover of ablative material.

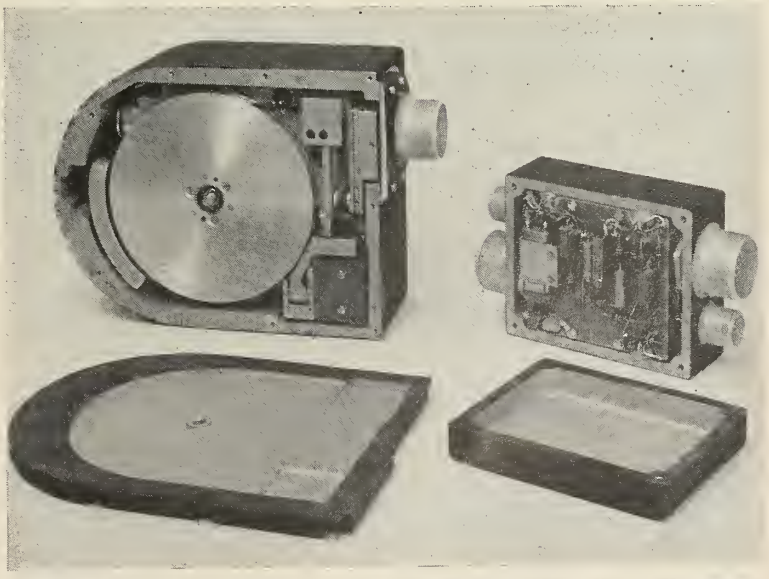
The complete system occupies less than one-fifth of 1 cubic foot. Capable of capturing information in a frequency band from 300 to 100,000 cycles per second, it will record two tracks of information utilizing parallel tracks on ¼-inch wide magnetic tape. The tracks are independent, each having its own record and reproduce amplifiers in the system's electronics unit.

The device begins recording on receipt of a command signal, continuing until expiration of the complete four-minute recording cycle. It then stops automatically. Depending upon type of operation desired, it does either one of two things: (1) Awaits another command signal, or (2) after 5 seconds, automatically reproduces the previously-recorded signal in reverse. It then stops and awaits another command signal to restart the transport in the recording cycle once more.

The recorder may be stopped at any time during the recording or reproduce portions of the cycle. At the completion of the reproduce cycle, the recorded data remains on the tape. Upon receipt of a command signal to begin another recording cycle, the existing signal is erased just before the new one is recorded.

The recorder provided nose cone information during re-entry period when attenuation of the radioed telemetry signals made ground reception impossible. This stored information was then reproduced in flight at a programmed time when telemetry attenuation no longer occurred.

The recorder's design presented problems of heat transfer and high-frequency vibration. A certain amount of heat is generated by the motors and tube filaments, and reducing the size of the equipment (or increasing the number of components per cubic inch of space) concentrates this heat in a small volume. Because the specified environmental ambient temperature was fairly high, it was quite difficult to obtain internal temperatures within the range required for reliable opera-



COMPLETE MR-100 occupies less than one-fifth of 1 cubic foot. Tape transport (left) and electronics assemblies (right) are shown with their covers removed.

tion of the components.

Although the tape transport assembly comprises the bulk of the system, it weighs only 14 pounds and measures 8-5/16 x 6½ x 3½ inches. Tape reels for the unit measure 5½ inches in diameter and can accommodate 1400 feet of tape which moves at 60 inches per second.

Components are mounted on a cast-aluminum chassis, which fits into a heavy cast-aluminum case. The case not only protects the operating mechanism from the external environment, but doubles as armor in protecting the tape during impact. The case and chassis are constructed so that if the mounting bosses on the chassis shear under impact, the raised portions of the chassis will come in contact with the case before the reels are crushed.

Embedded in the chassis are the three tiny motors for the system. There are two torque motors for the tape reels and a constant-speed motor which drives the tape at a uniform velocity.

Heart of the recorder—the magnetic record heads—is potted in a steel block, with centerline pivot bosses to locate them in a precision-machined thick-walled aluminum mounting box. The box, in turn, is enclosed by a close-fitting mu-metal container with a removable lid for tape threading. This provides double shielding against external magnetic fields.

With the exception of the control circuitry for the tape transport, all the circuitry is a part of the separate electronics assembly. The assembly contains, in addition to duplicate record and reproduce amplifier circuitry, a bias and erase oscillator and a crystal-controlled 93-kilocycle reference-signal oscillator.

To meet the temperature range specifications for the system of –55°C to+70°C, silicon transistors were selected. Other components such as a potentiometer, toroidal inductor, tantalum capacitors, and miniature resistors, were chosen for compactness and are mounted on etched boards. The etched boards fit compactly into the electronics case and are rigidly attached to a cast web. An inner mu-metal container shields the reproduce electronics. The complete assembly with covers installed weighs 6 pounds; measures 8½ x 4 x 3¼ inches.

As with any 60-ips tape transport, the inertia of the tape reels during starting and stopping is a basic problem. To obtain a 2-second start time, the lightest possible reel was required. Yet vibration and impact survival required great strength, so special reels were designed with tapered, aluminum flanges, precision-turned to 0.062-inch at the outer edges.

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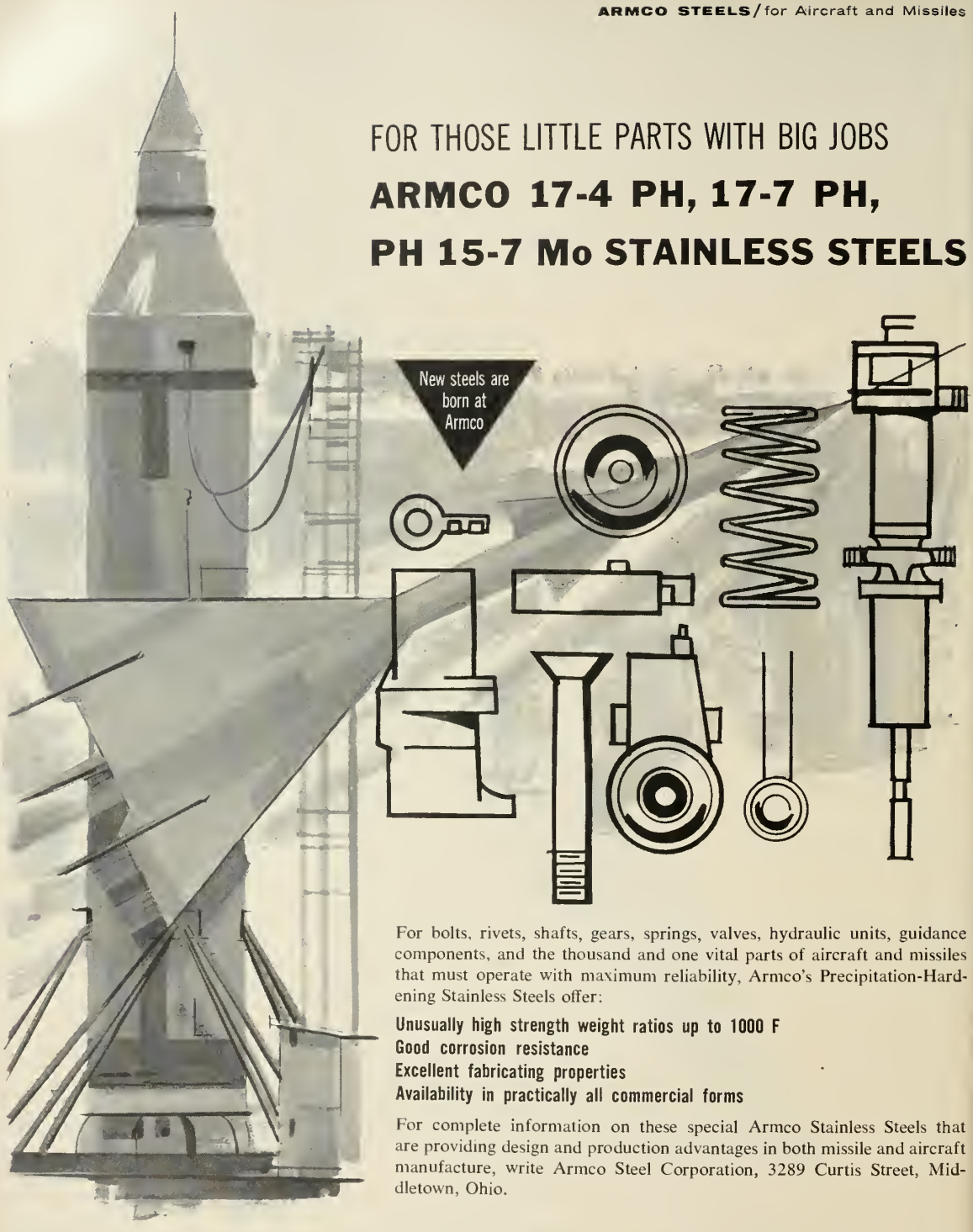

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Circle No. 14 on Subscriber Service Card.

propulsion engineering...

By JAY HOLMES

Which big liquid booster is better . . .

the *Saturn* or the so-called *Nova*? Both will develop about 1,500,000 lbs. of thrust. Both will have comparable burning times. Both will do about the same job.

Sam F. Iacobellis of **Rocketdyne** compared the two boosters on the basis of reliability, availability, performance and cost and came to the conclusion that neither the Rocketdyne single engine nor the ABMA *Saturn* cluster has a clear-cut advantage in all four respects.

Early reliability and low cost . . .

are advantages of the *Saturn* cluster, Iacobellis said in a paper at this month's American Rocket Society convention. But the single engine has higher ultimate reliability and greater performance. Iacobellis adds that the ultimate reliability of *Saturn* can be made competitive by adding a ninth spare engine.

For early availability and low cost (important) *Saturn* will be preferred. For performance and ultimate reliability, the *Nova* will get the nod. Furthermore, the big single engine is capable of being clustered into a booster with 6 million lbs. or more of thrust.

Reliability increases by about 20% . . .

on adding a spare to an eight-engine cluster, Iacobellis calculates. For example, assuming an 0.95 reliability for the single, smaller engine, an eight-engine cluster has about 0.67 reliability. If one spare is added, the reliability becomes about 0.82.

The Rocketdyne engineer also plots reliability of the engine against time for the single chamber, the eight-engine cluster and the cluster with a spare. To reach an 0.70 reliability figure, the *Nova* needs just under three years of testing. *Saturn,* which began in late 1958, would reach 0.70 reliability after about 22 months.

Cost of *Saturn* is lower too . . .

if we assume that only 50 boosters are required. Iacobellis figures that for this number the clustered booster would cost about 70% as much as the single engine. However, if many more of the engines are desired, the cost per unit of *Nova* drops below that for *Saturn.*

Department of Defense sources have estimated that the cost of 50 *Saturns* will be something over $800 million. Thus it follows that it will cost at least $1.14 billion to develop 50 single-cell *Novas.* This would supply 20 engine systems for vehicle development and six engine systems per year for five years of operational use.

On performance, *Nova* gets the nod . . .

because it can incorporate the latest developments in liquid rocket technology, while a cluster must make use of off-the-shelf engines. For a three-stage vehicle having a sea-level thrust of 1.5 million, Iacobellis assumes a 30,000 lb. payload can be delivered over an 8000-nautical mile range.

For the cluster, he assumes a 23,000-lb. penalty because of differences in the state of technology.

Ultimately, *Nova* will be more reliable . . .

than the *Saturn* cluster. Iacobellis' graph indicates the crossover point is about four years after the start of development, at which time the reliability of each engine is about 0.94. *Saturn's* reliability curve levels off about this time and doesn't rise much above about 0.95 unless a spare engine is added. For *Nova,* he calculates about 0.99 reliability after 6½ years.

If we plan to use these boosters to lift manned vehicles into orbit, ultimate reliability can be a rather important factor.

EFFICIENT, COMPATIBLE AUXILIARY POWER SYSTEMS...

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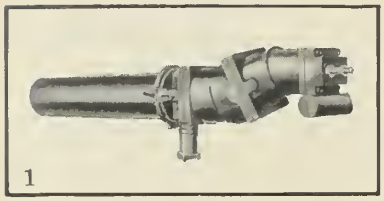
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Missile progress demands unquestionable reliability, maximum efficiency and compatibility of the system with the overall vehicle. These rigid standards are being met by Vickers with *missile industry-tailored* R & D, engineering, production and service capabilities blended with extensive experience gained from a large number of successful accessory applications on a majority of the current production missiles.

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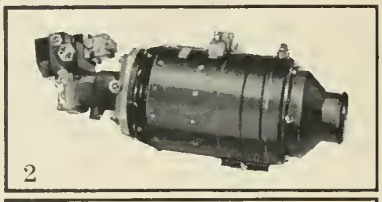
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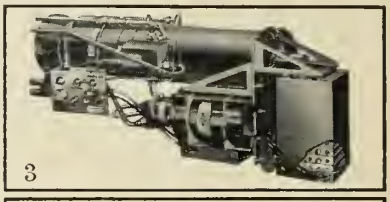
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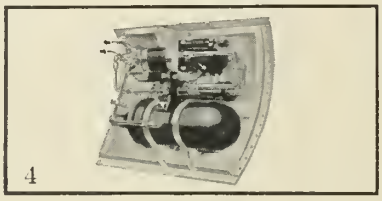
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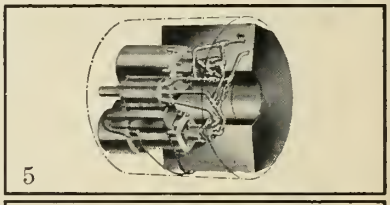
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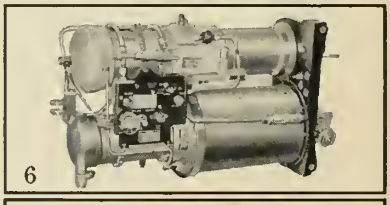
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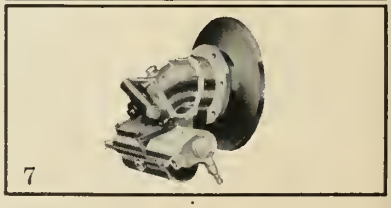
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Using proven components as building blocks, Vickers can shorten APS development time and speed delivery . . . all with the assurance of dependability. These advantages are passed on to you whether your specifications call for one or any combination of the following:

- TEMPERATURE TOLERANT SYSTEMS
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Radar Operational Simulation Keeps Navy on Continual Alert

Servonics device already operational with the Navy supplies realistic blips, could be used in solving tactical problems

by William E. Howard

WASHINGTON—Much depends today upon a radarman's reflexes.

In the increasingly complex "man-machine" relationship, his ability to make a split-second interpretation and identification of blips on a scope is all-important in the Nation's defense system. On him hangs the crucial time factor to set in motion the vast U.S. retaliatory forces to combat a surprise Red attack.

As the Cold War arms buildup moves implacably onward, with a hot war always an imminent possibility—yet seemingly remote—military units are hard put to keep the reflexes of these key human operators tuned to peak efficiency. With a nuclear-war response time measured in minutes, even a second's inattention could be fatal to a city—the Nation.

For thousands of radarmen aboard ship, on patrol planes, in the outposts of SAGE, the DEW line, and soon, BMEWS, boredom is an insidious enemy. So is the familiar. Long hours can drone by for some without even a passing seagull to command their attention. In training exercises, no matter what pains are taken to create combat-similar conditions, the operator still knows it is make-believe.

Lacking have been the elements of surprise and urgency—the sudden bowel-stabbing realization that the fast-moving targets flitting across the scope may actually be an enemy attack: the real thing.

Now, however, the Navy has a device which, with the flip of a switch, can inject this much-needed realism into the radar of a ship or task force at any moment of the day or night. Called the AN/SPS-T2 and developed by **Servonics Inc.**, of Alexandria, Va., the device reproduces signals very closely resembling those appearing on a scope in a real enemy air attack.

It is already operational with the fleet. Servonics has produced 30 of the instruments and holds Navy contracts for 135 more. It appears from company-sponsored studies that the technique of simulation used may help solve air defense training problems by minimizing the man-machine problem in today's complex weapon systems.

• **Versatility**—Originally conceived as strictly a training aid, the target simulator could be utilized to solve operating radar problems.

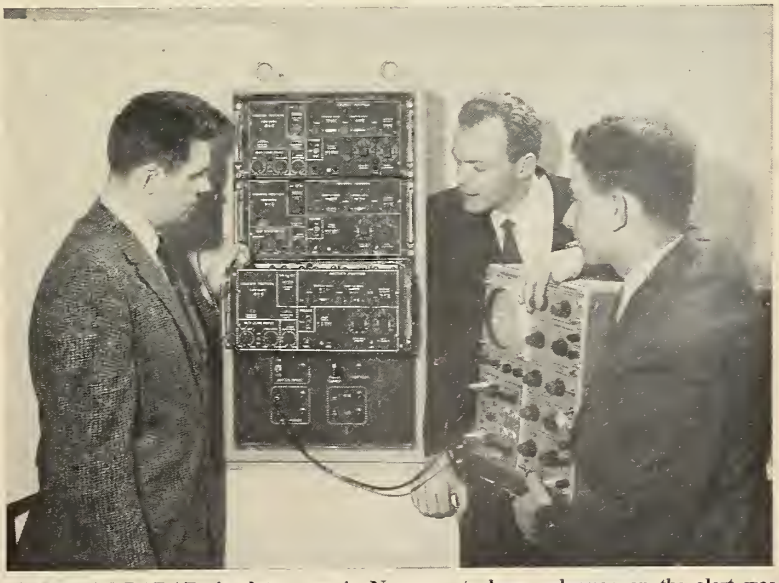
In addition to bombers and fighters, the company says, the device can simulate jamming from countermeasures and the signals can even be modified to reproduce missiles coming in at 17,000 mph. It thus is a potential trainer for BMEWS personnel as well as other military defensive units.

Aboard ship the AN/SPS-T2 can activate the entire weapon system permitting simulated targets to be mixed with the live targets simultaneously on height-finding, air search and surface search radars.

Advantages in this technique, as enumerated by Servonics, are:

• The operations officer can inject "ghosts" into sector search indicators at will to test the proficiency of radar operators in detecting unknowns.

• Ground control intercept maneuvers can be practiced without actually putting planes in the air. With closed loop simulation, pilots can watch the mission of the ground controller—thereby developing confidence between the pilot and the operator.



COMPACT RADAR simulator now in Navy use to keep radarmen on the alert was designed by Alex Long, center. Device may be used to train anti-missile batteries.

• Data handling capability of the ship's Combat Information Center can be increased through training of the team to cope with multiple high-speed unknown targets while reporting positional data.

• With several ships in fleet maneuvers, offset coordinates of each ship position relative to the target are measured by the simulator. The attacking targets are simultaneously cut on to fly courses, allowing each ship to receive the target complex as it would be viewed normally by their own radar.

• In the event a real target is wiped off the scope by interference or countermeasures, the simulator can inject an artificial signal to track the target from its last known position. Simulation of noise also permits training of operators to "see" through radars with a relatively high noise level.

The AN/SPS-T2 permits a form of tracking from air search radars and allows training in the correlation between air search and height finding radar data.

A single AN/SPS-T2 in a 14-cubic foot package generates six radar targets. However, the units can be hooked up in parallel to give the position, course, speed, altitude, turn rate and other data of as many as 30 targets. The simulator also reproduces relative motion of the target to ship, clutter, fading and range attenuation.

• **Started in 1956**—Designed to operate with all radars presently in the fleet, targets are generated by the simulator through manually manipulated knobs on the front panels of three of the four system cabinets. One unit provides information which is common to all the targets. It also is the source of the target video signals and antenna positioning signals which are supplied to the PPI and RHI indicators in associated radar systems.

The trainer is the brainchild of Alex Long, 32-year-old president and head engineer of Servonics, which was founded just four years ago this month. The company began developing the device back in April, 1956, under Navy sponsorship. Given a year to come up with a prototype, Long's team produced one in six months, and the Navy promptly ordered two more.

In early 1958, the simulator was subjected to fleet evaluation and in June of that year Servonics received a production contract in excess of $2 million.

It was aboard ship that the broader applications of operational simulation were realized. Now the company sees the AN/SPS-T2 as a prime weapon in the Cold War—keeping the Nation's front-line defenses in perpetual chips-are-down readiness.

ARS Abstracts

More Papers from the Recent Annual Meeting

WASHINGTON—The 14th annual meeting of the American Rocket Society held here Nov. 16-20 produced a number of significant papers in all areas of missile/space technology. M/R published many last week. Here are more:

Bio-Instrumentation

Objectives of Bio-Instruments, Albert W. Hetherington, Air Research and Development Command, U.S. Air Force, Andrews AFB, Md.

The author discusses the overall philosophy of bio-instrumentation. Specific goals discussed are the collection of scientific biological information, the monitoring of the status of the astronaut and the making the space-man's non-conscious and non-voluntary bodily status indicators a part of various control loops in the space vehicle. (ARS 930-59).

Biological Monitoring of Space Flight, Maj. Cloid Green, Aerospace Medical Center, Brooks AFB, Tex.

The paper discusses three phases of biological monitoring of space flight: the gathering of data from animals in order to delineate problem areas; the providing of a proving ground for the techniques under development; and the providing of protection and/or assistance for the human pilot. (ARS 931-59).

Instrumentation of Nervous System for Studies of Behavior, W. R. Adey, M.D., Univ. Calif. at Los Angeles, Los Angeles, Calif.

After presenting a history of brain mechanism study, the author discusses the results of tests monitoring brain regions in correlation studies of behavioral states, the special relationship of the temporal lobe to behavioral performance, the techniques of implantation of brain electrodes, required characteristics in amplifiers and recording systems, data reduction and computing, and self-stimulation techniques in behavior studies. (ARS 933-59).

"Space Canaries":—Implicit Biological Monitoring, Alfred Breckler, M.C., Leslie Kaeburn, Ph. D., Ben. L. Ettleson, A.B., and David W. Douglas, A.B.

The authors discuss biological research with animals in preparation for manned space flight. Specific subjects discussed are: difficulties in human and animal instrumentation; a history of feasibility experiments, surgical procedures, feasible parameters for radio transmission, and possible applications of animal research in the space program. (ARS 925-59).

Thrust Orientation Patterns for Orbital Adjustment of Low-Thrust Vehicles, Harold Brown and J. Richard Nelson, Flight Propulsion Laboratory, General Electric Co., Evendale, O.

The authors discuss the use of low-thrust propulsion systems to adjust a space vehicle's orbit. The paper covers the characteristics of a space vehicle's orbit and environment in cislunar space, the desired changes in orbit possible with low-thrust rockets, and the various types of missions in which low-thrust rockets can be useful. (ARS 955-59).

Differential Correction Experimentation with the Low-Eccentricity Geocentric Orbit, L. G. Walters, S. T. Van Sant, J. D. Enright, and L. Saskin, Aeronutronic, a

(continued on page 43)

Three generations of ARMA computers:
THE SECOND GENERATION

FOUND:
an intellect that can think anywhere

The systems of tomorrow will require digital computers that can think *anywhere*—intellects that will remain superior in any environment.

ARMA—already producing computers for its inertial guidance system in the ATLAS ICBM—has accepted the challenge and developed a lightweight, second-generation digital computer applicable to *all* types of navigation. It can be used in space, atmospheric, surface, subsurface and ground navigation, making possible programming flexibility.

This all-solid state computer, with *no moving parts* and using silicon semiconductors exclusively, has a memory that is non-volatile and has non-destructive readout. And this computer has 40 per cent fewer parts than ARMA's first-generation production model, which has a test performance unequalled by any other digital computer.

An even more sophisticated third-generation computer, surpassing the reliability of the first two with still less weight, will be produced in the future by ARMA. The reliability of all three generations will be assured by thorough testing in ARMA's environmental facilities—the most complete in the industry.

ARMA, Garden City, N. Y., a division of American Bosch Arma Corp. . . . the future is our business.

Attention, Engineers: Write to E. C. Lester, Emp. Supv., about career openings in R & D programs.

AMERICAN BOSCH ARMA CORPORATION

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• **Cape Canaveral, Fla.**—A **Lockheed** *Polaris* roared more than 900 miles down the Atlantic Missile Range Nov. 20 and landed near the predicted impact area near Puerto Rico. It was the second successful shot in the 900-mile test series.

It was followed on Nov. 24 by a "routine" test launching of a **Convair** *Atlas*.

• **Vandenberg AFB, Calif.**—The Air Force placed the eighth *Discoverer* satellite into a 120 to a 1000-mile polar orbit. But Air Force and Navy recovery teams again failed to recover a capsule dropped from the orbiting satellite. The capsule is believed to have plunged into the Pacific near Hawaii.

• **Washington**—The Atomic Energy Commission created an Aerospace Nuclear Safety Board to look into possible radiation menaces that might result from the use of nuclear-powered rockets. The board also would watch over development programs for nuclear ramjets and aircraft.

• **White Sands, N.M.**—A 31-year old airman—Capt. Joseph Kittinger—parachuted from the fringe of space, setting a new record. Kittinger jumped from the gondola of a balloon 76,400 feet over the desert. He plummeted 12,000 feet at speeds reaching 450 miles an hour before he opened his 28-foot parachute.

• **Los Angeles**—Missiles and space-related business accounted for 43% of **North American Aviation Inc.'s** sales in the FY which ended Sept. 30—compared to 20% in 1955. The company reported sales for the year topped $1 billion—a 16% increase over 1958's $904 million and second only to its record 1957 sales. Net earnings were $30.7 million, equal to $3.80 a share, against $26.7 million, or $3.34 a share, for the previous year.

• **Washington**—The Aerospace Industries Association told the Labor Department a redetermination of aircraft minimum wages might increase labor costs by as much as $100 million annually—thereby inflating defense procurement costs. AIA also said such action would give labor unions an effective weapon when wage reopening starts next year because it would tend to increase wages beyond rates agreed to in collective bargaining.

• **Washington**—Declaring space exploration will require increasing support from the military, ARDC Commander Bernard A. Schriever said the United States "cannot afford to concentrate solely on scientific explorations in space, and ignore its vast extension of the air as a theater of military operations." His statement was in direct opposition to Eisenhower Administration policy. Following the switch of ABMA to NASA, the President said he could not see "any reason why we should be using or misusing military talent to explore the moon. This is something that deals in the scientific field . . ."

• **Washington**—Additional funds were released by DOD for continued production by **The Martin Co.** of the Tactical Air Command's *Mace*. The Air Force said the total amount of the production program will now be about $100 million.

270 Watts Generated From Rocket Exhaust

An experimental thermionic generator tube which weighs 3½ pounds and slips like a sleeve over a flame tube has produced up to 270 watts from the exhaust of a solid rocket motor.

Developed jointly by **Radio Corp. of America** and **Thiokol Chemical Corp.**, the lightweight device in tests has proven to be efficient and feasible. Engineers of the two companies report that during powered flight, the tube's output could operate missile or space vehicle guidance, steering and telemetering packages—thus removing the requirement for heavy chemical batteries, increasing vehicle payload.

Resembling in operation a conventional two-element electron tube, the cathode of the thermionic generator is formed by the inner wall of the hollow cylinder, which is in contact with the hot exhaust. The outer wall forms the second electrode. Cesium vapor between the walls becomes ionized upon heating and transmits electrons to the outer electrode.

Industry on the Move

An astronertial and inertial guidance research center costing $4 million is being built by the **Nortronics Division of Northrop Corporation** . . . Near Dallas, **Temco Aircraft Corporation** is constructing a radiation systems laboratory . . . **Corning Glass** has formed a ceramic department to make parts for the electronic industry . . . **Tridea Electronics Inc.** has moved into a new location at South Pasadena, Calif.

New Liquid Hydrogen Facility

THIS UNIT with a capacity of more than 25,000 liters of liquid hydrogen per month is operating at Tonawanda, N.Y., laboratories of Linde Company, division of Union Carbide Corp. It turns out fluid with less than 2 parts/million impurities.

EXPLORE NEW AREAS AT IBM IN COMPUTER SYSTEMS

Now under development at IBM are new and unusual electronic computing systems that will greatly strengthen man's control of his environment. In one project, for example, advances in acoustics, oceanography, and information theory are being coordinated to yield a data system that will sentinel the ocean's depths. Another group is applying a computer's logic and computational capabilities to analyze, correlate, and identify input signals to data acquisition systems. In the late development stage is an extremely high-speed, large-capacity computing system which will automatically handle the large volume of detailed records and communications required by a nationwide sales operation. To staff such efforts, scientists, mathematicians, and engineers of vision are needed.

IBM's rapid expansion provides many opportunities for you to advance—either through technical achievement or engineering administration. You may work independently or with a small team, and you can choose your assignments from a broad range of research and development areas. Specialists of many different backgrounds are available to assist you in your work. This is an excellent opportunity for a scientific or engineering career that combines maximum growth potential with job stability.

ARS Abstracts

(*Continued from page 39*)

division of Ford Motor Co., Newport Beach, Calif.

The paper discusses a differential correction procedure inclusive of special perturbations which has been developed especially for the low-eccentricity orbit. The procedure has, in previous experiments, determined orbit in less than one minute of IBM-709 machine time. (ARS 960-59).

Optimum Re-entry via a Variable Control Force, F. J. Marshall, Institute for Systems Research Laboratories for Applied Sciences, Univ. of Chicago.

The author discusses the reduction of harmful re-entry affects by allowing the vehicle to choose its velocity for a given density by control forces. The four control systems considered are: a thrust controlled radiating body; an aerodynamically controlled radiating body, a thrust controlled, non-radiating body, and an aerodynamically controlled, non-radiating body. (ARS 956-59).

Outline of the Mechanics of the Power and Launching Phase for Missiles and Satellites, Carl A. Traenkle, Aeronautical Research Laboratory, Wright Air Development Center, Wright-Patterson AFB, O.

The author demonstrates how optimization problems of missile trajectories and satellite orbits can be solved very quickly by the method of "Reference Trajectory," followed up, if required, by the "Perturbation Method," thus refining the results to any wanted degree of accuracy. (ARS 958-57).

Planetary Perturbations of Interplanetary Orbits, James E. Michaels and Evelyn A. Strawbridge, Missile and Space Vehicle Dept., General Electric Co., Philadelphia.

The authors study the perturbation effects of the planets on interplanetary ballistic trajectories. The analysis results in an equation which integrates the instantaneous accelerations of a perturbing planet on a space vehicle over a predetermined ballistic flight path, giving the total deviation from that flight path. (ARS 957-59).

Researches in Interplanetary Transfer, John V. Breakwell, Rollin W. Gillespie and Stanley Ross, Lockheed Missiles and Space Div., Sunnyvale, Calif.

The paper explains a method by which interplanetary trajectories may be calculated extremely rapidly and to a degree of accuracy suitable for design studies. By splitting the three-center problem associated with interorbital ballistic transfer into three one-center segments which overlap somewhat at their junctions, solutions may readily be found by machine iteration. The extreme speed of the method enables wholesale amounts of worthwhile numerical results to be obtained. (ARS 954-59).

Power Systems

A Method of Predicting Missile Power Unit Performance Through the Use of Rocket Parameter, Paul C. Juhasz, Boeing Airplane Co., Seattle.

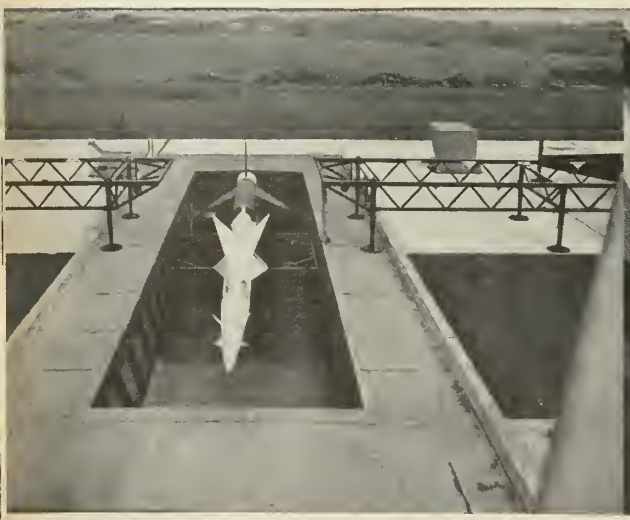
Presents arguments and supporting data for use of specific impulse as a suitable parameter for measuring performance of missile propellant-type secondary power units. (ARS 1036-59).

Approaches to the Ultimate in Conversion of Solar Heat-to-Electricity, Thomas Timar, Boeing Airplane Co., Seattle.

Discusses potential of thermal devices in converting solar energy to electric power. Shows what could be accomplished in weight reduction by converted effort and predicts that thermal devices may yet prove better than solar cells. (ARS 1038-59).

About the earthly side of the Nike Ajax.

The U. S. Army's Nike Ajax is a strange but potent bird. Graceful, tough, packed with delicate instruments. He will fly only once in his lifetime—only in the event of an enemy attack. To launch him with split-second timing and accuracy, the Army puts most of its manpower and most of its materials into ground equipment. And virtually all the material required other than electronic equipment can be purchased from one firm—United States Steel. Whether you're talking about carbon steel, high-strength low-alloy, or ultra high-strength alloy steels, Stainless Steel, steel fence,



The Nike Ajax spends his days in a concrete and steel nest like this one. ICBM's will also live this way, but in nests that will take *thousands* of tons of concrete and steel. U.S. Steel specialists work continually with designers and construction engineers to find ways to use steel to its full advantage on such projects to build stronger with less materials . . . to build them faster.

It takes miles of wire and cable to rig a Nike nest. It will take *hundreds* of miles when bigger birds are put to roost. The Army uses many types of steel and steel products in a Nike nest. U.S. Steel conducts research and knows how to cut costs for any steel product used in ground support equipment.

electrical cable, cement or wire rope, United States Steel maintains the technical services to provide the proper assistance to cope with any problem on materials for ground equipment. When a ground support program goes to the drawing board, consult with

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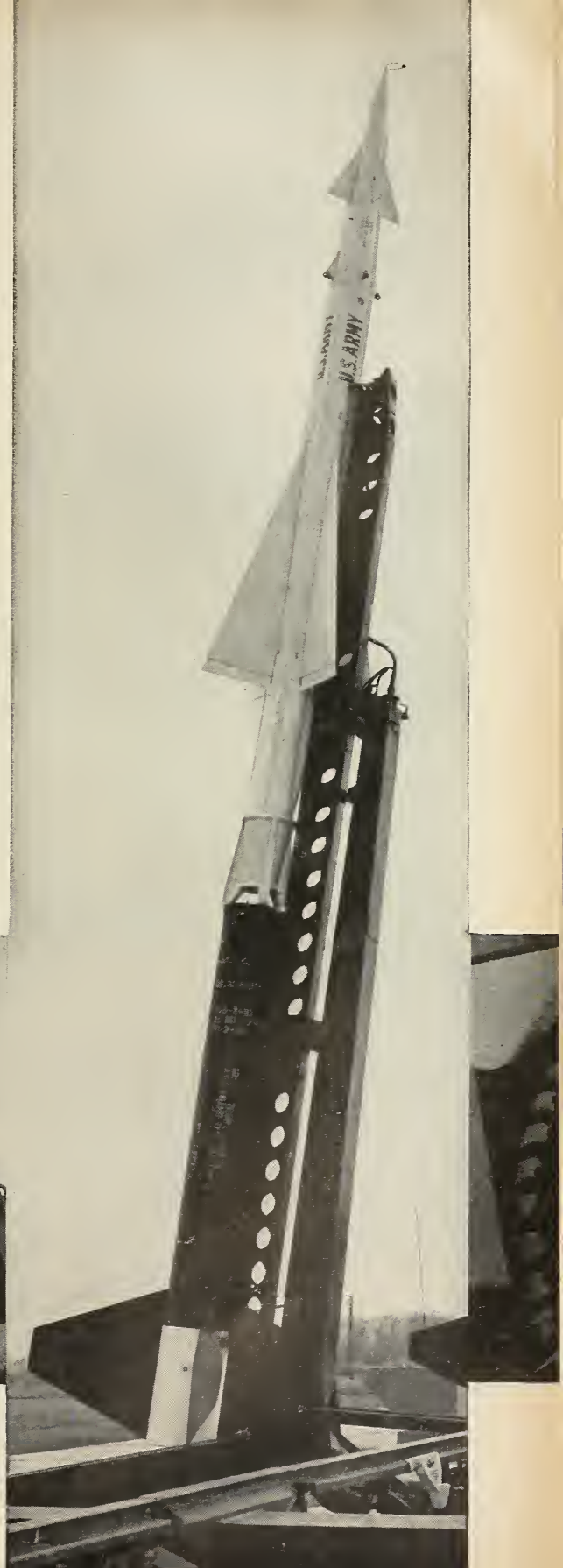

How light can you make a steel boom for any missile system without sacrificing strength? The proper selection of USS High-Strength Steels or Constructional Alloy Steels has cut the weight of similar equipment as much as ⅓—and *increased* the strength and service life.

New Thermal Relay Is Produced for Missile Use

A Type PT Thermal Time Delay produced by **GV Controls Inc.** is said to be a new design developed to provide greater shock and vibration resistance and higher precision than has been available before.

This relay may be operated under vibration of 20 g up to 200 cps and under shock of 50 g for 11 ms. There is no resonance below 2000 cps and extended exposure to these conditions causes no damage or change in characteristics.

Operating time delays of 3 to 60 seconds are available. Time delay is factory set within a tolerance of ±5%. Effects of ambient temperature have been greatly reduced and are held to ±5% over the range of −65°C to −125°C. Heater voltages range from 2 to 115 volts for delays of 3 to 12 seconds and from 2 to 230 volts for the longer delays.

Relays are hermetically sealed in a rectangular case 1 3/16" x 2 1/4" x ¾" high. Leads project thru the bottom of the case and are located on 0.2" grid spacing for convenience in use with printed circuits. Weight is 2 to ¼ oz.

Circle No. 245 on Subscriber Service Card.

Coating Temporarily Protects Polished Surfaces

Temporary protection of polished surfaces—metal, glass and many plastics—is provided by a new, scratch-resistant coating, Zincilate WST-100, that can be easily removed with a simple warm water rinse. The product is offered by **Industrial Metals Protectives Inc.**

The coating is non-flammable, will withstand forming and bending, and offers complete resistance to petroleum solvents. It is a non-reactive, inorganic type of coating that air-dries to full hardness in 30 minutes. Drying time can be reduced with warm air circulation or infrared baking.

Zincilate WST-100 requires no mixing, may be applied by spray, dip, roller coat, flow coat or pressure curtain methods. No special surface preparation other than a normal solvent wipe is needed. Coverage will average 1000 sq. ft. per gallon, at .001" thickness. Complete information may be obtained from Industrial Metal Protectives, Inc., 401 Homestead Avenue, Dayton 8, Ohio.

Circle No. 246 on Subscriber Service Card.

Machine Separates H_2, N_2 from Ammonia

NEW YORK—A compact machine capable of producing high-purity hydrogen and nitrogen gases from ammonia is being marketed jointly by **North American Phillips** of New York and **Hamler-Lewis, Limited,** of Chicago.

The device, known as the Norelco Ammonia-Gas Separator, employs a super-cold refrigerator and should eliminate problems often encountered in the delivery of hydrogen from outside sources, problems such as municipal transport restrictions.

Hamler-Lewis will install the separators on direct purchase or lease contracts, service the equipment and provide high-purity, metal-treating-grade ammonia delivery.

Circle No. 247 on Subscriber Service Card.

Relay Satellite System Under Development

An experimental communications relay-satellite system is being developed by **Bell Telephone Laboratories,** which has begun building the first prototype station here.

Primary objective in the program is to determine whether such a system could transmit and receive transcontinental broadband (900-channel equivalent) signals.

The experimental program will also provide several by-products: microwave radio signals will be analyzed to learn more about transmission effects, and the reflection characteristics of an orbiting satellite will be studied from the data obtained.

Two types of antennas will be employed: a paraboloidal reflector for transmitting, and a horn reflector for receiving. Almost perfectly unidirectional, the Bell Lab-developed horn antenna picks up less than one millionth as much as from other directions. It reduces ground radiation degradation to a minimum, according to Bell.

A highly sensitive receiver will employ either a pair of parametric amplifiers or masers for noise reduction.

The satellite experiments are expected to be preceded by test transmissions using lunar reflection. The test path—2300 miles long—will be between **Jet Propulsion Laboratory's** tracking station at Goldstone, Calif., and Bell's new Holmdel site.

Circle No. 248 on Subscriber Service Card.

Servo Valve Has Only Two Moving Parts

Kearfott Co., Inc. a subsidiary of **General Precision Equipment Corp.,** has introduced a unity-coupled shear orifice electrohydraulic servo valve capable of optimum performance in severe environments.

The valve consists of only two moving parts—a spool and a sliding fork integral with a torque motor's armature. Of titanium construction, this valve has large, full-opening "shear seal" orifices which virtually eliminate silting problems, while high shear forces easily clear the valve of contaminants. Essentially a two-stage four-way control valve, Model 6103's first stage consists of an electrical torque motor and a "shear-seal" orifice hydraulic amplifier; its second, or control stage consists of a precisely matched spool and sleeve arrangement.

Hydromechanical unity feedback relates spool position to torque motor armature position and also nulls out the effects of orifice variations produced by fluctuations in supply pressure and temperature. With hydromechanical positional feedback, flow force reactions are substantially reduced and hydraulic centering of the pilot position is accomplished without the spring hysteresis and null shift commonly encountered in valves using the force feedback principle.

Springs and mechanical null adjustments have been eliminated entirely, and final null adjustments are made electrically by a balancing control at the amplifier output stage. The torque motor's high power and long stroke contribute to valve stability, minimizing the effects of temperature shifts, vibration, and mechanical stresses.

High differential pressure on the spool, together with spool and sleeve hardness, combine to provide effective dirt shearing action and freedom from friction in the second stage. Suspectibility to magnetic contaminants has been minimized, and although fluid is allowed in the motor cavity to cool the coil at high ambient temperatures, the cavity is isolated from load flow by spool lands and baffles.

Circle No. 249 on Subscriber Service Card.

west coast industry . . .

BY FRANK G. McGUIRE

A Palo Alto research and development company with 26 employes and two boards of directors has taken an interesting approach to formation of a successful R&D effort. **Vidya, Inc.,** a partly-owned subsidiary of **Itek Corp.,** recently announced the composition of its scientific board of directors, which will provide counsel to technical and administrative top management in high-level decisions. Vidya is a relatively new firm specializing in orbital mechanics and control. re-entry, plasma physics, space electronics, and other sophisticated areas of space flight.

The scientific board of directors includes Luis W. Alvarez, physics; Dr. Nicholas J. Hoff, structures; Dr. Samuel A. Schaaf, aerodynamics; Dr. Joseph M. Pettit, electronics; and Dr. Kenneth Street, Jr., chemistry. Members of the business board of directors, some of whom would apparently qualify for the scientific board as well, include chairman J. H. Carter, a vice president of Itek Corp. and formerly manager of the *WS117L* program (*Agena, Discoverer, Midas,* etc.) at **Lockheed,** and company president Wallace F. Davis.

Originally formed by a group of senior scientists, many of them from the Ames Laboratory of NASA, Vidya was purchased by Itek this year, and reportedly has unlimited financial backing from the parent firm. The present group of 26 scientists and supporting personnel is expected to increase to several hundred within two years, and the company is now forming an aerospace division.

Convair's battle for a new warehouse site . . .
has reached the stage of circulating petitions, newspaper editorials, "unidentified interests" and indignant declarations. Cause of the uproar is the rezoning of a 24-acre plot of land adjacent to **Convair-Astronautics** from residential to industrial use, thus allowing Convair to build on it. The rezoning, approved by the city council and city planning commission, will take effect December 4, unless 9273 protesting signatures are presented on a petition by the previous day. The petition, with unknown backers, is being circulated by a professional petition circulator in hopes of blocking construction of the $4-million warehouse needed for the *Atlas* program. Many believe that the "unidentified interests" vigorously opposing the rezoning are an unsuccessful group of bidders for the warehouse site. Convair would be forced to buy other land if its present plans are blocked, and owners of nearby available land are suspected of backing the petition and other agitation.

Number of workers in aircraft/missiles . . .
in Southern California has doubled in the past nine years, despite recent general trends toward fewer production workers. It will be interesting to note the trend over the next nine years. Although no breakdown is available for aircraft/missile wages, the average weekly wage of employes in all manufacturing in Southern California was $65.58 in 1950 and $102.82 in September, 1959, both assuming a 40-hour week.

Arnoux Corp.'s fourth acquisition in four months . . .
indicates a rapidly expanding complex of electronic capability for the firm. Through its Automation Electronics division, **Arnoux** has acquired **Perfex Connector Corp.** for an undisclosed amount. Perfex recently moved into a brand new plant in Monrovia, where it manufactures both special and standard types of connectors. In August, Arnoux announced acquisition of **Instrol, Inc.,** of Santa Barbara, and **Automation Electronics Inc.** In October, **Astra Technical Instrument Corp.** joined the family as a producer of temperature transducers. More growth is reported to be in the making.

The Infrared Information Symposium . . .
held in Pasadena recently brought out some interesting figures in IR's future. It was predicted that this field will be in the $500 million category as a market by 1961, and will hit $5 billion by 1965. But nobody will know about it unless IRIS security loosens a bit. Of the 850 attendees at the meeting, 65 were security officers from various agencies.

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☐ **Opportunity for Advancement.**

Spacecraft and advanced missile projects—including Minuteman solid-propellant ICBM—are expanding at Boeing, creating an increasing demand for electronic-electrical engineers capable of moving up to positions of greater responsibility and income. To help engineers get ahead faster, Boeing maintains a company-paid graduate study program, and conducts regular personal merit reviews to assure you a continuing opportunity for individual recognition and advancement. Boeing also carries out other company programs designed especially to develop personnel for added responsibilities.

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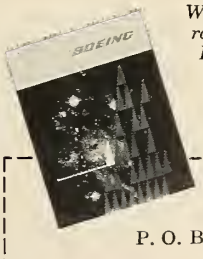

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Field of Interest .....

people

Thomas E. Gootée has left Government service to accept an executive position with Page Communications Engineers, a subsidiary of Northrop Corp., located in Washington, D.C.

GOOTÉE

Gootée will be Assistant Director of Maintenance and Operations for the firm, which performs government industrial global communications systems engineering, particularly in the fields of tropospheric, ionospheric scatter communications.

Prior to military and civilian government service, he was a field engineer with the National Broadcasting Co. in Chicago and New York.

J. C. Pitchford has been named vice president in charge of engineering at Benson-Lehner Corp. He will be responsible for the management and direction of the firm's expanding engineering department, with particular emphasis on implementation of a program for development of new products.

Jack Bair has been named Chief Mechanical Design Engineer for North Atlantic Industries, Inc.

BAIR

In his new assignment, Bair will direct design work associated with product diversification and the application of products to modular instrumentation systems for aircraft, missiles and ground checkout requirements.

Prior to joining the firm he was project mechanical engineer at Reeves Instrument Corp. where he was associated with the design of inertial platforms for the bomb scoring system used in development of toss bombing methods. He also worked extensively on miniaturized transistor amplifiers designed to extreme environmental and performance specifications.

Dr. Robert A. Fuchs has joined Electro-Optical Systems, Inc., as a principal scientist and head of the systems analysis group of the Space Defense Systems Division.

Prior to joining EOS, Fuchs was a member of the technical staff of Space Technology Laboratories where he was active in systems analysis work.

Maxwell H. Harts has been appointed chief engineer for Alpha Wire Corp. where he will be responsible for the company's research and development activities, maintain quality control and supervise the manufacture of custom cables.

Brian M. Gallagher, former design engineer with the Electro-Motive Division of General Motors has been named design engineer for Solar Aircraft Co. **Ben C. Axley, Jr.,** previously with Lockheed Missiles and Space Division, has been named chief of avionics in the research and development engineering division of Solar.

David E. Shonerd has been appointed vice president, engineering for Rocket Power, Inc., a division of The Gabriel Co.

SHONERD

Prior to joining the firm, Shonerd was assistant program director for the *Minuteman* weapons system at Space Technology laboratories. Before that, he was president of Era Engineering, Inc., developers of missile instrumentation. At Rocket Power, he will be responsible for all engineering operations relating to solid propellant rockets, high-altitude sounding systems, infrared energy sources, gas generation cartridges and space applications of solid propellants.

DeHavilland Propellers Ltd., has appointed **G. C. I. Gardiner** as Chief Executive of Ballistic Missile Engineering. He relinquishes his position as Chief Engineer but remains Technical Director of the company.

Three chief engineers have been appointed: **T. W. Air** becomes chief engineer of Ballistic Missiles; **G. H. F. Brown** chief engineer Propellers, Aircraft and Industrial Equipment; **Dr. G. H. Hough,** chief engineer Air-to-Air Guided Weapons and **C. C. Williams** has been named general manager.

Dr. Joseph Hull, formerly chief scientist, has been promoted to Director of the Research Laboratory of Litton Industries Electron Tube Division.

John F. Biehle has been appointed to the newly-created position of Technical Director of the Beryllium Components Division of Astrometals Corp.

BIEHLE

Biehle will be responsible for direction and coordination of research and development projects on beryllium, as well as provide technical liaison with industry and government agencies.

He was previously associated with Misco Precision Casting Co., Allegheny Ludlum Steel Corp. and Republic Steel Corp.

Since this ad first appeared on June 16th 1959 43 engineers have joined HMED – and there are approx. 38 positions at all levels open now!

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VERSATILE AIR CONTROL APPLICATIONS The revolutionary 412L can be used to defend a single airfield, or, by linking control sites together, it could be used in a limited action to provide air control for an area the size of Alaska. Similarly, by linking the capabilities of countries together, a system could be provided for the air control of an entire continent. Designed for both fixed and mobile applications, the 412L will be used primarily outside the U. S. since the SAGE system is used for the defense of this country.

HMEO IS ALSO DESIGNING THE "HEART" OF THE SYSTEM In addition to its prime mission of providing systems management, HMED will design, develop and produce the data processing and display subsystem which is the "heart" of the 412L. Capable of rapidly and automatically detecting and tracking air targets, the subsystem operates without human assistance, except under unusual circumstances.

OTHER FAR-RANGING PROGRAMS AT HEAVY MILITARY

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- Underwater Detection Systems
- Missile Guidance
- Data Handling Systems
- Communications

Individuals with experience in systems analysis or specific equipment design in the areas listed above are invited to forward their resume in complete confidence to Mr. George Callender, Div. 73-WV

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contracts

NAVY

$809,592—Raytheon Co., Microwave and Power Tube Div., Waltham, Mass., for electron tubes.

NASA

$178,000—University of Cincinnati, for research in celestial mechanics; the study of movements of celestial bodies in relation to gravity.

MISCELLANEOUS

$400,000—Flite-Tronics, Inc., Burbank, Calif., for the design and manufacture of laboratory test equipment. Subcontract from Hughes Aircraft Corp., Products Division.

$200,000—Yardney Electric Corp., N.Y., for the manufacture of compact, high-rate silver-zinc missile batteries. Subcontract from Convair and Convair Astronautics Div. of General Dynamics Corp.

$200,000—Temco Aircraft Corp., Dallas, for machining of components of a classified electronic countermeasures system. Subcontract from Sperry Gyroscope Co.

AIR FORCE

$101,000,000—General Electric Co., for continued development of advanced re-entry vehicles for *Thor* and *Atlas* missiles.

$2,210,594—Sperry Rand Corp., for components of radar set AN/APN-59 and data.

$2,000,000—Collins Radio Co., Dallas, for engineering, manufacture and installation of a microwave communication system for Fairchild AFB.

$323,175—Douglas Aircraft Co., Inc., Santa Monica, for 465 modification kits for the MD-1 rocket motor applicable to the *MB-1* rocket.

$61,000—Corning Electronic Components, Bradford, Pa., for feasibility study of multiple-tapped delay lines.

ARMY

Consolidated Diesel Electric Corp., Stamford, Conn., has received follow-on orders for hydraulic services consoles to be used in connection with the *Lacrosse* surface-to-surface missile. Amount not disclosed.

Kearfott Co., Inc., Little Falls, N.J., a subsidiary of General Precision Equipment Corp., has received an award to design, develop and build hydraulic control systems for the *Pershing* missile. Amount not disclosed.

Waste King Corp., Technical Products Div., Los Angeles, for research in the development of special lubricating systems for improved-performance gear drives.

$8,617,624—Aeronutronics Div., Ford Motor Co., Newport Beach, Calif., for *Shillelagh* missiles, a new light-weight surface-to-surface-weapon used for close-in support of troops.

$7,500,000—Radioplane Div. Northrop Corp., Van Nuys, Calif., for production of 400 RP-76 rocket-powered target missiles; broad flight service program to fly target missions for Army Air Defense practice teams firing *Nike-Ajax* and *Hercules* missiles. The ground support, control, and checkout equipment for the target missile system is also included.

$4,321,658—Henry C. Beck Co., Palm Beach, Fla., for construction of a complete launch complex (excluding blockhouse and serve structure) including above grade launch pedestal, subpad rooms, fuel and liquid oxygen facilities, high-pressure gas facilities and other supporting facilities for the *Saturn* rocket site at Cape Canaveral Missile Test Annex, Patrick AFB.

$1,705,379—Western Electric Co., for engineering and technical services in the *Nike* field support program.

$950,000—Raytheon Co., Waltham, Mass., for engineering services for the *Hawk* missile.

$830,580—Chrysler Corp., Detroit, for additional services on *Redstone* missile systems.

$542,885—Sperry Rand Corp., Salt Lake City, for design, engineering and fabrication of transistorized amplifier units.

$200,000—Electrodynamics Corp.'s Datalab Div., Pasadena, Calif., for magnetic-tape recorder/reproducers for use in connection with Project *Courier*.

$152,175—Sylvania Electric Products, Inc., Waltham, Mass., for engineering study of satellite tracking system.

$119,000—Sperry Rand Corp., Salt Lake City, for furnishing and delivering repair parts for missile systems. (Two contracts.)

$50,158—Monsanto Chemical Co., Everett, Mass., for electrochemical research of fuel cell technology.

$26,649—Curtiss-Wright Corp., Princeton, N.J., for preliminary design study and design and construction of a laboratory-scale thermoelectric generator for application beyond the earth's atmosphere.

BIDS

Procurement Branch, Aberdeen Proving Ground, Md.—Camera, thermal image: in a/w spec entitled Spec for Camera, Thermal Image—1 each—IFB ORD 18-001-60-64. Bid opening 11 December, 1959.

Purchasing and Contracting Div., White Sands Missile Range, N.M., ORDBS-P&C—Research metallograph unit—1 each—required delivery 120 days—IFB ORD 29-040-60-117—Bid opening 14 December, '59. Bid sets available through 7 December '59. Recorder, oscillographic, galvanometer type, with one quick look magazine. Required delivery 60 days FOB White Sands Missile Range, N.M. Bid sets available through 27 November or until exhausted. 1 each—IFB ORD 29-040-60-92—Bid opening 7 December '59.

Ogden Air Materiel Area, Hill Air Force Base, Utah. Attn: Directorate of Procurement and Production.—5 inch rocket target kit, type TDU-14/B—2498 each—IFB 42-600-60-90B—Bid opening 21 December '59. When replying mark OOPPPT.

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ORDNANCE DEPARTMENT
Of the Defense Electronics Div.

GENERAL ELECTRIC
100 Plastics Ave., Pittsfield, Mass.

The DOD Tells Industry

In an address before the American Management Association in New York recently, James P. Falvey laid down some cogent guide lines for industry in dealing with the military. Since Mr. Falvey is Deputy Assistant Secretary of Defense for Supply & Logistics, and since his points undoubtedly had the sanction of Secretary McElroy, industry might well give his words some close attention.

The Department of Defense, he said, expects American business to discard any feeling of complacency with its own progress and alleged invincibility. Maybe we are tops in automobiles and television sets, but:

> **"The cycle of industrial history has made a 180-degree turn. Survival does not depend primarily on mass production. We do not need any massive number of intercontinental ballistic missiles. And these weapons, in large measure, represent craftsmanship rather than mass-production capability. We are now in a period when scientific genius, supported by meticulous shop craftsmanship, has been phenomenally successful in building weapons of cataclysmic fire power."**

The major points he made to his management audience were these:

Survival depends on what we have now. Weapons delivered to the military must be of the highest possible quality and reliability—the nearest thing to perfection.

The cost of weapons must be reduced. Produce the simplest designs that will do the job. Make them reliable—but not gold-plated.

Use standard components and stop redesigning out of self-interest.

Industry has an obligation to take the initiative in eliminating superfluous requirements and to achieve standardization. Advise the contracting agency of wasteful and superfluous contractual requirements of any kind.

Months of time and a great deal of money are frequently wasted because technical proposals for negotiated contracts are delayed or incomplete. To be wary about disclosing full company data is a mistake. Procedures guarantee protection.

Time and money will also be lost if original pricing proposals are not realistic. Cost data must be up-to-date, complete and accurate.

As the military increases the concentration of military funds in costly individual projects, both the Department of Defense and probably Congress will insist on wider use of subcontracting. The Department of Defense small business subcontracting program, which has been undertaken on a voluntary basis in the past by several hundred military prime contractors, will very soon be mandatory on all recipients of military prime contracts of $1 million or more which offer subcontracting possibilities.

Industry must have the ability to discard old ideas, old weapons, obsolete equipment and unneeded facilities in favor of new products and production methods. The tendency to seek continued production of outmoded equipment for any reason, including the economic interest of a particular locality, is an unjustified industrial myopia.

These points, perhaps, are not radically new, but they are put with a succinct bluntness that is unusual outside the small, classified briefings that are sometimes held in the Pentagon. Couple these points with the stringency of the proposed 1960-61 budget. Calculate the competition for military projects and weapon systems both proposed and under way.

The conclusion seems apparent: future military contracts, from prime to the smallest component, are going to fall to the companies with known or demonstrable capabilities, recognized techniques—and sharp pencils.

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NEW PRODUCT BRIEFS

AUGE. Astra Corporation of Hatboro, .. has developed a gauge for use in gh pressure application, 1000 to 100,-0 p.s.i.g. This six-inch diameter gauge available in twelve ranges from 1000 100,000 p.s.i.g. Its element is a spe-al drawn and formed 316 stainless steel ultiturn helical Bourdon tube which ves longer life, and greater accuracy, d resists fatigue. It has mechanically aled ends, to permit cleaning. This ecial element is available in all ranges cluding 100,000 p.s.i.g. A new full rup-re Teflon diaphragm back provides aximum safety. Other safety features clude a high tensile safety plate be-een the element and the viewer and laminated safety dial glass. Of special terest to the use is the fact that the al is designed for maximum readability divisions are spread over 300 degrees the dial for all ranges. The ASTRA-UAGE is designed to Class AA stand-ds (ASA B.40.1-1939)—¼ of 1% ac-racy. The movement is of stainless eel throughout and special linkages re-ice shock and vibration. In order to otain maximum accuracy and to pro-de for auxiliary equipment, the move-ent and element are designed for aximum power in each range.

rcle No. 295 on Subscriber Service Card.

ANIPULATOR. Positioning and clamp-g work for welding, moving material and out of air locks, and many ordi-rily difficult tasks in vacuum are made sy by the RYE M-1 manipulator. andling can be done over a wide essure range from positive pres-res to better than 10^{-4}mm Hg, through e of double-pumped vacuum seals. Full otion through a 90° cone is possible th the easy 90° action ball joint. The foot stainless steel shaft can be moved and out of the chamber and rotated. sitive acting parallel jaws are con-olled by a pistol grip handle. The andard manipulator is furnished with a achined attachment plate with an "O" ng for positive seal, or is available ounted on blank-off plates or other nfigurations. Model RYE M-1 HT is i stainless steel beyond the handle and igger assembly and is especially use-l for high temperature applications.

rcle No. 296 on Subscriber Service Card.

RESSURE PUMP. A medium-pressure odel is now available in the Turbocraft family of petrochemical and cryogenic transfer pumps. The medium-pressure Series 2000 is intended for liquefied gas trailer and similar applications where compactness and lightness is essential. The pump is also useful for evaluating small, low-thrust rocket engines, replacing complex pressurization systems, and units have been supplied for liquid hydrogen and fluorine service. The pump's extreme flexibility allows it to be used either as a fuel pump or as an oxidizer pump in high-speed continuous or intermittent operation without cavitation. It can be removed from any system without affecting suction or discharge piping. Mounting can be vertical or horizontal.

Circle No. 297 on Subscriber Service Card.

CONVERTER. Data conversion from four binary inputs to a tape recording in the IBM 704 format is possible with an all-transistor data converter now being manufactured by the Electronic Engineering Company of California. The Data Converter will convert a 27-bit time code, one 20-bit data signal, and two-17-bit data signals into an IBM 704 magnetic tape. The unit will also supply signal outputs to seven central locations also in the IBM 704 coding but without gaps between the blocks. The sampling rate of the input data may be selected at 10, 20, 40, 80 or 100 pps. The Data Converter was designed for the multiplexing and the recording of range, azimuth, and elevation data from digital radar outputs together with a timing signal.

Circle No. 298 on Subscriber Service Card.

WHEEL DRESSER. A grinding wheel dresser, Model #10, is designed to fill a long existing need in Industry for a heavy duty—low cost wheel dresser, has been produced by the L. Newman Co. 6" long with a ¾" diameter shank. Made of high tensile strength cast aluminum alloy. Arbor equipment with sealed ball bearings. Specially developed cutters and abrasive wheels are interchangeable. The built-in tangential angle of the cutters (or wheels) eliminates the need for a breaking device and assures sharp, cool grinding, while eliminating burn checks and flying dead grain. In factory tests this tangential angled dresser provided 2/3 more grinding per trim. Model #10 will fit standard peterson cylinder head and lempco grinders.

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MISSILE LITERATURE

STEEL. A booklet on a high strength steel for use in missiles and rockets is now being distributed by Allegheny Ludlum Steel Corporation. The booklet, entitled "Potomec A High Strength Steel," is 24-pages long, end contains numerous graphs end charts on this chromium-molybdenum-x vanadium hot work steel. The steel, known as type H-11, is noted for its high strength up to 1000 degrees F, and is used in landing gears, solid propellant rocket cases, structural sections of aircraft and missiles, and many other applications.

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MISSILE ELECTRONICS. General Precision Equipment Corp., has issued a four-page text booklet describing echievements in navigation-guidance-control, data handling, detection, trecking and fire control and simulation end test equipment. It identifies principal components and systems programs underway at GPL, Kearfott, Librascope and Lind subsidiaries.

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BUTTERFLY VALVES. A new four-page condensed bulletin describing the complete line of Continental butterfly valves is now being distributed. Eight butterfly valve designs are presented in tabular form, which makes comparison and selection easy. Valve sizes range from 1" to 108", with pressure drops up to 1200 psi and temperatures up to 2000°F.

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ICE CALIBRATOR. An instrument which calibrates the thickness of ice on liquid oxygen tank exteriors during static missile test firings has been developed by Task Corporation, Anaheim, California. Task engineers state the probe, which bolts directly to a sheet metal mounting pad, can accurately record ice depth within $\pm$.010 of an inch. Containing a 15-24 volt D.C. operated rotary solenoid, a continuous AC signal is transmitted by a 10,000 ohm potentiometer within the unit. Cycling every 5 or 10 seconds, the signal is broken by one of two microswitches to enable an immediate reading on the test equipment while the second microswitch provides a DC signal to close a relay and deliver the arm of the probe to the return position. The device is 4" by 8" and the arm measures 12" in length. Entire unit is said to feature internal hydraulic damping and is sealed from external environment. Mounting provision can be modified to meet customer specifications.

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LEAK VALVE. Scientific Engineering Laboratories, Inc. has announced a new Palladium Leak Valve for control of hydrogen and deuterium gas flows. This valve consists of a 3½-inch diameter chamber, 4½ inches high, with e palladium thimble. The top flange is 5 inches in diameter and ¾-inch thick. Input and output connectors are female ⅛-inch diameter pipe fittings. Input can be pressurized up to 15 psi gauge. The valve is heated by an external 117-volt ac heater designed to be powered by a Type 10 Powerstat.

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MAGNETIC TAPE. A four-page illustrated bulletin describing CEC Magnetic Tape for digital and enalog recording is availeble from the DataTape Division of Consolidated Electrodynamics Corporation. Information includes performance qualities of the new tape, production techniques, and specifications.

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ZENER DIODES. A 130 page manual covering basic theory, design characteristics and applicetions for zener (voltage limiting) diodes has just been announced by Motorola's Semiconductor Products Division. This new handbook, the first of its kind, is intended to serve as a guide in the use of this versatile end relatively new component. Chapter headings include: Characteristics of Silicon Zener Diodes, Design Considerations, Regulated Power Supplies, Surge Protection, A.C. and D.C. Amplifiers, Temperature Compensation and Impedance Cancellation, New Approaches in Zener Diode Applications, and Specifications and Testing Methods.

Circle No. 206 on Subscriber Service Card.

PRECISION WIRE. Technical Data on precision wire wound end composition variable resistors is being offered in the new 24-page engineering catalog just published by Reon Resistor Corp. This collection of valuable engineering information is divided into two sections, one devoted to the precision wire wound resistors and the other to the variable resistors. In the precision wire wound sections such subjects are discussed as characteristics of resistance wire; temperature coefficient interpretation; "E" temperature coefficient; special temperature coefficients; termination of resistance wire; MIL-R-93B and MIL-R-944 nomenclature. The subject matter of the REON composition variable resistor section includes: MIL-R-94B nomenclature, the Reon part numbering system; interchangeability and a complete chart summary of test results on Reon variable resistors.

Circle No. 207 on Subscriber Service Card.

ELECTRONIC COMPONENTS. Bulletin GEZ-2910, 12 pages, describes General Electric's complete line of transformers, reactors, power supolies, modulators and other components for high voltage applications in the electronics industry. Publication includes pictures and detailed information on the features, characteristics and operation of the company's full line of products including "packaged" equipments such as pulse and filament transformers, rectifier and filament transformers, and power supplies, including rectifier transformer, filament transformer, filter and charging reactors.

Circle No. 208 on Subscriber Service Card.

RESISTORS. Chicago Telephone Supply Corp. has released a data sheet giving dimensional drawings and complete technical data on its new line of ¾" diameter miniature preset wirewound ½ to 5000 ohms resistance range variable resistors.

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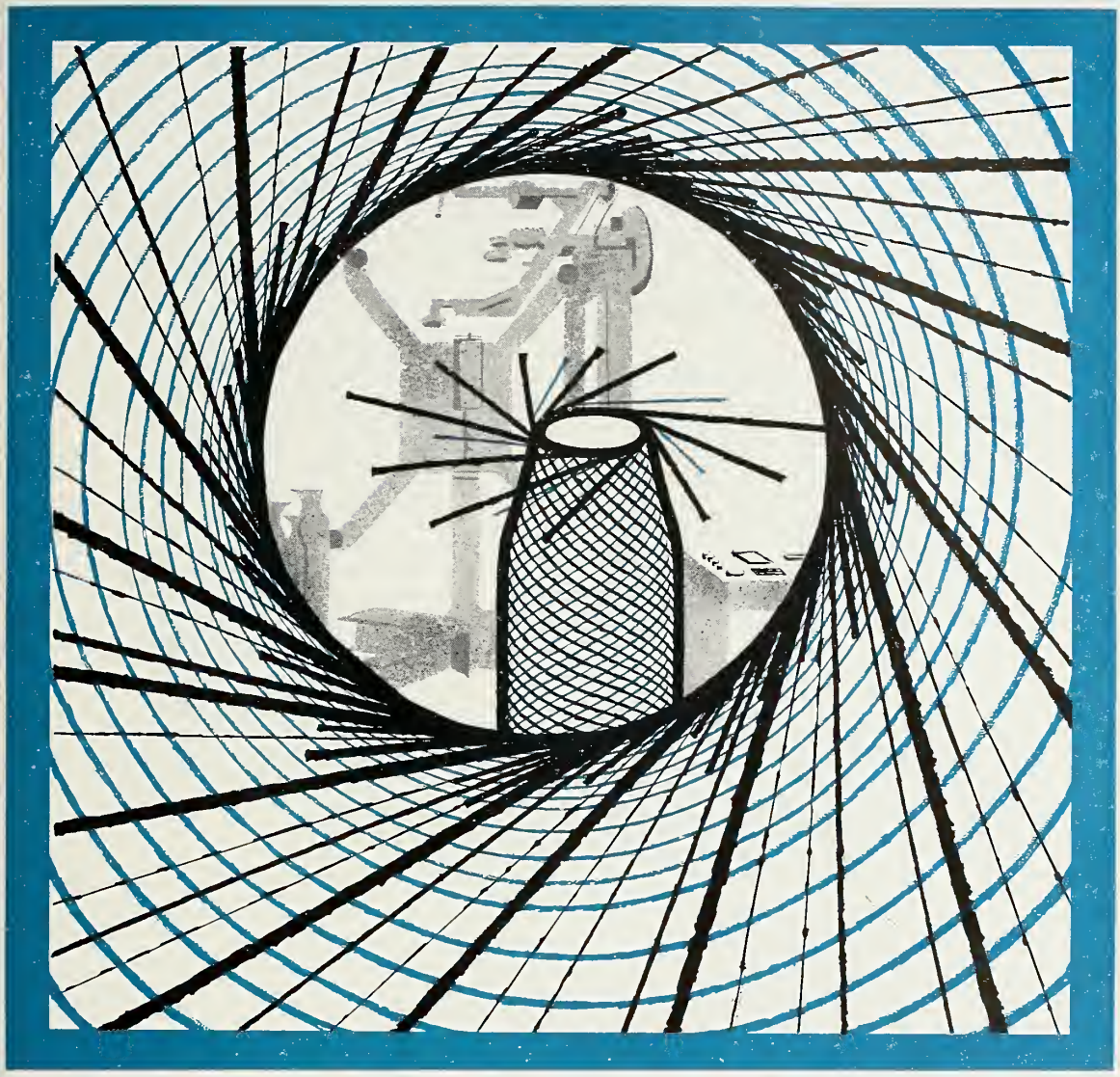

BRUNSWICK WINDS S-D RATIOS UP TO 2,000,000!

You can get an idea of the remarkable power of Brunswick's exclusive Strickland "B" Process (SBP) from the fact that it winds fiberglass filament to a strength-density ratio of 2,000,000. (The SD ratio of high strength steels is 800,000.) The hoop tensile values of these products have averaged 200,000 psi, and their composite wall strengths range from 120,000 to 140,000 psi. SBP gives unmatched reliability and precision in the winding of structural elements, bodies, internally and externally loaded vessels and large cylinders. The process provides unusually close machine resin impregnation control, and variable control of glass density. The winding equipment shown above will produce units up to 12 feet long and 6 feet in diameter. With slight modifications, it will wind much larger units.

Get more information on how SBP can serve you. Write or call: The Brunswick-Balke-Collender Company, Defense Products Division Sales Manager, 1700 Messler Street, Muskegon, Michigan–today!

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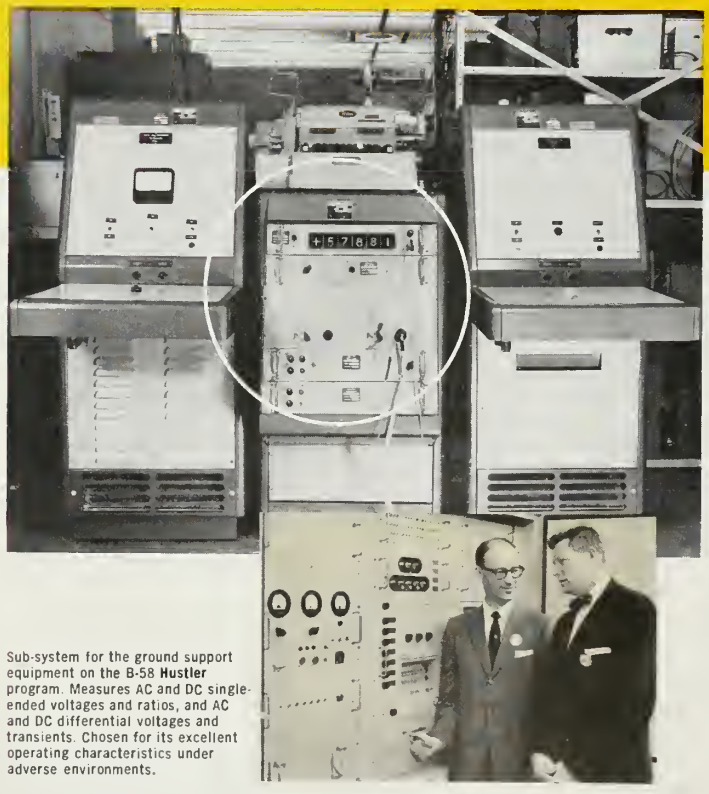
ELECTRO INSTRUMENTS can meet your systems needs NOW... with HARDWARE, NOT PROMISES!

Systems shown here are typical of more than 200 designed and built by EI and now in use. They range in complexity from data logging systems for automatic scanning, measurement and recording of data from multiple transducers...to high speed, automatic checkout systems for missile and aircraft...to systems for automating industrial processes.

Because of the EI modular design approach, many of these systems can be delivered on virtually an off-the-shelf basis, eliminating the long delivery times usually associated with system development. This approach also results in a low cost system because the modules are manufactured in large quantities. Cost is almost a linear function of performance capabilities desired.

Why not talk over your digital system requirements with your EI Sales Engineer? His system experience will be a valuable help in solving your problem.

Multi-purpose digital system for measuring a variety of transistor parameters while the transistors are being subjected to environmental testing.



Digital read-out sub-system of a large, automatic, transistor production checkout system.

Sub-system for the ground support equipment on the B-58 **Hustler** program. Measures AC and DC single-ended voltages and ratios, and AC and DC differential voltages and transients. Chosen for its excellent operating characteristics under adverse environments.

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MORE VERSATILITY—AC and DC voltages, AC and DC voltage ratios, ohmic resistances, capacitance, frequency, phase, inductance, time, or combinations of these basic input quantities can be accepted by the EI system.

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