APRIL 20, 1959

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION

First Digital Voltmeter With Mathematically Perfect Logic . . .

The first stepping switch voltmeter with mathematically perfect logic . . . and the first to be completely transistorized! It's the NLS V-34, the latest instrument to be developed by the originators of the digital voltmeter. The exclusive new digital logic of the NLS V-34 allows readings to be made without cycling stepping switches through all nine positions in each decade. For the first time, "needless nines" are eliminated . . . the result: longer switch life and shorter measuring time. Check the exclusive features listed below.

"NO NEEDLESS NINES"

FOR FASTER MEASUREMENTS AND GREATEST RELIABILITY

MATHEMATICALLY PERFECT LOGIC — No numbers change that absolutely do not have to change. Stable measurements can be made of varying voltages.

STEPPING SWITCHES SEALED IN OIL — Each stepping switch is mounted in an individual oil-filled container. No manual lubrication needed. Oil bath extends life by factor of ten.

PLUG-IN STEPPING SWITCH MODULES — Stepping switches can be replaced as quickly as plugging in the meter.

FIRST COMPLETELY TRANSISTORIZED DIGITAL VOLTMETER — Even logic functions are performed by semi-conductors. Switch points reduced to one-half those required by "completely transistorized" competitive meters. Only the NLS V-34 is transistorized to the fullest possible extent.

SPECIFICATIONS

Range to ±1000 volts . . . Ratio to ±.9999 . . . 10 Megohm input impedance . . . 0.01% accuracy . . . Automatic range and polarity changing . . . five-digit model also available.

Write today for complete information on the NLS V-34

Originators of the Digital Voltmeter

non-linear systems, inc. DEL MAR (San Diego), CALIFORNIA

COMPARISON CHART

The few steps required by the NLS V-34 to make a typical measurement (3rd column) are compared with the many required by competitive meters. Note the blue "needless nines" in the middle column.

NO. OF STEPS	COMPETITIVE METERS	NLS V-34
0	+.8888	+.8888
1	+.8889	−.8888
2	+.8880	−.9888
3	+.8890	−.0888
4	+.8800	−.1888
5	+.8900	−.1988
6	+.8000	−.1088
7	+.9000	−.1188
8	+.0000	−.1198
9	−.0000	−.1108
10	−.0001	−.1118
11	−.0002	−.1119
12	−.0003	−.1110
13	−.0004	−.1111
14	−.0005	
15	−.0006	
16	−.0007	
17	−.0008	
18	−.0009	
19	−.0019	
20	−.0029	
21	−.0039	
22	−.0049	
23	−.0059	
24	−.0069	
25	−.0079	
26	−.0089	
27	−.0099	
28	−.0199	
29	−.0299	
30	−.0399	
31	−.0499	
32	−.0599	
33	−.0699	
34	−.0799	
35	−.0899	
36	−.0999	
37	−.1999	
38	−.1099	
39	−.1199	
40	−.1109	
41	−.1119	
42	−.1110	
43	−.1111	

THE MEASUREMENT IS COMPLETED IN JUST 13 STEPS BY THE NLS V-34

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

Circle No. 1 on Subscriber Service Card.

YOU

see-

surely-

WITH

safety

THROUGH

Stretched Acrylics BY GOODYEAR

You are looking through an airliner window of stretched acrylic.

The plane is a Fairchild F-27—but it could be a Boeing 707 or Douglas DC-8. For all of these airliners—and some of the latest military jet aircraft as well—are using stretched Plexiglas* for windows and canopy bubbles.

Leading fabrication techniques and design criteria for low-cost mass production of stretched acrylics have come from Goodyear Aircraft Corporation—pioneer in this important field.

Goodyear Aircraft stretches Plexiglas in such a manner that it is transformed into a tough, durable, craze- and crack-resisting material without the loss of the fine optical properties for which acrylics are known.

These same techniques make possible Goodyear acrylic visors for pilot helmets—protecting their eyes without impairing their vision.

For facilities, experience and skills in all phases of acrylics fabrication—including similar operations and stretching and forming—the company to contact is: Goodyear Aircraft Corporation, Dept. 916-PD Akron 15, Ohio.

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Propulsion Engineering ..... MICHAEL LORENZO
Industry ..... JAMES J. HAGGERTY, JR.
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missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

APRIL 20 HEADLINES

MISSILE SUPPORT EQUIPMENT

MISSILE ELECTRONICS

THE MISSILE WEEK

NEW MISSILE PRODUCTS

DEPARTMENTS

NEXT WEEK: Pictorial highlights of World Congress of Flight The Optik, Suggested Measurement for Astronautics.

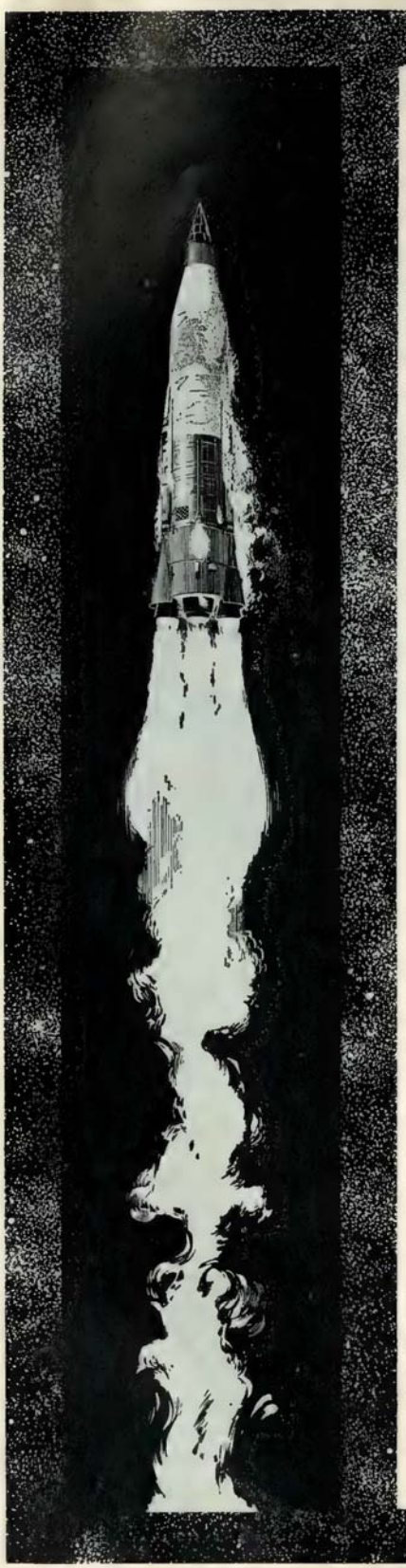
COVER: Goodyear has gone into a new line of support equipment for *Atlas* (p.23)

THE F-104A with *Sidewinder* is now "ready for combat" with 46th Fighter-Interceptor Squadron at Wright-Patterson.

NEW MOBILITY for *Honest John* is demonstrated by the Sikorsky S-60 crane helicopter which can carry a six-ton load.

INFRARED seeking *Firestone* by deHavilland is carried on Hawker Hunter in this recently released photograph.

ELABORATE and costly flight training facilities will be a part of GSE when man enters the missile (p. 20)



FIELD TEST ENGINEERS

Versatile, practical-minded engineers with a record of accomplishment in the missile or aircraft business may qualify for a field test position at Convair-Astronautics — creators and testers of the mighty **ATLAS ICBM.** A number of positions must be filled immediately at various locations, from Cape Canaveral, Florida, to Vandenberg AFB near Santa Maria, California. "Astro's" field test operations are in two major groups: *Activation* — coordination of construction and the integration of support systems with facilities; and *Operations*—the preparation, checkout and launching of the missile itself.

Most important requirement for these positions is *versatility* — that blending of education and experience which equips engineers to think in terms of hardware under field test conditions. An engineering degree and missile test experience are most desirable, but a sound background in related work can furnish the necessary qualifications. Specific requirements are in **ELECTRONICS** (R.F. communications, instrumentation, missile control and guidance systems) **MECHANICAL ENGINEERING** (pneumatics, hydraulics, propellant handling and loading, mechanical ground support equipment), and **CIVIL ENGINEERING** (establishment of design criteria on missile facilities). There are also outstanding opportunities for **ENGINEERS AND SCIENTISTS** in many other areas and at all levels for a variety of space programs under way at Convair-Astronautics' San Diego headquarters. Our engineering representatives will be conducting **INTERVIEWS** in these and other cities soon:

ALBUQUERQUE, BALTIMORE, BOSTON, BUFFALO, CHICAGO, CLEVELAND, DAYTON, DENVER, DETROIT, EL PASO, FT. WAYNE, INDIANAPOLIS, KANSAS CITY, LOS ANGELES, MINNEAPOLIS, NEW ORLEANS, NEW YORK, PHILADELPHIA, PITTSBURGH, ST. LOUIS, SPRINGFIELD, MASSACHUSETTS, AND WASHINGTON, D.C.

We invite qualified engineers and scientists to send a detailed resume at once so advanced arrangements can be made for a confidential interview. Write to Mr. G. N. McMillan, Engineering Personnel Administrator, Department 130-90.

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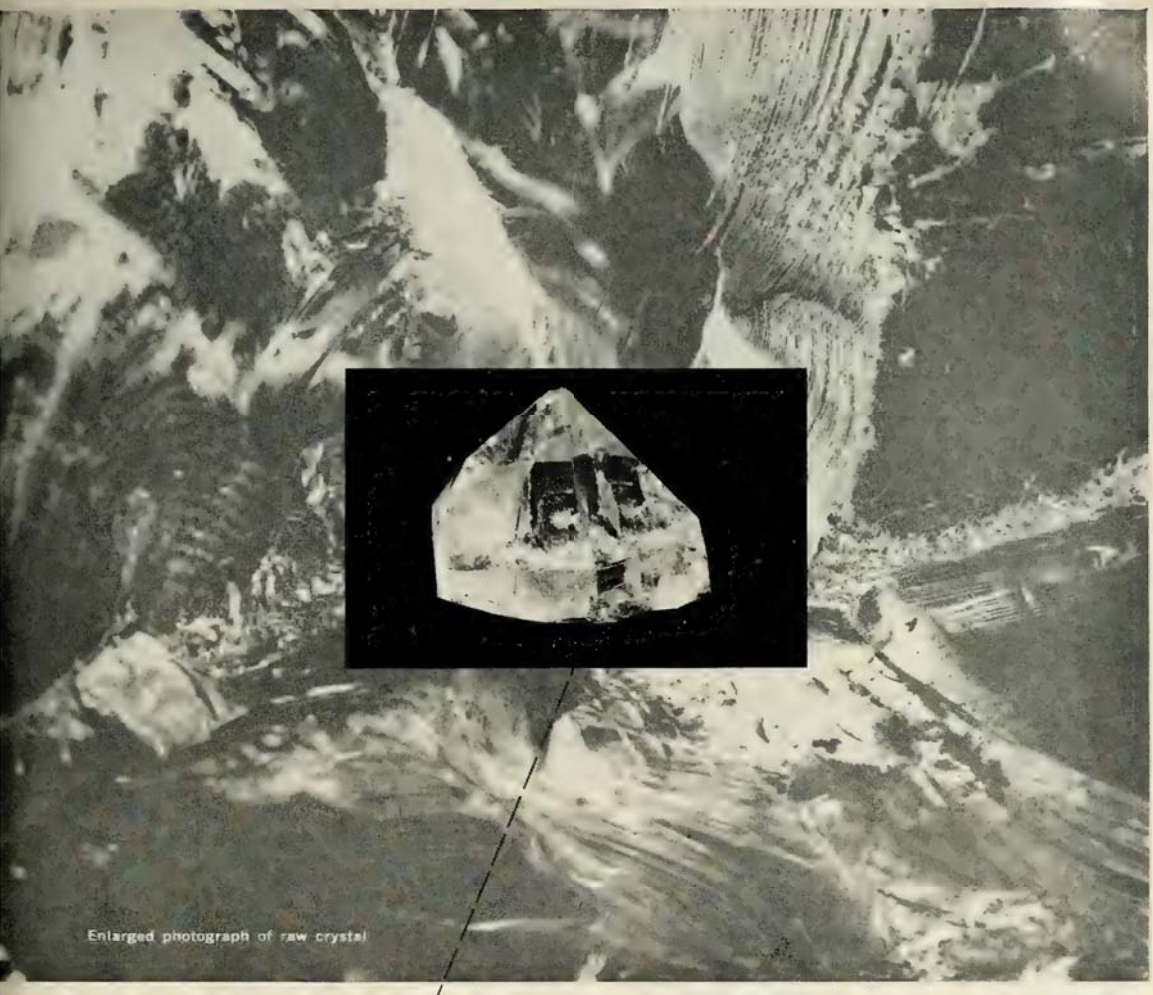

BULOVA **CRYSTAL CONTROLLED** VARIABLE FREQUENCY OSCILLATORS

Bulova Crystal Controlled Variable Frequency Oscillators are the *advance* in electronics most engineers have been seeking.

Why? . . . Because Bulova VCF packages combine small size and high repeatability with automatic frequency control or with a variation of nominal frequency by application of external voltage.

The ranges available extend from 10kc to 20mc. Variation at 10kc is up to 6cps, at 20mc up to 12kc. Resolution on these shifts is infinite, it's dependent on stability and resolution of modulating voltage, only. Drift, after stabilization, can be kept to less than 1 pp 10^4.

These unique crystal controlled variable frequency oscillators are only one of many recent advances made by Bulova Electronics. For information on these units, or on how Bulova experience in mastering component and system reliability can help your program, write Department A-1231, today.

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Brush militarized recordin

ystems are....

READY NOW FOR "2nd GENERATION" SPACE VEHICLES!

When "second generation" space vehicles become operational, the readout of their performance will be monitored by Brush militarized equipment already in existence.

For instance, the 100-Channel Operations Monitor that will record 100 channels of data simultaneously – on a chart 12″ wide! Complex checkouts are simplified.

Or 2- and 6-channel systems (including oscillograph and amplifier)... or the combination Analog and Sequential Recorder.

All equipment complies with Mil. E-16400, Mil. E-4158, Mil. E-4970 and other specifications as required.

For maximum reliability, equipment utilizes fast-response electric writing, proven on critical operational sites such as DEW Line, Jupiter and Thor checkouts.

It will pay to get familiar with this equipment now – before you are confronted with prototype design problems. Brush engineers are available to give you needed details, or write us direct.

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CEC's design capabilities and facilities for developing and producing complete missile ground support equipment is a matter of record. Typical of CEC's ground support equipment are static and dynamic checkout units for fuel systems ... propellant utilization exerciser systems...and electronic systems for telemetry, inertial guidance, and control checkout. For full information, send for CEC Bulletin 3017-X4.

Consolidated Systems CEC

CONSOLIDATED ELECTRODYNAMICS *300 N. Sierra Madre Villa, Pasadena, Calif.*

FOR EMPLOYMENT OPPORTUNITIES WITH THIS PROGRESSIVE COMPANY, WRITE DIRECTOR OF PERSONNEL

Propellant Utilization System Exerciser sequentially generates precise pressures for the fuel and oxidizer channels at 25 preselected points on a scale from zero to maximum, making possible precise checkout.

Pneumatic Checkout System is essentially a go, no-go device that automatically pressurizes and tests missile pneumatic systems during storage and pre-countdown periods. Sensing units detect any malfunction, transmit signals to automatic comparator.

Circle No. 6 on Subscriber Service Card.

We Educate Our Youth—Or Russia Will

U.S. industry has long shared a general concern that the country's annual harvest of scientifically trained college graduates was falling considerably below an essential level and dangerously behind the crop produced by the Soviet Union. But it has not done enough about its concern.

Congress voted a loan program last year to encourage scientific education, but student loan money—long available from other sources—went begging to a large degree. Young people have always been reluctant to step out on their own with a heavy debt over their heads. Individual companies and associations have helped by providing scholarships and making grants to colleges and universities, but the administrative process of awarding these has limited the number who could participate.

Now, with establishment of the National Merit Scholarship Corporation, a means has been established to provide the small or medium-sized company with a centrally organized, low-cost national testing mechanism to help them make the best use of available scholarship funds. And, because NMSC runs the administrative end of the program, from providing the academic testing to selection of the winners, companies which provide the funds are assured that 100% of their contribution goes to scholarship winners to defray education expenses.

The National Merit Scholarship Corporation was launched in 1955 with grants of $20.5 million from the Ford Foundation and the Carnegie Corporation. Since 1952 the Ford Foundation had been studying the possibilities of a nationwide scholarship program financed by private sources. One conclusion they came up with couldn't have been too startling—that most of the more able students who dropped formal education after high school gave lack of sufficient funds as a reason.

There were other conclusions: with the U.S. population increasing at the rate of three million a year and with the Cold War continuing to demand more and more of our industrial capacity, the competition for skilled help has become much sharper; that the lean crop of depression babies due to reach productive manhood (age 25-34) in the mid-1960's will be 700,000 fewer than today; that one-third of the top quarter students graduating from high school named science or engineering as their first choice for a continued education; that actually one-half of this one-third did not get to college at all.

Industry, which had not done too much before the advent of NMSC to ease the problem, in the last three or four years has come forward with a substantial beginning which reflects not only concern but acceptance of at least a share of the responsibility for solving the whole scientific education problem. This participation has gone up annually until some $12 million in scholarship aid has now been committed and 2300 of the nation's most able students are continuing an education which might otherwise not have been possible. In addition, an increasing number of companies have been awarding scholarships to children of employees on the basis of their performance in the Merit competition.

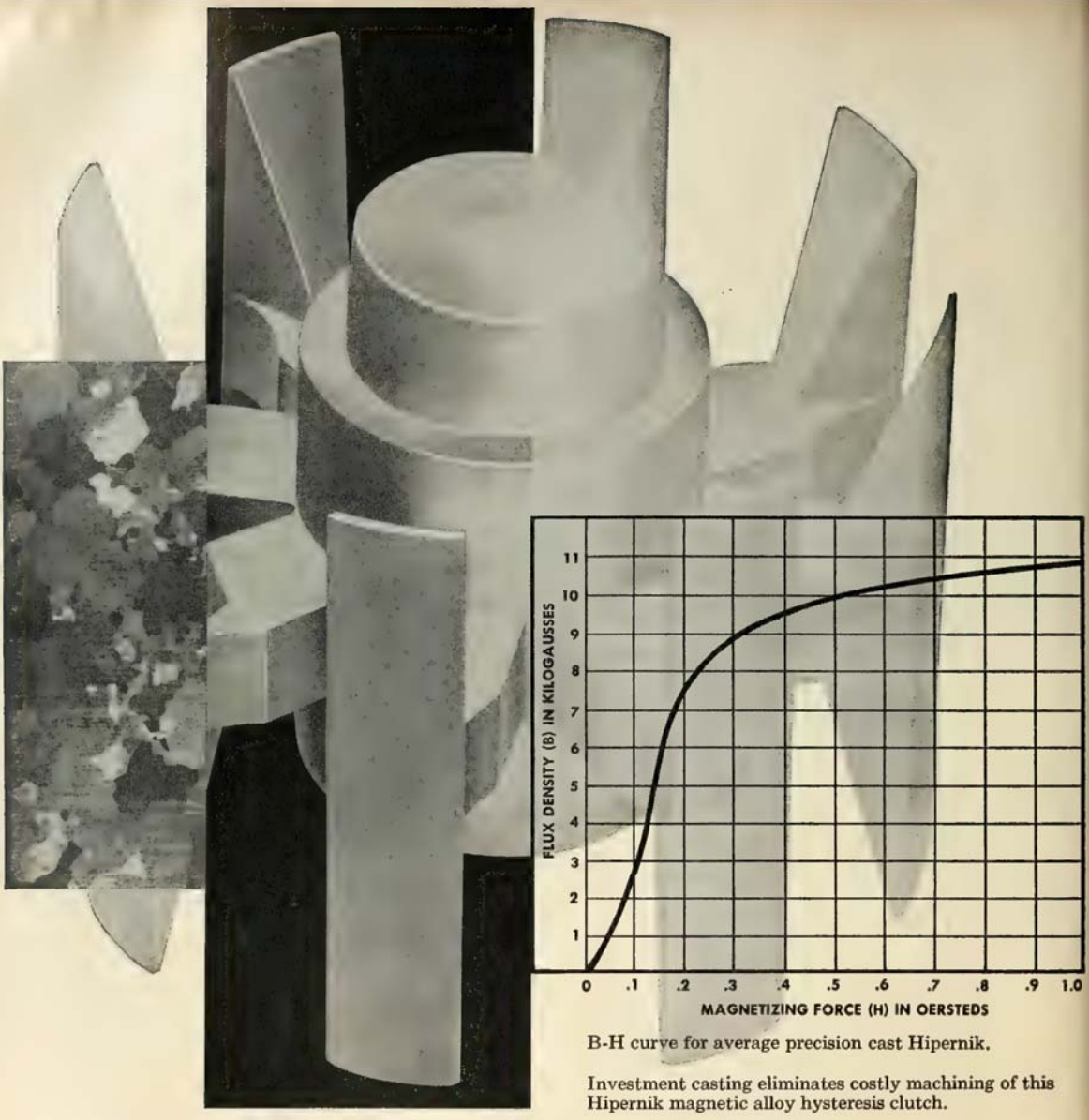
The number of companies actually participating in NMSC, to a large or small extent of the $12 million total, is 80.

We should like to see it stepped up to 800 and $120 million—ten fold—because we face a formidable antagonist who has stepped up his not ten but 20-fold. Russia's planning is long-range in view and deadly in intent. There, education right through the graduate and professional level is free and is available, according to official USSR announcement, "to everyone having the capacity to use it productively."

Today's engineering student is tomorrow's builder, inventor, genius. The challenge as well as the problem is clear. Industry, which has so very much at stake, must recognize that this is among the greatest of its responsibilities. Let's say that $12 million is a fair start, but only fair. And why only 80 companies out of America's thousands?

As another recently expressed it, we believe: "The rule is absolute, the race which does not value trained intelligence is doomed . . . tomorrow science will have moved forward yet another step, and there will be no appeal from the judgment which will be pronounced on the educated."

Clarke Newlon



B-H curve for average precision cast Hipernik.

Investment casting eliminates costly machining of this Hipernik magnetic alloy hysteresis clutch.

Westinghouse Hipernik Casting

... cuts costs, retains magnetic properties

The field of electronics has created special metal problems. The Westinghouse Metals Plant has accepted and solved some of these problems.

Cast Hipernik® is particularly adaptable to the requirements of missile control systems. Other applications in the electronic control and instrumentation fields are transformer cores, pole pieces, solenoids, torque motors, magnetic clutches and many special magnetic applications.

The Westinghouse Metals Plant may be able to cut your costs by eliminating unnecessary machining, yet delivering to you a completely finished component ready for assembly. This modern metals plant can furnish strip, sheet and bar stock in other magnetic and high temperature alloys. Write to: Westinghouse Metals Plant, Blairsville, Pennsylvania. Our latest bulletin on Hipernik will be sent to you by return mail. J-05005

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WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS-TV MONDAYS

washington countdown

IN THE PENTAGON

Research and Engineering Director Herbert York and his new R&E office are taking another long look at the *Nike-Zeus* AICBM program. Two of the principal reasons: The results of Project *Argus* and mounting pressure to find a defense against missiles in the face of Russia's increasing ICBM stockpile.

• • •

The Navy expects to have a fleet of five commissioned *Polaris* submarines by the end of next year. Three of the Nuclear subs will be ready to be placed on station by next summer—the earliest that Lockheed's *Polaris* is expected by some officials to be operational.

• • •

The Navy is engaged in one of its hottest behind-the-scenes fights in years. The issue: Navy Undersecretary William Franke's organization study recommending abolishment of restricted line officer billets and creation of a Naval Technical Corps. Opponents charge this means industry would soon find itself dealing strictly with non-technical line officers at the top of the Navy's big technical bureaus. Insiders also charge the real reason for the proposal is the Navy has fewer and fewer top-drawer sea commands to go around.

• • •

The Pentagon is pressing ahead with $6 million-a-year program of research projects aimed at developing low-altitude "flying saucers" based on the principal of creating a ground air cushion. They would range in size from a dozen to 1,000 feet or more in diameter. One huge model would skim the world's oceans at possibly hundreds of miles an hour and serve as a mobile seaborne landing field or rocket-launching platform. DOD will review all projects next month at a conference at Princeton University.

ON CAPITOL HILL

A new public battle appears certain over the on-again off-again U.S. program aimed at developing a nuclear-powered airplane. The Joint Congressional Atomic Research Subcommittee will hold its first public hearings on the controversial program later this month. In the past, subcommittee members have repeatedly called for more action on the program and administration officials have countered with public replies. But all hearings on the program have been secret.

• • •

Space exploration may pay off in more than glory for the first man to leave the Earth in a space craft. Rep. Victor L. Anfuso (D-N.Y.) has introduced a bill that would award the first American spaceman a tax-free $100,000 prize. The bill would not require the winner to collect in person.

• • •

The House Military Operations Subcommittee will issue a report on its investigation of management of the Air Force missile program without holding further hearings. The report is expected to be released in about a month.

AT NASA

NASA project people are split on whether the new family of *Scout* research vehicles is really needed. One proposal is a three-stage *Vanguard* which could be fired later this year while *Scout* probably would take at least 12 to 18 months development time before production. Systems manager selection for *Scout* is still undecided with NASA laying plans for fabrication "in house" at Langley. NASA's *Vanguard* proponents say modified *Vanguard* could do the job just as well as *Scout* and perhaps at less cost.

AROUND TOWN

Top U.S. space experts will meet in Washington June 29 for a two-day symposium on space research. The symposium is being sponsored by the National Academy of Sciences, the American Physical Society and NASA. It will end the academy's annual meeting which opens June 27. The academy also will hold symposiums on oceanography, the atmosphere and some of the still secret results of project *Argus*.

Jupiter and Redstone

with Aronson

TRAC-TRED* TURNING ROLLS

*T. M. REG. U. S. PAT. OFF. PAT. NO. 2,669,364

The U. S. Army Ordnance Michigan Missile Plant, operated by the Missile Division of Chrysler Corporation had problems concerning the handling of the Redstone and Jupiter missiles with their thin-walled skin (aluminum) without damage, such as wrinkling, marring or indenting. Also how to position the missile when being X-Rayed and having certain assemblies added as well as moving the large skin from place to place.

Their solution to these problems was Aronson Rubber Trac-Treds installed on specially built dollies: two (2) Idler double Trac-Treds with rubber treds and staggered to give constant contact with the skin and so positioned as to permit 90 degrees of the skin's surface to be nestled and supported by the treds. These Idlers are placed at either ends of the dolly. The Single-Rubber Trac-Tred Driver Unit, also giving 90 degrees of surface support, is located in the middle of the dolly providing the turning power. The Trac-Tred Driver unit is 110 volt to enable the complete unit to be moved to and worked on anywhere in the large plant.

For Steady, Positive, Precision Rotation of THIN-WALLED VESSELS use ARONSON TRAC-TRED TURNING ROLLS

Quality POSITIONERS by **Aronson MACHINE COMPANY**

ARCADE, NEW YORK

WELDING POSITIONERS • TANK TURNING ROLLS • TURNTABLES

Circle No. 8 on Subscriber Service Card.

BRUNSWICK "SHOOTS" THE RADOME RANGE TO 1200° F

Brunswick makes a new breach in the thermal barrier with newly developed non-metallic materials that boost the temperature tolerance of radomes and nose cones to 1000-1200°F for limited exposure periods — almost twice the previous limit. This new advance in Brunswick's Strickland 'B' Process of filament winding opens a new chapter in aircraft and missile designing.

New "SBP" filament winding results in the highest strength-to-weight ratios ever obtained in radomes and nose cones with significant weight savings over conventional structures. With unmatched electrical uniformity, Brunswick builds them to meet the tightest tolerances for dielectric constants and compound configurations. Brunswick offers full electronic testing facilities.

Brunswick radomes and nose cones now slice skyward on such supersonic aircraft as the advanced Convair F-106; on such missiles as the Boeing Bomarc and Lockheed Q5. For details on Brunswick's leadership in research, development and testing, write: The Brunswick-Balke-Collender Company, Defense Products Division, 1700 Messler St., Muskegon, Mich.

BRUNSWICK

MAKES YOUR IDEAS *WORK*

Circle No. 9 on Subscriber Service Card.

The low-down on low-level missions

Let them hide that target in a deep gorge . . . surround it with jagged peaks . . . shroud it with fog. A plane with an Autonetics monopulse radar system—like Republic's F-105—can find it at will . . . day or night, rain or snow.

Lightweight, compact NASARR is the only system in production that is equally effective for air search, automatic tracking, air-to-ground slant ranging, and terrain avoidance—from sea level to stratosphere. Accurate ground mapping rounds out NASARR's uncanny versatility.

Autonetics builds NASARR for the AN/ASG-19 armament control system—standard equipment for advanced versions of the F-105. Like all Autonetics guidance and control systems, NASARR does its delicate work *reliably* under extremes of speed, altitude, and temperature.

NASARR is one example of the type of system that is resulting from Autonetics' decade of development in monopulse radar.

Autonetics A DIVISION OF NORTH AMERICAN AVIATION, INC., DOWNEY, CALIF.
REGIONAL OFFICES: WASHINGTON, D.C. AND DAYTON, OHIO

INERTIAL NAVIGATION / ARMAMENT CONTROL / FLIGHT CONTROL / COMPUTERS AND DATA PROCESSING

industry countdown

STRUCTURES

Decision on air launched ballistic missile contractor is now expected on or before June 1. Why the rush and high priority? Oliver M. Gale, special assistant to Defense Secretary McElroy, says by 1963 SAC bombers equipped with ALBMS will be America's "major instrument" of retaliation against Russia. Gale indicates all other weapons systems will be secondary to ALBM, including *Polaris*.

• • •

Highly secret Project *Slam*—an advanced weapons system for the Air Force—is being developed by Chance Vought Aircraft. No one is saying officially what the project is about. But *Slam* is thought to mean "Space Launched Air Missile."

• • •

France's Nord Aviation is pushing production of "tens of thousands" of *S-10* and *S-11* anti-tank missiles for NATO countries. U.S. is the main customer.

• • •

Expanding French research organization S.E.P.R. is exploring cooperative tie-up with German companies. Recently allied with Italy's Bombrini-Parodi-Delfino, S.E.P.R. is developer of liquid and solid fueled rocket engines. Has operational a fighter plane, the Dassault Mirage III A, equipped with both jet and rocket engines.

• • •

First two artillery battalions to man the Martin *Lacrosse* surface-to-surface guided missile will be activated by June 25 at Ft. Sill, Okla. Six more battalions are programmed.

PROPULSION

Rocketdyne is test-firing a 400,000-pound thrust liquid propelled engine, which it says is largest of type in this country. Slight modification is expected to boost thrust to more than one-half million pounds. Engine appears to be scaled-down version of one million pound engine being developed for NASA—indicating single chamber of 1,000,000-lb. class is not yet in advanced hardware stage.

• • •

Goal of $250,000 Aerojet-General feasibility study is one-million pound thrust solid fueled rocket motor which would quadruple present capability. Aerojet believes study will pay off in providing know-how for building 10-15 million pound thrust engines.

ELECTRONICS

Future replacement for transistors in some uses is Naval Ordnance Laboratory's new "solion"—which carries electrical charge by ions in solution. Already applied in five elemental types for different circuit arrangements, unit is reported to be long-lived, stable, light-weight and simple. It requires 1/100 to 1/1000 the power needed for a transistor.

• • •

Promising results are reported by the National Bureau of Standards in laboratory investigation of two new test devices. They are: a modified plasma jet, operating at up to 8000° C, to provide excitation for spectrographic analysis of complex alloys (tests on stainless steel samples were accurate to within 2% coefficient of variation) and a stroboscopic vibration analyzer. This instrument determines aircraft and missile structural vibration characteristics for submicroscopic movement. Device uses transducer or vibration pickoffs for oscilloscopic display of amplitude and phase relations of complex structures.

• • •

For master planning, overall design and development of improved AIRCOM (Air Force Communications Complex) ITT is setting up a new unit—ITT Communications Systems Inc. at Paramus, N.J.

ASTROPHYSICS

Data for AF space programs is being gathered in series of flights to 115,000 ft. by 5¼ million cu. ft. helium balloons launched at Vernalis, Calif., by Cambridge Research Center's Research and Development Command. Instrumentation package is parachuted back to earth while balloon rises until it is shattered by expansion and cold in upper atmosphere.

SPACE MEDICINE

To determine space radiation effects upon a human, Los Alamos Scientific Laboratory has devised a mannequin called REMAB (Radiation-equivalent Man, Absorption). Transparent and containing skeleton, lungs and solution comparable to human tissue, REMAB is fitted with dosimeters to measure radiation exposure.

How To Specify Ground Communications For a Missile Base

First, consider the supplier's experience and reputation. DuKane Corporation, pioneer in electronic communication systems, has installed ground communication equipment on such bases as White Sands, Patrick AFB, and Fort Churchill . . . *Second*, get help from an expert. DuKane's engineers are ready to help you. They've had wide experience in all phases of communications, including giving direct help to architects and consulting engineers in designing systems to meet any combination of needs . . . *Third*, consider equipment and flexibility. Of all the manufacturers of voice communication equipment, only DuKane makes a truly complete selection: intercom, public address, paging, background music, private automatic telephone, wireless paging for key personnel, emergency and evacuation systems, and hospital communication systems—in any combination to form an integrated system of any size, a few stations to hundreds.

For missile base ground communications, come to the experts . . . Write or wire DuKane Corporation, Dept. MR-1, St. Charles, Illinois. If you specify electronic equipment, ask also for DuKane's chart of electronic equipment symbols.

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APRIL 20, 1959—VOL. 5, NO. 16

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

With government reconsidering fast tax write-offs, will—

1959 Be 'Boost' or 'Bust' Year for Space Research?

by William E. Howard

WASHINGTON—Importance to national security of winning the technological race into space is forcing the government to reconsider its pre-*Sputnik* decision to end fast tax write-offs for industry this year.

Administration officials are moving to extend rapid amortization provisions for another four years and to relax the regulations to include contractors for NASA and possibly the Federal Aviation Agency, M/R has learned.

Behind the move is a dawning realization that industry's lack of ready cash to plough back into basic research may be slowing down and injuring the nation's missile/space effort.

Industry leaders say most companies are "not sufficiently healthy moneywise" today. As a result, plans for needed facilities and research are going begging on the shelf. They blame much of their predicament on:

• A sharp curtailment in tax write-offs rammed through Congress in August, 1957, by Sen. Harry F. Byrd (D-Va.). This law expires Dec. 31.

• Renegotiation Board grabbing of legitimate "extra" profits on incentive-type contracts.

"Time is money," one Air Force contractor said, "The brains to solve R&D problems are available. It's a question of using them. The more we spend, the quicker we'll get the answers."

• **Cut to trickle**—If industry were allowed by the contract Renegotiation Board to retain even 3% or 5% for research it would make a "tremendous difference," many spokesmen say. The Pentagon is sponsoring a change in the Renegotiation Act for precisely this purpose. More important to industry, however, is the ability to conserve larger amounts of capital for research through rapid amortization of expensive plants and equipment.

Since the Byrd law went into effect, only a trickle of fast tax write-off certificates have been issued by the Office of Civil and Defense Mobilization. The total since June, 1958—about $100 million. Of this amount, approximately $80 million has been certified for missile/space R&D (see accompanying table).

And of the $80 million, companies are being permitted to write off an average of 65% over five years, instead of the customary 20 to 40 years. So the actual amount made available through this device over the past 10 months amounts in current yearly deferment to about $10 million—for the entire industry. Previous deferments run to approximately $35 million a year. These will be used up by 1962.

• **NASA pushing**—Although OCDM originated the legislation now being circulated through executive agencies, it is understood NASA is the prime mover.

Details of the proposed measure have not been divulged. But officials indicate that it would be a wide departure from the Byrd law, embracing all contracts involved with air-space aspects of national defense. This could mean a considerable liberalization of present regulations which restrict OCDM certificates to new research and development for the DOD and AEC.

• **Government paradox**—A possibility exists that this measure may never be introduced in Congress, if it meets with overriding objections from Internal Revenue and the Budget Bureau. Both these agencies view fast write-offs as a "loss" in revenue.

(Continued on page 53)

OCDM RAPID AMORTIZATION CERTIFICATES
June, 1958-April, 1959

COMPANY	PURPOSE	NO. CERTIFICATES	TOTAL AMOUNT CERTIFIED	% ALLOWED
AEROJET-GENERAL	Rocket propulsion	4	$2,012,000	60
AVCO MFG.	Ballistic missiles	1	438,000	60
BOEING AIRPLANE	Space vehicles & missiles R&D	4	3,221,000	60-65
CALLERY CHEMICAL	High-energy fuels	1	3,832,000	65
COLUMBIA BROADCASTING SYSTEM	Communications	1	1,102,000	25
CONVAIR	Missiles	5	1,810,000	60-65
FAIRCHILD	Missile engines	1	750,000	60
GENERAL ELECTRIC	Missiles guidance	3	20,509,000	50-65
HERCULES POWDER	Solid fuels	1	4,608,000	65
HUGHES AIRCRAFT	Electronic systems	3	1,738,000	65
LOCKHEED AIRCRAFT	Missile fabrication	11	3,139,000	60-65
MARQUARDT AIRCRAFT	Missile engines	1	375,000	75
MARTIN CO.	Missile R&D	10	3,322,000	60-65
OLIN MATHIESON	Propulsion systems	2	908,000	50-60
MOTOROLA	Electronics	3	773,000	65
POTTER AERONAUTICAL	Missile components	1	3,313,000	65
PRATT & WHITNEY	Rocket engines	1	8,200,000	70
REPUBLIC AVIATION	Missiles	1	5,570,000	65
ALBERT RIDINGER	Rocket chambers	1	1,188,000	65
TEXAS INSTRUMENTS	Electronic	2	5,230,000	40
THIOKOL CHEMICAL	Engine, fuel R&D	2	774,000	65-80
UNION CARBIDE	Missile parts	1	3,472,000	50
WESTERN ELECTRIC	Electronic systems	7	2,043,000	50-65

What will be needed in GSE—

When Man Enters the Missile

by Hal Gettings

WASHINGTON—Putting men into space vehicles will change the entire concept of ground support equipment, demanding much bigger handling and support vehicles, a far higher degree of safety and reliability, additional tracking facilities and landing and recovery systems—all at considerable cost.

This is the opinion of Ben F. Werner, ground systems branch manager of Boeing Airplane Co., who contends that the ground system has not received early and proper emphasis because its importance has been dwarfed by the vehicle itself.

Werner believes there is urgent need now for a balanced effort in all elements of the space program—especially in ground support—to meet the new and fascinating problems in design, management and operation raised by the requirements of a manned operational system.

The accompanying graph prepared by Werner shows, in terms of engineering manpower, the magnitude of the ground support effort for a typical manned space system. Costs of the total system and of the ground support elements can be expected to show a similar relationship.

WERNER

Werner points out that some existing support equipment and procedures can and should be used in future manned systems. However, some requirements will demand entirely new approaches. They include:

1. The use of man as an integrated part of the system;

2. Consideration of his safety and well-being;

3. Increase of boost energy imposed by the added weight, and

4. The fact that the vehicle will return to earth.

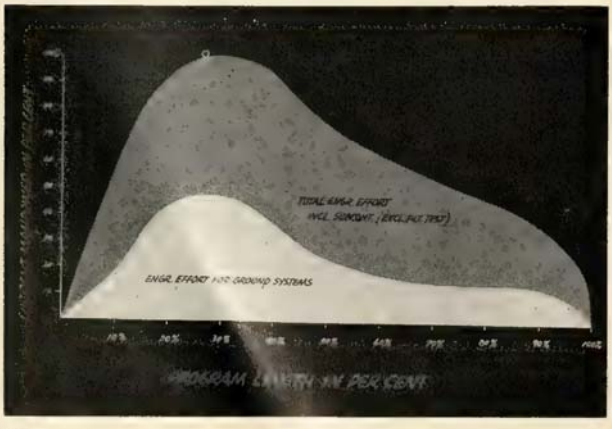
Each ground support job must be thought of as one with many other interrelated functions of an operational system. Attention must be given to research and development in new areas and to extending the state of the art in others.

• **Propulsion**—A larger propulsion system means larger handling and transportation vehicles, dollies, and cranes. Hoists will be required for vertical lifts in excess of 100,000 pounds. Likewise, transport equipment will be required to carry these loads, some of which may be as long as 200 feet, and designed for critical shock and bending stresses. A larger propulsion system means a bigger gantry, possibly up to 300 feet high, with up to 1500 tons of steel required.

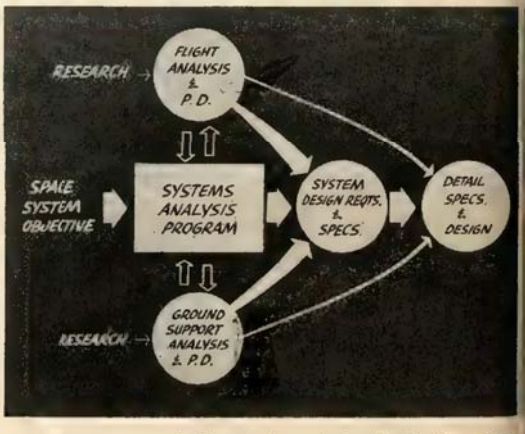
One new design proposed by Werner involves a multilaunch operational system wherein the vehicle and its propulsion system are assembled horizontally on a strongback in an assembly and test shop and then rolled to the launch area for erection by 3500-psi hydraulic actuators. For such a system the explosive propellants conceivably may be manufactured at the base rather than transferred cross-country.

Propulsion systems based on exotic fuels such as liquid hydrogen and fluorine and, ultimately, nuclear fuels will present new ground support problems. Recoverable boost stages may be used for certain operational systems, and recovery and recycle maintenance of recoverable boosters will introduce a whole new order of ground support

Bigger percentage of engineering effort on GSE . . .



GSE on par with flight development . . .



jobs and procedures.

• **Safety**—A higher degree of safety will be necessary at the launch site. Heretofore the launch area was cleared and control personnel safely hidden in a blockhouse well away from the site. But in the manned system a man will be sitting right on top of the powderkeg. Fueling procedures and last-minute servicing techniques must be developed to insure the greatest possible safety during this critical phase.

The question then arises as to when in the countdown the man should be put in the vehicle. Is a system provided for quick exit if something goes wrong during final countdown? What part will the man play as part of the control loop in the countdown sequence?

The reaction time of a manned system will inherently tend to be somewhat longer than that of the unmanned system. Means must be devised to shorten this period. Methods and mechanisms to put the man aboard are in their infancy, but Werner believes that rapid means to get the pilot to his station may be accomplished by employing elevators, tramways, or hydraulic lifts. There is no question that countdown time is at a premium with a man aboard. It's possible that certain countdown checks and functions may be delegated to the man—a possible simplification of the unmanned system.

• **Increased reliability**—The requirement of increased reliability is a tough one. Previously, costs and simplicity could be weighed against certain abort and failure rates; now reliability must be considered from the standpoint of man's safety at the launch site. The use of qualified proven equipment must be emphasized—both for the vehicle itself and for the ground support elements. Even though the man himself may increase the overall mission reliability, the test and prelaunch checkout job does not obviate the need for test equipment reliability, Werner said.

• **Escape system**—Providing an escape system imposes further requirements on the ground checkout function. If an escape system is to be effective, it must be capable of being exercised at any instant. During the flight phases the pilot has time to evaluate the need for using the system; but during launch and initial boost he may be incapable of recognizing the existence of trouble in time for effective action.

This places an additional task on the ground system. Closed-circuit optical surveillance of the launch site and other optical and electronic instrumentation, tracking equipment, and computers must be provided to allow instantaneous and continuous evaluation of boost system performance and provide for rapid use of the escape system. An unobstructed area must be provided close to the launch site for pilot abort landing and safe recovery.

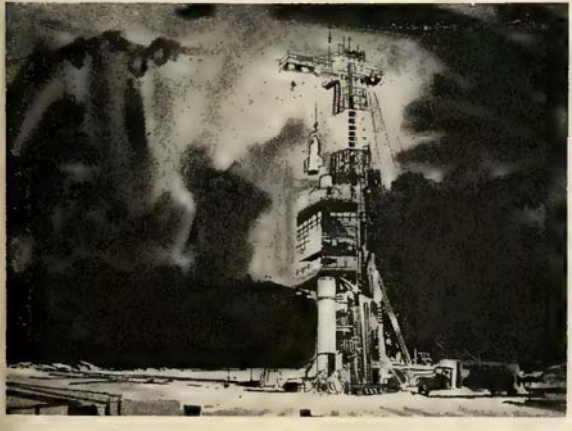
• **Designed-in maintenance**—When man leaves the atmosphere he must carry along his own environment for survival—air to breathe, pressure and temperature control, nourishment, and protection from radiation. Some of these systems will demand servicing and thorough checkout immediately prior to launch, requiring either a unique servicing system or equipment and personnel on platforms high above the ground, Werner said.

As an example, a five-hour orbiting mission for one man would probably require 200 pounds of liquid nitrogen-oxygen for breathing atmosphere, 90 pounds of nitrogen for equipment conditioning, 400 pounds of hydrazine for turbine system accessory power, and 400 pounds of chilled water as a heat sink for evaporative cooling of the man and his equipment compartment.

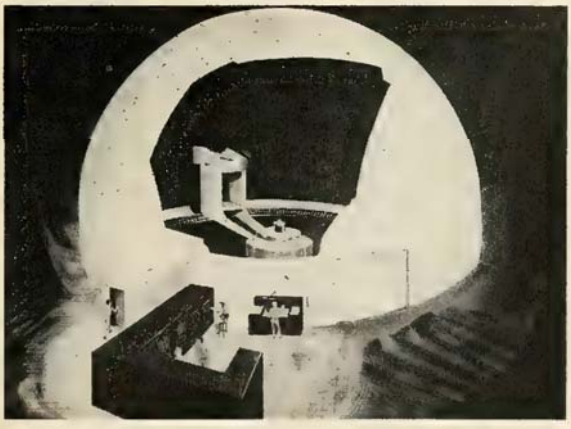
These servicings would be topped off immeditely prior to launch and have automatic disconnects. In addition, cool-air servicing for the man's compartment during preflight checkout would be necessary to reduce the demand on the on-board expendables. Another interesting requirement would be meticulous cleaning in the compartment to prevent any distraction to the pilot caused by floating dust and small particles during weightless flight.

• **Communications**—Adding man to the space system increases communication system requirements. Both new and existing facilities must be integrated into a global communications network. Additional radar tracking stations must be considered, since the need for locating and recovering the vehicle, particularly during an emergency re-entry, would require a capability in excess of that in existence or planned for. Ground tracking facilities also may be needed to provide significant flight parameter information to

Costly and elaborate launch complexes . . .



Expensive training aids . . .



the vehicle in case of primary navigation system failure.

With a man in the system, two-way voice communication would certainly be desirable. Such facilities would permit transmission of information to and from the vehicle and provide both a psychological benefit to the pilot and an effective way of evaluating his condition and ability to complete the mission.

• **Recovery**—The man in space must be gotten back intact, healthy, and willing to go out again on other missions. This means that an effective landing or recovery system must be provided. Here the ground support requirements are new and different from those of an unmanned system, Werner said. Landing sites must be prepared and equipped for scheduled recoveries and an effective and reliable system for cases of emergency deorbit prior to scheduled re-entry provided.

When touchdown is completed, radiation cleaning and vehicle cooling may be required before the pilot is removed. Handling and transportation of the vehicle back to the home launch base would be the next job.

• **Personnel training**—Obviously, the system must be manned with trained, competent personnel. The pilot and other crew members and the ground support personnel must be trained individually and as an integrated team. The training system must emphasize the need for absolute reliability throughout the system complex. Personnel failure can be just as disastrous as equipment failure.

All known training techniques and training devices must be used. The use of simulators is particularly important, since actual training flights are much too costly for extensive use. The training program must be designed not only for the development of proficiency but for the selection of suitable individuals for each of the demanding skills. Finally, complete flight crew confidence must be instilled and maintained in both the mechanical and human elements of the system.

• **Costs**—Space systems, especially manned systems, are going to be expensive. The word economical is difficult to use when speaking of such systems, but extensive efforts must be made to minimize the cost. The role of the ground system must not, of course, be emphasized out of proportion to its importance, but since it does represent a significant percentage of total cost, a major contribution can be made in this area.

Discoverer, Yes; Vanguard, No!

Polar satellite capsule is believed to have reentered; magnetometer try invalidated by second stage trouble

by James Baar

WASHINTON—The United States for the first time attempted a one-two assault on space on the same day with a double satellite launching.

The result: Success over the Pacific. Failure in the Atlantic.

The Air Force at 4:18 P.M. EST on April 13 launched a modified two-stage Douglas *Thor* from Vandenberg AFB. It successfully placed a 1600-pound *Discoverer II* satellite into a polar orbit ranging from 156 to 243 statute miles.

NASA at 9:49 P.M. EST the same day launched a regular three-stage Martin *Vanguard* from Cape Canaveral carrying two satellites. The second stage failed to ignite and the rocket fell into the sea.

Scientists said they plan another *Vanguard* launching carrying two similar satellites—a 22.6-pound lollipop-shaped cylinder and a 30-inch inflatable plastic-aluminum balloon—in the near future.

• **Mixed Success**—Two prime goals of the *Discoverer II* launching were:

—Testing of equipment designed to guide and stabilize a satellite in orbit for the first time, paving the way for development of an observation satellite.

—Re-entry and recovery of a 195-pound capsule ejected from the *Discoverer* on command. The capsule is designed to carry animals into space in future launchings.

ARPA, overall director of the *Discoverer* test series, and the Air Force said the first goal was achieved along with successful testing of launching, propulsion and communications techniques.

However, failure of a timing device made it impossible to eject the capsule as planned near the Hawaiian Islands where Air Force planes were waiting to attempt to catch the capsule with nets.

Still ARPA had an ace in the hole—an automatic "fail safe" device to eject the capsule on the satellite's 17th pass around the earth. Official spokesmen said telemetered data indicated the ejection took place over the Arctic ice cap and the capsule's retrorockets and parachute were working.

• **New equipment**—The entire 19.2-foot satellite—actually the *Thor's* Lockheed-built second stage—contained the new stabilization equipment designed by Bendix Aviation Corp.

Previously, satellites have tumbled as they orbited the earth. The stablization equipment was designed to hold this one steady in flight.

The satellite also contained a new infrared horizon scanner designed by Advanced Technology Laboratories and an inertial guidance system produced by Reeves Instrument Corp. to overcome previous guidance problems of orbiting vehicles.

A Lockheed telemetry system capable of making more than 100 measurements radioed performance data to tracking station at Vandenberg, Hawaii and Alaska.

A total of 165,000 pounds of thrust put *Discoverer II* into orbit. The liquid-propelled Rocketdyne engine of the *Thor* provided 150,000 pounds. The liquid-propelled Bell engine of the Lockheed second stage provided the remaining 15,000.

The *Thor* weighed over 100,000 pounds. The second stage weighed 8400 pounds before launching.

The two-stage vehicle placed *Discoverer II* in a nearly circular orbit with an orbital period of 90.84 minutes. Its estimated lifetime was about one month.

Launching of the big satellite was the first major success in the *Discoverer* series. The first *Discoverer* launched Feb. 28 from Vandenberg was believed to have gone into orbit, but because of a transmitter failure the Air Force was unable to track it.

The *Vanguard* failure was the seventh out of nine *Vanguard* launchings attempted so far.

The lollipop satellite contained a highly sensitive magnetometer designed to provide much-sought data about the earth's magnetic field.

The magnetometer—the most sophisticated used to date—makes its measurements on the basis of the free precession of protons around an electric current. It was developed by Varian Associates.

The .44-pound balloon would have been inflated with nitrogen after being ejected from the payload. It would have measured the density of space.

Goodyear's Approach for *Atlas* GSE

CRADLE FOR *Atlas* missile begins to take shape as I beams and cross braces are welded together.

OVERALL production line at Goodyear's Arizona plant. Long framework in center is 74-foot transport trailer nearing completion.

TECHNICIANS give final check to missile transport trailer and booster and nacelle carriage before taking out for road tests.

THIS huge clamp on forward end of *Atlas* missile-carrying trailer fits near nose section and holds missile in position while in transport to launching sites.

PHOENIX — Goodyear Aircraft's Arizona Division is now producing a new line of mechanical ground support and launching equipment for *Atlas*. Some $4 million in add-on orders recently were received from Convair, bringing production to a new high.

Equipment being produced at Litchfield Park includes a missile handling trailer, an allied booster handling trailer which transports the missile's booster separately and can position itself back-to-back with the missile trailer for installation purposes, engine gimbaling support stands, erection boom, its support and associate drive mechanism, and alignment rails and gages.

Goodyear points out that the new GSE permits rapid erection of the *Atlas* to launch position and quick replacement by another missile soon after firing. The familiar 13-story gantry tower, an integral part of previous *Atlas* launching complexes, is eliminated.

Goodyear has been associated with the *Atlas* program since 1955 when the first of a number of giant over-the-road transport trailer-erectors was built here. The transport has been used to carry the 80-ton ICBM to various test centers, including Cape Canaveral. The Arizona plant also produces ground support equipment for Martin's *Mace*. Other work on *Mace* is being done at the Akron plant.

A multi-million expansion program for constructing acoustic chambers for testing electronic equipment is underway at the Arizona division. The new facilities will enable Goodyear to conduct studies on a wide variety of problems created by sound waves of space age vehicles. Sound pressure levels of 150 db in a frequency range of 37.5 to 10,000 csps will be produced in the test chambers.

NASA May Have to Ask for More Funds

Eight satellite launchings, 2 space probes and 45-50 sounding rockets may require additional funds above requested $485 million

WASHINGTON—NASA could spend more money fruitfully in fiscal 1960 and the civilian space agency may have to ask Congress later for more than its presently requested $485 million FY budget.

These are impressions gained from reviewing the testimony by NASA's technical experts before a subcommittee of the Senate Aeronautical and Space Sciences Committee.

The agency outlined a program which includes the launching of eight satellites, two space probes, and from 45 to 50 sounding rockets during 1959; and six satellites, four space probes, and from 90 to 100 sounding rockets in 1960.

NASA's budget requests are based on the premise that certain vehicles, propellants, and scientific instruments will not be ready for use in FY 1960, and that R&D on future space systems will only need to be funded at a budget-predicted rate.

But extra funding will be needed to take advantage of the time saved if technological breakthroughs occur in any of these fields.

Vehicles which NASA expects to be the work-horses in space research during the next few years but which are not expected to be ready for use in FY 1960 are *Scout*, *Vega*, and *Centaur*.

Scout, a four-stage solid-propellant satellite launcher and sounding rocket, can orbit 150 pounds at 300 miles and send 1000 pounds in a vertical probe to 12,000 miles. Its test firing date is late this summer. Production is expected in June, 1960. It is funded in the FY 1960 budget for only $2 million, and yet its cost per vehicle is $500,000.

Vega, is a modified *Atlas* with a General Electric *Vanguard* engine which has start and restart capability as its second stage, and a 6000-lb.-thrust storable solid 6K engine by JPL as its third stage. It is scheduled to put a 5800-pound meteorological satellite in a 300-mile orbit, a 740-pound communications satellite in a 22,400-mile orbit, and to send large payloads of 1000 pounds or more to the moon and nearby planets. First firings are due late in 1960 and its production date is expected to be sometime in 1961. It is funded in the FY 1960 budget for $42.8 million.

Centaur, a modified *Atlas*, with a high-energy liquid oxygen and hydrogen engine (Pratt & Whitney) as its second stage and the JPL 6K on top, has a greater lift capability than *Vega* and will be ready at approximately the same time. It is funded for $41 million in NASA's FY 1960 budget.

In the FY 1959 budget NASA was able to transfer funds from one project to another as technology advanced. But many NASA scientists believe R&D projects in the FY 1960 budget will not be as flexible as they were in FY 1959.

Technological advancements in nuclear engine research since NASA prepared the budget could make this program demand more funds. In the FY 1960 budget, Project *Rover* is funded for $2 million and nuclear engine R&D is funded for $8 million.

Another project which could upset the budget, if it progressed faster than expected, is the one million pound single chamber engine (*Nova*) which is funded in FY 1960 for $30.2 million.

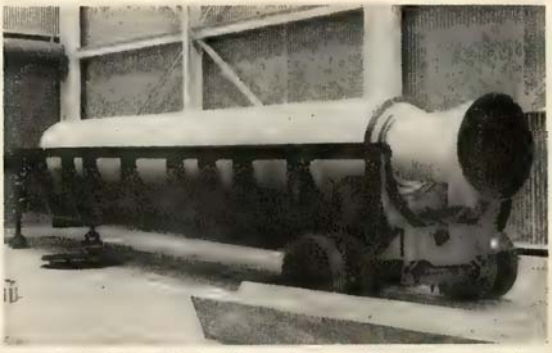
Most of the FY 1960 experiments will use existing hardware, and instrumentation which is ready now or in the near future. The difference between sending six probes, or 16 probes into the solar system of the type NASA contemplates, is largely a matter of money.

The House last week approved an Administration plan for increased spending on the *Mercury* program.

It passed and sent to the Senate by voice vote without audible dissent an Administration bill authorizing an appropriation of $48,435,000 in supplemental funds for NASA for the current fiscal year. The actual cash would be provided in a later appropriation bill.

The requested supplemental funds include $20,750,000 for research and development, all of it earmarked for the manned space flight program—Project *Mercury*.

The measure also authorizes $24,-250,000 for construction and equipment and $3,354,000 to cover cost to the agency of federal pay raises enacted by Congress last year.



AEROJET-GENERAL will supply the solid fuel second stage for NASA's "all-purpose" *Scout* vehicle.

Orlando Expansion

LAS VEGAS—Two items were uppermost among industry at the World Congress of Flight:

(1) Northrop is hoping to get AF support for its concept of a space trainer, possibly using a modified T-38 trainer and;

(2) Companies interested in commercial space flight applications may have to finance a new facility like Palmdale, probably in Orlando area with flights at the Cape.

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Nuclear Explosions in Space

- *Many techniques exist for detecting trapped particles*
- *But high-altitude bursts at some latitudes might leave no traces*
- *Adequate inspection procedures may be difficult to establish*

Last of four articles by PROF. S. FRED SINGER

WASHINGTON—It is difficult to overestimate the scientific importance of high-altitude atomic tests as a tool for probing the environment of the earth. The principal announced result of the *Argus* tests—the finding that the shell of trapped electrons remains fixed in position in space—already tells us a great deal about the origin of the earth's natural radiation belts.

In addition to satellite measurements of the *Argus* electrons trapped in the magnetic field, there are a variety of unconventional scientific measurements which would reveal much about the properties of the outer atmosphere of the earth, its state of ionization, behavior of the magnetic field out to a distance of several earth radii, and the propagation of hydromagnetic waves in this medium.

The various scientific methods for detecting the effects of space bursts have rather obvious political significance as well. The immediate question raised by the *Argus* tests is whether it is possible for a nation to conduct atomic explosions in space in secret. Or can all tests conducted in the upper atmosphere be detected by suitable observing stations either on the ground or in balloons, or with satellites?

It must be remembered that atomic tests at high altitudes produce no seismic effect, negligible (if any) fallout, and of course no blast effects.

Nature and Origin of Earth's Radiation Belts

Through a fortunate circumstance the *Argus* tests released electrons which attached themselves to a line of force going out to about one earth radius. It so happens that at this distance (4000 miles) we have the minimum between the inner and outer radiation belts of the earth. The *Argus* observations can now be used to shed important light on the origin of the natural radiation belts of the earth.

The outer belt, it is now generally agreed, has its origin from the sun. A theory for the trapping of solar corpuscular radiation was developed by the writer in 1956 and can now be used to calculate the expected radiation intensity distribution with altitude and latitude.

• **Nature of outer belt**—Here the theory comes to the following conclusion: A most reasonable explanation of the observed distribution with altitude is that the particles are low-energy protons and electrons (below one million electron-volts). The particles cannot be energetic protons (which could penetrate the rocket's skin), and they cannot be very energetic electrons either. It is most likely that rather soft electrons produce X-rays that finally set off the counter.

The falloff of the radiation intensity with altitude in Fig. 1 is predicted by the theory; it gives us the maximum number of particles that the earth's magnetic field can trap. The distribution along the line of force has been calculated from the distribution of the pitch angles of the trapped particles. It can be seen rather easily that the number of particles with small pitch angles (able to penetrate far along the line of force) is rather small. Most of the particles trapped have pitch angles near 90° and therefore move nearly at right angles to the line of force and are incident from that direction.

• **Inner belt**—When trapped radiation was found in the *Explorer* satellites in May, 1958, it seemed to the writer that the trapped solar radiation could not get down this close to the earth at the equator. In looking for other sources of trapped radiation, we found a possible source in high-energy neutrons produced in the earth's atmosphere by incident cosmic rays. Those neutrons which are emitted in an upward direction move outward along straight lines. Only after they decay into a proton and electron can the magnetic field become effective.

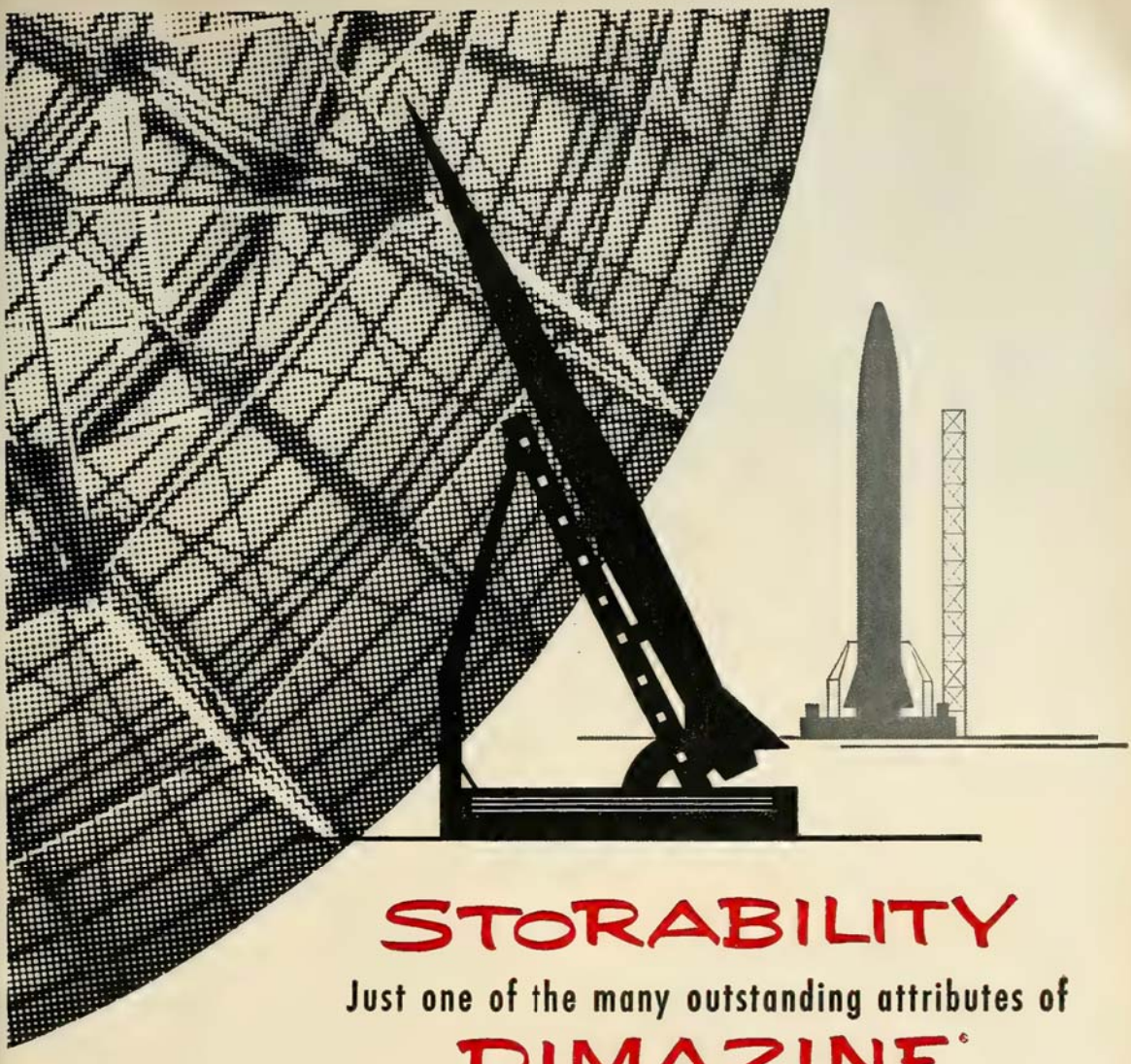
As shown in Fig. 1, the neutron theory leads to a radiation belt close to the earth's equator with a maximum at low altitudes. The trapped radiation

Soviet Claims Discounted

It is interesting to examine the claims of certain Russian astrophysicists that the inner radiation belt is the result of explosions of U.S. hydrogen bombs in Nevada. This statement can be attacked on a number of grounds. In the first place, any radiation released from H-bomb explosions, even if it could get into the trapping regions, would have a very short lifetime—of the order of days—whereas the measurements show that the inner belt is rather constant with time.

Furthermore, if the inner belt indeed consists of hard (energetic) protons, then there would be no way to account for it by H-bomb explosions.

There has been speculation in the press that the Russians really referred to the *Argus* tests, which had not been announced at that time; but this cannot be believed. In the first place, they spoke very clearly of the inner belt; seconcly, had they measured *Argus* electrons in the *Sputnik* they would have noticed their very short lifetime and could have drawn the proper conclusions; we can therefore be reasonably sure that they did not in fact make such observations. It appears more likely that their statements were politically inspired, particularly since they were coupled with the assertion that such atomic tests creating radiation belts also affect the earth's weather. That statement cannot be supported by facts.



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itself should consist of very penetrating protons of the order of 100 million electron volts. Experimental data by the University of Iowa group seem now to support the prediction of the theory and indicate that in fact a substantial portion of the inner belt radiation consists of penetrating protons.

The point of view concerning two independent sources of trapped radiation is not universally accepted. One school of thought holds that trapped solar radiation may diffuse downward towards the earth's equator and set up the maximum at low altitudes.

But, as has been pointed out by Christofilos, the constancy and fixed position of the *Argus* electron shell shows that such diffusion through the earth's magnetic field probably does not occur. It therefore gives great support to the point of view that the two belts of the earth are indeed of separate origin: the outer belt from an outer origin—i.e., from the sun; and the inner belt from an inner origin—i.e., effects of cosmic rays on the earth's atmosphere.

• **Countermeasures**—The outer (solar or soft) belt probably presents no great problem. But if the cosmic ray neutron theory is indeed confirmed by further measurements, then the inner hard belt presents a hazard to space flight—a manned vehicle operating in this region for long periods of time would have to carry a large amount of shielding. Without it, doses of a few roentgens per hour would be experienced.

Also, if the neutron theory is correct it predicts long lifetimes for the trapped particles of the inner belt and a small rate of supply. Once the particles are removed, for example by absorbing them in some way, it will take several months or years before they are replenished. If we operate large satellites in the region of the hard belt, they will intercept a large number of trapped particles and absorb them, thereby sweeping out the inner belt region and making it safe for manned operations.

In view of the support from the *Argus* tests, the sweep proposal for the inner belt is greatly strengthened.

One method of removing particles from the inner belt suggests itself—to use carefully controlled atomic explosions in space. By releasing rather non-penetrating fission particles which can disturb the magnetic field, the magnetic field disturbances in turn can release trapped radiation belt particles and dump them into the atmosphere. Calculations by the writer show that this scheme represents a distinct possibility for reducing the cosmic ray belt's intensity.

Unconventional Scientific Measurements

Radiation trapped in the earth's magnetic field can be measured directly by satellites or space probes. In addition, a variety of detection methods can be used from the ground or from balloons to investigate related effects produced by atomic explosions in space.

One of the most interesting phenomena to observe would be the occur-

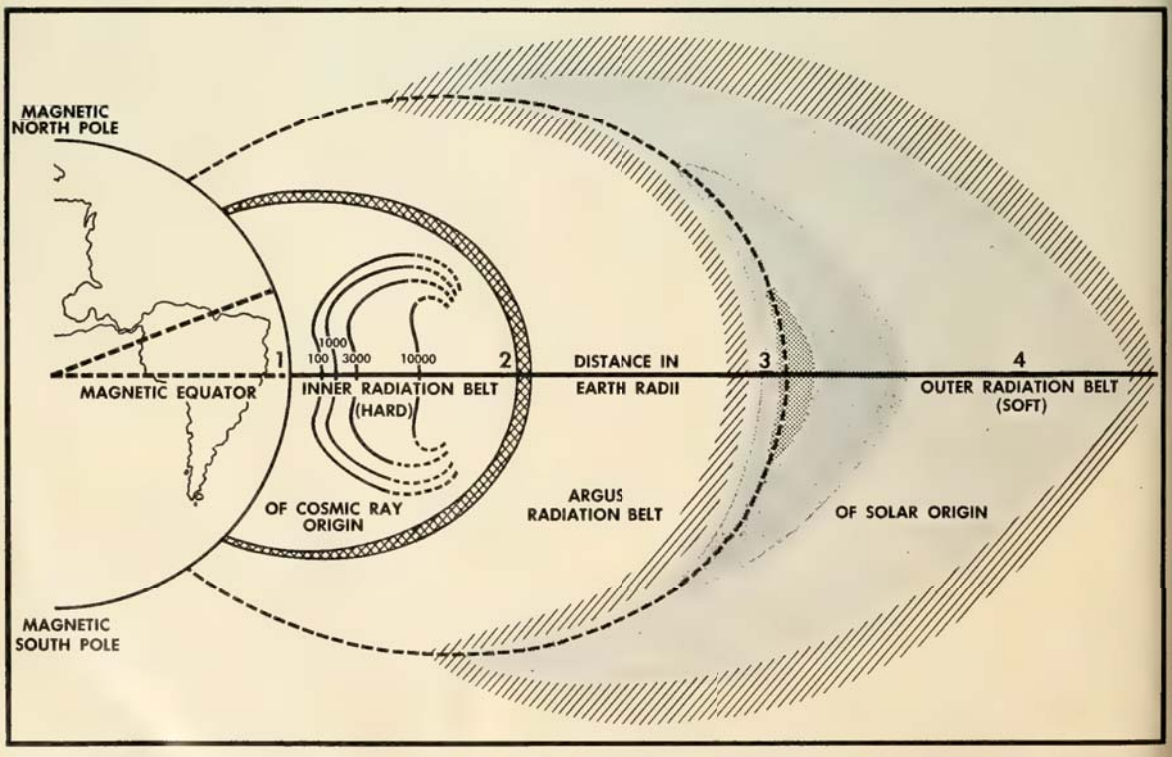
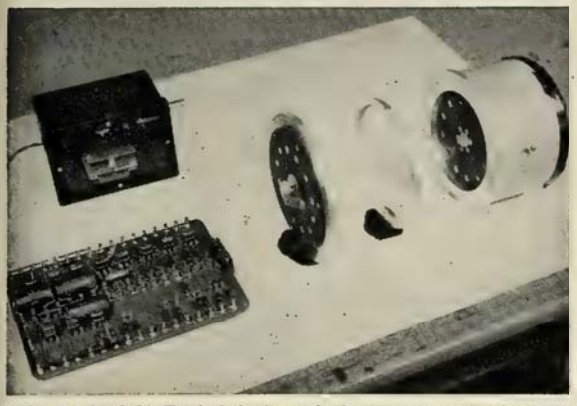


FIG. 1—Radiation belt intensities calculated from theory. For the inner belt, consisting mainly of hard (penetrating) protons, actual counting rates can be calculated. For the outer belt, made up largely of soft (easily shielded) electrons and protons, relative intensity distribution is calculated; the actual intensities will change, as will the position of the belt, depending on the amounts of fast plasma shot out from the sun. Location of *Argus* radiation is shown along the line of force reaching out to two earth radii (8000 miles from center of earth, or 4000 miles above sea level).



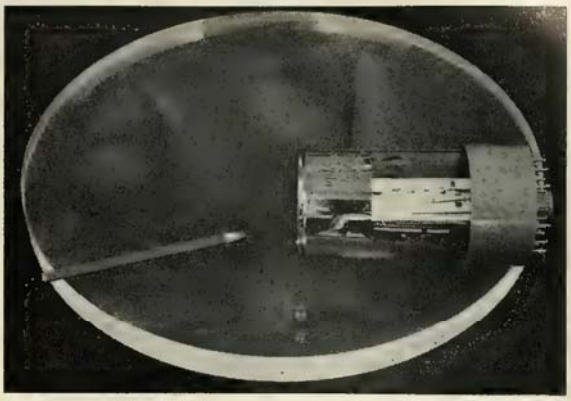


FIG. 2—(at left) Exploded view of ultrasensitive microbarometer which could be used to measure pressure pulses from atomic bursts in space. Black box contains Decker Corp.'s T-42 transducer (Courtesy Prof. W. Kasner).
FIG. 3—(at right) Large disk-shaped plastic scintillator for observing effects of incident fission electrons in the lower atmosphere. Light from the scintillation is guided by a cone (not shown) into a sensitive DuMont photomultiplier which puts out an electrical voltage pulse (Courtesy Prof. W. R. Webber).

rence of magnetohydrodynamic pulses produced in the earth's outer atmosphere by atomic explosions, principally by their fission fragments. We have calculated the effects to be expected and find that the waves would propagate with speeds of the order of several hundred miles per second; they would follow very closely along the magnetic lines of force and would be mostly reflected when they are incident on the earth's ionosphere at several hundred miles altitude. However, their effects could be detected at sea level, at balloon altitudes, in the ionosphere, and higher.

Above the ionosphere one direct way of looking for magnetohydrodynamic waves is with a rocket or satellite-borne magnetometer. One expects to find waves which are produced naturally in the auroral zone by trapped solar corpuscular radiation. They have a characteristic spectrum whose form can be calculated from geophysical data.

These waves should also produce magnetic effects at sea level, and in fact magnetic effects are observed in auroral latitudes, the so-called geomagnetic micropulsations. We believe that they are produced by magnetohydrodynamic waves above the atmosphere and would expect that atomic explosions will similarly produce such micropulsations at sea level. We have calculated the characteristic magnetic "signature" of an atomic explosion and find that it should lead to a decrease in magnetic field which is rather sharp, followed by a recovery and a slight increase. The effects observed below the ionosphere are of course smaller than those above the ionosphere.

• **Balloon detection**—An important tool for observations is the balloon platform. It is still the only means for making high-altitude studies over a long time at a relatively fixed geographic position.

Extremely interesting measurements can be made at a location where such a magnetohydrodynamic wave is incident. As the energy of the wave couples from the ionosphere to the lower neutral atmosphere a small fraction of the energy goes into acoustic form. A highly sensitive microbarometer has been designed (see Fig. 2) which may be able to pick up and "listen" to atomic explosions in space. Its high sensitivity is due to its unique design as well as to the use of a newly-developed ionization transducer.

From balloons one can also observe the incidence of trapped electrons into the upper atmosphere. A fraction of one percent of these electrons will produce gamma rays before they come to rest. These rays have a considerably greater range than the original electrons and will therefore propagate down to altitudes as low as 70,000 feet. The most sensitive instrument for detecting their presence is a so-called scintillation crystal coupled with a sensitive photomultiplier. An example of such instrumentation designed for balloon operations is shown in Fig. 3. Its large collecting area gives high sensitivity for incoming gamma rays.

• **Artificial aurora**—Most of the particles from the explosion, when incident on the upper atmosphere, will produce excitations of atoms and therefore an artificial aurora. It could be observed from the ground or from airplanes if it occurred at night, but to observe an aurora during the daytime requires special optical equipment carried in balloons. A spectrograph designed for automatically recording daytime aurora is shown in Fig. 4. It uses a concave grating "blazed" in the red where much of the energy of the auroral emissions is concentrated, and incorporates various features to reduce the effect of the daytime sky brightness.

• **Artificial radio "whistlers"**—A further consequence of an atomic explosion in space is the creation of a large number of ionized particles. As positive and negative particles become separated, at least for a short time, the sudden creation of a charge distribution should produce a radio signal. The very low-frequency radio waves propagate with low speeds very nearly along the line of force. But, as has been observed for natural "whistlers" produced by lightning discharges, the higher frequencies move with slightly higher speeds. As a result they arrive first, and what is observed on the ground is an audio tone which starts with high pitch and drops to low pitch in a second or so; hence the name "whistler." The necessary receiving equipment may consist only of a long wire antenna feeding into an audio amplifier.

• **Artificial radiation belt**—The various scientific measurements discussed above are of course important for telling us more about the interaction of charged particle radiations with the earth's magnetic field and the earth's outer atmosphere. In turn this

leads to badly needed information about the outermost atmosphere, the so-called exosphere.

For example, by comparing the theory of the radiation belt with experiments, it should become possible to measure and determine the atmospheric density in the exosphere.

A much more convenient method for studying the exosphere or the magnetic field is by artificial injection of particles to form artificial radiation belts of the earth. The use of accelerators carried in rockets and satellites has been suggested independently by Christofilos and by the writer. Such experiments would allow us to test in detail the atmospheric density at various levels above the earth and to monitor continuously the state of affairs of the earth's magnetic field above the ionosphere to determine whether it is quiet or disturbed.

Inspection of Atomic Explosions in Space

Aside from their scientific applications, the detection methods discussed determine whether atomic bursts in space can be detected or can be carried out in secret—a very pertinent question in view of current efforts to set up an international test ban for nuclear weapons.

It is difficult to give a definitive yes-or-no answer since so much information on the effects of high-altitude atomic bursts is based on theory and not on direct measurements. But the following conclusions stand out:

An atomic burst at high altitudes, say above 1000 miles or more, should lead to trapped radiation which can easily be detected by means of satellites. However, if the line of force along which the explosion takes place is at an auroral latitude, then the radiation released may blend in with the naturally present auroral radiation and might escape notice. For polar (magnetic) latitudes (above the auroral zone) the earth's magnetic field is no longer able to trap particles and they will escape into interplanetary space.

A different problem is posed by explosions at rather lower altitudes, of the order of 100 to perhaps 500 miles. As explained earlier, if the burst takes place over a magnetic "high" then practically none of the radiation will be trapped; it will instead be dumped into the opposite hemisphere.

Reference to our magnetic map (Fig. 1 in part 3 of this series) shows that it would be extremely difficult for the Russians to carry out an operation like *Argus* and escape detection. It is not possible to dump radiation into the Russian ionosphere without at the same time trapping a large fraction of the radiation for several days.

While effects occurring in the ionosphere above Russia might escape detection by Western observers, effects in the immediate vicinity of the explosion could be detected. Scientific methods for measuring the state of the ionosphere, in particular the propagation of radio waves, could indicate the occurrence of atomic tests. But setting up adequate inspection procedures may turn out to be a difficult technical problem because of the lack of adequate data.

Although U.S. negotiators have proposed only barring nuclear tests up to 30 miles in altitude, it is conceivable that a nuclear test ban may include tests in space as well as in the atmosphere. In that case, Project *Argus* will go down in history as a unique peaceful application by the United States of nuclear weapons designed for destruction. There is little doubt, to my mind, that *Argus* constitutes one of the truly important geophysical experiments of our time.

FIG. 4—Spectrograph designed to detect daytime aurora from a balloon. Half of the cover has been removed to show concave grating which is "blazed" to put most of light coming through slit (upper left) into red portion of the spectrum. Recording is done with specially sensitized film in cassette (upper right). Holder for filmstrips is shown next to spectrograph. Basic design of instrument follows that of Dr. R. Tousey, Naval Research Laboratory (Courtesy Profs. H. Griem and E. Hinnov).

Hughes Develops Complete Radiation Lab Service

CLEVELAND—A package radiation test laboratory including a robot "hot" material manipulator has been developed by Hughes Aircraft Company. Announced at the 1959 Nuclear Congress and Atom Fair, the company said it will provide a complete service for radiation facilities and lab equipment to meet specific customer requirements.

The service will include a "Linac," an extremely high current linear electron accelerator. Reported to be the "most powerful of its kind," it is considered to be less expensive than a reactor and, under certain conditions, is better for performing nuclear research.

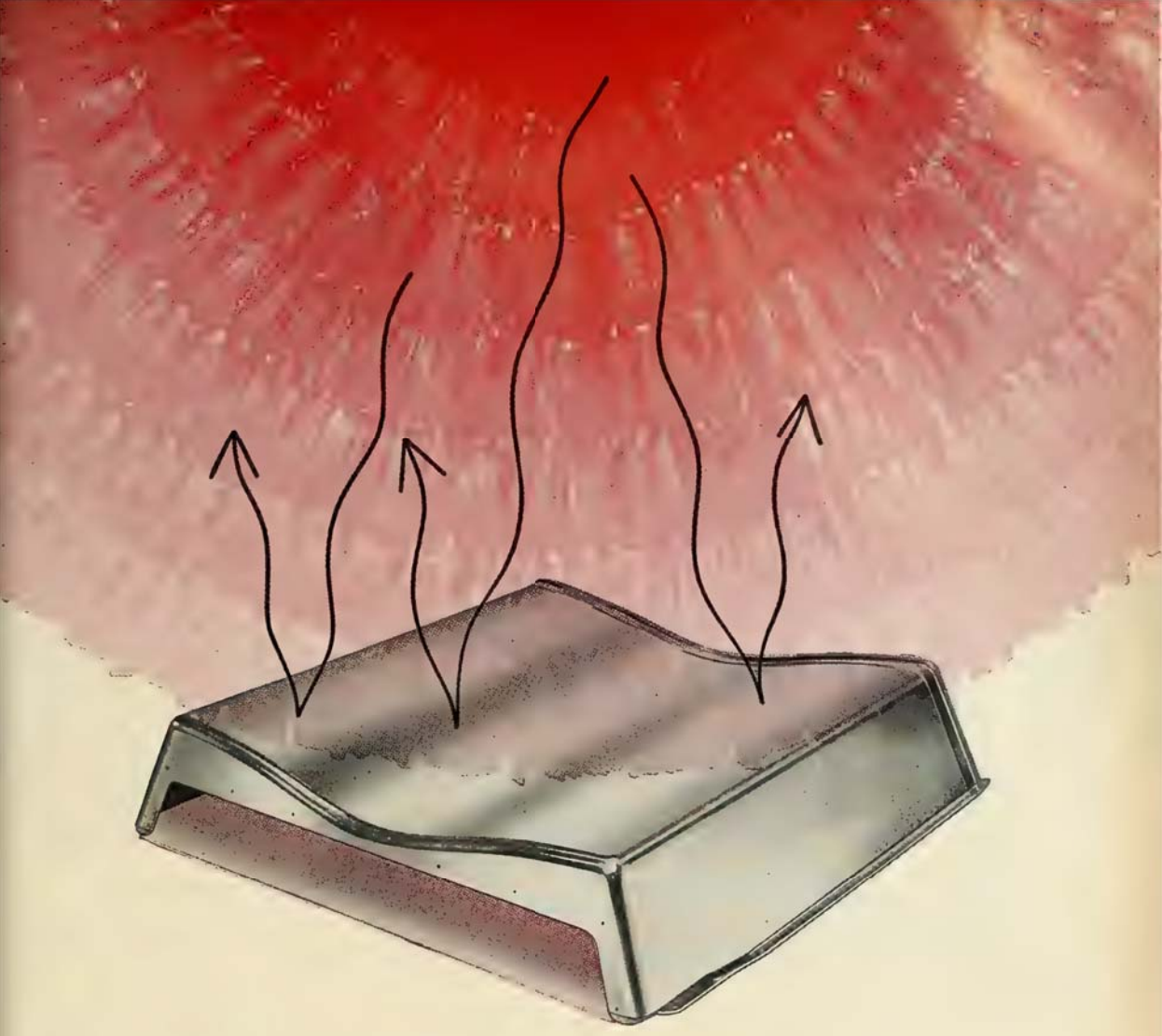
Nuclear reactor radiation simulators, cobalt radioactive sources, gamma or neutron Linacs, pulse or test reactors can also be provided. A gamma Linac now being manufactured can be used for flash testing components by bombarding them with a short, intense pulse equal to the radiation of an atomic or hydrogen bomb. The traveling-wave type of linear electron accelerator operates at 10 megavolts or more.

The manipulator, Mobot Mark I, is designed to work in dangerously radioactive rooms. It can even operate in deep water, the company said. Looking much like a fork-lift machine, the device is operated remotely from a console control center.

A microphone and closed-circuit TV provide "ears and eyes" for the operator. Capable of operating with tweezer-like care or with a 200-pound squeeze, Mobot can be directed electrically or by radio.

The equipment will be sold to research institutes and universities in addition to industry. The Linac accelerators and pulse reactors are being used to "flash test" parts used in the armament control systems of Air Force all-weather interceptors.

Hughes says the Linacs are far cheaper than reactors and under some conditions can serve the purpose better for facilities wishing to conduct nuclear research.



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Typical example of heat reflection
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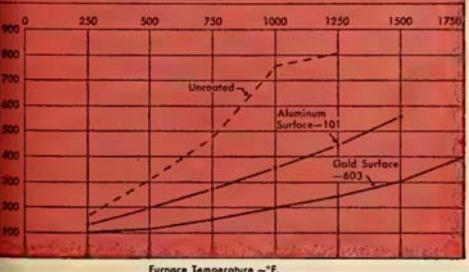

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Swedlow research is continuing the development of many combinations for the growing variety of aircraft, missile and electronic applications. To learn how these new materials can help solve your heat problems, contact the Swedlow plant nearest you. Or send for new literature—"Radiant Heat Reflective Laminates." Please refer to Dept. 21

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Avion Develops New IR Search System

CODES, built around commutating infrared detector, will be modified for satellite tracking

by Charles D. LaFond

PARAMUS, N.J.—A significant development in air-to-air infrared (IR) search systems was demonstrated for the first time at the World Congress of Flight in Las Vegas. It offers 10 times the sensitivity of other IR search receivers and three times the range of any known small air-to-air missile, according to its developers, Avion Division of ACF Industries, Inc.

Key to the advance, Avion said, is the use of an "ac commutating" IR detector. Avion's chief research consultant, Joseph Schwartz, developed the commutated cell technique and was responsible for building the first demonstration system.

Under a prime contract for the Air Force Cambridge Research Center, a modified version of the system is being developed by Avion for satellite detection and tracking.

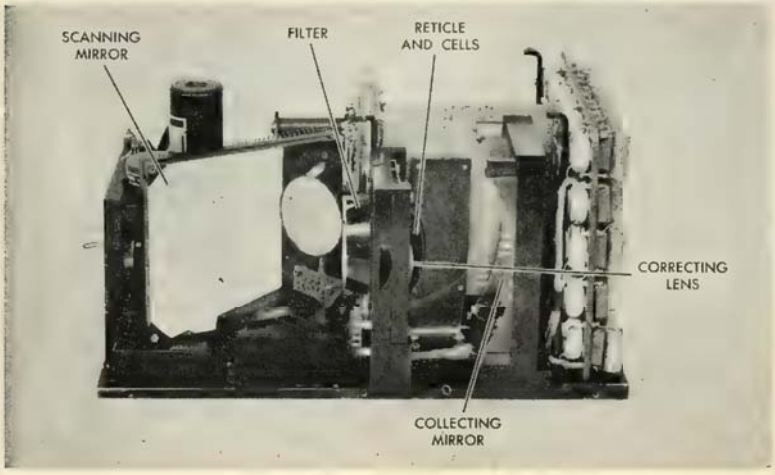
The company believes that the commutating IR detection system, called CODES, demonstrates the feasibility of a low-level storage and sampling technique for achieving high sensitivity and fast coverage. Of simplified design, the multichannel wide-field receiver employs single-channel electronics. Its developers believe CODES provides many advantages over conventional multi-element systems, and does so with a single amplifier.

The demonstration receiver, (Fig. 1), is packaged in a case measuring 8 x 13 x 7 inches overall. Including a five-transistor amplifier, the whole system weighs only 15 pounds. (Table 1 is a partial list of parameters.)

• **Past efforts**—In the design of infrared search sets, much effort has been applied to increasing detection sensitivity and reducing equipment complexity. Finding a practical solution based on today's state-of-the art materials necessarily has narrowed the field of potential techniques.

Although it is well-known that an increase in the number of detectors will increase sensitivity, most IR search sets now in use employ single cells. To scan a given field, a complicated system of motors, mirrors, and cams is required for the single cell. But an increase in detectors normally results in an increase in amplifiers. Therefore, an increase in electronics results from a decrease in mechanical design. This rapidly becomes prohibitive.

Avion has been a pioneer in its largely self-sponsored research and development work in IR detection and tracking. Temporarily sidestepping its hoped-for design of a thermal imag-



AVION's CODES IR detection system (cover removed) reportedly has 10 times the sensitivity of other search systems.

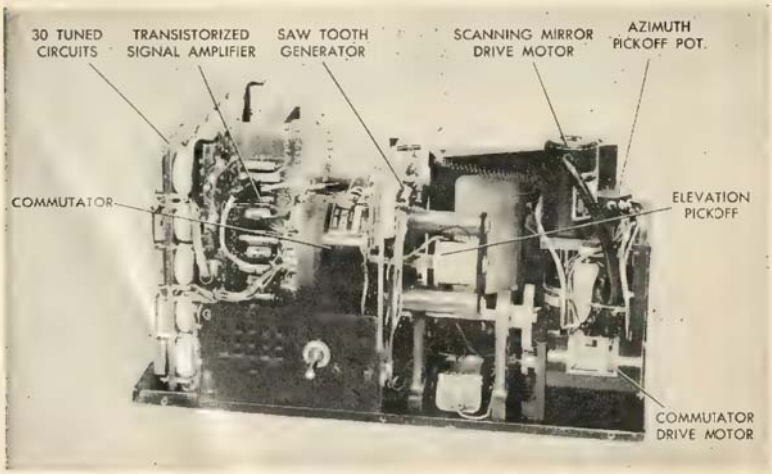


TABLE 1:
SOME PARAMETERS OF CODES

SEARCH FIELD	
Total search field	±45° azimuth by ±20° elevation
Instantaneous field	2.7° azimuth by 40° elevation
Frame time	1.5 sec, 2 fields per frame
CELLS (LEAD SULPHIDE)	
Size	1 by 2 mm
Jones S of cells (Sensitivity)	4×10^{-10} in 1.8 to 2.7-micron band
Time constant	200 usec
Field of view per cell	2.7° azimuth by 1.3° elevation
OPTICS	
Effective input aperture	1.7-inch diameter
Optical efficiency	30%
Net free aperture	4.4 cm^2
F number	f/1.0
Resolution	1.2 milliradians
Angular spot size	90% of energy in 1 milliradian
POWER REQUIREMENTS	
Motor drive	400 cps, 115 v ± 5 cps
Cell bias	120 v dc, 1.5 ma
Amplifiers and pickoffs	28 v dc, 20 ma

ing vidicon, Avion reduced the available solutions to one more immediately feasible—the multiple cell-single amplifier approach.

• **Design philosophy**—In designing the demonstrator equipment, Avion did not consider such factors as weight reduction, size limitation and optical efficiency. Future operational units, the company said, will reflect the optimum in design details consistent with the state of the art. But its designers believe that a typical operational version of CODES will weigh less than 10 lbs. and will be contained in a package 8 x 6 x 6 inches overall.

The demonstrator was designed to emphasize simplification and high performance. The feasibility of commutating detectors for greater capability in the general air-to-air search problem was the ultimate goal.

• **Operation**—Essentially, CODES functions in the following manner: Scanning action by an azimuthal rocking plane mirror provides IR input for a spherical optical system. A highly sensitive, multi-cell linear array provides detection, and the output of each cell is stored in a passive LC "tank" network before commutation. By means of a mechanical commutator, an amplifier sequentially samples each tank output. Thus, each cell sweeps out its portion of the field of view. The presence of a target is announced by ringing action in the tank; the ac signal is sampled by the commutator, and then amplified for visual display.

• **Design details**—A plane mirror rocking in azimuth and coupled with a position pickoff provides the scanning action and input to a concentric optical system. Gimbals are not used.

The optical configuration (concentric catadioptric) employs spherical surfaces only. As indicated in Fig. 2, following the plane mirror filter, a correcting lens, image surface, and an aperture stop comprise the optics. The aperture stop is located in the plane of the center of curvature, causing all IR rays to be meridional. An interference type filter at the center of curvature transmits in 1.8 to 2.7-micron band. Measured spot size (monochromatic and chromatic) is approximately 1.2 milliradians. Excellent resolution is achieved uniformly over the full field.

With a simple straight-line reticle pattern having a line spacing of nearly 0.0017 in., the reticle itself is formed on a curved surface, 1.25 in. long x 0.15 in. wide. Its 60 equal and alternately opaque and transparent lines are normal to the scanning path. Signal angular chopping is provided at 8 cycles per degree.

Typical of most airborne search applications, a 40° x 90° total field of scan is provided. A 2.7° instantaneous azimuth field permits a commutation rate of 1200 bits/sec.

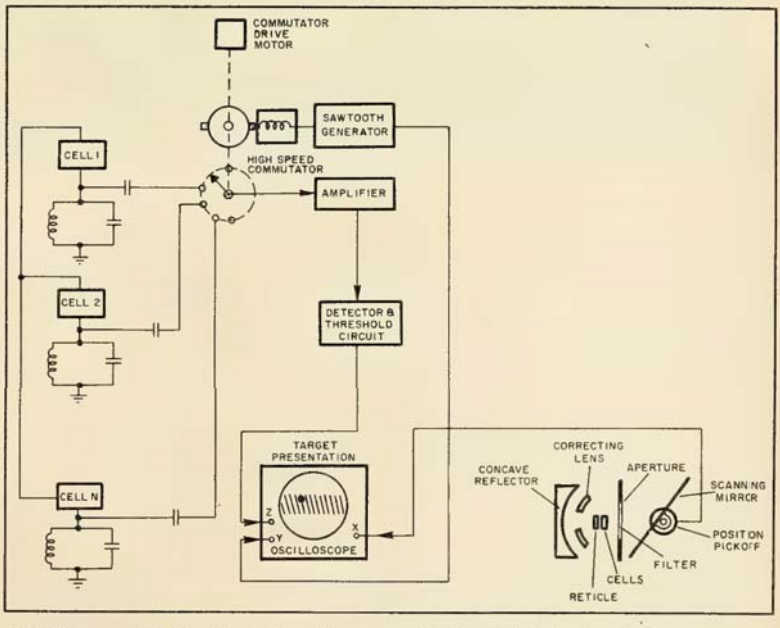
Thirty uncooled lead-sulfide cells, deposited on a curved surface, comprise the linear array. To optimize sensitivity, system bandwidth is consistent with time on target (0.023 sec.). Bandpass is provided in the 30 parallel-tuned circuits driven by the cell signals. Tuned-circuit bandwidth is 40 cps.

For low-level commutations, a 60-segment mechanical commutator, similar to those used in telemetering, is provided. The 30 signal channels are connected to produce two commutation cycles per rotation. To "unload" each tuned circuit during commutation, a resistor is included in the commutator arm.

Energy stored during integration drives the amplifier. The 1200-bit/sec. commutation rate commutates 0.75 cps of the 934-cps signal.

Peak-signal detection is guaranteed after amplification by full-wave detection in the signal amplifier. A threshold level then is set to permit positive target definition. To drive the Z-axis on an oscilloscope display, sufficient voltage is supplied by the addition of an-

(Continued on page 73)



CODES reportedly has three times the range of other IR air-to-air missiles.

D-P's Growth

Daystrom-Pacific to Enter Systems Work

by Richard van Osten

LOS ANGELES—Jumping into systems engineering is expected to boost Daystrom-Pacific's missile business to approximately 85% of its total volume within the next six months. This is the confident prediction of officials at the Daystrom, Inc. division here.

Missile components now comprise about 40% of D-P activity. Combinations of the division's in-production items will serve as a springboard to the systems.

One base of the systems designs will probably be the extensive line of subminiature, precision potentiometers now in production at a rate of 30,000 per month. Originally designed to meet D-P's own requirements in pick-off devices for gyro systems, these pots have turned into a prime dollar earner and much of the R&D work in systems has been carried by their sales.

The line is pretty well proven. Various types are in systems and subsystems for the *Explorer* satellites, *Titan, Atlas, Polaris, Jupiter, Bomarc, Talos,* and the forthcoming *Eagle.* Others are in use for missile systems by RCA, GE, Motorola, AC Spark Plug and Raytheon.

Second basic item for the new systems will be D-P's transducer line. Pointing out that few systems producers build their own transducers—and still fewer transducer producers are in the systems business—company officials believe a "from the ground up" combination of the two is mandatory to meet present or future requirements of missile precision and reliability.

Third base for the systems approach will be the division's experience in gyro design and production. Biggest production item for missile application are D-P's free gyros. These are in the GAM-77 *Hound Dog* autopilot and the *Polaris* test system. The company's

STEPS IN THE RACE TO OUTER SPACE

Lunar Unicycle

This 30-foot high Unicycle is designed for preliminary exploration of the Moon, once a base camp has been established. It's entirely constructed of inflated, rubberized fabric, with the exception of strengthening members, hatches and a few other items of equipment. Gyros stabilize and steer the vehicle; electric motors furnish the driving power.

Electricity for the motors and instrumentation comes from solar batteries mounted in the "parasol". The cleated, rotating wheel upon which the Unicycle travels is made of inflated tubes. A spare wheel, carried around the body, acts as a bumper in traversing narrow defiles. Built in two sections, these wheels are assembled by belt-lacing type fasteners.

The upper level, the navigating and communications deck, is ringed with recording and surveying instruments. Living quarters make up a middle deck and below is the hold with supplies, spacesuits, oxygen equipment and spare apparatus, needed for survival.

In the background, two of the expedition's ferry ships are seen; one landing, one unloading in the bright Earthlight.

Inertial navigation systems will play an increasing role in the exploration of outer space. ***ARMA*** is actively supporting the Air Force's program in long range missiles and is in the vanguard of the race to outer space. ***ARMA*** . . . Garden City, New York. A Division of American Bosch Arma Corporation.

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APPARATUS DIVISION

TEXAS INSTRUMENTS
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gyros were also used in the *Regulus II* pitch control system and in Lockheed's *X-17*. For other applications, D-P is turning out rate gyros at something between 300 and 500 units per month.

For systems application, some of the three base products may be off-the-shelf configurations. Other systems will require specialized development of one or more of the base components for integration into a system.

• **New gyros**—In the gyro areas, current developments include a cageable free gyro for the *Tartar* missile and vertical gyros for a drone guidance system—the latter is expected to have a high volume potential. An air-erected vertical gyro, some of which have been built by D-P before, is also under development. New design is expected to double the capabilities of older models.

Many of the new gyros will have specific applications in themselves, but most are likely to be included in the company's systems designs.

• **Adaptable transducers**—There is much divisional enthusiasm for the null-balance pressure transducer, both as a single item and in systems.

The unit is designed to sense a pressure range of 31 to 0.80 in. Hg or an equivalent −1000 ft. to +80,000 ft. in pressure altitude. Sensitivity is said to be better than one ft. at sea level and 25 ft. at 80,000 ft., and basic design is adaptable to static, total or differential pressure applications. Instrument range can be increased or decreased with a respective compromise or improvement in sensitivity and accuracy. A shaft rotational position is provided as a function of sensed pressure value. Ports, electrical connectors and output shaft are available in standard hardware configurations.

The present model of the transducer may have limitations in pure ballistic missile applications. But it will probably find use in shorter range missiles or in supersonic aircraft when precise altitude may be absolutely required for airborne launches of certain missile systems now under development.

• **Future systems**—Future plans include an air data computer for flight control or a heading check. A possible missile application might take the form of a "rough check" system of in-flight position prior to activation of an arming circuit. Another system, similar in function but utilizing a different concept, is based on a unique accelerometer design. It could be used also for arming and fuzing of a weapon prior to or during re-entry, or for control adjustment in relation to velocity. This latter system is part of a military requirement that has not been completely met to date.

F-108, NUCLEAR TURBOJET, AND RAMJET PROJECTS OFFER CHALLENGING OPPORTUNITIES TO PROFESSIONAL ENGINEERS AND SCIENTISTS

Advanced projects for air and space operations now underway in the Controls and Accessories Division at Marquardt Aircraft offer engineers and scientists challenging opportunities in a variety of technical areas. Here, where we are dealing with development problems on high-performance systems with stringent design and reliability requirements, professional engineers will find real challenge and opportunity for accomplishment.

Project personnel are currently working in such areas as the engine control system for the G-E nuclear turbojet; inlet control systems for the McDonnell F-4H, North American F-108 and the North American Hound Dog missile; the fuel control system for the supersonic Bomarc's ramjet engine; auxiliary power systems, pumps, and actuators; and are developing a unique and advanced space power unit.

C & A Division activities range in scope from preliminary design through final production.

Professional engineers and scientists capable of making contributions in these and related areas are invited to investigate the employment opportunities at Marquardt. You will find a combination of significant, active projects and a lively interest in new ideas, creating an environment for professional growth. May I suggest you write Mr. Floyd Hargiss, Professional Personnel Department, 16552 Saticoy Street, Van Nuys, California?

Roy E. Marquardt, *President*

C & A Division engineers made many contributions to the "state of the art" when they developed the fuel control system for the supersonic ramjet engine.

Marquardt
AIRCRAFT CO.

VAN NUYS AND POMONA, CALIFORNIA—OGDEN, UTAH

GE's New Slave Mechanic Has 'Fingers'

'Handyman'—result of four-year development—will go to work in radioactive areas

SCHENECTADY, N. Y.—A machine representing the latest development in a progression of master-slave devices has been announced by General Electric Company. Its makers believe it to be the world's first electro-hydraulic servo manipulator having a bi-lateral (or force reflecting) feature and articulating "fingers." Spatial correspondence is provided between the master and slave units.

Taking its name from its principal function, "Handyman" is the result of nearly four years of development work by GE's General Engineering Laboratory here. Created for the company's Aircraft Nuclear Propulsion Department under contract with the U.S. Air Force and the Atomic Energy Commission, it will be used in dangerous radioactive areas for work on components for aircraft nuclear powerplants.

GE spokesmen said the research and development program required a close study of human anatomy. Ten basic motions were designed into each arm and hand: compounded, they make possible an almost infinite range of movement—all dictated by a master unit located outside the danger area. The operator feels what Handyman feels—and hears what it hears.

With his own arms and hands inside the master unit harness, the operator goes through motions desired of the manipulator. Handyman duplicates every movement simultaneously. Whatever the manipulator is handling, the operator feels too. For example, when Handyman clutches a hammer, the operator directing the master unit can close his fist only part way.

The portion or percentage of the forces encountered by the slave and reflected to the master varies according to the will of the operator. In most tasks, the operator feels but one-third the force exerted by the slave.

• **Vital statistics**—The system is composed of five units—master, slave, electronic console and two hydraulic pump units to circulate hydraulic fluid through master and slave units.

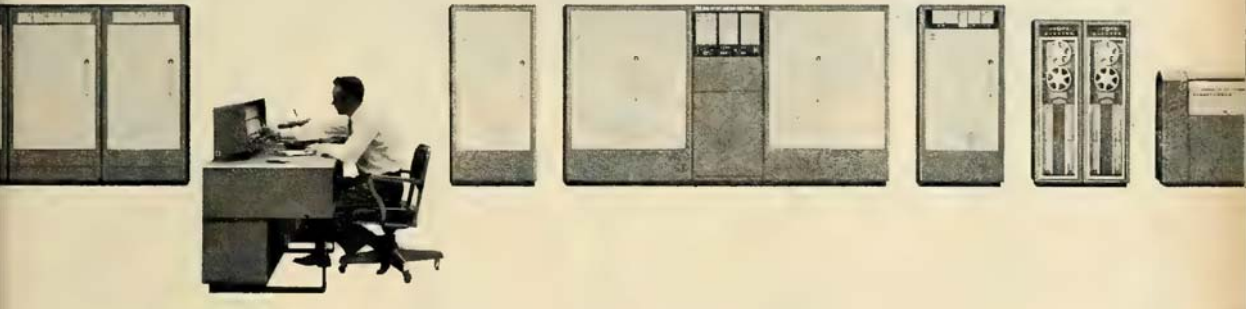
Company spokesmen also provided some vital statistics concerning Handyman's construction and operation. A few highlights:

1. The "hand" has five motions: two in the finger, two in the opposing thumb, and one at the wrist.

2. The forces encountered by the slave unit, or a portion of them, are reflected back to the master controls. The ratios of force reflected back to the operator can be adjusted in increments of 3 to 1, 5 to 1, 10 to 1, and 0.

3. Electrical signals are converted into hydraulic forces by electro-hydraulic servo valves. Servo valves and hydraulic actuators are located near the point of force demand. These juxtapositionings have reduced the number of hydraulic lines needed to distribute hydraulic power to each servo valve. Thus, the hydraulic lines are connected in a "Christmas tree" pattern of distribution rather than many parallel lines.

proven again and again: Burroughs 205 Computer



Designed to handle with ease a wide range of computational problems, the Burroughs 205 is delivering results daily in a great variety of scientific and business applications... from refinery design to inventory control, wind tunnel test analysis to insurance premium billing, telemetered data reduction to operations research. The 205 was selected to work on these and countless other tasks because of its speed, 4080 words of memory, ease of program loading, vast magnetic tape storage capacity and multiple-card processing versatility... features which make the 205 today's best dollar-for-dollar computer value. The 205 is just one part of a complete line of Burroughs electronic data processing equipment, helping hundreds of industrial users to save precious man-hours and to solve important problems. Write for 205 brochure, ElectroData Division, Pasadena, California.

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Space Highlights Flight Meet

First World Congress of Flight attracts 5000 delegates, bringing industry and government together on problems

By Betty Oswald

LAS VEGAS—Opening of the First World Congress of Flight here was highlighted by the successful orbiting of a *Discoverer* satellite from Vandenberg Air Force Base as some 5000 delegates met to discuss problems inherent in the space race and their possible solutions.

The Congress in a sense represented the first attempt to weld into a consistent whole all of the decisive elements which start with aircraft and at present end with plans for spacecraft.

Delegates came from some 71 countries, many of which are behind the Iron Curtain, and there was representation from almost all elements of industry, the military and other agencies of government.

Meetings were well attended and serious. Behind the relaxed atmosphere at Las Vegas, there was genuine concern over problems posed by the arrival of the jet age and the future coming of the space age.

There were indications that many who had doubted the feasibility of the Congress were now convinced that a necessary start had been made in the battle to find a way by which industry and the government could talk together.

Meetings included a discussion of the problems of missile management, a Space Age Conference which dealt with such questions as the defense space program, the aims of space exploration, man in space and the relationship of space to foreign policy.

Industry briefings dealt with the *Argo* series of 2500-mile, Mach 20 low-cost research and development test vehicles, space applications for infrared techniques, astroinertial navigation, range instrumentation for space probes and a wide variety of other questions which must be solved before the space age becomes reality.

A session was devoted to international research efforts including the work of the Air Force Office of Scientific Research and the project activities of ARDC's European office. Recognizing that the entry into space will involve major changes in current education patterns, one session was devoted to aerospace education, with educators from many foreign countries attending the meetings.

• **Old and New**—Exhibits covered not only existing hardware but, in some cases, the dreams of scientists and engineers, many of which were 10 or more years in the future. These included a mockup of the *Mercury* space capsule, in which man is expected to orbit the earth within two years, and a mockup of the *X-15* rocket research craft, which will provide answers to many of the problems which the *Mercury* pilot will face. Hardware included *Atlas*, *Thor-Able*, most of the smaller tactical missiles now in or soon to be in inventory, and a mockup of the *Genie* AAM utilizing a nuclear warhead.

Notwithstanding the futuristic tone of the Space Age exhibits, there was no escaping the wedding of the old and the new. World War I airplanes flying over the same field as missile-carrying, supersonic jet aircraft set the same pattern of extremes as the World War I invention, the tube mortar, being used in the Project *Mercury* capsule to fire a drogue parachute.

Distant-future concepts included Avco's ADOS, Astro-nautical Defensive-Offensive System, a method of insuring peaceful space travel through the use of one and two-man space ships with nuclear weapons and various other types of armament. The *Ados* vehicle greatly resembles a flying saucer with a tail, uses electronic detecting and computing techniques still to be developed.

Other exhibits dealt with advanced communications and electronics equipment for space craft, and new propulsion hardware. Product improvement permitting pilot training in spacecraft was suggested in presentations of a new supersonic jet trainer, the Northrop T-38.

Steering Jets by Bendix Stabilize *Discoverer II*

DETROIT—*Discoverer II* is stabilized in its polar orbit by a set of steering jets.

The mechanism, developed by Bendix Aviation Corp.'s Research Laboratories Division, may lead to development of an observation satellite. All previous satellites tumbled, making continuous aiming of a camera impossible.

In the steering jets, gas is discharged in response to electrical signals from *Discoverer's* inertial reference package, providing desired thrust up to 20 pounds.

Just give us the "envelope". . . we'll do the rest!

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Contemporary weapons systems, because of their complexity, necessitate sub-contracting of major components, sub-systems and structures. And versatile capabilities... theoretical, technological, mechanical and managerial . . . are required to produce these "envelopes" efficiently and economically.

Aeronca has these integrated facilities. That is why we can provide a *Co-ordinated Design, Tooling and Production Service.* This packaged service begins with evaluation of basic environmental data and culminates with "on schedule" deliveries. It has been eminently successful in supporting current operational weapons systems.

Aeronca's leadership is evident in its existing facility for designing and producing . . . in quantity . . . a complete range of brazed stainless honeycomb structures. This specialized capacity is one of the few *in actual operation* in the industry today.

With extensive background in proprietary and sub-contract programs, Aeronca is prepared to work with you on air vehicle, missile, ground support equipment and technical consultation projects. And we can say with confidence . . . *just give us the envelope and we'll do the rest.*

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more about the missile week

Negotiations looking to a merger of Thiokol and Marquardt started this week. Odds favor the merger of the two big propultion companies.

For return to earth, *Mercury* capsule will be equipped with mortar-fired drogue parachute to stabilize the vehicle at 68,000 feet. Drogue will be jettisoned at 10,000 feet when the main 'chute is activated. This provides impact velocity of 30 ft./sec. at 5000 ft. A reserve landing system, completely independent and mechanical, is available to the test pilot.

Mock-up of Avco's Astronautical Defensive-Offensive System (ADOS) for Air Force (M/R April 13) looks like a flying saucer with a protruding boom on which a nuclear weapon is mounted. Futuristic one-man spacecraft is designed for deep-space missions. Ring of defense rockets revolves around man-carrying sphere, enabling rockets to be fired in any direction. Nuclear weapon is placed on boom to protect pilot and is for targets too big for rocket missiles to handle.

High-vacuum research indicates to ABMA's Dr. Karl J. Pschera that "only inorganic materials" can survive exposure in interplanetary space. Organic materials such as rubber and plastics, he says, vaporize or undergo molecular distillation in a vacuum. More research may expose new reliability problems involving metal fatigue and creep encountered in space conditions.

New missile alloy—EK31XA—is reported to have double the strength at 500°F of any known light metal. Dow Chemical Co., developer, says it consists of magnesium, didymium and zirconium.

"Adult" *Atlas* first operational series test got off to shaky start April 14. The ICBM exploded about 1000 ft. above its Cape Canaveral launch pad on what had been programmed as a 5000-mile flight.

Jupiter IRBM is ready for deployment with troops. Chrysler Corp. says recent tactical weapons test demonstrated "beyond question" that production line hardware is ready for use.

Newly-synthesized tetracoordinate phosphinoborine molecule (mw 12,500) is hope of American Potash & Chemical Corp. to develop heat-stable plastics withstanding temperatures up to 400°C.

Air Force is asking Congress in its 1960 budget for $109.8 million in new obligational authority for *Dyna-Soar*—$73 million in expenditures to develop the manned-glide vehicle.

Maj. Gen. J. B. Medaris gives this breakdown of spending by his Army Ordnance Missile Command: .25% for operation of headquarters; 5% for systems management and technical supervision, including testing and range management; 5% for research, engineering, fabrication and technical effort to maintain in-house capability for directing industrial contractors; and 89.75% with private contractor organizations.

Polaris solid fuel consistency will be checked with 25-million-volt betatron, which cuts process time to minutes. Navy's Allegany Ballistics Laboratory, Cumberland, Md., is getting the $112,325 Allis-Chalmers X-ray machine this summer.

Detection of micron-sized particles in missile fuels is reported by Grumman Aircraft and Sperry Products with a new ultrasonic device. System works as fuel is being pumped from truck or tank to rocket and will automatically cut off flow on finding contaminants. Has worked successfully on checking fluids from –298°F to 1050°F.

Expansions: Sperry Gyroscope Co. has acquired a 52,000-square-foot building at Syosset, L.I., to produce *Polaris* ship's inertial navigation systems (SINS) and navigation data assimilation centers (NAVDAC's). Dynatronics, Inc., in the midst of an enlargement program, expects to move into a new 20,000-square-foot plant at Sanford, Fla., in June. Republic Aviation is erecting a $14 million, 120,000-square-foot R&D center at Farmingdale, N.Y., for missile/space research. It will be ready early next year.

Look for negotiation of a contract to develop *Vega* second stage, which will use LOX and kerosene-fueled existing power units. Similar in concept to *Centaur*, *Vega* is to be put into space with an *Atlas* booster.

Pentagon reveals that a single MB-1 *Genie* nuclear warhead costs $243,000; rocket itself costs $7000. *Genie* is carried by fighters of the North American Defense Command.

Ground will be broken at Lowry AFB, Denver, for second $40 million *Titan* ICBM base. This brings to four the number of hard *Titan* bases that have been announced. Seven *Atlas* bases are in various stages of construction.

propulsion engineering

Four ceramic nozzle materials with the longest functional lifetimes have been determined at Battelle Memorial Institute. They are silicon carbide, zirconium boride, beryllia, and a silicon-impregnated graphite surface. The functional life varies from 60 to 107 seconds on an engine burning hydrogen and oxygen at 4500°F. Among the shortest-lived materials are graphite coated with zirconium carbide, boron carbide, and hafnium carbide—with lives of about 15 seconds. Battelle scientists observe significant differences in functional life between ceramics of similar composition.

High-purity thorium for basic studies of the metal's properties can be prepared by a new process to be announced early next month during the Philadelphia meeting of the Electrochemical Society. High-grade thorium oxide is reduced by calcium in an inert atmosphere at 1742°F. Some calcium chloride must be present. The resulting thorium is a powder. The technique was developed by C. I. Whitman, Sylvania-Corning Nuclear Corp.; N. Fuhrman, now with Lansdale Tube Co., and R. B. Holden, currently with Olin Mathieson Chemical.

Super-pure aluminum for property studies also will be described to the electrochemists. R. R. Haberecht, P. R. Mallory & Co., starts with 99.99% pure aluminum prepared by zone refining. He treats this to vacuum melting to achieve aluminum with metallic impurities of only 1-3 ppm, and less than 5 ppm of carbon. He says this super-pure product shows marked improvement in corrosion resistance over the 99.99% pure aluminum.

Aluminum is revealing more about itself all the time, thanks to increased research and increasing availability of pure forms for fundamental study. A new refractory crucible, aluminum nitride, developed especially to aid aluminum research, has been described to the American Ceramic Society by George Long and L. M. Foster, Aluminum Company of America. It is the only material yet discovered that is not attacked by aluminum under investigation in a temperature range of 3282°-3632°F. It shows good ceramic properties and has been pressed into heretofore unavailable labware.

Metal-free phthalocyanine is a superior solid lubricant in the 1000°F area, a Battelle Institute team reports. A project conducted for Fairchild Engine and Airplane Corp. showed that other members of the phthalocyanine family also are good high-temperature solid lubes. In testing various proposed lubes, the group killed two birds with one stone by using various materials also under study for the balls in the wear machine. Most promising for high-temperature sliding systems are AISI Type M-1 tool steel and titanium carbide-nickel-molybdenum cermet.

Lubrication research in Germany is taking the form of molybdenum sulfide studies. German chemists report in *Chemiker-Zeitung* that moly-sulfide's layer structure recommends it to high and low temperature and pressure uses. It will also find "application in unusual atmospheric conditions."

Czechoslovakian metallurgy is rapidly becoming an Iron Curtain showcase for scientific progress. Recent reports include a detailed analysis of the function of temperature change on crack distribution in cooling castings, and development of more durable coatings for metal molds. Frantisek Havlicek reports in *Slevarenstvi* (Vol. 6, No. 9) that rectangular, square, and even elliptic cross-sections resist cracking better than round cross-sections. Nonhomogeneous temperature distribution is a function of casting shape, Havlicek says. Alois Sustek reports in the same issue the development of a new series of adhesion and cohesion coatings for metal molds. They are said to be superior to previous coatings in durability, among other things. The new Czech coatings are good for 700-800 pourings, whereas the older coatings broke down after 350-450 pourings.

Where the shape of things to come

is programmed by AMPEX tape recorders

The profiler above is shaping parts for new Lockheed Electras. Exact tool positions are being defined by command signals—as many as 200 per second—from the Ampex FR-100 in the control system to the right of the machine.

The accuracy of such a milling operation increases with the number of points defined per inch of tool motion. One reel of magnetic tape defines millions of points, programming up to 1½ hours of continuous machine operation. Recycling a tape loop will program an entire run of identical work-pieces.

Shaping parts by command signals from Ampex-equipped automatic control systems is now routine production operation at such places as Lockheed in Burbank, Martin at Denver, Rohr at Chula Vista, Convair at Ft. Worth and San Diego, and Giddings & Lewis at Fond Du Lac, to mention only a few.

Even though punched cards and paper tape are still proving adequate for many of today's less-sophisticated automatic control installations, systems engineers are increasingly interested in the superior speed and data-handling advantages of magnetic tape. An Ampex FR-300, for instance, can extract a short burst of digital information equal to that on an entire punched card in less than 4 milliseconds, including start and stop.

In configurations like the one illustrated, the advanced Ampex FR-100A, with its 14 tracks on 1-inch tape, has ample reserve for extra functions. Six tracks may be used for tool-position coordinates; others for start, stop, coolant, or even voice instructions.

Whether you believe the future of automatic control lies in point-to-point positioning, continuous-path control, or both—Ampex magnetic tape recorders have built-in reserve capabilities which make them worthy of consideration as a component for any control system designed for tomorrow's needs.

First in magnetic tape instrumentation

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soviet affairs

by Dr. Albert Parry

As we watch carefully what the Soviet press says about U.S. rocketry, missilery, and electronics we may discover just what (precisely or approximately) they lack but would like to have. Sometimes such Russian writings may indicate in which fields or categories the Soviets are behind; often they show that Moscow is on a par with us but means to forge ahead. On occasion the implication is: "Those darned Americans are catching up with the Soviets. We must not let them."

What, for instance, is the United States doing to switch from liquid to solid fuels in rocket engines? Early in March *Sovetskaya Aviatsia* ran a special article on "speed-up work to improve solid-fuel rocket engines," now being done not alone by U.S. experts but also by "the military specialists of other NATO countries." The author of the survey, Maj. Y. Tikhomirov of the Soviet engineering troops, begins with the gleeful assertion that Americans and their allies have been turned toward solid fuels by "the large number of failures in launching liquid-fueled American rockets."

In text and diagram, Tikhomirov explains the principles of solid-fuel rockets. He goes on to say that U.S. and other NATO experts "plan to apply solid-fuel engines to nearly all kinds of rocket systems," and that "no expense is spared" to this end. The implication, quite possibly, is: Shouldn't we, the Soviets, do the same? Or, if the Soviets are doing very well in this field of solid fuels, shouldn't the Red effort be stepped up yet further?

Our *Argus* experiment had been "guessed" (if not otherwise learned) by Soviet scientists shortly before we made it public. On March 8, in *Izvestia,* Professors I. S. Shklovsky and V. I. Krasovsky in a joint interview ventured their belief that the United States was "testing their atomic weapons, with explosions at great heights of 100 to 200 kilometers." They went on to speculate on the general aims of such experiments pretty accurately. A wishful note was quite evident: Why shouldn't Russia do something of this type?

Outright admissions of Russian gaps include the recent statement by Dr. Alla G. Masevich, the well-known, personable, 40-year-old Russian astronomer, made to a reporter from the Moscow *Ogoniok* (March 8) to the effect that on her trip to the United States a few months ago she was shown "an automatic electronic machine to measure stars," the like of which she had not seen before. She said that an American professor demonstrated it to her at the Naval Observatory in Washington. "I regretted," she added significantly, "that we in the Soviet Union do not have any such machine."

Last but not least, on Feb. 19, one K. Gil'zin in *Literaturnaya Gazeta* described the "parts of a solar power installation meant for possible exploitation on the moon," as exhibited in Washington by Westinghouse and explained in detail by Dr. Peter Castruccio. The Soviet writer concedes that this idea is rather good, but he attacks Dr. Castruccio for "joining the American Professor (S. Fred) Singer in the latter's proposal to transform the moon into a launching site for atomic weapons." (Gil'zin misinterprets, perhaps deliberately, Prof. Singer's 1957 paper, in which he merely worked out the physical effects of an explosion on the moon.)

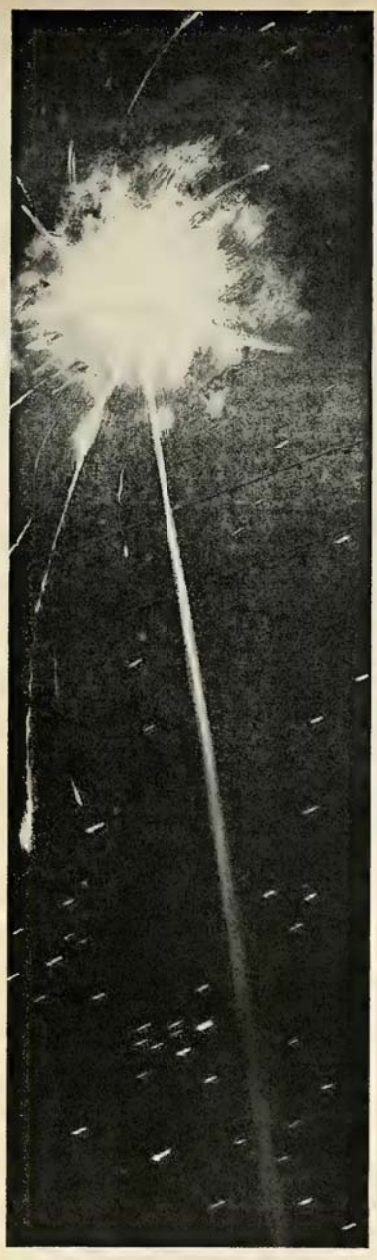
The Russian writer's wrath is aroused by Dr. Castruccio's articles in M/R on the "strategic advantages of lunar bases" as military fortresses of the future. Comrade Gil'zin entitles his article, "For Shame, Doctor Castruccio!" He cries shame also on M/R for publishing Dr. Castruccio's writings.

However, my impression is that these cries of indignation are but camouflage, and that interest in the U.S. idea of solar power installations on the moon is the main point of Gil'zin's outburst.

The man:

. . . a top missile scientist at White Sands, N. M., missile range where preliminary *Nike Zeus* tests take place. He is a key member of the highly specialized military-civilian team that is putting this agile anti-missile missile through its development stages.

When *Zeus* goes on active duty, it will follow Douglas *Nike Ajax* and *Hercules* missiles into service with the North American Air Defense Command. And it will be maintained by Army personnel assisted by Douglas field service men who have extensive experience in the *Nike* program.



The mission:

. . . anti-missile defense. *Zeus* will roar out from emplacements around cities and industrial and military areas to intercept approaching enemy ICBM's . . . or bombers.

The missile:

. . . *Nike Zeus* is being developed by Douglas under a Western Electric-Bell Telephone program. System will include electronic detection gear to pick up enemy ICBM's at extreme range and then guide *Zeus* out to destroy them. Vital statistics: CLASSIFIED.

Depend on **DOUGLAS**

The Nation's Partner in Defense

Transistors vs. Tubes

To the Editor:

Your article of March 16 on "Transistors vs. Tubes" requires a few comments . . .

It is all too easy to say that "radiation" harms transistors and let it go at that. A first step should be to assess the rest of the environment which accompanies this "radiation," its effects on the system, and the comparable radiation damage. It is of little use to replace a transistor by a less susceptible vacuum tube only to find that accompanying overpressure and thermal effects are the dominating destructive agents coincident with the radiation level against which one is now protected.

Now as to some particulars. I do not know the difference between primary and secondary fission products; however, the penetrating power of these products, even at their original velocity when they emerge from a detonation, is insufficient to pierce any missile, rocket, or aircraft skin, so I do not readily see how they can effect a transistorized system.

The accompanying gamma radiation from such a cloud, even in its early stages, is many orders of magnitude below that which will degrade semiconductors, especially since gamma radiation causes very little permanent damage and, at the radiation levels encountered in a cloud, only the barest minimum of temporary changes.

As of the effects of "high" neutron fluxes on transistors, it cannot be overemphasized that in the context of relationship to missiles, as differentiated from the completely different problem encountered with nuclear propulsion aircraft, one should be exceedingly careful of defining the limits of the possible and probable environment before making a sufficiently broad condemnation.

It should furthermore be pointed out that even vacuum tubes and their associated circuitry are subject to sizeable effects at radiation levels which are both possible and probable in a number of applications.

P. H. Haas, Chief,
Nuclear Vulnerability Branch,
Diamond Ordnance
Fuze Laboratories,
Washington, D.C.

It was not the intention of the article to take sides in the transistor vs. tube controversy. Our purpose was to call attention to a matter of vital concern to the industry and point out that, in the opinion of many observers, more research is needed concerning the effects of radiation on both tubes and solid state devices. M/R plans to publish in the near future several articles in which both sides will be allowed to give their views.

Not Air-Launched?

To the Editor:

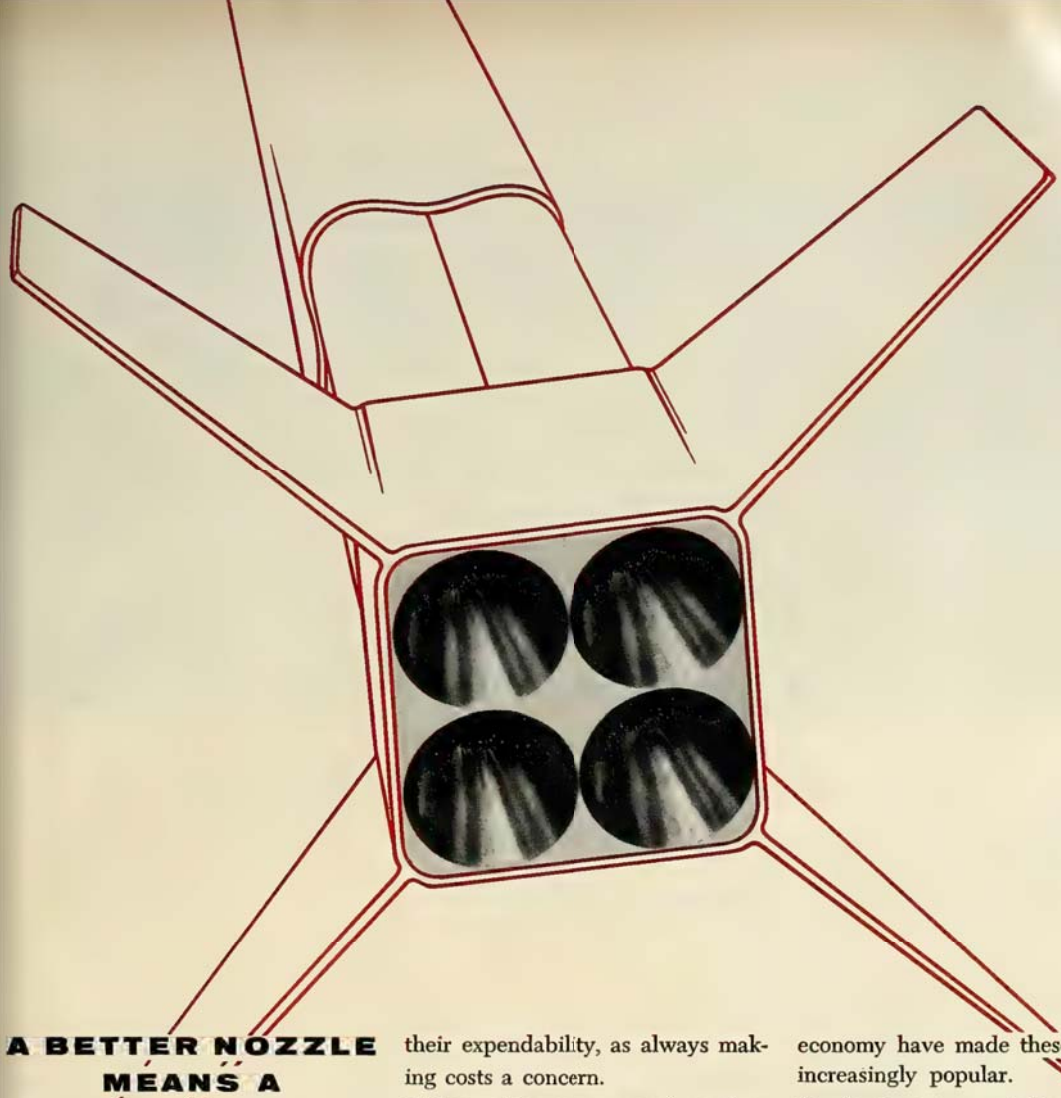
I am rather disturbed about one, and possibly two, mistakes in your March 23, 1959 issue of M/R.

In the Washington Countdown section, page 15, under the heading of "the mystery firing . . ." I was sorry to see the word "McDonnell" misspelled "McDonald." But I was glad to see that it was spelled correctly on page 23, right hand column.

2. In the same article the statement was made that the two-stage missile that McDonnell fired was an "Air-launched" missile. I have very strong reason to believe that this statement is incorrect. I believe that it was a "ground-handled" missile. Would you please straighten this out?

Herbert E. Wodtke
3530 A Pennsylvania Avenue
St. Louis 18, Missouri

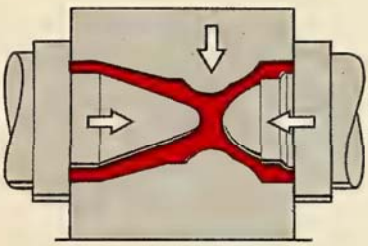
We regret the misspelling of McDonnell too. Our sources tell us that the missile launched was McDonnell's version in the ALBM competition. However, DOD will not comment.



A BETTER NOZZLE MEANS A BETTER MISSILE

Nozzles for guided missiles are an important factor in performance and, of course, in cost. In the end result during their short-span service, they must produce proper thrust without disintegrating. In early production, despite their simple symmetrical shapes, they posed many knotty problems. Special alloys, thin sections, and close tolerances spelled trouble. So did their expendability, as always making costs a concern.

Today, after many years' production, we have delivered a staggering number of these problem pieces. The secret of our success has been our own unique Cameron forging



processes which have extended the scope of ferrous forgings far beyond traditional restrictions in shape, size and quality. Elimination of welds along with better grain structure, internal as well as external curvatures, and considerable machining economy have made these forgings increasingly popular.

Our forgings are available as forged, rough machined, or finished machined, ready to save money in any phase of your operations. If you have a forging problem in components ranging from a few pounds to 8000 pounds, especially something for extreme service (high stress, high temperatures, etc.) we may have the answer. Special alloys are no problem because we produce our own steel with the most modern controls and tests from melt shop to delivery dock. Just call, write, or come by . . .

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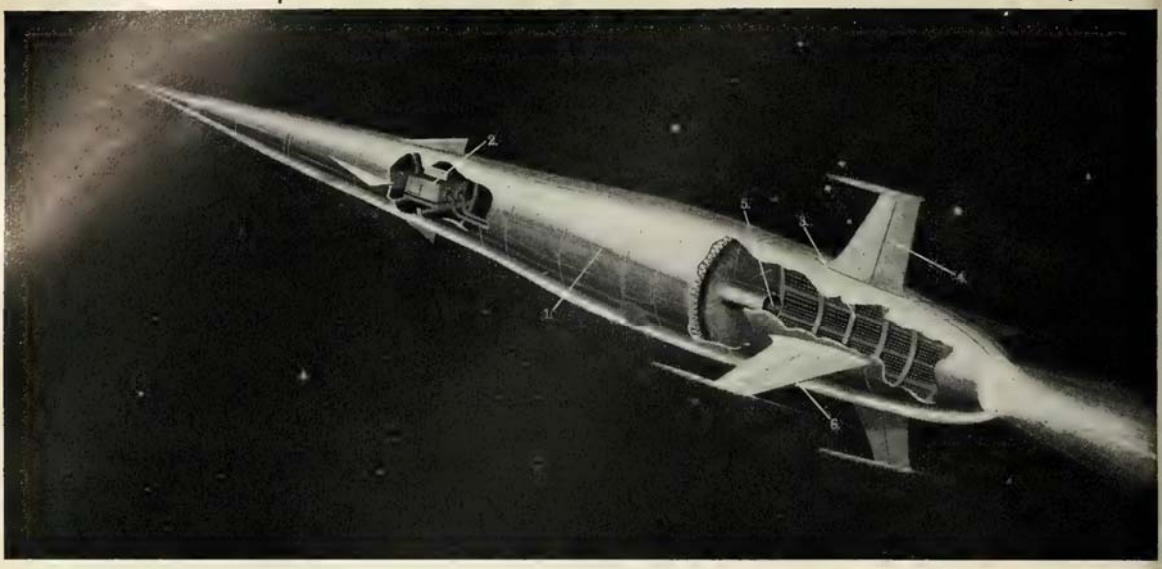
DOW | MAGNESIUM



Design a missile with light, strong magnesium alloys

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

THERMAL PROPERTIES OF LIGHTWEIGHT MAGNESIUM

offer advantages to missile men

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

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

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

For more complete data send for Bulletin 141-187 "Magnesium Alloys for Elevated Temperature Use." Contact your nearest Dow Sales Office or write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Department 1300CL4-20.

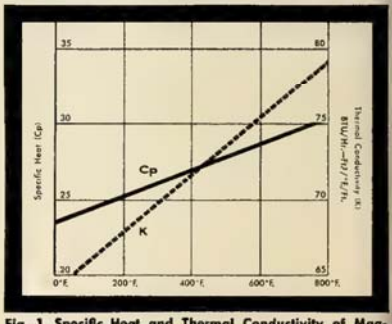


Fig. 1. Specific Heat and Thermal Conductivity of Magnesium-Thorium alloys.

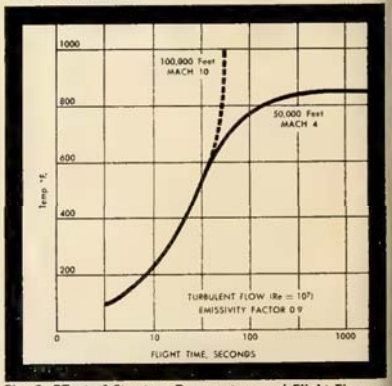


Fig. 2. Effect of Structure Temperature and Flight Time on Mg-Th Sheet Alloys at Mach 4 and 50,000 Feet and Mach 10 and 100,000 Feet.

THE DOW CHEMICAL COMPANY · MIDLAND, MICHIGAN

. . . TAX WRITE-OFFS

(Continued from page 19)

On the other hand, NASA and DOD are for it because they can "save" money. In many instances DOD has had to spend appropriations for brick-and-mortar and specialized equipment which industry wouldn't—or couldn't afford to—put up without a tax incentive.

NASA apparently has adopted a policy of buying from commercial sources rather than building its own facilities. An official told M/R continuation of rapid tax write-offs therefore becomes of "import to national security" by aiding the space program.

A bill extending the Byrd law for four years—and including NASA contractors—has been introduced by Rep. Richard M. Simpson (R-Pa.), ranking GOP member of the House Ways and Means Committee. No hearings have been scheduled on this measure (HR 5326). Committee aides say there may not be any.

• **Old bugaboo**—Conceivably, inclusion of NASA could rekindle an old Congressional controversy which brought about the Byrd law. For the space agency intends to spend billions of dollars in the next few years. And most of it would be eligible for fast write-off.

Such magnitude would approach the hey-day of the program, which was started in 1950 during the Korean War to help mobilize defense industries. In the 1950-57 period, OCDM granted rapid amortization certificates on $23 billion worth of expenditures by some 220 different industries.

The shut-off came amid charges that the privilege was being abused. One sore point: certification could be granted then whether or not an applicant held a defense contract. Some lawmakers felt this was handing out five-year tax reductions.

Spokesmen for industry countered that it was only a deferment in tax payments and no revenue was "lost" by the Treasury in the long run. Furthermore, they pointed out that during an inflationary spiral, long-term amortization was unrealistic on specialized facilities which depreciated rapidly and whose replacement costs were steadily mounting.

• **Present status**—Since 1955, when the rocket program began cranking up, OCDM estimates that a total of approximately $350 million in certification has been allowed firms directly connected with the missile/space industry. Smallness of this figure attests to the stringency of the program since 1957, although billions are being spent on missile development.

About 175 applications for certificates are pending before the OCDM. Some of these date back "a year or more," the agency says. One official concedes the delay "could be a factor" in holding up the construction of facilities valuable to the missile/space effort. Reasons for the hold-up:

All applications must be processed through several agencies of the DOD and AEC.

No certificates were issued from August, 1957, through June 1958, while new regulations geared to the Byrd law were being written.

An M/R survey indicates that in the past 10 months few companies have derived very substantial tax deferment to provide money for extra research facilities now, nor in the immediate future.

Unless Congress grants an extension beyond Dec. 31, even this rivulet will dry up. In this event, several industry experts believe, more money must be found somewhere to pump into basic research—or the entire U.S. space effort will suffer.

west coast industry

by Fred S. Hunter

The debate over how space money should be spent seems to be warming up.

The other day, Dr. A. R. Hibbs, Jet Propulsion Laboratory's outspoken chief research analyst, declared U.S. preoccupation with military aspects of space is "out of all proportion to any realistic application." Hibbs said he doubted that Russia would shudder if American troops planted a flag on the moon. "They know the moon is two days travel away while their ICBM's take only 30 minutes to reach our cities."

In discussing realities of space exploration before an erudite audience at CalTech, Dr. Simon Ramo, executive vice president, and Dr. Ralph P. Johnson, vice president and general manager, Thompson Ramo Wooldridge, had this to say: "If the refinement of the capability for effecting mass destruction by quick and irresistible means at intercontinental distances comes into competition with the expansion of a capability for exploring space—and the two lines of development are already diverging—we can hardly doubt that the projects for military ends will be given priority."

To a financial audience, Dan Kimball, Aerojet-General president, put it this way: "We can't make any valid distinction between 'useful' military hardware and 'useless' exploration of space. Both of them take the same kind of power, the same kind of vehicle and the same kind of guidance. Just as the airplane that could photograph could also bomb, so the satellite which can spy in orbit can be used for any military purpose we or the Russians desire. Let's not fool ourselves about that!"

New plant Hoffman Electronics is building at El Monte, Calif., for its semiconductor division, plus the output of the present Evanston, Ill., plant which is to continue, will up this company's production of solar energy converters to half a million monthly. Hoffman's accomplishments in increasing efficiency of solar energy cells from 3% to 9% and 10%, and in developing new methods to manufacture them in production quantities, have made the solar cell the lowest weight power source for space vehicles. Hoffman forecasts that the volume of its semiconductor division—$6 million in 1958—will reach $30 million by 1965 as industry is made aware of the usefulness of these wonder products.

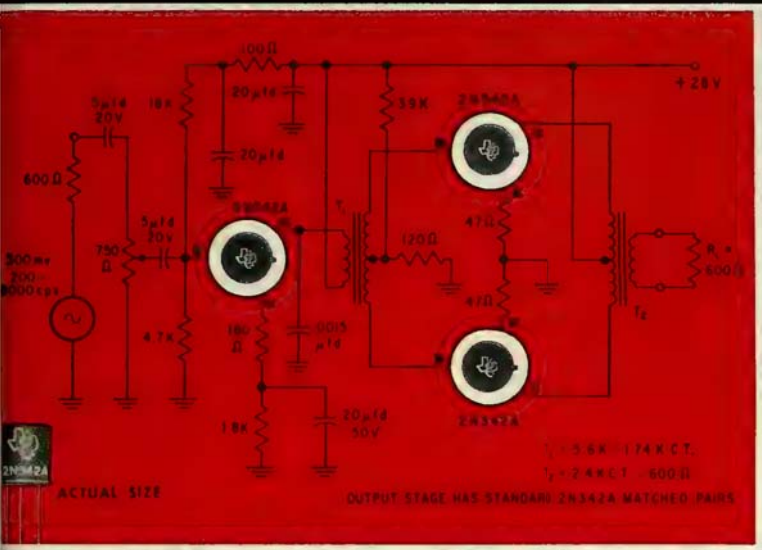
Lockheed may follow example of Hughes, Aeronutronics and others and join the movement to Orange County for a permanent abode for its new electronics division. It is looking for a site to build. It is presently located temporarily at Maywood in the old feeder plant originally purchased by Lockheed for production of subassemblies for the Super Constellation. Lockheed also made a few early Electra parts here, but until the electronics division moved in the facility had been idle for about nine months.

Marquardt had already phased in production on the new model RJ43-11 ramjet engine for the longer-range *Bomarc B* when the Air Force's $300-million order to Boeing was announced. Generally, frames run ahead of engines in this business, but in the *Bomarc* development it has been the other way around. The Dash II engine is produced at Marquardt's Ogden plant, but has to be shipped to Van Nuys for testing. The new testing facility being built in Utah will be completed in September or October, but won't be ready for actual operation until the first of next year. It will take a little time to test the test facility.

S. K. Hoffman, general manager of Rocketdyne, says eventually missiles will take off and return to the launching site in a vertical position, be checked, refueled and launched again on space missions.

TI Silicon Transistor Application Note

TRANSISTORIZED INTERCOM EXCEEDS MIL-E-5272B SPECS



CIRCUIT SPECIFICATIONS

150-mw output from -55°C to 100°C at less than 10% harmonic distortion over frequency range

Frequency response @ 25°C stable within ±2 db of 1000 cps 100 mw reference level from 200 to 8000 cps

Frequency response @ -55°C and 100°C within ±3 db of 25°C frequency response

Less than 3-db gain variation @ -55°C and 100°C compared to 25°C measurement

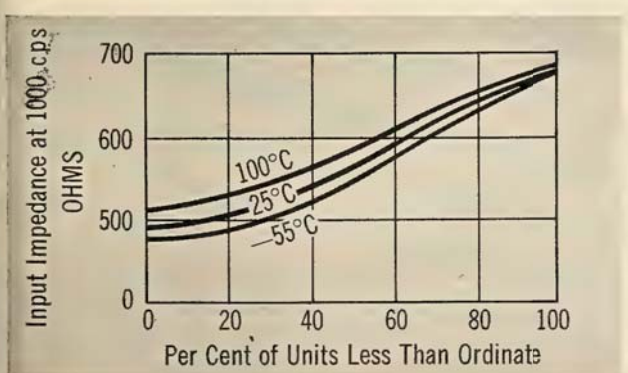
LOUD AND CLEAR AT 100°C!

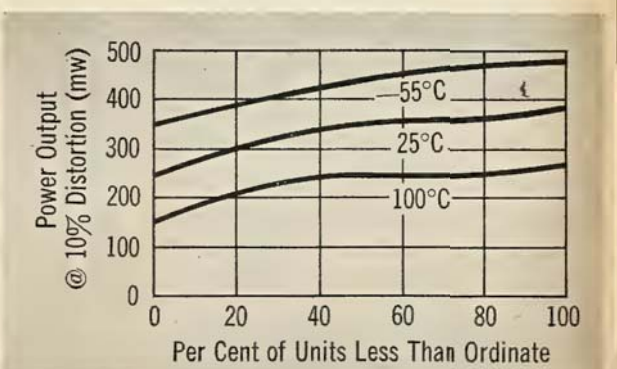
. . . with TI 2N342A silicon transistors from stock

You can satisfy the 71°C equipment requirements of MIL-E-5272B at 100°C with the intercom amplifier circuit shown above — using TI 2N342A silicon transistors with . . . guaranteed 3-to-1 linear beta characteristics . . . 85-v collector-to-emitter breakdown, giving a wide safety range with 28-v aircraft supplies . . . plus dissipation capability of 1 watt at 25°C and 200 mw at 125°C.

The newest addition to the *use-proved* TI 2N339 series introduced in 1957, this medium-power unit carries the full-year TI guarantee and is immediately available *off-the-shelf* from all TI distributors in 1-249 quantities. For production quantities, contact your nearest TI sales office.

TYPICAL INTERCOM AMPLIFIER PERFORMANCE CHARACTERISTICS USING 2N342A TRANSISTORS





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DALLAS, TEXAS

contract awards

ARMY

$2,991,000—**Rocketdyne Div., North American Aviation, Inc.,** for classified design and development.

$2,010,910—**Corbetta Construction Co.,** Chicago, for construction of Missile Master facilities at Arlington Heights, Ill.

$1,050,000—**Sperry Phoenix Co.,** for universal automatic pilot.

$618,296—**E. I. Noxon Construction Co.,** Los Angeles, for *Atlas* assembly building at Vandenberg AFB.

$517,900—**The Firestone Tire & Rubber Co.,** for engineering services, modification of guided missiles and *Corporal* repair parts (three contracts).

$443,576—**Olin Mathieson Chemical Corp.,** for R&D on composite double base loading and firing missile, *Nike-Zeus.*

$395,842—**Eitel-McCullough, Inc.,** for electron tubes.

$349,947—**Nortronics Div., Northrop Aircraft, Inc.,** for a tape library.

$279,538—**Servo Corp. of America,** for Doppler radio detection finders.

$275,939—**Gilfillan Bros., Inc.,** for *Corporal* repair parts.

$230,698—**Rheem Manufacturing Co.,** Downey, Calif., for R&D.

$197,000—**Solar Aircraft Co.,** for terminal subsystems for space intercept study.

$175,000—**Machlett Laboratories, Inc.,** Springdale, Conn., for electron tubes.

$133,744—**Raytheon Manufacturing Co.,** for electron tubes.

$110,263—**Raytheon Manufacturing Co.,** for electronic assemblies for *Hawk* (an estimated 40% of this will be subcontracted).

$109,800—**Magnetic Research Corp.,** Hawthorne, Calif., for amplifiers.

$94,439—**ITT Laboratories,** Fort Wayne, Ind., for research on direct view integrating image converter tubes.

$91,628—**Western Electric Co., Inc.,** for *Nike* spare parts and components.

$89,386—**General Electric Co., Missiles and Space Vehicles Dept.,** for production of films in connection with Phase II of *Little John* program.

$85,318—**Mult-A-Frame Corp.,** Detroit, for fabrication of rocket storage racks.

$84,700—**Chicago Bridge & Iron Co.,** Atlanta, for construction of booster pump station reservoir at Redstone Arsenal.

$79,288—**Autonetics Div., North American Aviation, Inc.,** for services, spare parts, test equipment and accessories for the Juke Box computer.

$73,500—**North Carolina State College,** for study of motion of spin-stabilized rockets during burning, determination of launch parameters and development of instrumentation for determining experimental data, and to simplify analysis of this data.

$62,611—**Raytheon Manufacturing Co.,** for electronic components for *Hawk* missiles (two contracts).

$62,116—**Sanborn Co.,** Waltham, Mass., for oscillograph recording system.

$55,952—**Belock Instrument Corp.,** College Point, N.Y., for integrating gyro assemblies.

$50,285—**Arthur D. Little, Inc.,** Cambridge, Mass., for investigation of emissive properties of satellite surface before covering materials.

$50,000—**North American Aviation, Inc.,** for rocket engines.

$49,913—**Electro-Optical Systems, Inc.,** Pasadena, Calif., for R&D.

$40,000—**Douglas Aircraft Co., Inc.,** for rocket frame components.

AIR FORCE

$3,830,000—**American Machine & Foundry Co.,** for design and development of underground installation of guidance antenna for the *Titan* ICBM.

$898,333—**Air Products, Inc.,** Allentown, Pa., for liquid oxygen and liquid nitrogen.

$897,600—**Eitel-McCullough, Inc.,** for electron tubes.

$442,726—**Hoffman Laboratories, Inc.,** for liquid oxygen tanks.

$383,500—**Gilfillan Bros., Inc.,** for landing control set.

$289,880—**The Hallicrafters Co.,** for radar transmitters.

$232,310—**Cutler-Hammer, Inc., Airborne Instrument Lab.,** Mineola, N.Y., for design, development and fabrication of one molecular amplifier group.

$216,000—**Chance Vought Aircraft, Inc.,** for operation and maintenance of the Space Positioning Range near El Centro, Calif.

$163,070—**Sylvania Electric Products, Inc.,** for electron tubes (two contracts).

$150,000—**Westinghouse Electric Co.,** for high-power silicon transistor production refinement program.

$101,779—**Electronic Batteries, Inc.,** Brooklyn, N.Y., for storage batteries.

$100,288—**Electrical Specialties Co.,** Dayton, Ohio, for rectifiers.

$99,932—**Continental Electric Co.,** Geneva, Ill., for electron tubes.

$91,575—**Raytheon Manufacturing Co.,** for electron tubes.

$75,679—**Olin Mathieson Chemical Corp.,** for monomethyl hydrazine for testing and evaluation in support of Weapon System 138AA.

$69,646—**Vitro Laboratories Div., Vitro Corp. of America,** for continuation of research on high-intensity arc for ion propulsion.

$64,354—**RCA Defense Electronics Products Div.,** for design and development of airborne optical measurement system.

$58,176—**Westinghouse Electric Corp.,** for R&D on magneto-optical properties of ferri-magnetic rare earth garnets.

NAVY

$240,000—**New England Instrument Co.,** Woonsocket, R.I., for missile components for *Sparrow III* missiles (a subcontract from Raytheon).

$85,383—**Kearfott Co., Inc.,** Clifton, N.J., for synchros.

$74,778—**National Cash Register Co.,** Dayton, Ohio, for research in microencapsulation or reactive materials.

NORTRONICS UNIVERSAL DATICO SOLVING CHECKOUT PROBLEMS FOR ALL 3 SERVICES!

Positive proof that Datico is truly universal automatic checkout equipment: contracts for checkout requirements on missile systems and equipment in all three military branches of the Department of Defense.

ARMY – Nortronics is developing for the U.S. Army a set of Datico universal test equipment designed toward the test of seven different complete missile systems.

NAVY – An application of the Universal Datico is being developed for operational checkout of an advanced U.S. Navy missile system.

AIR FORCE – Universal Datico is at work today in a U.S. Air Force operational environment, operated by service personnel on a production-line checkout application to U.H.F. equipment.

Today's Universal Datico is available off-the-shelf: Federal Stock Catalog Number 6625-650-7542. It can be readily packaged for maximum mobility, and is applicable for use at launching sites, maintenance areas, depots, and assembly-line checkout stations.

Tomorrow's Datico is already in advanced development – by the same management-engineering team that delivered Datico in time for today's weapons. *For your systems checkout requirements at all test levels,* call Nortronics. Or, write: Chief Applications Engineer, Dept. 2003-G2, Nortronics, A Division of Northrop Corporation, 500 East Orangethorpe, Anaheim, California.

NORTRONICS *A Division of* ***NORTHROP CORPORATION***

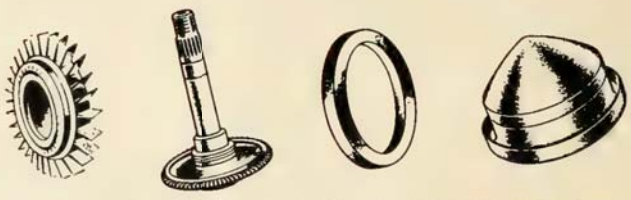
SUPER ALLOY STEELS FOR JET AGE PRODUCT SPECIFICATIONS

by MIDVAC

When parts for missiles . . . super aircraft . . . and other jet age products call for super alloys to operate at high temperatures specify MID-VAC Steels.

MID-VAC Steels — produced by the MIDVAC Process of consumable electrode vacuum melting — have increased tensile and impact . . . improved stress rupture strength at elevated temperatures . . . long fatigue life. They meet specifications of critical parts where strength is needed at temperatures above 1000°F. Super alloys for missile combustion chambers, tail cone assemblies, nose cone or structural members, aircraft landing gear parts and compressor rotor blades.

Offered in ingots, billets or forgings. Write for technical data on these new super alloy steels.



Midvac Super Alloys for missile combustion chambers, tail cone assemblies, jet engine parts and other parts requiring properties beyond the capabilities of conventional steels.

MidVac Steels

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people


DONOVAN

Allen F. Donovan, a vice president, has been named director of advanced systems planning for Space Technology Laboratories, Inc. The new advanced planning staff, according to STL, is a step toward "development of those systems which will be required in the future to replace today's ballistic missile and space systems." Donovan has held positions in the aircraft industry and with the Cornell Aeronautical Laboratory in R&D of manned aircraft, guided missiles and space vehicles. During four years with STL, he has been technical director for rocket vehicle aspects of the Air Force Ballistic Missile Programs.

Dr. Clark T. Randt has been appointed Scientist for Space Medical Research in the Office of Research Grants and Contracts of the National Aeronautics and Space Administration. He was Associate Professor of Neurology in the Department of Medicine, Western Reserve University, and Director of the Division of Neurology, University Hospitals, Cleveland. Dr. Randt will plan a long-range basic research program; it is expected that a large portion of the work will eventually be carried on by medical schools and other research organizations under Federal grants and contracts. In addition, Dr. Randt will assist NASA in human factors studies related to manned space flight.

Three new appointments have been made at Grand Central Rocket Co. **Albert T. Camp,** former head of the Propellant Division, Naval Ordnance Test Station, China Lake, is assistant vice president and director of research. Known for his direction of the *Sidewinder* missile and one of the top solid-propellant experts, he is credited with development of temperature-independent solid-propellant rockets and the explanatory formula for their combustion mechanisms. **John Gustavson,** Danish chemical engineer, was named senior engineer of the advance planning division for space propulsion. **Frederick F. Harris** was appointed director of Quality Control Div.

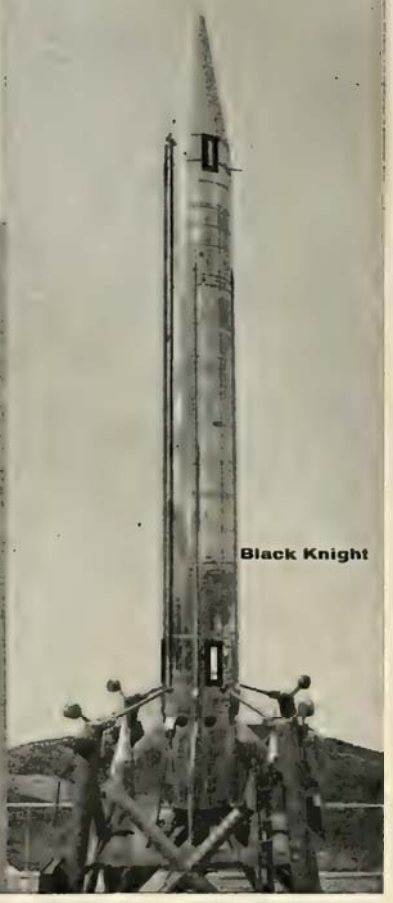

HARMONY

Joe C. Harmony has been named director of general engineering-receiving tubes for CBS-Hytron, the electronic manufacturing division of Columbia Broadcasting System, Inc. He replaces **E. K. Wimpy** who has been assigned to the new post of manager-marketing research. Harmony has served as manager of each of the firm's receiving tube plants and also as general manager of receiving tube operations.

FLIGHT POWER

Lockheed Jetstar

Bristol/Ferranti Bloodhound



Black Knight

eady specified in 8 countries for 14 different aircraft includ- the outstanding Lockheed Jetstar.

GLE MAMBA—jet-prop . . . stressed for naval operations such deck landing and catapulting . . . installed in the Short mew.

OR—a fully developed ramjet engine . . . powers the Bristol/ ranti Bloodhound guided missile system, chosen as Britain's jor air defence weapon, ordered by Sweden.

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UBLE MAMBA—jet-prop . . . virtually twin-engined reliability long oversea reconnaissance duties . . . powers the Fairey nnet.

CENTAURUS AND HERCULES—two radial piston engines, with Bristol-pioneered sleeve-valves . . . renowned for their reliability and long overhaul life.

P181, P182—turboshafts . . . remarkably compact for power developed . . . P181 designed for helicopters, P182 for fixed-wing aircraft.

Bristol

Siddeley

ENGINES LIMITED

BRAIN-POWER translated into FLIGHT POWER

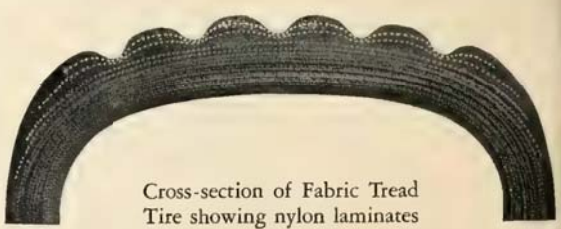
B. F. Goodrich Fabric Tread Tires picked for the X-15

Up, up — 100 miles up at fantastic speeds — the North American X-15 will carry man to the fringe of Earth's atmosphere. And when the X-15 lands it will land at a speed that will demand top tire performance.

That's why B.F.Goodrich Fabric Tread Tires have been selected for the nose wheels of the X-15. Already in service on our fastest jet fighters and missiles, these revolutionary B. F. Goodrich tires outperform all previous jet tires.

Nylon laminates built into tread stock reduce rubber distortion under load, equalize modulus between tread and carcass, check formation of "shock wave". Unique Fabric Tread designs eliminate stress points found in ordinary high-speed tires, also resist tread cutting and punctures.

Without a doubt, B.F. Goodrich Fabric Tread Tires mean safer takeoffs, more landings, for your supersonic aircraft. Find out more about Fabric Tread right now by contacting *B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Dept. MR-49, Akron, Ohio.*



Cross-section of Fabric Tread Tire showing nylon laminates

B.F.Goodrich *aviation products*

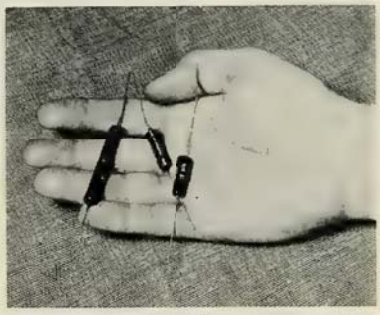
Novel Resistors 10 Times Smaller, Lighter

Market plans for new molecular-structured resistors, purported to be 10 times smaller and lighter than present resistance components, have been announced by **Daystrom-Weston Instruments, Daystrom, Inc.**

The micro-miniature resistors are the first commercial production of elements developed from the micro-module concept—the idea of combining extremely small elements of uniform shape and size into a single tiny module capable of performing complete circuit functions.

Basically, the micro-miniature resistors are a solid state material in the form of a ceramic wafer approximately 10 thousandths of an inch thick and .35-inch square. By processing suitable substrates, these micro-wafers are inscribed with a series of "isolation lines" which produce the resistor characteristics desired.

Single or double-sided resistor elements can be designed, and various combinations of circuitry can be employed with the basic micro-element.



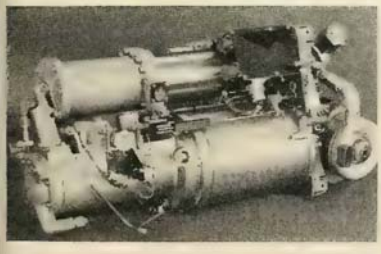
These wafer-like elements may then be combined into modules of standard size and shape comprising circuit sub-assemblies.

Each resistor element—weighing 50 milligrams—contains four resistors, averaging 10,000 elements (or 40,000 resistors) to the pound and a packing density of 600,000 parts per cubic foot.

The microscopic resistors are developed in wafer element forms designed for reliabilities of meantime to failure of 100,000 hours.

Circle No. 225 on Subscriber Service Card.

High Reliability Claimed For APU Power Unit



A new model auxiliary power unit, designed with an unprecedented maximum degree of reliability, simplicity and flexibility, to supply electric power for a missile's guidance and control systems has been developed by **The Garrett Corporation's AiResearch Manufacturing Division.**

The latest APU eliminates external plumbing, cuts the number of valves to less than half the number originally used on AiResearch APU's now being manufactured for the *Nike-Hercules*. It starts instantly and has better serviceability.

Designed to operate on ethylene oxide, the new AiResearch APU may also be used with hydrazine. With minor modifications a solid propellant can be utilized. Thus, the new unit provides maximum flexibility through the use of proven components available now, with the advantages of using other energy sources with adaptations.

The current model supplies five horsepower for a duration of 7½ minutes at specific load schedule. Its altitude range is from sea level to more than 100,000 feet.

Components in the AiResearch APU include a squib starting mechanism, variable delivery hydraulic pump, accumulator, reservoir, fuel tank, manifold valve assembly, alternator, speed control, and turbine drive unit.

The squib start initiates ethylene oxide decomposition by igniting a small replaceable solid propellant charge, which provides instantaneous starting capability without rearming the gas generator. The charge has been sized to assure acceleration of the turbine to rated speed within two seconds at ambient temperature as low as minus 65°F.

The variable delivery pump delivers required system flow at a pressure range of 2880 to 3200 psig.

A new design utilizes a single valve block to house all valves necessary for proper operation of the unit. This manifold valve assembly reduces the previously required number to seven.

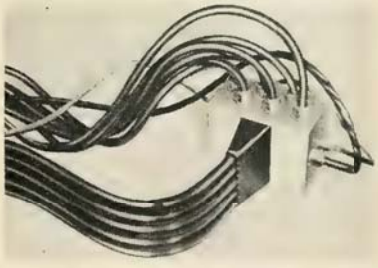
A new alternator for the APU has been designed which is a two-phase, permanent magnet, pad-mounted machine sized for existing requirement. One phase provides 30 volts ac for direct rectification to dc for operation of a fuel control valve. The second phase provides 120 volts ac for missile lift-off signal and the turbine frequency sensor.

The turbine is not subjected to adverse effect of step load changes resulting in better speed regulation. The turbine assembly has been redesigned to incorporate a pad-mounted, variable displacement pump and alternator, providing ease of replacement in the field. The turbine rotating assembly consists of a turbine wheel and shaft assembly.

The APU weighs 85 pounds less fuel and oil. It measures approximately 30 inches long, 12 wide and 15 high.

Circle No. 226 on Subscriber Service Card.

New Electronic Cable Utilizes Compact Assembly



Custom electrical and electronic cable and cable assemblies designed to help solve missile cable problems are being manufactured by the **Aeronautical and Instrument Division, Robertshaw-Fulton Controls Co.**

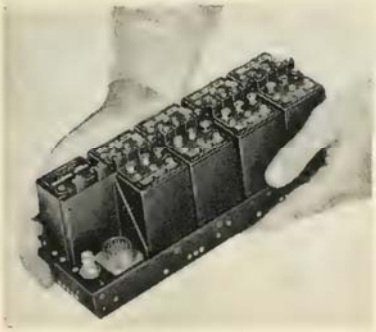
Missiles use multi-conductor cable to link electronic components and systems, involving both airborne and

ground support or test equipment, and as many as 30 to 40 electrical leads may be needed to connect complete electronic units. Conceivably, each lead might have a different material. Since it is no longer practical to string individually the many cables that may be required from blockhouse to launching pad, or from pad to missile, electrical conductors now are bound into compact cable assemblies, protected with suitable jacketing materials and provided with integral electrical connectors.

Cables are custom designed to meet customers, specific requirements and can be manufactured to nearly any length or size. They are manufactured on special planetary cabling machines designed by the firm. These unique machines are capable of completing the most precise and complex cables to meet the ever-increasing demand for specialized cable configurations.

Circle No. 228 on Subscriber Service Card.

T-Shaped Mini-Mount Aids Miniaturization



Smallest space installation of telemetry components within a missile is said to be made possible by the new Type 1405 mini-mount, manufactured by **Tele-Dynamics Inc.**

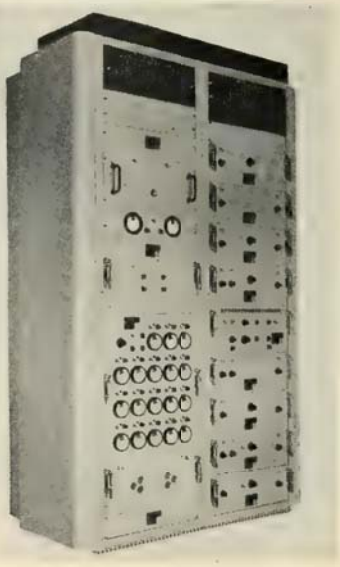
The mount is a pre-wired, welded "T"-shape which is designed to accept TDI type 1213A subcarrier oscillators and a TDI type 1106A wide-band amplifier. Sizes are available for four, eight, and 12 subcarrier channels.

The mount attaches directly to the vehicle structure and the miniature plug-in units contribute their own structural strength to the assembly when they become clamped to the T-member. All test points, trimmer controls, and receptacles are accessible.

Functionally the mount and its plug-in components act as the data input section of a telemetry transmitting system. Data voltages are applied to the subcarrier oscillators for conversion to FM information. The mixer amplifier provides a composite FM output which drives a telemetry transmitter. Inflight calibration is available through relays included in the mount base. When externally actuated, the relays connect fixed-level voltages, supplied externally, to the subcarrier oscillators to provide a standard frequency deviation.

Circle No. 229 on Subscriber Service Card.

Auto-Checkout For Telemetry Discriminators



A method for the improvement of reliability of FM/FM telemetered data is provided by the Model 5006 Automatic Discriminator Checkout System developed by **Dynatronics, Inc.**, Orlando, Fla.

This unit generates the 18 RDB standard FM/FM subcarrier frequencies simultaneously at 11 separate frequency deviations and also 18 simultaneous current outputs for comparison with outputs of discriminators under test. It provides automatic, semi-automatic, and manual operation.

In automatic mode up to 18 discriminators are fed with their respective channel frequencies and the output indicated by meters for comparison.

The channel frequencies are slaved to a master deviation selector which automatically drives through 11 deviations of plus or minus 1.5, 3, 4.5, 6, 7.5 and 0 percent.

Standard currents are likewise automatically compared with the discriminator at each point. If a meter reaches a preset limit the sequence is stopped and a light indicates the out-of-tolerance discriminator. Linearity of the discriminators to checked to better than 0.1%.

Circle No. 230 on Subscriber Service Card.

Tiny Mercury Battery, Capacitator Produced

A solid tantalum capacitor half the thickness of a dime, and a tiny mercury battery the size of an aspirin have been developed for the Army Micro-Module program according to an announcement by **P. R. Mallory & Co Inc.**

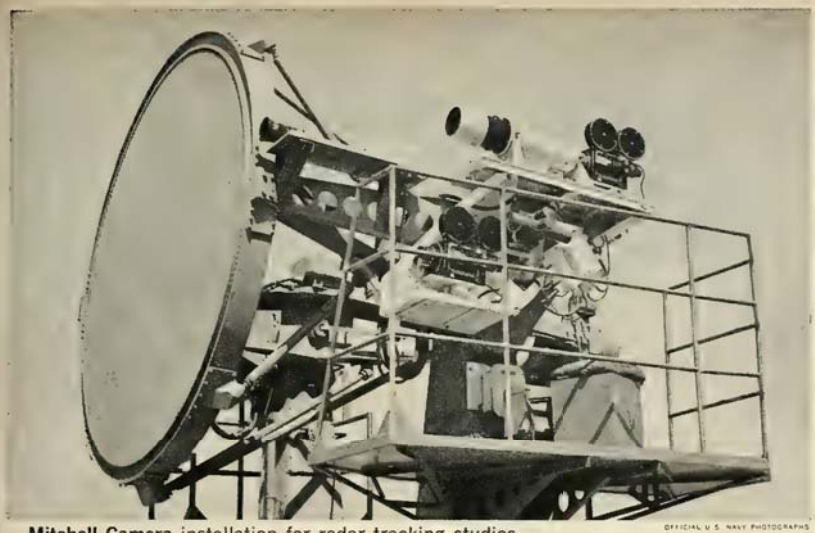
The Mallory micro-module tantalum capacitor was developed in two thicknesses, .028" in ratings up to 15 mfd x volts, and .35" in ratings up to 30 mfd x volts. Three different ratings and five terminal arrangements were developed in each thickness. The units have an effective operating temperature range of −65° to 85°C.

The Mallory RM 312 mercury battery was designed for modules requiring a self-contained source of power. The powerful little battery has a diameter of .305" and is only .135" thick.

The P. R. Mallory Co. is cooperating with RCA, the prime contractor for the Army Micro-Module program. The program was established to provide the Armed Forces with components and communications equipment physically reduced in size, but with no compromise in quality or reliability of performance.

Major emphasis of the program is on reducing the logistical problem through the development of electronic equipment that is less bulky and requires less technical know-how to operate than present equipment. Emphasis is also on reducing maintenance and "down time" through the use of "throw-away" component packages.

The micro-module as presently conceived, is the combining of micro-miniature transistors, capacitors, diodes and other components (called micro-



Mitchell Camera installation for radar tracking studies.

OFFICIAL U.S. NAVY PHOTOGRAPHS

HOW MITCHELL CAMERAS SUPPLY VARIED DATA IN ROCKETS AND MISSILES DEVELOPMENT

- Exact Pin Registration During Film Exposure
- Event Time to 1 Millisecond

Data dial instrumentation by Mitchell camera.

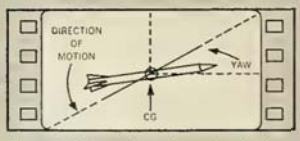
Extensive testing instruments incorporating Mitchell 16mm, 35mm and 70mm cameras provide key data at the U.S. Naval Ordnance Test Station at China Lake, Calif., one of the primary weapon development centers of the Navy's Bureau of Ordnance.

Fifty Mitchell 35mm cameras are used on radars, tracking camera mounts and fixed tripods to record missile and rocket development. Camera motors allow synchronous as well as in-phase operation of several cameras covering a test...important in film assessing. Eight 16mm Mitchell cameras are used for pictorial coverage of tests.

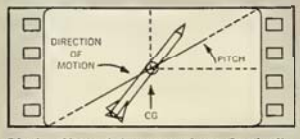
One metric photographic group shoots as much as 20,000 feet of 35mm film in one day. Other Mitchell cameras record underwater, engineering and aviation tests at this ordnance center.

For information on Mitchell cameras, write describing your requirements.

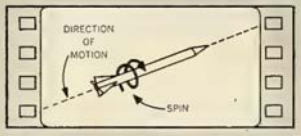
The Mitchell camera, by virtue of its exact pin registration during film exposure, allows these data to be determined to a reasonably high degree of accuracy through the use of film assessing equipment built to take advantage of this feature:



Yaw—Side-to-side motion of missile.

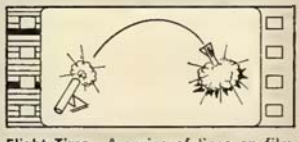


Pitch—Up-and-down motion of missile.

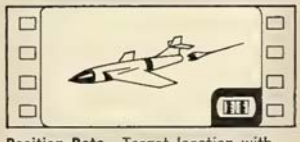


Roll—Turning motion of missile.

Miss Distance—Gap between missile and target at point of interception.

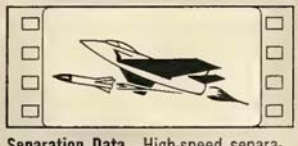


Flight Time—A series of lines on film; timed to accuracy of 1 millisecond.



Position Data—Target location with azimuth and elevation readings.

Pictorial Record—Record of all visible actions during test.



Separation Data—High-speed separation actions for detailed study.

elements) suitably combined to form a sealed or encapsulated solid body. These module units are so designed or packaged to make reasonable the discard of the entire unit when any one component goes bad.

Circle No. 231 on Subscriber Service Card.

Diode Switch Has Fast Triggering Time

A 200-milliwatt Dynistor diode switch is now available in commercial quantities from **Westinghouse Electric Corp.** The device is a multi-junction, two-terminal germanium switch that can transfer from a blocking to a conductive condition in fractions of a microsecond. This switching time is considerably shorter than that of switching transistors of comparable power handling capacities.

In the 200-milliwatt rating, the Dynistor diode can be used for applications in computers and core-driver circuitry. It can also be used as a protection against transient overvoltages, as an oscillator, a sawtooth wave generator, a fast acting relay, and a

phase controlled rectifier, among other applications. The device is available in four breakover-voltage categories ranging from 50 to 200 volts.

In operation, the Dynistor diode is triggered by a short duration trigger pulse, which can be of less than one-microsecond duration, and of sufficient magnitude to insure raising the voltage on the device above its breakover voltage.

To turn the device off, the voltage must momentarily be reduced to zero, or the current through the device must be reduced below minimum sustaining current. Thus, it is essentially an on-off switch similar in operation to a gas discharge tube or neon bulb. The major difference is that the voltage drop in the conducting condition of the diode is less than a volt. The faster switching times, ranges of breakover voltages, and small size are other major differences. The unit is encapsulated in a JETEC Type 30 case.

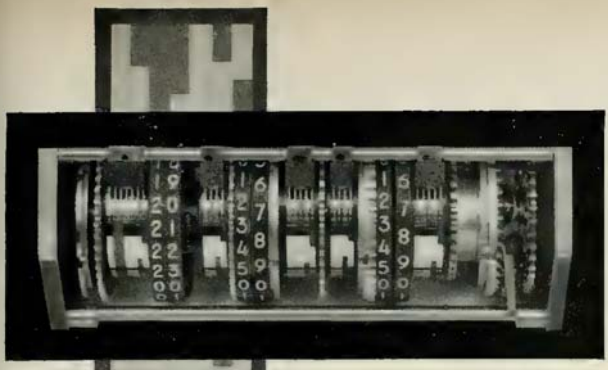
Circle No. 232 on Subscriber Service Card.

Ultrasonic Delay Lines Have Wide Period Range

Development of ultrasonic delay lines with very short and long delay times has been announced by **Corning Glass Works.** They will store a signal with minimum attenuation for periods ranging from less than 50 to more than 15,000 microseconds.

Ultrasonic delay lines are produced by Corning for military radar systems. The new, very short and very long delay lines greatly extend the range of possible delay times.

Ultra-short delay lines were de-



. . . Kearfott analog-to-digital converters

accuracy, reliability, varied capacities and codings

Kearfott's direct drive converters translate shaft rotation into electrical and visual digital form. These mechanically positioned units consist of coded drums, the number depending on the code and total count. The first, or units drum, connects directly to the input shaft and rotates as the shaft turns. On models where more than one drum is used, high speed odometer type gearing provides interconnection. All models can be read "on the run" or "on demand" and all tracks may produce simultaneous or serial readings, depending on the interrogating pulse.

The high performance and quality of Kearfott's analog-to-digital converters are assured by stringent testing for:

Mechanical Accuracy: The location of any code transition point must fall within one-third bit of its true angular position.

Low and High Temperature: All units operate efficiently at temperatures ranging from — 65° F to + 260° F.

Brush Skip: Conducted in conjunction with tests for temperature, vibration, shock and acceleration. A typical brush skip test employs 200 μsec., 23V DC amplitude interrogating pulses at 4000 cycles per second. With the shaft rotating, each output drum track is monitored for a total of 500,000 pulses, in which "lost" counts or "skips" will not exceed 1 in 15,000.

Shock: Kearfott converters are subjected to 18 shocks in three different planes with shock loading of ± 15 g's.

Vibration: Units must withstand vibrations between 5 and 500 cps with applied load of ± 10 g's.

Acceleration: All units are subjected to radial accelerations of varying magnitudes up to a maximum of ± 7.5 g's.

Life: Over 1 million linear feet (1000 hours at 82 RPM) of continuous brush travel on drum coded patterns can be achieved without excessive wear to drums, brushes or other sub-components.

Write for new ADAC brochure.

ANALOG-TO-DIGITAL CONVERTER CHARACTERISTICS

Kearfott Unit No.	423830-1	423607-1	Y1241-11A	P1240-11A	Y1240-11A	U1240-11	P1241-11A
Code (1)	B.D.	B.D.	B.D.	B.D.	B.D.	B.D.	C.B. (Gray)
No. of Drums	1	1	2	3	3	4	5
Range	0 to 84 in 348.5° of arc. 11.5° dead spot coded O	−19 to 0 to + 19	0 to 359	(+) 0 to (+) 999 (−) 999 to (−) 0	0 to 359.9	0 to 359.9	0-32,768 (2^{15})
Bits per Revolution	85	39	40	20	40	40	16
Revolutions for Total Range	1	1	9	100	90	90	2,048
Volts D.C.	23	12	23	23	23	23	10.5
Current (ma.)	20	20	20	20	20	20	20
Inertia (gm. cm.²) (2)	158	48	104	28	158	100	20
Unit Diameter (in.)	2⅛	1¾	1 15/16	1 1/16	1 15/16	1.875	1 1/16
Unit Length (in.)	31/32	1 1/16	1-43/64	1 15/16	2 1/16	2.8125	3
Life (3)	10^6 revolutions or 10^3 hours						
Static Torque (in.-oz.) (4)	0.5	0.1	1.0	.5	1.0	1.0	2 (break) 1 (running)
Weight (oz.)	5	3.5	5.75	4	7.75	6.5	5
Maximum Speed (RPM)	1100	250	300	400	300	700	600
Dielectric (Volts DC)	500	500	500	500	500	500	500

(1) B.D. (Binary Decimal), C.B. (Cyclic Binary).
(2) Inertia measured at maximum trip.
(3) Under recommended conditions.
(4) At room temperature.

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

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A subsidiary of General Precision Equipment Corporation
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West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

veloped through glass composition research at Corning. The new glasses have nearly a zero temperature coefficient of time delay, and can provide delay times up to several hundred microseconds without the need for bulky and heavy heating equipment.

The glasses are manufactured by the same techniques used in production of optical glass and therefore can be formed into standard glass shapes.

The very long delay lines were developed through improvements in fused silica production methods, which make it impossible to form plates of pure fused silica up to 48 inches in diameter. The extremely low acoustic attenuation of fused silica makes possible delay times of 15,000 microseconds in a single plane delay line.

The company formerly achieved maximum delays of 5250 microseconds by using folded, or multiple, delay lines.

Fused silica is produced by a unique evaporation process developed by Corning research scientists. The material is said to be one of the purest man-made substances.

Circle No. 233 on Surbscriber Service Card.

Ball Bushings Weigh Only 0.15 of an Ounce

Thomson Industries, Inc., has commenced producing miniaturized linear ball bushings specifically designed for military systems requirements requiring miniaturization.

Designated INST-396, those ball bushings are for use on shaft diameters of 0.1246″ and 0.1871″. Overall dimensions are: O.D.—0.3125″, Length —0.5″ and 0.375″ and 0.562″ respectively. They weigh only 0.15 and 0.30 ounces. Despite small size, each bearing contains three complete ball circuits with each circuit containing 16

600 pounds of missile ... tons of gray matter

The Bullpup, air-to-ground missile by Martin Orlando. Small, light . . . almost dainty compared to some monster missiles. Yet deadly! Fire one . . . mission complete.

That's because of the gray matter . . . tons, if you could measure it . . . poured into the Bullpup by the men of Martin Orlando. Every day these men grab fistfuls of the future . . . engineer it, program it through computers, reduce the data, design hardware, test it . . . and add it to the present.

Working in the finest R&D and production facility, located in sunny Orlando, Florida, these men probe the limits in electronics, propulsion, guidance . . . the complete spectrum of large weapons systems. Martin Orlando's chief asset is gray matter . . . clear, imaginative, experienced thought. And we can always use more. Come . . . and bring your gray matter.

Senior level openings for Electronic Engineers, Physicists, and Electrical Engineers in these design areas: pulse circuitry, electronic packaging, transistor circuitry, production test equipment, digital and analog computer. Opportunities for men experienced in calculating solid state parameters, molecular distribution and quantum mechanics. Send confidential resume to: J. F. Wallace, Director of Professional Staffing, The Martin Company, Orlando 24, Florida.

MARTIN
ORLANDO

A great name in electronics/missiles

balls in the smaller and 17 balls in the larger ball bushing.

Fabrication of precision ball circuits in this miniature size was made possible by the development of special milling techniques, using a 16 to 1 pantograph ratio.

Although small in size, these bushings possess all of the supersensitive characteristics of the larger and heavier instrument quality bushings. In addition, they are said to be extremely rugged in construction and capable of withstanding high vibrational and shock loads. The precision manufacturing techniques, combined with the anti-friction rolling design, assure minimum static and rolling friction together with a high degree of reliability and repeatability.

The miniature bushings consist of three basic parts: an outer sleeve and balls made from stainless steel and a ball retainer made from brass. An alternate material is 52100 chrome bearing steel. All parts are precision machined and then individually inspected for both surface finish and dimensions. Each bearing is also individually tested for sensitivity.

Where required, shafts having a surface finish of 2-4 rms are supplied, individually fitted to bushings to provide clearance of .0001" minimum and .003" maximum. Shaft materials are either stainless steel or 52100.

Circle No. 234 on Subscriber Service Card.

Rocket Shut-off Valve Produced for New ICBM

A six-inch rocket propellant shut-off valve for remote control has been developed for a major ICBM by the **Clary Dynamics Division of Clary Corp.**

The gate valve can be controlled electrically or manually and is designed for pneumatic or hydraulic actuation.

It is designed to operate at –35 to +160°F with a response time of .5 to 1.5 seconds. With minor modifications, the shut-off valve will operate at temperatures of –320 to +250°F.

Leakage rate with upstream fuel pressurization of 12 PSIG is .5 CC's per minute; leakage with downstream air pressurization of 50 PSIG is less than 10 CC's per minute. Maximum operating pressure is 60 PSIG.

The shut-off valve will pass a flow of standard liquid fuels at the rate of 2000 gallons per minute with a pressure drop of .31 PSIG. It weighs 16½ pounds.

Circle No. 235 on Subscriber Service Card.

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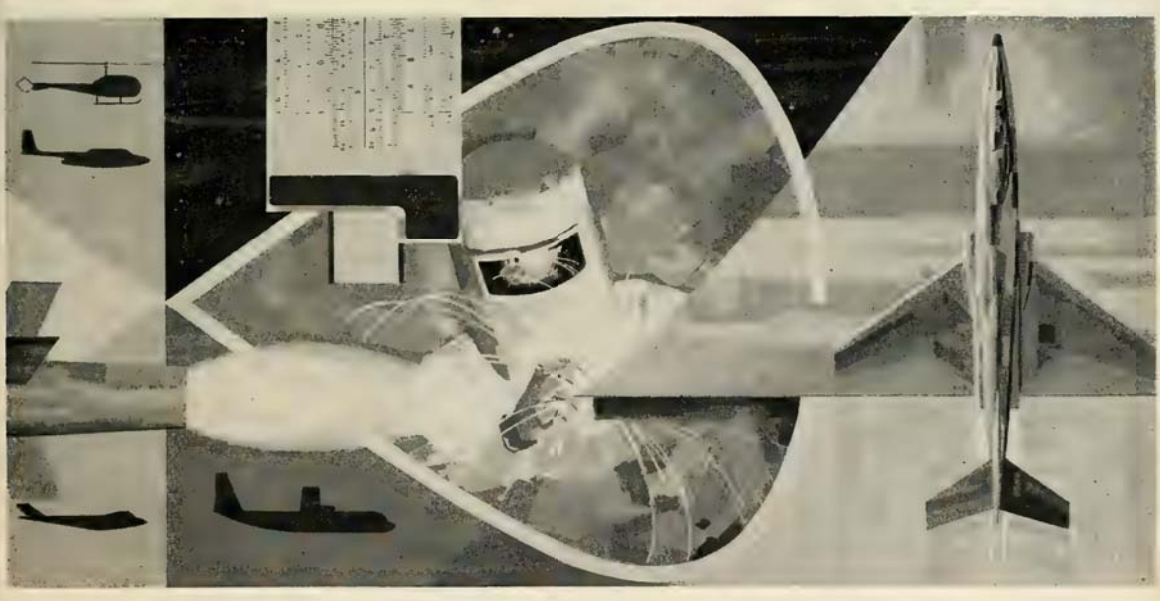
AIRCRAFT-DALLAS

FROM DESIGN
TO PRODUCTION
TEMCO
FOLLOWS THROUGH

Temco is regarded by its customers as a follow-through company . . with solid performance in every aspect of the contract from design to production. We consider it our business to be a partner on the job . . to cooperate willingly, to communicate freely.

Temco follows through by keeping top management and the customer informed on overall progress and program status. It follows through on quality control . . on materials during testing without waiting for a go-ahead on the next move. It naturally follows that Temco delivers a quality product, on schedule, and at the lowest possible cost.

For many years Temco has grown in the fields of subcontracting and aircraft modification. In addition it is rapidly developing its own proprietary products and participating in prime weapons systems development. It has the management, the capabilities, integrated skills and facilities to design, develop and produce for the electronics, aircraft and missile industries. Whether you need a component, subsystem or complete system, team up with Temco . . Temco follows through.



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MODERN WEAPON SYSTEMS

Depend on Reliable Technical Manuals!

Reliability is the key factor stressed more and more in military equipment procurement, especially for components of modern weapon systems. Maintaining equipment reliability in the field requires Technical Manuals of exceptional quality. The thinking of the military on this point is clearly reflected in the following quotation from Specification MIL-M-005474B:

"Modern weapon systems and support equipment represent a vastly increased complexity in equipment, with the result that each manual MUST be, and shall be, engineered as carefully as the equipment which it covers; sufficient time, thought and energy shall be expended to make it so. In sharp contrast with any idea that technical manuals can be a "cheap and dirty" effort in a program involving design and production of costly and complex equipment, a new high standard shall be sought in the development of technical manuals produced to this specification. The cost of operation and maintenance can skyrocket when Service personnel fail to 'get the word,' that is, when they fail to get clearly understandable, well-written and well-illustrated manuals."

We are gratified to note this firm statement of policy since it defines a quality of service and product which is standard with Spruce Co. Each project, large or small, is directed by a publication engineer supported by quality control procedures and complete production facilities. With this approach we are able to consistently produce the accurate, readily understandable and well illustrated technical manuals demanded by the military.

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. . . INFRARED

(Continued from page 33)

other gain stage following the threshold circuit.

Azimuth-position voltage (0.2 vdc/-degree) is derived from a precision potentiometer (see position pickoff, Fig. 2). Elevation sweep, defined by the position of the commutator, is derived from a sawtooth generator circuit. The sawtooth synchronizing signal is from a variable reluctance pickoff. Two pulses per commutator rotation correspond to the two commutation cycles per rotation.

• **Performance**—The calculated sensitivity of CODES is 2 x 10^{-11} watts/-cm^2 for a probability of detection of 80% per frame and a false alarm rate of 10/hr. When testing CODES, the signal from one cell was processed. The system noise equivalent input was observed as 1.6 x 10^{-11} watts/cm^2 in the 1.8 to 2.7 micron band. Then all of the system was operated at a low false alarm rate. For a 50% single-scan probability of detection, a signal of 2 x 10^{-10} watts/cm^2 was required. This corresponds to an S/N for one cell of approximately 12. It can be shown, however, that for low false alarm rates 50% detection probability should be an S/N of 4. Thus the detection capability of the demonstrator compared with one cell is reduced by a factor of 3.

Operational models of CODES, when optimized, will be more compact and lighter. According to Harvey Dubner, manager of Avion's Advanced Development Laboratory, this will be achieved in part by eliminating the rocking plane mirror as the scanning collector. Instead, scanning in future models will be accomplished by rotating or rocking the whole unit. The adaptation will of course vary with application and the vehicle.

• **Corrections**—Measured sensitivity in the demonstrator is correctable by optimizing the optical transmission. Also, the original unit was operated under a limiting condition from a source other than cell noise. A 1-db noise rise was measured between cell bias "on" and "off." Cells are available with improved contour and of improved materials for higher level operation that will increase the usable signal, after commutation, by a factor of 1.7.

In pilot production now, an Avion spokesman said the company will be ready for regular production of operational models in 8 to 12 months. At that time, cost for small quantities will be "under $5,000."

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NEW PRODUCT BRIEFS

ACHINE UNIT. Simplex machine unit rings, constructed to meet low-cost uirements of many applications, e been introduced by Hoover Ball Bearing Company. Designed for t loads at normal speeds, the ma- ne unit includes a single row bear- of deepgroove design with extended er ring, equipped with two set screws locking the bearing on its shaft. parable seals may be used either gly or on both sides of bearing. A e lock ring holds the entire unit se- ely in its straight bore housing. rings are available in shaft sizes n 1/2" through 1-3/16".

le No. 245 on Subscriber Service Card.

NYL CABLE FILTER. Wicoa "No- n" cable filler, developed to replace , cotton or other similar filler ma- als for environmental grade military ctronic cables, has been announced the Wire Co. of America. The filler a flexible rod of fungus-resistant, -hygroscopic vinyl, extruded over a tral core of glass fiber, which pre- ts stretching. It is named "No-Con" ause it is a non-conductor rod and not, in error, be soldered to an ctrical connector. Certified as an ironmental grade material to con- n to specifications MIL-C-915-A and -E-5272A, its operating temperature ge is minus 80°F to plus 200°F. It vailable in a full range of diameters, n .050" to .250" on spools up to 000' continuous lengths.

le No. 246 on Subscriber Service Card.

SELESS POWER SUPPLY. Develop- nt of a 6-36 volt dc at 15 amperes sistorized transient-free power sup- has been announced by Perkin En- eering Corp. Model No. MTR636- is designed for testing transistorized uits where transistor failure occurs the conventional statically-regu- d power supplies due to line and d transients. This unit has a regula- of ±25 millivolts; a ripple of 5 ivolts RMS maximum and dynamic edance of 50 milliohms maximum n O-20KC. No output fuses are re- red due to an automatic current ting circuit which provides overload short circuit protection automatic- . Conservative design within the unit mits operation at 15 amperes with nterrupted service, even in the case a transistor failure. It features mag- ic amplifier regulation for regulation ripple specifications.

le No. 247 on Subscriber Service Card.

UHF CONNECTOR. Edlen Inc. has announced the production of a new UHF connector, designated the Crimpee CR-8-UF. The connector is a 50 OHM matched fitting which requires no soldering, eliminating the problem of melted dielectric. The outer shell makes positive 360° contact with the cable braid. The connector is compatible with all existing connectors, and will fit the SO-239 socket. Mechanically strong, the cable braid will break before the connector pulls apart. The insulator is made of teflon, and the other parts are silver plated brass.

Circle No. 248 on Subscriber Service Card.

DIGITAL VOLTMETER. An all-electronic digital voltmeter, capable of making 50 measurements per second, is now being marketed by Electro Instruments Inc. The four-digit model 8409 features totally transistorized logic circuits; ± digit accuracy; automatic polarity; automatic, manual and remote ranging; 1000 meg ohm input impedance; BCD and decimal output; direct printer operation; provision for external reference voltage; and modular construction throughout.

Circle No. 249 on Subscriber Service Card.

CURVE TRACER. A transistor curve tracer for engineering, training, production and servicing applications has been developed by the Inter-Mountain Instruments Branch of Curtiss-Wright Corp.'s Electronics Div. Known as model TCT-2, the instrument can display either one curve or a five curve family. The V_c and I_c waves are directly calibrated. It displays collector voltage-collector current (output) curves for common emitter or common base connection. The tracer is designed for use with any standard DC oscilloscope with single presentation possible with any standard AC oscilloscope. Another feature of the transistor curve tracer is that emitter-base voltage for selected input currents may be measured by using an external DC meter to characterize points on the input curve.

Circle No. 250 on Subscriber Service Card.

DELAY LINE. Control Electronics Co. has developed a compact lag-type delay line for use with signals in the sonic frequency range. Known as the F344, this lag type delay line has an impedance of 1100 ohms, a band width of 15 kcs and a total delay of 76 microseconds.

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• • New Missile Products

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MISSILE LITERATURE

PRINTED CIRCUITS. A booklet on "Reliability and Cost in Printed Circuits" has recently been issued by the Arthur Ansley Manufacturing Co. It discusses the relationship between various factors affecting both cost and reliability and points out that the proper printed circuit design may simultaneously cut overall cost and increase reliability. The greater care needed to manufacture high reliability printed circuits does of course, increase initial cost, but in military and industrial electronic equipment this increase is well justified.
Circle No. 200 on Subscriber Service Card.

FORGING. The Cameron Iron Works has released a brochure describing its plant and the scope of its forging development. The brochure depicts Cameron facilities for forging high densite steels into jet engine components; stainless steels into nuclear reactors, jet engines and steam power components, and high-quality alloy steels into short-lived missile components.
Circle No. 201 on Subscriber Service Card.

ACTUATORS. A 15-page booklet describing linear and rotary hydraulic servo actuators, is offered by the Dalmo Victor Co. These units are designed for use in applications requiring wide dynamics speed range and high-frequency response performance. Booklet includes design and flow requirements needed to meet specified servo loop performance figures.
Circle No. 202 on Subscriber Service Card.

MAGNETIC SERVOS. An eight-page color brochure entitled, "High Power Transistor Magnetic Servo Amplifiers," has been published by Magnetic Amplifiers, Inc. Illustrated with photographs, diagrams and charts, the booklet, designated Bulletin S-961, describes the manufacturer's "Advanced Design 'B' Line" of servo amplifiers built for industrial and military use. Applications cover power control for such varied equipment as automated milling machines, lathes, jig boring machines, camera and light positioning systems, computers, optical tracking systems, inertial platforms and radar antenna positioning systems. Technical data deals with 1 to 4 stage systems, utilizing AC or DC inputs with transistor-magnetic or all magnetic configurations for 60 and 400 cycle per second systems. Detailed engineering and performance specifications are given for each system.
Circle No. 203 on Subscriber Service Card.

STATISTICS. A new and expanded 1959 edition of EIA's statistical series on the electronics industry is now available. New areas added include statistics and products in the consumer area, a complete electronics industrial products dossier, and military electronics data covering aircraft, missilery, and government expenditures. Copies of the 5th annual "Fact Book" for 1959 prepared by the EIA Marketing Data Department are available to non-EIA members for 75 cents.
Circle No. 204 on Subscriber Service Card.

TELEMETRY. A reference bulletin to engineers in planning telemetry rece ing systems has been issued by Te Dynamics Inc. The miniature FM Te metry Receiving Systems Bulletin ill trates typical systems and describes dividual TDI building-block componen receivers, subcarrier discriminators, m ter controls, record-monitor-mixers, po supplies, and pre-wired mounts. Descr tions also cover the widely used TDI commutation Set and Tape Error Co pensation System. The bulletin goes i detailed examples of systems for rece ing FM/FM, PAM/FM/FM, PDM/FN FM signals.
Circle No. 205 on Subscriber Service Ca

PULSE TRANSFORMERS. A new te nical bulletin describing the P Ser miniature encapsulated pulse tra formers, designed especially for print circuit and automatic assembly appli tions, has just been published by Te nitrol Engineering Co. The P Series wound on high-permeability ferrom netic cores, resulting in a transforn design with a high pulse-width to ri time ratio. The units are available in number of case styles with a range pulse widths from 0.05 to 10 mic seconds for either vacuum tube or tr sistor applications. The small height the transformer case and special pin rangements make them particularly su able for printed circuit boards, while guide key on the side of the ca which fits cylindrical feed devices, ma the transformers ideal for producti runs using automatic assembly machin
Circle No. 206 on Subscriber Service Ca

ANTENNAS. A revised and expand second edition of the "I-T-E Anten Handbook" has just been published. T I-T-E Circuit Breaker Co. has writt strictly for the antenna systems en neer. This small book provides curves estimating antenna performance and t physical characteristics required achieve a particular antenna perfor ance. It should be particularly valuab to those in the fields of radar a microwave communications.
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TITANIUM. A brochure on titanium h been published by Harvey Aluminu The 36-page booklet is intended as reference for engineers, metallurgis and designers. A section on how tanium is made discusses in detail co version of the basis ore into sponge a melting of sponge into ingot form. T publication also describes advantages titanium covering strength and weig high-temperature performance, fatig strength, corrosion resistance, erosi resistance, and thermal properties. rating chart outlines corrosion properti of the metal and specifications a characteristics of the various titaniu alloys.
Circle No. 208 on Subscriber Service Ca

SILICON. A catalogue outlining t production techniques and various typ of silicon diodes and transistors h been released by the Semiconduct Division of the Sperry Rand Corp.
Circle No. 209 on Subscriber Service Car

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- Provision for external reference voltage

Plus accessory modules for every application

AC: All transistorized Model 110; considerably faster AC/DC conversion than presently available models. Fully automatic ranging and direct AC voltage readout on the Model 8409.

Ohmmeter: All transistorized Model KIM-000. Provides constant current through test resistor with negligible power dissipation. Voltage measurements made across resistor and read out directly in ohms with fully automatic ranging.

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