JUNE, 1958

missiles and rockets

INCLUDING MISSILE ELECTRONICS

MAGAZINE OF WORLD ASTRONAUTICS

This Issue: MISSILE OPTICS AND TELEMETRY

Hydro-Aire's two fresh slices of solid-state power supplies:

a DC to DC power supply (we call it the "DYNASTAT") and an AC voltage regulator. Made to be airborne—and already ordered for two advanced new missile systems—these avionic units are based on radically new circuitry with no moving parts, no tubes or other glassware, no components of questionable reliability. Naturally, they are smaller and lighter than conventional devices. They are also more efficient, longer lasting and simply foolproof. Read the descriptions. Then, let us show you how to slice them to your requirements.

AC VOLTAGE REGULATOR— Provides constant voltage output for alternating current source ±1% over ±10% changes in input voltage, and zero to 100% load changes. 95% efficient. Less than 2% waveform distortion. Can be provided for single, two or three-phase, power to 3 KVA for any frequency—60 cps to 1600 cps. Temperature range: —54 deg. C. to +125 deg. C. Response time: less than 50 milliseconds. Typical example: 450 VA, 3 phase average sensing unit that weighs 5.5 pounds and has volume of 75 cubic inches.

DC to DC POWER SUPPLY (DYNASTAT)— Output available from 5 to 15,000 volts with power output to 2 KW and voltage regulation to 0.1% over much of this range. 70% efficiency. Input 28V D.C. 10%. Temperature range: —54 deg. C. to +71 deg. C. for high power units, and to +120 deg. C. for lower powers.

HYDRO-AIRE
BURBANK, CALIFORNIA

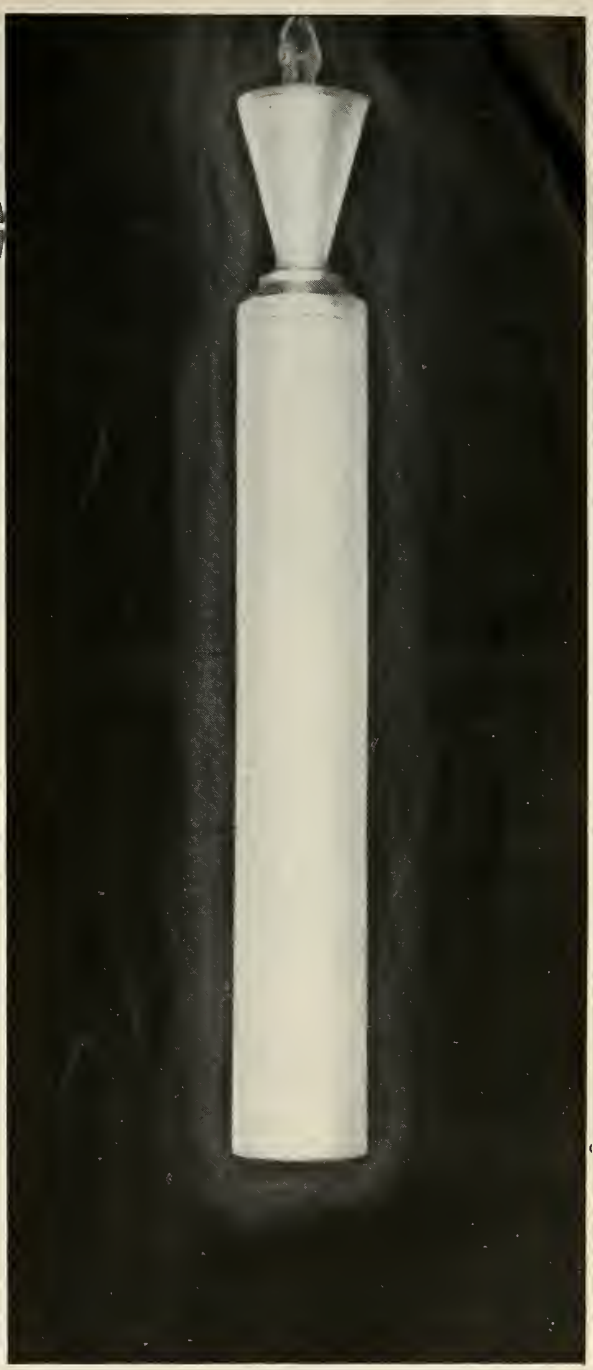
Anti-Skid Braking Systems • Fuel System Controls • Pneumatic Controls • Actuation Systems Electronic Devices

Producing Controls for Every Basic Airborne System

Circle No. 28 on Subscriber Service Card.

SPAWNING GROUND

for a rocket's fury



By the time you read this message, the large rocket motor case shown here—white-hot from heat treating—will be standing ready, loaded with solid propellant, poised to rush a guided missile skyward.

Once it has been triggered into action, this rocket will generate 3500° F. heat—be called upon to withstand pressures of 1200 pounds per square inch—and the thrust from its nozzle will be equal to the power of 50 Diesel locomotives acting in unison.

Spawning such rockets calls for some real engineering—of a type not surpassed anywhere outside of Goodyear Aircraft Corporation.

Two interesting facts bear this out:

(1) Goodyear Aircraft has produced more large-size rocket cases than any other manufacturer—possibly more than all combined.

(2) Goodyear Aircraft maintains one of the largest facilities available in this country for this exacting production. And these facilities are currently completing a huge expansion.

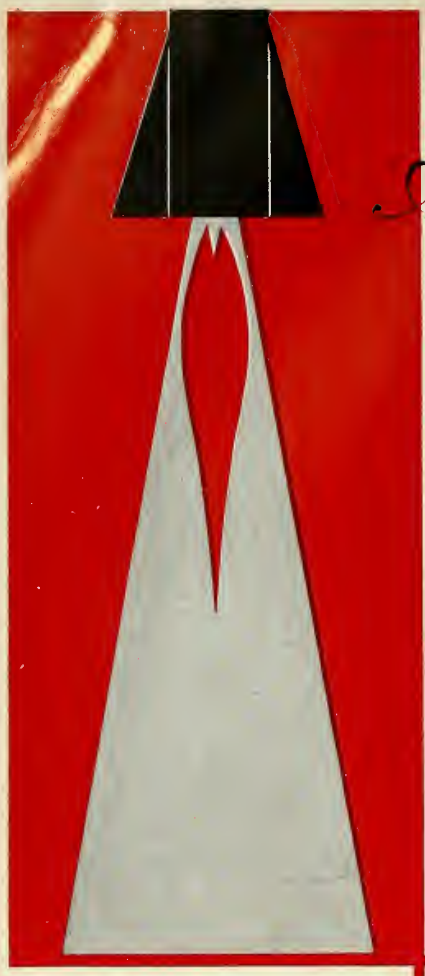
Fact is, Goodyear Aircraft developed the basic design concept which made these large lightweight rockets possible—engineering which slashed the weight of the cases up to 50%.

Summary:

Pioneer skills, vast and varied experience, complete facilities and ready availability make Goodyear Aircraft the surest thing in rockets. Write: Goodyear Aircraft Corporation, Dept. 916PR, Akron 15, Ohio.

GOODYEAR AIRCRAFT

Plants in Akron, Ohio, and Litchfield Park, Arizona



Announcing a specialized

MISSILE SUPPORT SERVICE

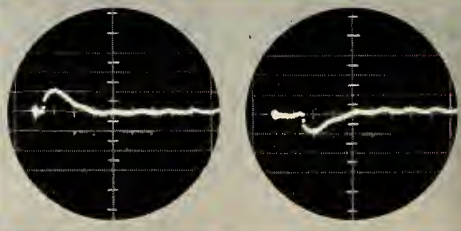
You worry about the missile... let Packard Bell Electronics take care of ground support! Proven performance in this field has resulted in a separate missile equipment section devoted exclusively to ground test and launching equipment. Here, in a 21,500 sq. ft. facility geared for short run production, experienced management shoulders complete responsibility. Here the most radical design changes are absorbed during the process of development. Here direct assembly supervision by production engineers eliminates costly and time-consuming delays. A reliable source, any way you look at it. And a reliable way to rid yourself of a major headache!

ENGINEERING BEYOND THE EXPECTED

DESIGN—When time dictates, available equipment can be adapted to your specifications. But you receive custom design, *beyond the expected*, when you need it. For example, the transistorized MAGAMP power supply (right). This unit provides a faster response time... a lower overshoot and undershoot... and remote regulation at longer distances than has ever been achieved before with this type of power supply.

DELIVERY—A contract from Douglas Aircraft for "Thor" test equipment was awarded in March 1956. A total of 100 units, comprising 30 different units, was delivered before deadline in November. On-time delivery at its best... delivery *beyond the expected.*

This transistorized MAGAMP power supply delivers a 27V to 42V output at 0 to 300 amperes, *regulated at a load up to several hundred feet away.*



The MAGAMP has a surge capacity of 400% overload for 2 seconds. Regulation at the load is 1% or better. Recovery time is less than 50 milliseconds. Overshoot and undershoot are less than 25%, with a 30% change in load. (Scale in above photos: 5V/CM and 10MS/CM.)

PACKARD BELL ELECTRONICS
Missile Equipment Section
Technical Products Division
12333 W. Olympic Blvd.
Los Angeles 64, Calif. · BRadshaw 2-2171

missiles and rockets

Magazine of World Astronautics

1001 Vermont Ave., N.W., Washington 5, D.C. Tel. STerling 3-5400

missiles and rockets Vol. 3, No. 7, June, 1958

Published every month by American Aviation Publications, Inc., 1001 Vermont Ave., N.W., Washington 5, D.C. Printed at the Telegraph Press, Harrisburg, Pa.

Executive, Editorial, Circulation Offices: 1001 Vermont Ave., N.W., Washington, D.C. WAYNE W. PARRISH, President & Publisher; LEONARD EISERER, General Manager; C. A. HURT, Assistant Publisher; LAWRENCE BRETTNER, Circulation Director.

Subscription rates: U.S. and Canada—1 year, $8.00; 2 years, $12.00; 3 years, $14.00. Foreign—1 year, $9.00; 2 years, $14.00; 3 years, $17.00. Single copy rate—$.75. Subscriptions are solicited only from persons with identifiable commercial or professional interests in missiles and rockets. All subscription orders and changes of address should be referred to: FRANK R. WILLIAMS, circulation fulfillment manager. Second class mail privileges authorized at Washington, D.C., with additional entry at Harrisburg. Copyright 1958, American Aviation Publications, Inc.

Member, Audit Bureau of Circulations and Associated Business Publications, Inc.

this issue: Missile Optics and Telemetry

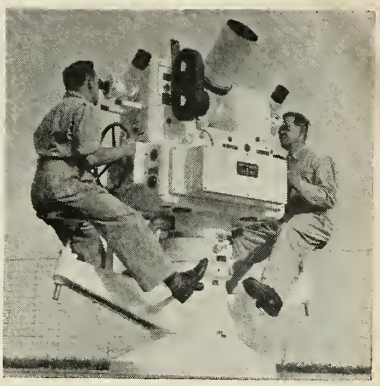
news and trends

special features

next issue:

The first of m/r's weekly issues—the News and Business edition—will be in the hands of subscribers by July 7. On July 14, readers will receive the first Engineering and Electronics edition.

cover picture:



The missile and space era has developed many new applications for optical precision instruments. In addition to improving existing designs, the optical industry, both here and abroad, has created a series of ultra-precision instruments. These instruments will aid the U.S. missile industry and military in their efforts to evaluate and improve the performance of ballistic missiles and satellite-carrying vehicles. A typical example is the EOTS (Electronic Optical Tracking System) cine-theodolite shown in the above photograph. Designed and manufactured by Contraves AG of Zurich, Switzerland, many units are now installed in military tracking stations in the U.S., with several more scheduled for future installation. (See p. 122).

columns

departments

Every Job is an Interesting Job at DIVERSEY!

Above you see a recent one. It is a high pressure accumulator for a missile being finish machined by a Diversey craftsman. It's a tough alloy steel and the job requires closely controlled tolerances.

What makes this job interesting and significant to you is that Diversey can take a forging, run it through automatic contour turning operations, and finally apply the expert finish machining being done above.

Diversey does outstanding work in missile metal machining because they have the finest machinists, the largest facilities, and alert, capable, and progressive technical people. Bring your interesting and tough jobs to Diversey.

SEND FOR FREE BOOKLET

LEADERS IN CONTOUR MACHINING

Diversey ENGINEERING COMPANY

10550 WEST ANDERSON PLACE
FRANKLIN PARK, ILLINOIS • *A Suburb of Chicago*

FROM NOSE TO NOZZLE, FROM FIN TO FIN, CONTOUR TURNED PARTS—WITH PRECISION BUILT IN

The Fourth Element

It took this country thirty-five years to get an Air Force. Since the first World War, air defense was a stepchild of the U.S. Army—an almost unbelievable approach for the most advanced country in the world. In many ways this concept cost the United States billions of dollars in unnecessary expenditures. It tied American aviation to strictly earthbound methods and principles and often to very restricted and inhibited thinking, research and development.

Are we about to repeat this shortsighted approach to building our Space Force? Tying spacepower to airpower, or to land or seapower, cannot be justified because of any historic, industrial or military reason. We have the spectacle of all three services scrambling to take over the space power capability, while simultaneously—in many quarters—pooh-poohing it. Development of a true space capability, in ballistic missiles, satellites, and beyond, has been delayed years by earthbound, seabound, or airbound thinking. This thinking has made the most common word for satellite a Russian one. It has made us come out second best in the race for long-range ballistic missiles. Now, many of the foremost foot draggers are emerging as space champions in shining armor—we wonder for how long.

The fact is, however, that a new concept and a new industry, the space systems industry, is rapidly arising, and it appears that government must organize in the same way. We must and will have a U.S. Space Force. The only question is whether we are going to have to fight the battle for thirty five years, as did the airpower advocates, or can we be a little wiser and more forward looking this time and do it now? Do the Air Force advocates remember what it took to set up a separate Air Force?

Of this we are morally certain: the squabbling over this new infant will not cease, nor will the baby grow to healthy maturity until he is recognized as a new individual and not regarded merely an excrescence on an existing adult.

Traditionally we have classified our services according to the medium in or on which they operate, although it took many years for airpower to gain co-equal status with land and seapower. We are repeating the same error that hogtied airpower for many years—and some of the greatest airpower proponents are aiding and abetting this action—to their everlasting discredit. To argue that spacepower is merely an extension of airpower is to ignore the facts.

Likewise, to force a shotgun wedding between the National Advisory Committee for Aeronautics and a National Space Flight Agency is, in our opinion, an even greater error than to perpetuate the existing division of space weapons among the three traditional services.

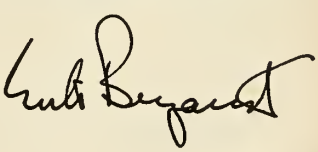
The NACA is an excellent organization that has made invaluable contributions to the growth of American aviation, but only a minor fraction of its facilities have any significant utility in advancing the new science of astronautics.

The most likely outcome of a merger of missions would be to place *aeronautical* experts in charge of *astronautical* development. Seniority considerations would make such an outcome almost inevitable. The more experienced people are more experienced in air science, not space science, since the latter is in itself young. To expect that the appropriation pie would then be cut to give *astronautics* a fair share, when *aeronautical* people are doing the cutting, would be naive in the extreme. It would be just as naive to expect men whose entire careers have been spent studying the problems of aeronautics, to take bold action in the area of astronautics.

True, to some extent the NACA can contribute to the advancement of astronautics, but so can many other research organizations, civilian and military. This know-how must be pooled under a separate, co-equal civil space agency.

The men of the air age should not presume omniscience in this new area they have so recently embraced. Nor do the middle bracket air scientists have to assume the cloth of spacemen to insure their livelihood. We shall still need better aircraft for many years to come.

There are many things that need to be learned and done in the area of non-military astronautics. Let us place direction and execution of this work in the hands of experienced space scientists, unhampered by inbred aeronautical bias.



when and where

JUNE

IAS, AIEE, ISA, National Telemetering Conference, Lord Baltimore Hotel, Baltimore, Md., June 2-4.

First National Guided Missile Industry Conference, Mayflower Hotel, Wash., D.C., June 4-6 (Robert H. Goddard Memorial Dinner, June 6).

Armed Forces Communication and Electronics Assn. Convention, Sheraton-Carlton Hotel, Wash., D.C., June 4-6.

IRE Second National Symposium on Production Techniques, Hotel New Yorker, N.Y., N.Y., June 5-6.

American Rocket Society, Semi-annual Meeting, Hotel Statler, Los Angeles, Calif., June 8-11.

Fourth International Automation Exposition and Congress, New York Coliseum, June 9-13.

Military Electronics, Second National Convention, Wash., D.C., June 16-18.

American Institute of Chemical Engineers, 50th Anniversary Meeting, Phila., Pa., June 22-27.

Special Summer Program on Random Vibration, an introduction to the vibration problem in missiles, and jet aircraft, Massachusetts Institute of Technology, Cambridge, Mass., June 23-July 3.

AIEE, Air Transportation Conference, Statler Hotel, Buffalo, N.Y., June 25-27.

Industry Missile & Space Age Conference, Aero Club of Michigan, Hotel Statler, Detroit, Mich., June 30-July 1.

JULY

IAS National Summer Meeting, Ambassador Hotel, Los Angeles, Calif., July 8-11.

NACA Ames Aeronautical Laboratory, Triennial Inspection, Moffett Field, Calif., July 14-15.

Fifth Annual Symposium on Computers and Data Processing, Albany Hotel, Denver, Colo., July 24-25.

Third Annual Exhiborama, Society of Photographic Instrumentation Engineers, Second Annual Symposium, Statler Hotel, Los Angeles, Calif., July 29-31.

AUGUST

AIEE, IRE, NBS, Conference on Electronic Standards and Measurements, National Bureau of Standards Boulder Laboratories, Boulder, Colo., Aug. 13-15.

ASME, A. I. Ch. E. Conference, Northwestern University, Evanston, Ill., Aug. 18-21.

WHERE THERE MUST BE NO METAL FAILURES . . .
USE AIRCRAFT QUALITY STEELS* FROM

Acme-Newport

**Plate, sheet and strip in alloy and carbon grades*

America permits no second guessing about her defense weapons. So prime and subcontractors specify Acme-Newport aircraft quality steels for vital plane parts, guided missiles and Jatos. Uniform quality and proper response to heat treatment are essential characteristics of this mill's alloys and carbons, including chrome-molybdenum AISI 4130 type. Physical fitness for military service qualifies Acme-Newport plate, sheet and strip for all commercial applications too. Technical knowledge, 71 years' experience, convenient location and modern facilities and methods make this your logical source for chemically accurate steels.

Acme-Newport Steel COMPANY

NEWPORT, KENTUCKY

A SUBSIDIARY OF ACME STEEL COMPANY

Circle No. 32 on Subscriber Service Card.

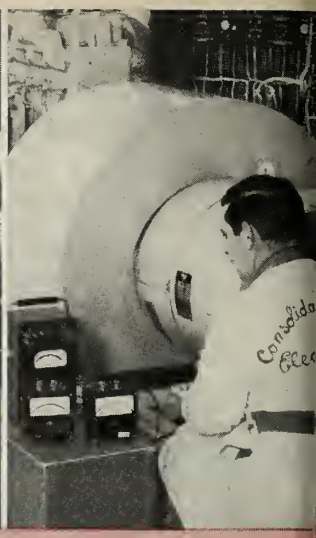
in GROUND SUPPORT CONDIESEL

COMPETENCE serves the INDUSTRY'S NEEDS

This amazingly broad one-source resource for solutions to specific problems is comprised of specialist groups. Each has its own facility and products . . . all enjoy the advantage of reciprocal stimulus through careful interchange of research, engineering and production ideas.

Adroit handling of any customer needs . . . and anticipation of "tomorrow's" problems . . . have resulted in the availability for the military and industry of a composite experience of specialist skills in providing components, products and sub-systems for missiles and aircraft . . . submarines, too.

And, of great importance to YOU . . . are those probing, ingenious minds at Condiesel and their abilities, based upon experience, to bring your problem quickly into sharp focus . . . design the answer deftly . . . produce it honestly . . . deliver it on time.



AIRCRAFT EQUIPMENT DIVISION

Stamford, Connecticut

Condiesel has provided more aircraft and missile ground support in variety and quantity than any other manufacturer. Sophisticated support equipment is this division's specialization.

Products Include:

Aircraft Support
- Electric
- Hydraulic
- Pneumatic

Missile Support
- Testing
- Fueling
- Handling
- Launching

POWER EQUIPMENT DIVISION

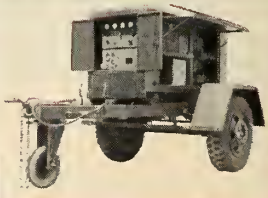
Stamford, Connecticut

Over 15,000 Condiesel power generating units serve every branch of the armed forces. Manufactured in every type and size, these units provide precise electric power wherever required. Typical: Dewline, Matador, Regulus, IGY.

Products Include:
- Uninterrupted Power Supply Units
- Fire Fighting Vehicles
- Diesel and Gasoline Engine Generator Sets
- Pumps and Compressors
- Switchgear

CONDIESEL COMPETENCE is your Competitive Answer

U.S.A.F. multi-purpose unit



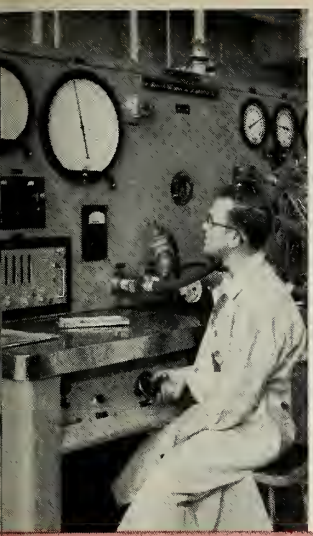
U.S.M.C. Power Supply

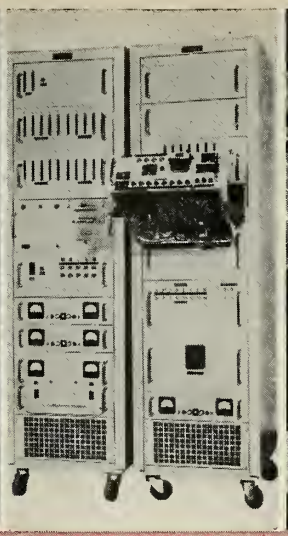
We welcome the opportunity as a sub-system, and

CONSOLIDATED DIESEL

EXECUTIVE OFFICES

CANADIAN OFFICE





TEST EQUIPMENT DIVISION

Stamford, Connecticut

Test equipment for the manufacture and support of missiles and aircraft. Condiesel designed and built equipment is used by Hamilton Standard, Allison, Holly, T.W.A., Pan American ... and in support of Matador, Regulus, Lacrosse.

Products Include:

- High temperature, high pressure hydraulic and fuel control test facilities
- Hydraulic, pneumatic test stands
- Missile power packs

CONSOLIDATED AVIONICS CORPORATION

Westbury, L. I., N. Y.

At Con Avionics, advanced electronic capabilities produce a broad range of electronic systems. Typical is the automatic digital computer check-out equipment for the inertial guidance computer of the "Titan" ICBM.

Products Include:

- Data reduction systems
- Aircraft and missile flight test instrumentation
- Automatic test and control systems
- Power supplies

LIMA ELECTRIC MOTOR CO.

Lima, Ohio

Over a quarter century of building standard and special rotating electrical machinery to NEMA, JIC and UL standards. Backed by over 300 nation-wide sales and service stations.

Products Include:

- Drip-proof, totally enclosed, explosion-proof motors, from 1 to 150 horsepower.
- Motor generator sets
- Lima selective speed drives
- Integral gearhead motors

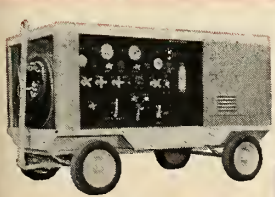
CONSOLIDATED CONTROLS CORP.

Bethel, Connecticut
Inglewood, California

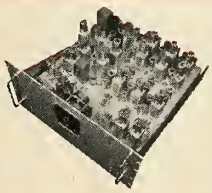
Development and manufacture fuel control systems, and components, temperature and pressure control devices for missiles and aircraft... Typical: B-58 Hustler nose wheel steering system ... J-79 fuel control components.

Products Include:

- Pressure and thermal switches
- Airborne controls ... hydraulic, pneumatic and electronic
- Temperature sensing devices
- Nuclear control systems

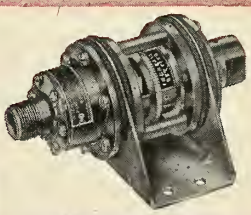


Hydraulic Stand



Computer Test Drawer

Motor Generator Set



Pressure Switches

component manufacturer of assisting you in preparation of your complete weapons system proposals.

ELECTRIC CORPORATION

LUDLOW AND CANAL STREETS, STAMFORD, CONNECTICUT

C. D. E. C. OF CANADA LTD., REXDALE, TORONTO, ONTARIO

letters

Free Radical System

To the Editor:

In reference to the article "How Good Are Free Radicals?" (m/r March, p. 78), I should like to mention several discrepancies.

The specific impulse (sec) of H is listed as 2160, whereas it should be about 1400, shifting, or about 1200, frozen.

The figures given for He* are incorrect (Table III). These figures are actually for %'s He* *one-tenth* of those shown. In other words, He* has a specific impulse (sec) of about 800 at 10%, rather than 100% He* in He. 100% He* will have a specific impulse of over 2,000 $\frac{\text{lb. (F)-sec.}}{\text{lb. (M)}}$

Hence the performance potential of He* is much greater than your figures would indicate.

Dr. G. C. Szego
Supervisor-Thermodynamics
Applied Rocket Research,
Rocket Engine Section
General Electric Co.
Cincinnati 15, Ohio

In answer to the specific impulse of H, the data was obtained from Aerojet and represents a theoretical value (limiting.) You are correct that in Table III, the helium column, should have read 10% mol He in He. This means the concentration at night would be 0.1 of stated value. This is for He only—Ed.*

Tantalum Availability

To the Editor:

In the article "Materials Build a New Technology" (m/r March, p. 91), there are some misstatements which should be corrected:

The author (W. C. Rous, Jr.) shows the availability of tantalum as "Gen. avail. limited quantity" (current status), "Unpredictable; critical material" (probable future status), "Performance good, avail. unpredictable" (potential development).

Mr. Rous also states that "Tungsten, tantalum and rhenium all have very high density and high temperature resistance. They are very scarce, are difficult to produce in specific shapes and their future development is unpredictable."

Later in the article, however, Mr. Rous appears to contradict himself when he states that "molybdenum, tantalum, tungsten and columbium (niobium) are the most feasible metals for development as elevated structural materials on the basis of melting point, availability, price and vapor pressure."

What we object to specifically is the implication that tantalum is "very scarce", that its availability is "limited" or "unpredictable."

While it is true that during 1956-57, the demand for certain forms of tantalum (notably the materials used in tantalum capacitors) exceeded our production capacity, we do not know of a single project which has been delayed or abandoned because of a lack of tantalum. We have just completed a plant in Muskogee, Oklahoma, which will add 50% to our tantalum-producing capacity.

According to a recent news article, "Figures on tantalum refining are guarded, but refinery output has probably more than doubled in the past six months. The major supplier has upped his capacity by 50%. Another refiner reportedly is able to produce as much as the total supply of a year ago. And, it is learned, there are four new sources."

Allan L. Percy
Director of Public Relations
Fansteel Metallurgical Corp.
Chicago, Ill.

The information regarding the availability of tantalum was gathered in the fall of '56, about the time (as Mr. Percy verifies) demand for certain forms of tantalum was temporarily exceeding production. This implied that the current supply was "generally available in limited quantity", and that if a national emergency arose at the same time as tantalum sheet were desired in advance type aircraft, the future supply would be "unpredictable."

Referring to tungsten, tantalum and rhenium characteristics, a misleading statement would have been eliminated if the following had been stated:

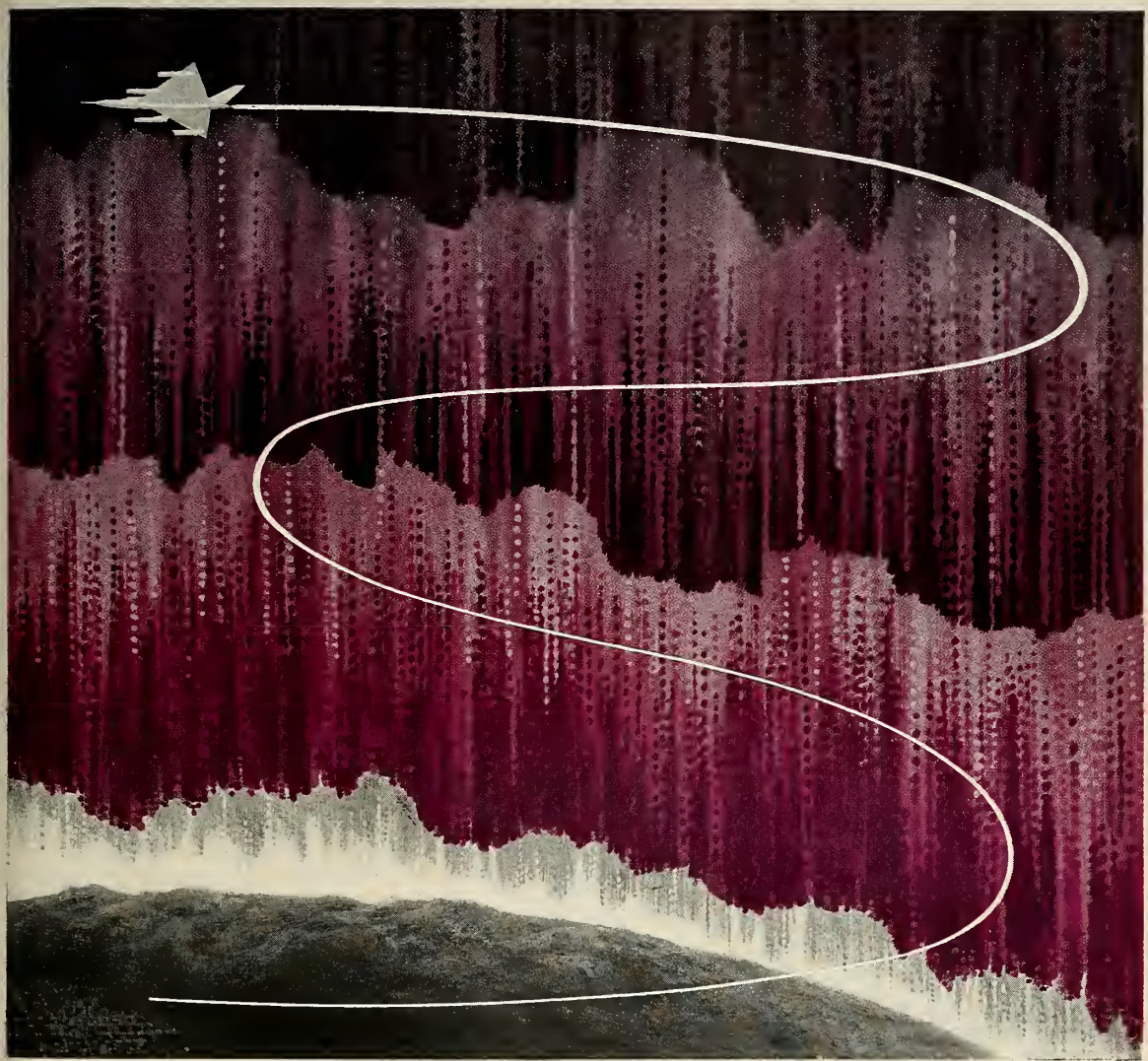
"Rhenium is very scarce. Tungsten, and to a lesser degree, tantalum, is difficult to produce in large sheets. Development of sufficient sized sheet production by such methods as compacting and densifying fiber metals is a possibility. However, future airframe use on this basis is unpredictable."

I believe we all agree to the statement regarding the status of molybdenum, tantalum, tungsten, and columbium (niobium).—W. C. Rous, Jr.

Brass Indifferent?

To the Editor:

I recently heard a newscast that the Navy had successfully launched a *Subroc* missile, and I tried to find out more



New extreme-high-temperature lubricants for missiles and supersonic aircraft **SHELL ETR GREASES**

One of the serious lubricating problems faced by designers of missiles and supersonic aircraft has been solved by scientists at Shell Research Laboratories.

The problem: to find a grease which would permit components to operate with certainty under extreme high temperatures. Co-operation with representatives of bearing manufacturers and military personnel resulted in a completely new class of greases—SHELL ETR GREASES.

These greases can easily withstand temperatures up to 600°F. They give superior lubricating performance because of a special thickener—an organic vat dye—which has exceptional heat stability and jelling efficiency.

If you are presently in the market for an ultra-high-temperature-range grease, we will be glad to provide more information on Shell ETR Greases.

SHELL OIL COMPANY

50 West 50th Street, New York 20, N.Y.
100 Bush Street, San Francisco 6, Calif.

SHELL

. . . letters

information on the subject. The local Navy office recommended reading "quite an article" on *Subroc* in your April issue. ("Navy Pushing New Underwater *Subroc* Missile", p. 37.)

I also want to commend you on the editorial "We're Falling Behind Again" (m/r April, p. 9).

It's pretty disconcerting to talk to people, presumably knowledgeable, day after day and encounter little other than indifference or stupidity on the subject of nuclear propulsion of missiles. In talking to high brass, some savvy on the subject is detectable, but mostly none. If this is the official attitude of that branch of the Armed Forces charged with "massive retaliation", no wonder Pentagon re-organization is in order.

Giles S. Crosse
17 Mann Avenue
Fairborn, Ohio

Glad to have such agreement with our viewpoint. Our opinions are strong on this matter, too . . . Ed.

Titanium Strength

To the Editor:

In the excellent "1958 Missile Materials Review" (m/r March, p. 69), we feel that Table III gave a rather unfortunate comparison between titanium and other materials of construction.

Titanium alloy strength is listed in the table as 90,000 psi, which would be approximately correct for unalloyed titanium used today by the airframe industry. However, some of the alloys in use by the airframe and jet engine people range in strength from 120-160,000 psi, which would make titanium appear considerably better.

Actually, the alloys which we are recommending for missile applications would be heat treated to a strength of 190,000 psi. In some cases where ductility is not a major factor, we believe these alloys can be successfully heat treated to 205,000 psi ultimate tensile.

Excepting the more conservative figure of 190,000 psi, this would change the strength density ratio to 1,170,000. As you can see, this is considerably better than the present glass plastic values and very close to the value given for future glass plastics.

R. C. Durstein
Assistant Product Manager
Crucible Steel Co. of America
Midland Works, Titanium Div.
Midland, Pa.

Thanks for the clarification. Other readers will also welcome it . . . Ed.

AEROJET-GENERAL CORP.

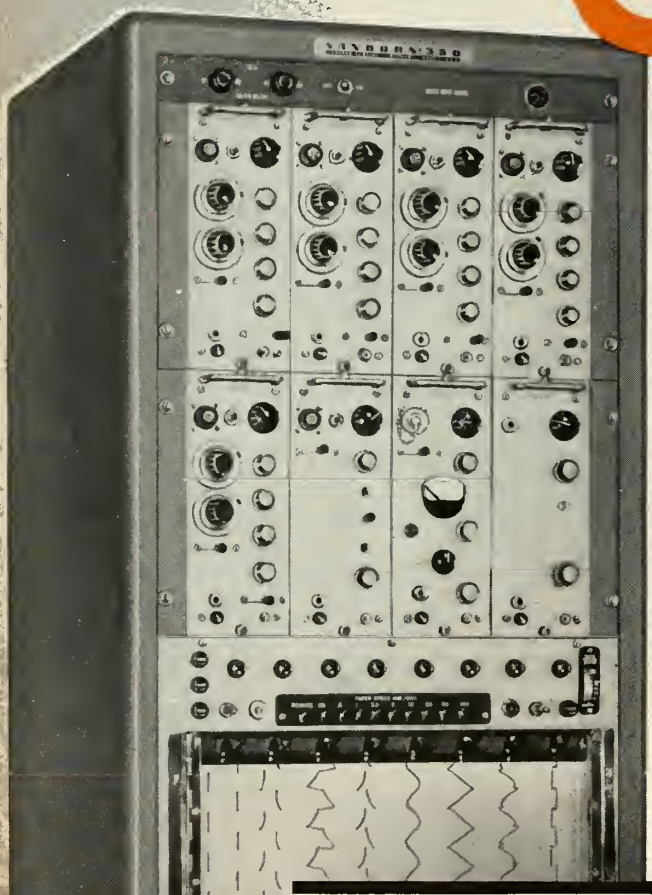
THE GENERAL TIRE

A SUBSIDIARY OF THE GENERAL TIRE & RUBBER COMPANY

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

only one direct writer

...THE NEW SANBORN 350



6- OR 8-CHANNEL OSCILLOGRAPHIC RECORDING SYSTEM

6- OR 8-CHANNEL SYSTEM IN ONE CABINET

Each module of four Preamplifiers takes only 10½" of panel space, complete Recorder-Power Amplifier package only 17½". All controls are on front panel. Total panel space, including ventilating fan and master power panel, 49". Entire system normally installed in one cabinet 22" x 22" x 73¾", to place recorder and controls at convenient height.

FREQUENCY RESPONSE TO 120 CPS

Essentially flat from 0 to 100 cps at 10-division amplitude peak-to-peak, 3 db down at 120 cycles. Built-in pre-emphasis circuit in Power Amplifier.

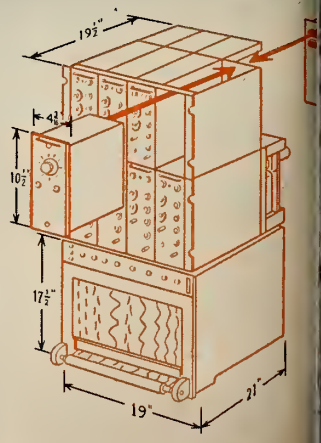
HEAVY CURRENT FEEDBACK, TRANSISTORIZED POWER AMPLIFIERS

Long term drift less than 0.2 div. over 20°C. changes, short term less than 0.1 div. for 24 volt line voltage changes. Response time 4 ms. In-phase rejection ratio 100:1. Gain stability better than 1% with 20°C. and 20 volt changes.

LINEARITY: 0.2 DIVISION OVER ENTIRE 50 DIV. CHART WIDTH

This is the new Sanborn "350" — today's most comprehensive answer to *combined* improved performance, versatility and reliability in an oscillographic recording system of compact size. First *compare* all the "350" design and performance improvements . . . then consider *the many ways they can help you* do *more kinds* of measurement and recording, with *more* accuracy, speed, convenience and reliability.

Experienced sales-engineering representatives in all principal cities. Call the one near you for complete "350" facts.



gives you all these features

INTERCHANGEABLE PREAMPLIFIERS WITH INDIVIDUAL POWER SUPPLIES

Compact, plug-in units with 4 3/16" x 10 1/2" panels. Present types include Carrier, Servo Monitor (demodulator), DC Coupling, True Differential DC. Can be used separately for driving optical oscillographs, 'scopes, tape recorders, etc.

LIMITER CIRCUIT AHEAD OF POWER AMPLIFIERS ASSURES DAMPING AT ALL TIMES

Limiting of input prevents amplifier saturation or cut off; so that galvanometer damping is never lost.

RUGGED, RELIABLE, LOW VOLTAGE, LOW IMPEDANCE GALVANOMETERS

Fewer turns of heavier wire and completely enclosed coil increase reliability. High torque (250,000 dyne-cm.). Hysteresis level less than 0.1 division. Designed for easy replacement in field.

RECORDER-POWER AMPLIFIER PACKAGE IN ONLY 17 1/2" OF PANEL SPACE

Integral, tube-free package includes eight power amplifiers and power supply, which use power transistors and solid state rectifiers. Operates on 115 volts, 60 cycles. Simple paper loading from front. Individual stylus heat controls, chart speed pushbuttons, motor switch, timer-marker switch, fuses, paper footage indicator all on front panel. Connectors for input signals, output monitoring (±1 volt with respect to ground from 2.5 ohm source) and complete remote control provided at rear.

VELOCITY FEEDBACK DAMPING

True damping by velocity signal from separate winding over galvanometer driving coil. Damping control accessible from front of Recorder for easy adjustment.

(ALL DATA SUBJECT TO CHANGE WITHOUT NOTICE)

GALVANOMETER NATURAL FREQUENCY 55 CPS

Higher natural frequency provides higher over-all system frequency response.

INKLESS RECORDINGS IN TRUE RECTANGULAR COORDINATES

Heated stylus creates sharp, smudge-proof trace on plastic coated Permapaper. Chart channel width 1 7/16" (approx. 4 cm), ruled in 50 div. of 1/32" each.

RECORDER-AMPLIFIER UNIT HAS 0.1 VOLT/CHART DIV. SENSITIVITY

Can be used alone, when preamplification is not needed. (Three complete 8-channel Recorder-amplifier-power supply units can be mounted in one cabinet.)

ELECTRICAL PUSHBUTTON CHART SPEED CONTROL, WITH PROVISION FOR REMOTE CONTROL

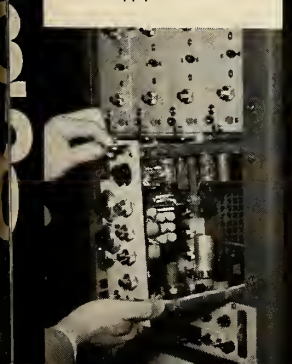
Any of nine speeds (0.25, 0.5, 1.0, 2.5, 5, 10, 25, 50, 100 mm/sec.) instantly selectable by pushbutton. Plastic strip for channel identification markings.

QUALITY COMPONENTS USED THROUGHOUT

JAN components used wherever practicable; for example, note in the photos hermetically sealed MIL-T-27 power transformers, MIL-approved electrolytic condensers in all power supplies, ruggedized premium-type tubes in Preamp power supplies, etc.

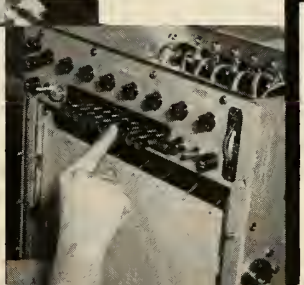
SANBORN COMPANY
INDUSTRIAL DIVISION
175 WYMAN STREET, WALTHAM 54, MASS.

Any "350" Preamplifier installs easily in any channel. Electrical connections made by mating connectors on Preamp and Power Supply.



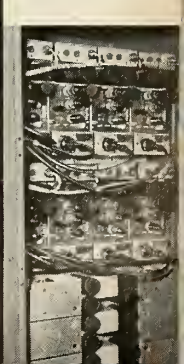
Quick, simple paper loading is done from front; hinged viewing window is removable. About 8" of record visible. All controls on front panel.

Any of nine chart speeds can be instantly selected by pushbutton. Remote control of all functions provided by connectors at rear.



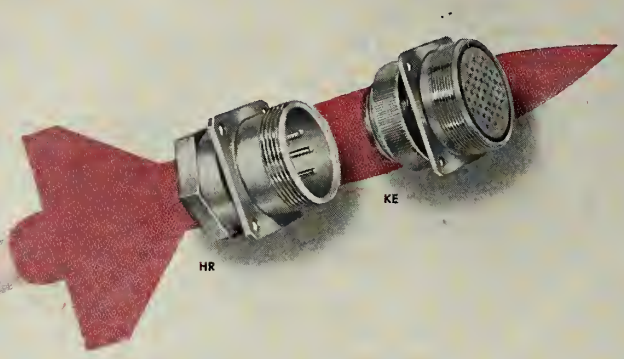
Recorder back plate holds eight plug-in Power Amplifier modules (one shown unplugged in photo), four on either side of Power Supply section. Entire back plate removable for servicing.

Eight-channel "350" from rear, showing (upper half) eight individual Preamp Power Supplies on four-unit module frames, and below them, Power Amplifiers and Power Supply on rear of Recorder Assembly.



NEW

CANNON PLUGS



For greatest reliability in the hot spots

NEW **HR** SERIES

1000°F continuous duty type

The most advanced design to protect against extreme heat, nuclear radiation and moisture formation. Moistureproofing on these connectors is accomplished by means of ball cone seals on mating surfaces. Available in production quantities in wide range of MS-type shell styles and sizes. Two to 24 contacts per shell. Wide variety of insert patterns that mate with standard MS types. A modification of the HR series, rated at 650°F continuous duty, is also available.

Write today for Technical Bulletin T-111

NEW **KE** SERIES

Moisture-resistant firewall type

First plug to satisfy both high-temperature requirements for fireproof Class MS-K connector and vibration-proof, moisture-proof requirements of MS-E Class. Meets 2000° flame test specified in MIL-C-5015—stands up under 400°F continuous operation. Fluorinated silicone seals for moisture-proofing improve resistance to oil and skydrol hydraulic fluid. Two basic shell types for conduit and wire bundles. Wide variety of insert arrangements and shell sizes in long and short types.

Write today for Technical Bulletin T-98

27,000 KINDS TO CHOOSE FROM!

Call on Cannon for *all* your plug needs. If we don't have what you want, we'll make it for you—whether you need one or a million. We're ready to help you at any stage—from basic design to volume production—with the largest facilities in the world for plug research, development and manufacturing. Write us today about your problem. Please refer to Dept. 438

CANNON PLUGS

CANNON ELECTRIC COMPANY

3208 Humboldt Street, Los Angeles 31, California

Where Reliability for YOUR Product is Our Constant Goal.

Factories in Los Angeles; Salem, Mass.; Toronto; London; Melbourne; Paris; Tokyo. Representatives and distributors in all principal cities. Please see your Telephone Yellow Book or write factory.

contract report

Trends

The Renegotiation Act will be renewed. At this writing, that's about all that's clear in this situation. There's quite a fight brewing on Capitol Hill as to exactly what form the renewal will take. But you can count on some easing of the regulations governing allowable profits earned through the "efficiency and economy" of the contractor. Increased profits on Defense business for the purpose of supporting additional research, development and facilities will not be allowed. The Government, instead, will probably hike the degree to which it directly supports these activities.

Continued jiggery-pokery with contract payments seems inevitable as the Government resorts to expenditure slowdowns in order to keep the budget deficit within preset limits. There's also a danger of another contract cutback in order to preclude expenditures reaching too high a level. Neither retarded payments nor ceilings on the rate of contracting should reach the extreme degree of last fall.

As an aid to distressed labor areas, new clauses are now being written into government contracts. These set an order of preference for placing subcontracts, as follows: (1) Small business concerns in labor surplus areas; other concerns in labor surplus areas; (2) small business concerns not in labor surplus areas.

Another policy decision affecting contracts is designed to equalize business by instructing procurement offices that, most things being equal, the contract will go to the company that has the smallest backlog.

The 5% budget transfer authority requested by the Department of Defense refers to authority to transfer funds up to 5% within each major budget category—not authority to transfer 5% of the total military budget in one lump sum, according to Assistant Defense Secretary W. J. McNeil.

Anyone with Thor or Jupiter contracts faces an uncertain future. The actual final decision as to how many of each will be produced is yet to be made. One proposal that's favored would hike *Thor* orders and cut back *Jupiter*, perhaps to limit of AMBA's Huntsville production capacity. This would, in effect, peg *Thor* as the weapon; *Jupiter*, for space flight work.

The foreign missile market has been pegged at $288 million—at least that's the portion of the foreign aid budget in 1959 allocated to "missiles and modernization of aircraft". Actually, the total foreign market for U.S. missiles will be somewhat larger, since some countries are planning to pay for their own *Nikes* and *Lacrosses*.

An inherent danger in the current proposals to reorganize the Department of Defense is the evolvement of a Ministry of Supply kind of set-up—the concentration of all research, development and procurement authority in a single office. A danger in this, starkly demonstrated by the British Ministry of Supply, is a reduction in the number of different ideas that are fed into the hopper. Other dangers are a widening bureaucratic gap between developer and buyer on the one hand and ultimate user on the other; increased red tape that comes with a large, multi-faceted organization.

Awards

By Commander, HQ, AMC, Wright-Patterson AFB: Servo Corp. of America received $326,090 for infrared receiving set. Boeing Airplane Co. received $474,229 for a handbook study of B-52 special weapon delivery capability. Thiokol Chemical Corp., Utah Div., received $597,145 for product improvement of the M-16 rocket engine in support of *Matador* missile. The Martin Co. received $10,192,000 for TM-76A missile data and spares. Lockheed Aircraft Corp. received $200,000 for MB-1 special store flight test on F104A aircraft, and $551,582 for special weapons flight test evaluation program on model F-104A air-planes. Sperry Gyroscope Co., Div. of Sperry Rand Corp., received $188,657 for control, directional type S-3B for support of SM.

By New York Ordnance District: Allen B. DuMont Lab., Inc. received $59,673 for evaluation of high resolution missile tracking system. Belock Instrument Corp. received $82,296 for design, engineering and fabrication of a guidance and control system. Columbia University received $60,000 for analysis of radar noise in the *Nike* and related systems. Knapp Mills, Inc. received $51,868 for an irradiator. Coordinating Research Council, Inc. received $65,000 for research and development work on fuels, lubricants and related materials.

By Boston Ordnance District: Arthur D. Little, Inc. received $101,230 for complete area toxic rocket weapons system.

By HQ, Air Force Office of Scientific Research, ARDC: Columbia University received $47,000 for continuation of research on sampled data feedback control systems. University of Michigan received $36,490 for continuation of research on "standnig detonation wave", Vitro Laboratories, Div. of Vitro Corp. of America, received $65,000 for investigation of the high intensity arc for ion propulsion. University of Michigan received $36,000 for research in "mechanism of boundary layer stability and transition." General Dynamics Corp., General Atomic Div., received $91,249 for investigations of the interaction of hydrogen and oxygen atoms with surfaces. North American Aviation, Inc., Rocketdyne Div., received $90,438 for analytical studies on ion propulsion. Polytechnic Institute of Brooklyn received $27,000 for continuation of research on "information processes". Cornell University received $48,645 for research on "probability theory and analysis". Massachusetts Institute of Technology received $29,935 for a study of the mechanics for optimization of celestial trajectories. Oklahoma State University of Agriculture and Applied Sciences received $34,000 for investigations of semiconducting properties of type IIb diamonds. New York University received $25,500 for investigation of thermal stresses in structures by photoelastic techniques. Northwestern University received $53,735 for an investigation of phase transformations in solids. California Institute of Technology received $37,340 for research on "stellar compositions and the related nuclear processes". New York University received $35,031 for research on ignition and combustion of organo-metallic compounds. Carnegie Institute of Technology received $41,327 for research on "conformal and variational methods". Princeton University received $42,300 for investigations of fundamental concepts in physics. Aeronutronic Systems, Inc. received $58,705 for research on the influence of sound waves on chemical reaction rates. Litton Industries of California received $91,344 for research on high vacuum friction, and $92,923 for research on electromagnetic plasma accelerator. Bell Aircraft Corp. received $42,353 for research on "effects of damping on panel flutter", and $91,852 for research on "aero-physics of recoverable re-entry vehicles".

By HQ, AFMTC, ARDC, USAF, Patrick Air Force Base: Technitrol Engineering Co. received $59,526 for increase in funds. Westvaco Chlor-Alkali Division of Food Machinery and Chemical Corp. received $37,873 for rocket propellant. John C. Abbott received

. . . contracts

$54,540 for services and materials for Mezzanine. General Dynamics Corp., Convair Division, received $20,000 for increase in funds. Perkin Elmer Corp. received $79,776 for increase in funds. Radiation, Inc. received $175,000 for increase in funds. Cubic Corp. received $184,145 for increase in funds. Reeves Instrument Corp. received $112,293 for increase in funds. Cubic Corp. received $66,981 for services and supplies to evaluate secor and cotar equipment and prepare a final engineering report.

By HQ AFFTC, ARDC, USAF: Electronics Associates, Inc. received $39,238 for computer. Grand Central Rocket Co. received $159,781 for Viper II rocket engines. Associated Missile Products Co. received $54,868 for instrumentation system for test stand. Thiokol Chemical Corp. received $52,385 for modification and delivery of 12 "recruit" rocket engines.

By HQ Air Force Cambridge Research Center, Air Research and Development Command, USAF, Laurence G. Hanscom Field: University of Alaska received $49,983 for research directed toward a study of ionosphere in high latitudes. Rantec Corp. received $35,206 for analysis of basic design techniques and fabrication of breadboard model flat-plate radar antenna. Temple University received $50,000 for research directed toward the attainment and utilization of high temperatures. Metal Hydrides Inc. received $91,585 for research on the preparation of semi-conductor silicon from silane. Northeastern University received $75,000 for research in statistical communications theory and reliability. General Communication Co. received $29,987 for beacon radar. Stanford Research Institute received $99,110 for research on radiation and reception of electro magnetic energy from aircraft and guided missiles. Bendix Aviation Corp., Research Laboratories Div., received $54,971 for instrumentation to measure the composition of the atmosphere at 300-mile altitudes. Bendix Aviation Corp., Research Laboratories Div., received $61,922 for design, development and construction of a modified Bendix Model 15-100 spectrometer adapted for rocket installation. Allied Research Associates, Inc. received $55,635 for research directed toward the testing and evaluating of forecast procedures. Ball Bros. Research Corp. received $32,917 for design and construction of a rocket-borne monochromatic camera. Cornell University received $54,000 for radio scattering in the troposphere. Sylvania Electric Products Inc. received $34,422 for infrared scattering study.

By U.S. Naval Ordnance Laboratory: Contractor Heppenstall Co. received $28,000 for mandrel Mach 10 nozzle rough-machined forging type 303 stainless step-down bore.

By District Public Works Office, Eleventh Naval District: Staiger Construction Co. received $48,000 for correction of explosion damage.

By Navy, Bureau of Ordnance: Ford Instrument Co., Div. of Sperry Rand Corp., received $14 million for the production of electronic computers for the *Tartan* and *Terrier* guided missile systems.

By HQ, Mobile Air Materiel Area, USAF, Brookley AFB: Bendix Aviation Corp., Pioneer Central Div., received $94,708 for liquid oxygen content gauge.

By Ogden Air Materiel Area, USAF: Northrop Div., Northrop Aircraft, Inc., received $503,601 for rocket mission evaluators.

By HQ, AFTC, ARDC, USAF, Edwards AFB: G. W. Galloway Co. received $179,269 for the design and development of a nitrogen and helium testing system.

By AFMDC, ARDC, USAF, Holloman Air Force Base: Coleman Engineering Co., Inc. received $90,066 for modification of liquid propellant sled. North American Aviation, Rocketdyne Div., received $447,000 for liquid propellant rocket sled system.

By Dept. of the Navy, Office of Naval Research: Douglas Aircraft Co. received $48,671 for research on high temperature polymers. Batelle Memorial Institute received $35,000 for research on the high temperature properties and alloying behavior of platinum-group metals. Northwestern University received $25,000 for research on time constrained logistical decisions. Ramo-Wooldridge Corp. received $49,456 for research involved in perfecting solid state, low temperature computing elements. Lockheed Air-

What's new in TITANIUM welding:

Resistance and fusion welding as fabrication procedures have become increasingly important with the advent of missiles and aircraft designed for sustained operation at Mach 3 and better.

Titanium alloys are available which provide fusion-weld efficiencies of 100 percent, and spot-welded joints with excellent load carrying capacities.

Through its new Toronto, Ohio, rolling mills —designed specifically for titanium operations —Titanium Metals Corporation of America can provide light-gage flat-roll weldable products of consistently highest quality, on the fastest delivery schedules, at the lowest possible price in the industry today.

Q. What are the leading welding grades?

A. Ti-75A, a single-phase unalloyed grade which is readily formable; Ti-5Al-2.5Sn, a single-phase alloy grade which provides excellent resistance to oxidation up to 1200°F; and Ti-6Al-4V, a duplex-phase alloy grade with guaranteed minimum tensile strengths to 130,000 psi. Guaranteed minimum mechanical properties of these grades are:

GRADE	DENSITY lb/cu in	Guaranteed Room Temperature Properties 0.2% YS	UTS	Elong, % in 2"
Ti-75A	0.163	70,000	80,000	20
Ti-5Al-2.5Sn	0.162	110,000	115,000	10
Ti-6Al-4V	0.161	120,000	130,000	10

Q. Are special precautions required for welding these grades?

A. Titanium is spot-welded more readily than aluminum and many of the carbon and low alloy steels, and requires no special precautions. Spot-weld machine settings used for titanium and stainless steel are very similar.

Titanium is fusion-welded with inert-gas-shielded arc welding techniques and joint designs which are also similar to those used for other metals. Two fundamental principles must be considered:

1. Coated electrodes and other fluxing compounds cannot be used.
2. Titanium weld joints must be shielded from the normal atmosphere with an inert blanket of argon or helium during welding.

Q. Does that mean chambers are mandatory for fusion weldng?

A. No. Open air welding is adaptable to production operations when both root and face of the weld are protected from the air. Small parts and complex shaped weldments which are difficult to shield adequately may still be welded more easily and economically inside a chamber. This is described in detail in TMCA's publication, *Titanium Welding Techniques*, Engineering Bulletin #6.

Successful titanium welding techniques hove enabled fabricatars to produce missile prapellant storage battles which resist internal pressures af 8000 psi at —300°F. This all-titonium battle, produced by Rheem Manufacturing Compony, Dawney, Calif., is Ti-6Al-4V, fusion-welded in on argon atmosphere. Designers say use of titanium bottles can add up ta 700 miles to the range of an IRBM.

Q. Are titanium welds more susceptible to corrosion attack than the base metal?

A. Titanium welds offer the same excellent corrosion resistance as the base metal. Stabilizing heat-treatments, employed with many other materials, are *not* required.

Successful welding is a key factor in today's designs. It enables designers to draw upon titanium's unique combination of properties: light weight, corrosion resistance, and ability to withstand operating temperatures from –300°F to 1000°F — for the added performance vital to these uniquely critical times.

Titanium Metals Corporation of America has just completed the first comprehensive study of welding techniques yet published by the industry. This 32-page publication draws upon metallurgical considerations to recommend and explain techniques required for quality titanium weldments.

Titanium Welding Techniques, as well as other publications, in the most extensive data library in the industry, is available from Titanium Metals Corporation of America, 233 Broadway, New York 7, New York. This important literature is yours for the asking.

TIMET®

TITANIUM METALS CORPORATION OF AMERICA

233 Broadway, New York 7, N. Y.

Clip out and mail coupon for helpful Engineering Data on TITANIUM

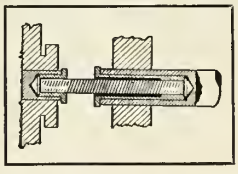
NAME

ADDRESS

CITY STATE

- ☐ Bulletin 1 Properties of Ti-6Al-4V
- ☐ Bulletin 2 Heat-Treatability of Ti-6Al-4V
- ☐ Bulletin 3 Analytical Chemistry of Titanium
- ☐ Bulletin 4 Mechanical Testing of Titanium
- ☐ Bulletin 5 Properties of Ti-155A
- ☐ Bulletin 6 Titanium Welding Techniques
- ☐ Other .....

FLEXIBLE SHAFT COUPLING FOR MISSILES AND ROCKETS



Coupling is used for the transmission of power or control of movement between parts located close together in a piece of equipment. It is not a separate type of flexible shaft but rather an added application of flexible shafting.

The coupling can be composed of either power drive or remote control flexible shafting although the latter is generally used due to the added advantage of its ability to rotate both clockwise and counter clockwise. Generally used between two units which are but a few inches apart, coupling may transmit power between any two parts regardless of their relative positions.

For example, the diagram above shows an advantage in using small lengths of flexible shafting in a coupling application. Although the drive end and the driven end are not exactly in line, the coupling compensates for the difference in alignment between the two.

Many manufacturers use flexible shaft coupling even where parts may be connected by solid shafts because of the savings realized in the initial and the maintenance costs as well as in time and labor.

For complete information on how flexible shaft couplings may help improve your product design, write F. W. Stewart Corporation, 4311-13 Ravenswood Avenue, Chicago 13, Illinois.

Circle No. 100 on Subscriber Service Card.

. . . contracts

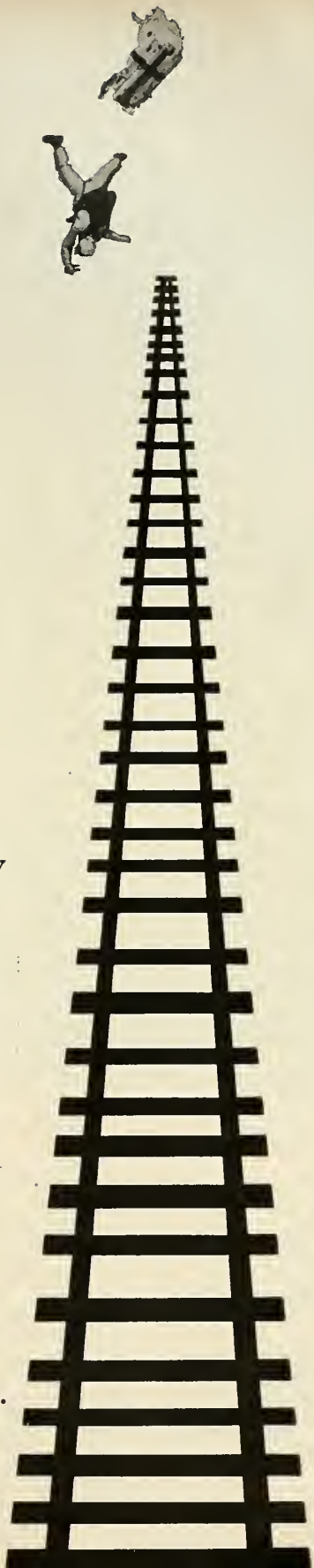
craft Corp. received $37,189 for research on electron spin echo storage.

By Dept. of the Navy, Bureau of Aeronautics: Alloyd Research Corp. received $48,792 for refining studies of refractory metals. Raytheon Mfg. Co. received $1,500,000 for materials and services to construct a flight test facility. Phillips Petroleum Co. received $94,344 for investigation of physical and chemical properties of jet fuels. Unted Aircraft Corp., Pratt and Whitney Aircraft Div., received $374,500 for reports covering design, specifications, weight and performance of nuclear propulsion systems. Crosby Laboratories, Inc. received $70,166 for study and investigation of devices for counteracting the doppler frequency shift.

By District Public Works Officer, Sixth Naval District Bldg.: Nat G. Harrison Overseas Corp. received $111,240 for instrumentation facilities at West End, Grand Bahama Island, British West Indies for the AFMTC.

By U.S. Army Ordnance District, Los Angeles: California Institute of Technology received $7,422,654 for engineering research relating to guided missiles, free rockets, materials and wind tunnel operation. SERVO Mechanisms, Inc. received $50,123 for LOX tanking system. Douglas Aircraft Co., Inc. received two contracts totaling $87,047 for repair parts for *Nike* system. Firestone Tire & Rubber Co. received $150,197 for field service engineering in connection with *Corporal* missile and related ground handling equipment. Gilfillan Bros. Inc., received six contracts totaling $425,932 for replenishment repair parts for the *Corporal* missile system, and $168,611 for repair parts for guided missile, artillery M2 and related ground handling equipment. G. M. Giannini & Co., Inc. received $86,350 for parts and assemblies for transmitter and accelerometer. Douglas Aircraft Co., Inc. received $15,000,000 for *Nike-Hercules* launching area items. Nortronics, a Div. of Northrop Aircraft, Inc., received $350,000 for maintenance shop set for *Nike-Hercules*. North American Aviation, Inc., Autonetics Division, received $34,561 for able system. Wallace O. Leonard, Inc. received $29,720 for transducers. Electro Optical Systems, Inc. received $99,362 for investigation of ionized gases. Firestone Tire & Rubber Co. received $775,644 for engineering services related to *Corporal* missile system. Dale Products, Inc. received $305,476 for T309 testers with spares and auxiliaries. North American Aviation Inc. received $1,650,000 for rocket engines. Magnetic Research Corp. received $59,700 for temperature adapter. Firestone Tire & Rubber Co. received $28.84 for replenishment repair parts for guided missile and related ground handling equipment; $168,015 for concurrent repair parts for *Corporal* missile; and two contracts totaling $94,216 for concurrent repair parts for *Corporal* missile ground handling equipment. North American Aviation Inc. received two contracts totaling $660,000 for rocket engines. California Institute of Technology received two contracts totaling $275,020 for engineering research and development on guided missiles, free rockets, materials and wind tunnel operation. Douglas Aircraft Co. Inc. received two contracts totaling $194,125 for repair parts for *Nike* system. Convair, a division of General Dynamics Corp., received $966,720 for feasibility study of redeye system. Telemetering Corp. of America received $47,421 for technical services. Aerophysics Development received $1,498,139 for *Dart* antitank guided missile. Firestone Tire & Rubber Co. received $75,750 for guided missile surface-to-surface system. Gilfillan Bros. Inc. received five contracts totaling $665,246 for replenishment repair parts for the *Corporal* missile system. Firestone Tire & Rubber Co. received $25,306 for concurrent repair parts for *Corporal* missile ground handling equipment; $157,212 for concurrent repair parts for *Corporal*. Douglas Aircraft Co. received $40,000 for pump, vacuum and LOX tank equipment installation. North American Aviation Inc. received three contracts totaling $360,000 for rocket engines. Aerophysics Development Corp. received $462,792 for study report on drop test of *Jupiter* nose cone. California Institute of Technology received $792,275 for engineering research and development relating to guided missiles, free rockets, material and wind tunnel operation.

By U.S. Army Ordnance District, St. Louis: Denver Research Inst., University of Denver, received $29,224 for research and development effects of thermal cycling between subzero and moderately elevated temper-



We built a railroad into the sky

Atop Hurricane Mesa, Utah, Coleman Engineering Company built and operates the Air Research and Development Command's Supersonic Military Air Research Track, called Project SMART.

Track testing is a new and useful tool for evaluating—prior to flight—the reliability of the essential components that go into our missile and weapons systems. Today, at Project SMART, with rocket sled vehicles, the mission is to simulate the actual conditions of supersonic flight, and to study the effect of emergency bail-outs on both men and equipment.

From the edge of the cliff—1,500 feet above the valley floor—the track measures two and one-half miles.

But it is bigger than that!

This railroad reaches back to America's recognition of the dignity and value of human life . . . and extends to the future perfection of safety in the air.

Coleman

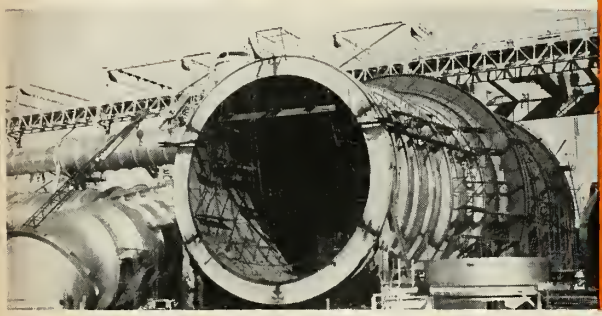
Engineering Company, Inc.

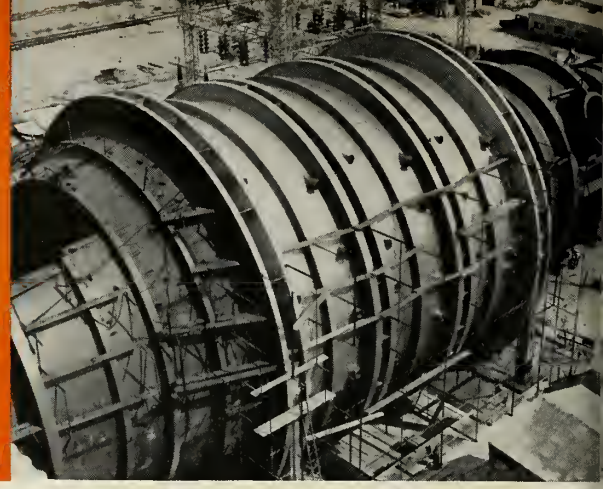
6040 West Jefferson Boulevard
Los Angeles 16, California
Washington, D.C.; Dayton, Ohio;
Ft. Walton Beach, Florida

Circle No. 38 on Subscriber Service Card.

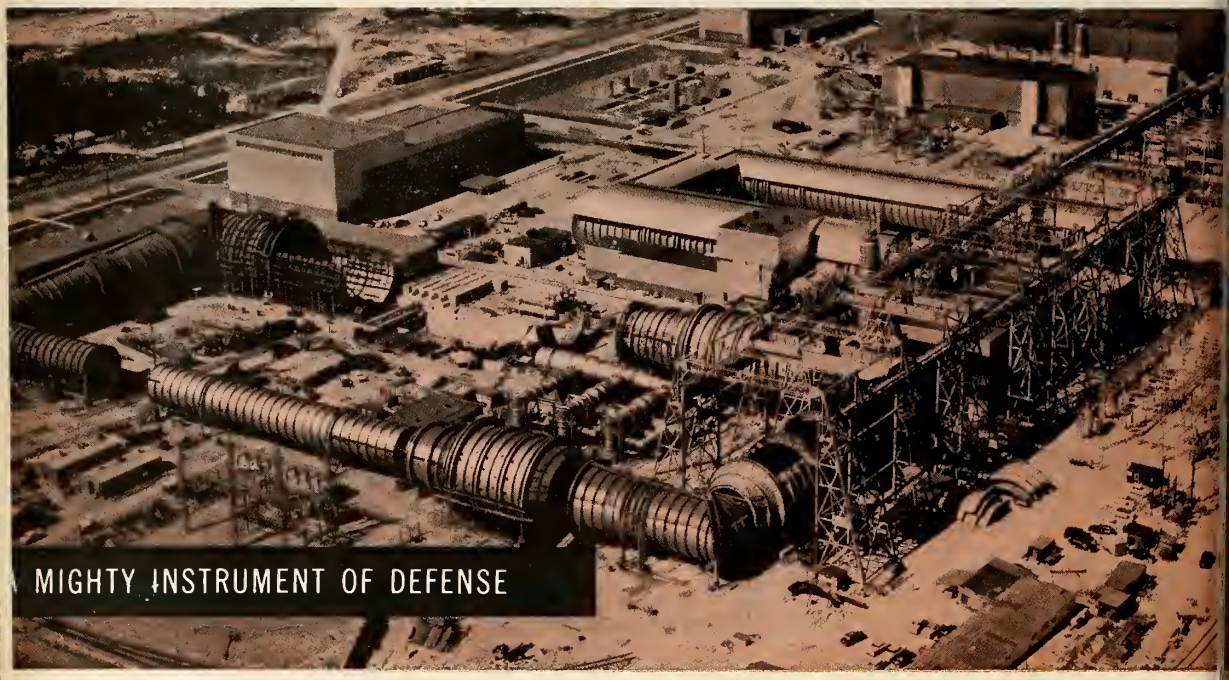
One of the tremendous coolers (right) required in the Supersonic circuit—55′ in diameter.

Transonic return duct No. 2 (below), with compressor and motor area under craneway in background.





Steel Platework by Pittsburgh-Des Moines



The Propulsion Wind Tunnel Facility at Tullahoma, Tennessee

The two largest wind tunnels of their speed in the country are shown built and under construction by PDM in the picture above. The Transonic Tunnel, now in operation, and the Mach 5 Supersonic Tunnel going up beside it are projects of the Arnold Engineering Development Center, Air Research and Development Command, USAF. The U.S. Army Corps of Engineers is the construction agency. • The size and complexity of this work are a measure of Pittsburgh-Des Moines' ability to meet dependably your most exacting platework requirements. Write us for consultations and preliminary estimates on your forthcoming projects.

PDM
STEEL PLATE WORK

Pittsburgh-Des Moines Steel Company

Plants at PITTSBURGH, DES MOINES, SANTA CLARA, FRESNO, and CADIZ, SPAIN

Sales Offices at:

PITTSBURGH (25) .....3476 Neville Island
NEWARK (2) .....1760 Military Park Bldg.
CHICAGO (3) ..680 First National Bank Bldg.
EL MONTE, CAL. .....P. O. Box 2012
ATLANTA (5) ..361 E. Paces Ferry Rd., N.E.
DES MOINES (8) .....977 Tuttle Street
DALLAS (1) .....1281 Praetorian Bldg.
SEATTLE (1) .....Suite 384, 500 Wall St.
SANTA CLARA, CAL. .....683 Alviso Road
DENVER (2) ....323 Railway Exchange Bldg.

. . . contracts

atures on the tensile properties of materials.

By Philadelphia Ordnance District: Douglas Aircraft Co., Inc. received four contracts totaling $152,437 for *Nike* spare parts and components. Western Electric Co., Inc., received 20 contracts totaling $1,964,489 for *Nike* spare parts and components. N. C. State College of Agriculture and Engineering, University of N. C., received $30,000 for investigation of brittleness cause in ceramics. Radio Corporation of America received $52,745 for government facilities for use in *Talos* defense unit. Textile Machine Works received $96,559 for thruster. Air Products, Inc. received $2,163,514 for semi-trailer, liquid oxygen.

By San Francisco Ordnance District: Ampex Corp. received $56,000 for end use guided missiles and related material.

By Cleveland Ordnance District: Goodyear Aircraft Corp. received $1,236,887 for fixed price contract with price redetermination for *Nike-Hercules*. Ohio State University Research Foundation received $29,450 for research into bodies in a fusible heated airstream.

By U.S. Army Ordnance District, St. Louis: Midwest Research Institute received $27,980 for research and development of magnus airforces in aeroballistics.

By Springfield Ordnance District: Data Control Systems, Inc. received $92,533 for telemetering station.

By Redstone Arsenal, U.S. Army: Brown Engineering Co., Inc., received $45,000 for engineering, design and drafting services necessary for the development of rocket motors and launchers. Southern Associated Engineers, Inc., received $377,785 for engineering, incidental services and materials related to the preparation of ordnance drawings for the guided missile program. Hydromatics Inc., received $31,823 for pressure-operated valve assembly.

By Frankford Arsenal: Norden-Ketay Corp., Precision Components Division, received $52,500 for synchro receiver.

By U.S. Army Engineer District, Corps of Engineers, Detroit: Douglas-Cloud Co. received $265,418 for construction of supporting tactical facilities at special AAA sites.

By U.S. Army Engineer District, Corps of Engineers, Norfolk: Equipment Engineering Corp. received $55,669 for elevator improvements.

By U.S. Army Engineer District, Corps of Engineers, Los Angeles: P. J. Walker Co. received $426,001 for nose cone training facility at Cooke AFB. Westmont Engineering Co. received $134,174 for elevator improvement and conversion at special AAA sites.

By U.S. Army Engineer District, Corps of Engineers, Chicago: Mayfair Construction Co. received $294,400 for construction of additional facilities at special AAA sites.

By U.S. Engineer District, Corps of Engineers, N.Y.: C. W. Lauman and Co., Inc. received $107,760 for special AAA facilities.

By Corps of Engineers, U.S. Army, Omaha District: Olson Construction Co. received $416,673 for construction of rocket assembly. Korshoj Construction Co. received $94,065 for construction of rocket storage facilities.

By U.S. Army Engineer District, Corps of Engineers, Charleston: Boyle Construction Co. received $67,991 for construction of high altitude training building.

By U.S. Army Engineer Area, Corps of Engineers: James Farina Corp. received $191,770 for construction of elctro magnetic laboratory and electronic lab airborne facility.

By Corps of Engineers, U.S. Army, Office of the District Engineer, San Francisco: Clarence Ward Construction Co., Inc. received $490,159 for rocket assembly building.

By Army Map Services, Corps of Engineers, U.S. Army: Product and Industrial Engineering Corp. received $33,000 for U.S.S.R. topographic map engraving of Czechoslovakia.

By U.S. Army Engineer District, Corps of Engineers, Mobile: Whaley Co. received $202,973 for construction of launcher emplacement area, operations support building

. . . contracts

and addition to Building 4711 at Redstone Arsenal. Greenhut Construction Co. received $231,890 for construction of Model II shelters for *Bomarc*-Est facilities at Eglin AFB. Perusini Construction Co. received $155,960 for construction of nose cone assembly and check-out facility at Redstone Arsenal.

By District Engineer, U.S. Army Engineer District: George A. Rutherford, Inc. received $138,274 for G/M lab mechanical testing Holloman AFB. Allen M. Campbell received $1,325,855 for guided missile assembly building. C. H. Leavell and Co. received $88,041 for meteorological test facility, White Sands Proving Ground. The Costanze Construction Co. received $279,147 for special AAA conversion for *Nike-Hercules*.

By U.S. Army Engineer Div., New England, Corps of Engineers: J. H. Manning Corp. received $196,000 for construction of rocket storage building.

By General Stores Supply Office: Thiokol Chemical Corp. received $35,049 for polymer powder.

By U.S. Army Signal Supply Agency: Western Electric Co., Inc. received $149,120 for solid state maser studies. Radio Corp. of America received $2 million for reports on micro-miniature module. University of Michigan received $78,000 for services, facilities and materials for conducting experimental investigation of microwave radiometry techniques in detection of airborne targets. Western Electric Co. Inc. received $347,700 for services and materials for study and investigation related to transistors and transistor-like devices. Ramo-Wooldridge Corp. and Pacific Semiconductors Inc. received $95,858 for study on variable capacitor diodes. Haller, Raymond and Brown, Inc. received $79,462 for study of long-range intercept and data processing equipment and techniques.

By 308 Customhouse, Wilmington, N.C., U.S. Army Engineer District: Thompson and Street Co. received $958,800 for construction and rehabilitation.

By U.S. Army Ordnance Missile Command, Redstone Arsenal: E. I. Du Pont De Nemours & Co., Electrochemical Dept., received $59,274 for hydrogen peroxide. Linde Co., Div. of Union Carbide Corp., received $99,450 for liquid nitrogen and liquid oxygen. Thiokol Chemical Corp. received $304-882 for continuation of R&D work on solid propellant-type engines for large rockets.

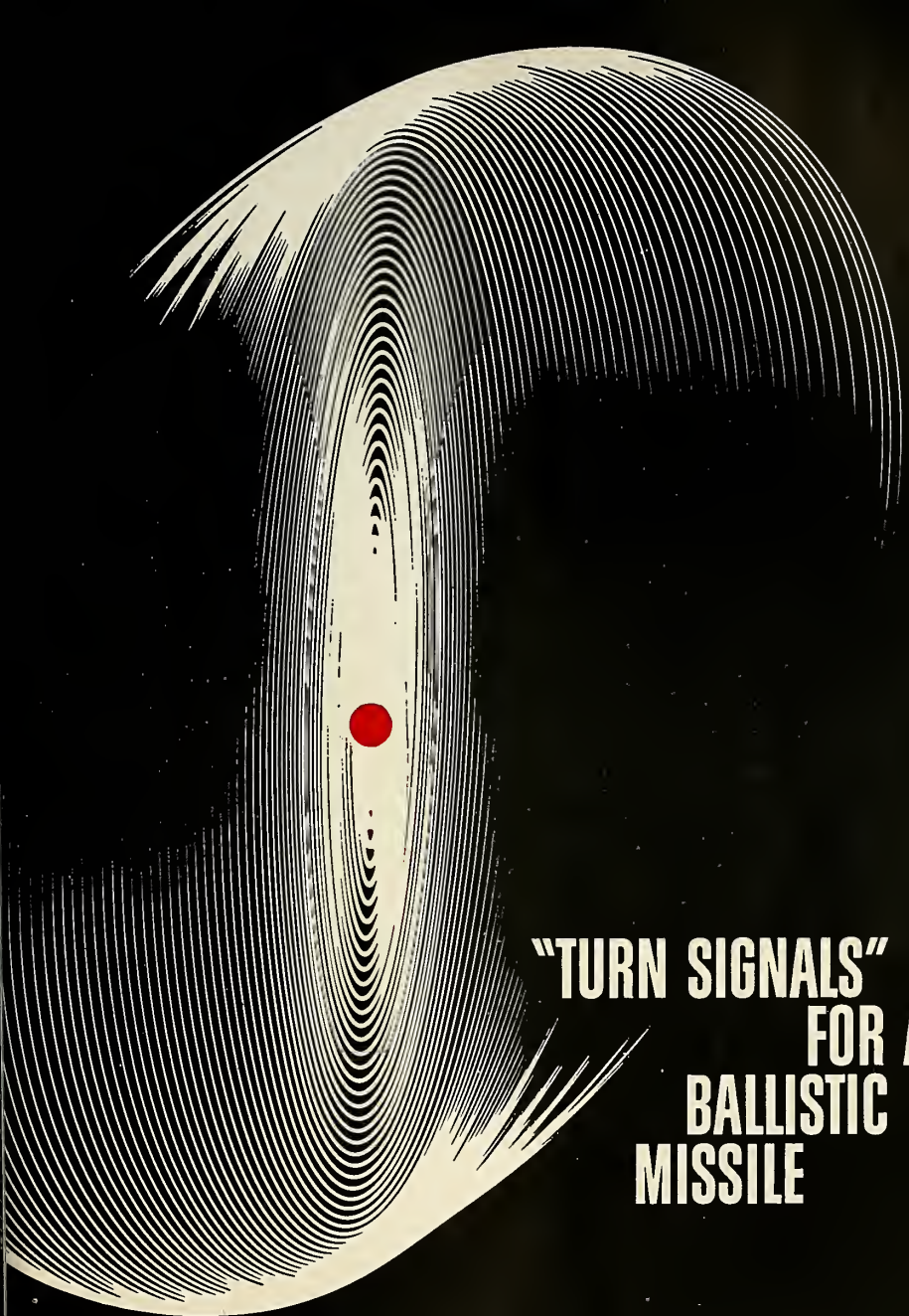
By U.S. Army Ordnance Missile Command, Redstone Arsenal: Grove Valve and Regulators Co. received $29,875 for valves and regulators.

By U.S. Army Electronic Proving Ground Procurement Office, U.S. Army Signal Supply Agency: Motorola Inc. received $60,207 for study of the techniques employed in automatic plot of enemy signal origin, electronic countermeasures and the automatic data processing system.

By Procurement Office, Aberdeen Proving Ground: Fidelity Construction Corp. was awarded $25,159 for construction of rocket static firing barricade, and gun and rocket firing barricade. High Voltage Engineering Corp. received $26,400 for beam analyzing and stabilizing system-accessory.

By U.S. Army Electronic Proving Ground Procurement Office, U.S. Army Signal Supply Agency: Pacific Div., Bendix Aviation Corp., received $29,523 for telemetering supplies.

By HQ, AFOSR: University of Ill. received $27,750 for experimental research upon the electronic properties of non-metallic crystals. Columbia University received $29,550 for research on "paramagnetic resonance absorption spectroscopy." Western Reserve University received $75,000 for research on "factors controlling non-linear phenomena in ferromagnetic and ferroelectric ceramics." American Institute of Physics received $35,790 for collection and evaluation of literature in the field of fluid physics. University of Michigan received $100,000 for research on "investigation of crystal defects by electron-spin resonance." Horizons, Inc. received $26,556 for research on "rare earth carbon systems." University of Maryland received $62,750 for research on "solid state theory; $112,058 for mathematical research in fluid dynamics and applied mathematics; and $47,258 for "theoretical research program in statistical mechanics and chemical physics."★



"TURN SIGNALS" FOR A BALLISTIC MISSILE

BURROUGHS ELECTRONIC COMPUTER "MASTERMINDS" THE ATLAS INTERCONTINENTAL BALLISTIC MISSILE

Steering the 250-mile-per-minute Atlas into the precise trajectory required for the missile to accurately strike its target 5,500 miles away, calls for incredibly close computation. And that's where Burroughs comes in—with an electronic computer specially designed to receive complex information, compare it with the pre-calculated direction, and signal the missile necessary changes to set it unerringly on its course.

Important contracts are not new to Burroughs Corporation with its 70 years of demonstrated competence. But it is the recent defense projects that serve best to underscore Burroughs' breadth and complete capability, from research through mass production to actual field installation and service. Burroughs Corporation, 6071 Second Avenue, Detroit 32, Michigan.

BURROUGHS CORPORATION

THE FOREMOST NAME IN COMPUTATION

missile business

by Seabrook Hull

Missiles have come of age. For proof note that a mutual fund called Missiles-Jets and Automation Fund, Inc., has now been formed. Its fundamental investment policy is based on the anticipated long-term growth trend of this field. A registration statement was filed with the Securities and Exchange Commission on May 8, covering a proposed offering of 500,000 shares of capital stock at $10 per share. A nationwide underwriting group headed by Ira Haupt and Co. is expected to offer the shares early in June.

Mutual funds—a sort of pay-as-you-go deal, whereby you buy shares in a comprehensive portfolio on a regular basis—have, in recent years, come into wide popularity. Unlike insurance, as a means of saving, mutual funds appreciate not only according to the brilliance of a management company's investment acumen, but according to the inflation of the economy as well. This particular fund will be interesting to watch, since its portfolio will largely cover that industry which now produces missiles, rockets and space flight equipment.

Andrew G. Haley, partner in the D.C. law firm of Haley, Wollenber & Kenehan; president of the International Astronautical Federation; General Counsel of the American Rocket Society; is president and director of the Missiles-Jets & Automation Management Company, which will direct the fund's affairs. Another of the fund's directors is Dr. Theodore von Karman who, along with Haley, was fundamental in the founding of Aerojet-General Corporation.

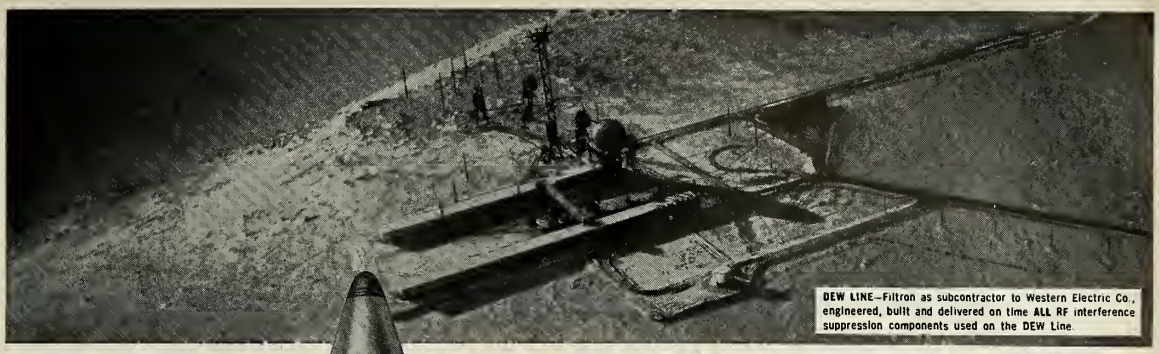
Now for the gripes: First of all, this column notes an increasing tendency on the part of government contractors to grant prime missile systems contractors facilities contracts. This is all fine, and it's human nature to try to keep as much of the business in the house as possible and to get Uncle Sam to foot as much of the bill as possible.

However, considering the vital needs and growing plight of the American taxpayer, the question being asked more and more is this: How about checking the availability of facilities already in existence before forking over millions of dollars for duplication.

Note for example, the recent award to a West Coast rocket-maker for metal-working and heat-treating capacity; to a New England prime systems contractor for small-gyro-making capacity; to a Southern company for a "from-the-turf-up" solid-rocket motor casing plant?

This business is all right for stuff that doesn't already exist or is a vital part of a hyper-critical R & D operation. But as a duplication of existant production capacity, it not only nicks the taxpayer unnecessarily into funds that would otherwise be placed for essential R & D and/or production missiles.

Congress is in session now. If you've got any gripes of your own or want to pick up these cudgels, now's the time to do it.



DEW LINE—Filtron as subcontractor to Western Electric Co., engineered, built and delivered on time ALL RF interference suppression components used on the DEW Line.

FILTRON

The leader in RF Interference Suppression Engineering can help speed your Missile Program

Filtron's Field Engineering Division, the most experienced in the world on RF interference suppression . . . have played major roles in the following programs:

DEW Line • Atlas • B-58 Hustler • Falcon • Redstone Talos • Titan • Atomic Subs • Bomarc • Jupiter-C And other major classified programs.

Experience gained in the successful RF interference suppression programs from these weapon systems, is available now to manufacturers of missiles and advanced weapon systems wishing to augment their engineering manpower.

Filtron, and Filtron alone, has developed RF interference suppression requirements and solutions for missiles, block houses, test stands, launching sites, checkout equipment, telemetering and associated electronic systems. Frequency ranges from 30 cycles to over 10,000 megacycles.

Our missile engineers will gladly discuss your missile project requirements at your convenience.

Filtron's mobile RF Interference laboratory at Convair's Atlas missile test stand.

Field Engineering Division

FILTRON CO., INC. FLUSHING, NEW YORK • CULVER CITY, CALIFORNIA

west coast industry

by Fred S. Hunter

Rocketdyne recently regrouped its engineering functions. One of the more important changes had to do with establishment of one group for large engine systems and another for small engine systems.

This company has been associated in the public eye mostly with its larger rocket engines. But it is pretty busy in the small engine field, too—Vernier engines that range from 500 to 3,000 pounds thrust.

One of Rocketdyne's past efforts was development of a liquid 2.75 that the Army tested on helicopters at Camp Rucker. But small engines cover a wide range. Rocket powerplants as big as 20,000, 30,000 or 40,000 pounds thrust come under the jurisdiction of the small engine group. Anything, as a matter of fact, up to V-2 size.

Keep your eye on Northrop Aircraft's new Nortronics division. It's coming along fast. It has more than 1,800 workers in electronics manufacturing, a backlog of more than $60 million, and a general manager with vision, Dr. William F. Ballhaus.

Bigger furnaces?—Robert Archer, president of California Doran Heat Treating Co., which recently installed a three-zone tower furnace capable of handling work to 48 in. diameter and 16 ft. long, said missiles soon will require a furnace capable of handling 10 ft. diameters and lengths up to 24 or 30 ft. California Doran is already working on designs for a king-size furnace.

Archer admits concern, however, over a phase of government procurement, which worries a lot of subcontractors. This is government installation of competitive equipment. It would cost about $700,000 for a 10 ft. diameter furnace, including building to house it, control and operating equipment. That is a lot of investment, Archer points out, "if the government is going to compete with us."

In complete disregard of the surrounding peril, a family of owls built a nest in the top of the *Atlas* ICBM static test tower at Convair's Sycamore Canyon test site. "I guess," a test engineer wryly remarked, "the owls don't think much of the project."

Hughes Aircraft's cushioned containers used for shipping *Falcon* GAR rockets have been improved to absorb more shock. The new DFSC-3 containers are airtight and spot tested through 18 rough-handling methods.

National Aviation Corp. now holds 10% of Marquardt Aircraft Co. This is the third biggest block of Marquardt stock. The other two blocks are: Laurence S. Rockefeller, 20%; Olin Mathieson, 25%.

Ryan Aeronautical is working on a "stand-off" missile for the Navy. Project is called Ryan M109.

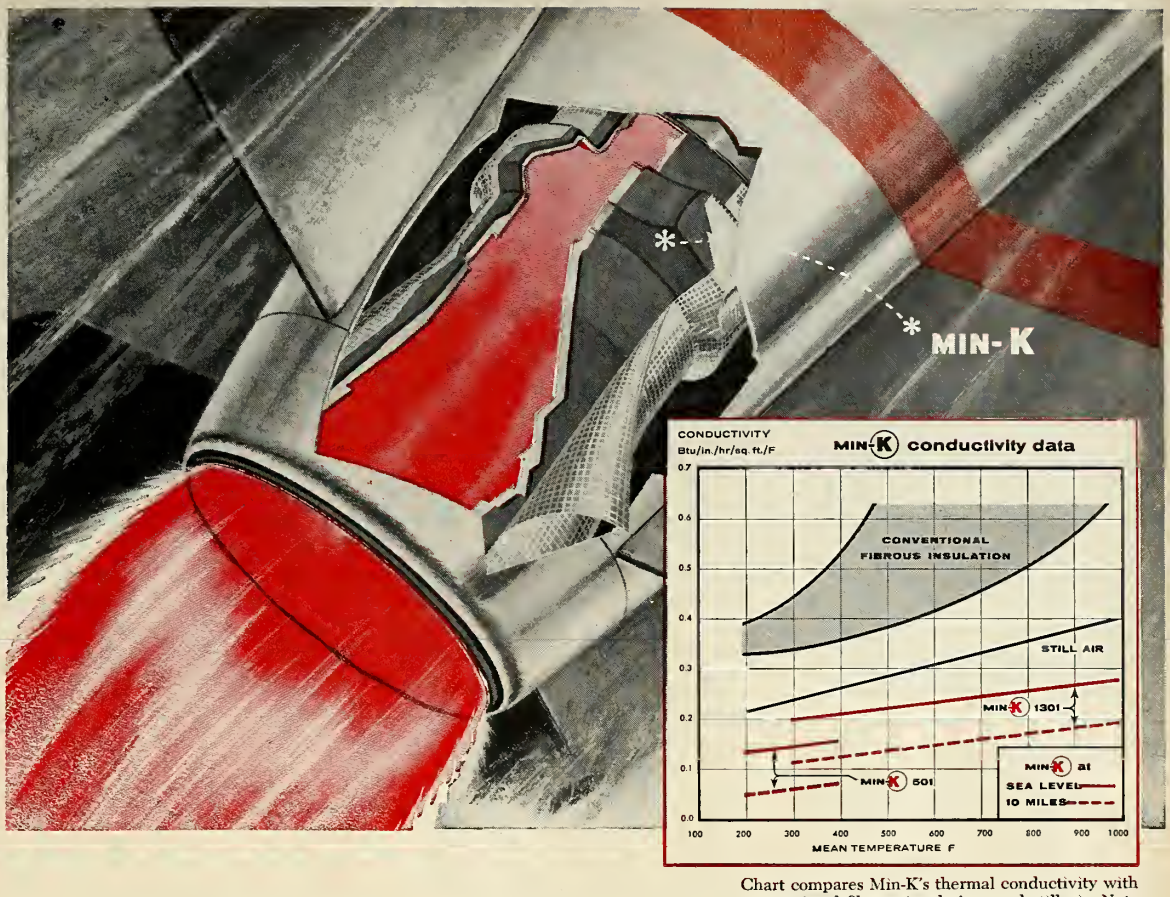


Chart compares Min-K's thermal conductivity with conventional fibrous insulations and still air. Note that Min-K's conductivity decreases with altitude.

Johns-Manville announces . . .

A scientific break-through in missile insulation!

New MIN-K has lower conductivity than still air—performs better the higher it flies

- **Saves missile space to boost fuel capacity and range**
- **Protects instrumentation more effectively to increase accuracy**
- **Offers lower thermal conductivity than any known insulating material**
- **Now performing successfully in operational U.S. missiles**

Min-K is in every meaning of the term—a scientific break-through!

For in Min-K, Johns-Manville research scientists have developed an insulating material entirely new in concept, an insulation so effective that its thermal conductivity is actually below what was long called the ultimate—the molecular conductivity of still air.

Increases accuracy and range

With this new low in thermal conductivity (less than half that of the best fibrous insulations), Min-K contributes to greater accuracy by providing more effective protection of temperature-sensitive instrumentation . . . increases range by conserving space for greater fuel storage.

Insulates better the higher it flies

Unique with Min-K is improved performance at altitude, for its thermal conductivity drops appreciably as atmospheric pressure decreases. At an altitude of 10 miles, for example, Min-K's thermal conductivity is decreased by as much as 40%, and further decreases at higher altitudes!

Manufactured by J-M as integral parts—Min-K insulations are precision molded to any shape you specify . . . encased in high-temperature metal foils or laminated to reinforced plastics. Min-K insulations include a wide variety of strengths, densities and temperature resistances.

For detailed information about Min-K, write Johns-Manville, Box 14, New York 16, N. Y. (Ask, too, for aviation insulation brochure IN-185A.) In Canada, Port Credit, Ontario.

JOHNS-MANVILLE

JOHNS-MANVILLE PRODUCTS

space age

by Norman L. Baker

• **Radiation belt**—A crash program for launching satellites at larger angles of inclination from Cape Canaveral is under consideration as a result of the high radiation belt encountered by *Explorer* I and II. Tentatively identified as either protons or X-rays emanating from the sun, the intensity rate recorded might make travel beyond 1,000 miles impossible. Yet, space medicine scientists are not deeply concerned. Latest postulations consider either localized concentrations, or a belt a thousand miles in depth—making extended flights in the radiation regions unnecessary.

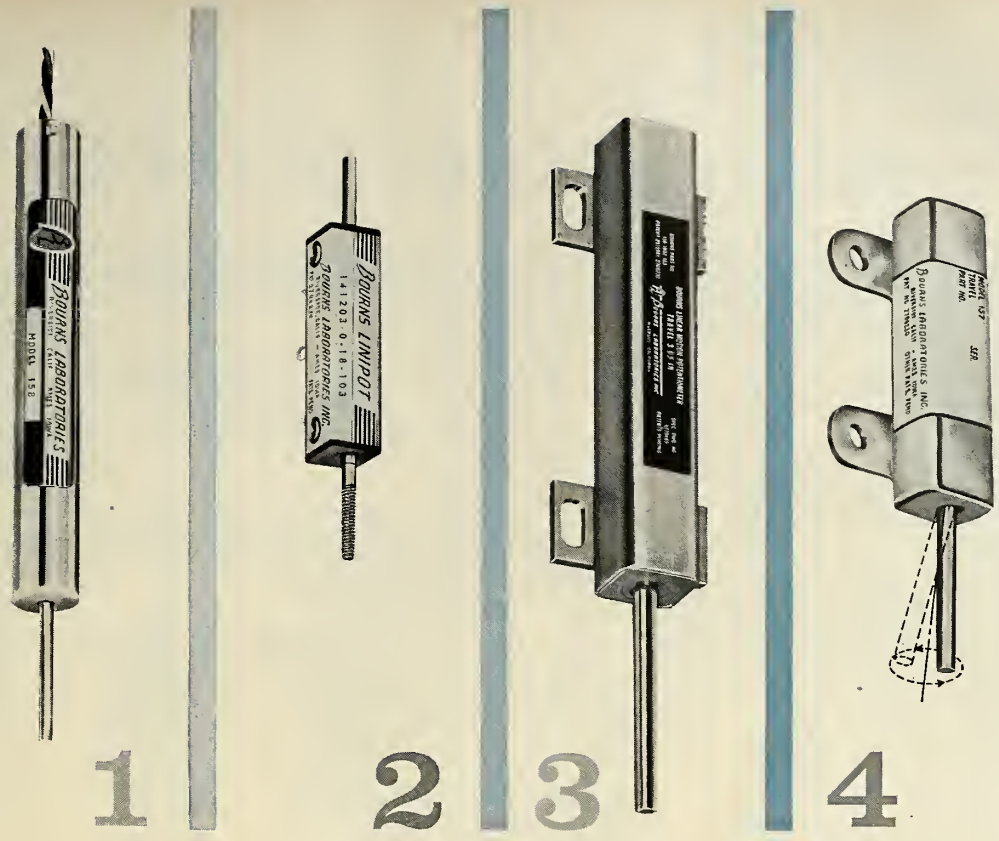
• **Liquid propellant engineers** are now conceding that their position as competitors in the next generation of long range missiles can only be assured by switching to storable fuels. Liquid oxygen, long the workhorse oxidizer, will gradually give way to oxidizers such as nitrogen tetroxide combined with unsymmetrical dimethyl-hydrazine or hydrazine itself. Acid, an excellent oxidizer, is on its way out. Even under the best storage conditions, acids eventually contaminate and erode everything that comes in contact with them. This has been demonstrated in the exorbitant overhaul and repair contracts now outstanding in the *Nike Ajax* missile system.

• **Contract negotiations** for the *Minuteman* ICBM are undergoing a period of muddled confusion. Competition is at an all time high. Astrodyne, the Air Force dark horse, has begun the switch to castable propellant manufacturing facilities, but needs help from the AF in developing facilities that could handle the large grains needed by the *Minuteman*. Successful development of five to eight foot grains is still months away, contrary to the Navy's claims of *Polaris* FBM success.

• *Sputnik* **IV and V**—Experts trying to anticipate the Russians next satellite achievements are predicting that one of the next two vehicles will be equipped for a reentry attempt possibly with an animal passenger. The big question—will the USSR let the U.S. make the first attempt at impacting the moon's surface? The Air Force is still denying it will attempt the first lunar probe on July 4.

• **Aero Medical scientists** in Dayton, Ohio, recently demonstrated that a man immersed in water can withstand 13 g's of acceleration for a period of four minutes. Completely mobile throughout the test, the duration of the run was limited only by the man's ability to breathe. This experimental device is reported as another Russian first. The rocket pioneer, Tsiolkovsky, proposed a similar machine many years ago. It was later proved successful in an experiment by two Soviet scientists by subjecting a frog immersed in a liquid to an acceleration of 1000 g's.

• **Top defense department** officials responsible for closing the expanding gap in Russian and U.S. satellite efforts are not impressed by the launching of *Sputnik* III. At the same time, they calmly announce that it may be two years before the U.S. can afford to divert military rockets for launching scientific satellites weighing more than a ton. The *New Horizon* (formerly *Pied Piper*) reconnaissance satellite is regarded as more important. The October shoot, planned for launch from Point Mugu into a polar orbit, will be a half-ton dummy vehicle.



FOUR IMPORTANT NEW SHORT-TRAVEL POSITION TRANSDUCERS FROM BOURNS

Here are four problem-solvers made especially for travels of ½" to 6".
These are small instruments—units you can fit into the really *tight* spaces.
All of them offer long life under extreme vibration and heat (as *high* as 450°F)
...and each one solves a *special problem*, too:

1 FITS INSIDE ACTUATORS The Model 158 is small, tubular, unique—it fits *completely inside* hydraulic actuators or other telescoping devices.

2 FITS IN TIGHT SPACES The model 141 LINIPOT® is the smallest unit of its type available. Cross section is only ¼" x 5/16"

3 SIMPLIFIES SHAFT ALIGNMENT Where alignment is impossible, or where side loads exist, use the Model 156 ALIGN-O-POT®. It's self-aligning.

4 NOISE-FREE AT 40 G's If you have high vibration environments and alignment problems, your solution is the Model 157 ALIGN-O-POT.

These are only four models. There are hundreds more available, with many variations, in travels up to 32"

Write for new Instrument Brochure

Protected by one or both of U. S. Patents Nos. 2,706,230 and 2,805,307. Other patents pending.

BOURNS
Laboratories, Inc.

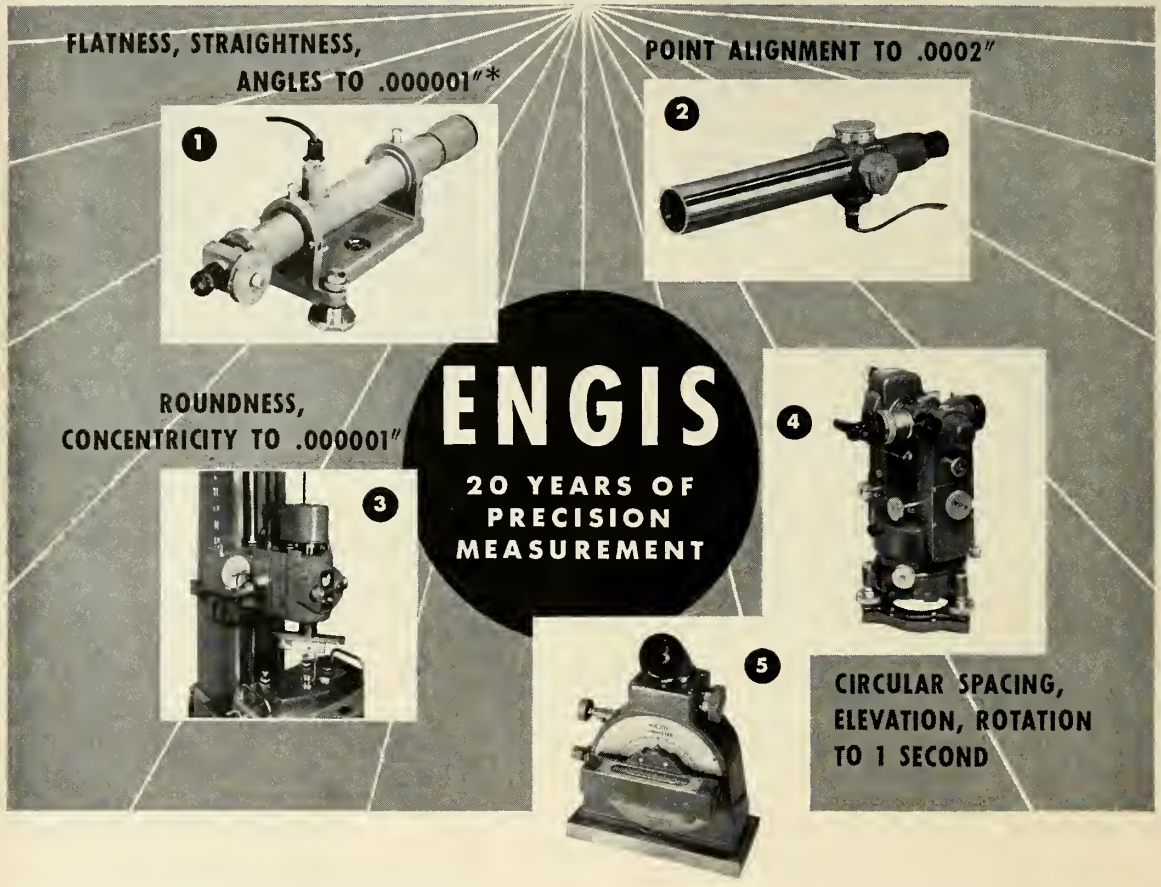
P. O. Box 2112C • Riverside, California

FIELD OFFICES: 21 Walt Whitman Road, Huntington Station, L. I., New York
4515 Prentice Street, Dallas 6, Texas

ORIGINATORS OF TRIMPOT® AND TRIMIT®
PIONEERS IN POTENTIOMETER TRANSDUCERS FOR POSITION, PRESSURE AND ACCELERATION

Circle No. 42 on Subscriber Service Card.

gaging...
micro-inches or miles



1. **MICROPTIC AUTO-COLLIMATOR**
Detects change of angle to .1 second direct reading—range, 10 minutes. *The universal optical tooling instrument to test alignment, straightness, flatness, squareness, angles to better than .000001" per inch.

2. **MICRO-ALIGNMENT TELESCOPE**
For alignment of all points at any distance; built-in standard and high precision micrometers; improved auto-reflection and auto-collimation equipment for precise squareness setting. Complete projection accessories.

3. **TALYROND ROUNDNESS ANALYZER**
The electronic master instrument to measure and record roundness and concentricity on all products of circular cross section. Full range of magnifications, motorized adjustments, for diameters from .01" to 12".

4. **MICROPTIC THEODOLITE NO. 2**
Direct reading to 1 second; fully enclosed precision bubble; specially designed for engineering and testing application. New auto-collimation features.

5. **MICROPTIC PRECISION CLINOMETERS**
For all accurate angular settings over 360 degrees; reading direct to 1 second or to 10 seconds. The most precise instruments of a complete range.

Fully illustrated description available, together with application engineering data from years of successful optical tooling and metrology experience.

ENGIS EQUIPMENT COMPANY 431 S. DEARBORN STREET, CHICAGO 5, ILL.

OPTICAL, MECHANICAL, ELECTRONIC GAGES AND INSPECTION DEVICES

Circle No. 43 on Subscriber Service Card.

washington trends

by William O. Miller

All the noise being made about how many *Thor* squadrons or how many *Jupiter* squadrons will be activated or sent to overseas bases is just so much sound and fury. Reliable reports are that no decision has been made, nor can be made, right now. Reason: Douglas tooled up too fast and for the moment, it can't handle immediate mass production of the *Thor* with the various modifications being plowed into the bird. Most hopeful guesses are that there will be attempts at delivery to Britain—maybe—by the end of the year.

Quietly heard among the Pentagon whispers is plans for a TCBM—Transcontinental Ballistic Missile (see page 39). Reports are that the Air Force is after the job to develop the TCBM, which is said to be in the 11,000 mile range class. Simple arithmetic shows it could hit anywhere on this shrinking planet.

Despite statements to the contrary made by DOD information chief Murray Snyder, the Chiefs of Information of the Services have not been consulted about the proposal to take them and their departments into the "protective custody" of DOD. Perhaps Mr. Snyder was referring to the formation of an ad hoc committee, with members from each service, to study the proposal and make recommendations. Just one catch—the committee has held no meetings and there is no plan in the works, except perhaps in the office of Mr. Snyder's executive officer, John Carland.

The Rebel viewpoint was given recently during the Senate Special Committee on Space and Astronautics. An astute member of the Fourth Estate asked the Chairman of the committee, Senator Lyndon Johnson, what DOD meant. Said the Texas senator: "Democrats of Dixie."

Speculation and rumor have been the two biggest results of the current reorganization tempest. One rumor making the rounds is that Secretary of the Navy Thomas S. Gates will make a summation for the opposition and then resign. The truth: yes and no. The Navy chief may resign in the not-too-distant future, but not as a result of the reorganization squabble. And there won't be any sounding off before, if he does. Gates is a fighter, and if he backs out of the fight for what the Navy believes, it would do little more than open his influential post to a pro-reorganization appointee. Such an appointee would come from outside present Navy executive ranks. The first reason is obvious, and the second is that there really isn't a heavyweight available to take on the job. If Gates resigns, the real reason will be that he has been in the inner circle that sits on the outer circle of the Pentagon for five years already. He's been heard to say any man loses his usefulness after just so many years in the rarified Potomac atmosphere.

A second report is that DOD is dickering with the star of the Army missile team, Wernher von Braun, for a job in ARPA. Forget it. Second only to his loyalty to the U.S., is the missile expert's loyalty and concern for holding together the team he has built at Huntsville.

Testifying before the Senate Space Committee, Roy W. Johnson, director of the Advanced Research Projects Agency, said that if the Atomic Energy Commission was formed on the basis of "Atoms for Peace" . . . it wouldn't have gone very far. Thus, Mr. Johnson reasoned, ARPA should be formed under the DOD on a military war-time basis, rather than on a "space for peace" basis. (DOD, rather than a civilian agency, would be the decision-making agency). Also, Mr. Johnson added that "military-oriented people are more alert in emergencies." (?). He gave as an example the aircraft industry of today, which he said was spurred by the military needs of aircraft, rather than civilian.

BRUNSWICK HONEYCOMB IS *MIRACLE METAL!*

Brunswick Laminated Honeycomb weighs only .0005 of a pound per square inch, yet this miracle in metal can support over 1000 pounds per square inch. Metal honeycomb's high strength to weight ratio, resistance to sonic vibration, resistance to flexure are just some of the many advantages it offers aviation.

Leading producers of military aircraft regard Brunswick as the prime supplier of compound contoured honeycomb components. Brunswick has earned this reputation. Experience and engineering skills in depth are furthering it! Every phase of production is held well within the tolerance limits by skilled research.

Whatever your problem in metal honeycomb, conventional metalwork or in reinforced plastics, Brunswick can do the *complete* job . . . from design right through fabrication and testing. Write today to: The Brunswick-Balke-Collender Co., Defense Products Division, 1700 Messler St., Muskegon, Mich.

BRUNSWICK

MAKES YOUR IDEAS *WORK*

VOL. 3 NO. 7

JUNE, 1958

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

U.S. Pushing Big Family of New Missiles

Air Force Proposes 11,000 mile TCBM

by Erik Bergaust

We are far behind the Russians (and probably will be for another five years), but you can't say we aren't trying to catch up! U.S. Air Force is believed to be pushing a new concept in long-range missiles—the TCBM or Trans-Continental Ballistic Missile, with a range of 11,000 miles, almost halfway around the globe. Despite the "no comment" from Air Force officials, m/r's traditionally reliable sources have indicated the new missile will essentially be an *Atlas* or *Titan* with skip-glide characteristics, i.e. with small aerodynamic surfaces or wings. Purpose: Air Force will be capable of launching a missile toward any target on earth from homeland bases.

Meanwhile, the Navy—as predicted by this writer in the April 1958 issue of m/r—is pushing harder than any one of the services toward a truly sophisticated missile program. The Navy has more than a dozen new missiles in the works including one which may turn out to be "the ultimate" in air-to-air defense. Undoubtedly the Navy's goal is to become the number one service as far as missiles are concerned.

• **ARCON is a Navy research missile** in the design and development stage. The missile has been statically tested and is approaching final production. Developed by Atlantic Research Corporation, the *Arcon* is a solid-propellant missile.

• **IRIS is another research vehicle,** also built by Atlantic Research. This missile is reported to be somewhat nearer production than *Arcon*. It is a solid-propellant rocket.

• **XKDT-1 is a new rocket-powered Navy** target drone, sometimes referred to as *Teal*. Under a Temco Aircraft contract the XKDT-1 is designed as a high-speed target for Navy air-to-air missiles such as *Sparrow, Sidewinder* and others. Temco's remarkable contribution to the missile business often has been overlooked. One Washington official says, "Temco's work on the XKDT-1 is so remarkable it indicates they (Temco) is in the missile business for good."

• **The Navy is reported** to be particularly proud of its new air-to-air missile, the EAGLE. This weapon—for which no development contract as yet has been awarded—is termed the "most sophisticated air-to-air system ever thought of" by experts close to the Navy. No details have been revealed.

• **BETTY (Mk90)** is another sophisticated weapon developed by the Navy. An offshoot of *Lulu,* the Mk90 is a nuclear depth charge which can be launched from ships as well as aircraft. No details are available.

• **In the same category** as the *Betty* is the Navy's HOT POINT, a nuclear warhead missile designed for anti-airfield bombing. The weapon also can be employed against marine targets, such as surface vessels and subs.

• **The sailors also** have something in mind for their mothballed battleships in case things should get hot and they would have to re-commission them. KATIE reportedly is a missile projectile capable of being fired from battleship 16-inch guns. It would carry a nuclear warhead.

Most interesting of the new Navy missiles seems to be the new family of air-to-surface weapons. Nuclear warheads are reported to be considered for all of them. Only one contractor has been named. Sources have revealed that all of the weapons are beyond the research and development stage.

• **BOAR, which is definitely** equipped with an atomic warhead, is unguided. The missile is rocket boosted. It is in production. Royal Industries is believed to have a production contract.

• **RAVEN is another air-to-surface** weapon for the Navy. No production contract has been awarded. A hot-gas generator propulsion system is reported to be employed.

• **HOPI might represent the most advanced** of the Navy air-to-surface vehicles. Undertaken by NOTS, the *Hopi* carries a hydrogen warhead and is beyond the development stage.

Navy missile men also are pushing their forthcoming family of underwater missiles. While it took the sailors many, many years to accept and understand the concept of this obvious approach to modern warfare, much has been done to catch up. Only a few weeks ago the development contract for the EX-8, a sophisticated rocket-powered torpedo missile, was given to Aerojet. Bendix Pacific also is reported to be in on it. Furthermore, Navy's old supplier of torpedoes—Westinghouse Ordnance, Baltimore—is working on a contract to develop ASTOR, and Anti Sub Torpedo Ordnance Rocket. Status: development.

There is a report that the Oceanographic Laboratory at Woods Hole, Mass. is working on something "just out of this world" for the Navy (in terms of underwater warfare) but no details were available at press time.

• **Air Force, being hampered** by missile firing mishaps and somewhat concerned about the fact that its ballistic missile program already costs the U.S. taxpayer *three million dollars a day,* seems to be overlooking the fast-moving Navy. As is known, the Navy's efficient *Sidewinder* has been adopted by the Air Force. The Air Force also may find it necessary to adopt other Army or Navy missiles because of the all-out effort on the big missiles. However, the Air Force is pushing the MCM (Missile-Carrying-Mouse) which is reported to be an experimental, large surface-to-air missile carrying several smaller target-seeking (infra-red) anti-aircraft missiles.

Air Force also is trying to materialize its LAZY DOG missile—a small two-inch air-to-surface device to be used against troop concentrations. Developed at Eglin, LAZY DOG is reported to be "tops in anti-personnel warfare."

• **The Army doesn't have much** to brag about either. There is, nevertheless, a report that the soldiers are working hard on a new anti-missile missile called the VIGILANTE. Some sources indicate this is the Army's answer to the Air Force *Wizard* challenge. The somewhat unique *Vigilante* is in the r & d stage.

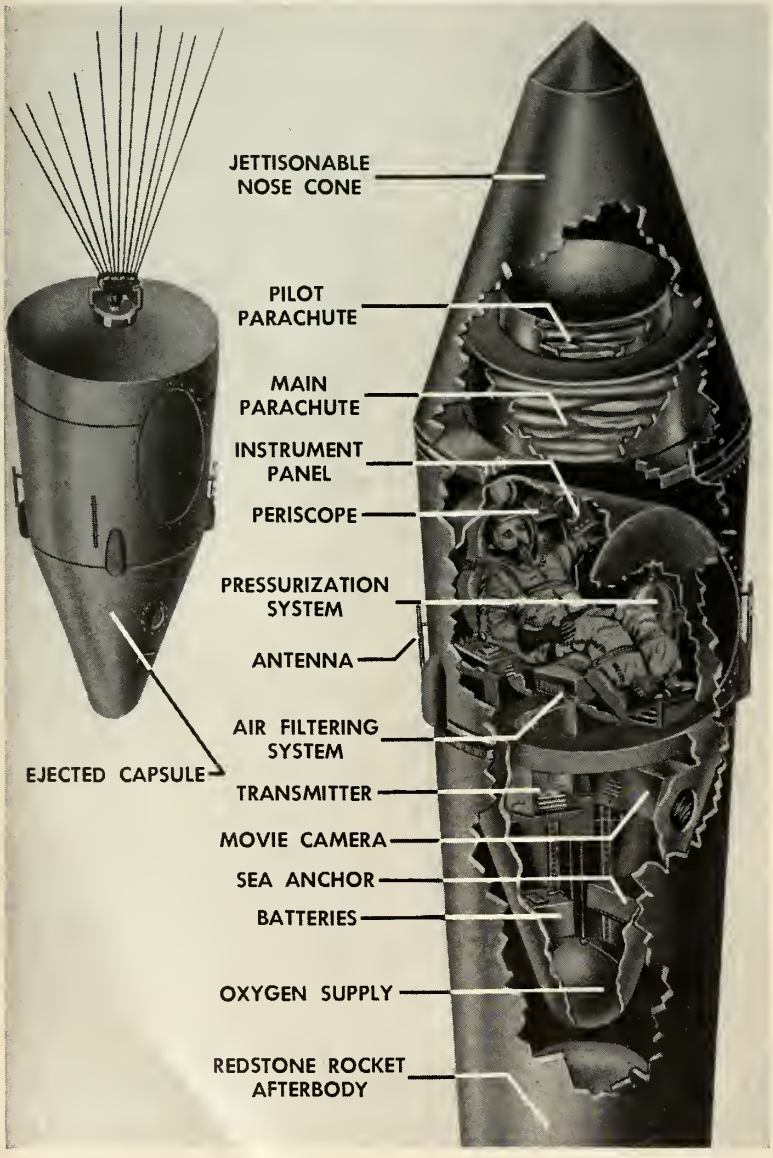
Air Force Won't Support Project *Adam*

by Norman L. Baker

Project *Adam*, an Army proposal to send a man 150 miles out into space, has been blocked by the Air Force to boost its own X-15 plans. The proposal, drawn up several months ago by members of the Army, Navy and Air Force, involves a highly formulated plan for enclosing a man within the control section of a modified *Redstone* rocket; boosting the section 150 miles up in near vertical flight; and recovering the package by parachutes.

Late last year, several high officials from the Air Force at Holloman AFB, N.M.; Randolph AFB, Texas; and from the Navy at Pensacola, Fla., were asked by ABMA personnel to participate in the design, development and program planning of the project. All officials contacted were very enthusiastic about the proposal and without hesitation volunteered their services with the announcement they were "solidly behind it."

This situation prevailed until ARDC headquarters told its personnel to "get out and stay out." Original plans included Lt. Col. D. G. Simons as designer of the capsule and its first pilot (despite his denial of it). Col. Simons has been designing capsules for years for animal flights in rockets and balloons. A Wright Aero Medical Lab official is believed to be one of the men behind the AF denouncement of the proposed project.



L. Corcoran

PROJECT *Adam* recoverable manned capsule; 70 in. wide, 120 in. deep.

• **Weightlessness**—All the people involved in Project *Adam* are determined that the chances of returning the man alive must be better than excellent. This is where a close analysis of not only project *Adam*, but also the AF manned flight in the X-15 is necessary.

Maj. Apt, while piloting the X-2, was killed when he lost control, in what is believed to have been under conditions of weightlessness. In Col. John P. Stapp's opinion, weightlessness is still the one big question to be answered before safe manned space flight is assured.

Yet, the X-15 is scheduled to fly next year without real knowledge of what effects extended periods of weightlessness will have on the pilots response control. All weightlessness tests to date have been for only seconds of time.

Complicating the safe return of the X-15 pilot still further will be the use of an untried, still to be developed, rocket engine. Its thrust will approach that of the *Jupiter*-C rocket—it will use the dangerous liquid oxygen, and yet it will not have the years of testing background and proven reliability of the *Jupiter*-C engine.

The experts say there should be two approaches to the first manned satellite. The AF has proposed that the X-15, with large rocket boosters, be utilized as the first such flight. In case of plane failure or pilot's loss of control, he would still need a proven system of automatic recovery from satellite altitude and velocity. This is the major field of experimentation for Project *Adam*.

Project *Adam* would be ready for first flights one year from the date of program approval. Any program for placing man in space with the X-15, at the current rate of development, would be two or three years away.

Project *Adam* would investigate four areas of experimentation: safety of launching rocket, weightlessness, aerodynamic heating and reentry and recovery techniques.

• *Redstone* **reliable**—Of all the rocket carriers in existence in the United States, the *Redstone* missile is the most tried and reliable. In develop-

ment since 1953, it has been fired repeatedly as a basic *Redstone* short range missile, later modified as the booster for the *Jupiter*-C configuration, and now is in the hands of Army troops. A *Jupiter*-C configuration—minus the upper staging arrangement and Hydne fuel—would be utilized for Project *Adam*.

The *Redstone* is also the most aerodynamically stable missile in U.S. arsenal. Its stability, referred to as 'arrow stability,' is similar to the stability characteristics of an airplane. In the event of engine failure shortly after launching, the *Redstone* remains in a vertical attitude throughout the remainder of its flight. This optimizes the chances of ejecting the human cargo from its nose for recovery.

The IRBM and ICBM missiles, on the other hand, do not have these control features. Within seconds after power failure, these missiles pitch over to horizontal attitude with a usual resultant explosion.

Adam would subject its pilot to at least six minutes of combined negative g's and complete weightlessness. Total flight time, from launch to return to earth would be approximately ten minutes. Pilot would go into weightless free fall about two minutes after blasting off, when the rocket reaches burnout.

Six minutes later, the drag chutes would be fully open and lowering the capsule to the surface of the ocean. Acceleration of the rocket would subject pilot to a maximum of 7 g's for slightly over ten seconds. This is well within proven tolerable limits.

Studies on the problems of aerodynamic heating, reentry and recovery principles were conducted by the Cook Research Labs of Morton Grove, Ill. at the invitation of ABMA. Cook devised the parachute-flotation equipment for the *Jupiter*-C and *Jupiter* IRBM test nose cones that have been successfully recovered in recent tests.

Early experiments involved the recovery of monkeys from high altitude (50-60 mile) rocket flights. The Project *Adam* equipment would be based upon the same principles, but much improved over the present system.

• **Equipment**—Two to three high speed drag chutes would slowly decelerate the manned capsule upon entering the atmosphere. The opening of the chutes would be automatically controlled by an acceleration-deceleration switching system, designed to hold g's forces below the pilot's limit of endurance.

The capsule within a capsule is designed to float in an upright position, similar to a buoy, after landing in the water. The equipment is arranged in the lower cone section of the capsule for attainment of a low center of gravity.

An automatic radio beacon which begins transmitting while the capsule is still in flight would guide recovery ships to the point of impact. The pilot would also be in constant radio contact throughout the flight.

Additional recovery features include flashing beacon light for night recovery, sea dye marker, and sea anchors to stabilize the bobbing capsule and prevent drifting.

The "space cabin" capsule for housing the pilot would be a cylinder about 4 ft. in diameter and 6 ft. in length. It is designed for insertion within the equipment capsule through a side access door.

It would be equipped with an oxygen supply, air filtration system, nitrogen pressuration system, recording instrument panel, emergency manual controls for attitude and parachute release control, and a periscope for external viewing.

The pilot would be strapped in a supine position in a special acceleration couch. Controls for emergency operation would be located at the 'arm rest' position to enable manipulation during acceleration.

Four flights, costing an estimated $10-12-million, have been planned. The first two flights would be equipment-test experiments, with well-instrumented monkeys as passengers. The remaining flights, fully equipped, would be manned.

In anticipation of government approval of the proposal, four out of twelve elongated *Jupiter*-C rocket carriers, constructed for satellite launchings, have been put aside for the Project *Adam* experiments.★

Propulsion, Electronics To Get Missile Money

Propulsion and electronics manufacturers may get the majority of future weapon systems business, it has been forecast by Malcolm A. MacIntyre, Under Secretary of the Air Force.

MacIntyre recently told a group of bankers in New York: "Development and production of future vehicles which are primarily electronic devices with frames designed to house the systems may be managed by electronic companies. Similarly, propulsion manufacturers may become prime contractors." He added that during the early stages of space vehicle development and production, quantity orders of 10 or less may be the business norm.

Jupiter Test Sparks IRBM/ICBM Firing Series

Although the recent successful flight of the *Jupiter* got most of its "press" from the nose-cone recovery, Army scientists are more elated about a little-known problem which the flight proved had been solved.

Problem was the propulsion system —reduction gearing in particular. Significant thing is that in prior flights, gearing that had been checked out perfectly on the ground, failed in flight. ABMA personnel recognized the problem and rectified it.

Their successful solution will now be used on the *Thor* and *Atlas* missiles, so look for a whole series of IRBM and ICBM tests in the near future.

In the test, the Army successfully fired and recovered the full *Jupiter* combat nose cone from a flight that went the design distance of 1,650 statute miles. The IRBM employed the same nose-cone recovery techniques which permitted the recovery last fall of the *Jupiter*-C test nose cone.

The important result of this test is that the nose cone survived its reentry intact, i.e., in such condition that a nuclear payload inside could have been detonated at its intended altitude. This is the first successful actual firing of a full-fledged reentry nose cone.

The *Jupiter* nose cone recovery gear was developed by Cook Research Laboratories. Chrysler Corp. is the prime contractor on *Jupiter* production. North American Aviation Rocketdyne division makes the 135,000-pound thrust liquid propellant motor.

The sequence of recovery is as follows:

While still out in space, the back cover of the nose cone is exploded away. Fifteen seconds later, a parachute is ejected explosively. This occurs at under 5,000 feet altitude, so that the bulk of the nose cone's reentry has been accomplished before it is artificially slowed. At this point the nose cone is white hot.

Prior to impact in the water, a recovery package separates itself from the nose cone by means of explosive screws. This package releases a balloon whose bouyancy keeps the nose cone near the surface, and serves both as a radio beacon and a light.

In the final stage, prior to hitting the water, the balloon trails the parachute, thus permitting the latter to take the brunt of the impact shock. After entering the water, a small depth charge fires to enable waiting recovery personnel, (estimated about 20 miles from the expected point of impact), to sound range on the location. In addition, a dyemarker and shark repellent are released into the water.★

Space Bill May End Military–Civilian Battle

House measure sets up liaison committee— Senate prepares similar space legislation

The current legislative tug-of-war on the President's proposal to create a civilian space agency could be resolved by a bill which has cleared the House Select Committee on Astronautics and Space Exploration.

The pacifier may be in a provision that would establish a special liaison committee, representing the Defense Department, which would work in the proposed National Aeronautics and Space Administration. Under the President's proposal, NASA would be a reorganization and enlargement of present the National Advisory Committee for Aeronautics—which does research on aircraft. The House bill, however, would create a much stronger independent administration that would cooperate, but not conflict with, Defense Department devolepment of military weapons.

The proposed liaison committee would settle disputes over whether a particular space project was in the province of the military or the space agency. Failing, the decision would be made by the President. The Senate is working on similar legislation.

Other features of the house bill are:

1. A precedent-setting anti-secrecy provision which would require the space administration's data to be made public, except where it can be withheld under a specific law or for national security reasons.

2. Abolishing present special House and Senate space committees, and replacement by a joint House-Senate committee like the one now handling atomic energy matters.

3. Provision of a 17-member Aeronautics and Space Advisory committee, which members of NACA would attend. Government representatives, including at least three from the Defense Department, would represent nine members.

4. Inclusion of the space administration director (Dr. Hugh Dryden, present director of NACA, has been mentioned as a likely candidate for the post) at attend National Security Council meetings. Also, the space administration should be given power to appoint 200 scientists and engineers.

• **Testimony**—During House hearings, Roy W. Johnson, director of the Advanced Research Projects Agency of the Defense Department, said he was opposed to a civilian space agency with over-all control—the agency should, in effect, handle only uncompleted projects by the military. He said he favored only an extension of the NACA.

Johnson was backed in his opinion by Defense Secretary Neil H. McElroy, and other top spokesmen for the Armed Forces. They said the President's proposal might water down military control. McElroy said the Defense Department must continue to have "funding and direction" over the "military aspects of the space program."

• **Legislation readied**—The Special Senate Committee on Astronautics and Space Exploration, which recently concluded hearings on the President's proposal, is preparing to write legislation now.

During the hearings, Senator Styles Bridges complained that the President's program has "fallen over backwards" toward civilian control, and gives too little voice to the military. A fellow committee member, Senator Clinton P. Anderson, complained that the space agency would leave the military—as well as representatives of private interests—with too much power over space activities.

Other criticism was that the Administration proposal does not provide for international cooperation in space research; fails to recognize the importance of nuclear energy for space propulsion; civilian space exploration would become wrapped in unnecessary secrecy; and the director of the space agency could act independently of his 17-member advisory board. Make-up of the board also was questioned.

Some Senate objections were removed when the Administration offered clarifying amendments. One amendment would give the government a majority of seats on the advisory board, and members of the board could not be representatives of private corporations or seeking government space contracts.

Senator Bridges' basic complaint was that in the "popularity" of the civilian control concept, too much of a barrier could be placed between the military departments and the civilian program. He asked what would happen, for example, if the agency wanted four *Atlas* missiles for its explorations and the Air Force thought the missiles were needed for defense.

Assistant Defense Secretary Donald Quarles replied that space exploration would depend very heavily on military missiles for some time to come, and "priorities" would be decided by the President.

What's in Name for Space Agency?

While direction and responsibility for the nation's space exploration, in the words of Senator Lyndon B. Johnson, chairman of the Special Senate Committee on Astronautics and Space Exploration, "seems to be scattered around in as many agencies as have an interest in the field," there also is no dearth of suggested names for a principal agency.

Here are a few:

National Astronautics Agency (proposed in Senate bill 3604)

National Aeronautics and Space Agency (President's proposal in Senate bill 3609)

National Aeronautics and Space Administration (proposed by House Astronautics and Space Committee)

Astronautical Research and Development Agency (proposed to President by American Rocket Society)

Department of Science and Technology (proposed in Senate bills 3126, 3180)

Federal Space Exploration Commission (proposed by National Society of Professional Engineers)

Outer Space Commission (proposed in House bills 9874, 9966).

Revised Policy Suggested On Federal Secrecy Rules

The House Committee on Government Operations has recommended that American science be freed from the straitjacket of excessive secrecy and has detailed its recommendations in a report to the House.

The committee suggested that a system of uniform security clearances, applying to scientists working for all agencies and all defense contractors, should be established to increase the efficiency and economy of the clearance procedure.

The "need-to-know" criteria should be abolished, according to the committee, so that American scientists who have passed a rigid security clearance may have ready access to the technological information necessary to help the nation regain scientific supremacy

"Neat Scientific Trick": *Sputnik* III in Orbit

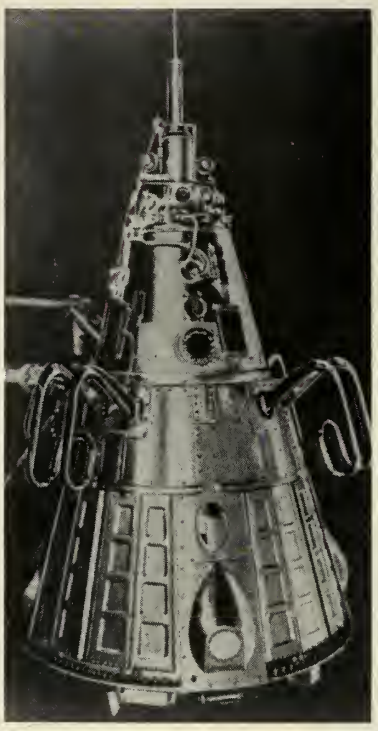
an m/r staff analysis

"On May 15, 1958, the third Soviet artificial earth satellite was orbited. The sputnik's orbital plane, like those of the first two, is at an angle of 65 degrees to the plane of the equator. At 1,167.4 miles, the third sputnik's maximum height of orbit exceeds that of the previous two. It circles the globe in 106 minutes.

"The outstanding feature of the new sputnik is its weight—2,925 pounds, almost 16 times greater than that of Sputnik I and almost 100 times heavier than America's first and third sputniks, Explorer I and Explorer III.

"Further important steps in the conquest of outer space, particularly in obtaining valuable data on the moon's surface and in the study of pre-lunar space, will require sputniks of considerable size and equipped with diverse instruments . . . Sputnik III's launching confirms the possibility of an early solution of these problems . . ."

Release by the Embassy of the Union of Soviet Socialist Republics



Sovfoto

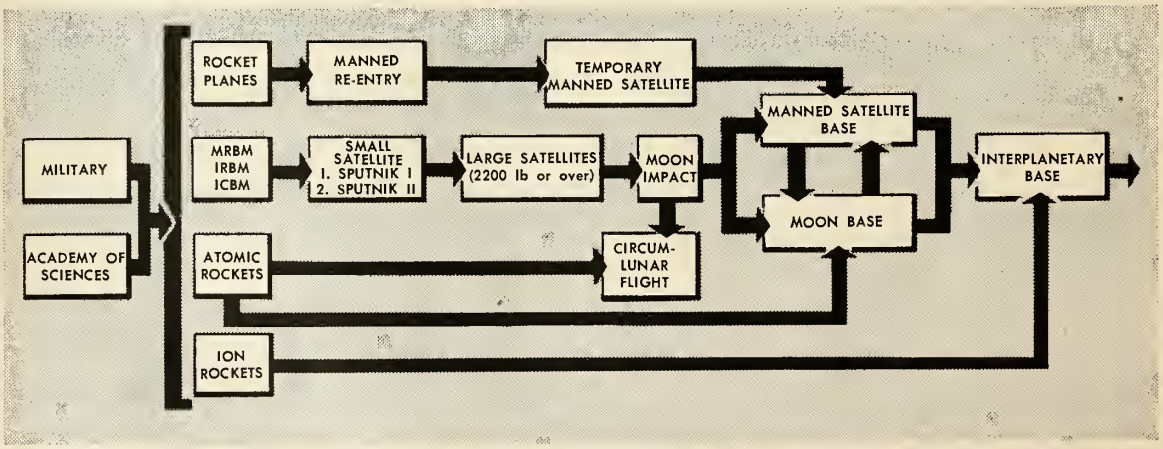
The launching of the third Soviet earth satellite should provide conclusive evidence to the United States that Russia is following a well organized and coordinated space program. Although the Soviet program as well as our own may be suffering some mishaps, it is forging ahead in tremendous strides. Ample evidence is at hand.

Sputnik III is a particularly significant achievement because of its size and weight, which demands a thrust still not available in the United States. But, just as significant, is the vast array of experiments being conducted simultaneously indicating that the Soviets may have achieved a degree of miniaturization. Dr. Joseph Kaplan, Chairman of the U.S. National Committee for the IGY, said the information obtained from the instruments in *Sputnik* III will be of tremendous value to world scientists.

The great size of *Sputnik* III "means that practically all the experiments which were done separately in smaller satellites are now being done together in one package. The data thus collected, on the intensity of solar radiation and the magnetic fields in the upper atmosphere, is likely to be more accurate than that gathered in smaller satellites where instruments must be miniaturized," Kaplan said.

This latest satellite is further warning of the advanced state of the Soviet military rocket program. Military officials disagree on the amount of thrust needed to boost the 1½-tons into orbit, but all agree that the thrust is in excess of that needed to power an ICBM. The guidance and reentry capability of the Soviet intercontinental ballistic missile is an unknown factor. But the general concensus is the belief that Soviet scientists have a workable solution to these problems.

• **Data available**—The released data on the shape and size of *Sputnik* III provides a means of estimating the size and power of the launching rockets. It is estimated that the last stage rocket orbiting ahead of the satellite nose cone is 6 to 8 ft. in diameter and approximately 70 ft. in length. This corresponds to available figures of the



OPERATIONAL CHART of the Soviet rocket, missile and space travel program illustrates the step-by-step plan of operation.

T-2 IRBM, reported to have a thrust of 254,000 pounds. The weight of the last stage is further estimated to be about 7,000 pounds.

The Soviets did not disclose the number of stages used in the launching vehicle, although it could have been either a two or three stage rocket developed especially for the satellite launching. Power to boost what is possibly 5 tons to an orbiting velocity may have required a thrust of about 800,000 pounds. This could be a single rocket engine or a cluster of three of the 254,000-lb. thrust units.

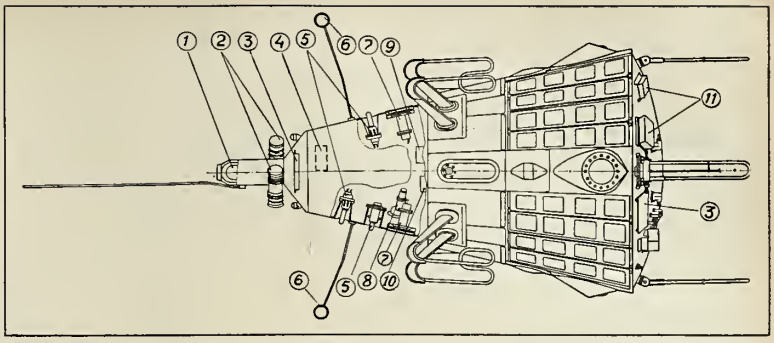
The USSR had considered sending *Sputnik* III to the moon, but, according to astronomer N. Varvarov, it was too early for the lunar probe to be worthwhile. Lack of necessary instruments for transmitting data back to the earth was given as the reason for postponing the moon shot.

Dr. Wernher von Braun said the latest Russian accomplishment merely confirms his belief that the Russians are ahead of us in the missile and space programs. "We simply have not got the rockets yet to lift a satellite of similar weight."

• **Any mishaps?**—Soviet scientists continue to deny there were any failures in this latest satellite. An Italian Communist news agency had reported earlier that an attempt had been made on May 1 and May 3. Each time the launching was postponed "due to technical difficulties." Unlike the United States' program of using the same vehicle for several flights, each of the Soviet satellites have been radically different in configuration, size, weight and instrumentation. This would necessitate additional development and modification time between individual launchings.

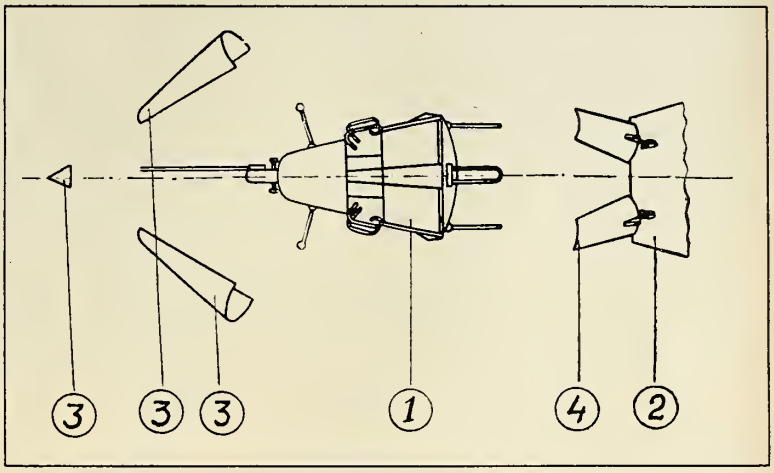
Particularly significant is the possible utility of a satellite the size and weight of *Sputnik* III as a man-carrying reentry vehicle. The Army has proposed the boosting of a man to 150 miles altitude housed in a capsule of a modified *Redstone* nose section (see page 40). This capsule would be very similar in size and weight to *Sputnik* III.

The cone of *Sputnik* III houses an instrument of every variety the United States intends to send into orbit during the remainder of the IGY. Apparently additional space is available within the cone for more instruments. Only 2,133 pounds of the total satellite weight of 2,919.53 pounds is instrumentation. Data collection and transmission should continue for the entire estimated 6 months life span as a result of its solar batteries.



Sovfoto

DIAGRAM of SPUTNIK III. Components include: 1) Magnetron to measure gravity, 2) photo multipliers, 3) solar batteries, 4) apparatus to register photons in cosmic rays, 5) magnetic manometers, 6) ionic traps, 7) electrostatic fluxmeter, 8) mass spectrometer tubes, 9 and 10) cosmic ray instrument, 11) micro-meteor impact recorder.



Sovfoto

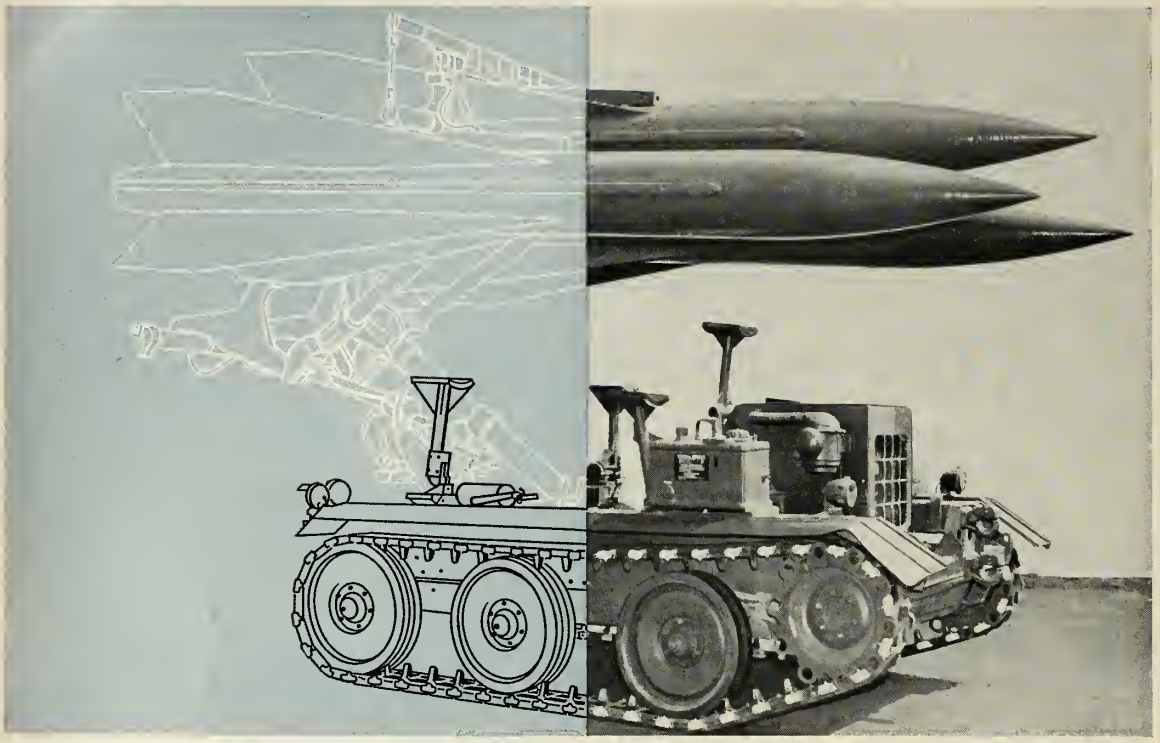
SEPARATION of SPUTNIK III from the last stage. 1) satellite, 2) rocket case, 3) the separating protective cone, 4) shields separating from the satellite.

Soviet Embassy

IN A TECHNICAL radio center, the leading observation post of the SPUTNIK III satellite, the incoming radio signals are monitored on a receiving oscilloscope.

...speaking of

Missile Ground Support **MOBILITY**



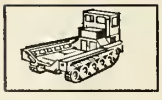
WE TAKE IT FROM CONCEPT TO COMPLETION

Few firms, if any, in this country can offer you the complete capabilities and experience FMC can provide in the field of mobile military equipment. Over the past 17 years, FMC has designed and built more types of military-standardized tracked vehicles than any other company in America. This background of experience is currently being applied to missile ground support equipment projects. Starting at the design concept phase, on through development, engineering and production, FMC provides a single source of coordinated responsibility. Also, important savings in time and costs can be effected by using FMC's fully integrated facilities devoted exclusively to defense production. And, contractors know that they can rely on FMC to meet contract delivery requirements – on schedule. For more information contact us, today. *Consult with FMC at the initial stage of project planning.*

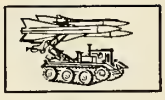
Creative Engineers: Find stimulating challenge at FMC Ordnance Division

FMC'S PROFILE OF EXPERIENCE:

Multi-Purpase Vehicles

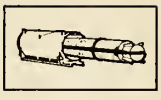


Prime Movers



Tronsporter-Loaders

Launcher-Erectars & Power Units



Shipping & Storoge Contoiners

Propellant Handling Systems

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION

Ordnance Division

Missile Equipment Section 1-B

1105 COLEMAN AVENUE, SAN JOSE, CALIF.

STL Early Explorer In Space Technology

The field of space technology is so new that few companies can lay claim to have entered in on the "ground floor." One organization that can claim to be "first" is Space Technology Laboratories, a Division of The Ramo-Wooldridge Corp. of Los Angeles.

Since 1954 STL has been responsible for overall systems engineering, technical direction and related research for the Air Force's intercontinental and intermediate range ballistic missile programs.

An STL's role assumes new importance, as it becomes more apparent that techniques and specialities developed in ballistic programs will have many applications in the future.

STL today claims it is the largest professional group in the nation devoted exclusively to research, development and systems engineering in ballistic missiles, space projects, and related advanced technology.

In the electronics field, STL has a number of analytical and experimental projects in progress which are concerned with the development of advanced guidance and control systems.

The projects include investigations in ionospheric and tropospheric propagation phenomena, advanced concepts of components and circuitry design, and new techniques for packaging.

STL's is also exploring such areas as high Mach number flow phenomena, materials research, hydraulic power servo systems, dynamics of fluids in tanks, boundary layer research, high temperature gas dynamics, magnetohydrodynamics and cryogenics.

Research and development facilities at STL are in pace with the many and varied programs in aerodynamics, hypersonics, propulsion and structures. STL has an extensive computation and data processing installation, which includes two large-scale scientific digital computers, a 300-amplifier analog computer, a 30-channel analog-to-digital converter, and a specially designed data reduction center for analysis of telemetry data.

STL's primary purpose is to provide systems engineering for ICBM and IRBM. It must determine the basic design characteristics of each weapon system, define subsystem specifications and assure final compatability of the whole system.

This includes determination of overall system stability, allotment of reliability requirements to the subsystems,

. . . news and trends

and specific analysis concerned with trajectory choice and control, guidance accuracy, and detailed control system performance.

STL carries out these efforts within the framework of an up-dated R&D plan, supported by sustained scientific and engineering investigations to insure the fundamental technical soundness of the programs.

Other areas of assistance to the Air Force include planning for logistics support, personnel requirements, and training and operational facilities required in the transition of a weapon system from the R&D phase to operational employment.

STL has indicated that the precision of control and guidance for a vehicle aimed at the moon or planets is not substantially greater than that required for the ICBM-IRBM program, and even less precision is needed to guide a vehicle into a near-circular orbit of the Earth.

The organization is headed by Dr. Louis G. Dunn, executive vice-president and general manager, who has had 22 years experience in aerodynamics, structures, jet propulsion and guided missile research.

Other key people in the organization include Dr. Milton U. Clauser, vice-president and director of the Physical Research Laboratory; Allen F. Donovan, vice-president and director of the Aeronautics Laboratory; and William M. Dunke, vice-president and associate director of the Systems Engineering Division.

HEADING Space Technology Laboratories' organization is Louis G. Dunn, executive vice-president and general manager, who has more than 22 years engineering experience.

LOUIS G. DUNN, executive vice-president of Space Technical Laboratories.

. . . news and trends

Army Contracts Over 80% Missile Money to Industry

Of the total funds expended by Redstone Arsenal and Army Ballistic Missile Agency, over 80% are spent with industry. In retort to charges that with its "arsenal" concept, most of its funds are spent at government-owned facilities, the Army points out that of the funds spent by Redstone Arsenal during the last year for missile development, production and procurement, 92% was paid out to industry, while 8% remained in the house. ABMA states that of all the funds allocated to the *Jupiter* IRBM program, 86% went to industry.

Missiles Sales Meeting Scheduled In Hartford

The Association of Missile & Rocket Industries will hold a Connecticut Missiles Sales Conference at Hartford, June 24.

The morning session will deal with missile and propulsion sales outlook. At the afternoon session, the outlook for sales in guidance, electronics, frame and ground support will be discussed.

Representatives of government procurement agencies will participate. Firms which have indicated they will take part include Hercules Powder, Dow Corning, Borg Warner, Reaction Motors, Aerojet, Rocketdyne, Thiokol, Hamilton Standard, Perkin Elmer, Federal Telecommunications Laboratory, Sperry, Raytheon, General Electric, Philco, ARMA, Western Electric, Barth Corp., Baldwin-Lima-Hamilton, Martin, Diversey, ACF and AMF.

Erik Bergaust, executive editor, m/r, will speak at the noon luncheon.

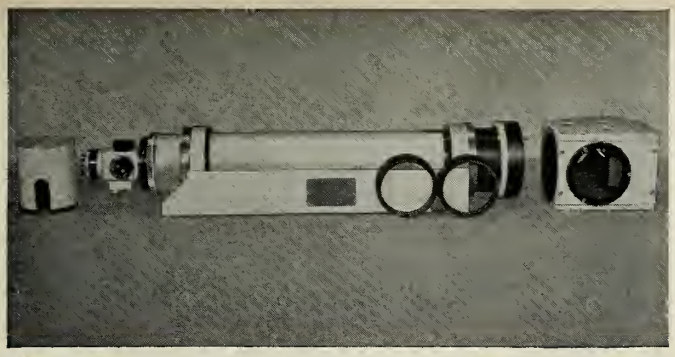
Canadian Astronautical Society Gains Members

The Canadian Astronautical Society, which was formed in Toronto last year, has now reached a membership of several hundred scientists, engineers and technicians.

The society held its second general meeting in late April, and featured an exhibition of rocket hardware built by members.

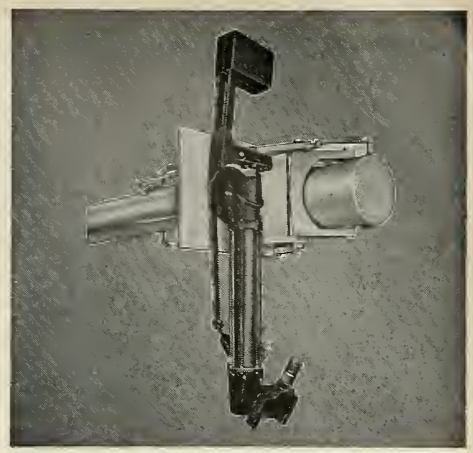
Dr. P. A. Lapp, president, reported that since the society's formation, experimental and theoretical activities are proceeding well in specialist sections such as propulsion, electronics, analysis, and astronautics.

Members of the de Havilland Aircraft of Canada, Guided Missile Division, are providing the nucleous for the society.



Problem To align radar antennas with extreme accuracy.

Solution Kallmargen 30X Callimatar.
Meosures *within* a *pencil's width* at a mile.



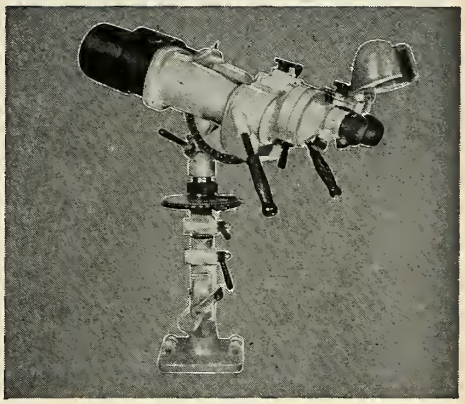
Problem Remate viewing in the presence of barmful radiatian, heat, pressure, water or taxic gases.

Solution Kallmargen Wall Periscapes with nanbrawning aptics, carrosion-resistant materials, 180° scanning.

Kollmorgen instruments like these are bridges between the eye and the invisible.

The various instruments on this page all have one purpose in common—they allow the observation and measurement of objects which it would otherwise be impossible to see in detail. In bunkers, under water, in the absence of light, in the presence of radioactivity and under many other adverse conditions, Kollmorgen remote viewing instruments have brought the eye of the observer to the heart of his problem.

A letter to us with a simple sketch illustrating your remote viewing problem will place one of America's most respected and versatile designers and manufacturers of optical instruments at your service. For more information write Department [106



Problem Detailed, lang-range abservatian at seo under varying weather conditians.

Solution Kallmargen 20X, 120 Ship Binocular. Wide, bright field. Hermetically sealed, super lightweight.

Problem Internal inspectian af inaccessible oreas of tubing, lang bares, machinery, engines, aircraft structures.

Solution Zeiss-Kallmargen Self-illuminating Borescapes. Diameters fram .100", lengths to 45 feet. Bright, clear field.

K O C **KOLLMORGEN**
optical corporation
347 KING STREET, NORTHAMPTON, MASS.

ARPA Seeks More Money For Biological Tests

Geophysicists will soon be moving over to give biological scientists a turn at bat for experiments in earth satellites, if Fiscal Year 1959 funding for the Defense Department's space division—the Advanced Research Projects Agency—is an indication.

An ARPA spokesman told m/r that new funds will include a "sizeable amount" for biological research with earth satellites, but the current need is for scientists to outline what experiments should be made in order of priority.

An important step in this direction was taken in May during a symposium on the possible uses of satellites for life-science experiments; co-sponsored by the American Institute of Biological Sciences, the National Academy of Sciences, and the National Science Foundation.

The symposium, which closely paralleled a meeting several years ago that led to geophysical research with satellites, was organized to stimulate thinking on space biology experiments which could lead to manned flight.

Scientists were assured by the government that when space biology experiments are proposed and accepted, earth satellites will be made available.

• **What's first?**—Initial experiments will fall into three broad categories: determination of cosmic radiation effects on living tissues; the effects of weightlessness on living systems; and how to provide a livable atmosphere for prolonged periods of time for the occupants.

Geophysical research with satellites is now providing invaluable information on radiation, but the effects of weightlessness are mostly an unknown quantity.

This will pose one of the great problems in satellite biological experiments, calling for an engineering design for true weightlessness, the symposium was told. Rotation and tumbling of present satellites produce an acceleration field, which does not give true weightlessness.

Another factor which will limit the solving biological experiments is the recovery of the satellite vehicle. For the biologist, telemetry cannot substitute for getting the experiment back to earth.

ARPA is serving as a clearing house for experiment proposals, until such time that a decision is made on whether the proposed National Aeronautics and Space Agency will take over direction of space biology research.

As such, ARPA is working with the Air Research and Development Command, Army Research Office, Atomic Energy Commission, National Advisory Committee for Aeronautics, National Science Foundation, Office of Naval Research, National Academy of Sciences, and the American Institute of Biological Sciences, all having interests in this field.

• **Some contracts**—Few space biology experiments are in the contract stage. Air Force has asked for bids on small animal survival capsules for launching this fall. A satellite yeast experiment to measure radiation was scrubbed with failure of a *Vanguard* launching, and will not be carried out until this fall or winter.★

m/r editorial viewpoint:

No Place for Snyderisms

Here's a news item which nobody can put an official stamp of suppression on: Ruefully-awakened newsmen covering Cape Canaveral have overwhelmingly voted Murray Snyder the public official they would most like to see take the first trip in a manned (but not recoverable) earth satellite.

We can readily assume that this distinctive title also has the blessing of the Washington press corps which must deal daily with the Pentagon, some members of Congress who are pushing for freedom of information, and Snyder's own Defense Department public information colleagues.

Snyder's record as "Czar of Pentagon Information," while never envied, has become despotic in the past nine months. With the launching of the first *Sputnik,* he hastened material into picture, print and air waves to assure this nation that anything the Reds could do, we could do better—as if this could make up for five lost years between 1945 and 1950 when the pleas of missilemen fell on deaf Defense Department ears.

Snyder managed to build up the December 6 *Vanguard* firing, an unproven scientific experiment, into a classic fiasco of politically-inspired and mishandled publicity that put the hopes of a free people at an unparalleled low.

When he realized he could not keep satellite launchings and missile firings a secret from the public at the gold-fish-bowl Canaveral testing area, Snyder masterminded an ingenious "deal" with some unthinking newsmen, who now realized they sacrificed some professional ethics by going along with him. The deal appeared harmless.

In exchange for certain "privileged, not classified" information, correspondents would not give an advance publicity build-up to a missile firing. Concessions even included grandstand seats inside the test area. It meant binoculars used at Coca Beach and the hours of waiting in unseasonably cold weather were at an end. Correspondents were to be informed in advance of any test.

This publication was not, and never shall be, a party to this or any other such agreement. We do not want "privileged" information declassified by Snyder for politically expedient reasons, but information the public has an inherent right to know. Newsmen who went along with Snyder at Canaveral learned their lesson when several tests went through without that "promised" advance notice.

Since October, Snyder, for so-called "policy reasons" which no one can define, has clamped down a lid on information that will not endanger national security. Legitimate unclassified news, purely scientific papers and even advertising copy have been the victims of his "policy reasons."

Now, by Presidential sanction and Snyder's own admission to the House Armed Services Committee, he is more than willing to take on the task of deciding what information the American public should have and understand about our defense and participation in the new era of space.

Snyder admits he will become a Supreme Censor in the proposed "consolidation" of public information functions of all branches of the Armed Forces.

Snyder's new role should raise him to new heights. But he should remember that unlimited power can corrupt the possessor and where law ends, tyranny begins. Suppressed news, when it eventually comes out, bites with keener fangs. We, for one, do not intend to stand by and let him tell a free nation what he wants them to read and think. We'll continue to spell things out.★

"...AND QUIETLY BOLD"

A Message to the Scientific Community from Dr. Hugh L. Dryden, Director, NACA

NACA has pioneered in preparations for manned and unmanned space flight for the past six years and has designed and built unique aerodynamic, structural and propulsion facilities for space research. We of NACA are moving to insure that our contributions to space technology will match our record in aeronautics. It is imperative that America lead the way in the peaceful exploration of space. Our nation has the talents and resources to do the job. But we must recall the wisdom of the Killian Committee which recently said: "Let us be cautious and modest in our predictions and pronouncements about future space activities and quietly bold in our execution."

Hugh L. Dryden

Hugh L. Dryden

Hugh L. Dryden, Director, NACA; Ph.D., Johns Hopkins University

NACA has a staff of 7,750 research scientists and supporting personnel spread among its research centers on both Coasts and in Ohio. NACA staff members in pursuit of new knowledge have available the finest research facilities in the world, including several of the largest and fastest supersonic and hypersonic wind tunnels, hot jets, a fleet of full scale research airplanes, which will include the X-15, hypersonic ballistic ranges, shock tubes, a nuclear reactor establishment, rocket facilities, a research missile launching site, tracking devices, and the most advanced mechanical and electronic computers.

NACA Fields of Research Include: Analytical Dynamics, Solid State Physics, Hypersonic Aerodynamics, Magneto Hydrodynamics, Energy Sources, Propulsion Systems, Aerodynamics, Automatic Stabilization, Vehicle Configuration and Structure, Materials, Flight Simulation, Instrumentation.

A number of staff openings are becoming available. You are invited to address an inquiry to the Personnel Director at any one or all four of the NACA research centers:

Langley Aeronautical Laboratory, Hampton, Virginia
Ames Aeronautical Laboratory, Mountain View, California
Lewis Flight Propulsion Laboratory, Cleveland, Ohio
High-Speed Flight Station, Edwards, California

(Positions are filled in accordance with the Aeronautical Research Scientist Announcement 61B)

NACA

The Nation's Aeronautical Research Establishment

. . . news and trends

Filmed Space Lectures Available to Industry

A series of filmed space technology lectures, given by 36 of the nation's top astronautical experts, is available from the University of California. The films were produced jointly by UCLA and Ramo-Wooldridge Corp., and feature such space scientists as Dr. Wernher von Braun, Dr. William H. Pickering, Dr. Hubertus Strughold and Krafft A. Ehricke.

They cover the subject of space from past history to future prospects and take in the many facets of commercial uses, technical problems, human factors and communications.

With two exceptions, each of the 17 programs consist of two lectures, running a total of one-and-a-half to two-and-a-half hours. Eight companies and the Naval Ordnance Test Station, China Lake, Calif., have already contracted for the newly released films which rent for $2,300 for the complete set.

Rental arrangements can be made through O. E. Patterson, director, Department of Visual Communication, University Extension, UCLA, Los Angeles 24, Calif.

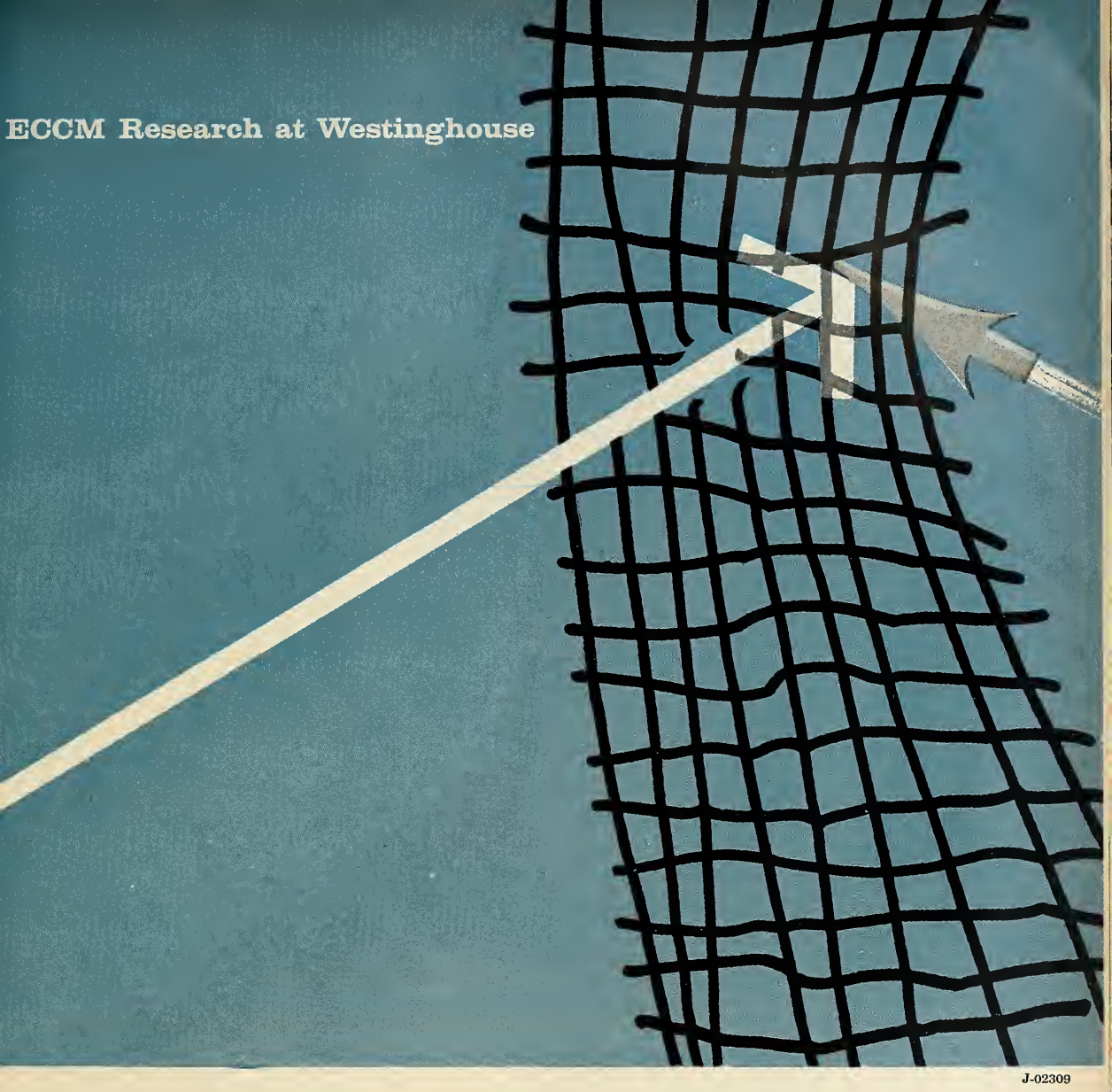
Boost-Glide Possibles Have Now Been Cut to Two

Only two companies are still in the running for the development contract for the Dynasoar "boost-glide" rocket bomber project. According to information recently received by m/r, these are The Martin Company and Bell Aircraft Co., whose Dr. Walter Dornberger first promoted this project in the U.S.

This is the manned weapon concept that would rocket-boost a hypersonic bomber to "free space" altitudes and speeds 15,000-to-20,000 miles per hour —the vehicle to glide from altitude back into the atmosphere, dropping its payload on the way. It is based on the Eugen Sanger proposal of 1935. The Russians are known to be in the advanced stages of developing and testing such a vehicle.

10th Annual IAF Congress May Meet in Moscow

Preliminary negotiations are underway between Andrew G. Haley, president of the International Astronautical Federation, and top members of the USSR Academy of Sciences to hold



J-02309

There's a way to punch a hole in that screen

Despite any jamming screen an intruder might use, new Electronic Counter-Counter Measures Techniques developed by Westinghouse will slash through to locate and track him—destroying his defense.

In this and in other vital military areas, continuing creativity by the scientists and engineers of the Westinghouse Electronics Division is helping to keep the American defense ahead... by designing, developing and producing the latest in military systems.

Westinghouse Electronics Div., P.O. Box 1897, Baltimore 3, Md.

WESTINGHOUSE
ELECTRONICS
DIVISION

MILITARY SYSTEMS
RADAR
COMMUNICATIONS
MISSILE CONTROL,
DATA PROCESSING
AND DISPLAY

Circle No. 49 on Subscriber Service Card.

YOU CAN BE SURE...IF IT'S Westinghouse

next year's IAF Annual Congress in Moscow.

"Moscow would be particularly appropriate in view of . . . the immense contribution of the USSR in all branches of astronautics," Haley said. If the Russians turn the proposal down, the Tenth Annual Congress will be held in Washington, D. C.

Other subjects under discussion in Moscow include (1) whether Prof. Leonid I. Sedov of the Russian Science Academy would accept the presidency of the IAF to succeed Haley, and (2) progress of the IAF Cooper Committee which is attempting "to define the regions of air law and space law jurisdiction."

The committee, which will submit its findings to the United Nations, is comprised of the following members: United States, Chairman John Cobb Cooper, Dr. L. R. Shepherd, Dr. Athelstan F. Spilhaus, Andrew G. Haley; Germany, Dr. Alex Meyer; USSR, Leonid I. Sedov.

Haley, who is known as the dean of space law, arrived in Moscow on May 26th and plans to stay until June 8.

• **IAF Amsterdam meeting**—The Ninth Annual Congress of the IAF, which will meet in Amsterdam August 25-30, will feature simultaneous translations of papers from English to German and German to English.

Dr. Theodore von Karman will deliver the inaugural lecture and will be followed by J. M. Kooy and Eugen Sanger. Dr. Shepherd will chair the first session.

On Thursday, August 28th, delegates will be free to join a sightseeing trip of the Amsterdam area.

"The Law of Outer Space" will be the subject of discussion Friday morning. Thirty-two representatives from ten countries will participate.

Saturday, August 30th, has been reserved for papers from USSR scientists and others, who will be traveling from the International Astronomical Union, to be held in Moscow, August 13-20.

Wernher von Braun to Get Goddard Memorial Trophy

Dr. Wernher von Braun, technical director, ABMA, will be the recipient of the first Dr. Robert Goddard Memorial Trophy at the Dr. Robert H. Goddard Memorial Dinner, to be held the evening of June 6 at the First National Missile Industry Conference.

The presentation will be made by

Wayne W. Parrish, publisher of American Aviation Publications. Selection of the award was made by the editors of MISSILES & ROCKETS magazine for what they consider the greatest achievement during the year of 1957 to advance the missile, rocket and space flight programs of the United States. Text of the award reads in part, "this achievement was the technical supervision and leadership that led to the successful development, testing and accurate flight of the United States' first intermediate-range ballistic missile, the *Jupiter*, and the first U.S. Space satellite."

• **Lockheed award**—Lockheed Aircraft Corporation will be presented with the first missile award by Borg-Warner Corporation at the Robert H. Goddard Memorial Dinner on June 6.

The award is presented "to the organization or company which during the year 1957 in the opinion of the judges contributed most to the advancement of the art of guided missiles or astronautics in the United States of America."

The specific contribution for which Lockheed is being cited is the "remarkable" development of the *Polaris* FBM. Decision to present the award to Lockheed was made by a group of editors prominent in the aviation, missile and astronautics fields.

National Space Program Outlined by NACA Director

Space programs that must be promptly undertaken by NASA (National Aeronautics and Space Agency) under the directorship of NACA (National Advisory Committee for Aeronautics), were recently outlined by Dr. Hugh L. Dryden, NACA director, at a speech before the Tenth Annual California Wing Convention, Los Angeles, Calif.

The proposed space programs, which fall into three groups as presented by Dr. Dryden, are:

1. Projects for development of satellites and space craft such as those used for reconnaissance, which being military operations, would be carried forward by the Defense department.

2. Projects for development of satellites and space vehicles with the special capabilities required by science to probe the secrets of our solar system, which would be the responsibility of NASA.

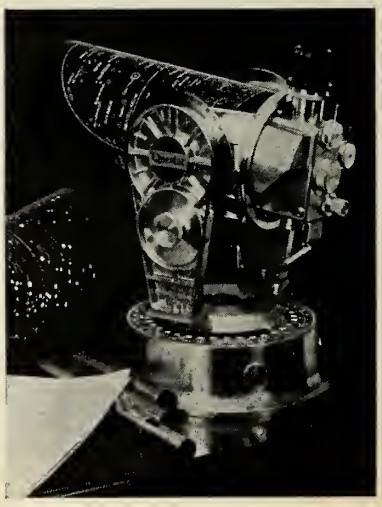
3. Space projects that will be use-

ful for both military operations and the data-gathering needs of civilian science, which will be reviewed jointly by the DOD and the NASA.

Dr. Dryden also discussed the responsibilities of NASA for development, testing, launching and operation of aeronautical and space vehicles. He pointed out that NASA will have to develop new space vehicles, and it would be possible for NASA to build the organization and facilities for space vehicle construction. But, he added, "such action would be very costly and much additional time would be required."

He recommended that design and construction of these space vehicles be performed, on contract basis, at existing facilities. In such cases, sponsorship might be either under NASA or jointly with the DOD.

Optical System Tested At High Altitudes

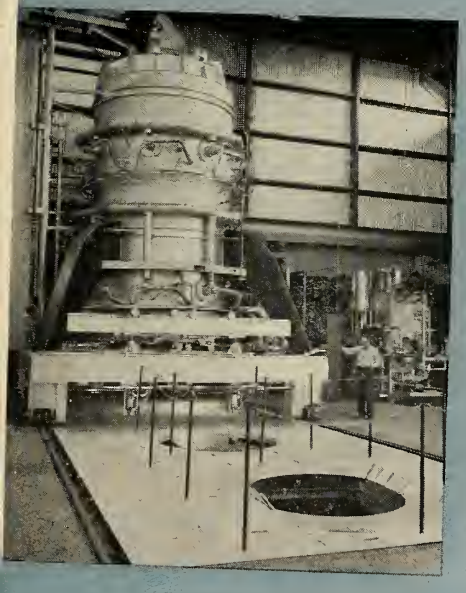


A compact catadioptric (mixed lens-and-mirror system) telescope (with precision optics) took a balloon ride to 40,000 ft. early in May. The telescope was made by the Atlantic Research Corp. of Alexandria, Va. for the Questar Co., New Hope, Pa.

Astronomer Alfred Mikesell and Cdr. Malcolm Ross, physicist, both of the U.S. Naval Observatory and the Office of Naval Research, made the flight with a twofold purpose: for astronomical observations under the superior viewing conditions available at that altitude, and to test new techniques used to record body reactions at the hazards of extreme altitude.

The Questar telescope was chosen for its combination of compactness—

POLARIS



Facilities at Norris-Thermador for the manufacture of rocket and missile metal components include not only equipment for cold forming operations such as deep-drawing and cold-extrusion, but also for roll-and-weld fabrication of solid propellant motor case assemblies for Polaris and the M-15 Jato. Equipment includes complete machining facilities and heat-treating furnaces. The gantry-type, controlled-atmosphere furnace at left is one of the largest in the country. This type of manufacture is performed at plants located in Vernon, California and Waco, Texas. Our engineers are available to assist you with your metal parts problems. For additional information, write for Brochure GP-1.

NORRIS-THERMADOR
CORPORATION
NORRIS DIVISION
5215 South Boyle Avenue • Los Angeles 58, Calif.

DESIGNERS AND MANUFACTURERS OF ROCKET AND MISSILE COMPONENTS

focal length 42.4 inches, barrel length 8.0 inches—with precision-mirror surface 1/64 wave or better to true spherical. Quartz optics were specified to Atlantic Research, since quartz shrinks less than optical glass.

The telescope accompanied the scientists into the "icebox" at Bethesda Naval Medical Center, Md. (where space medicine research is conducted) to test the effect of −70°F. temperature on the stability of the image.

Although much information was obtained on body reactions to the extreme cold and difficult working conditions, the continual motion of the balloon's gondola made it impossible to take photographs with the Questar. Nevertheless, interesting information was obtained from visual sightings.

Convair

THE XKDT-1 *TEAL*, a rocket-powered target drone developed by Temco Aircraft Corp., is being readied for flight. The drone is evaluated as a new target to provide fighter pilots with a speedy, low-cost target. Shown here, last-minute preparations are made before the *Teal* is attached to an F3H-2M plane for aerial launching. The *Teal* approaches the speed of sound, with altitudes up to 50,000 ft. *Teal* is one of family of new U.S. missiles discussed on p. 39 of this issue.

Air Force Space Program To Feature Rocketeers

An impressive program is taking shape for a space symposium to be held November 10-12 in San Antonio, Texas.

The symposium, sponsored by the Air Force School of Aviation Medicine, Randolph AFB, will feature top figures in U.S. satellite and rocket research. Among them will be:

Dr. Hugh L. Dryden, director of the National Advisory Committee for Aeronautics; Dr. Joseph Kaplan, U. of California physicist and head of the U.S. IGY National Committee; Dr. Fred L. Whipple, director of the Smithsonian Astrophysical Observatory; Dr. James A. Van Allen, U. of Iowa rocket authority on high-altitude research; Dr. Gerard P. Kuiper, U. of Chicago astronomer and specialist in planetary atmospheres; Dr. J. Fred Singer, U. of Maryland space expert on flight and satellite operations; and Dr. Ernst Stuhlinger of the Army Ballistic Missile Agency, designer of the *Explorer* satellites.

The program will feature specialists in every aspect of space exploration, with emphasis on man's venture beyond the Earth's protective atmosphere, and the necessary conditions for his survival. Data collected from intensive study of the cosmos, during IGY, also will be presented for the first time.

Co-chairmen of the symposium are Maj. Gen. Otis O. Benson Jr., commander of the School of Aviation Medicine, and Dr. Hubertus Strughold, Research Advisor and founder of space medicine.

Urge Tax Credit for Research, Development

A plan which would give corporations a direct credit on their federal taxes, amounting to 35% of the amount they spend on approved research and development of products and services, has been advanced by H. Leslie Hoffman, president of Hoffman Electronics Corp.

Hoffman said that the plan would help create a $600 billion gross national product.

Jupiter-Vanguard Rocket To Launch 1-Ton Satellite

Army has proposed to Advanced Research Projects Agency that a *Vanguard* first-stage engine be mounted atop a *Jupiter* in order to place a one-ton satellite in orbit around the earth. This is one of several Army programs now being considered by ARPA.

This proposal differs from the Air Force's *Thor-Vanguard* in that AF is using the second and third stage engines of *Vanguard,* while Army proposes to use the General Electric first stage engine, rated at 27,000 sea-level static thrust.

Small Size, Low Cost Target Missile Developed

Aeronca Manufacturing Corp. has announced development of a low-cost target missile, said to be half the size of comparative designs.

The propulsion system uses liquid fuel which "is as simple as a solid fuel propellant and in many ways safer," according to the company. The missile is fueled at the factory and is ready for launching upon delivery.

Ground-launched by a zero-length launcher, the missile is said to operate at a sea-level performance of Mach 1. It requires no "cooperative equipment" aboard operational weapons, which utilize the missile as a target.

The system provides miss-distance information which is unaffected by speed, configuration attitude or atmospheric conditions, according to a company official. Gross weight is given as 366 pounds.

Army Moon Rocket Program, Designated Juno-II, OK'd

The Defense Department has approved the Army's *Juno-II* program for placing one 130-lb. satellite in orbit and firing two lunar probes before Christmas.

Juno-II is based on the same engineering approach as that employed with *Jupiter*-C, except that the *Redstone* first stage will be replaced by a modified *Jupiter* IRBM. Chrysler Corp. is prime production contractor on both *Jupiter* and *Redstone*.

In addition, the second, third and fourth stage arrangement of the clustered solid propellant rockets will probably be altered as to how many of what size solid rockets are used.

Present plans are that all three of these vehicles will be completed and fired before the end of the current calendar year. Defense Department has approved the preparation and firing of

three of the vehicles very soon.

Juno-I is the official Army name given to the current *Explorer* satellite series. Word *Juno* was decided on because with the German pronunciation of "J," the word becomes "you-know." Major responsibility for *Juno-II* rests with ABMA and Jet Propulsion Laboratory.

Air Force's Moon Rocket Has Second Stage Trouble

The second stage of Project *Able*, Air Force's *Thor-Vanguard* hybrid, did not fire at all during the recent unsuccessful shoot from Cape Canaveral. Project *Able* is the Air Force's early moon rocket project, geared for an attempt before the end of the year. Some reports claim that an attempt will be made to hit or orbit the moon on July 4, 1958.

The *Able* rocket consists of a *Thor* first stage topped by the second and third stages of *Vanguard*. *Thor* is the Air Force's Douglas-made IRBM. *Vanguard* is the Navy's satellite launching rocket. The Martin Company is the systems contractor, with Aerojet-General Corp. being responsible for the second stage and Grand Central Rocket Co. supplying the third stage motor. In the recent shoot, the second stage failed to ignite after burnout of stage one.

AMF Finally Purchases Green Mountain Site

American Machine & Foundry has now bought the last of 2,700 acres of land constituting "Green Mountain" just outside of Huntsville, Ala. The land actually was purchased by the Huntsville Industrial Expansion Committee to preclude any knowledge of whom the land was being acquired for, and in order to assure that it was bought at a "fair and equitable" price.

HIEC then turned the land over to AMF at cost. This puts AMF in good position to go ahead with its oft-considered plans to mine the mountain, which is solid limestone, and to further go ahead with the proposed operation of an underground factory—in the halls and passageways excavated during the mining operations. This latter proposition is even more of a likelihood, now that the Army Ballistic Missile Agency has abandoned a similar proposal on the grounds of Redstone Arsenal.

AMF is currently interested in various kinds of ground support equipment, electromagnetic research and other missile and missile-related activities.

Genisco G-Accelerators play vital role in ICBM development

Threading the needle half-way round the world leaves no room for error.

Inertial guidance—self-contained guidance systems used to direct huge ICBM's to the target—depends for its accuracy upon the degree of internal instrumentation perfection. Switches, relays, delicate instruments, and hydraulic and electrical systems must operate perfectly—even while subjected to tremendous acceleration forces.

Testing components and complete asssemblies to simulated operational G-forces, as required by MIL-E-5272A, before relying upon their operation in actual flight is easily accomplished with Genisco's G-Accelerators.

Genisco's precision centrifuges are available in five standard sizes—from high-speed machines capable of high G-loadings, to large 12-foot diameter machines capable of accommodating complete electronic or electromechanical systems.

All models incorporate features necessary for critical laboratory testing, as well as the ruggedness and simplicity of operation required for production-line test programs.

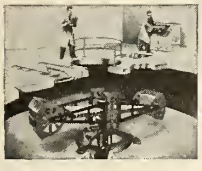
Many automatic features minimize operator responsibility and chance for error. Built-in safety features and integrity of construction provide maximum protection to both personnel and machine.

Complete specifications on all machines and accessories are available. *Write, outlining your specific requirements.*

MODEL B78
Accommodates test objects up to 25 pounds; 1200 G-pounds max.

MODEL C159
Accommodates 100-pound test object on each end of boom; 2000 G-pounds max.

MODEL D184
Range of 1 to 800 G's; 1000 G-pounds max.



MODEL E185
Subjects two 300-pound assemblies to 100 G's. 30,000 G-pounds max.

Genisco INCORPORATED

reliability first

2233 Federal Avenue,
Los Angeles 64, California

Reds Build Interim Missile/Sub Fleet

Seagoing Missile Among New Developments

by Frank G. McGuire

The Soviet Union today has a missile-armed submarine fleet which could unquestionably inflict great damage directly on the continental United States. Naval intelligence has reportedly learned that Russia has been able to completely waterproof its seagoing missile *Comet* II, for towing behind conventional submarines. According to reports, each submarine tows three missiles and a launching canister.

The *Comet* II, a medium range ballistic missile, has a solid-propellant rocket motor with thrust estimated at 99,000 lbs., and is currently in production. Since it is not possible for this missile to reach all sections of North America, it is considered to be a stop-gap weapon until development of the 1,800-mile *Comet* III, which is expected to be completed within the next year to eighteen months. *Comet* III is presently undergoing testing.

[Some experts have indicated that *Comet* III is an air-launched "stand-off" weapon, but most data seems to establish its seagoing role. Again, it may be merely a matter of differing designations.]

• **Performance**—Launching of the *Comet* II, utilizing the new method, is accomplished by loading the missile into the cannister like a shell into a mortar tube. The after-end of the cannister is flooded to tilt it into a vertical position, and gyro stabilizers then maintain the cannister in a relatively steady position.

Actual firing of the *Comet* II is then undertaken much as in our own *Polaris* system, i.e., the missile is tossed clear of the launcher and its solid propellant motor is immediately ignited. *Comet* II is understood to have radio-inertial guidance.

Depending on the extent to which this system is now in operation, the Soviet submarine fleet poses a far greater threat to the United States than the German U-boat fleet ever did. Generally-accepted estimates place the number of Soviet submarines at about 600, with a high rate of construction constantly increasing this number.

Despite the fact that most of the fleet consists of W-class, or World War II boats, adoption of the new *Comet* II launching system could enable most of these fleet type vessels to launch operational missiles having considerable range.

Immediately after the end of World War II, Soviet naval authorities realized the potential value of missile-armed submarines and pushed for development of such a system.

The Germans had conducted a few test launchings, using the V-2 submersible canister, and considered the system to be usable, though not yet perfected. The floats, plans, and missiles themselves fell into Soviet hands at the end of the war. The entire system had been located at the Schichau shipyard at Elbing in East Prussia.

German developers of the undersea launching system estimated that one submarine could tow three V-2 launching containers, weighing about 500 tons each, for 30 days at an average speed of 12 knots.

• **J missiles**—The J-series of missiles, which resulted from great improvements over the German V-1 "Buzz Bomb", was subsequently put into interim service with the Red Fleet. The J-1, now obsolete, is pulsejet-powered and boosted by two solid-propellant rocket motors. Its speed is over 500 mph and its range in the vicinity of 375-400 miles.

It has since been succeeded by the J-2 and J-3, each of which has increased range and speed over the J-1, but none of the J-series is believed to have a range of over 550 miles nor speed greater than 875 mph.

Due to the inability of the J-series to reach the interior areas of North America, military necessity has compelled the development of long-range ballistic missiles. The *Comet* and *Golem* series are designed to enable submarines standing off either coast to reach every part of the continent.

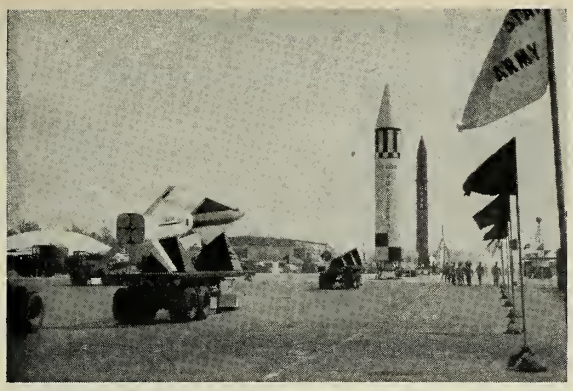
It is therefore thought unnecessary, in a sense, to strive for ranges greater than 1,800 miles in a submarine-launched missile since no part of the United States lies more than 1,800 mile from open seas. The *Comet* III should, therefore, be the Soviet equivalent to our *Polaris* FBM.

Our own Navy is believed to have considered waterproofing the *Polaris* FBM but abandoned the idea.★

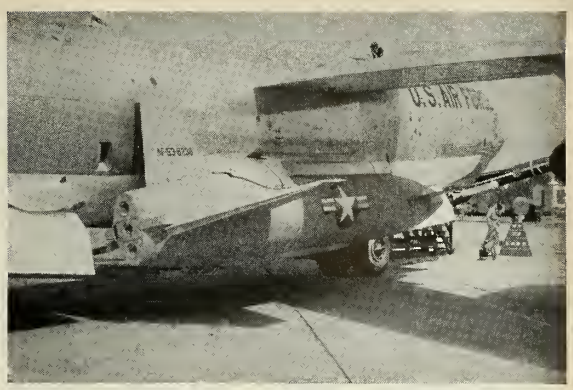
SOVIET MISSILES ADAPTABLE TO SUBMARINE LAUNCHING

Model	Range (Miles)	Length (Feet)	Diameter (Feet)	Thrust (Pounds)	Powerplant	Status	Remarks
J-1	375-400	27	20.6 (Wing span)	1935	PJ & 2 SPR	Obs.	520 mph top speed.
J-2	525	36.5	23.6 (Wing span)	4850	TJ & 2 SPR	Exp.	645 mph top speed.
J-3	450	37.1	23.6 (Wing span)	14,950	TJ (or RJ) & 4 SPR	Pre-Prod.	875 mph top speed.
Golem-1	395	53.8	5.41	121,000	LPR	Obs.	Oxygen & alcohol fuel.
Golem-2	1250	57	7.2	220,000 (1st Stage) 72,000 (2nd Stage)	LPR & SPR	Test	Solid-propellant booster, liquid-propellant sustainer, (acid fueled). Underwater-launch.
Golem-3	7.5	17.1	5.9	14,950	4 SPR	Exp.	Experimental prototype accounts for very short range. Used for research in extreme-depth launchings to 650 ft.
Comet I	100	36.7	4.3	53,250	SPR	Exp.	Also designated CH-17.
Comet II	625	42.3	5.9	99,000	SPR	Prod.	Waterproofed for towing behind WWII-type submarines. Also designated CH-18.
Comet III	1800	n.a.	n.a.	220,000 (?)	SPR	Test	Soviet equivalent of Polaris.
T-7A	50	25	3	18,000	SPR	Oper.	Succeeded by Comet I.

ABBREVIATIONS: Obs.—Obsolete; Exp.—Experimental; Prod.—Production; Oper.—Operational; PJ—Pulsejet; TJ—Turbojet; RJ—Ramjet; LPR—liquid propellant rocket; SPR—solid propellant rocket; n.a.—not available.

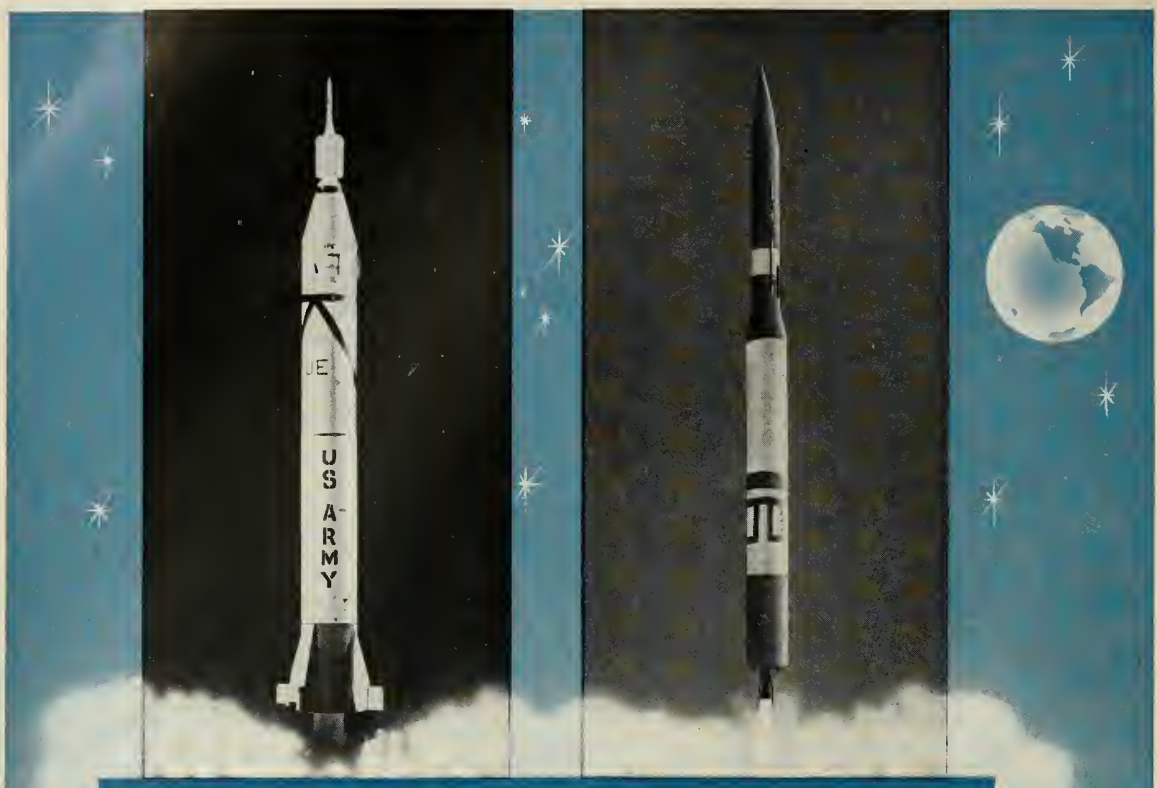


ARMED FORCES DAY in Washington, D.C. was primarily a day for missiles. Army, Navy and Air Force, in a display at Andrews Air Force Base just outside of Washington, showed the hardware with which American will fight another war, if it should be forthcoming. Above are a line of Army missiles with *Nike Hercules* in the foreground, then *Jupiter, Redstone, Honest John,* etc. And, tucked up against the lower fuselage of a B-47 Stratojet bomber, is the Air Force's air-to-surface missile as it will be carried in combat.



SUBSTANTIAL SAVINGS in fabrication and tooling costs on the *Terrier* surface-to-air guided missile, in production for the Navy, are expected to result from a new "batch process" chemical milling facility. Shown here, a *Terrier* part is being checked after masking compound has been stripped away. The etching process is ideally suited to *Terrier's* difficult contour relief production problems.

U.S. Navy



NEW HEIGHTS FOR DIMAZINE

unsym-Dimethylhydrazine

DIMAZINE, the liquid fuel with the unique combination of all-round advantages, played a major role in powering *both* the Army Jupiter-C and Navy Vanguard satellite vehicles.

The successful orbiting of our earth satellites marks a new high point in the scientific and technological achievements of our defense services and their industry contractor teams. Westvaco is privileged to have contributed to this effort by pioneering the commercial development and large-scale production of UDMH, under the trademark *Dimazine*.

Photos: Courtesy U.S. Army and U.S. Navy

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION

Westvaco Chlor-Alkali Division

General Sales Offices:
161 E. 42nd STREET, NEW YORK 17

Telemetry Key to Missile Operation

Some Systems Now In Use—And a New Approach That May Lead To Increased Information Handling Capacity

by Raymond M. Nolan

BY FAR, THE MOST IMPORTANT way to obtain information from missiles while they are in flight is through the technique of telemetry.

Essentially, telemetering can be defined as the measurement of a desired quantity in the missile, conversion of that quantity to an electrical signal suitable for use, transmission of the electrical signal to a collection station, and reconversion of the signal to a form suitable for monitoring or further analysis.

First link in the telemetering chain is a device to measure and collect the information. This device, commonly called a transducer, can take a number of forms. These are:

Variable-Resistance Devices: Units such as these generally feed their information directly into the telemetering transmitter without further amplification. Some of the more common devices are potentiometers, strain guages with a resistance output, and themistors (see m/r April 1958, page 213.)

Thermocouples: These devices measure by means of recording differences in output between two dissimilar pieces of material.

Variable-Reluctance Devices: Variations in these units are commonly used to cause frequency changes in an oscillator circuit.

Other well-known types are piezoelectric and thermoelectric transducers, manometers, and variable capacitance units.

The next section of the telemetering system accepts the transducer outputs and shapes them into a form which is suitable for radio transmission to the ground link.

Although there are several types of sub-systems in service, the continuous FM/FM (FM-modulated, FM-carrier), the PWM/FM/FM (Pulse-Width modulated, FM-carrier), and PAM/FM/FM (Pulse-Amplitude-modulated FM-carrier) are used most.

• **Sending devices**—FM/FM is basically a scheme where the quantities measured by the transducers are converted into, or used as electrical signals which deviate the frequency of sub-carrier oscillators. The various sub-carriers, in turn, frequency-modulate an RF carrier. Frequency modulation is used throughout because of its freedom from noise (amplitude deviations), and suitability to miniaturization and compact packaging.

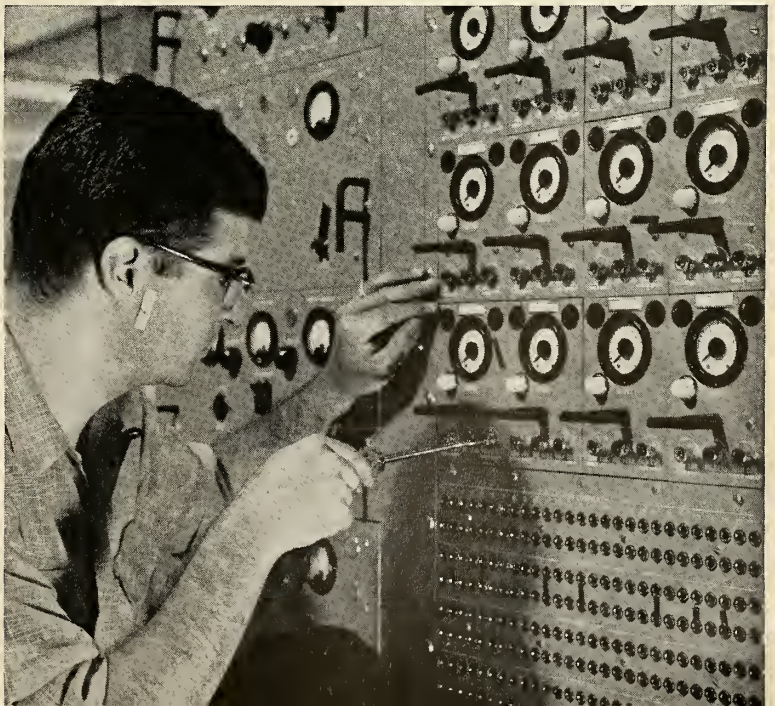
A type of sub-carrier oscillator, the voltage-controlled oscillator, was described in some detail in the February issue of m/r (page 129). The considerations for ruggedization and miniaturization were discussed by the author.

There are two basic uses for sub-carrier oscillators. One is for continuous operation where high-quality information is desired; the other for intermittent sampling through a commutation device where the number of *types* of information desired exceeds the requirement for extreme resolution.

Commutation of signals means that the total number of information channels is increased directly as the number of available channels in the commutator itself.

The signals from the transducers

PULSE AMPLITUDE MODULATION decommutation station at GE's MOSD facility.



Manufacturers of Telemetry Components

TRANSDUCERS

Advance Industrias, Inc.
Allegany Instrument Co., Inc.
R. C. Allen Business Machines, Inc., Aircraft Instruments Div.
American Electronics, Inc.
Atlantic Research Corp.
B & F Instruments, Inc.
BJ Electronics, Borg-Warner Corp.
Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Divs.
Cardinal Instrumentation Corp.
Chesapeake Instrument Corp.
Cleveland Instrument Co.
Coil Co. of America
G. L. Collins Corp.
Computer Instruments Corp.
Consolidated Electrodynamics Corp.
Crescent Engrg. & Research Co.
Datran Electronics, Div.—Mid-Continent Mfg., Inc.
Dynac, Inc.
Dynametrics Corp.
Eaton Mfg. Co., Inc., Fredric Flader Div.
Edcliff Instruments
Electro Products Lebs., Inc.
Electronic Procasses Corp. of California
Endevco Corp.
Fairchild Controls Corp., Components Div.
Fenwal Inc.
Friez Instrument Div.-Bendix Aviation Corp.
Gates Electronic Co.
Gudeman Co., The
Haller Raymond & Brown Inc.
Kollsman Instrument Corp., Sub.—Standard Coil Products Co. Inc.
Wallace O. Leonard, Inc.
Maico Electronics, Inc.
Massa Labs., Inc.
Minatron Corp.
Narda Ultrasonics Corp., Tha
Perkin-Elmer Corp.
Photocon Research Products
Roflan Co., The
Southwestern Industrial Electronics Co.
Trans-Sonics, Inc.
U. S. Gauge Div.-American Machine & Metals, Inc.
Vap-Air Div., Vapor Heating Corp.
Varo Mfg. Co.
Warren Transformer Co., Inc.
Western Coil Products Co.
Western Electro-Acoustic Lab.
Westinghouse Electric Corp.

DISCRIMINATORS

Amelco, Inc.
American Electronics, Inc., Data-Tronics Div.
Baird-Atomic, Inc.
Bandix Aviation Corp., York Div.
Bomac Laboratories, Inc.
Burroughs Corp.
Centronix Inc.
Data-Control Systems Inc.
Dwyer Engrg. Co., Inc.
Epsco Inc.
Johnson Electronics Inc.
Librascope Inc.
Optimized Devices, Inc.
Pacific Div.-Bendix Aviation Corp.
Systron Corp.
Telechrome Mfg. Corp.
Tele-Dynamics Inc.
Varo Mfg. Co.
Waugh Engrg. Co.

COMMUTATORS, SWITCHING

Airflyte Electronics Co.
Arnoux Corp.
Burroughs Corp., Electronic Tube Div.
Computer Instruments Corp.
Data-Control Systems Inc.
Electro Tec Corp.
Electro Tec Corp., Virginia Div.
Electro-Miniatures Corp.
Instrument Development Laboratories, Inc.
La Pointe Industries Inc.
Librascope Inc.
Mycalex Corp. of America
Pacific Div.-Bendix Aviation Corp.
Seeburg Corp., The
Skiatron Electronics & Television Corp.
Talley Corp., The
Telechrome Mfg. Corp.
Telectro Industries Corp.
Winder Aircraft Corp. of Fla.

BAND PASS FILTERS

Adler Electronics, Inc.
American Electronic Labs., Inc.
American Research & Mfg. Corp.
Applied Research Inc.
Bogart Mfg. Corp.
Browning Laboratories, Inc.
Bulova Watch Co., Electronics Div.
Burnell & Co., Inc.
Carad Corp.
Celco-Constantine Engrg. Laboratories Co.
Chicago Electronic Engrg. Co., Inc.
Collins Radio Co.
Cornell-Dubilier Electric Corp.
D & R, Ltd.
Data-Control Systems Inc.
Daven Co., The
Defiance Engrg. & Microwave Corp.
Demornay-Bonardi
Diamond Antenna & Microwave Corp.
Douglas Microwave Co., Inc.
ECS Corp.
Electronic Transformer Co., Inc.
Entron, Inc.
Epsco Inc.
Filtron Co., Inc.
Fugle-Miller Labs Inc.
Hermetic Seal Transformer Co., Div.-Southwestern Industrial Electronics
Highland Engrg. Co.
Hycon Eastern Inc.
Johnson Electronics Inc.
Lenkurt Electric Co., Inc.
J. W. Miller Co.
Munston Mfg. & Service, Inc.
NYT Electronics, Inc.
National Coil Co.
North Hills Electric Co., Inc.
Orbitran Co., Inc.
Ortho Filter Corp.
Potter Co., The
Ram Electronics Inc.
Sage Laboratories, Inc.
Saratoga Industries
Herman Hosmer Scott, Inc.
Southwestern Industrial Elactronics Co.
Spectrum Instruments, Inc.
Telectro Industries Corp.
Televiso Corp.
Terminal Radio Corp.
Tobe Deutschmann Corp.
Topper Mfg. Co., Inc.
Transformers, Inc.
Transonic, Inc.
Tucson Instrument Corp.
United Electrodynamics, Div.-United Geophysical Corp.
United Transformer Corp.
Vanguard Electronics Co.

AMPLIFIERS

Acro Products Co.
Acromag, Inc.
Acton Laboratories, Inc.
Advance Industries, Inc.
Airborna Accessories Corp.
Aircraft Armaments, Inc.
Airtron, Inc.
Allegany Instrument Co., Inc.
American Electronics, Inc.
American Electronics, Inc., Data-Tronics Div.
Applied Research, Inc.
Arenberg Ultresonic Laboratory, Inc.
Baird-Atomic, Inc.
Bogue Electric Mfg. Co.
Brush Instruments, Div.—Clevita Corp.
Centronix, Inc.
Century Electronics & Instruments, Inc.
Consolidated Airborne Systems, Inc.
Consolidated Avionics Corp.
Consolidated Electrodynamics Corp.
Data-Control Systems Inc.
Daven Co., The
Du Kane Corp.
Dwyer Engrg. Co., Inc.
Dynamics Instrumentation Co., Div.-Alberhill Corp.
Electronic Assembly Co., Inc.
Feedback Controls, Inc.
Gray Mfg. Co., The
Hallamore Electronics Co.
Haller Raymond & Brown, Inc.
Heiland Div.—Minneapolis-Honeywell
Highland Engrg. Co.
Hoover Electronics Co.
Jordan Electronics, Div.—Victoreen Instrumant Co.
Keithley Instruments, Inc.
La Pointe Industries, Inc.
Lear, Inc., Grand Rapids Div.
Gerard G. Leeds Co., Inc.
Mid-Century Instrumatic Corp.
George L. Nankervis Co.
Owen Labs., Inc.
Photron Instrument Co.
Reeves Instrument Corp.
Resdel Engrg. Corp.
Rheem Mfg. Co., Electronics Div.
Roflan Co., The
Senborn Co.
Servomechanisms, Inc., Mechatrol Div.
Simpson Electric Co.
Telechrome Mfg. Corp.
Telectro Industries Corp.
Westbury Electronics, Inc.
Western Electro-Acoustic Lab.
Westronics, Inc.
Wilcox Electric Co., Inc.
Winder Aircraft Corp. of Fla.

are usually fed into a signal converter, which changes them to a form suitable for use and then applies them to the commutator or directly to sub-carrier oscillators (where continuous sampling is required).

The signals that go to the rotating commutator are impressed on the proper legs, and the commutator feeds them to a gate at proper intervals.

The commutator actually has several functions: As it rotates, it provides excitation voltages to the transducers in order of use, delivers a master synchronization pulse to the gate, and also delivers the gating impulse.

The gating device maintains a constant width between pulses by electronic means, and operates on the information pulses with multivibrator and cathode follower circuits to obtain the sub-carrier oscillator inputs.

• **How they work**—In the transistorized voltage-controlled oscillator described in the February issue of m/r, (p. 129) the voltage across the tuned circuit is 90° out of phase with the current in the loop.

During alternating half-cycles, the circulating tank current passes through the emitter-to-base diode of a modulator transistor, and during the remaining half-cycles, passes through a diode.

A dc control-signal current is fed into the input terminals and biases the emitter of the modulator transistor by varying amounts. The collector of the modulating transistor will then supply reactive current to the tuned circuit, causing a shift in the oscillator frequency.

The sub-carrier oscillator outputs are generally mixed and fed into the transmitter unit of the telemetry system. However, in some cases further amplification is introduced before the signals are applied to the input of the transmitter unit.

The transmitter, as mentioned before, uses the sub-carrier oscillator outputs to frequency-modulate its RF signal. The signal is then multiplied and amplified in the conventional manner for transmission to the ground receiving station.

The final link in the airborne portion of a telemetry setup is the antenna.

Almost every type available has been used, ranging from a conventional stub to flush sections on the missile skin. Most test missiles carry stubs or some variation, but production missiles will probably incorporate flush antennas.

• **Reception**—Ground reception of the telemetered signals is by conventional, precision FM receivers, which separate the mixed signal, by means of discriminators, into the original sub-carrier outputs.

Either or both of two processes is then applied to the signals: Direct oscillograph recording where immediate information is required, and magnetic tape recording for future playback or for input to a computing facility.

Usually, tape recording is done simultaneously so that in case of recording equipment failure, a permanent record of the telemetered information is always available.

Another function of the receiving station is the insertion of time-coding, so that accurate time-interval reference is available both on the direct recorder and magnetic tape.

A description of one data-processing and computation center currently in use appeared in the February issue of m/r (page 95.) One of the functions of this center—the processing of analog information recorded on magnetic tape into a form suitable for application to a digital computer—would make use of the raw-data on the receiving station magnetic tapes. In this function, the computing center converts the tape data into digital information on tapes compatible with IBM 704 computer equipment.

• **Converting data**—The conversion system consists essentially of equipment to handle continuous FM, PAM/FM, and PWM/FM telemetered data. It does not decommutate or scale the data, since this can be done during the computation process.

Initially, a time-code translator uses the time signals recorded at the receiver site to generate instructions to the conversion system. In the event of range station time failure, the time-code translator supplies its own time reference.

In the next step, a bank of FM discriminators separate the various subcarrier channels and route them to several places—including an electronic commutator for the continuous FM signals, a low-pass filter for the PAM/FM signals, and a PWM-to-amplitude converter for PWM/FM signals.

The electronic commutator can accept up to five discriminator outputs of continuous FM information and use the signals to present sample data of each channel in cyclic fashion.

The low-pass filter used with the PAM/FM signals is included to block unwanted high frequencies in the information. The pass band effects a compromise between rise time and noise.

Since the volts-to-digits converter accepts signals in the form of a pulse amplitude train, the PWM/amplitude converter is used to change the pulse width train into pulse amplitude form.

Further in the conversion process, signals are fed from the electronic commutator, the low-pass filter and the

Manufacturers of Telemetry Components

F-M RECEIVERS

Adler Electronics, Inc.
Aeronautical Electronics, Inc.
Bendix Radio Div.-Bendix Aviation Corp.
Blonder-Tongue Labs., Inc.
Browning Laboratories, Inc.
Communications Co.
Data-Control Systems Inc.
Electronic Communications, Inc.
Haller Raymond & Brown Inc.
Nems Clarke Co., Div.-Vitro Corp. of America
Land-Air, Inc., Sub.—California Eastern Aviation, Inc.
Marconi Instruments
Motorola Inc., Military Marketing Div.
National Electronics Laboratories, Inc.
Philco Corp., Government & Industrial Divs.
Herman Hosmer Scott, Inc.
Seeburg Corp., The
Seeley Electronics
Stromberg-Carlson, Electronics Div.
Telechrome Mfg. Corp.
Telectro Industries Corp.
Tele-Dynamics Inc.
Terminal Radio Corp.
Transvision, Inc.
Winder Aircraft Corp. of Fla.

F-M MULTIPLEX

Browning Laboratories, Inc.
Collins Radio Co.
Communications Co.
Data-Control Systems Inc.
Haller Raymond & Brown Inc.
Motorola Inc., Military Marketing Div.
National Electronics Laboratories, Inc.
Herman Hosmer Scott, Inc.
Seeburg Corp., Tha
Skiatron Electronics & Television Corp.
Telectro Industries Corp.
Tele-Dynamics Inc.
Terminal Radio Corp.
Winder Aircraft Corp. of Fla.

INSTRUMENTS, GRAPHIC RECORDING

Air Logistics Corp.
Airborne Instruments Lab., Inc.
Alden Electronic & Impulse Recording Equip. Co.
Allegany Instrument Co., Inc.
Antlab Inc.
Baird-Atomic, Inc.
Barnes Development Co.
Benson-Lehner Corp.
Brush Instruments, Div.-Clevita Corp.
Burroughs Corp.
Centronix Inc.
Consolidated Avionics Corp.
Consolidated Electrodynamics Corp.
Curtiss-Wright Corp., Electronics Div.
Edgerton, Germeshausen & Grier, Inc.
Electric Auto-Lite Co., The
Electro-Tech Equipment Co.
Fischer & Porter Co.
General Electric Co., Apparatus Sales Div.
General Railway Signal Co.
Hagan Chemicals & Controls, Inc.
Heiland Div.—Minneapolis-Honeywell
Kay Electric Co.
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co., Indust. Div.
F. L. Moseley Co.
Offner Electronics Inc.
Palmer Thermometers, Inc.
Perkin-Elmer Corp.
Potter Aeronautical Corp.
Sanborn Co.
Scientific Instrument Co.
Southwestern Industrial Electronics Co.
Tally Register Corp.
Westinghouse Electric Corp., Air Arm Div.
Westronics Inc.

ANTENNAS

Advance Industries, Inc.
American Brass Co., The
American Electronic Labs., Inc.
American Machine & Foundry Co.
Andrew Corp.
Bogart Mfg. Corp.
Continental Diamond Fibre Corp., Sub.—The Budd Co.
Dalmo Victor Co., Div.-Textron Inc.
Joe Davidson & Associates
Dayton Aircraft Products, Inc.
Defiance Engrg. & Microwave Corp.
Diamond Antenna & Microwave Corp.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div.
General Electronic Labs., Inc.
Haller Raymond & Brown Inc.
Hazeltine Electronics Div.-Hazeltine Corp.
Hi-Lo Manufacturing Corp.
Lear, Inc.
Mark Products Co.
Mechanical Div.-General Mills, Inc.
Munston Mfg. & Service, Inc.
Polarad Electronics Corp.
Radio Corporation of America, Defense Electronic Products
Reaves Instrument Corp.
Republic Aviation Corp., Guided Missiles Div.
Ryan Aeronautical Co.
Stromberg-Carlson, Electronics Div.
Sylvania Electronics Systems, Div.-Sylvania Electric Products Inc.
Technical Appliance Corp.
Transco Products, Inc.
Victor Electric Wire & Cable Corp.
Washington Aluminum Co., Inc.

RADIO FREQUENCY OSCILLATORS

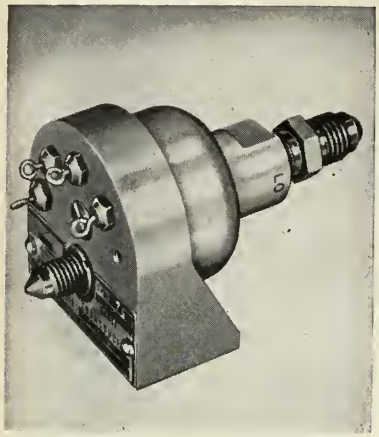
Adler Electronics, Inc.
Airborne Instruments Lab., Inc.
Boonton Electronics Corp.
Boonton Radio Corp.
Consolidated Electrodynamics Corp.
Haller Raymond & Brown Inc.
Hickok Electrical Instrument Co., The
Interelectronics Corp.
Johnson Electronics Inc.
Kay Electric Co.
Manson Laboratories, Inc.
Ralph M. Parsons Co., The, Electronics Div.
Seeburg Corp., The
Tel-Instrument Electronics Corp.
Terminal Radio Corp.
Thompson Products, Inc.
Wave Particle Corp.
Weinschel Engrg.

R-F

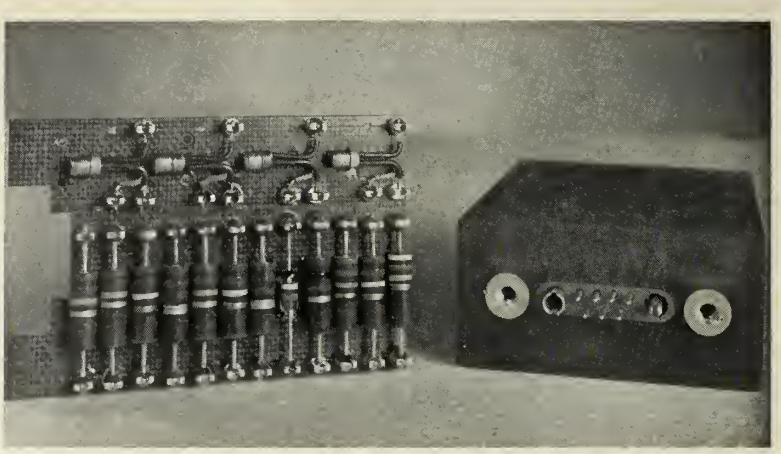
Adler Electronics, Inc.
Airborne Instruments Lab., Inc.
Alpha Instrument Co.
Boonton Electronics Corp.
Boonton Radio Corp.
Consolidated Electrodynamics Corp.
Cooper Development Corp.
Cubic Corp.
Diamond Antenna & Microwave Corp.
Electronic Communications, Inc.
General Communication Co.
Haller Raymond & Brown Inc.
Hickok Electrical Instrument Co., The
Instrument Motors
Interelectronics Corp.
E. F. Johnson Co.
Johnson Electronics Inc.
Kay Electric Co.
Manson Laboratories, Inc.
Munston Mfg. & Service, Inc.
Ralph M. Parsons Co., The, Electronics Div.
Polarad Electronics Corp.
Seeburg Corp., The
Technical Oil Tool Corp.
Tel-Instrument Electronics Corp.
Telonic Industries, Inc.
Terminal Radio Corp.
Wave Particle Corp.

TRANSMITTERS

Acoustica Associates, Inc.
Advance Industries, Inc.
Aircraft Armaments, Inc.
Amelco, Inc.
Collins Radio Co.
Communications Co.
Cubic Corp.
Du Kane Corp.
Electronic Communications, Inc.
Electronics Development Co., Inc.
General Electronic Labs., Inc.
General Railway Signal Co.
Haller Raymond & Brown Inc.
Hazeltine Electronics Div.-Hazeltine Corp.
E. F. Johnson Co.
Lane Electronics Mfg. Corp.
Manson Laboratories, Inc.
Motorola Inc., Military Marketing Div.
Munston Mfg. & Service, Inc.
National Electronics Laboratories, Inc.
Pacific Div.-Bendix Aviation Corp.
Ralph M. Parsons Co., The, Electronics Div.
Radiation, Inc.
Reeves Instrument Corp.
Republic Aviation Corp., Guided Missile Div.
Resdel Engrg. Corp.
Ryan Aeronautical Co.
Sarkes Tarzian, Inc.
Seeburg Corp., The
Skiatron Electronics & Television Corp.
Stavid Engrg., Inc.
Stromberg-Carlson, Electronics Div.
Sylvania Electronic Systems, Div.-Sylvania Electric Products Inc.
Telechrome Mfg. Corp.
Telectro Industries Corp.
Tele-Dynamics Inc.
Terminal Radio Corp.
Westinghouse Electric Corp.
Wunderlich Radio Co.



HIGH RESOLUTION type Bourdon-tube transducer, one of many new products.



TYPICAL voltage-controlled sub-carrier oscillator unit developed by Shepard Instrument Company. Photo shows transistorized unit before and after encapsulation.

PWM-amplitude converter to volts-to-digit converters. Then the amplitudes of each sample are converted to parallel data codes for recording by the digital recording units—the last devices in the conversion link.

The volts-to-digit converter also interjects codes for bad data, data present, time, time code present, and frame synchronization. Versatility here is an important factor.

The digital recorder units accept synchronous data codes and time codes suitable for IBM 704 use, and introduce the final information which must be included on the digital tape before use in the General Electric computing facility.

This system, while not typical, includes most of the elements necessary for converting raw data on magnetic tapes into data suitable for the digital processes. Only through the use of digital computers can the necessary exhaustive analyses be made.

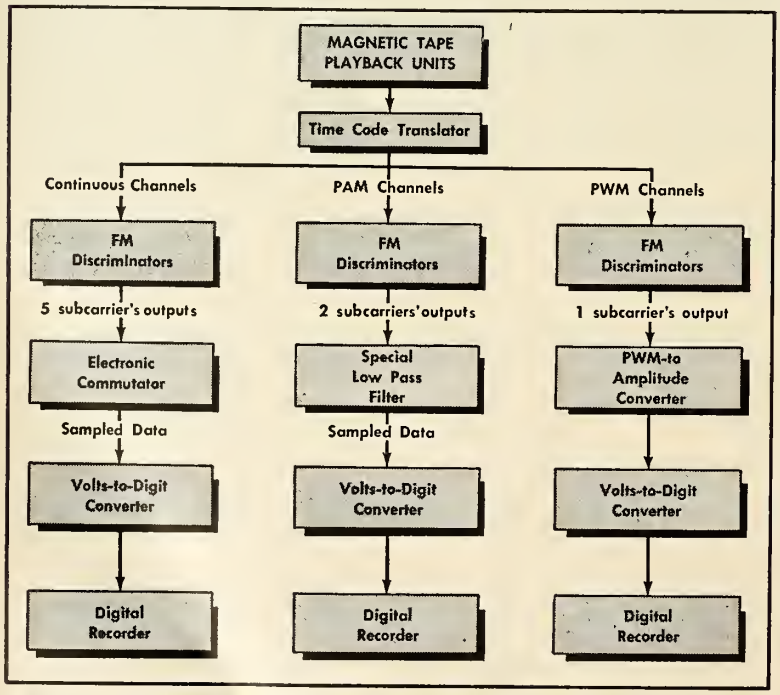


DIAGRAM of analog-to-digital conversion system used by GE's MOSD data center.

No attempt will be made here to describe the variety of computers available to process the data, but most units fall in the unclassified area and performance specifications are readily available from the manufacturers.

The accompanying tables list a number of manufacturers who make various types of telemetry equipment, but a complete list would probably require two or three times as much space because of the large number of manufacturers who are directly or indirectly connected with this field.

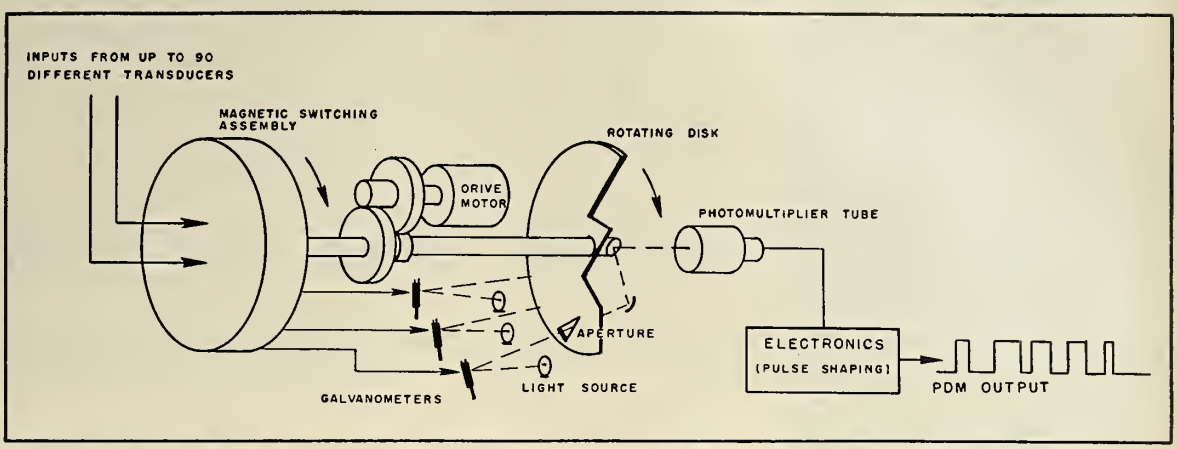
• **Data collection**—A new approach to a not-so-new problem has recently been suggested by Consolidated Electrodynamics Corp. Their suggestion—a PLEXICODER for pulse-duration modulation (PDM) and multiplexing.

The problem is this: more and more telemetered information is wanted, but the collection and time-sharing of this information has had several obstacles.

The transducers that could provide the information needed within the environmental limits specified were generally of the "low-level" time and produced only a few millivolts as an output. Efforts to time-share the information by use of a commutator was found to be impractical. Until recently, several approaches to the problem were in general use.

First of these, of course, was the potentiometer-type transducer, with a voltage output capable of modulating the sub-carrier oscillator directly. But many engineers feel that these devices had just about approached the limits of their use.

Another approach uses amplification of low-level output. But ampli-



SCHEMATIC DIAGRAM of Consolidated Engineering's PLEXICODER PDM commutator. Unit uses light source.

fiers are expensive, and regardless of their refinement, contribute to the overall system error. They also require more power and add weight to the telemetering equipment.

Low-level commutation immediately reduces size, weight, power requirements, and cost. However, it has not proved to be too practical because of the rather limited number of channels which can be used. Commutation rates of PDM systems exceed the handling capabilities of mechanical commutators for low-level signals.

• **Unit description**—The PLEXICODER uses recording galvanometers and achieves high-speed commutation and conversion to PDM by interupting a light beam. The unit can handle 90 channels.

Each input signal is fed through two hermetically sealed, magnetically operated switches—which act as a double-pole, single-throw switch to a galvanometer.

The unique design of this input switch eliminates induced voltages normally associated with a magnetic switch. These switches are opened and closed in a predetermined time sequence by moving magnets, so that a given galvanometer is energized by a transducer for only a specific time period.

Each galvanometer may accept as many as six different inputs in sequential fashion.

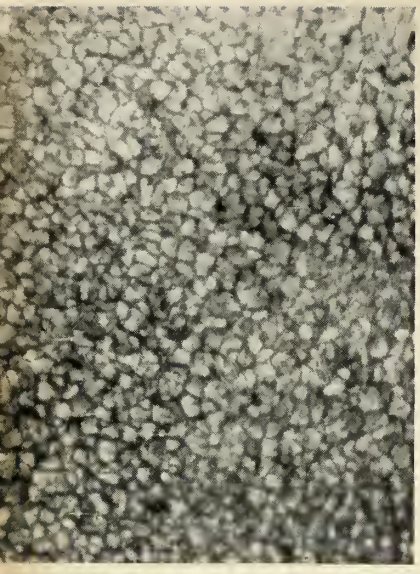
The light beam from the galvanometer passes through an aperture, cut in the shape of a right triangle, to a disk which rotates at a constant speed and at a right angle to the light path.

As the aperture crosses the light beam, light is admitted to a photomultiplier tube for a duration dependent on the beam's position along the hypotenuse of the triangular opening.

The beam's position depends on the angular displacement of the galvanometer mirror, which is in turn proportional to the transducer input to the galvanometer coil. As the light beam strikes the tube, a voltage pulse is developed by the tube. The duration of this voltage pulse is a direct linear function of the transducer signal transmitted to the PLEXICODER.

This description is intended to be representative of the current thinking in this field. It also represents the current and future developments which may be expected due to the extreme importance of telemetering.★

RESEARCH MODEL being instrumented at NACA's Langley Aeronautical Laboratory.



STRATOSCOPE SOLAR TELESCOPE photo of sun is far sharper and more detailed than any taken from the Earth.

Optics Move Into Space:

Satellite "Eyes" To View Earth Weather Conditions

by William Strouse*

THE DESIGN AND PRODUCTION of high performance optical systems for use in the upper atmosphere and in space requires the solution of many unique problems. Optical performance is naturally the prime requisite of any system, and weight minimization is always an important factor. Careful consideration of the environmental situation is essential to develop reliable instrumentation for operation under the varied and difficult conditions aloft. Both the Stratoscope telescope and the *Vanguard* Weather Eye described in this article provide examples of the types of problems encountered in the design and construction of optical systems for operation in the upper atmosphere and space.

Astronomy took what may be considered its first move "into space" last fall, under the auspices of Project Stratoscope. A 12-in. aperture telescope-camera, designed and built by the Perkin-Elmer Corp., Norwalk, Conn., was launched to 80,000 ft. by large Skyhook balloons to photograph the sun.

Prior to Project Stratoscope, photographs of solar granulation had been taken from manned balloons at altitudes of 20,000 to 25,000 ft.

As Project *Vanguard* progresses, optics will take real strides into space. "Weather Eye" optical systems, designed and produced for the *Vanguard* program, will be carried aboard the satellite to measure the infrared energy reflected from the earth's cloud layer. These tiny devices will give meteorologists greater quantities of information than now available for weather prognostication.

• **Satellite Weather Eyes**—A beneficial use for earth satellites will be the gathering of meteorological data for weather forecasting. At present, weather forecasts are based on observations covering only 5-10% of the earth's surface.

The Weather Eyes, developed and built by Perkin-Elmer for the U.S. Army Signal Corps Laboratories at Ft. Monmouth, N.J., will implement the first attempts at comprehensive meteorological reconnaissance. Scheduled for the fifth *Vanguard* shoot, the "Eyes" will make possible "mapping" of the Earth's cloud cover. Cloud formations and densities are key indications of forthcoming weather.

Weather Eyes will be used in pairs, mounted back-to-back on the central core of the 20-in. *Vanguard* satellite. They will peer outward in opposite directions through holes in the satellite shell. Their direction of view will make a 45° angle with the axis rotation of the satellite.

---

*Project Engineer, Engineering and Optical Division, The Perkin-Elmer Corp., Norwalk, Conn.

VANGUARD'S **"Weather Eye" is designed to measure IR radiation from earth's clouds.**

As the satellite spins in flight, the field of view of one "Eye" will sweep across the earth or its cloud cover, below and forward. The other "Eye" will sweep the area below and rearward during the second half of each rotation.

In this way, the "Eyes" will collect infrared energy characteristics of clouds. In similar fashion to a television raster, an infrared picture of the clouds will be built up by successive sweeps. The "Eyes" will cover some 600 miles wide on a sweep. Satellite rotation will be about one revolution per sec.

The infrared energy will be focused on a one millimeter square Ektron (lead sulfide) detector. The electrical signal from the detector will be recorded on magnetic tape, where it will be stored until it is read-out and transmitted on later command from ground telemetering stations.

The very "fast" f/0.7 optical system makes possible the rapid sweep rate of the projected detector area over the clouds. It also allows a compact configuration which readily fits into the satellite.

With weight limitation of prime significance in the satellite program, the short focal length of the system aids in keeping each Weather Eye one-half ounce under the initial weight limit goal. Each optical unit weighs 3½ ounces.

In order to minimize weight, the cell is made of .010 in. thick stainless steel sheet, type 430. After the sheet is butt-welded into a cylinder, a bead is spun at the front of the cell for stiffening the structure. Near the rear of the cell, a controlled form indentation is spun into the metal to form a seat for the beveled face of the primary mirror.

Type 430 stainless steel, and primary mirror glass type BCS-2, were chosen for an approximate match of thermal expansion. The low-weight method of mounting the primary mirror requires a close fit between glass and cell diameters, and, accordingly, the match of expansion co-efficients.

The primary mirror is bonded into place with Pliobond. Thus, it is permanently "squared-on" and located with respect to the detector cell location. Small variations in location of the focal surface are compensated by shifting the detector to the exact focal area with spaces.

The ribs holding the detector cell are of the same stainless steel, .010 in. thick. These are spot welded to the main cell and silver-soldered to the thinwalled brass detector cell. The entire unit is buffed and given a gold finish to minimize the effects of stray radiant energy.

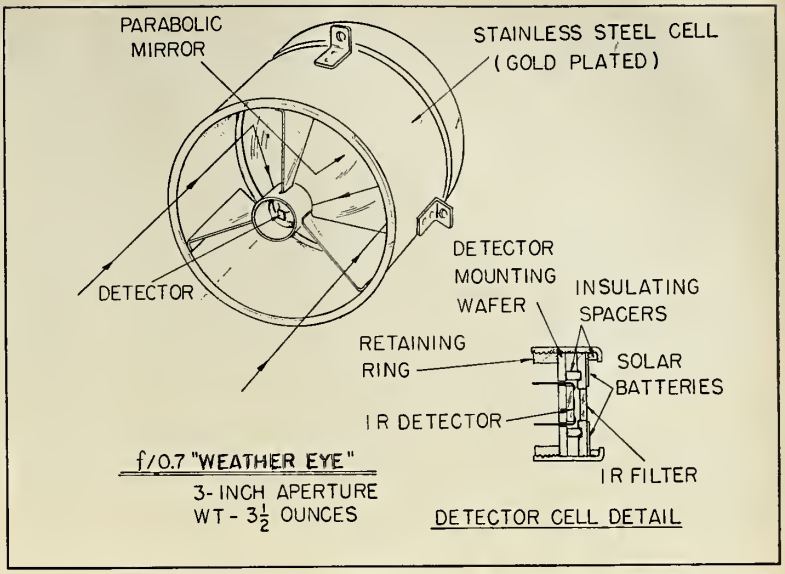
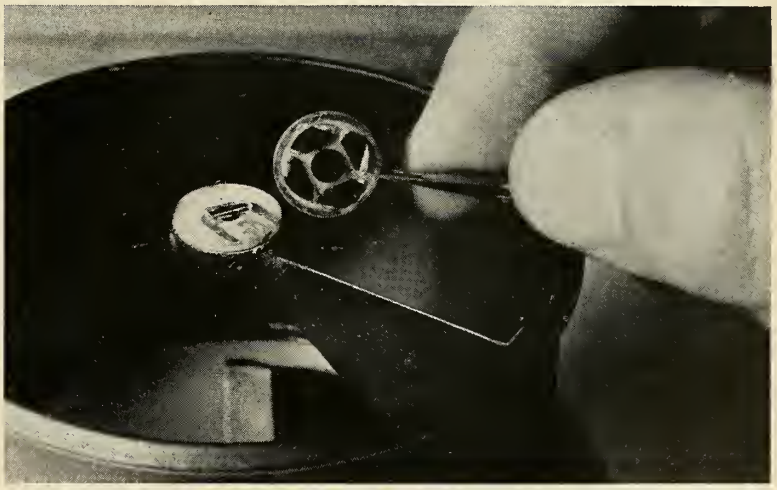


DIAGRAM OF SATELLITE "Weather Eye" with additional details on the detector cell.



SILICON SOLAR BATTERY SYSTEM (black oblong objects in center) are used by the instrument to differentiate between day and night.

An alternate configuration for the Weather Eye was considered, which would have made possible further weight reduction by ½ to ¾ ounce for each unit. It was decided however, that a gain in reliability, i.e., resistance to damage from vibration and acceleration, was achieved by the well braced structure described.

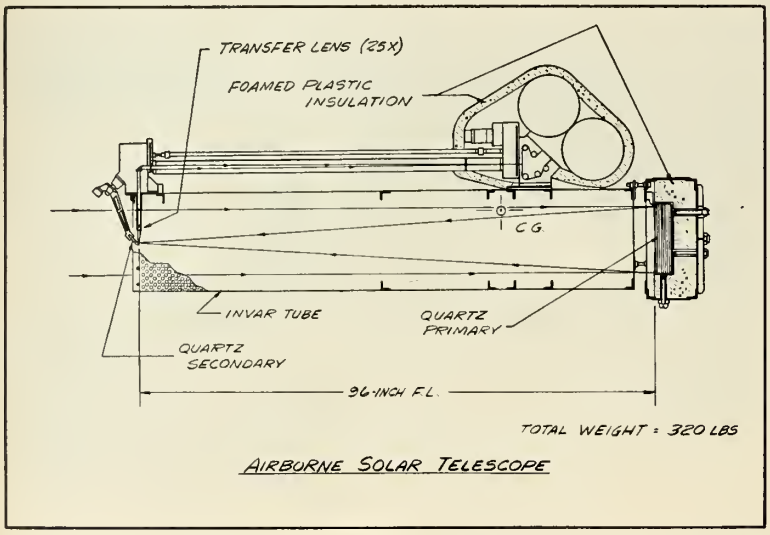
• **Stratoscope solar telescope**—The Weather Eye optical unit is a relatively simple device, however, the Solar Telescope is a more complex optical system. It is part of the complete Stratoscope system involving the support frame, pointing mechanisms and balloon which carries the telescope to high altitudes.

The goal of the Stratoscope project was to obtain photographs of unprecedented resolution of the "granulation" on the solar surface. This would determine which of various astrophysical theories most closely describes the physical reality.

Such detailed photographs cannot be satisfactorily obtained through the earth's atmosphere—the air is in a constant state of image-degrading turbulence, especially during daylight hours.

Under the auspices of the Office of Naval Research and Dr. Martin Schwarzchild, director of the Department of Astronomy, Princeton University, the Solar Telescope made two successful balloon flights in September

FRONT AND REAR VIEW of the assembled satellite "Weather Eye" units.



SOLAR TELESCOPE diagram, developed by Perkin-Elmer for Project Stratoscope.

and October, 1957 to photograph the surface of the sun.

From a vantage point over 80,000 ft., above 98% of the earth's atmosphere, the telescope-camera took 8,000 35mm photographs of the sun on each flight.

The measure of success for the Stratoscope project was to be the attainment of one perfect photograph of the solar surface.

It was expected that the equipment would survive the shock of its first parachute landing back to earth. In the event that it should not, it was mandatory that the telescope and camera perform reliably to obtain one perfect picture on the first flight.

The resolution of detail obtained on film is limited by diffraction of the telescope's 12-in. aperture. The optical elements must therefore be of "perfect" quality, so they cannot cause degradation of image quality. "Perfect" in optical shop practice means conformance of the glass curve to a true paraboloid within one-twentieth of a wavelength of light.

The pertinent features of the telescope are shown in the schematic diagram. The primary mirror is an f/8 paraboloid whose surface does not depart more than one millionth of an inch ($\lambda/20$) from a parabolic curve. The secondary mirror is a flat diagonal which diverts the light 90°.

The doublet transfer lens compensates for the coma of the primary, while magnifying the primary image 25-fold. A small prism diverts the light again toward the camera, where, on 35mm film, a frame size 1 x 1½ in. is exposed. Each photograph covers about one-half percent of the sun's area or roughly 50,000 by 75,000 miles.

• **Project Stratoscope**—The balloon-launched telescope was sent aloft at dawn. An hour, or slightly longer, was required for the balloon to reach its ceiling altitude. By preset timing arrangements, the telescope pointing system was actuated after sufficient time for aerodynamic equilibrium to be achieved.

The telescope was pointed at the sun by the photoelectric-servo system for a period of about an hour to achieve warm-up of the guidance-stabiization circuitry.

Photography began by energizing the telescope-camera motor, and proceeded for slightly more than two hours.

After photography was completed, the telescope was pivoted to a protected position within the support frame and the system returned to earth by parachute.

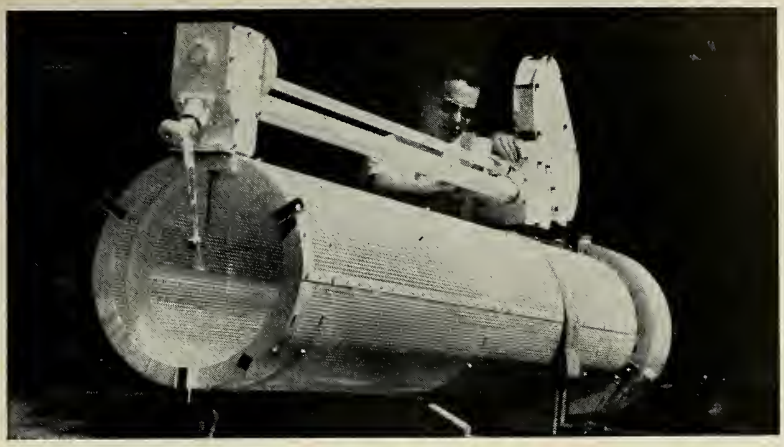
The sun's radiation warms every object upon which it falls—unless the body is a perfect reflector at all wavelengths. The air temperature at 80,000 feet is about −60°C, and the sky above is a radiant energy "sink" of absolute zero.

The combination of these circumstances comprises an environment fraught with potential difficulty for an astronomical telescope. Accurate alignment, constant spacings of elements, and turbulent air currents all require detailed consideration if the highest optical performance is to be achieved.

The primary mirror coating, although of high-reflectivity evaporated aluminum, is not a perfect reflector. Approximately 12% of the sun's radiation is absorbed and causes heating of the mirror. To minimize effects of this heating, the mirror is made of quartz, an optical material of minimum thermal expansion. Changes in the general curvature of the mirror, which cause changes in focal length, are thus kept within negligible limits.

The warming of the mirror's front surface spreads throughout the quartz, and the heat is conducted through the mirror supports to the mirror cell walls. There are localized cooled areas where the supports touch the blank. These heat sinks on the back will result in non-uniform cooling and cause the front surface mirror curve to depart from the 1/20-wave smoothness necessary to achieve perfect imagery.

The thermal conductivity of the



COMPLETED TELESCOPE undergoing final tests at manufacturer's plant.

mirror was reduced to a negligibly low value by making a .25-in. wall, ¾-in. diameter micarta tubing with nylon buttons, which have small (1/8-in. diameter) areas of contact with the mirror. The light structure of these supports served the additional purpose of being easily breakable, so that on a hard landing they would yield and minimize fractures of the primary mirror.

• **Precautionary measures**—The cell was lined with 3-5 in. of foamed plastic, which served the dual purpose of thermal insulation and shock absorption if the mirror supports gave way at landing. The back and edge of the primary mirror were given a "shine" (as opposed to an optically figured polish), and coated with evaporated aluminum to reduce radiation losses from the mirror.

The tube of the telescope establishes the separation of primary mirror and secondary diagonal. This spacing must be accurately equal to the focal length of the primary. Since change in length of the tube could not be tolerated, it was made of Invar, the alloy whose thermal expansion is a minimum for structurally suitable metals.

To minimize effects on the temperature of the tube, it was covered by white paint (titanium dioxide pigment), as were all other exterior parts of the telescope. The tube was perforated, to reduce the weight and minimize disturbance to image quality from air convection by breaking the flow into small eddies.

At the focus of the primary mirror was a Newtonian diagonal mirror. All the energy of the sun that streamed into the full 12-in. aperture was concentrated into a 7/8-in. diameter image for viewing.

If the secondary mirror were to be fixed at this location, it would be badly distorted due to heating, and there would be danger of loss of the aluminum coating from the high temperatures developed. The elements of the system to which energy is transferred by this mirror would also be distorted by the constant stream of energy.

To circumvent these possibilities the secondary mirror was kept in motion and was out of the sun's image 98% of the time. The rotation of the arm holding the mirror was synchronized with the shutter and film transport.

During 2% of the time that the diagonal mirror diverted light to the camera, the film exposure took place. Duration of exposure was determined by a focal plane shutter. Exposure time was 1/1000 sec.

Appraisal of these precautionary design features indicated there was still uncertainty of success toward achieving the one perfect picture of the solar surface. To insure utmost reliability in performance, a further step was taken to be certain of a good picture even if the previous measures stoll allowed shifting of the focus.

The small 25-power transfer lens was traversed axially in a sequence of 20 steps to cover and safely exceed the region of space wherein the focal might fall. The range traversed was 2.5 millimeters. This precaution resulted in purposely losing 19 of every 20 shots. Consequently, of the total of 8,000 negatives exposed, only 400 photographs could be good.

The film was protected from extreme cold, which might result in breaking the forces needed to move it through the camera, by insulating covers which conserve heat from the pre-launching environment. The motor which drives the telescope-camera's mechanisms was enclosed by these covers, to utilize the heat developed in the motor.

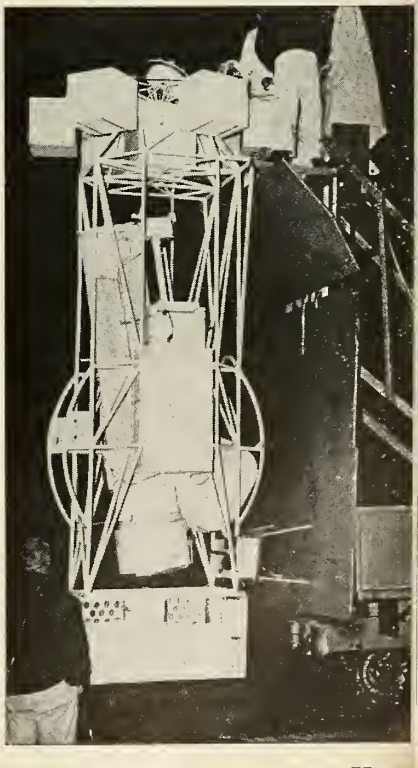
• **Successful result**—The numerous precautions produced a highly successful system. The telescope, after two flights into the upper atmosphere, returned to earth with photographs of unexcelled resolution and with only slight mechanical damage resulting from landing.

The Princeton astronomers plan, in 1959, to fly the Solar Telescope again for further photography of the sun. The pointing will be directed via radio control from a ground station. The area to be photographed will be selected by television monitoring of the field of view of the telescope. Photographs are desired of "special interest" regions, e.g., sunspots, faculae, and solar prominences.

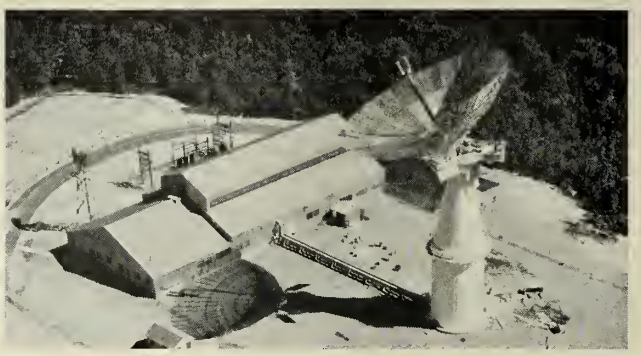
Due to the success of this first effort in extra-terrestrial astronomy, a 36-in. aperture balloon-borne telescope is being planned for use on objects in the night sky.

The optical systems discussed above are the forerunners of diverse, more complex, and larger systems of the future. These future systems will embody the same design considerations which have already been proven in systems operation.★

FINAL PREPARATIONS are made just prior to launch. Telescope is seen in its support cradle. Ascending and descending, it was in a vertical position. After attaining ceiling height, a time mechanism lowered the telescope, and photo-electric servo controls pointed it at the sun.

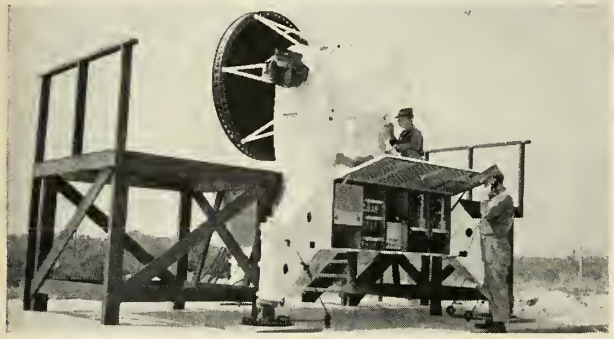


Army



MIT

The Army Signal Corps DIANA moon radar has been used to develop a technique for the testing of *Vanguard* tracking stations. The experimental Millstone Hill long-range radar (right) has an 84-foot parabolic reflector.



Army

NACA

Tracking radar for *Nike* SAM is checked by Army technicians at Fort Story, Va. This is one of two radars used to direct *Nike* in its interception. NACA radar (right) tracks a research model launched from Wallops Island, Va.

RADAR TRACKING

During the flight test phase of every missile program, ground-based radar tracking systems play an unpublicized—but extremely vital—role in recording the missile's performance.

Missile experts know that a rocket's accuracy must be determined in the first few seconds of flight. A small error at the start can mean hundreds of miles of error at the target.

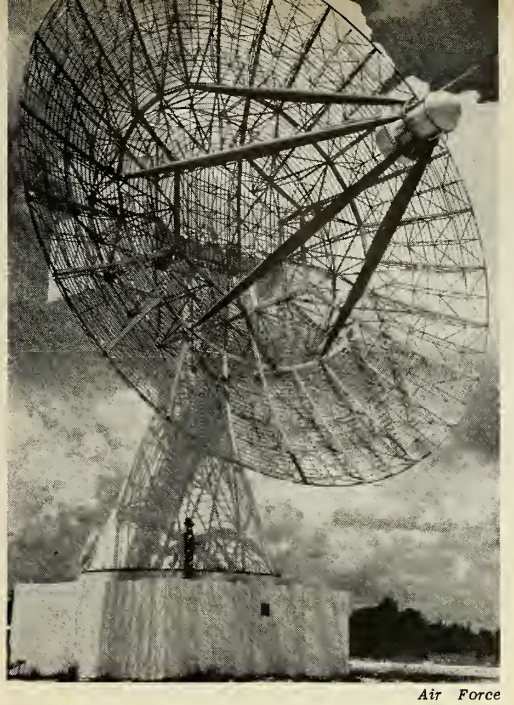
Radar instrumentation requires a tracking and plotting system that can follow a missile through its entire flight path; and at the same time record azimuth, elevation, height, and range position instantly. This requires not only the tracking instruments but a data-transmission and processing system for transcribing in the form of a permanent record, the flight characteristics of the missile.

The basic components of a radar tracking system consist of a radar transmitter, a receiver for pickup and amplification of the echo of the transmitted signal, a position indicator for display of range and azimuth data, a data-transmission system for feeding a computer which analyzes and records the data. The size and range capabilities of radar systems vary with the design range and flight performance of the missile.

Stanford Research Institute's 61-ft-diameter radar uses a 100 mc transmitter to gather meteor data.

Air Force

One of five 60-ft-diameter radars used by the Air Force in Florida for missile-tracking work.

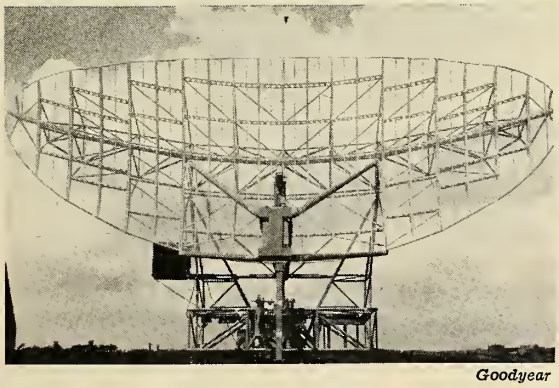


Air Force

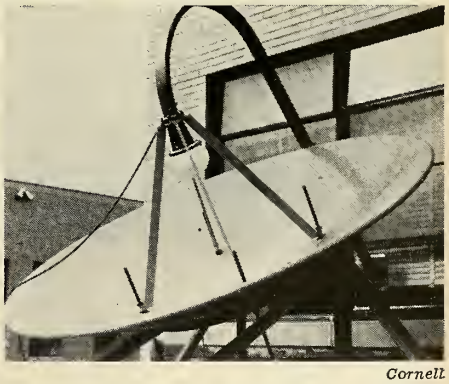
Air Force

Modified radar antennas with bore-sighted cameras track missiles, at Cape Canaveral, Fla.

Part of the nation's air warning system, this 750-sq. ft. antenna was built by Goodyear Aircraft. Eight-ft. microwave antenna dish (right) has been used by Cornell Aeronautical Labs to emit radar signals at 17 million watts.



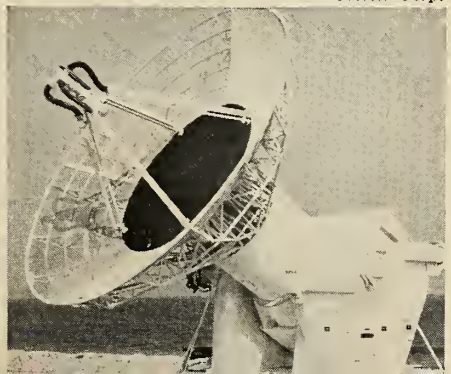
Goodyear



Cornell

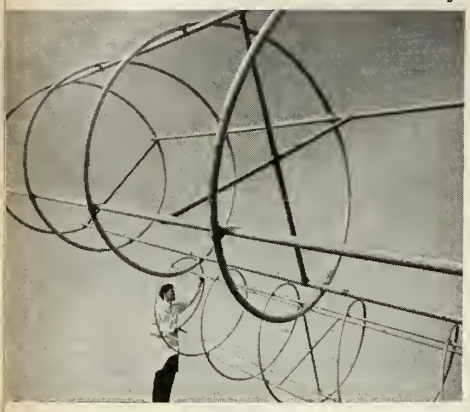
Equipment used to track Army *Explorer* included this Carrier Corp. radar located on the Florida coast. The *Hawk* surface-to-air radar (right) developed by Raytheon, tracks low-flying targets while ignoring stationary objects.

Carrier Corp.



Army

Ramo-Wooldridge



Doppler radar antenna picks up data on electron density in space 50 miles up and out.

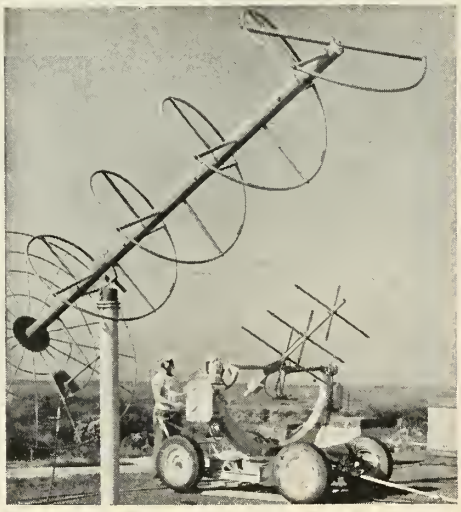
TELEMETRY TRACKING

Depending upon the type of antenna utilized by the missile transmitter and the angle of coverage of the transmitted signal, the types of telemetering antenna needed for ground receiver units are quite varied.

Helical-beam antennas, which are quite efficient for the FM band, are the most widely used. This type of antenna consists of a helix positioner, so that its axis is in line with the source of radiation from the transmitter antenna. At Cape Canaveral and Pt. Mugu long range proving grounds, the equipment is located at mobile temporary sites or installed in the launch pad block houses.

Radar telemetering systems (pulse-position modulation) promise to be the most advantageous for missile research and development programs. Objections to this form of telemetering are the high voltages required, in addition to the sensitivity of the components to changing temperatures and pressures.

Elaborate helix antennas, left, which receive telemetered data from NACA launched research models at Wallops Island. Crudely-fashioned Japanese antennas, for tracking *Baby* rockets, right, are strikingly similar.



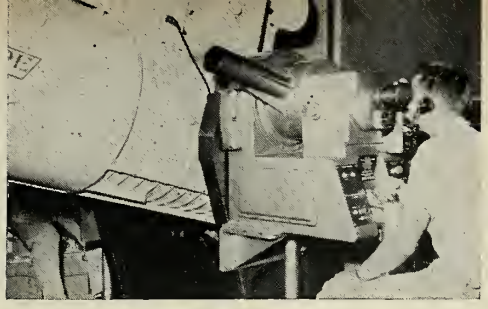
NACA

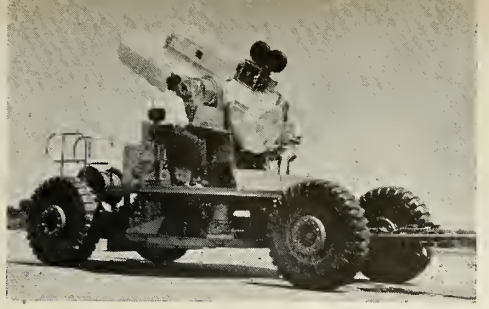
Itokawa

Students study telemetry antenna for *Corporal* on battery control trailer, left. Patrick Air Force Base MK-51 Director with telemetry radar antenna used in tracking missiles during early flight, right.

Army

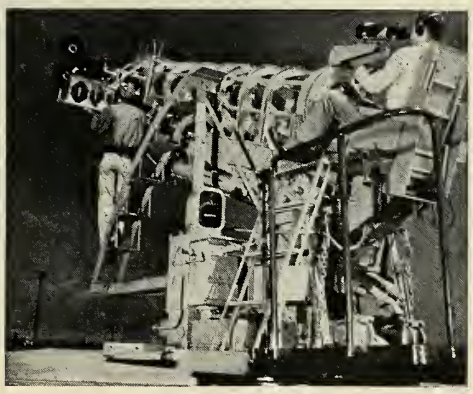
Air Force



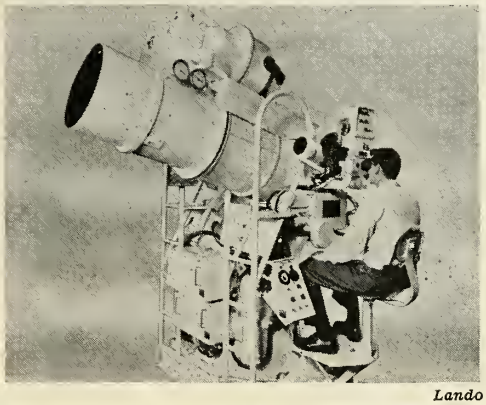


Perkin-Elmer

Operator mans eight-ton Perkin-Elmer Recording Optical Tracking Instrument at Air Force Missile Test Center, left. Unit can be operated remotely. Transportable optical tracking system, right, lines up skyward.



Army



Lando

Sixteen-inch reflecting telescope on 90-mm anti-aircraft gun tracks high altitude rockets at White Sands, left. J. W. Fecker Inc., IGOR (Instrument Ground-based Optical Recording) missile tracking telescope, right.

OPTICAL TRACKING

The elevation, height, azimuth, flight attitude and range during the first few minutes of a missile's flight can be recorded for later evaluation by combining phototheodolites and synchronized telescope cameras. Units now installed at Cape Canaveral can observe and photograph missiles for hundreds of miles. Some phototheodolites are operated in conjunction with radar telemetering equipment, providing a more accurate recording than could be obtained with one of the systems operating alone.

A phototheodolite is basically a motion picture camera equipped with long range lens of high resolution. The shutter is operated by a central timing control that synchronizes shutter action with the telemetering system. Several of the telescopes are located at intervals down range in order to make full flight recordings. The central timing control system assures later identification for any instant of the flight for one continuous data recording.

In addition to the photo record, a continual check on the accuracy of the telemetering equipment is a supplemental advantage of the optical system. On many flights where the telemetering system has failed to operate properly, the optical tracking equipment has saved the day. Optical instrumentation demands a high degree of care and possesses extreme accuracy.

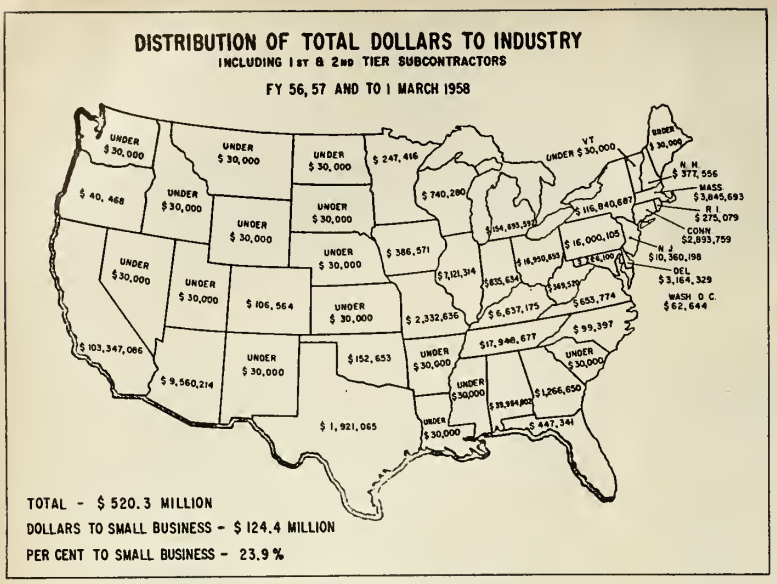
The telescopes range in power from 20 to 30, with a very narrow field of view. Manual control of optical instrumentation is rapidly becoming a thing of the past, due to this narrow field of view. Instruments operated manually are provided with cross hairs for centering the system on the missile.

Camera on 40-mm gun platform tracks missiles to 140-mile height at Holloman Air Force Base.

Air Force

IGY satellite tracking camera weighs three tons. Twelve are being placed around the world.

Perkin-Elmer



ARMY'S allocations to small firms show trend as . . .

Congress Takes a Serious Look at:

Small Business Status in Missile Procurement

by Donald E. Perry

THE POWERFUL Senate Subcommittee on government procurement has gone to the defense of the nation's small businessman to determine if he's getting a fair share of the mushrooming procurement dollar for missiles-astronautics.

Recently, this subcommittee, which has delved into all forms of government procurement, for the first time centered its attention on the lucrative astronautics-missile field. Three days of hearings resulted in a majority committee opinion that the potential of small business in missiles-astronautics is getting short-sighted glances from some government procurement quarters, while at the same time:

1. $4 to $6 billion is being spent for missiles and related equipment, and prospects for this procurement indicate that it will soon eat up 50% of the defense budget.

2. The missile industry is coming to the realization that there is no need for production runs totaling thousands of units, requiring acres of plant space, and tens of thousands of assembly line workers.

3. Every dollar spent directly on missile systems demands that $2 to $3 be spent on missile support equipment.

4. Small business is demonstrating that it has the capacity to handle imaginative projects in a matter of minutes with considerable savings.

The leading question in the minds of the subcommittee was the present status and future of small business (less than 500 employees) in missiles-astronautics.

• **Present status**—Today, according to Defense Department figures, small business is averaging 20% of every dollar spent on missiles-space procurement.

Whether this is a fair average or not, the Small Business Administration doesn't know—there are too many intangible factors. However, SBA points to a Navy estimate that about 40% of all Navy procurement goes to small business.

Small business gets the bulk of its missile-space dollar through subcontracting. SBA's so-called gripe is that many areas of small business capability —for prime production, research and development—are not being exploited.

Another complaint by SBA is that service contracting officers are inclined to give prime contracts to a select few. One investigating Senator put it this way: "Small business often has to go to the prime contractor, hands extended, bow three times in the right direction, and just maybe, may become a subcontractor."

In fiscal year 1957, for example, the Army gave only 4.5% of its prime contract dollar to small business; the Navy less than 3%; and the Air Force, eight-tenths of 1%. The same year, small business received only 4.3% of the total dollar value of research and development prime contracts.

Army statistics show that of 46 R&D prime contracts, 25 production contracts (well over 50%) went to the firms—mostly big business—who had handled R&D.

• **Future status**—In fiscal year 1958, with missile spending at an accelerated rate, small business apparently is faring worse. Small firms received only .8% of prime contracts during the first half of 1958, while in fiscal year 1957, they received 1.9%. Stepped up R&D activities in fiscal year 1958 have failed to bring an improving status to small business in prime R&D contracts, the committee learned. Awards for the first eight months of 1958 amounted to $1.9 billion, an increase over the same period of 1957 when $1.8 billion in contracts were awarded.

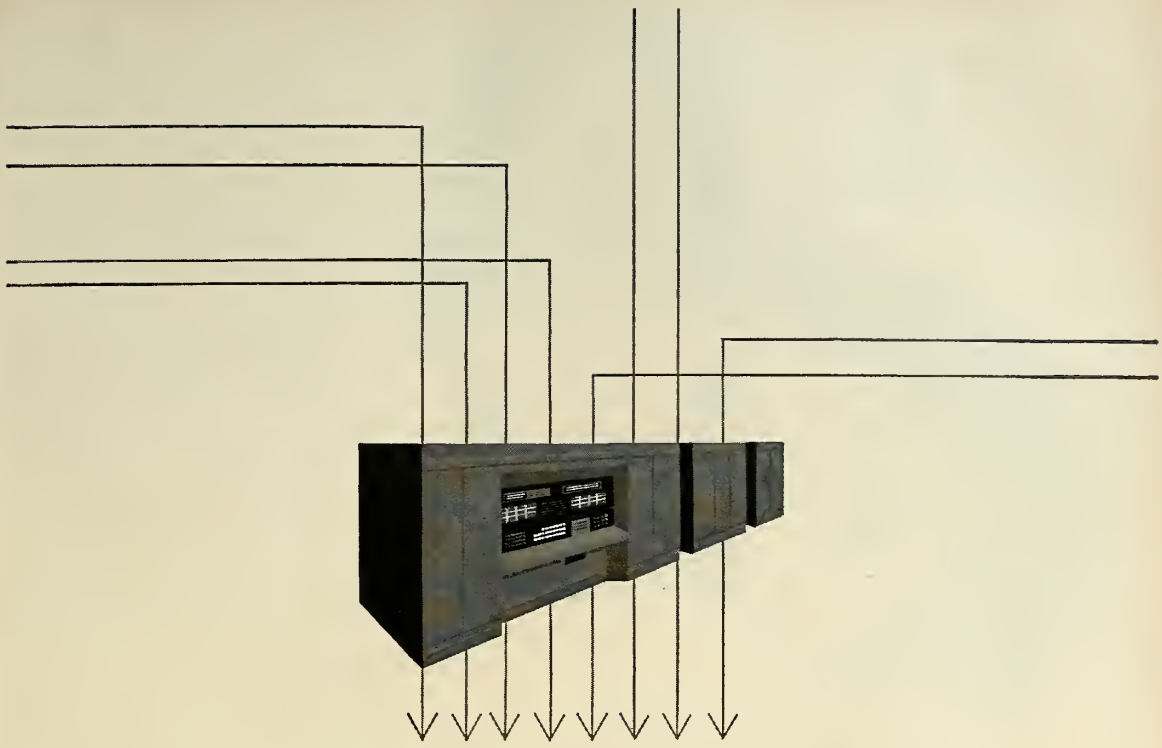
But, the small business percentage of the 1958 total was only 2.6%, as against 3.4% for the comparable period during the preceding fiscal year.

The February percentage was 4.4%, compared with 3.4% for the same month in the previous year. For fiscal year 1957, the awards to small business totalled 4.3%. Total awards to all firms during 1957 amounted to $3 billion.

In fiscal year 1959, which begins next month, the dollar for missile-space procurement will continue to spiral upward.

• **Report due**—The Subcommittee questioned whether the Defense Department's weapon system concept of procurement resulted in concentrating the bulk of the productive missile capacity in a handful of huge corporations. Hearings showed this is largely so, but the concept of procurement has grown so large, testimony indicated, that to change the system now could destroy the defense readiness of the nation.

Senators sought assurance that there are safeguards against permitting a few contracting officers, perhaps inadvertently, to go against the anti-monopoly work of the Department of Justice and the Federal Trade Commission. The



The **ORGANIZATION** and **RETRIEVAL** of **INFORMATION**

The organization and retrieval of large volumes of diverse types of information is rapidly becoming one of today's more serious problems. Major areas where the problem exists include business and industry, the military, the government, and the scientific and engineering community itself.

In its simpler forms, the problem may involve, for example, the automatic handling and analysis of business data such as payrolls, sales and manufacturing figures, insurance premiums, and other essentially statistical data. At the other extreme are certain complex military situations which require the concurrent interpretation, analysis, and integration on a very short time scale of data from a wide variety of sources, including field reports, photographs, news reports, estimates of industrial activity, and the like. In many of these situations, there is the additional requirement to translate the information from a foreign language into English.

The development in recent years of electronic data handling equipment is now making possible the practical solution of many of these problems. Such equipment has the capability to perform arithmetic operations, make decisions among alternatives, store and retrieve large quantities of information, and at high speed automatically perform long, complex sequences of operations.

At Ramo-Wooldridge, work is in progress on advanced information handling systems that are characterized by large volume and widely different forms of information, short time scales, and a variety of uses and users. The scope of the work includes the planning of systems and procedures, programming various types of data handling equipment, and formulation of requirements for new equipment. Research is also under way on the machine translation of foreign languages into English.

Engineers and scientists with experience in the following fields are invited to explore the wide range of openings now available:

Systems Engineering
EDP Systems
Computer Programming
Console Design
Display Development
High Acuity Optics
Photo Interpretation

The Ramo-Wooldridge Corporation

5730 ARBOR VITAE STREET • LOS ANGELES 45, CALIFORNIA

. . . small business

committee wanted to know whether there's an increase in the trend of giant corporations to self-produce many items they never produced before, and also, how giant firms are using government-furnished facilities.

Senators inquired as to the government's security clause of "need to know", which may preclude many small business firms from gaining contract knowledge for competitive bidding.

The Senate group will probably make their report this month. Information received is that the subcommittee will praise the Navy on setting aside contracts for small business competition and giving small business a better share of the prime and subcontracting dollar.

The Army will get a reprimand for not farming out more small business contracts from its arsenal-concept of weapons development. The Air Force will be hit harder, because its ballistic missiles procurement precludes most small business participation in prime contracts.

The main theme of the subcommittee's conclusions will reportedly state that if the Defense Department continues to ask Congress to appropriate billions to usher in the space age, then every effort should be expended to utilize the talent and services now available in small firms.

• **Outlook**—Big business will continue to get the lion's share of the prime contract dollar, but reportedly, the Armed Services will be probing into contracts to insure that every possible consideration will be given to small business. The subcommittee is hopeful that small business soon will be averaging 25% or more of the missile dollar.

The report will also emphasize that, whenever possible, missile systems should be divided into components which can be furnished by competitive bidding. As missiles now under development reach hardware stage, the subcommittee will insist that more contracts be let by competitive bids. The report will also insist on increased information on subcontracting opportunity, possibly under revamped security conditions.

The following summary presents the cases of the three Armed Services before the Subcommittee.

• **Navy testimony**—Some 23% of missile money is believed to have gone to small business—3% in prime contracts and 20% in subcontracts. This compares with about 40% to small business for all Navy procurement.

BuAer gives missile contractors

New Bendix DC-PAK is like magic

TREMENDOUS POWER OUTPUT IN A TINY STATIC PACKAGE

With its new line of DC-Paks*, Bendix now offers the latest in static power supplies for the aircraft and missile industries. Lightweight and compact, the DC-Pak provides reliable power packaged in the most practical manner for those industries where weight and space are at a premium.

The DC-Pak is built to give thousands of hours of efficient, trouble-free operation. Made with only four major parts (and no moving parts), it requires an absolute minimum of maintenance. For example, even a dead short across the output for a full hour will not harm the DC-Pak. Also input surge protection can be provided.

Units can be supplied with either single or multiple output, depending upon the needs of the customer. For full details on these transistorized units—and how they can be tailored to your exact voltage and amperage requirements—write BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY.

*TRADEMARK, BENDIX AVIATION CORPORATION

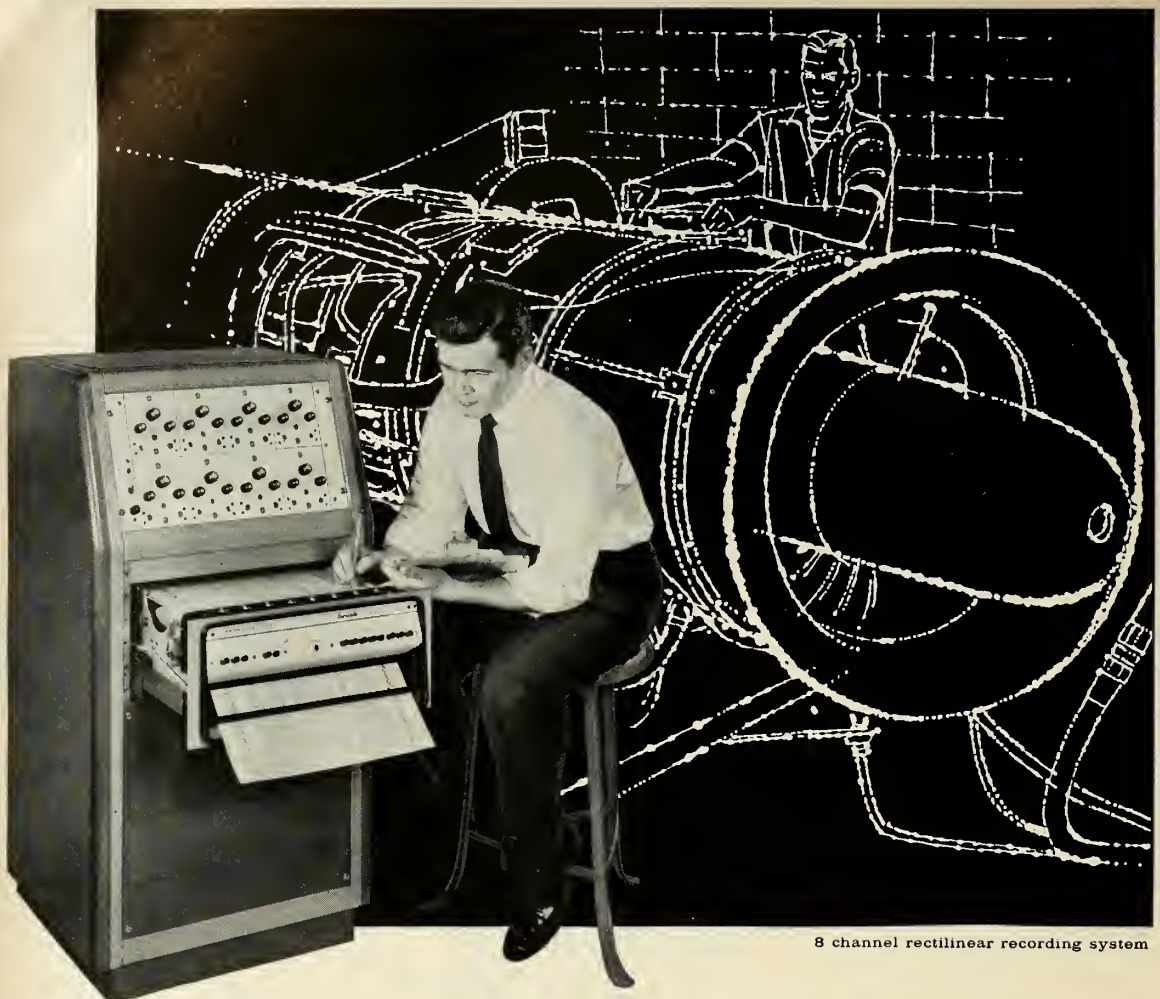
Specifications of Typical DC-Pak Units

Input range	24.5 to 30.5 VDC	24.5 to 30.5 VDC
Nominal input	27.5 VDC	27.5 VDC
Output voltage	250 VDC	up to 500 VDC
Power output	50 watts	100 watts
Regulation	better than 8%	better than 8%
Ripple	1% or better, depending an requirements	1% or better, depending on requirements
Efficiency	up to 80%	up to 80%
Maximum mounting base temperature (operating)	+85°C.	+85°C.
Minimum operating temperature	−40°	−40°
Storage temperature	−65° to +100°C.	−65° to +100°C.
Weight	1 lb. 4 oz. (50-watt unit)	1 lb. 8 oz. (100-watt unit)
Size	4½″ x 2¼″ x 2⅛″ (minimum)	5″ x 3″ x 3″ (minimum)

West Coast Office: 117 E. Providencia, Burbank, Calif.
Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.
Canadian Affiliate: Aviation Electric, Ltd., P. O. Box 6102, Montreal, Quebec.

Red Bank Division

Bendix AVIATION CORPORATION



8 channel rectilinear recording system

Brush ultralinear recording systems

...WHEN RELIABILITY IS OF VITAL CONCERN

The circuits, mechanisms, components and materials in this 8-channel recording system have *already proved their reliability* in Brush instrumentation now in use in the most critical applications—such as radar surveillance, computer readout, missile checkout on remote test ranges . . . in extremes of temperature, humidity and other abnormal conditions. At Brush, the high reliability factor is always a basic consideration in design.

In the system shown here, trace presentation is rectilinear. Thermal writing provides clear, sharp traces, excellent for reproduction. Eight chart speeds, stepped from .4 to 100 mm/sec., operate by pushbutton controls. The system readily adapts to pertinent MIL specs.

With their wide measurement ranges, Brush *Ultralinear* Recording Systems may be used for development and checkout of industrial as well as military equipment. Factory branches, service and warehousing at Arlington, Va., Boston, Cleveland and Los Angeles; engineering representatives in all key locations.

ASK FOR NEW CATALOG
Describes 2, 4, 6 and 8 channel systems—rack and mobile—ink, electric and thermal writing.

brush INSTRUMENTS
DIVISION OF
3405 PERKINS AVENUE CLEVITE CORPORATION CLEVELAND 14, OHIO

. . . small business

prime responsibility for *Sparrow* III, *Corvus, Bullpup* and *Regulus* I and II. Their reasoning is that primes have the capacity and can assume responsibility for producing a complete missile. Small business is precluded from this stage of procurement, but utilized in the next cycle—subcontracting.

On the *Sparrow*, the prime contractor (Ratheon Manufacturing Co.) has subcontracted, in the last three years, approximately 59% of dollars received from Navy. In 1956, small business got 48%; in 1957, 59%; and in 1958 (to date), 56%. This is largely due to the advanced stage of the missile, where standardization of many components makes bidding possible on a competitive basis.

Corvus started its career in 1956. In 1957, 2.6% of *Corvus* money went to small business; in 1958, 5.12%. Percentage probably will improve again next year.

Navy's BuOrd, which has cognizance over *Sidewinder, Talos, Terrier, Tartar,* and a special projects office for *Polaris,* points out that during fiscal years 1956, 1957 and the first half of 1958, six of its principal missile prime contractors did extensive subcontracting with small business. Here is the breakdown:

Prime Contractor	% Subcontracted	% of Subcontracted Dollar Awarded to Small Business
A	52	74
B	68	24
C	45	27
D	68.6	29.1
E	28	66
F	50	60

To date, some 2,500 to 3,000 small business firms have received subcontracts from *Polaris* prime contractors. Lockheed Aircraft Corp., prime system contractor for *Polaris,* has dealt with 901 vendors, 82% of them small business firms. And of the dollars spent, 73% were spent with small business.

Polaris primes have awarded approximately 80% of their subcontracts to small business. The following statistics illustrate this trend:

Contractor	Total Subs.	Small Bus.
Lockheed	901	739
Aerojet-General	158	131
Aerojet-General (as sub to IMSD)	155	116
Interstate Electronics Corp.	241	197

• **Army testimony**—Since the 1956 activation of Army's ABMA, small business has received 23.9% of Army missile dollars. ABMA spent $520 mil-

. . . small business

lion on *Redstone, Jupiter* and *Jupiter* C in 1956, 1957 and up to March 1, 1058. Small business received $124 million of this amount.

Prime contractors passed on 19% of the dollars paid them to small business. Primes are Chrysler Corp., Ford Instrument Co., and North American Aviation. In the same period, Army made 1,574 procurements, many for applied research, with 51.3% going to small business.

Army reports that during fiscal year 1957 and the first half of 1958, prime contractors kept 28% of each dollar; 48% went to large business, and small business received 24% which amounts to about $152-million.

In 1959, Army expectations are: some 48% or $369 million will be subcontracted to large business; 28%, or $215 million will not be sub-contracted; and 24%, or $185 million will be subcontracted to small business.

• **Air Force testimony**—In the area of ballistic missiles alone, 21% (more than $267 million) of all money paid to prime contractors has gone to small concerns as first-tier subcontractors and suppliers. Some 58% of the funds for ground support equipment went to sources other than the system contractors, and of that, 44.8% went to small business.

Of five ballistic missile programs, Air Force says that small business has received approximately $117 million of some $603 million, or 19.4% of total dollars. There are 16 hardware producing primes in the ballistic missile program and approximately 250 principle subs.

Douglas Aircraft Co. is utilizing about 8,473 small business concerns as subcontractors of *Thor,* and more than 23%, or $18 million, went to small business.

The U.S. Air Force says as a December 31, total invoices to all prime contractors in the ballistic missiles program represented $1.3 billion. Of this amount, $269 million on first tier subcontract basis went directly to small business.

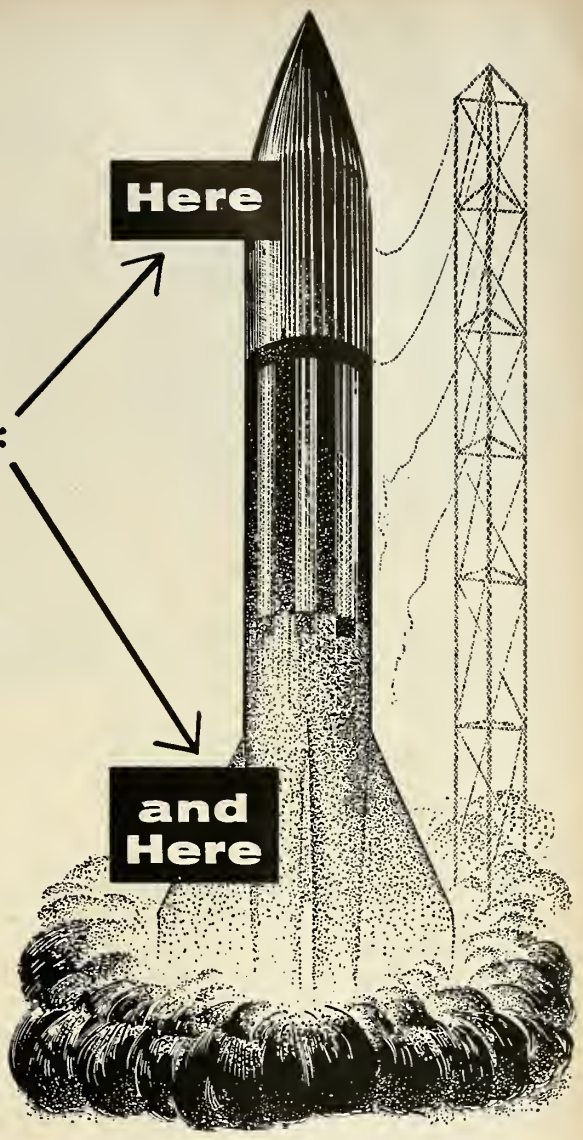
Convair Astronautics Division, prime contractor for *Atlas,* reports that more than 37%, or $105 million, went to 2,875 small business companies and their affiliates.

Martin Company, prime contractor on *Titan,* reports 27%, or $34.9 million, went to 1,500 small companies.

Rocketdyne, largest manufacturer of propulsion systems for *Atlas, Thor,* and *Jupiter,* reports 20%, or $45 million went to 4,000 small business organizations.★

ARMCO
PH 15-7 Mo Stainless

Helps You Put More Power



Weight-saving possible with special Armco Stainless Steel creates opportunity to increase explosive power or propellent

Developed specifically for missiles and aircraft, Armco PH 15-7 Mo Stainless Steel gives you new opportunities to trim important pounds from structural parts, tanks, power plants and accessories. The latest addition to Armco's precipitation-hardening stainless steels, PH 15-7 Mo, offers a combination of properties that meet the requirements specified by missile designers.

High Strength—In Condition RH 950, PH 15-7 Mo has a *guaranteed minimum* room temperature F_{ty} of 200,000 psi. At 800 F its typical F_{ty} is 150,000 psi. Up to 1000 F it offers exceptionally high strength-weight ratios, among the highest provided by any aircraft material.

Good Corrosion Resistance—This new Armco Stainless resists corrosion much better than the hardenable stainless steels and somewhat less than Type 302. It eliminates the need for plating or other surface protection.

Excellent Fabricating Properties—Armco PH 15-7 Mo is welded, spun, drawn, formed and machined by standard production methods. Fabrication is done in the easily-worked annealed condition, then parts are hardened by simple heat treatment.

Available in All Forms—PH 15-7 Mo stainless is produced commercially in a wide range of sizes in sheet, strip, foil, plate, bar, wire and forging billets.

For complete information on the properties of Armco PH 15-7 Mo, its heat treatment and fabrication, just fill out and mail the coupon.

New steels are born at Armco

ARMCO STEEL CORPORATION, 2238 Curtis St., Middletown, Ohio

Send me information on Armco PH 15-7 Mo Stainless Steel.

NAME_____

COMPANY_____

STREET_____

CITY_____ ZONE_____ STATE_____

ARMCO STEEL

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

DELCO'S FAMILY OF HIGH POWER TRANSISTORS

Typical Characteristics at 25°C

	DT100	DT80	**2N174A	2N174	2N173	2N443	2N278	2N442	2N277	2N441
Maximum Collector Current	13	13	13	13	13	13	13	13	13	13 amps
Maximum Collector Voltage (Emitter Open)	100	80	80	80	60	60	50	50	40	40 volts
Saturation Resistance (13 amp.)	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02 ohms
Max. Square Wave Power Output at 400~P-P*	400	310	310	310	225	225	180	180	135	135 watts
Max. Sine Wave Power Output at 400~P-P*	180	140	140	140	100	100	80	80	60	60 watts
Power Dissipation (Stud Temperature 25°C)	70	70	70	70	70	55	55	55	55	55 watts
Thermal Gradient from Junction to Mounting Base	1.0°	1.0°	1.0°	1.0°	1.0°	1.2°	1.2°	1.2°	1.2°	1.2° °C/watt
Nominal Base Current I_B (V_{EC} = —2 volts, I_C = —1.2 amp.)	-19	-13	-19	-19	-13	-24	-13	-24	-13	-27 ma

*Adequate Heat Sink

**Designed to meet MIL-T-19500/13 (USAF) 18 JUNE 1957

Performance characteristics to meet your switching, regulation or power supply requirements

These ten Delco Radio alloy junction germanium PNP power transistors are now in volume production. They are characterized by high output power, high gain, and low distortion. And all are normalized to retain superior performance characteristics regardless of age.

Check the data chart above—see how they fit your particular requirements in current switching, regulation or power supply. Write for detailed information and engineering data. Delco Radio maintains offices in Newark, N. J. and Santa Monica, Calif. for your convenience.

BRANCH OFFICES

Newark, New Jersey
1180 Raymond Boulevard
Tel: Mitchell 2-6165

Santa Monica, California
726 Santa Monica Boulevard
Tel: Exbrook 3-1465

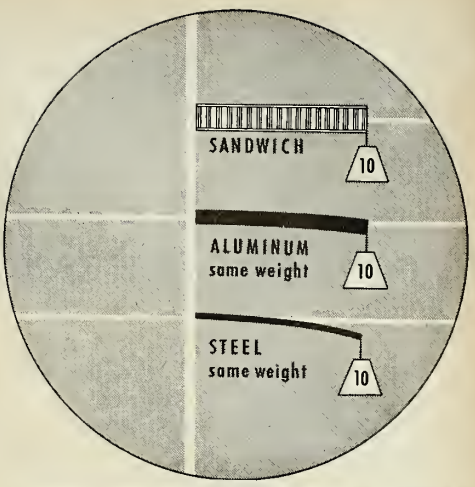
DELCO RADIO
Division of General Motors
Kokomo, Indiana

Circle No. 56 on Subscriber Service Card.

Antennas are getting bigger and . . . .

Sandwich Construction Keeps Them In Shape

by Herman Holland*



OUTSTANDING CHARACTERISTIC of Sandwich construction is high strength-to-weight ratio.

TWO PROGRAMS have created an urgent requirement for large tracking and scanning radar reflectors: the nation's accelerated program for developing long-range missiles; and the need for adequate missile defense systems.

In the field of long-range missiles, the steadily increasing range and altitude of the newer birds means that tracking antennas must grow in size. Experts familiar with the problem see a demand for reflectors ranging up to 100 ft. in diameter in the very near future.

In the field of missile defense, the longer ranges now demanded of radar already make very large size reflectors a necessity, and the longer ranges necessary in the future will create a need for even larger ones.

The electrical design of such reflectors is not an imposing problem, but the translation of any such design into usable hardware is another matter.

During actual operation, these enormous tracking and scanning reflectors must move constantly and with rapid acceleration to various positions involving elevation and azimuth.

Since the structures are essentially mirrors (or lenses), their parabolic reflective surfaces must be maintained with no appreciable degree of deflection if they are to be fully efficient.

Further complicating the problem is the fact that such reflectors must be capable of operating almost instantaneously under highly varied and frequently severe climatic conditions.

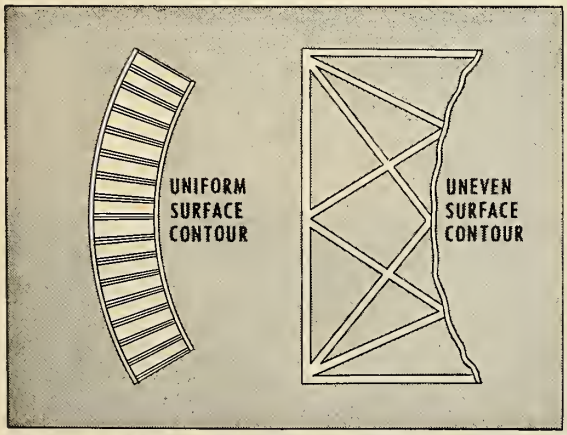
Such functional requirements pose real problems for the engineer accustomed to designing smaller reflectors. Although the performance requirements for smaller reflectors can usually be accommodated simply, these requirements become increasingly difficult to satisfy as reflector sizes increase.

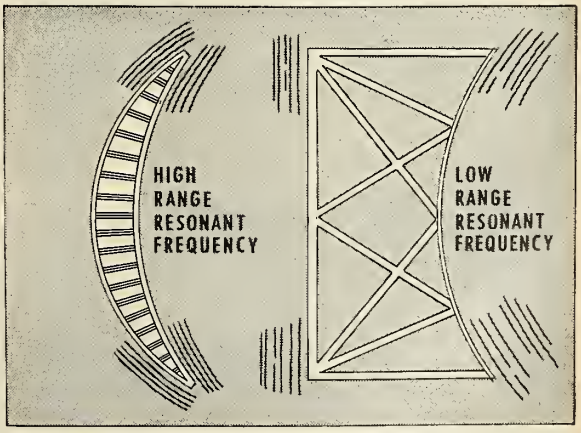
• **Enter the sandwich**—Under these circumstances, the design concepts and the materials selected for large reflectors become significant. Considering the combination of structural, environmental and functional conditions that influence the design of articulated reflectors, a first essential is that materials used offer a combination of highly rigidity and minimum weight.

Designers of missile structures, who have encountered similarly challenging rigidity-weight problems, have turned in many cases to sandwich structures for their solutions. It was natural, then, to turn to a similar construction method for large-size reflectors, incorporating, wherever possible, sandwich construction to hit the desired goal of optimum rigidity-weight.

At Narmco Manufacturing Co.,

Chief Engineer, Narmco Mfg. Co., La Mesa, Calif.

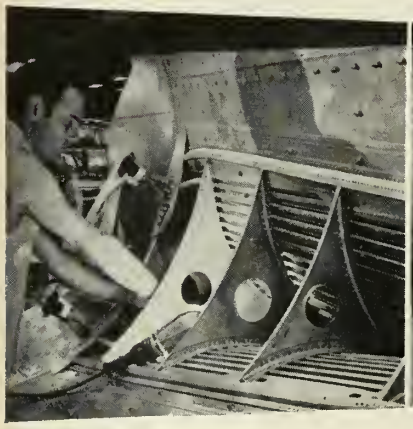


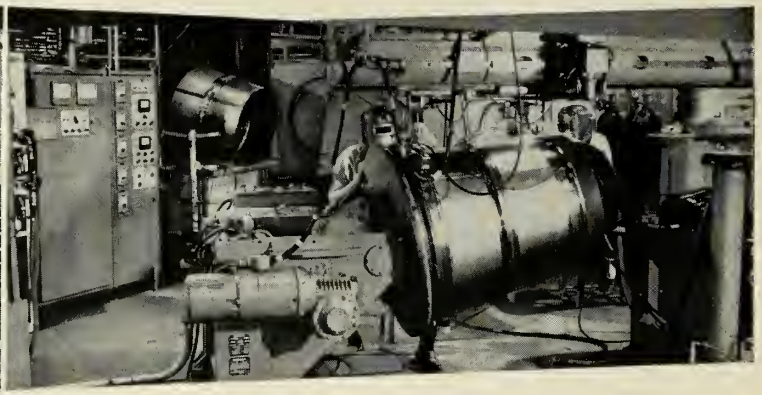


LEFT—Uniform surface contour maintained by sandwich construction. RIGHT—A comparison of resonant frequency. Frequency is influenced by stiffness, weight, and configuration; thus sandwich construction offers design advantages that are due to flexibility.

Temco | AIRCRAFT DALLAS

..TITANIUM and TOMORROW





At Temco titanium is keeping its promises to the aircraft industry. No longer the intransigent metal, titanium in precision assemblies has become routine here. Through the development of Temco's Ti-Brite process, the tough titanium scale which once limited the material's usefulness is electrolytically removed without etching or disturbing the most precise dimensions.

And at Temco a successful process for chrome-plating titanium may be the major break-through in the feasibility study for extending its temperature resistance beyond the 800-1000°F range. Forming, spot welding, precision machining are everyday operations. Temco's proven capabilities in precision automatic fusion welding have proved especially effective in the assembly of titanium parts. A case in point: the front compressor casings of Pratt & Whitney's J-57 engine, produced at Temco.

Quality and reliability of assemblies produced at Temco are assured by the extensive facilities of the Quality Control Department and Metallurgical Laboratory. These include the newest non-destructive spectographic and large X-ray equipment.

Capabilities in advanced metallurgy . . in titanium, aluminum, austenitic steel, stainless steel . . are typical of Temco progress. And now research and development capabilities are challenging the rare earths . . berylium, columbium, tantalum, molybdenum . . for tomorrow's needs. As the aircraft industry grows, so do Temco's capabilities to design, tool and produce for it. **Whether your need is for o component, o subsystem or o complete system . . . on inspection of Temco will be informotive ond profitoble.**

TEMCO®
AIRCRAFT CORPORATION • DALLAS, TEXAS

CHALLENGE TEMCO...TODAY!

. . . sandwich radar

engineers have found that sandwich construction offers a variety of design and performance advantages for large radar reflectors.

One advantage is contour fidelity of the parabolic reflective surfaces. Contour fidelity is chiefly influenced by the basic rigidity of the structure and rigidity, in turn, is influenced by two factors: the inherent stiffness of the structure and the weight of the structure.

Lightness is an obvious necessity in a reflector because deflection—whether created by acceleration and deceleration loading, by wind loading, or by loading caused by ice formation or similar environmental hazards—tends to increase sharply as the weight of a structure increases.

To some degree, weight actually establishes a vicious circle: the greater the weight, the more the loads tend to build up. Conversely, inherent lightness in a reflector offers cumulative performance advantages. Inertia load deflections caused by acceleration and deceleration, for example, are greatly reduced when the weight of the structure is minimized.

Weight and rigidity also influence the resonant frequency of a large parabolic structure. Generally, it is desirable to maintain the natural resonant frequency of a reflector in closely controlled ranges to avoid functional and mechanical problems involving the drive mechanism.

Basically, resonant frequency is influenced by both weight and rigidity along with configuration. In a sandwich structure these vital factors can be controlled through design, and the selection of face and core materials.

• **Construction details**—This makes it evident that lightness, plus inherent stiffness, are key design factors in a large reflector. Sandwich construction —as its capabilities have been widely demonstrated in the missile industry—offers the ideal combination.

Since a sandwich is essentially a composite structure in which the load-carrying elements are high-density face materials uniformly stabilized by a low-density core material, this type of structure offers exceptional section properties.

As a result of this full skin stabilization, a sandwich reflector maintains its design contour within extremely close tolerances. Also, inertia load deflections produced by acceleration and deceleration are reduced because of the inherent lightness of the structure.

Another important advantage is the inherent lightness which simplifies all

ANNOUNCING

immediate availability as plates and heads

LUKENS

The Strong, Economical Alloy Steel

-320°F.

At as low as half the cost of other materials for low-temperature work, readily available Lukens Nine Nickel is proving its tremendous usefulness for storage and process vessels handling liquid nitrogen and liquid oxygen. It can be furnished in the form of plates and heads in a broad range of sizes.

PRICE: Approximately $0.30 per pound, including heat treatment. Exact prices will be furnished on request.

-320°F.

SPECIFICATIONS: Lukens Nine Nickel is produced to meet ASTM A-353 and A-300 specifications. It is included in the ASME-UPV Pressure Vessel Code, Section VIII, 1956 edition.

-320°F.

PROPERTIES

Minimum tensile strength	90,000 psi.
Minimum yield strength	60,000 psi.
Elongation in 2 inches, minimum, per cent	22.0

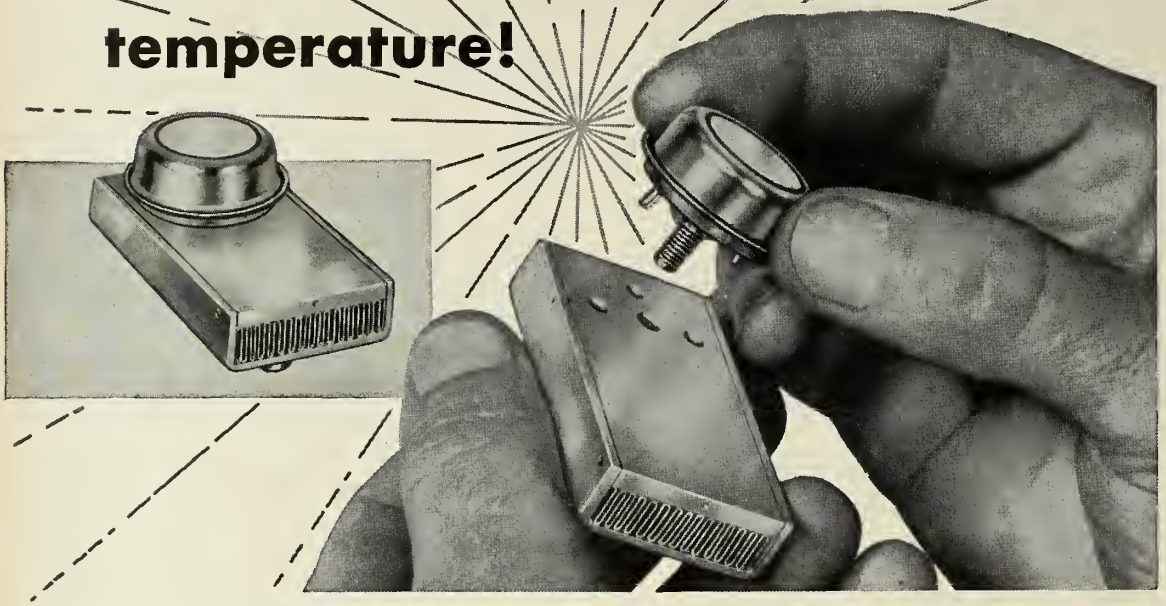
Charpy impact tested in accordance with ASTM A-300 Specification down to —320° F.

-320°F.

COMPOSITION

Carbon, maximum, per cent	0.13
Manganese, maximum, per cent	0.80
Nickel, per cent, (approx.)	9.00
Silicon, per cent, (approx.)	0.30
Phosphorous, maximum, per cent	0.035
Sulfur, maximum, per cent	0.040

UAP COLD PLATE controls TRANSISTOR junction temperature!



minimizes transistor derating for thermal conditions . . .

UAP cold plate U-521330, designed for Collins Radio Company, dissipates heat generated by power transistors used in ground and airborne electronic circuits. The heat is transferred across a pressure thermal contact to cooling air. The cold plate controls the transistor junction temperature within operating limits compatible with the installation. Therefore, transistor derating is minimized.

The cooling air, which is forced through the cold plate, can be ducted from an air cycle refrigeration system; a ram air supply; an air manifold within the electronic compartment or a pressurized equipment package.

The aluminum cold plates are bonded by UAP's dip braze method which produces extremely lightweight assemblies with maximum heat transfer area within the core. Cold plates can be used individually or assembled in manifolded banks.

DESIGN PERFORMANCE CHARACTERISTICS OF U-521330 COLD PLATE
Air flow: 7 lbs. per hr.
Air pressure drop: 0.25" H_2O corrected to .0765 density
Temperature drop in cold plate: 1.5°C per watt dissipated
Weight: Approximotely 1 oz.
Performance characteristics can be modified to requirements.

For complete information call the nearest UAP Contractual Engineering Office

CALIFORNIA.....1101 Chestnut St., Burbank Colif., VI 9-4236
NEW YORK.....50 E. 42nd St., New York 17, N. Y., MU 7-1283
OHIO.....1116 Bolonder Ave., Dayton, Ohio, BA 4-3841
CANADA.....United Aircroft Products, Ltd., 5257 Queen Mary Road, Montreol, Canada, ELwood 4131

UAP UNITED AIRCRAFT PRODUCTS INC ®

a famous family of aircraft essentials since 1929

UNITED AIRCRAFT PRODUCTS, INC.

1116 BOLANDER AVENUE, DAYTON, OHIO

other elements of a reflector system—both from a functional and a cost viewpoint.

The size, complexity and power requirements of a radar reflector drive mechanism vary in direct proportion to the weight of the reflector itself. The more complicated the moving unit, the more costly and complex must be the driving mechanism. But by minimizing weight, the designer can also simplify the drive mechanism.

• **Size considerations**—Sandwich offers additional advantages as a design medium for large reflectors. For one thing, sandwich reflectors can be transported and assembled with comparative ease. In contrast to large reflectors of tubular truss design, which normally require expensive on-site construction, sandwich reflectors can be prefabricated in segments, and can be assembled at an isolated installation sites with a minimum of expense.

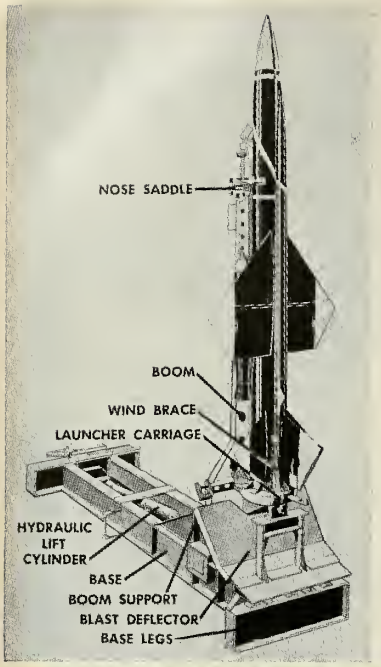
Because of its basic cellular structure, a sandwich reflector lends itself potentially to incorporation of an internal temperature control system. Such a system could serve to equalize the expansion and contraction of the sandwich faces when subjected to extreme temperature variations, that would otherwise render the reflector inoperative, perhaps when most needed.

While sandwich offers a number of design and performance advantages, it should not be regarded as the solution to all large reflector design problems. In the case of reflectors of extremely large size, it is possible that a combination structure may prove to be the optimum design. In such massive structures, many design problems must be taken into account.

Although reflectors up to 30 ft. in diameter can probably be fabricated entirely of sandwich materials, they require a combination of sandwich construction plus external bracing.

Another consideration is that, as the range and altitude of missiles increase, the "eyes" of radar systems must probe ever further and with ever greater signal fidelity. These requirements may not only obsolete the familiar open-grid reflector, but make a continuous-surface reflector a mandatory design.

In a conventional open-grid structure, a continuous reflective surface must, in essence, be superimposed over a tubular truss skeleton, thereby adding materially to the weight of the total structure. However, the continuous reflective surface is actually an integral load-carrying component of a sandwich structure and serves a dual role at no increase in overall weight.★



Ground Support Manufacture:

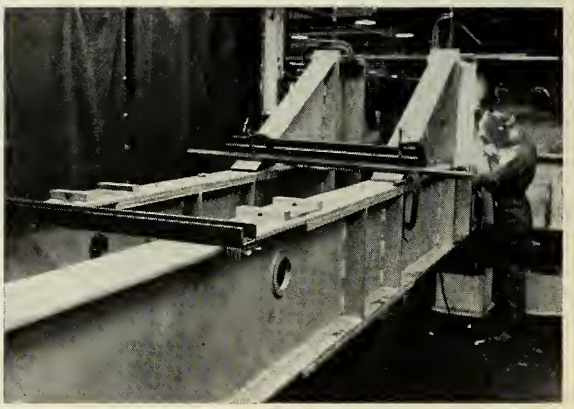
Launchers Challenge Structural Engineers

Launchers and erectors, with their related hydraulic and electric support equipment, are the largest single subsystem in the missile weapons system. They may range from simple racks or pads and truck mounted rails to elaborate, complex launcher-erectors.

In the *Bomarc* system, each missile will be housed in an individual hangar, mounted on its launcher erector in a horizontal attitude, fueled, checked out and readied to fire. Within seconds of a firing alert, the hangar must open, the missile be erected and the erecting boom moved away from the missile. To lift the 8-ton *Bomarc* smoothly and swiftly, and hold it in position against surface winds, dictated the development of a heavy 13-ton highly efficient launching system.

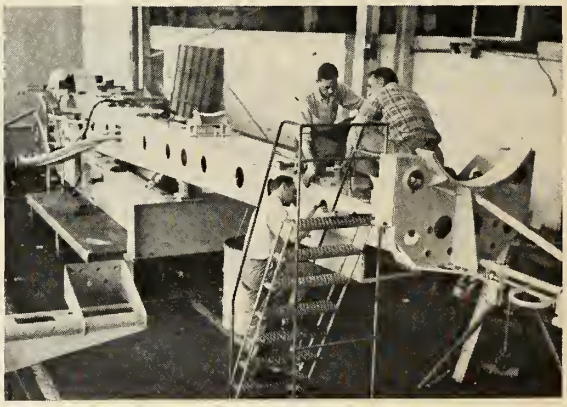
Several of these launchers, slated for installation at the *Bomarc* operational training base at Eglin AFB, Fla., are being produced for Boeing by the American Machine and Foundry Company's Buffalo, N.Y. plant. These pictures illustrate a part of the AMF operation.

1 Beams supplied by U.S. Steel are cut to length and webs reinforced in first operation of launcher base fabrication.

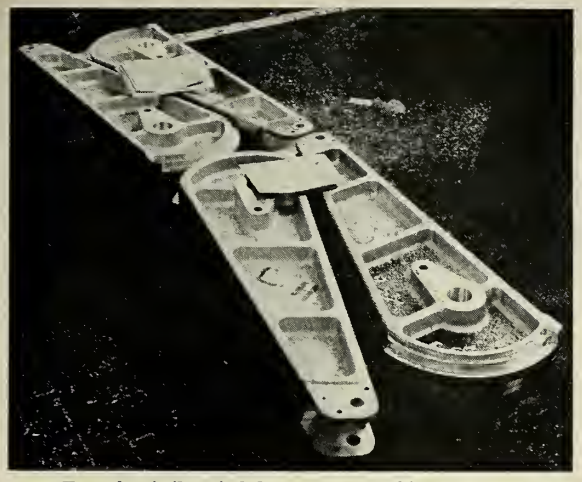


2 Boom supports and base legs are welded to finished base section in jig designed to hold tolerances to within ± ⅛ in.

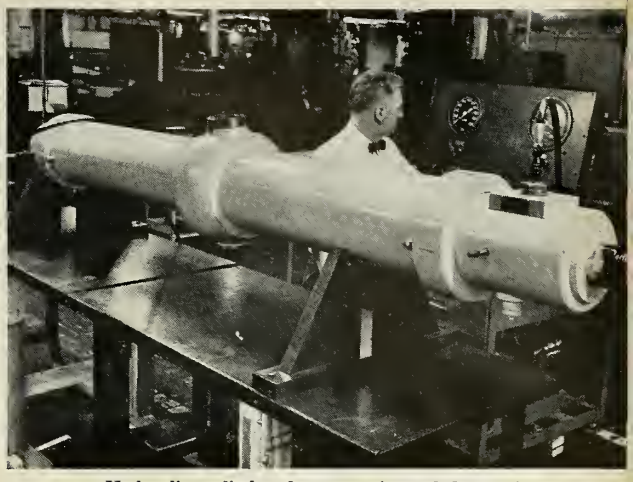
3 Completed base—sand blasted, and painted—is moved to final assembly where lines and wiring are installed.



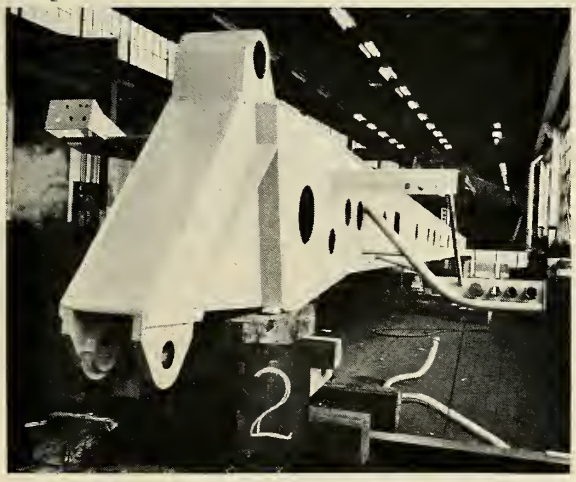
4 Launcher in final fabrication. Boom and lift cylinder are in position. Last conduits are being installed near nose saddle.



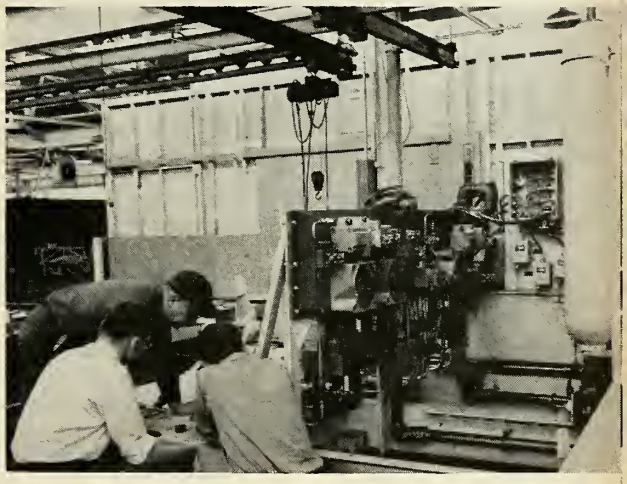
5 Forged missile wind braces are machined to close tolerances at AMF Buffalo.



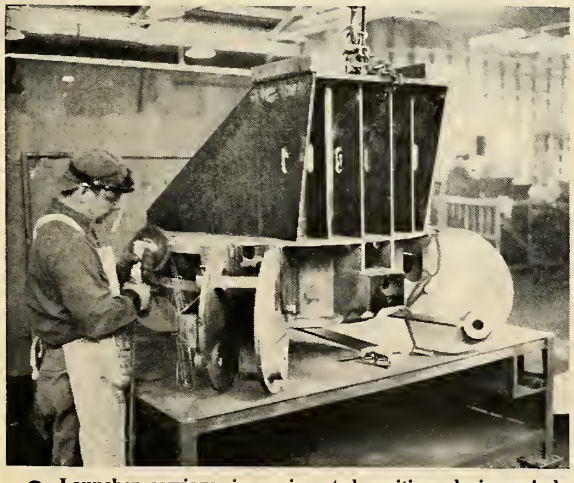
6 Hydraulic cylinder for operation of boom is pressure tested after arrival from Elko Products.



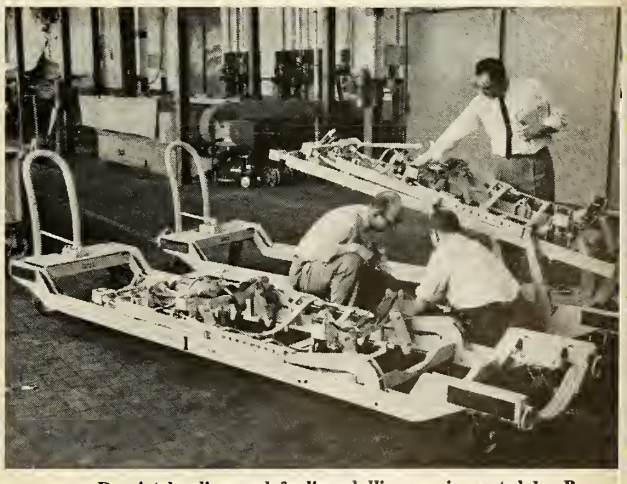
7 Missile boom, stored in final assembly area, as received from Lukens Weld and Wayne Pump.



8 Final adjustments are made to the *Bomarc* hydraulic power supply. Unit will be installed in missile hangar.



9 Launcher carriage, in an inverted position, during grinding operation for removing rough weld heads.



10 Ramjet loading and fueling dollies are inspected by Boeing and AMF engineers.

Automation

Computer Effects and Social Effects

SPACE TRAVEL will depend directly upon the use of computers—both in design and in their present use as controllers.

These were the thoughts expressed by C. C. Hurd, director of automation research, International Business Machines Corp., in a speech at the annual Western Joint Computer Conference in Los Angeles, Calif.

Hurd asserted that the most important effect of automation is its influence on man and his thinking. It is now possible to contemplate certain "adventures" which would be impossible without automatic methods of information handling.

• **Computer applications**—The bulk of the conference was dedicated to computers per se rather than to specific applications, tlhough there were several applications of the machines to the missile and aircraft fields.

Prominent among the displays was the Athena computer system, designed as part of the ground-based guidance system for the Air Force/Martin-Denver *Titan* ICBM, and built by the Remington-Rand Univac Division, Sperry-Rand Corp.

The Athena has the task of following the missile's flight with radar—determining position, direction, and velocity. It then compares this input information with that of the desired flight path. The comparisons will be made at one-half second intervals.

Any corrective action required will be automatically transmitted to the missile's airborne guidance section.

• **Social effects**—Speaking on "The Social Problems of Automation," Prof. Harold D. Lasswell, School of Law, Yale University, warned that automation "speeds up the tempo of whatever it touches."

"The most complex weapons and weapons centers are supervised and tended by rather small teams. Infiltration and surprise depend upon small, agile units; and sabotage and espionage networks call for such structures. With the spread of automation, components of the total machine become vulnerable to the well-placed few.

"Automation has an important psychological effect by reducing emotionality in combat preparations or activities. The machine intervenes between fighters; the target is an incident in complex and impersonal sequences," the Professor declared.★

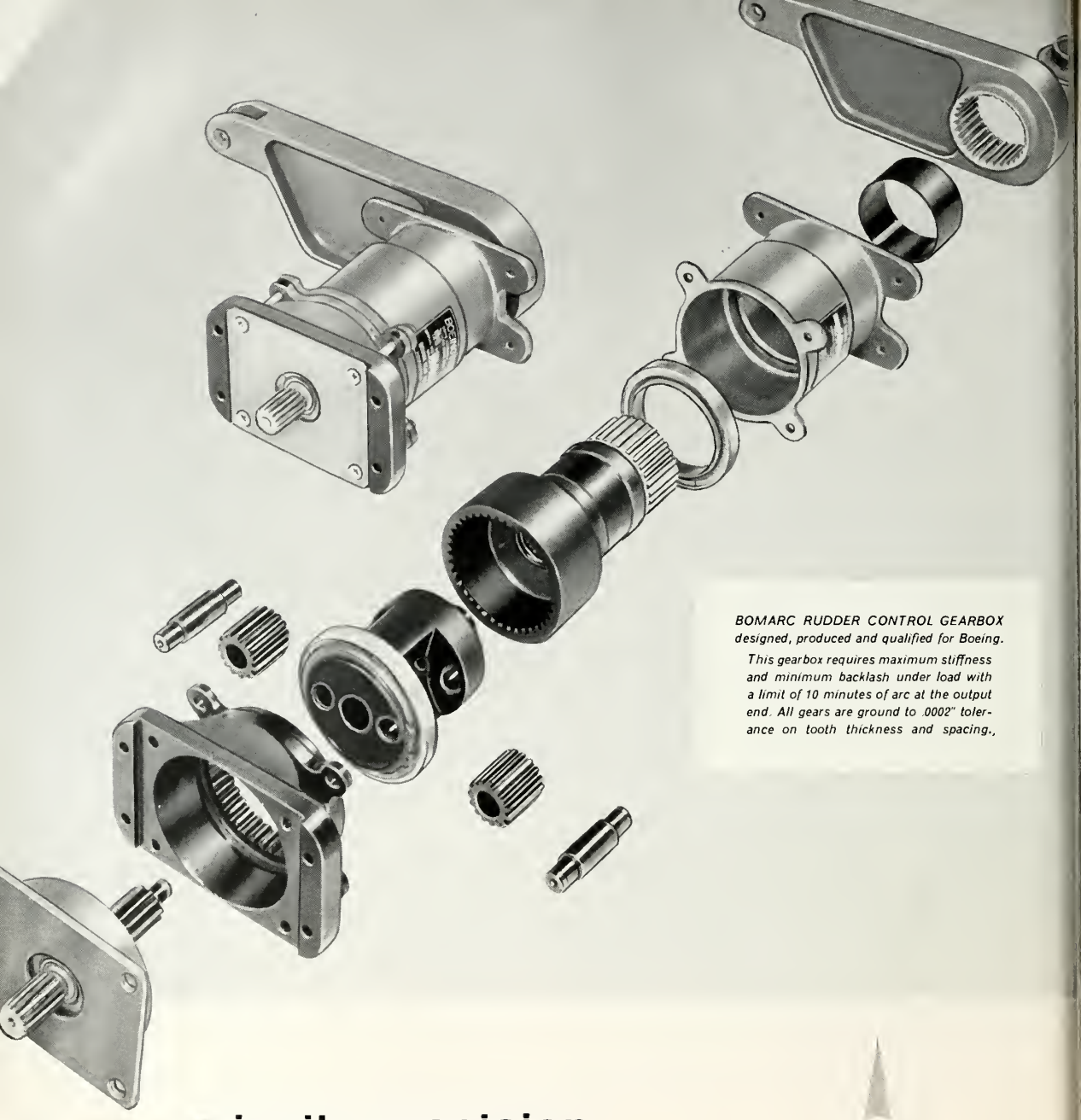
Measuring the bore of a steel liner ground in assembly with the lower housing of the Sikorsky S-56 Helicopter transmission. Its complex, thin-walled casting must be machined with all bores and faces within an angular tolerance of plus nothing and minus one minute and thirty seconds and with linear tolerances of plus or minus .002.

Precision is our only product!

● You know what aeronautical precision means today. You know the infinitesimal tolerances demanded, the strengths specified. Yet you can be sure that, whatever the specifications, I. G.W. has just one product—precision.

IGW

INDIANA GEAR WORKS, INC.
INDIANAPOLIS 7, INDIANA



BOMARC RUDDER CONTROL GEARBOX
designed, produced and qualified for Boeing.

This gearbox requires maximum stiffness and minimum backlash under load with a limit of 10 minutes of arc at the output end. All gears are ground to .0002" tolerance on tooth thickness and spacing.,

missile precision

is <u>our</u> kind of precision

● We cut our teeth on missiles. They're our kind of job. Their tolerances hold no terrors for our kind of men, their perfection holds no problems. Indiana Gear was *made* for missiles.

IGW

INDIANA GEAR WORKS, INC.
INDIANAPOLIS 7, INDIANA

Dr. Fred L. Whipple—

Eyes on the Skies

by Erica Cromley

THE NEWLY AWAKENED interest in space is pushing the nation's top astronautical scientists out of their laboratories and onto the platform to feed a hungry public the facts.

Added inroads are made on scientists' valuable time by the various governmental agencies and bureaus, which suddenly find that the satellite era has thrust part of their operations into the space picture. One of the men most in demand is the director of the Smithsonian Astrophysical Observatory, Dr. Fred L. Whipple, who heads the U.S. satellite optical tracking program, which includes Operation Moonwatch.

Although he realizes the importance of scientific liaison with the government and the public, Dr. Whipple foresees a possible danger: "Older scientists must now serve on so many committees that they don't have time to teach younger scientists. This means that in a few years we may not have any scientists, only committees."

• **Pre-Satellite efforts**—Dr. Whipple's first active contribution, directly related to space flight, dates back to 1946 when he was a consultant for a secret Rand project and wrote the paper, "Possible Hazards to Satellite Vehicles from Meteorites."

During the late '40s and early '50s, Whipple and a few other forward-looking scientists "tried to stir up interest" in space flight in government circles, although this was not a coordinated effort.

By 1954, the space-wary government was beginning to thaw. In November of that year, Fred Whipple participated in the original meeting on Project Orbiter, at the call of Naval Commander George Hoover.

Other space enthusiasts present were Dr. Wernher von Braun, Dr. Fred Singer, Austin W. Stanton of Vargo, Inc., and Fred Durant, the first president of the International Astronautical Federation.

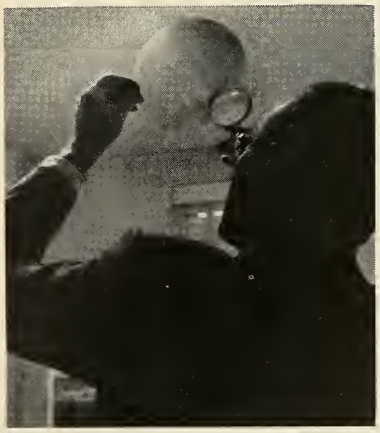
Things moved quicker after that. In the summer of 1955, while the Whipples were Europebound, the President announced that the United States would put up a satellite as part of its participation in IGY.

Fred Durant recalls that shortly afterward, when he met Whipple in Copenhagen where the IAF was meeting, they toasted President Eisenhower's historic announcement, under the impression that Project Orbiter was at last underway.

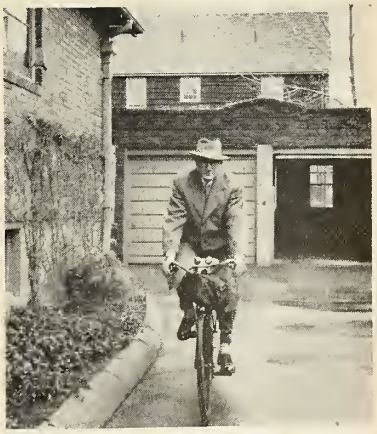
• **Moon tracking**—Just before the European trip, Dr. Whipple had left his post as chairman of Harvard's Department of Astronomy to head the Smithsonian Astrophysical Observatory at Cambridge, Mass. After the decision to launch *Vanguard,* there was no question as to the National Science Foundation's logical choice to head the visual tracking teams.

When Dr. Whipple first took over,

DR. WHIPPLE paints abstractions using math formulas as color and line guide.



THE MAN who heads our satellite visual tracking program probes *Sputnik* photo.



THE ASTRONOMER pedals to work from his home in Belmont, Mass.

. . . profile

the observatory's staff numbered six. Under the impetus of the coming satellite program, the staff grew to almost 100. One scientist said recently that "Whipple has a natural talent for administration. Morale at the Observatory and throughout the Moonwatch program has been extremely high. His arrival really gave a shot in the arm to the Smithsonian."

The twelve official world wide tracking stations, and the 230 volunteer observer posts, are on an around-the-clock watch to follow the man-made moons through their orbits. Findings are then sent to the Observatory at Cambridge.

Dr. Whipple, J. Allen Hynek, associate director of the Smithsonian, and the staff coordinate and feed the information into computers and analyze the findings. Eleven formal reports have been produced, and the first comprehensive published report is expected next month in the Smithsonian publication, "Contributions to Astrophysics."

Whipple's present post marks the second time that the government has called on the famed astronomer for assistance in an official capacity—although he has served on many panels, and acted in an advisory capacity.

• **Operation Window**—The United States first tapped Whipple in 1942 to head Operation Window, the radar countermeasure used successfully by the Army and Naval Air Forces.

It is a confusion reflector consisting of small packages of one-half wave length aluminum dipoles, which when released from a plane, scatter and act as tiny antennas, sending back decoy echoes on the enemy's radar screen.

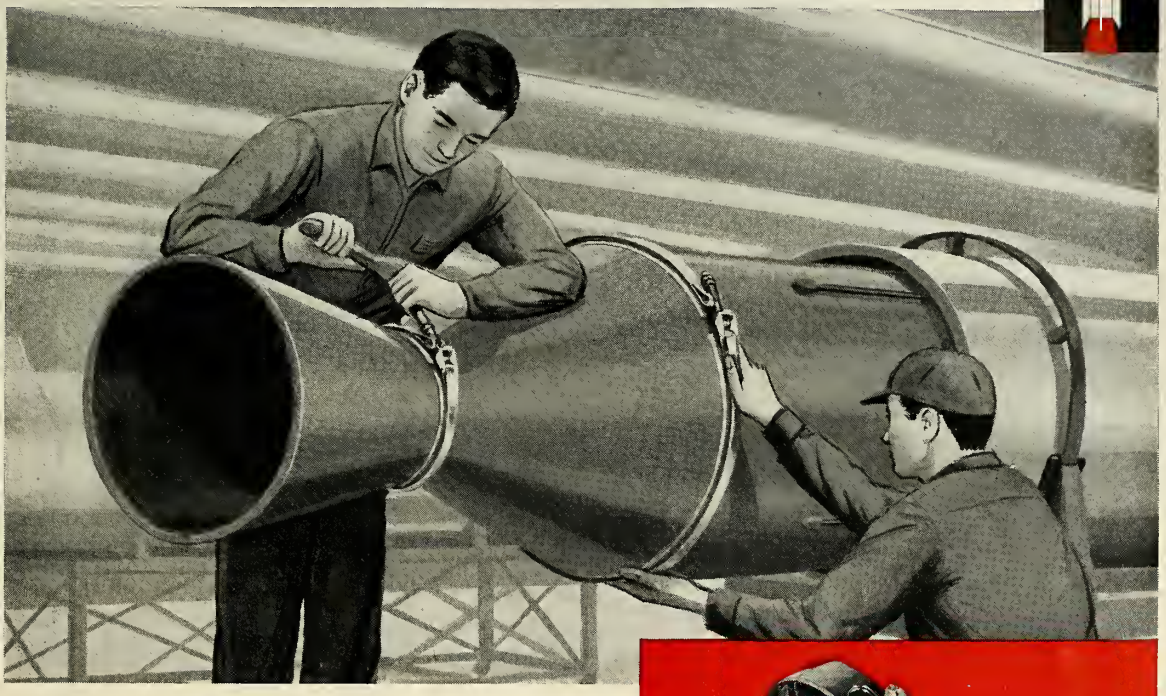
Whipple said that Operation Window "was considered so hot nobody wanted to do anything about it, because we were afraid the Germans might pick it up and do even more with it. We finally went ahead anyway. We found out after the war that the Germans had also thought of the idea early in the war, but hesitated to use it for the same reason."

Whipple's wife, Babette, said that Operation Window marked the turning point in her husband's career . . . "It brought him out of his ivory tower."

• **Early trends**—Whipple received his AB from the University of California in 1927, and admitted that he "was not too clear" where he was going. "I didn't exert myself too much in college. I took courses that were easiest, like math."

"It was at graduate school," his

Get Perfect Fluid Line Seal at Extreme Temperatures and Pressures With MARMAN CONOSEAL JOINTS



The Marmon CONOSEAL provides metal gasket compression with the flexibility ond sealing qualities farmerly obtained only through the use of orgonic seals. Dissimilar metols con be subjected to extremes of temperature and pressure with lineor deflections up to 1/16 inch without sacrifice of o perfect seal. Light weight with low envelope clearance. Available in three operating performonce ranges −300° F to +1800° F. Stondard sizes from 1″ to 12″ O.D. tube size with speciol sizes designed to your requirements.

Get Complete Information. Fill in and mail this coupon today!

MARMAN DIVISION
Aeroquip Corporation

AIRCRAFT SALES DEPARTMENT
11214 EXPOSITION BLVD., LOS ANGELES, CALIFORNIA
IN CANADA: AEROQUIP (CANADA) LTD., TORONTO 19, ONT.

*CONOSEAL is an Aeroquip Trademark. Marman Praducts are cavered by U.S. & Foreign Patents & ather Patents Pending

MARMAN DIVISION, Aeraquip Carparatian, MR-6
Aircraft Sales Department,
11214 Expositian Blvd., Los Angeles, Califarnia

Please send me full infarmatian an Marman CONOSEAL Joints.

Name_____

Title_____

Company_____

Address_____

City_____ Zone_____ State_____

Outstanding Performance

of these Two Naval Air Weapons depends on

Reliability

of ALL electronic equipment

58

Vital Electronic Units in Chance Vought's F8U Crusader Aircraft and Regulus Missiles are Protected by

ROBINSON

Met-L-Flex mounting systems isolating against shock and vibration

17 FOR F8U AIRCRAFT...

- Fire Control Radar Scope
- CNI System (AN/ASQ-17)
- Voltage Regulator
- Mach Control
- APQ-51 RF Head
- APQ-51 Compressor
- APQ-51 Power Supply
- APQ-51 Modulator
- APQ-51 IF Amplifier
- APQ-51 Power Junction Box
- APQ-51 Modulator Controllor
- APQ-51 Radar Central
- ARN-21
- Oscillograph
- Intervalometer
- Computer AXC-530
- Pressure Ratio Transducer

41 FOR REGULUS I, II MISSILES...

- Ground Control Consoles (3)
- Warhead Switch
- Dynamotors (2)
- Special Relay Units (3)
- Destructor Control Relay
- Function Control Relays (2)
- Junction Box
- De-Coder Audio Systems (2)
- Oscillograph
- Flight Path Stabilizer
- Control Interlock
- Baro-Switch
- Pressure Potentiometers (2)
- Trounce Guidance System
- Servo Amplifiers (2)
- Sub-Carrier Oscillators (2)
- Mach Control
- Multi-Coder
- DC-20 Multi-Coder
- DB-1 Multi-Coder
- Destructor Control
- Function Relay
- Calibrators (2)
- Relay Switch
- Sensitive Relay
- Flight Position Terminator
- Inertial Guidance System
- Pressure Switch
- Video De-Coder
- Beacon Transceiver

ROBINSON CONTROL IS RELIABILITY CONTROL

ROBINSON AVIATION INC.
TETERBORO · NEW JERSEY

West Coast Engineering Office: Santa Monica, Calif.

wife added "that he decided to become an astronomer and started to really study."

Whipple was an avid tinkerer from the time he was quite young. Projects that he worked on in the toolshed on the Red Oak, Iowa farm, included building models with a Meccano Set and experimenting with chemicals. "Then I went into my photographic phase," Whipple recalls. When he was in his teens, he built radio receivers, "though I never became a ham."

Dr. Whipple credits his parents with spurring his interest in science "mainly because they were consistent in their discipline. A consistent upbringing is necessary for the young mind with a scientific bent. It gives you the feeling the world is in an orderly system and a sense of order is of prime importance to a scientist." The elder Whipples also encouraged him in his attempts to satisfy his insatiable curiosity.

• **The Drs. Whipple**—Mrs. Whipple is the present source of encouragement to her husband through the long hours and tremendous pressure brought on by the satellite programs.

She is also a scientist in her own right, though her interests are in the social rather than the physical sciences. She has a PhD in psychology from Radcliff, and now works in psychological research on children at Massachusetts General Hospital.

Although Whipple is away from home much of the time, Mrs. Whipple accompanies him on some trips. "I don't like him to be away," she admitted, "but on the other hand, trips give him freedom from the everyday 'incoming' basket and the tremendous responsibilities and constant decisions at the office. Sometimes trips afford the only opportunity for him to do some uninterrupted serious thinking."

The Whipple's two little girls are fast becoming astronomy-minded. Sandra, eight, and Laura, six, are spending a lot of time star-gazing, but their mother feels this is due to the little boy next door "who is mad on astronomy," rather than their father.

All four Whipples are bicyclists. Dr. Whipple cycles to and from work "as long as there is no precipitation and as long as the temperature is greater than 10° above zero."

Another activity in which Dr. Whipple indulges is rose gardening, although he breeds roses more for scent than for looks. The 51-year-old scientist pitches in with the housework occasionally "to keep fit." His wife doesn't encourage this, because she "doesn't approve of husbands taking over around the house."

A strictly enforced Whipple rule is "no plans are ever made for Sunday." Mrs. Whipple said that "since my husband's time is so regimented, he wants one day when he can do what he feels like doing—so no invitations are extended or accepted for Sundays."

Both Mr. and Mrs. Whipple dabble in painting. He concentrates on abstracts "because I can't draw too well." Recently, he began experimenting with Stochastic painting—abstractionism carried to its ultimate, in which mathematical formulas determine the length and direction of the lines and the selection of colors. He calls it "a cynical approach to art" but says the results have been "interesting."

• **Scientist's scientist**—Dr. Whipple is highly regarded in the scientific community, where he is known as "a scientist's scientist." He has written over 130 articles on astronomy, including a contribution to a controversial series of articles which ran in COLLIER'S magazine, and later became the book: ACROSS THE SPACE FRONTIER.

Whipple has strong opinions on many subjects. "He doesn't hesitate to disagree with people" said Fred Durant, who attended a recent astronautical symposium with Whipple.

At the symposium, Dr. Thomas Gold had stated that dust thickness on the surface of the moon averaged about 100 ft. Whipple disagreed and made the statement, widely quoted in the press, that there was "no more dust on the moon than on the top of your piano."

This, of course, was a head-on run-in with prevailing scientific opinion. Another of Whipple's strong opinions was expressed at a recent House Space Committee meeting, at which he emphasized that the new space bureau should be independent of the military.

• **Red Carbon**—One measure of the success of Whipple's satellite tracking program was revealed during his appearance before the Space committee: the Russian scientist have used our Moonwatch program as the basis for their own visual satellite tracking programs.★

gyroscopic yardsticks

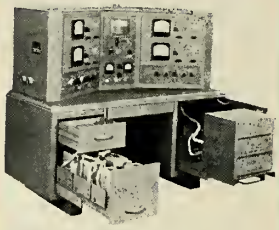
For analysis, evaluation, and measurement of rotational phenomena, Sterling Precision's complete line of gyro test components puts you way ahead . . . in design, development, simulation, and checkout.

T806 GYRO TEST TURNTABLE

High precision, rugged table for testing low-drift gyros in either open or closed loop. Ease and accuracy of tilt permits polar axis drift tests as well as vertical, inverse vertical and horizontal tests without shifting gyro.

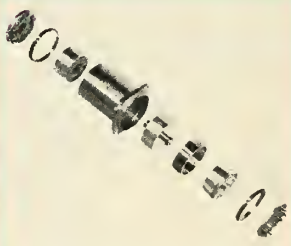
T818 36″ SYSTEM TEST TURNTABLE

For alignment of inertial components and to observe gyro and platform drift characteristics. Tiltable through 180° with full 360° azimuth adjustment. Will support complete navigation system platform (up to 500 lbs.).



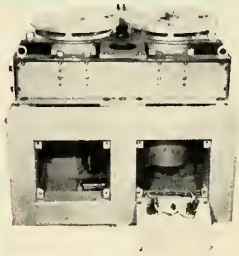
T838 GYRO TEST CONSOLE

Completely self-contained electronic control console for use with T806 Gyro Test Turntable. Other control consoles can be designed to accommodate your specified gyro data requirements.



T808 PENDULOUS ACCELEROMETER

Sensitive, fully floated and damped miniature pendulum consisting of single-axis pendulous float, signal generator and torque generator, enclosed in hermetically, sealed case for use in Schuler tuning of inertial platforms.



T852 TWIN SPIN TABLE

A checkout unit for spot performance checking of system components including rate gyros, linear accelerometers and tachometers.

T850 48″ SINUSOIDAL ROLL TABLE

A multi-positioning, single-axis driven, three-gimbal roll table for oscillating loads at constant rate (29 cpm) and variable amplitude (0° to 74°, p-p). Rotatable fully 360° (with tilt of ±20°) about horizontal roll axis.

COMPLETE LINE AVAILABLE
FOR COMPUTER AND CONTROL ENGINEERS

FOR PARTICULARS, WRITE . . .

STERLING
PRECISION CORP
INSTRUMENT DIVISION
17 MATINECOCK AVE., PORT WASHINGTON, NEW YORK
PHONE: PORT WASHINGTON 7-7200

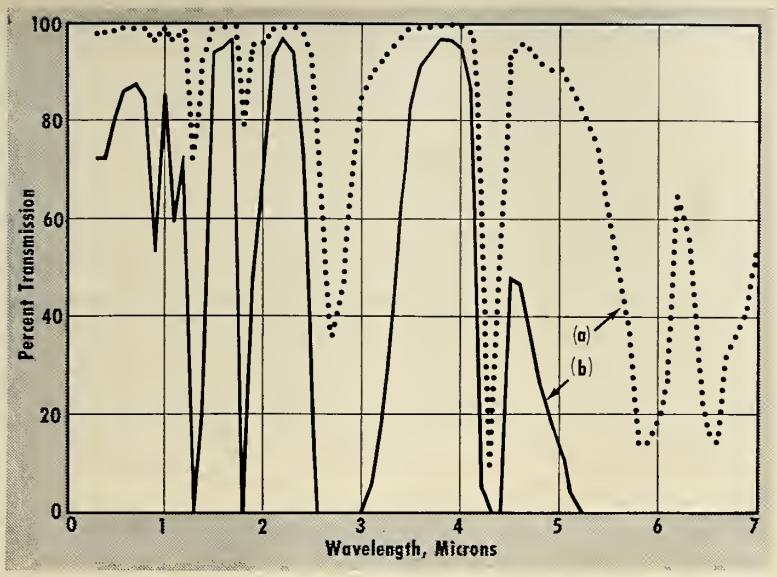


FIG. 1. Transmission of the atmosphere at (a) ten mile range at 50,000 ft. (b) one mile range at sea level. Transmission increases at higher altitudes.

Infra-Red: New Uses for an Old Technique

by Roger S. Estey*

THE GENERAL PRINCIPLES of the use of infrared radiation for detection and guidance with respect to distant objects are well known. Equipment has been built and is operational which will detect and track objects on land and sea or in the air.

The technical press has carried many excellent survey articles and detailed reports of developments in this field. The application of these techniques to missiles and space vehicles specifically, however, poses unusual problems and creates a wealth of new technical possibilities which will be discussed in this article.

The infrared portion of the spectrum is used for military applications not only because many targets emit in this region, but also because the avoidance of visual radiation produces a certain degree of operational security. This latter feature is of limited value in some of the newer applications. When appropriate to the discussion which follows, any or all regions of the optical spectrum will be considered.

Basically, infrared techniques can be used to perform one or more of four fundamental functions, namely: a) detection, b) recognition, c) tracking, d) communication. It will be shown that three of these functions are typically passive, and the other is inherently active in nature.

Infrared is usually considered a passive technique, that is, the equipment responds to the characteristic thermal radiation from the target. When used in this mode we are able to detect, recognize, or track objects which radiate thermally because of combustion of fuel, aerodynamic heating, or insolation (exposure to sunshine).

The principal use of active infrared is in the communication field, where the line-of-sight characteristics of the infrared beam lead to a high degree of security and small power requirements.

• **Atmosphere and background**— The absorption by the atmosphere seriously limits the performance of infrared devices which operate in close proximity to the earth. This absorption is most serious when the path between source and detector is long, and when the path traverses regions of low altitude.

The range of atmospheric transmission values to be expected is shown in Figs. 1 and 2. The upper curve of Fig. 1 shows the transmission over a ten-mile horizontal path at 50,000 ft. Although there are a few sharp and narrow absorption bands, the atmosphere is essentially transparent under these conditions from the near ultraviolet to the practical long wavelength limit of photoconductive cells. At higher altitudes the transmission is greater.

The lower curve in Fig. 1 illustrates the transmission of a one-mile path at sea level. It is also reasonably representative of the transmission of a vertical path through the total atmosphere. It will be noticed that in this case the infrared signal is confined to specific "windows" in the atmosphere.

The tangential path from a point on the earth's surface is an absorption path of particular interest in space navigation. A space vehicle located a few hundred miles or more from the earth's surface will be unable to resolve small terrestial details, but will be able to establish a line of position with respect to the earth as a sharp-edged disk.

The discontinuity between the earth and its atmosphere, each of which is radiating thermally, and the adjoining cold outer space, produces an abrupt signal gradient.

Two items are of interest here. The properties of this tangential path are quite independent of the range to the space vehicle or missile. Hence, the transmissive properties can be adequately and readily determined by solar

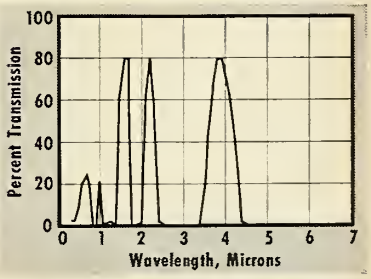


FIG. 2. Transmission of a tangential air path.

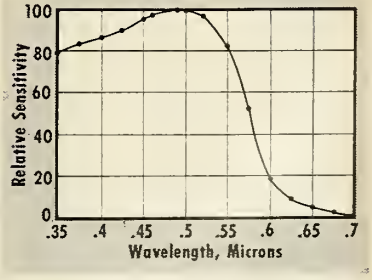


FIG. 3. Spectral sensitivity of multiplier phototube.

*Nortronics Division, Northrop Aircraft, Inc.

AERO-THERMODYNAMICISTS EXPLORE HIGH-SPEED RE-ENTRY

A report to Engineers and Scientists from Lockheed Missile Systems — where expanding missile programs insure more promising careers

Advanced weapon system technology has brought to the forefront problem areas requiring attention to interaction between aerodynamic and thermodynamic phenomena. Typical of these is the problem of high-speed atmospheric re-entry.

Expanding research and development activities have coincided with acceleration on top priority programs like our Polaris IRBM, and Reconnaissance Satellite. At the same time, positions for qualified engineers and scientists have opened up that are unequalled in responsibility or in opportunities for moving ahead.

Positions in **aero-thermodynamics** include such areas as: aerodynamic characteristics of missiles at high Mach numbers; missile and weapon system design analysis; boundary layer and heat transfer analyses in hypersonic flow fields; and calculation of transient structural and equipment temperatures resulting from aerodynamic heating and radiation.

In addition, openings exist at all levels in **Gas Dynamics, Structures, Propulsion, Test Planning and Analysis, Test Operations, Information Processing, Electronics,** and **Systems Integration.** Qualified engineers and scientists are invited to write Research and Development Staff, Sunnyvale 7, California.

Lockheed **MISSILE SYSTEMS**

A DIVISION OF LOCKHEED AIRCRAFT CORPORATION

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

Maurice Tucker, Aero-Thermodynamics Department Manager, right, discusses combined aero-thermodynamic re-entry body tests being conducted in Division's new "hot-shot" wind tunnel. Others are Dr. Jerome L. Fox, Assistant Department Manager, Thermodynamics, left, and Robert L. Nelson, Assistant Department Manager, Aerodynamics.

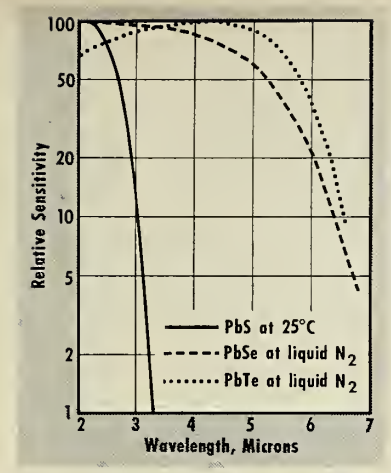


FIG. 4. Sensitivity of photoconductors.

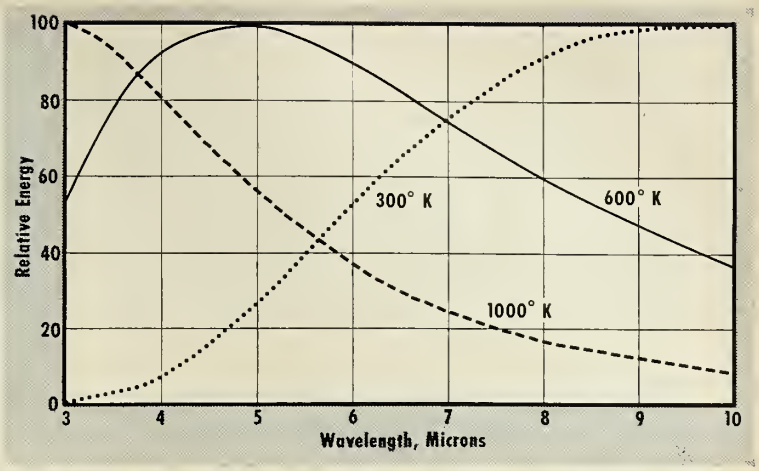


FIG. 5. Blackbody curves normalized at maximums, wavelength vs. relative energy.

observations at zero altitude (sunrise or sunset).

There appears to be no available means for measuring the signal discontinuity from a terrestrial surface point. A very high altitude laboratory would be required.

From the viewpoint of infrared techniques above the atmosphere—how are we to describe the background radiation for space? The sky background of outer space is startlingly black, against which the stars, planets, and the sun stand out in tremendous contrast.

Three other features are conspicuous. The background radiation of star light corresponds to a very high blackbody temperature, so that the peak of the spectral distribution curve is in the visible. This is totally different from the low temperature radiation from heated vehicle or missile surfaces, or from the band-type emissions from rocket flames.

The sky background of stars has a fixed distribution of energy in space. This means the sky background can be mapped and charted, and may serve for the rough determination of position.

This technique can be employed with instruments of very limited angular resolution, which may be advantageous in some cases. The energy distribution of the sky background can be mapped from the earth and programmed into an instrument for use as required.

Within the atmosphere, observers have been plagued by scattering of solar energy. As a result, the infrared background by day is several magnitudes more intense than by night. This distinction is so serious that different techniques and different standards of performance are obtained in the two cases.

In space, day and night do not have the same significance. The sun's angular position in the field, or the fortuitous obstruction of the solar rays by the earth or moon, are the important elements in a given situation. Space vehicle velocities are fast enough to seriously limit the usefulness of any such periods of obscuration that may occur.

Radiation from the atmosphere has irregular gradients in space and irregular variations of intensity with time, so that a background signal of optical noise is superimposed on and degrades any signal carrying intelligence. So far as we know, space backgrounds do not have these characteristics and the background of any modulated signal will be extremely quiet.

• **Sources of infrared radiation**—Infrared sources under discussion include missiles, space vehicles, celestial objects, and the earth's surface. Types of radiation include blackbody radiation which is distributed more or less uniformly over the spectrum, and the radiation from flames.

Flame radiation is emitted largely at those wavelengths corresponding to the atmospheric absorption bands. As a result, the increase in signal from flames due to high altitudes is very much greater than the increase of signal from blackbody-type of radiation.

Missiles during take-off and boost emit copiously from the tail flames. This radiation is very intense and conspicuous. After boost, the missile emits a conspicuous signal whenever the surface temperature is high from the combustion of fuel or from aerodynamic heating.

As a result, the signal from missiles may well persist over-all but a short interval in the middle of the flight.

Space vehicles are heated by solar radiation and in turn radiate to space. The heat balance between these phenomena determines the resulting vehicle temperature. A hypothetical example, grossly over simplified, will serve to illustrate this.

Assume our space vehicle is a sphere with a skin which is a perfect conductor of heat and has an emissivity equal to unity. Since the solar constant is 129.6 watts/ft² at the mean distance of the Earth, and since the insolation is proportional to the projected area, the radiation incident on the sphere is 129.6 watts/ft² of projected area.

This absorbed radiation will raise the surface temperature, uniformly it is assumed, until the radiation emitted from the total spherical surface area just balances the radiation received on the projected areas. For a sphere, these areas are in the ratio 4:1 and so the heated sphere will radiate 32.4 watts/ft².

This corresponds to a skin temperature of 280°K. This skin temperature can be increased slightly (approximately 40°) by the use of a reflecting surface on the side away from the sun. Similar techniques can decrease the skin temperature of the space vehicle considerably.

This means that space vehicles are not effective infrared sources in terms of their thermal emission, and this small signal can be decreased if desired, but cannot be increased significantly.

Celestial objects, the sun, planets, and stars emit in various parts of the spectrum without restriction. Since position is the only information to be obtained from the observation of these

objects, the techniques are dictated entirely by the special character of the sources and the sensitivity characteristics of available detectors.

These are all very high temperature sources with maximum energy in the visible region of the spectrum. The experience of astronomers, on the one hand, and engineers working with daytime star trackers on the other, indicates that techniques involving the visible and the very near infrared regions are most satisfactory for the observation of celestial objects.

The earth's surface can be observed from missiles or space vehicles. The information may be used for guidance, involving the vehicle's position, or for reconnaissance, involving the study of terrestrial features. Surface features have low thermal contrast and are difficult to pick up.

Nortronics and other organizations are working on sophisticated infrared instruments involving special scanning routines, multiple channels, contrast control by optical filtering, and other techniques.

Guidance with respect to conspicuous local surface features poses a difficult problem in discrimination and interpretation, and may require the support of reconnaissance by infrared mapping.

Guidance of space vehicles at too great a distance for the resolution of surface features is another matter. In this case, the earth is seen as a disk with a conspicuous edge, and the signal contrast between the thermal radiation from the earth at approximately 300°K and the negligible radiation from the adjacent segment of space is very large.

This steep gradient can be observed instrumentally, and the center of the cone swept out by the observing instrument is the true vertical from the geometrical center of the earth. The accuracy of such a measurement is limited by atmospheric refraction and by the non-spherical nature of the earth's surface, with or without cloud cover.

Refraction is a substantially constant correction of about 0°–35′. The effect of mountains, clouds, and the ellipticity of the earth can be lumped together. They are associated with specific regions of the earth, and produce effects which are definite in linear measure, but produce angular errors inversely proportional to the range.

The transmission of the tangential air path shown in Fig. 2 shows a deep and wide absorption band between 2.5 and 3.4 microns, and a very transparent window between 3.4 and 4.4 microns. If measurements are made in the four micron window, the gradient will be more abrupt and will represent the tangent to the earth's surface.

Measurements made in the three micron absorption band will show a less abrupt gradient which measures the outer portion of the atmosphere. The effective depth of the atmosphere varies with latitude and with the distribution of the continental masses.

It is believed that these variations are significantly larger than surface variations, and it is also believed that horizon detectors should use the four-micron window.

• **Detecting instruments**—It is clear from the previous discussion that two distinct types of instrumentation are required, corresponding to sources of low and high temperature energy distributions. Generally speaking, instruments with peak sensitivity in or near the visible range are most suitable for the observation of self-luminous celestial objects.

Reconnaissance and guidance against

low temperature targets are best accomplished with detectors having high sensitivity to five or six microns or beyond.

Short wavelength detection employs components and techniques familiar to professional astronomers. The modern design of a photomultiplier tube is a typical short wavelength detector. These phototubes have high quantum efficiency and very low noise.

These devices are commercially developed to an unusual degree of excellence. For example, a typical tube can be built with a cathode area 0.32 in.^{2}, a quantum efficiency approaching 50%, and the spectral sensitivity curve shown in Fig. 3.

The associated optical system may employ either lens or mirror elements, and optical glasses have adequate transparency in the wavelength region concerned.

A typical optical system employs a high speed objective—to image the distant target into a focal plane where modulation or angular discrimination occurs. The radiant flux is then transferred to the sensor.

The resolution and angular capability of the instrument depends on the quality of the objective, and the capability of the associated scanning system. The time constant of the phototube and amplifiers is much less than any mechanical-type scanner can use to full advantage.

Longer wavelength detectors are typically of the photoconductive type. They are characterized by a very small sensitive area, adequate spectral sensitivity, time constancy, and noise limitation. Cells sensitive beyond three microns require liquid nitrogen cooling. The spectral sensitivities of three typical cell types are shown in Fig. 4.

Art detection or observation was limited to low or moderate altitudes, and the useful spectral region has been limited by the intense atmospheric absorption beyond five microns.

This limitation is removed at very high altitudes, and photoconductors sensitive to longer wavelengths are able to exploit the energy which thermal targets emit in the region beyond five microns. This advantage is further emphasized by the blackbody curves shown in Fig. 5.

Typical optical systems used with these detectors include germanium or silicon lenses for the smaller elements, and mirrors for the larger. Because of the very unusual values of refractive index and dispersion which these materials have, the customary simplified optical design methods yield very misleading results. As a result, specialized design techniques are required.

Fortunately, these and other materials can be combined to produce high speed lens systems with satisfactory reductions of the most troublesome aberrations such as spherical, chromatic, coma and astigmatism.

• **The future**—This article has shown that the guidance requirements of missiles and space vehicles pose many new problems, and require new applications for old techniques.

Space vehicles obviously require cells sensitive to longer wavelengths. They also require mosaic cells which can record images simultaneously, rather than sequentially through mechanical scanning devices.

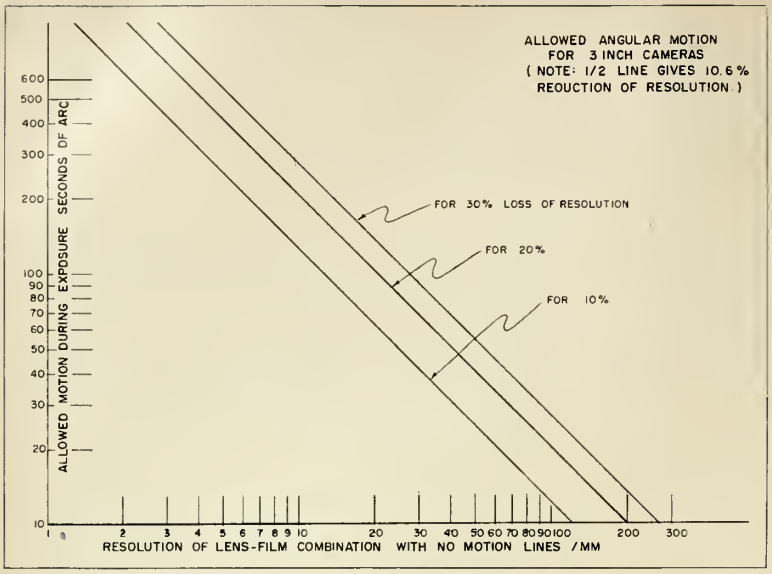
Guidance requires both simple and refined devices for observing angular position, with respect to the earth and celestial objects.

In the case of space vehicles, particularly, refined and specialized stable platforms are required, which will orient our apparatus as desired.

The application of techniques, and the solution of these and related problems, will make possible the more effective guidance of missiles and vehicles in the upper atmosphere and in space.★

TABLE OF CHARACTERISTICS

GENERAL	
System	Passive
External energy	None
IMAGE CHARACTERISTICS	
Presentation time	Instantaneous
Resolution	Good
Contrast and tone	Excellent
DETECTION	
Of surface properties	Yes
Of radiant heat sources	Yes
Of hidden installations	Yes
Of camouflage	Yes
FALSE SIGNALS	
Subject to camouflage	Not very readily
Subject to jamming	No
WORKING VALUES	
Suitable to daylight	Yes
Adaptable to night-time	Yes
Range Information	Not direct
GENERAL	
Water vapor penetration	Some, depending on wavelength of equipment
Cloud penetration	Reduces efficiency
Smoke and Haze penetration	Poor at short wavelengths Better at longer wavelengths
OTHER CHARACTERISTICS —Basic Equipment	
Weight	Comparatively light
Complexity	More complex
Size	Larger
Coverage	Virtually any angle



If Photos are Used for Intelligence:

Cameras Need Stable Mounting

by R. G. Sanders*

INFORMATION CONTENT is the yardstick by which the effectiveness of the aerial reconnaissance photograph is judged. And to judge it properly, these factors must be considered:

The intelligence gained from an aerial photograph or from an infrared recording is directly proportional to the quality and clarity of the picture.

The quantitative means for determining quality or clarity in a photograph is a bar type resolution chart.

The values measured on the negative are read in terms of lines per millimeter.

Currently, standard aerial cameras produce resolutions which vary from 20 lines per millimeter to 35 1/mm, depending upon the lens and film characteristics. Some cameras under development aspire to values as high as 50 1/mm or more. These values are measured in the laboratory on the optical bench.

The intelligence sections of the armed forces want to achieve resolutions, under flight operational conditions, as closely equal as possible to the laboratory capabilities of the aerial cameras. Unfortunately, the vehicles have characteristics which cause the image to be degraded to a fraction of the laboratory test values:

a) Forward motion of the vehicle; b) Roll; c) Pitch; d) Yaw; e) Vibration.

Of the above, forward motion, roll, and vibration are the major factors in image degradation, while pitch and yaw are important but usually of lesser magnitude.

• **Stabilization system**—Protection of image quality from the foregoing degrading factors during operational flights has been responsible for the growth of a highly specialized company—The Aeroflex Corp., Long Island City, New York.

This relatively small company has, for the past fifteen years, devoted its entire research, engineering, and production facilities to insuring maximum information from aerial reconnaissance vehicles by means of specially designed mounting systems.

While current designs are for manned aircraft; the experience, techniques, and equipment directly apply to unmanned vehicles such as reconnaissance drones, missiles, and rockets. Some preliminary designs have been started, to serve special missile and rocket purposes.

Isolation of the aerial camera or infrared sensor utilizing the "shock mount" techniques is adequate for the protection of the physical items of equipment from the destructive effects of vibration and shock.

However, experience has proved that "shock mounts" of various types frequently aggravate image degradation due to vibration. This results from the angular motion imparted to the camera caused by out-of-phase motions at the several supports and by non-centered c.g. location of the camera.

A picture taken during the angular movement of the camera is roughly similar to that produced by a hand-held amateur camera which is carelessly moved during exposure. Further, the "shock-mount" design is incapable of counteracting any of the other degrading factors. Hence, the shock-mount approach by itself has long ago been abandoned.

The only truly effective means of achieving high resolution reconnaissance photography is through the use of a peculiarly specialized stabilization system.

In effect, the sensor is mounted on a stable platform and is fixed in space during the time that the exposure is being made. Thus, very little, if any, angular movement of the camera can take place regardless of the type of disturbing force.

The effectiveness of the stabilizing system is measured in terms of the number of seconds of arc through which the camera rotates during a specified exposure time, such as 1/10 sec., 1/50 sec., or 1/100 sec. The amount of angular motion which can be tolerated without serious degradation to the image varies inversely with the focal length of the lens.

In the accompanying charts, if a 10% loss in resolution in flight is accepted, a photographic system having a laboratory capability of 50 1/mm can tolerate an angular rotation during exposure of 26 seconds of arc for the specified lens. A lens of twice the given focal length would limit the permissible angular movement to 13 seconds of arc. The roll and pitch rates which may be experienced in reconnaissance drones, missiles, and rockets exceed those normally experienced in manned aircraft.

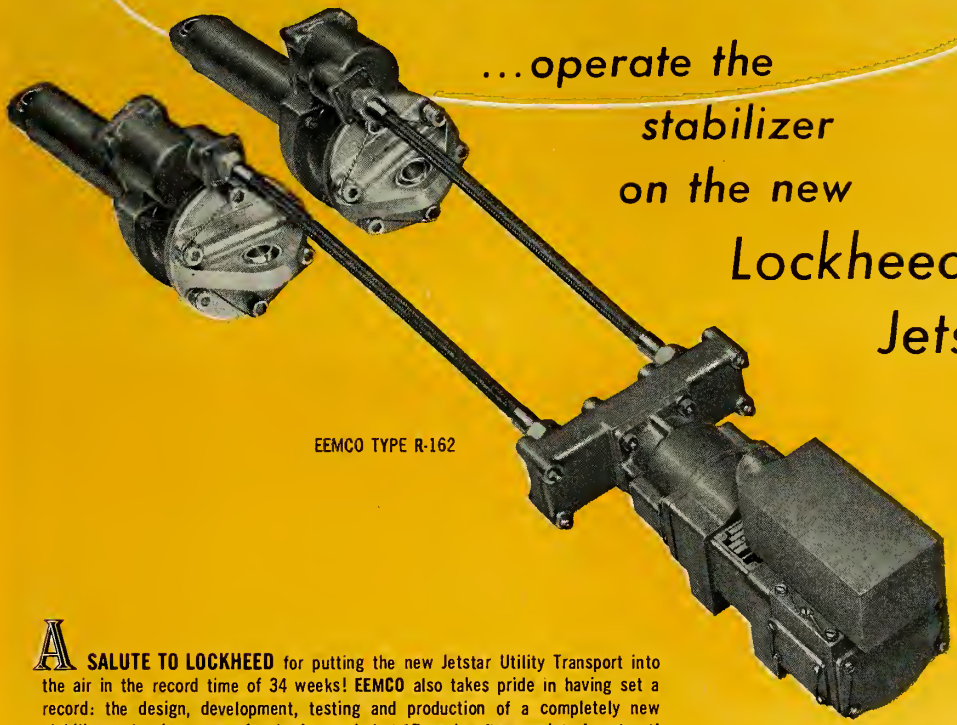
The second chart shows the angular motion of the camera, which results from various degrees of vehicle roll or pitch during any selected exposure time. Unfortunately, it is not always possible to use high shutter speed, which obviously helps the photographic quality. Bad weather or early morning and late afternoon operations require slower shutter speeds.

Assuming of 10° roll rate, during which a camera with a 1/100 second shutter speed is exposed, an angular camera motion of 360 seconds of arc would be experienced. Under this condition, a 3" focal length camera with a

*Vice-President
The Aeroflex Corp.

EEMCO CONTROLS

...operate the stabilizer on the new Lockheed Jetstar



EEMCO TYPE R-162

A SALUTE TO LOCKHEED for putting the new Jetstar Utility Transport into the air in the record time of 34 weeks! **EEMCO** also takes pride in having set a record: the design, development, testing and production of a completely new stabilizer actuating system for the Jetstar in but 17 weeks after receipt of contract!

The Jetstar's new **EEMCO** actuating system, **EEMCO** Type R-162, is capable of handling a total operating load of 15,000 lbs. in tension or compression on both jacks. It will operate Jetstar's stabilizer many times during an average flight, therefore hundreds of thousands of operations will be performed during the life of the unit. Reliability to the extremes of environmental conditions and ruggedness were prime specifications.

EEMCO's ability to produce these actuating units for Lockheed Aircraft Corporation in record time is a result of the fact that **EEMCO** has specialized in the design and production of aircraft motors and actuators for many years. It makes nothing else. And because of high ratio of output to weight and the reliability built into all of its products, there is an **EEMCO** special motor or actuator on the majority of the latest missiles and jet aircraft now in production or in prototype stage. Please note the specifications on this Jetstar component.

SPECIFICATIONS FOR TYPE R-162 ACTUATING SYSTEM

Voltage: 28-volt DC
Stroke: 8.25 inches
Speed: .3 inch per sec. at maximum load
Maximum Load: 10,500 lbs. on each jack, tension or compression
Maximum System Load: (both jacks) 15,000 lbs.
Ultimate Load: 50,000 lbs. on each jack, tension or compression—100,000 lbs. total
Military Specs: Assembly designed to meet MIL-M-8609, MIL-A-8064 and MIL-E-5272A

Features:

1. Jacks are equipped with non-jamming stops.
2. Single power unit drives the jacks at synchronized speed.
3. Jacks are equipped with auxiliary reduction for a control mechanism.
4. Motor has magnetic clutch and brake.

Your Inquiry is Invited

EEMCO ELECTRICAL ENGINEERING & MANUFACTURING CORP.

4612 West Jefferson Boulevard, Los Angeles 16, California • Telephone REpublic 3-0151

DESIGNERS AND PRODUCERS OF MOTORS, LINEAR AND ROTARY ACTUATORS . . . EXCLUSIVELY!

Circle No. 65 on Subscriber Service Card.

Think small

Mechanical brains for missiles must be as tough and tiny as possible . . . a design problem that calls for experts skilled in both electronic computers and miniaturization.

ARMA's computer group has shrunk a digital computer module until it's the size shown above . . . a feat comparable to squeezing the contents of a steamer trunk into a cigarette package.

Right now, in fact, through new techniques of solid state circuitry, systematic design and compatibility testing, ***ARMA*** is producing a family of airborne digital computers that are operational under the most severe conditions of vibration, temperature, noise, acceleration and deceleration, and nuclear radiation.

For information on our fully transistorized, airborne digital computers, contact ***ARMA***, Garden City, N. Y. A division of American Bosch Arma Corporation.

5836

AMERICAN BOSCH ARMA CORPORATION

laboratory resolution of 50 1/mm, would be reduced operationally by this one factor to 8 1/mm.

•**Performance analysis**—The Armed Forces specify the type of ground information they wish to detect. From this beginning, the performance required of the reconnaissance system is formulated. At this point, the Aeroflex specialists enter the program to devise a mounting system which will enable the photographic or infrared sensors to meet the resolution requirements under operational conditions. The analysis usually follows a step-by-step procedure:

Forward Motion Compensation—Most amateur photographers are familiar with the problem of photographing a speeding automobile. The same problem exists in reverse in photographing the ground from a fast moving vehicle in the air. This blurring effect of movement can be eliminated by either of two methods:

a) Moving film—In this method, the film is moved during the exposure at a speed which is proportional to the altitude and speed of the vehicle and focal length of the camera. This method usually requires a complex mechanical and electrical design, with attendant maintenance problems. However, where photographs have to be taken at frequencies greater than two per second, it is the only satisfactory method.

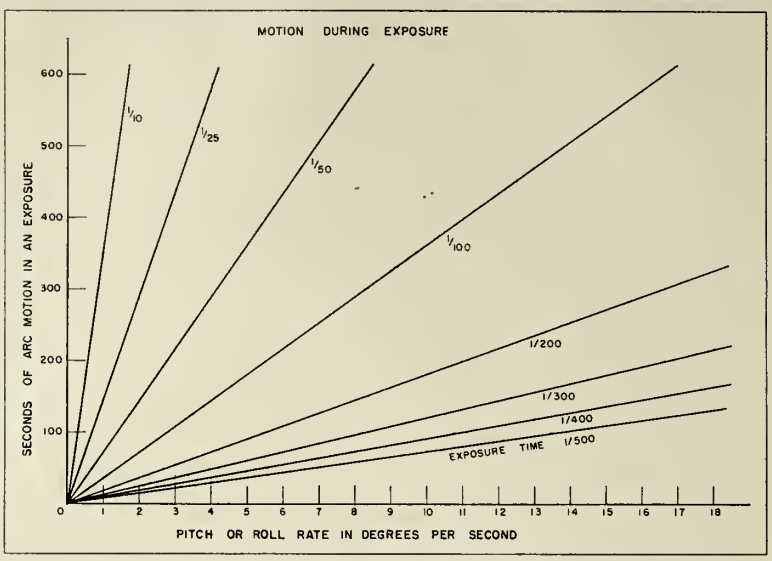
b) Swinging Mount—The deliberate swinging of the camera, at a prescribed angular rate along the ground track of the aircraft, provides a relatively simple means of compensating for the image motion factor.

Roll Stabilization—Although forward motion compensation may be provided, serious image degradation can result from very small roll movements of the vehicle.

Single axis stable platforms have been made for special situations to compensate for this factor.

Pitch stabilization—This factor by itself is usually low in frequency and has little effect on resolution. No occasion has yet occurred to require separate pitch stabilization. However, it can exceed any of the foregoing. A two axis stable platform of special design can minimize or eliminate vibrational image degradation.

This dictates a mount having a roll and pitch capability. Naturally, such a mount for the camera also



FACTORS for exposure times, as affected by motion of vehicle.

eliminates the image degradation due to the characteristic roll or pitch of the vehicle.

• **Functions of system**—The maximum protection of the inherent resolution of a reconnaissance sensor which is practical to achieve results from a stable platform must have the following functions: roll stabilization, pitch stabilization, aximuth remotely controlled (not stabilized), image movement compensation either in magazine or in the mount.

Space and weight limitations in vehicles cannot be denied. However, if a vehicle is primarily for reconnaissance, it should be of such size as to permit use of the art equipment to insure the information required by the Armed Forces. For counteracting the angular disturbances due to vibration, the pitch stabilization is equal in importance to roll stabilization.

Yaw Stabilization—A properly designed mount provides (where space envelope permits) a means for varying the azimuth position of the camera, with respect to the longitudinal axis of the vehicle. This provision enables the camera image movement to be parallel to the ground track of the vehicle. Large errors in the rate of image motion compensation can occur from uncorrected vehicle drift, thereby degrading the imagery.

Some sophisticated stabilization systems provide for the yaw motions of the vehicle. This refinement is usually superimposed upon the azimuth movement. However, the degradation to the image due to yaw variations is small, and is not worth the complex mechanism needed to overcome it.

Vibration—Under some conditions, the image degradation results from the vibration characteristics of a vehicle. The situation, involving existing vehicles modified for reconnaissance, makes the space and weight problem very real.

In such cases, the various image quality protective features are sacrificed in the following order: 1) Azimuth correction 2) Pitch stabilization 3) Roll stabilization 4) Image motion compensation.

Of the above, the last two should be retained if at all possible.

• **System components**—Basically, a system for protecting the image quality of a reconnaissance sensor consists of a three gimbal frame for azimuth, roll and pitch.

The mechanical-structural design is of great importance—due to the high sensitivity of the optical system being stabilized. It is in this design area that techniques of design, based upon long experience, are of major importance.

The special reference is mounted on the inner gimbal. This unit is a specially designed vertical gyro. Among its special features are: a) Nulling type b) Extreme smoothness of pick off c) Sensitivity d) Performance in presence of vibration.

The necessary electronics are preferably located also on the inner gimbal, to increase the inertia of the sensor to obtain greater self-stabilizing effect. The error signal, which develops in the

UNSURPASSED QUALITY FINE PITCH GEARS

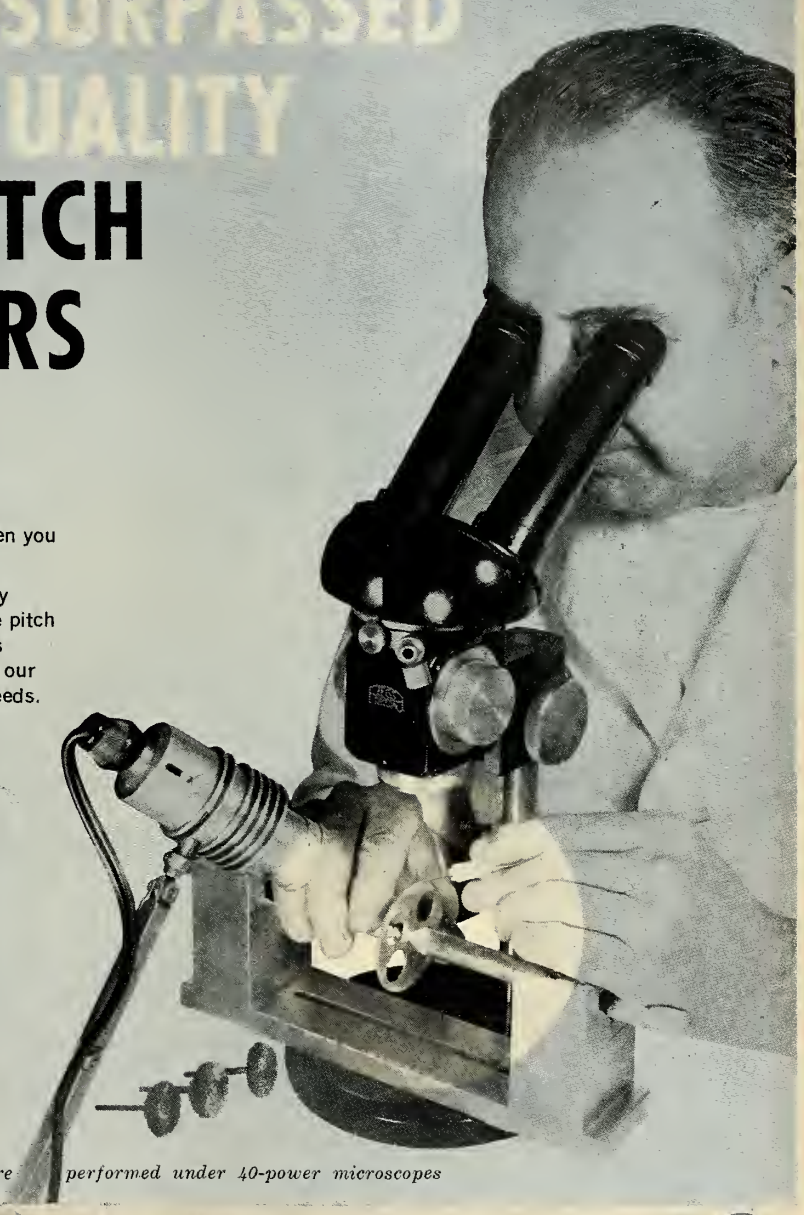
by WESTERN GEAR

There is no limit to the solution of power transmission problems when you rely on Western Gear.

For example, if you have extremely critical applications requiring fine pitch gears which exceed in many cases standards for "master" gears, let our engineers concentrate on your needs.

Then, through our use of highly skilled craftsmen, meticulous workmanship, exact temperature control and critical inspection, you can be certain your gear requirements are exactly as specified . . . custom engineered . . . vastly superior to so-called "precision" stock gears.

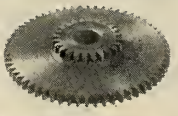
SPECIFICATIONS: 300 to 24 diametral pitch, from .0625 inches in diameter up, classes P1 to P3 or better, in accordance with AGMA standards.



Production burring operations are performed under 40-power microscopes

Stainless Steel
P-2 Straight Bevel Gear Set

Stainless Steel
P-2 Cluster Gear



Stainless Steel Black Oxide
P-1 Cluster Spur Gear

Stainless Steel
P-3 Cluster Gear

Stainless Steel
Black Oxide P-1 Segment

WESTERN GEAR Corporation
ENGINEERS AND MANUFACTURERS

PLANTS AT LYNWOOD, PASADENA, BELMONT (CALIF.), SEATTLE AND HOUSTON

5810

ASK YOUR WESTERN GEAR MAN *about* **UQ** *fine pitch gears*

WESTERN GEAR CORPORATION, c/o Glenn Malme, P.O. Box 182, Lynwood, Calif.
Please send Precision Gears Bulletin #5811

NAME _____

TITLE _____ COMPANY _____

ADDRESS _____

CITY _____ STATE _____

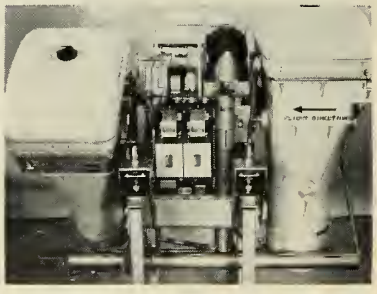
. . . cameras need

vertical gyro due to the coercive effect of bearing friction and cables which must cross the gimbals, is processed through the electronics to torquer motors on the roll and pitch axes.

These torquers are of unusual design due to the critical demands of the optical system mentioned above. The coercion is thus overcome, the error signal is reduced to zero, and the senor is undisturbed within the sensitivity and tolerance of the system.

• **Rocket reconnaissance**—Missiles and rockets are not likely to be called upon to produce mapping type of photography. Thus, verticality only in a gross sense, is necessary for general missile or rocket reconnaissance operations.

Utilizing the ARX-3 type of nulling gyro pendulously erected, a verticality under certain conditions can be achieved to approximately ±30 minutes of arc operationally. There is no data available on performance in missiles or rockets to date.



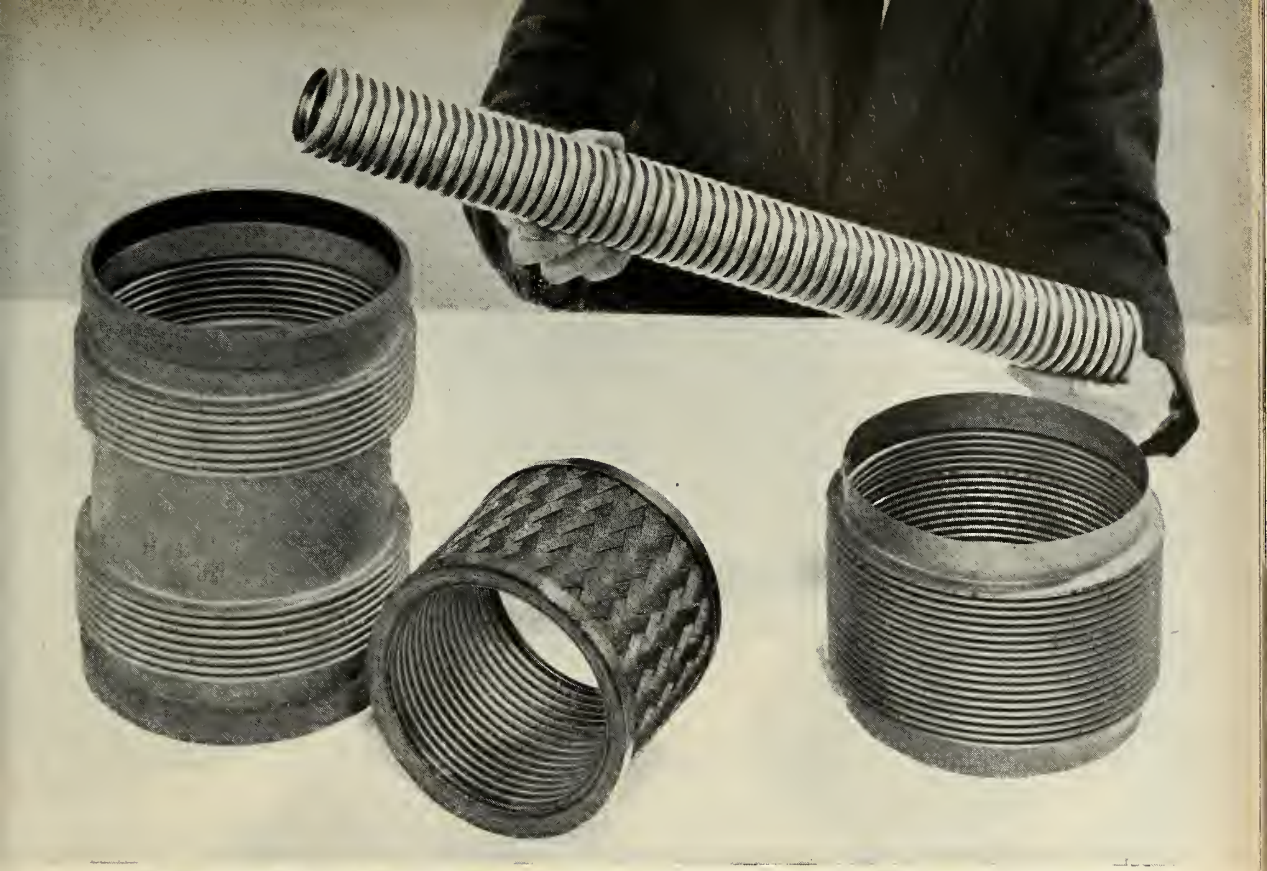
A stabilized torquer mount with image motion compensation accommodating three K-38 cameras.

However, it is conceivable that verticality in the order of ±1½° or 2° could be expected. With more sophisticated vertical reference systems, the probable error can be progressively reduced down to ±3 minutes.

Every installation is a new project to consider.

Standard shelf equipment does not exist in the usual sense. What does exist is a wealth of data based upon theoretical analysis, laboratory and operational test programs, together with specialized circuitry, electronics, gyros, torquers and gimbal structures.

Without any question, these techniques and components apply in large measure to the requirements in reconnaissance missiles and rockets.★



FLEXIBLE CONNECTORS, in a variety of sizes, constructions, materials, are designed to meet many working conditions. Our sales representatives in cooperation with our engineering design service will be glad to be of assistance.

BIG space-age problems get BIG flexible metal tube answers

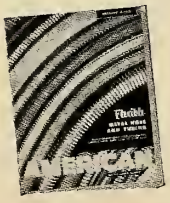
Large-diameter flexible metal connectors in stainless steel and other alloys—to handle expansion and contraction, wide range of temperatures, corrosive fluids, high pressures, and vibration.

Jet engines, modern chemical plants, rockets, atomic energy plants have created a new technology that calls for new products. The American Metal Hose Division of The American Brass Company is constantly working with design engineers on special flexible connector assemblies to meet new problems.

Equipped to work in stainless steel, Monel, and aluminum as well as in other alloy steels and copper alloys, these Anaconda specialists welcome the opportunity to help you get the flexible metal hose you need to meet your problems of expansion and contraction, movement, vibration, corrosion, pressures, and temperatures.

FREE TECHNICAL SERVICE. For engineering assistance on special products—or for a free copy of our General Catalog showing the full line of standard American Flexible Hose and Tubing products—write: The American Metal Hose Division, The American Brass Company, Waterbury 20, Connecticut. 58168

WHEREVER CONNECTORS MUST MOVE



AMERICAN
FLEXIBLE METAL HOSE AND TUBING
an
ANACONDA®
product

Circle No. 68 on Subscriber Service Card.

THE AMERICAN BRASS COMPANY MR
American Metal Hose Division, Waterbury 20, Conn.

Please send me your free, 60-page General Catalog containing basic information on all types of metal hose and tubing, fittings, etc.

NAME & TITLE .....

ADDRESS .....

COMPANY .....

CITY, ZONE, STATE .....
(PLEASE PRINT OR TYPE)

Tracking System

Fecker Takes On Swiss Camera-Optical Device

J. W. Fecker, Inc., Pittsburgh, a subsidiary of American Optical Company, recently announced that it had been appointed to represent Contraves AG of Zurich, Switzerland, for the sale and service of EOTS (Electronic Optical Tracking System). EOTS, a cine-theodolite system, is now in use in numerous military tracking stations throughout the United States, and more units are scheduled for installation in the near future.

Employing two or more cine-theodolites synchronized by a master station, the EOTS requires a two-man operational crew. It is used primarily for obtaining accurately-timed position information of airborne objects on 35 mm film, recording their angle values in relation to the EOTS system.

According to J. W. Fecker, Inc., the EOTS is considered the most accurate tracking cine-theodolite system in existense today, with an unreduced accuracy equal to the reduced accuracy of other comparable systems.

The actual dynamic performance of the EOTS has been shown to have an error substantially less than 5 seconds of arc. This accuracy is possible when all systematic errors have been taken into account and the equipment is operated under the proper environmental conditions.

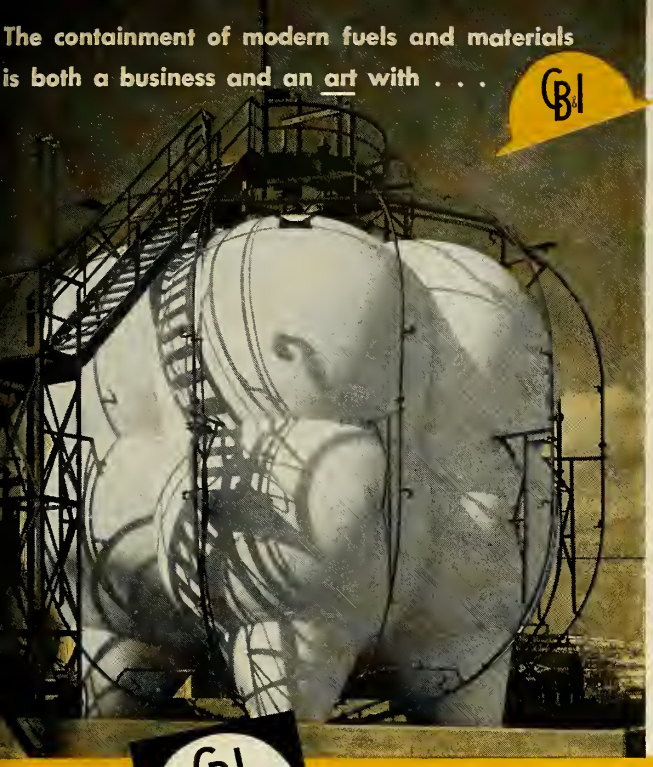
The vernier arrangement for reading angle information is such that 1/1000 of a degree may be estimated.

The position of the target is obtained by three-dimensional double projection. For this purpose, the elevation and bearing at which the target is seen from an accurately-established base line on the ground are measured and recorded by at least two units simultaneously. The larger the trajectory to be studied, the greater the number of units to insure accuracy in all measurements.

In the missile field, the EOTS records such special data as engine ignition phase, booster separation, combustion burnout, impact phase, and detonation of warhead, in addition to trajectory and flight attitude.

Synchronization of each unit is achieved by the master station which transmits impulses through a VHF-FM radio link or by cable. Its design allows control not only by its two operators, but also by radar or a computer; the latter being used for target acquisition in tests over very great distances.

The 35 mm camera may be set to take photographs at frame rates up to 32 per second, and holds 1,000 feet of film.

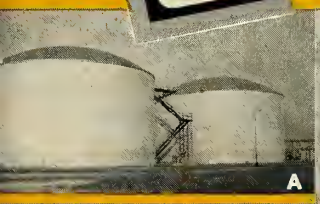


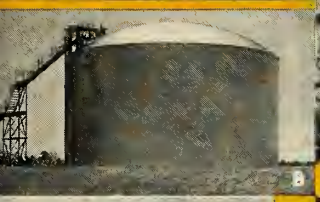
Chicago Bridge & Iron Company offers a complete and fully coordinated facility for the engineering, fabrication and erection of structures and vessels to contain and store modern fuels, chemicals and other process materials: in gas or liquid form, at high or low pressures, and at high or low temperatures.

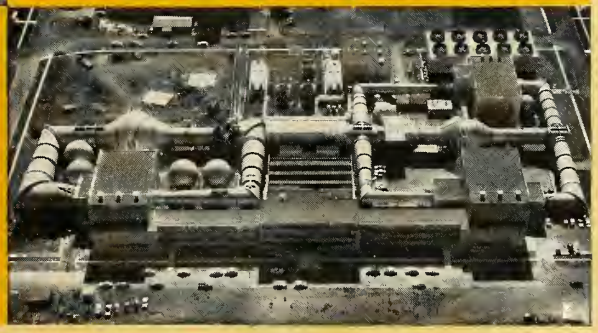
Included in the CB&I Services are facilities for metallurgical control, stress-relieving, X-ray and welding—and techniques developed during nearly 70 years of service to industry. Five strategically located CB&I plants are staffed and equipped to serve your *specific* requirements for corrosion resistant metals for solid, lined or clad steel, alloy or non-ferrous construction.

A few typical installations are shown and described below. Of particular interest, is HORTON-CLAD®—a new vacuum bonding process which makes it possible for CB&I to produce composite plates in a larger range of combinations than has previously been available. Write our nearest CB&I office for the new bulletin on *Hortonclad* and literature on *CB&I Special plate structures.*

See CBI for Creative CRAFTSMANSHIP IN STEEL







TOP, LEFT—14-lobe MULTISPHERE designed, fobricoted and erected by CB&I to store 100,000 gollons of liquid methyl chloride at 150 lbs. working pressure. Design offers optimum versotility for pressure vessels.

A—5052 ALUMINUM was used for these ommonium nitrate storage tonks.

B—LIQUID PROPANE is stored by refrigeration at 1½ lbs. working pressure at minus 44° F in this unique 70-ft. diameter tonk, designed and built by CB&I.

C—MULTICYLINDER Multi-lobe pressure vessels such as this offer advantoge of high pressure storage where spoce is limited. Vessel is designed for 250 lbs. working pressure.

D—VACUUM SERVICE is provided by Hortonsphere® ot a University of Toronto wind tunnel installotion.

E—TUNNEL SECTIONS for wind tunnel were fobricoted ond erected by CB&I. A supersonic wind tunnel for Convair Division of General Dynomics was recently completed by CB&I as a "turnkey" project.

PRESSURE VESSELS • REFRIGERATED STORAGE • VACUUM SERVICE • HORTONCLAD® • ENGINEERING • FABRICATION • ERECTION IN ALL METALS AND COMBINATION METALS

Chicago Bridge & Iron Company

CBI

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston • Kansas City (Mo.) • New Orleans
New York • Philadelphia • Pittsburgh • Salt Lake City • San Francisco • Seattle • South Pasadena • Tulsa

Plants in: BIRMINGHAM, CHICAGO, SALT LAKE CITY, GREENVILLE, PENNSYLVANIA and at NEW CASTLE, DELAWARE
In Canada: HORTON STEEL WORKS LTD., TORONTO, ONTARIO

Representatives and Licensees: Australia, Cuba, England, France, Germany, Italy, Japan, Netherlands, Scotland

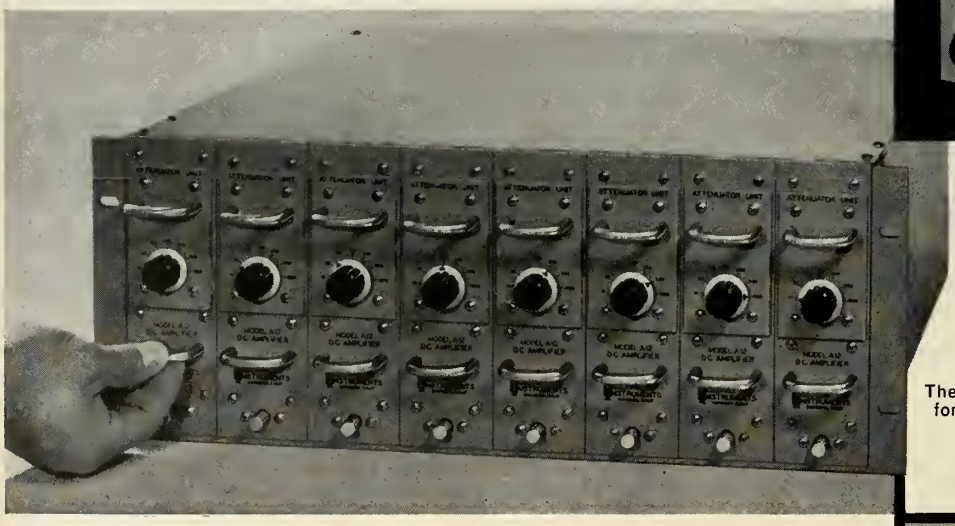
New Electro Instruments A-12 DC amplifier totally transistorized

equal to or better than the best vacuum tube instruments!

The new Model A-12 DC Amplifier is the preferred systems link for amplification, normalization and impedence transformation. Use of solid state elements assures maximum reliability; power dissipation is only seven watts. Mil-type components are mounted on coated plug-in printed circuit boards for protection against vibration and corrosion.

versatility plus economy

Electro Instruments produces a series of plug-in mode selectors and attenuators for the A-12: single ended, differential and operational, fixed and variable gain.



Eight to a rack
The A-12 is packaged for high density use; mounts eight across in 19" relay rack panels.

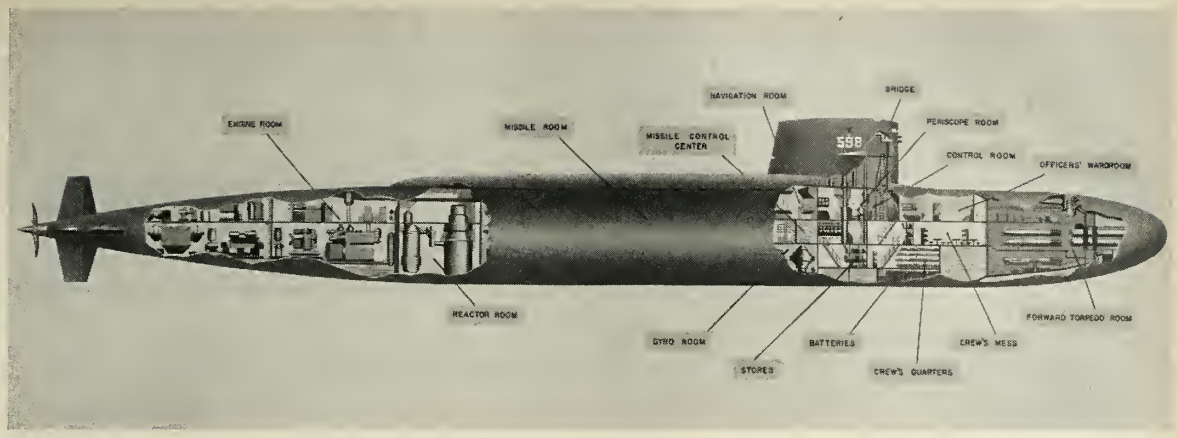
SPECIFICATION SUMMARY

	Single Ended Input	Differential Input
Gain:	Fixed gain set to any value from 10 to 1000 inclusive by front panel plug-in units. Gain switching plug-in attenuator available with gains of 0, 10, 20, 50, 100, 200, 500 and 1,000. Adjustable upward 6db from setting with potentiometer.	Fixed gain set to any value from 10 to 1000 inclusive by front panel plug-in units. Gain switching plug-in attenuator available with gains of 0, 10, 20, 50, 100, 200, 500 and 1,000. Adjustable upward 6db from setting with potentiometer. (Fixed gain plug-in units only.)
Input Impedance:	100 megohms shunted by 0.001 mfd (typical).	10,000 ohms.
Source Impedance:	5K or less (to meet noise specification).	
Drift:	Less than 2 microvolts in 200 hours at constant ambient temperature. Less than 0.4 microvolt per degree centigrade.	Less than 2 microvolts in 200 hours at constant ambient temperature. Less than 0.4 microvolt per degree centigrade.
Ambient Temperature:	0° to 50°C.	0° to 50°C.
Noise (Referred to input):	0-3 cps 5 microvolts peak to peak 0-750 cps 4 microvolts rms. 0-50 kc 8 microvolts rms.	0-3 cps 10 microvolts peak to peak 0-750 cps 6 microvolts rms. 0-50 kc 11 microvolts rms.
Frequency Response:	±3db to 50 kc (typical); ±1.0% to 2 kc	±3db to 50 kc (typical); ±1.0% to 2 kc
Output Capability:	±10 volts at ±100 ma DC or peak AC to 10 kc	±10 volts at ±100 ma DC or peak AC to 10 kc

Write today for complete specifications on single-ended, differential and operational models.

Electro Instruments, Inc.

3540 Aero Court
San Diego 11, California



FBM Submarine: Ultimate Weapon?

by William O. Miller

IF ONE SCHOOL OF THOUGHT has its way, the entire U.S. Navy, with the exception of submarines and certain supporting forces, will be "torpedoed"—by U.S. submarines.

They are the military philosophers, both in and out of the service, who insist that the day of ships and weapons that have to operate on the surface is just about over. This includes not only the ships of the fleet, but the vast merchant marine which today transports practically all the world's goods.

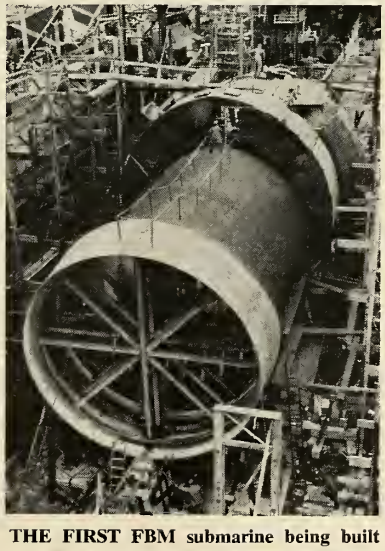
Not for the first time in its history, but in a peculiar way, the influence of this group has helped to place the Navy on the horns of a dilemma. The focal point of this dilemma is the rapidly rising star of the Navy team, the submarine, and particularly the *Polaris* or Fleet Ballistic Missile submarine.

For the past several months there has been a steady parade of top Naval officers and civilians to Capitol Hill to testify before members of the House Subcommittee on Appropriations. They have testified in detail on the overall program, with emphasis on the submarine program. The Navy had asked, via the Department of Defense, for nine FBM submarines which would utilize the *Polaris* missile.

While the same witnesses had to "sell" as hard as possible in hopes of getting the money needed to carry out the program, they were producing ammunition for the zealous submarine supporters. Sub supporters declare that the submarine is the only type vessel the Navy needs, and all else is well down the road to being obsolescence.

• **The system,** which saw its birth after the now famous fight headed by Rear Admiral Rickover, had its ups and downs until the first nuclear powered boat, Nautilus, was delivered and proved herself beyond all expectations. The second factor was the high speed and maneuverability capabilities resulting from the development of the Albacore configuration.

The third and final part of this system which brought it to its present top priority position is the *Polaris* missile, announced a year and a half ago. All the components, and the FBM system as a whole, have been the reason for justifiable enthusiasm and support by the entire Navy, as well as the submariners.



THE FIRST FBM submarine being built at the Electric Boat Groton Shipyard.

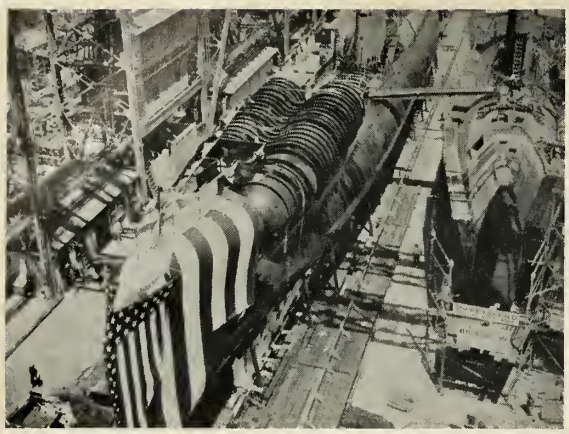
• **The case for** the submarine is a strong one. There's no arguing with the submarine's greatly increased speed and maneuverability, its practically unlimited range and cruising ability and the nuclear missiles and torpedoes shortly to come. It's greatest asset is the ability to disappear into the vast ocean depths and proceed to carry out its mission in any part of the world.

Those who want a more diversified fleet readily admit the facts for the submarine speak for themselves. But the extremes to which some of the submarine enthusiasts go approach what might be termed "deep blue yonder" ideas. The claims they make basically are true, but many of them are projections which may take a number of years.

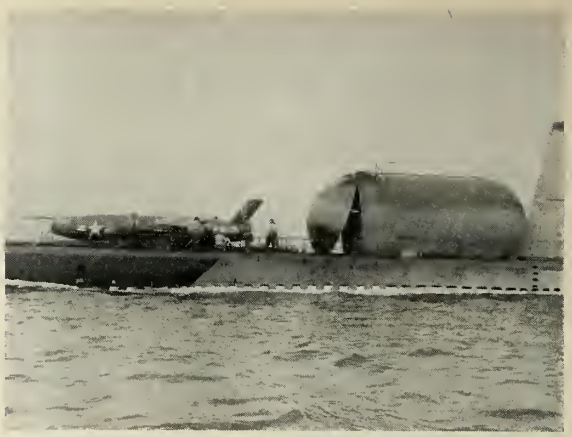
They claim it is necessary to go under the sea with everything because we won't be able to control the surface. As one high ranking officer in the Pentagon commented, "If we don't control the surface of the seas, we won't be controlling much of anything else, anywhere, anyhow."

Sonar research is a big item in the Navy program. This is particularly true of the deep sonar research because of the increasing depths that modern submarines can go to and associated unknown sonar conditions.

As a means of both detection and identification, it is extremely important insofar as anti-submarine activities by



REGULUS II stowage is on the forecastle of the Grayback, first of six new guided missile subs employing Reg I or Reg II.



GUIDED MISSILE submarines in either fleet, the Tunney and the Barbero were first of type with Regulus I capability.

submarines increase with development of more sophisticated weapons such as *Subroc*.

In discussing deep sonar, Rear Admiral L. D. Weakley, CNO's Anti-Submarine Warfare Readiness executive, pointed out the advantages of lower depths.

"While sea water is a good conductor of sound, many factors enter its effectiveness and reliability as far as evaluating and actually knowing what you have," he said. "The salinity of the water, temperature layers, activities of marine life and many other vagaries must be taken into consideration. This is particularly true the nearer you get to the surface."

Admiral Weakley went on to explain that in greater depth a higher frequency can be used and the band narrowed, which eliminates some of the background noise so prevalent nearer the surface.

The ardent submarine promoters brush aside or ignore a number of difficult problems. Rear Admiral Weakley described the submarine as deaf, lame and blind.

"The increased speed and maneuverability, plus extended range, brought on by the Albacore configuration and nuclear power plant, has greatly diminished the lameness, continuing improvements in sonar is alleviating the deafness, but we are in urgent need of a better detection and identification system," he said.

While the idea of transporting all ocean-borne cargo by submarine or submarine-towed barges is perfectly feasible, it is fantastically expensive. Best estimates are that the cost per ton mile for submarine cargo is about 30 times that for cargo carried by surface ships.

Sonar contacts have been made at ranges up to 80 miles, but this was under optimum conditions and is not the average by any means. One of the Navy's top priority programs is in sonar research and development, which one admiral presently describes as an opaque system.

• **A balanced fleet** is the aim and desire of the majority of the top people who are responsible for operating the Naval Establishment. They argue the Navy has but one purpose—to serve as a deterrent to aggression anywhere in the world, and to maintain control of the seas in time of emergency or war, if it should come.

It is conceded that the FBM submarine with its *Polaris* missile will be one of the greatest deterrents this nation will have. However, the official Navy position recently was summed up by Admiral Arleigh Burke, Chief of Naval Operations:

"Control of the seas requires a very diversified naval force to counter any threat to our use of the seas, no matter what it is. This takes more than a single approach to naval weapon planning. This is important—for it is all too easy to become fascinated with the possibilities of new and revolutionary weapons systems and forget the more conventional things that continue to be equally essential to control the seas."

A variety of methods of attack is the aim of the Navy, not only in weapons systems but in the missiles themselves. Rear Admiral K. S. Masterson, Director CNO's Guided Missile Division, pointed out that while developments usually mean the phasing out of less sophisticated missiles, it is advisable to keep on hand certain slower lower flying birds to give the desired variety.

Admiral Masterson likened military planning to playing a game of chess.

"If a nation has to defend against an attack and it is known that the attacking force would use only one type of method and one means of delivery—then his problems are decreased manyfold. If he must defend against many types of attacks, then he must devote his resources and manpower to many weapons and many defense systems.

"This may be likened to a chess game whereby we have only one method of playing. The opponent will quickly devise a defense to stop this plan of attack. This defense would be followed by a rapid checkmate. No stalemate or stand-off."

Long range planning is in keeping with the team concept and mutual exploitation of the advantages of a variety of weapons and systems and goal.

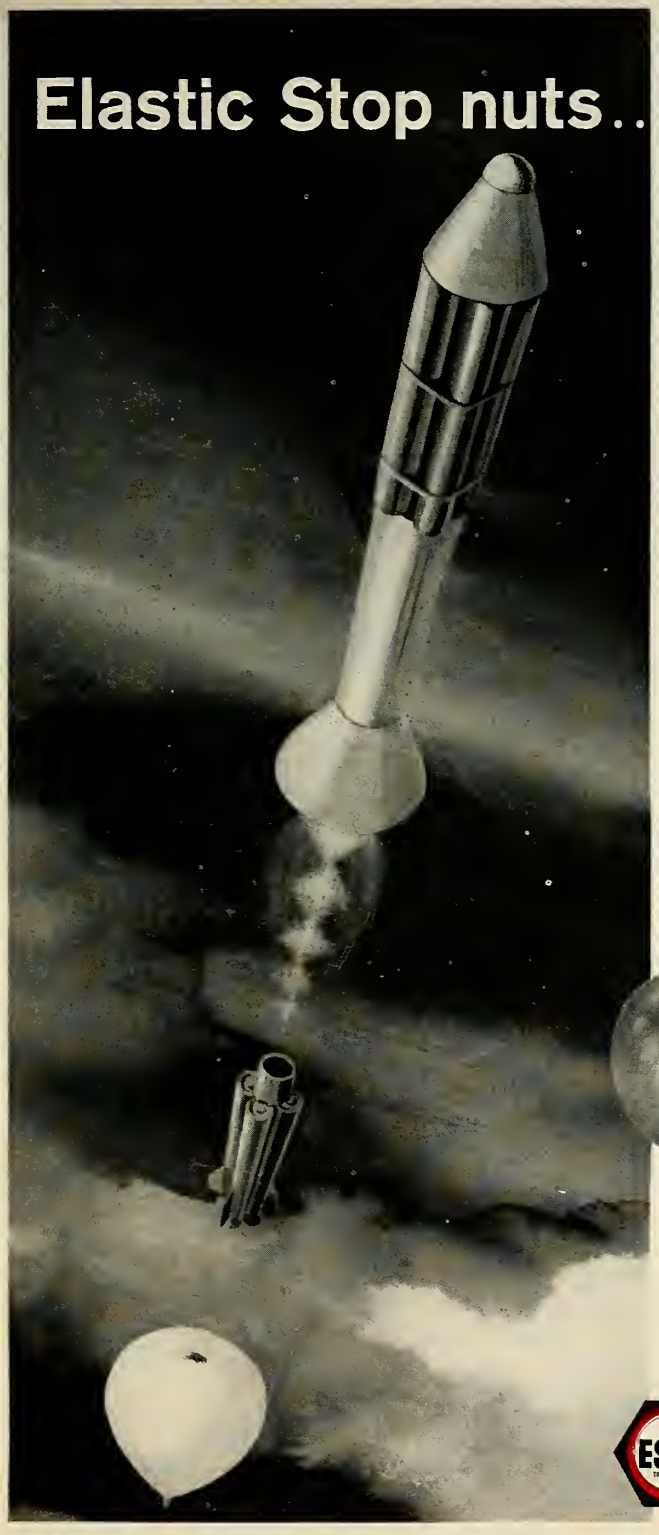
• **Five boat programming** is the pace set for the initial series of the Fleet Ballistic Missile submarines. The Department of Defense has asked for two additional boats, in addition to three already authorized.

A considerable part of the time Navy witnesses spent testifying before the House appropriations Subcommittee was devoted to the *Polaris* missile and the FBM submarine program.

After questioning three witnesses, the lawmakers finally found out who actually made the decision to request only two additional FBM submarines in the supplementary budget, instead of six additional boats as recommended and asked for by the Navy.

Assistant Secretary of the Navy (for financial management), J. Sinclair Armstrong, told the committee that the nine boat program had been recommended to the Department of Defense by the Secretary of the Navy,

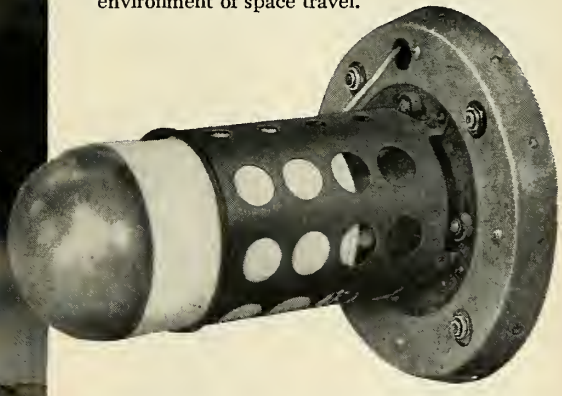
Elastic Stop nuts.. *make first trip to the exosphere*



What were the requirements for an exploratory trip into the exosphere? The success of project Far Side established these two among others:

1. A launching platform located as far as possible above the effects of atmospheric drag
2. The use of hardware of proved ability

Some of this hardware can be seen in the close-up of Far Side's nose-mounted payload. In the photo showing the payload before the nose cone was placed over it, three of the four Elastic Stop nuts used to secure the third stage rockets to a retaining ring are clearly visible. They are standard ESNA hex nuts—with the familiar red nylon insert. These are the self-locking fasteners that have proved their ability to hold tight under the severest requirements of aircraft operation, through almost three decades of progress in aircraft design and construction. And now they have proved their ability to meet the requirements and unusual environment of space travel.



The complete line offered by ESNA includes self-locking nut designs for every missile, aircraft and power plant application. They cover a range of operating temperature requirements from −80°F. to over 1300°F. For specific information, send the details of your application to ESNA. Write to Dept. S17-691, Elastic Stop Nut Corporation of America, 2330 Vauxhall Road, Union, New Jersey.

An artist's version of the launching of the Far Side rocket. The four-stage vehicle was carried to an altitude of 100,000 feet by a polyethylene balloon made by General Mills. Fired straight up through the balloon, Far Side rocketed to the greatest distance from the earth ever reached by a man-made device. The prime contractor for the Far Side project was Aeronutronic Systems, Inc., a subsidiary of the Ford Motor Company, for the Air Force Office of Scientific Research (ARDC).

ESNA® TRADE MARK

ELASTIC STOP NUT CORPORATION OF AMERICA

but he wasn't sure who exactly cut the number to two boats.

The second witness, some time later, Assistant Secretary of Defense (Comptroller) W. J. McNeil, said he assumed it was the decision of the Secretary of the Defense and the President, based on the recommendations of the Joint Chiefs of Staff.

Finally, when Secretary of Defense McElroy appeared and was asked who had made the decision he said:

"It was a decision made by Mr. Quarles and myself. What ultimately happened was we submitted this to the Joint Chiefs of Staff for consideration and this had the concurrence of the Joint Chiefs of Staff."

McElroy went on to say the JCOS were not asked to consider the advisability of more than the two additional submarines, and that they approved the decision and the budget as a package.

One of the committee members asked the Secretary what would be the financial gamble between the time the money was appropriated for the four more additional boats the Navy wants, and the time positive test results would be available on the *Polaris* sub. The question followed an explanation by McElroy as to why the B-52 program was selected for an increase in numbers, whereas the *Polaris* program was not.

The Secretary said the decision was made because the B-52 is considered a proved weapon which is available now and the *Polaris* FBM submarine is considered a prospective weapon, and that there is a time gap before we will have a completely tested and proved reliable long-range missile.

On the assumption that such tests would be completed by December 1959 and that the submarines were laid down this year, the estimated loss, McElroy said, could be held to a range of between $25 and $30 million for ordnance and vessel costs.

He went on to say that no loss would be incurred for the missile and support equipment procurement since these funds would not be fully contracted. Only several million dollars would be lost because of special tooling.

The above estimates were made on the following assumptions: construction awards for the four submarines concerned would be awarded during the first two quarters of the fiscal year 1959; none of the specialized fleet ballistic missile equipment would be

UNDER ONE ROOF: FRAME, BRAIN AND MUSCLE FOR A MISSILE

Whatever the missile problem—*frame, brain, muscle* —or *all three*—Ryan has the experience and demonstrated ability to design, develop and produce as both a prime and subcontractor.

Ryan missile know-how stems from these successful projects:

AIRFRAME—Complete development—aerodynamic and systems design, testing, field servicing and quantity manufacturing—of the Ryan Firebee jet drone missile... now in volume production for use by the Air Force, Navy, Army and RCAF. Research and development studies on air-launched vehicles and external stores.

GUIDANCE—Development and production of advanced systems of military radar "intelligence"... for guidance of supersonic missiles, advanced type automatic doppler navigators and radar hovering control and navigation equipment for helicopters, airships and VTOL aircraft. Ryan is *the* pioneer and leader in continuous-wave radar techniques. The automatic stabilization and control system for the Firebee is also designed and produced by Ryan.

PROPULSION—Manufacture of powerful liquid rocket engines for Army surface-to-surface missiles. Ramjet combustion chambers for Air Force ground-to-air missiles. Major high-temperature components used by various turbojet-powered missiles.

From basic design to full production Ryan can be relied upon to do the job well

RYAN BUILDS BETTER

AIRCRAFT • POWER PLANTS • AVIONICS

Ryan Aeronautical Company, San Diego, Calif.

. . . FBM submarines

installed by December 1959; the navigation and missile checkout equipment on order would be applicable to other Navy programs without loss; and that missile production facilities would be substantially completed by December 1959, but would in large part be useable for other programs.

It was estimated that it would cost about $852-million to complete the four additional subs the Navy wants for its nine-boat program. So far, about $1.4-billion has been authorized for the *Polaris* program.

• **Testimony in detail**—Rear Admiral W. F. Raborn, who heads up the *Polaris* FBM project, was questioned at length as to the optimum program and stood by the nine-boat recommendation that went to the Department of Defense.

He explained this was based on the availability of shipyards without disrupting other high priority construction work, the procurement of additional missile production facilities without undue overtime prices, and the ability to produce missile components without going into large expenditures to produce numbers not yet fully tested. Raborn said that while he would not consider the nine boat program a crash program, a 15-boat program would be one.

Although a complete *Polaris* missile has not yet been tested nor yet coupled with the submarine, Admiral Raborn expressed the utmost confidence in its success because of successful components tests. He said now it is largely an engineering job.

The acceleration of the *Regulus* II and *Snark* development as interim program came up for discussion during the Secretary McElroy's testimony. McElroy said no attempt was made to accelerate these two programs because the Navy and the Air Force did not consider them of high priority for acceleration, in relation to the remainder of the ballistic missile program.

McElroy also said that he agreed it was the opinion of the Joint Chiefs of Staff and the Department of Defense that despite time which must elapse before the advent of the *Polaris* operational capability and other missile power, the Services have ample destructive power without accelerating either the *Regulus* II or *Snark* programs.

Regulus II, meanwhile is planned for six submarines. They probably are the Grayback, which was completed at Mare Island in March; the Growler,

. . . FBM submarines

completed last fall at Portsmouth, and four nuclear powered boats, the Halibut, Pollack, Permit and Plunger.

Presently two submarines are equipped with *Regulus* I, Tunny and Barbero; however, the *Regulus* I program is in the process of being phased out.

• **Contracts awarded**—Contracts have been awarded for three FBM submarines. Two are being built by General Dynamics and one at the Mare Island Shipyard. There has been no indication as to who will get the contracts for the two additional FBM boats asked for in the supplemental appropriation.

Keels for two more nuclear powered submarines were laid last month at General Dynamics' Groton shipyard. They were for the second FBM sub awarded the Electric Boat Division and for the Tullibee, an anti-submarine submarine.

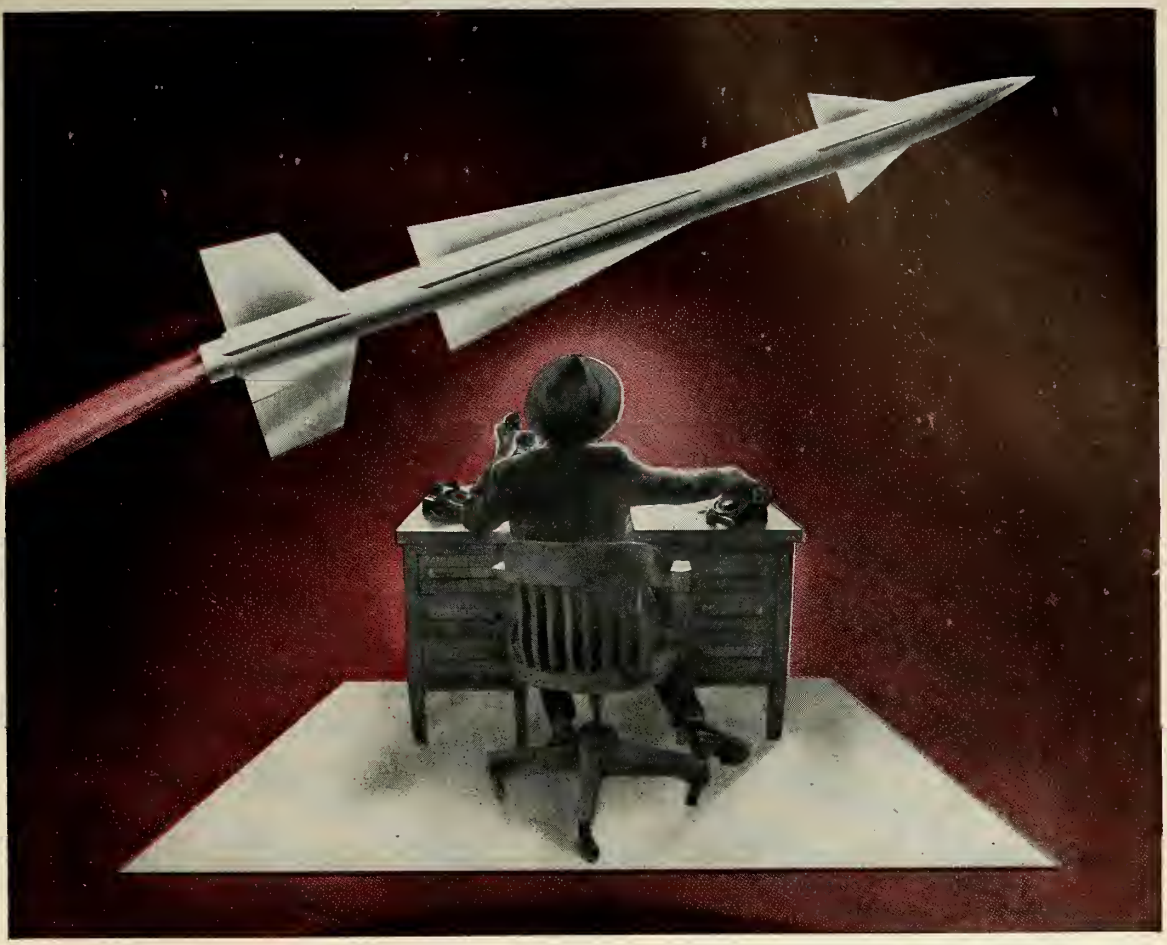
It was from this same yard that last week the Skipjack, first of the single screw modified Albacore configuration boats, was launched. Also under construction at EB's Groton shipyard is the Triton, the first reactor submarine and largest submarine ever constructed, some 7,200 tons. The Triton, a radar picket sub, will be launched this summer.

A total of 17 nuclear powered submarines are authorized or under construction. Nuclear powered boats are being built or are authorized at General Dynamics' EB yard at Groton; U.S. Naval Shipyard at Mare Island and Portsmouth; Ingalls Shipbuilding Company, Pascagoula; and Newport News Shipbuilding and Drydock Company, Pascagoula; and Newport News Shipbuilding and Drydock Co. The last of the diesel powered boats are building or authorized at Ingalls; New York Shipbuilding Corporation and Portsmouth.

Six of the guided missile submarines now under construction will be equipped with the latest anti-submarine torpedoes and *Subroc*, when it is developed to make them the nation's most potent anti-submarine weapons.

At present, there are 113 submarines in service. This number will drop some as new boats are commissioned, but the number will remain substantially the same because of training requirements. Of the 113 boats now in service three are nuclear powered.

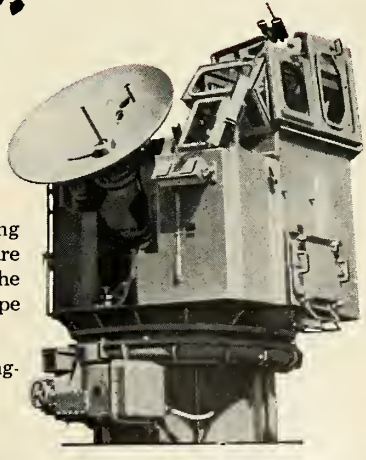
The Navy has a sizeable submarine fleet in mothballs, but most are of World War II vintage.★



Space Reporter at Work!

. . . must be accurate . . . must be reliable

These Qualities are the Standard for Engineering and Production at Daystrom Instrument.



Our engineers and production specialists working together as a hard-hitting team have established an outstanding performance record in the manufacture of Radar Antenna Pedestals and related intelligence equipment. We have the necessary machine tools and other facilities to get the job done on a prototype or volume production basis.

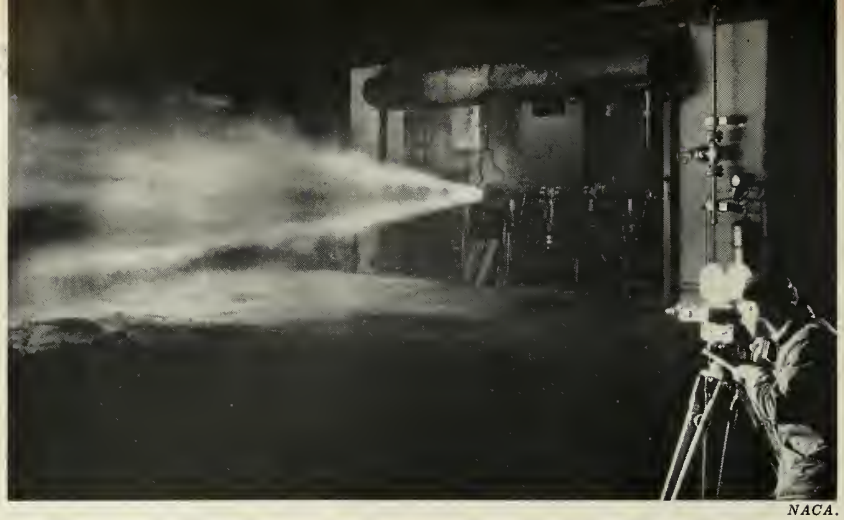
We can meet your immediate requirements or help you plan for your long-range needs.

Contact us now for complete information about our qualifications in the Radar Intelligence field.

DAYSTROM INSTRUMENT

Division of Daystrom Inc.

ARCHBALD, PENNSYLVANIA



NACA.

CAMERA HELPS RECORD the firing of a 5,000-pound thrust high-energy fuel rocket.

Cameras: Top Testing Tool For Missiles

Instruments taught new tricks in order to spot trouble at speeds far beyond the ability of human eyes to record

by Peer Fossen

PHOTOGRAPHY, long established as a prime recording means for industry, has acquired some new tricks to keep pace with advances in projectile performance and velocity. As a result, the camera has become a key research tool for qualitative and quantitative study of missile test phenomena.

Whatever happens too fast for the eye to see, too fast to follow, too dangerous to watch directly, or occurs too far off to view directly, is in photography's domain. In short, when missile engineers want answers to "what, where, when, how and why" in connection with the performance of their "birds," photography can help supply these answers.

• **What?**—What actually happens inside a rocket thrust chamber is of prime interest to the engine development engineer. Recently, engineers at one major rocket engine firm developed a simple photographic system for pinpointing fuel droplet phenomena inside a combustion chamber.

Windowing a test rocket motor with quartz, the men constructed a strip-camera set-up which froze the rapidly-moving droplets on a superfast photographic emulsion.

The droplets—less than 100 microns in diameter and moving through the chamber at 100 feet per second—proved to be a challenging subject. Designing a lighting source which provided sufficient contrast between the translucent droplets and the white-hot combustion zone, the engineers shot at the rate of two microseconds per exposure.

Result: a sequence record of droplet phenomena answering such questions as change in droplet diameter, rate of droplet formation, evaporation, droplet velocity, and the pattern of droplet distribution.

The same firm also developed an ingenious oscillographic recording and color photography combination. Proceeding from the premise that the more phenomena that can be simultaneously recorded and selectively interpreted the better the testing—instrumentation engineers set about untangling the maze of interlocking oscillographic trace sweeps.

Filters of selected densities and colors were used to capture the intercrossing oscillographic trails on a specially spooled roll of Ektachrome film, 200 ft. long and seven inches wide. According to the company, as many as 18 intermeshed trails of varying hues have been pin-pointed for individual study.

Results of such early investigations into color oscillography suggest the possibility of employing color negative material, true panchromatic print paper, and appropriate filters for selective black-and-white records of individual oscillographic traces.

Further, in connection with rocket engine performance studies, photography has been employed to by-pass the hazards of close-up viewing of volatile missile propellant combustion.

High-speed movie cameras positioned obliquely 20 to 50 ft. behind rocket engine exhaust areas are slowing down combustion phenomena for subsequent study and evaluation. Operating at speeds up to 5,000 frames per second, the cameras are contributing valuable information on the characteristic flame patterns of a wide variety of propellants.

At one USAF flight test center, close to 100 such motion picture cameras are employed. These cameras photograph engine start and shut-down, flame patterns, after-burning, etc., exhibited by rocket engines developing up to 1 million lb. of static thrust.

• **Where?**—Regardless of whether a missile shoot is a success or not, those charged with responsibility for the project want to know where the vehicle went. One of the prime means of missile tracking is the theodolite. Adding the dimension of motion picture photography, cine-theodolites record on film the exact azimuth, slant elevation, and bearing of projectiles under observation.

Result is a photo-record of the projectile with appropriate location information included on each numbered frame of film. In current wide-spread use in theodolites is a World War II development—Kodak Linagraph Shellburst film, which possesses the necessary contrast capabilities and red sensitivity for effective tracking of the transonic projectiles.

The chief advantages of cine-theodolite photography are:

1) Information as to exact positioning of missile when adverse phenomena occur; 2) data concerning effective ranges of tracking films used under a wide variety of atmospheric conditions; and 3) accurate plotting information as to impact area, thereby facilitating the solution of recovery problems.

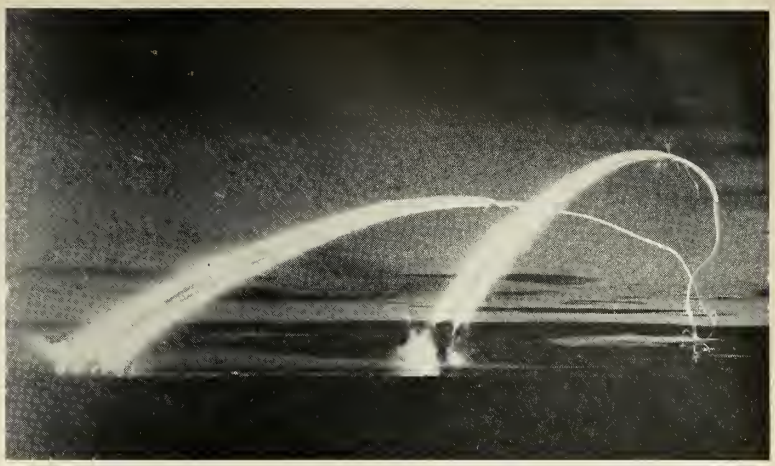
• **When?**—When deterioration occurs during the transonic phases of missile flight testing, the ability of photography to expand transistory action aids later evaluation.

The jet-sled, well-known for its contributions to ejection seat studies, has also proven its value in destructive testing of experimental missile components. At one high-speed track, sleds are propelled down a 10,000 ft. precision aligned railroad track at speeds in excess of Mach 2.

Effects of speed, acceleration, and deceleration on structural members and internal missile components are recorded by cameras operating at speeds of 24 to 1,500 frames per second. Subsequent review of the films enable the technicians to pin-point the occurrence of a breakdown.

• **Why?**—When transonic projectiles go awry and do not carry out assigned missions, it is of prime importance to determine "why." Here, too, photography has been playing a key role.

For example, detective work in the area of fuel leakage is receiving a tangible assist from conventional color photography. Using substantially the same film familiar to amateur photographers, project engineers trace the effects of fumes and leakage of red fuming nitric acid rocket fuel by covering the aft section of the vehicle with



SNCA—SE.

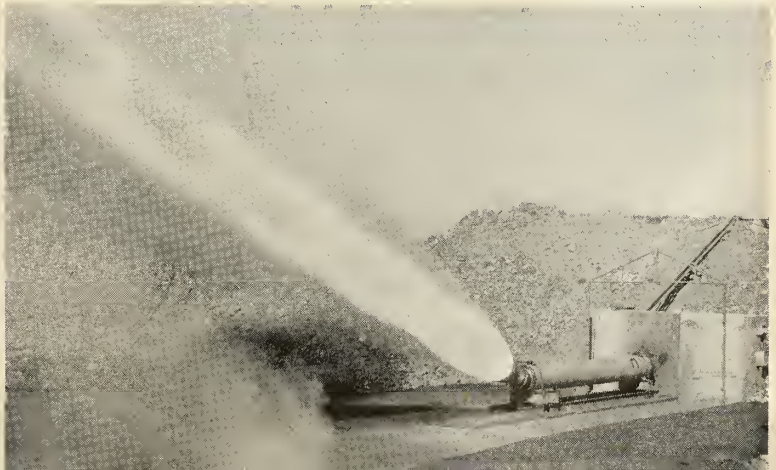
NIGHT PHOTOGRAPHY is spectacular aid to investigation of missile trajectory.

Aberdeen Proving Ground.

CINE-THEODOLITES give a photo-record of the missile with appropriate location.

SHOCK-WAVES of a large solid propellant rocket are clearly visible to camera.

Aerojet-General Corp.



. . . cameras

acid-reacting paint, noting the corrosive effect indicated on the subsequent photo-color records produced.

Another key problem area—why missile skins exhibit changes in surface characteristics at high temperatures—is under photographic examination.

In ground test laboratory facilities, test coupons of missile skin materials, such as commercially pure titanium and manganese alloys, are subjected to selected time and temperature steps. The resulting changes in coupon color are then recorded in chart on color prints.

Thus, spot field comparison can be made, followed by laboratory evaluation of characteristic missile skin colors of retrieved missiles. Color print-charts are used as indicators of the approximate temperature conditions by the test missile.

One of the problems associated with the night firing of ballistic-type rockets is the momentary flash blindness experienced by many pilots at the moment of release. Engineers made photometric measurements of the blast effect and were able to develop counter measures accordingly.

• **How?**—In order to check how internal missile components operate, many missile technicians employ photography. One company in the rocket engine field makes use of a high-speed camera at film speeds up to 180 feet per second to check out electrical circuit performance in guided missile components.

Known as a streak camera, the unit monitors pattern response directly from the cathode ray tube under conditions varying from no load to full load. Data reduction is accomplished by using the film's velocity through the camera as a time base, enabling examination of ripple voltage traces of prototype transformer-rectifier components on varying time scales.

Various types of film are used in the high-speed streak camera, depending on the type of phospor in the oscillographic display screen involved.

As might be expected, some problems are encountered when a camera, built to withstand no more rugged shocks than the jouncing encountered in the back of a pick-up truck, is destined for internal mounting in a missile. Where peak acceleration loads of 200 g's are anticipated, special camera construction adapted to withstand transonic vibration and gravitational phenomenon is indicated.

Work is currently progressing on special photographic equipment for in-

NEW FROM Saginaw

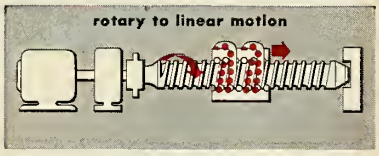
PHOTOGRAPHED ACTUAL SIZE
BALL CIRCLE DIAMETER: only 3/16 inch

SMALLEST ball/bearing SCREW OFFERS BIGGEST ANSWER TO CRITICAL POSITIONING/CONTROL PROBLEMS

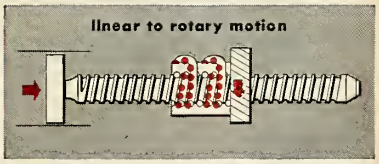
Another timely development by Saginaw . . . for imaginative manufacturers of ultra-precise controls in the electrical and electronic fields. For Saginaw Miniature b/b Screws will solve critical positioning/control problems for radar tuners, missile and rocket guidance and telemetering systems, automatic switch-gears, electronic machinery controls . . . plus a host of other applications.

These amazing little fellows are so compact and weigh so little—you can save greatly on space and weight. So efficient—over 90%—you can use much smaller motors and gear boxes. So precise—you can position components within .0005 inch per inch of travel. (If application requires, lash can be eliminated.) So dependable—you can rely on remarkably long service life even in extremely adverse environments.

Every day Saginaw's experienced engineers are helping more and more forward-looking manufacturers to gain these advantages of Saginaw Miniature b/b Screws. Let them help you plan your application. No obligation. Simply phone, write or mail the convenient coupon below.



NUT TRAVELS: When rotary motion is applied to the screw, the b/b nut glides along the axis of the screw on rolling steel balls, converting rotary force and motion to linear force and motion with 4/5 less torque than acme screws.



SCREW TRAVELS: When rotary motion is applied to the b/b nut, the screw glides along its longitudinal axis on rolling steel balls, converting rotary force and motion to linear force and motion with unprecedented efficiency.

Saginaw
ball bearing Screw

SAGINAW STEERING GEAR DIVISION OF GENERAL MOTORS • SAGINAW, MICHIGAN
WORLD'S LARGEST PRODUCER OF BALL BEARING SCREWS AND SPLINES

SEND TODAY FOR FREE 36-PAGE ENGINEERING DATA BOOK . . .
or see our section in Sweet's Product Design File

Saginaw Steering Gear Division
General Motors Corporation
b/b Screw and Spline Operation
Dept. 11MR, Saginaw, Michigan

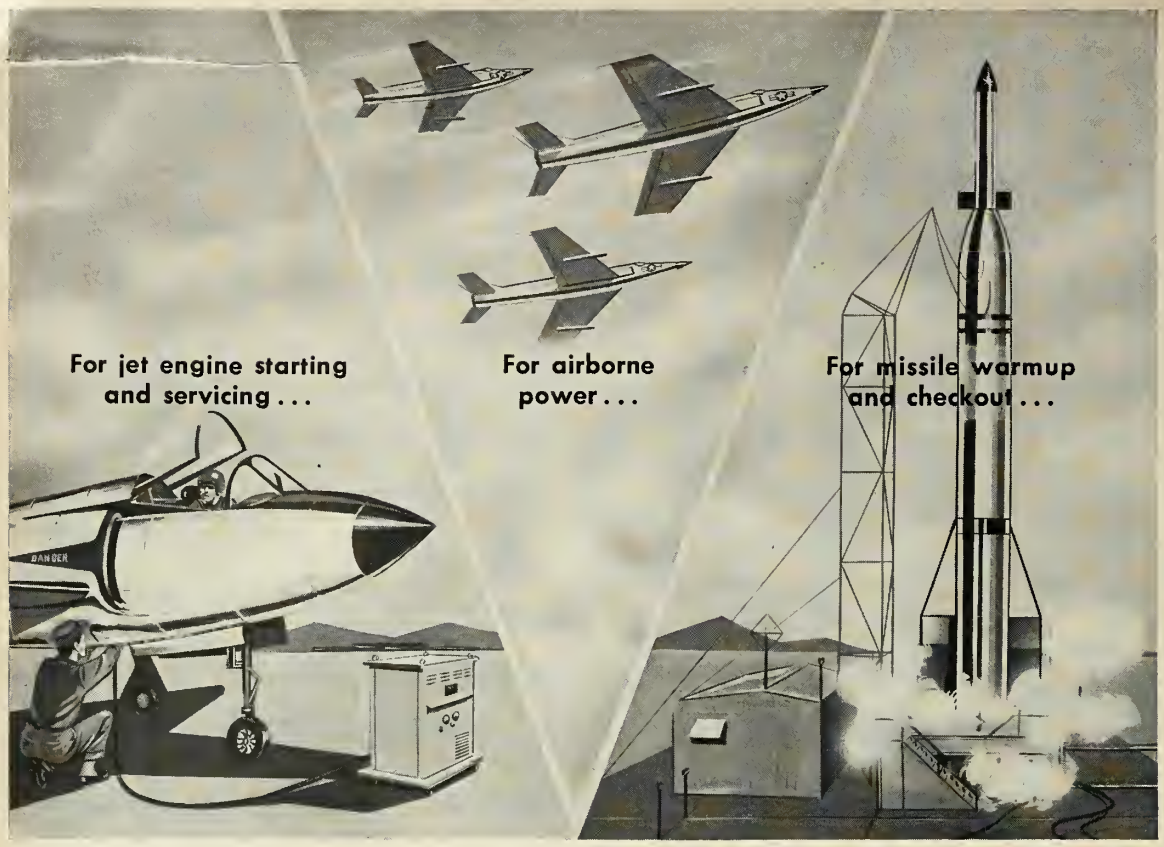
Please send new engineering data book on Saginaw b/b Screws and Splines to:

NAME_____

COMPANY_____ TITLE_____

ADDRESS_____

CITY_____ ZONE____ STATE_____



G-E RECTIFIER DC POWER SUPPLIES OFFER PROVED HIGH RELIABILITY

Today, more than a dozen late-model aircraft and missiles are equipped with General Electric rectifier power supplies. The skills gained in engineering these applications—plus G.E.'s 40 years of metallic rectifier experience—provide the "know how" we need to produce highly reliable rectifier DC power supplies for you.

Check these General Electric features:

- No moving parts to replace (except cooling fans in some applications)
- No tubes to replace
- No stack replacement necessary with non-aging silicon cells
- Lightweight—the G-E 1-amp transformer-rectifier weighs only 14 ounces; the 200-amp, only 15 pounds
- High overload capacity
- High efficiency (up to 87%)
- High power factor (90% and over)
- Many extra features such as sequencing, protection, alarm circuits, remote sensing, etc., can be incorporated

PROTOTYPES AVAILABLE

Prototypes are available promptly from General Electric's complete line of rectifier power supplies, including:

- Transistor power supplies
- Magnetic amplifier power supplies
- Controlled rectifier power supplies
- Brute force power supplies
- Motor-alternator power-supply systems
- Any static conversion device

For dependable, on-the-spot DC power—normal or unusual application, airborne or ground, military or commercial, regulated or unregulated—for prototype orders, production quantities, or brand-new designs such as inverters or DC-DC converters—get the help of your G-E Apparatus Sales Engineer! Or, write for more information to Section D465-8, Rectifier Department, General Electric Company, Lynchburg, Virginia.

Progress Is Our Most Important Product

GENERAL ELECTRIC

. . . cameras are top testing tool

General Electric Co.

PHOTOGRAPHING rockets at night requires split-second timing between pilot and photographer to insure usable results.

ternal missile use, designed to supply vital information on the launching and acceleration phase, missile component failure, and miscellaneous in-flight data to augment ground photographic tracking.

It is often desirable to study in-flight performance of experimental missile components or internal hardware that have become suspect on basis of past performance. Failure of such components is generally accompanied by peak vibrational build-up, which may progress for only a fraction of a second before total failure of the part under investigation.

Phenomena of such transistory nature can only be observed via ultra-high speed photography. Similarly, a running photographic record may be desired of internal missile instruments, particularly during launching and atmosphere re-entry.

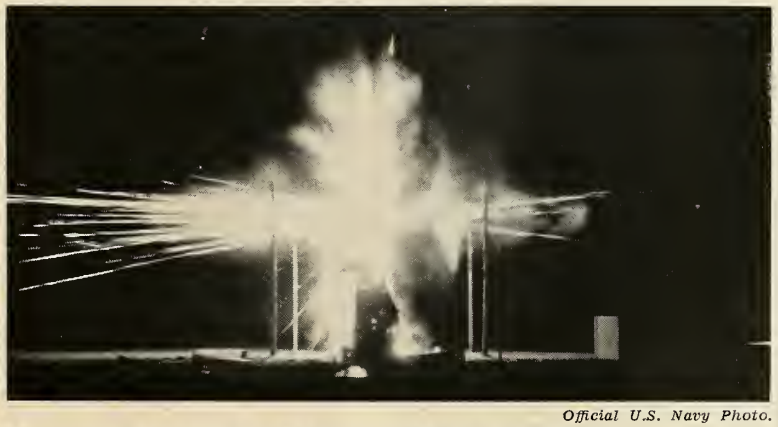
• **Missile photography essential**—According to the president of one major firm in the missile industry, photography provides an indispensable means for protecting the missile package—the thousands of man hours and often millions of dollars riding with a single experimental projectile.

Even if the missile fails to leave the launching pad, the state of missile art will advance with the helping hand of photography.

When it is realized that some companies carry a complement of 15 photographers to remote testing sites and send photo technicians as high as 40,000 feet in "chase" planes to document shakedown flights of prototype projectiles, photography appears to loom large in the future missiles picture.

Missile photography is yet a youngster and will presumably grow with man's strides into space. Currently, in the work-a-day world of missiles photography, test centers in conjunction with photographic manufacturers, are spearheading research into photographic materials to match the unusual testing conditions encountered.

Apropos is Khrushchev's recent comment to the effect that Americans have all the secrets of photography and Russians all the secrets of rockets, which contains at least a particle of truth—at least on the photographic side of the ledger.★

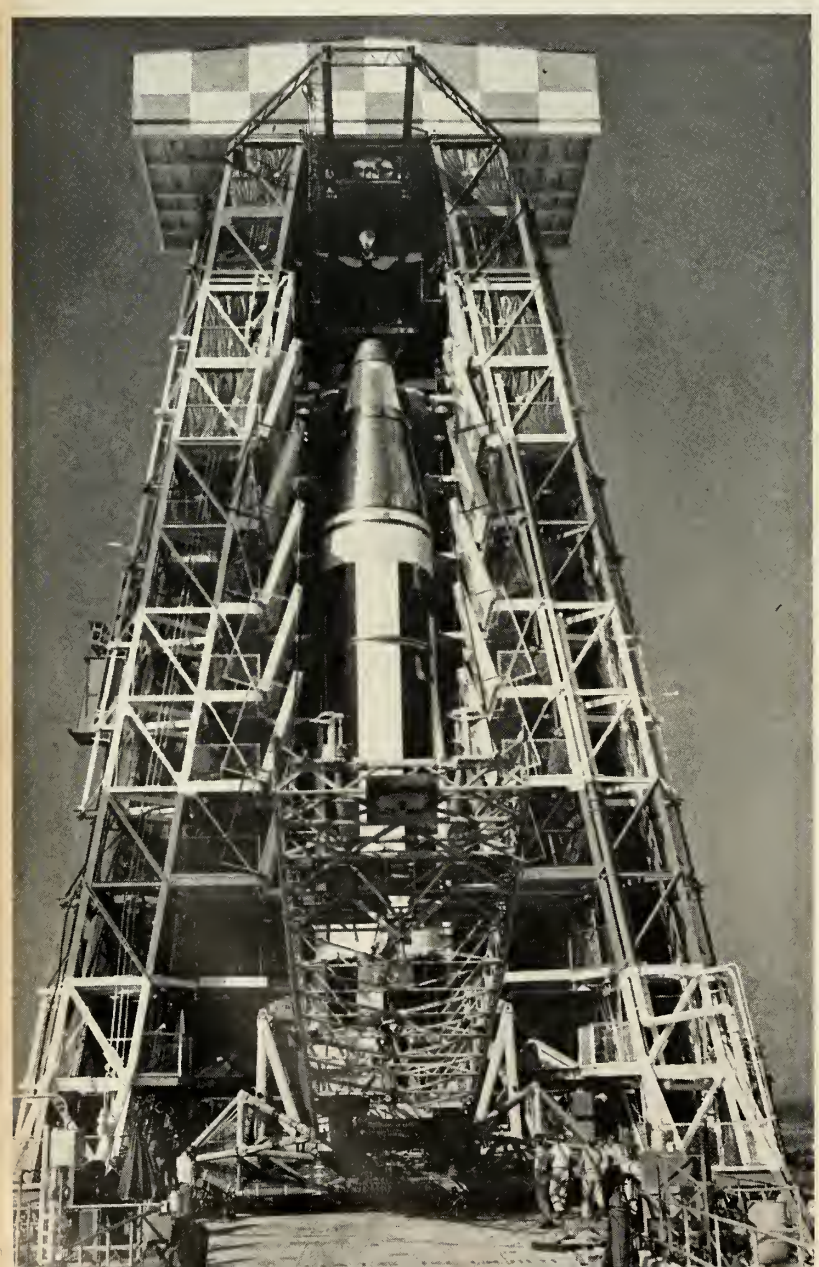


Official U.S. Navy Photo.

BLAST from an experimental warhead shows pattern in night photo.

Atlas Calls for New Shock Techniques

Mountings to withstand tremendous shock over relatively long periods developed for missile testing operations as new "birds" gain in power and speed



UNTIL FAIRLY RECENTLY, shock mounting systems were built to withstand relatively mild vibration and low-order shock over long periods of time. But, with the advent of missiles and rockets, came the need for mountings which could provide the utmost in reliability, during high launching shock and for upward of 30 minutes of flight duration, as the missile travels in and out of the atmosphere.

Scientific techniques and facilities solved this complex problem for the *Atlas* ICBM. These included the analog computer for optimum design, individual component tests to assure suitability, final tests on the completed assembly, and design refinements to provide the best performance.

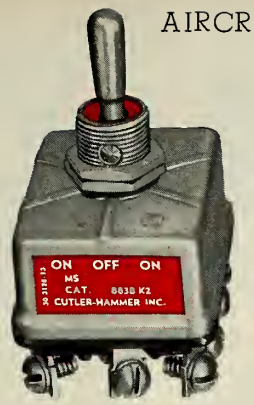
The problem of mounting sensitive electronic packages was encountered early in the *Atlas* development phase. The prime contractor, Convair Astronautics, required a complete mounting system, not just a simple vibration isolator.

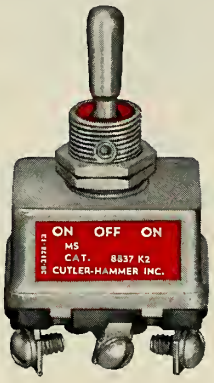
This meant that the elastic, damping, snubbing and structural characteristics of the entire system had to be evaluated and a special mounting system designed. The vibration problems involved were so special that no stock mounting came close to meeting the requirements.

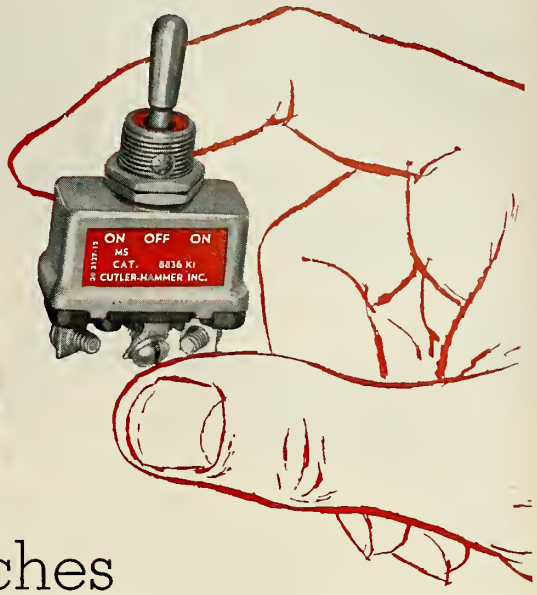
• **Rigorous specifications**—Convair established and met the following requirements for the performance of the mounting system:

1. The assembly (electronic equipment, mounting system and associated missile structure) would be subjected to a sinusoidal vibration of 1″ double amplitude displacement from 1 to 18 cps and ± 16 G from 18 to 2,000 cps along each of the three major axes, one of which must be the major longitudinal axis.

2. The assembly would also be







Now... Positive Action Switches ...another first from Cutler-Hammer

Now, after six years of intensive research, testing, and development, Cutler-Hammer offers another Cutler-Hammer *first* . . . a positive action toggle switch. Cutler-Hammer Positive Action Switches are new from toggle to terminals . . . new in design, new in construction, and new in performance and lasting dependability.

Here is the *first* switch with positive-make wiping contact action . . . the perfect control for very low energy circuits. And the positive-break switching action provides safe, reliable control of high energy circuits. Here is the *first* toggle switch where the contacts can be opened and closed independently of any spring pressure. Here is the *first* completely sealed, environment proof switch. All of these *firsts* plus the many other important improvements make these Cutler-Hammer Positive Action Switches *must* components whenever and wherever dependable electrical circuit control is important.

Cutler-Hammer's single, double, and four pole Positive Action Switches provide unlimited circuit combinations and are available in either standard or environment proof enclosures. For detailed information, write today for Publication EA-168.

CUTLER-HAMMER Inc., 1234 St. Paul Ave., Milwaukee 1, Wis.

CUTLER-HAMMER
AIRCRAFT CONTROL
C-H

These advanced features of design guarantee dependable performance under *all operating conditions:*

- Wiping contacts insure perfect switching for very low energy circuits
- Positive-break action insures safe, reliable switching with high energy circuits
- Direct toggle-to-contact mechanism guarantees switching action
- First totally enclosed, environment proof toggle switch
- 1° lever throw opens circuit
- Positive detent action prevents switch teasing
- New insulating material gives 3 times greater arc tracking resistance
- Greater terminal clearance for easier wiring
- Improved bushing seals are molded in place

subjected to the following steady-state accelerations which may be superimposed on the vibratory disturbances:

a) 10 G forward along the major longitudinal axis.

b) 2 G aft along the major longitudinal axis.

c) 1.5 G anywhere in plane perpendicular to the major longitudinal axis.

3. With any combination of the above vibratory and steady-state acceleration inputs to the assembly, vibratory response measured on the mounted electronic equipment must fall under a specific transmissibility curve. Any resonant peaks between 150 and 2,000 cps must be below a transmissibility ratio of 0.25.

4. In addition to the very difficult response requirements, the mounting system must withstand a 30-minute vibration dwell test along each of the three major axes, at the most severe resonant frequency for that axis, and at the specified input amplitude to the assembly.

5. The mounting system was required to have snubbing elements that would be operable only during excessive overloads, but yet not affect the operation of the mounting system during expected vibratory and steady-state accelerations. The mounting system was also required to be ultimately fail-safe with positive metal-to-metal interlocking parts.

6. The mounting system must withstand the following temperatures, under nonoperating conditions, without impairment of its capabilities: −80°F for periods of at least three days; 125°F, plus the full impact solar radiation of 360 BTUs per square foot per hour for periods of four hours per day, or 160°F with no solar radiation for periods of four hours per day, whichever is greater.

7. The mounting system must operate satisfactorily in ambient air temperatures of −65° to 125°F, and must withstand combined effects of any of the probable combinations of snow, sleet, hail, ice, fog, smoke, wind, sand, dust, ozone and salt atmosphere which might be encountered.

8. The system must be capable of both intermittent and continuous operation at relative humidities up to 100%, including condensation due to temperature changes. The system must fit a space envelope defined by Convair with a maximum motion in any direction of 3/8°.

9. Each of the cylindrical shaped electronic packages is symmetrical, and its center of gravity coincides with the elastic center of the mounting system.

• **Design analysis**—After thorough analysis, it was determined that the performance requirements could be best met with a vibration isolation system consisting of separate springs, damping elements and snubbers located symmetrically around each end of the electronic units.

Space limitations and the high performance specifications dictated that an optimum design be obtained. The analog computer was used to simulate all known system factors and evaluate the effects of a number of proposed design innovations.

Rapid solutions generated by the computer speeded the selection of a final system design. This was then fully evaluated over the entire frequency range, with the computer reproducing the exact performance conditions of the vibration isolating system.

The detailed design requirements of each of the separate elements of elastic restraint, damping and snubbing were separately considered and translated into manufacture of prototype components. Performance of both springs and dampers was then checked under the exact dynamic conditions that would be required by the design specification.

With the individual component designs established and with final dynamic component life tests completed, the individual components were combined with special supporting structure to complete the vibration isolator system.

The supporting structure for the vibration components was chosen to provide an extremely rigid structure to withstand high shock loads, and to be compatible with the stiff requirements of low transmissibility over the frequency range that runs from 150 to 2,000 cps.

• **Final system**—The final design of the canister-type mounting system supplied to Convair for use in the *Atlas* consists of two end rings that contain the vibration isolation components and two tie beams that hold the end rings in position.

The entire assembly fits on specially shaped cradle blocks, and is held rigidly in place by heavy steel straps that hold the end rings tightly against the mounting cradles. This arrangement allows the entire vibration isolator and electronic unit to be removed quickly from the supporting structure simply by loosening two bolts.

The sub-assembly at each end consists of an inner and outer ring connected by high-performance load springs, snubber assemblies, friction dampers and high-frequency surge suppressors.

The outer ring is of high-strength cast magnesium, with a special contour on the outside diameter to fit the supporting structure in the missile. The inner ring is machined to receive the mounting flange of the electronic package.

The complete assembly provides a compact high-performance vibration isolator which will protect the electronic equipment throughout the entire frequency spectrum. Special attention was given to the response of the complete system and associated structure over the entire frequency contemplated spectrum.

The required response over the entire frequency range was obtained by providing the desired structural frequencies in the mounting assembly, and the use of proper high-frequency design techniques.

This phase of the program was particularly important, since the effective input to the mounting components of the vibration isolator sometimes grows to 150 g in the high-frequency region, due to resonances in the attaching structure used in the missile. The final refinements during this phase of the design work were made by actual tests of the equipment on a high-frequency shake table.

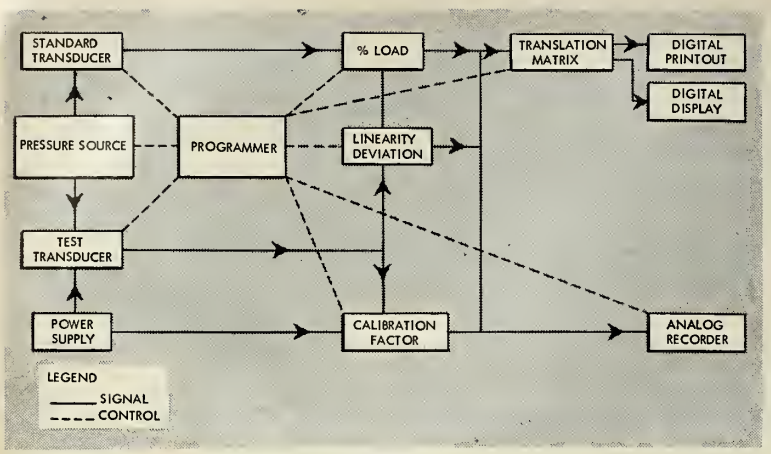
• **Stepped damping**—The extremely large amount of friction damping required to limit the resonant amplitude of the mounted equipment would have compromised the overall high-frequency performance. Stepped damping was introduced to improve the high-frequency response.

With a constant g input (a requirement of this mounting specification), the displacement amplitude decreases inversely as the square of the frequency. Stepped damping automatically provides a reduced amount of friction damping with decreasing input displacement, until all damping in the system is inactive.

At this point, the vibration isolator will respond as if it were a completely undamped system. This is the prime reason for the excellent high-frequency performance of the mounting system.

Recognition of unique problems such as those encountered in stock and vibration, and their solution by analytic methods, is a good indication that no approaches are being left unexplained in the design of the newest U.S. missiles.

The problem of shock and vibration is not a new one—it has long plagued automobile and airplane designers. Missile engineers must find answers faster.★



CIRCUITRY measures drift, zero-load output, temperature sensitivity and electrical calibration characteristics directly as a percentage of full scale.

New Aid to Testing:

Automatic Calibrator Speeds Missiles

by Donald E. Perry

WITH MANY PRIORITY missiles in advanced testing, pressure measurements of shock, acceleration and internal-external temperatures can not be more accurate than the calibration of the transducer itself. Thus there is an acute need for an automatic calibrator for missile work.

Such a calibrator has been developed by the Allegany Instrument Co. of Cumberland, Md. Known as the Autocal, the device eliminates three serious shortcomings of existing calibration techniques.

One is the time required. In many facilities where a large number of transducers are used in a single test, or where testing is done daily or weekly (such as static testing) a serious calibration backlog can develop.

A single transducer takes 10 to 15 minutes to calibrate. If electrical readout is not in immediately usable numbers, some 20 to 30 additional minutes will be required to rework the data. Often, high-priority missile tests must be held up, or if they go ahead, accuracy of data on pressure is questionable.

A second shortcoming of existing calibration techniques, generally not recognized in the missile industry, is the part that dynamic characteristics of pressure transducers are different than characteristics revealed by present static calibration techniques.

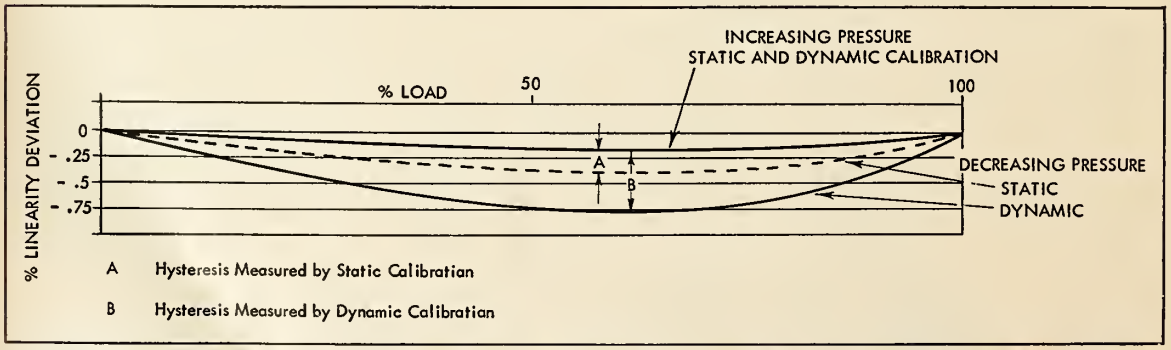
A third point is that calibration accuracy is limited by calibration equipment, and much equipment today has been adapted or converted from the basic design function for which it was built.

• **Advantages**—Allegany's Autocal promises to overcome these problems. Autocal calibrates one to twelve pressure transducers at an average of two minutes per transducer, which could eliminate calibration backlogs. No time is lost connecting and disconnecting transducers.

A transducer can be replaced as soon as it is calibrated, without interrupting further calibration. This makes it possible to calibrate over 200 transducers a day with one or two operators, and saves considerable costs at test facilities.

Autocal also displays and records linearity, hysteresis, calibration factor and drift characteristics. It is upon these determinations that the accuracy of the pressure measurement depends.

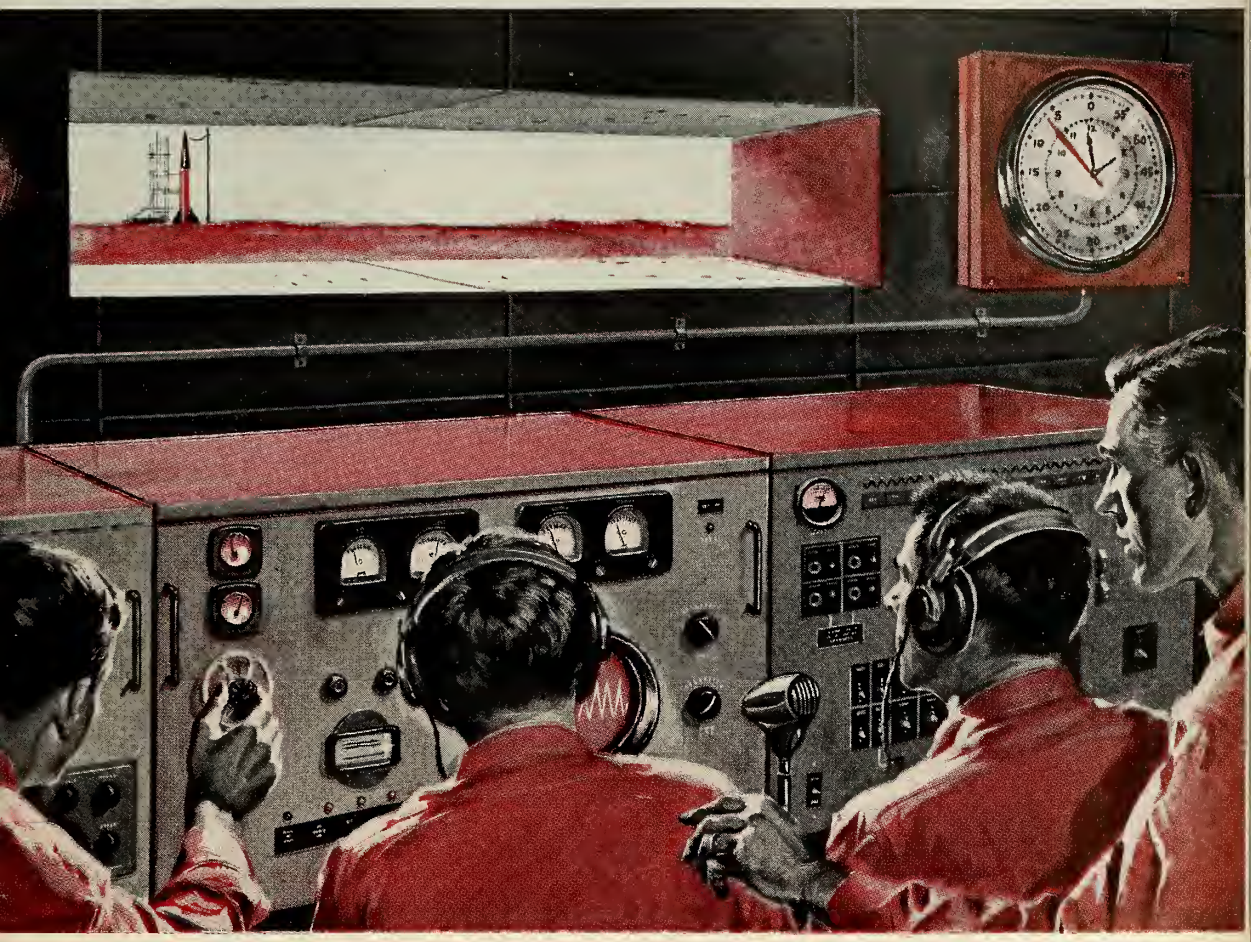
The device is not an automation of



DISCREPANCIES between the step function and Autocal's continuous-type calibration were realized by calibrating a number of pressure transducers both ways. Linearity deviation differs from 0.5% to 1.0% of full scale. Note average discrepancy.

If your problem calls for

MISSILE GO-NO-GO TESTING



Link's Design, Engineering and Production Abilities Provide the Answer

Link has established an enviable record of achievement in the design, development and manufacture of Go-No-Go systems evaluation test equipment. With this experience, Link serves many industries confronted with problems in the field of electronics.

In addition to test equipment, Link's know-how in the rapidly-changing electronics industry covers many other areas, including:

- Simulators
- Evaluators
- Optical Systems
- Ground Support Equipment
- Component Assemblies
- Computers

Experience, highly specialized engineers, and modern, complete production facilities enable Link to custom-build electronic equipment for many missile applications. Each item of equipment—a result of continuous research and development, imaginative management and stringent quality control—is the most advanced in its field.

Link can be of assistance in solving your problem. Write or call Jack Ritchie, Engineering Sales, Binghamton 3-6311 (ext. 277) for complete information. A brochure of our facilities is available on request.

LINK

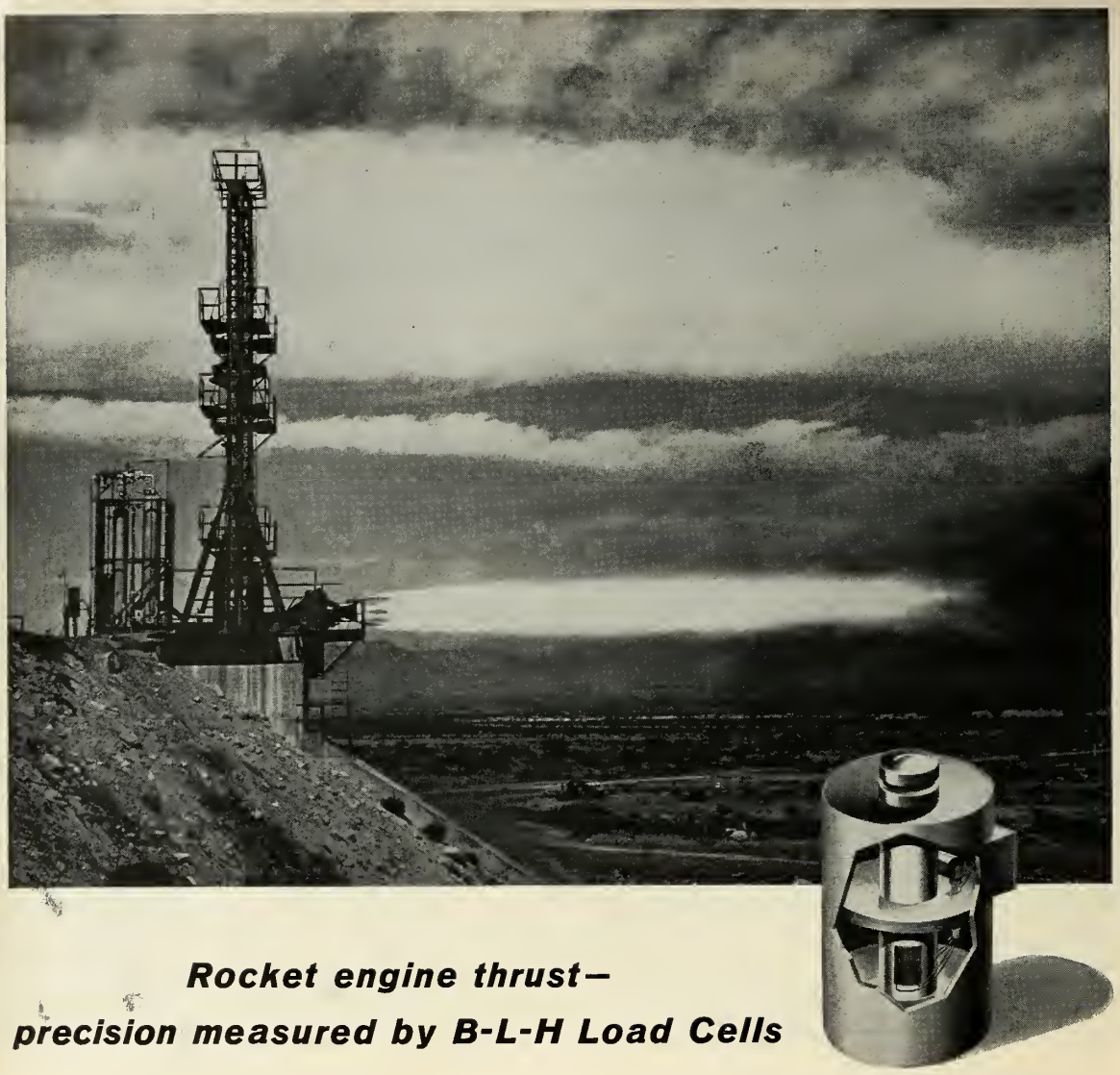
GENERAL PRECISION EQUIPMENT CORPORATION GPE

LINK AVIATION, INC.

BINGHAMTON, NEW YORK

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

Circle No. 19 on Subscriber Service Card.



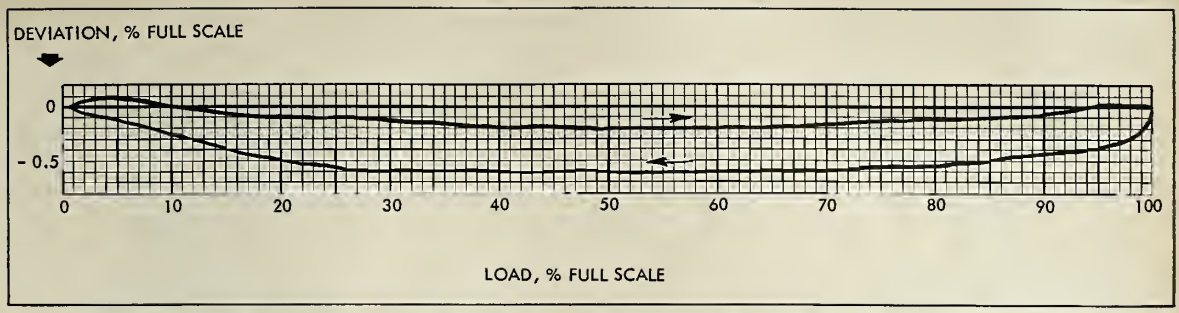
Rocket engine thrust— precision measured by B-L-H Load Cells

It takes rugged, yet highly responsive, instrumentation to measure the explosive thrust of a rocket engine on test. B-L-H has solved this problem completely and accurately with its SR-4® Load Cells, mounted in a specially designed test stand of its own. The thrust of the anchored engine is exerted against the load cells. Instrumentation, which can be located at some point remote from the stand, gives moment-by-moment visual readings on dial indicators—or makes records of the performance on graphic recorders, digital printers, computers, etc.

Electronic transducers offer you the answer to virtually any testing or research problems involving tension, compression, torque, etc. With appropriate instrumentation, they can also determine center of gravity, weigh loads at rest or in motion, control batch and continuous processes, and record all data required. Long-term accuracy is within $\pm 1/10\%$, repeatability within $\pm 1/20\%$.

For more information on B-L-H electronic transducers —load cells, pressure cells or torque meters—ask to have one of our field men call, without obligation. And write to Dept. 9-F for a copy of Bulletin 4300.

BALDWIN · LIMA · HAMILTON
Electronics & Instrumentation Division
Waltham, Mass.
SR-4® strain gages • Transducers • Testing machines



X-Y RECORDER of Autocal provides continuous record. The recorder is electrically driven through a mechanical take-off from the servo balancing motor shaft. Consequently, the accuracy of the digital information is not affected by any possible inaccuracies of the X-Y Recorder. Records produced increased calibration efficiency.

present step-function calibration principles with digital voltmeter readout. It does, however, employ the principle of dynamic calibration with digital readout in transducer terminology.

• **Factors to watch**—The step-function techniques with static readout, in which pressure is applied in steps, has inherent faults that affect transducer calibration accuracy. These faults include pressure overshoot, drift due to waiting for equilibrium and "hunting" due to pressure leakage.

Under the "step" method, pressure is rapidly applied until a desired value is reached. Then, after waiting for equilibrium to be reached at that value of pressure, a reading is taken. This usually requires four steps, with the equilibrium point at each step determined by floating a dead weight or starting a pressure regulator.

This method is satisfactory for calibation of visual gages, and for manual calibration of pressure transducers when proper precautions are taken in applying pressure.

But there are factors which influence calibration accuracy. For example, pressure overshoot (due to the inertia of a compressible pressure medium) exercises the transducer about the calibration point and does not give a true reading for that point.

As a result the data point cannot be taken immediately and sufficient time must be allowed to reach equilibrium. Waiting for equilibrium, transducer output will drift because of redistribution of stresses in the sensing element, and the apparent characteristic will be influenced by the time required to take a data point.

Calibration can be further affected by "hunting" due to pressure leakage and necessary correction. Leakage may occur at pressure connections and between the dead weight piston and cylinder.

This leakage is an important consideration in a multi-channel calibration system where many pressure connections are used. Each connection increases possibility of leakage, and a steady equilibrium point in reality can never be reached.

• **Function of system**—To overcome the accuracy limitations of step-function and static readout technique, Autocal has a dynamic pressure calibration system. This technique features a continuous pressure curve that increases linearily from zero to full-scale pressure, and then back to zero pressure. Most important, data is taken at any desired point along this curve.

With a continuous pressure curve, errors present in static calibration are eliminated, and since the pressure function is continuous, overshoot is not possible. Transducer drift is also eliminated because it is not necessary to wait for a reading.

The system is in continuous equilibrium and data can be obtained at any time. "Hunting" due to pressure leakage is eliminated for the same reasons.

To determine quantitatively the discrepancies between the step-function and Autocal's continuous-type calibration, a number of pressure transducers were calibrated both ways. Linearity deviation was found to differ from 0.5% to 1.0% of full-scale pressure.

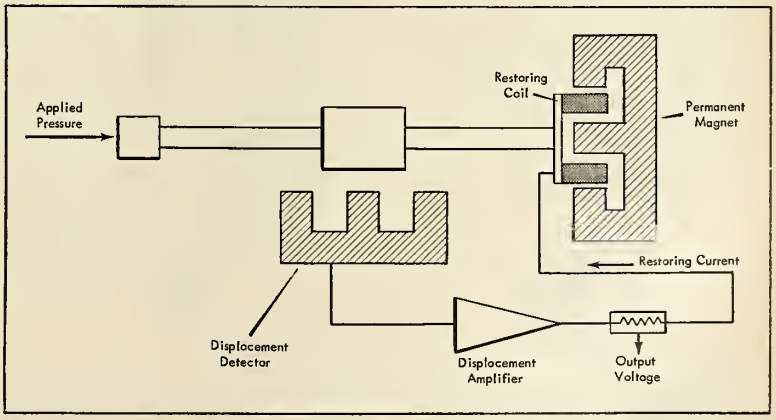
The actual Autocal circuitry was designed to measure cracacteristics such as drift, zero-load output, temperature sensitivity, and electrical calibration directly as a percentage of full scale. Desired accuracy for measuring charactertistics often is 0.1% full scale or better.

To obtain this accuracy, measuring circuits should have a resolution of approximately 0.01% full scale. This requirement plus the low voltage output of wire strain transducers, led to a potentiometer circuit using a null balance principle as the method of obtaining the desired resolution and accuracy.

• **Measuring pressure**—A standard transducer of the force-balance type is used to measure the applied pressure. An all-electronic servo system applies a feed-back current to the standard transducers that is proportional to the applied pressure.

The linearity and hysteris is of the standard transducer is less than .05% of full scale, and can be considered to be a straight line in this application.

The output of the standard transducer is read by the percent load cir-



STANDARD transducer of force-balance type is used to measure applied pressure.

. . . automatic calibrator

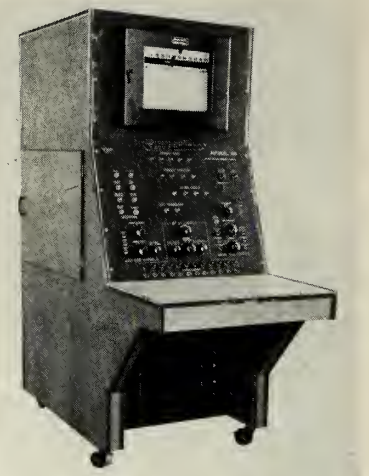
cuit with a full scale reading of 100% for any pressure range. The pressure at any intermediate point is read directly, therefore, as a percentage of full scale.

The linearity deviation of the test transducer is determined in one measurement and expressed directly as percent of full scale. This is accomplished by accurately comparing the outputs of the tests and standard transducers.

Because the standard transducer is linear, test transducer linearity appears as error signal and is measured in the deviation circuit. This permits higher accuracies than possible by measuring the actual voltage output of the test transducer and then determining the deviation from a straight line.

Similarly, the Calibration Factor Circuit determines test transducer full scale sensitivity in a direct measurement. This circuit measures the ration of the test transducer full scale output to its excitation voltage or current, in order to obtain the mv/v or mv/ma factor, and eliminates absolute measurements of output and excitation. Accuracy is thus improved by a factor of two or more.

A servo-operated circuit is provided to balance the test transducers to zero electrical signal at zero pressure. Because the conventional shunt balancing circuit can effect the transducer sensitivity and cause a calibration error, a voltage bucking circuit has been selected and introduced to balance the test transducer.



ELECTRICAL cabinet of Autocal Digital information is displayed on cyclic basis.

Digital recording is used to present

PRESSURE CABINET of Autocal contains six standard transducers, a standard transducer selector and servo system, manifold connections for 12 test transducers, plus voltage power supplies and other components.

TAMED: *the elemental fury of fluorine!*

Still thinking of elemental fluorine as "too hard to handle"? Not any more! As a result of General Chemical research, this "optimum" oxidizer can now be stored, transported and handled directly *as a liquid* in tank-truck tonnages. If you are interested in working with fluorine as an oxidizer for rocket fuels, or for any other application, this development could be of major importance to you.

Benefits of liquid fluorine. Now that fluorine is available in liquid form and in bulk quantities, you can handle and store it more easily, more safely and more economically than ever before. An important *plus* value—the shipping containers can also be used as storage tanks.

Halogen fluorides also available. The halogen fluorides, too, are commercially available from General Chemical. Chlorine trifluoride is available in ton cylinders and cylinders of 150 lbs. net. Bromine trifluoride, bromine pentafluoride and iodine pentafluoride are offered in various-sized cylinders to suit demand.

Write for free technical bulletins. A comprehensive new technical bulletin, "Fluorine," will be sent you on request. Also Technical Bulletin TA-8532-2, covering Chlorine Trifluoride and other Halogen Fluorides. Write for your free copies today.

Allied Chemical

First in Fluorine Chemistry

GENERAL CHEMICAL DIVISION

40 Rector Street, New York 6, N. Y.

Can this experience in unique cooling applications help solve a problem for you?

Custom designed cooling is our business at Ellis and Watts. For example, we have recently engineered and built highly specialized equipment for the following applications:

- Liquid coolers for electronic components (bulletin 94)
- Cooling Klystrons with air to liquid heat exchangers (bulletin 95)
- Special units to cool airborne electronic gear (bulletin 99)
- Cooling equipment for huge complex electronic computers (bulletin 102)
- Electronic console and rack coolers (bulletin 105)
- Small portable field units to cool huts filled with electronic gear for missile ground support, battlefield television, communications and radar (bulletin 106)
- Conditioning systems for Radome shelters (bulletin 108)
- Mobile cooling units for trailer-mounted electronic systems for missile and aircraft ground support (bulletin 111)
- Units to cool automatic landing devices for carrier and land-based aircraft (bulletin 122)
- Cooling equipment for fixed or mobile flight training simulators (bulletin 124)
- Dewpoint control equipment for pressurized radar waveguides (bulletin 128)

These are but a few examples. On land (MIL-E-5272A), on the sea (MIL-E-16400B), in the air (MIL-E-5400B) — even in outer space (MIL-E-8189A) — E-W specialized cooling equipment guarantees the performance of your electronic systems, independent of environmental conditions, for military or commercial applications.

If your project involves cooling . . . it's a job for Ellis and Watts. We are staffed with specialists who will analyze your requirements, submit a proposal, design and build equipment promptly and to your complete satisfaction. Field installation and maintenance services available.

Ellis and Watts Products, Inc., Dept. M, Cincinnati 36, Ohio
Please send the following information:

☐ Bulletin 94 95 99 102 105 106 108 111 122 124 128 (circle numbers desired)
☐ Cooling load calculating Nomogram
☐ Booklet "How to determine requirements for cooling electronic equipment"

Name.....Title.....
Company.....
Address.....
City.....Zone.....State.....

ELLIS AND WATTS PRODUCTS, INC.

Cincinnati 36, Ohio.
Designers and builders of MIL-AC Units

the measured transducer characteristics. These are digitized by shaft position encoders, and an output is provided for an IBM summary punch.

Although digital readout gives higher accuracy and resolution than analog recording, it is a sampling system and does not provide a continuous record. An X-Y Recorder is incorporated to provide this information.

The recorder is electrically driven through a mechanical take-off from the servo balancing motor shaft. Consequently, the accuracy of the digital information is not affected by the inaccuracies of the X-Y Recorder.

• **Physical description**—Autocal has two semi-portable cabinets interconnected by three electrical cables. The pressure cabinet contains six standard transducers, a standard transducer selector and servo system, manifold connects for 12 test transducers, test transducer excitation voltage power supplies and of course, pressure manifold.

Also featured is a pressure and vacuum source with linearizing valves, rate valves, by-pass valves, pressure regulators, and other components necessary for operation.

The pressure cabinet is controlled electrically by the electrical cabinet. Six standard transducer mounting positions are in the pressure cabinet, any one of which is selected by a switch in the electrical cabinet. A standard transducer can be quickly mounted in any position to cover more than six pressure ranges.

The electrical cabinet contains the control panel, control circuits, measuring circuitry, analog-to-digital converters and translation matrixes, X-Y Recorder, and other components required for measuring transducer characteristics and controlling calibration cycle.

Digital information is displayed on the control panel lamp banks on a cyclic basis. Printout is made by command from the control circuit and overrides the cycling system. After printout, the cycling system again resumes control of the displayed information.

Information also is recorded in log form on an X-Y Recorder. A pen indicates the present load, while the chart position indicates the percent linearity deviation. In this manner, a deviation vs. load curve is drawn as pressure is applied to the transducer. A second pen is used to record the calibration factor.★

Moscow briefs

• **Re-entry problems**—The problem of returning future *Sputniks* to Earth intact is summarized in SOVETSKAYA AVIATSIA by V. Borisov, of the Astronautics Section of the Shkalov Central Aeroclub in Moscow.

1. Deceleration of the *Sputnik* must be achieved gradually.

2. The Earth's atmosphere can be utilized in such a way that, on the *Sputnik's* return, the satellite will re-enter the atmosphere in a spiral. This can be accomplished "by changing the *Sputnik's* structure and its ascending power."

3. Most important, "all methods of returning the *Sputnik* to Earth boil down in the final analysis to a fight against high temperatures," the Soviet scientist explained.

Deceleration, Borisov explains, can be accomplished, among other methods, by magnetic aerodynamics. Magnetic fields will help solve the problem of safe re-entry for satellites in the following way:

As friction and burning of the *Sputnik's* shell ionizes the air in front of the moving satellite, the area surrounding the *Sputnik* becomes a conductor of electricity. This particular conductivity can be increased near the moving *Sputnik* by scattering small quantities of elements possessing a high ionization capacity, such as sodium and potassium.

The hot air, containing ionizing elements, will play the role of coils of the armature of an electric-current generator, while the magnetic field created by the *Sputnik* will be the generator's constant or direct field.

As the *Sputnik* reenters the atmosphere, the passing of such armature from the hot air through the *Sputnik's* magnetic field will create an electric current, thus decelerating the air's rush against the satellite.

This electrical current will sharply reduce the temperature of the *Sputnik's* surface, the Soviet article stated.

Various other systems of cooling and protecting the *Sputniks* are mentioned by Borisov, including "a ceramic surfacing, containing 20 kilograms of oxide of beryllium, which can absorb the heat exuded during a vertical 40-second fall of a *Sputnik* weighing 45 kilograms."

Cooling systems listed by Borisov include circulating methods, porous methods, and evaporating methods. The circulating cooling system depends on a gas or liquid sent through the *Sputnik's* heated parts "to turn the heat away."

The porous method is based on a liquid which gradually comes through

. . . moscow briefs

special pores in the *Sputnik's* shell, evaporating at the expense of aerodynamic heat, and "thus saving the shell." Cooling is achieved from evaporation when "the upper stratum of the shell evaporates by changing from a solid into a gaseous state."

• **A large** *Sputnik* will serve, within a few years, as an assembling and launching site for space rockets, predicts Prof. E. Kollman of Moscow. He declares that among the rockets to be launched from *Sputnik,* the first rocket will orbit the moon and check "the effect of flight on a living organism." Other rockets will be launched from *Sputnik* to land on the moon without crews in their initial phase, and later with crews. Finally, the *Sputnik's* personnel will hurl rockets up to Mars.

• **Soviet rockets**—"There is no doubt whatever," writes Y. Golovanov in KOMSOMOLSKAYA PRAVDA, "that in the next few years our brain, will power, and toil will prove to be stronger than the Earth's gravity, and . . . above the Moon's gigantic craters our Soviet rocket will rush, filling the hearts of Earth's people with pride and joy."

Golovanov also said about the future use of rockets in transporting Soviet freight and mail, "Inhabitants of Vladivostok will receive Moscow newspapers only 40 minutes after the papers come off the press."

• **At the recent national congress** of the Communist Youth League in Moscow, the League's secretary charged that, "although Soviet people have accomplished veritable miracles in science and technology, Soviet writers have failed to create artistically outstanding books about these wonderful achievements."

In KOMSOMOLSKAYA PRAVDA, foremost Soviet writers and editors specializing in the popularization of science published a collective letter complaining that their field is woefully neglected by young Russian journalists. Only a little more than 100 Soviet writers and journalists chose science and technology as their regular subjects, and among them new writers are rare.

The authors of the letter appealed to the Soviet government to increase the number of science writers and to establish a central organization for them; above all, to introduce a regular program of training for young writers aspiring to be experts in the scientific-technological field.

• **Plastic rockets** are a sure thing of the future. So predicts V. Korshak, a

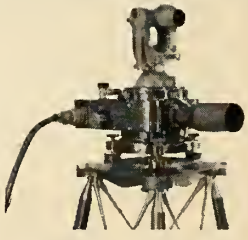
Ready . . . AIM . . .

New P-E missile theodolites automatically align inertial guidance systems to within a few seconds of arc.

A new family of missile auto-theodolites has been developed by Perkin-Elmer to align inertial guidance systems with unprecedented accuracy. These theodolites are now operational at a number of missile sites and are being used in the production, testing and alignment of stable platforms.

P-E auto-theodolites monitor and automatically correct guidance equipment to within ±2 seconds of arc under day or night tactical conditions. They are available in short, medium and long-range instruments which operate from distances up to 1,500 feet. Although these auto-theodolites were developed for missile work, they are readily adaptable to a variety of non-military applications requiring highly accurate angular data.

These instruments are examples of Perkin-Elmer's ability to combine precision optics with electronic and mechanical systems. For regular information on Perkin-Elmer's design, engineering and production facilities, ask to receive OPTICS PLUS, our new quarterly publication. Write us at 776 Main Avenue, Norwalk, Conn.



Perkin-Elmer Azimuth Alignment Auto-theodolites. **Short Range** — working distance, 0 - 100 feet; **Intermediate Range** — working distance, 0 - 800 feet ; **Long Range** — working distance, 200 - 1,500 feet (discriminates sway from rotational movement and automatically compensates for both).

ENGINEERING AND OPTICAL DIVISION

Perkin-Elmer *Corporation*

NORWALK, CONNECTICUT

Circle No. 23 on Subscriber Service Card.

corresponding member of the Soviet Academy of Sciences. He declared that in time not only airplanes, but rockets, will successfully be built of plastics.

• **Tantalum, one of the rare metals** known for its extreme heat-resisting quality and used in rocket and jetplane-construction, is a special feature of the Soviet Scientific-Research Institute of Colored Metals and its Rare Metal Laboratory, located at Ust-Kamenogorsk in Soviet Kazakhstan. (This, incidentally, is the town where former Premier Georgi Malenkov is now the exiled manager of a local power station.)

A recent Soviet report states that the Rare Metal Laboratory is regularly visited by the metallurgical experimenters of China, Bulgaria, Rumania, Poland, and other Red-bloc countries. They use the Laboratory in their atomage work with rare metals.

• **The moon's crust temperature** will soon be measured by Russian scientists with the aid of a new and special telescope. This telescope, says TRUD, "will allow scientists to measure in millimetric waves the temperature of the uppermost stratum of the Moon's crust, at the depth of about a centimere."

• **The American command** "has no effective means to combat guided ballistic rockets," writes Col. B. Aleksandrov in SOVETSKAYA AVIATSIA. These rockets are presumably those to be launched by Soviet forces in case of war.

• **A cruiser rocket-carrier** is apparently a part of the Soviet navy, judging from a statement buried in a recent TRUD article.

• **The Russian ICBM** "showed the world's record of speed and distance and thus opened new horizons in science," declared President Alexander N. Nesmeyanov of the Soviet Academy of Sciences. The recent annual meeting of the Academy was devoted to a review of 1957 achievements.

• **The Academy's astrophysical expedition,** headed by Professor V. G. Fesenkov, has returned to Moscow from Egypt where it completed its investigations of zodiacal light in the Nubian desert. Egyptian scientists participated in the work of the Soviet group. Political, as well as scientific considerations, motivated the sending of this Soviet expedition to the Middle East. Similar researches were simultaneously conducted by other Russian astrophysicists in Soviet Central Asia.

• **In the Soviet pavilion** at the Brussels Fair, the full-scale models of *Sputniks* I and II continue to attract general attention. The model of *Sputnik* I is suspended in air, while that of *Sputnik* II is on a revolving stand. The famous beep-beep sounds are reproduced faithfully.

Considerable interest is also aroused by an exhibit called "Cosmic Rays." Created by a group of Soviet scientists, it illustrates the inception and development of a cosmic-ray shower. The exhibit demonstrates a process wherein a cosmic ray strikes the atoms of an air stratum, breaking and splintering these atoms as they reach the Earth in the guise of secondary rays.

The entire process is shown with the aid of multicolored electric lamps attached to clustered metalic rods. Also exhibited is a powerful apparatus, claimed to be of original Soviet construction, showing cosmic particles as they actually penetrate the exhibition hall from cosmic space.

• **Three Soviet organizations** will open a "world center" of IGY data in Moscow. The center will be a special building in the Lenin Hills, presumably near the famed skyscraper of the University of Moscow. It will have its own libraries, laboratories, and other facilities.

The three sponsoring organizations in charge of IGY work by Russian scientists are:

The Scientific-Research Institute of Aeroclimatology, also known as the Chief Office of the Hydrometeorological Service, attached to the Council of Ministers; the Scientific-Research Institute of Earth Magnetism, Ionosphere, and Radiowave Distribution, attached to the Ministry of Communications; and the Academy of Sciences.

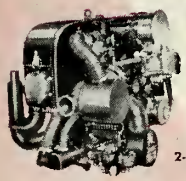
The "world center" of Soviet IGY data will be open to both Russian and foreign scientists, who will be free to acquaint themselves with the center's materials and research facilities.

• **Red kudos**—The Soviets have praised the astronomical observatories of Chile, Finland, the Netherlands, China, Czechoslovakia, Bulgaria, Poland, and Yugoslavia for being especially helpful in relaying to Moscow their observation data on *Sputnik* II.

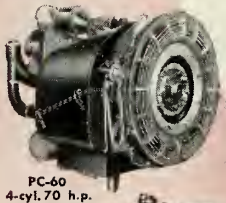
• **Stargazing**—Main center for meteorite-filming for the Soviet IGY program is the University of Odessa's astronomical observatory. Moscow Izvestia recently devoted a special feature article to its "meteorite patrol."

• **French missiles**—The Soviet ministry of defense has evidenced interest in the testing field of the French army's

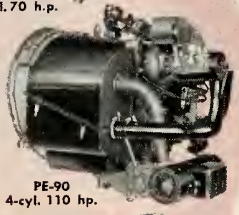
Muscles for the Missile Age!



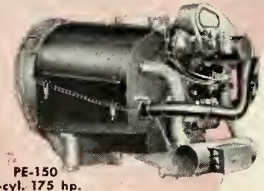
PC-30
2-cyl. 34 hp.



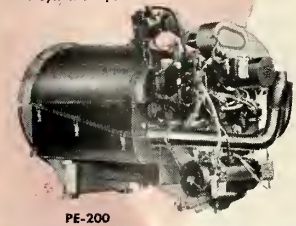
PC-60
4-cyl. 70 h.p.



PE-90
4-cyl. 110 hp.



PE-150
6-cyl. 175 hp.



PE-200
8-cyl. 250 hp.

. . . Continental Packettes Are Approved Power for a Wide Range of Ground Support Equipment

Nearly 50 different items of ground support equipment, now in use all over the globe, are built around the unique family of Military Standard engines developed by Continental Motors and designated as Packettes. These approved power plants (Mil. E6449-A) are adapted to the needs of equipment for all branches of the Armed Forces. They are already in being—in fact, in volume production—for such units as air conditioners, compressors, crash trucks, generators (gas and electric) refueling systems, heaters, blowers, Teracruzers, multi-purpose tugs, and many others. For the five Packette models, from 30 to 250 horsepower, offer a combination of advantages available nowhere else:

1—The proved dependability of the Continental aircraft engines on which they are based.

2—Adaptation to use in any climate, from the equator to the pole.

3—Lightness, simplicity, and ease of servicing, resulting from their air-cooled design.

4—Wide interchangeability of parts among companion models, and also among models of the standard Continental aircraft engine line.

●

IF THE APPLICATION FALLS WITHIN THEIR POWER RANGE, NO OTHER POWER WILL DO THE JOB SO WELL

WRITE FOR COMPLETE INFORMATION

Continental Motors Corporation
Aircraft Engine Division MUSKEGON, MICHIGAN

CONTINENTAL MOTORS® Powerful as the Nation AMERICA'S STANDARD

. . . moscow briefs

guided missiles in the Sahara. A detailed article on this subject recently appeared in the ministry organ, KRASNAYA ZVEZDA. The author, G. Polskoy, writes that "only fragmentary information is available" about this 10-year old field, but that nevertheless "this information permits us to form some idea about the French firing ground in the Sahara."

• **Coming attraction**—Late this spring or early in the summer, British leftists plan a "march of protest" against American rocket bases on British soil. The march will begin in the extreme south of England and will terminate at that point of northeastern Scotland where one of the rocket bases is to be established. The Soviet press applauds the planners of the protest demonstration.

• **Capitalistic Recognition?**—OGONIOK revealed recently that Konstantin Tsiolkovsky (1857-1935), Russia's famed rocket pioneer, was granted patents not only from the Russian government, but also from Washington, Vienna, Paris, Berlin, Rome, London, Brussels and Stockholm. A recent exhibit of the original patents at Moscow's Polytechnical Museum attracted many visitors.

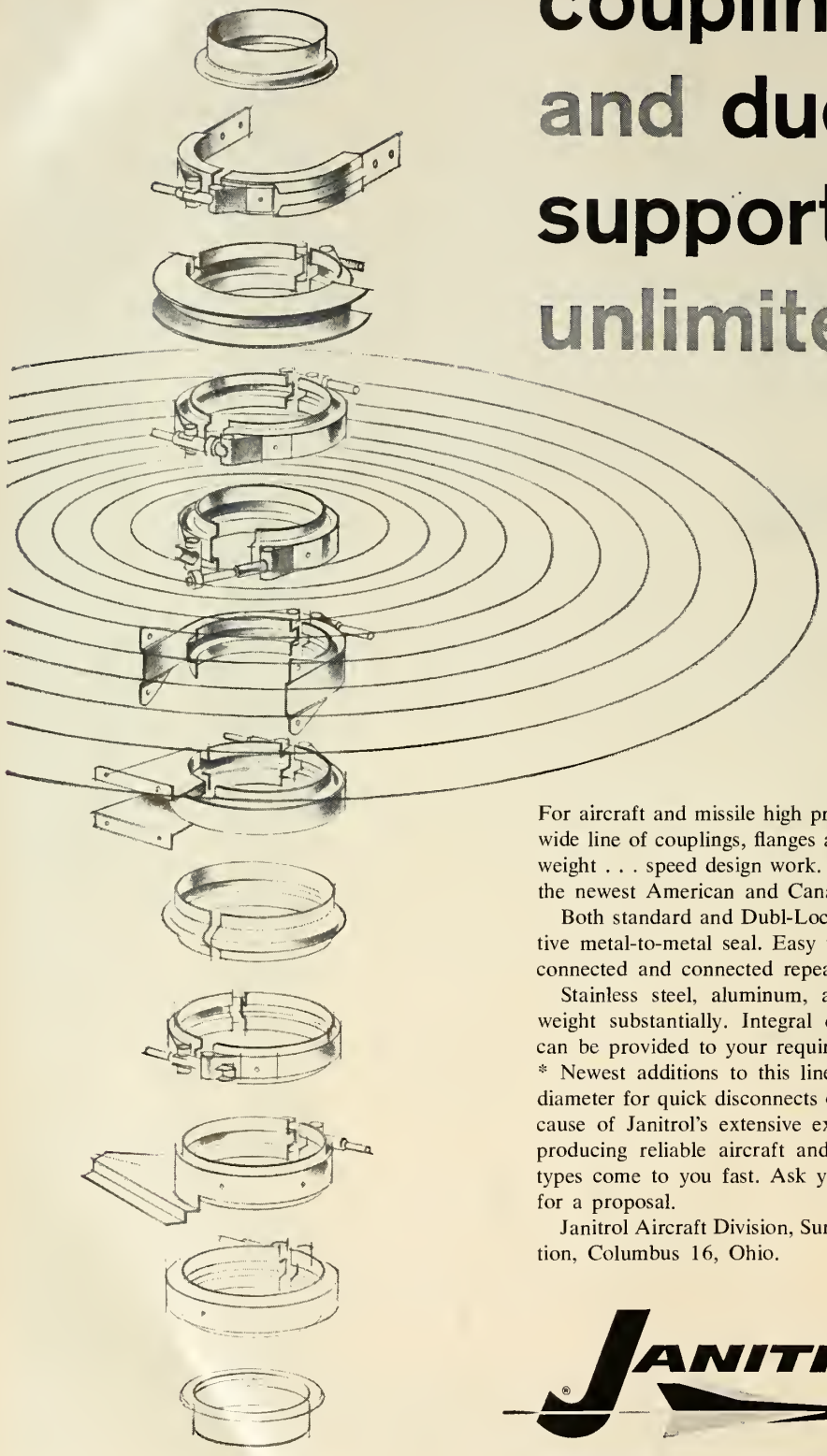
• **Red missile base**—Informed sources indicate that Russia may be building missile launching sites in Valona, Albania, an Adriatic port about 400 miles from Rome.

This information follows reports that Russian missile bases are also being established in four other Red satellites—East Germany, Poland, Hungary and Czechoslovakia.

The information did not spell out the type of construction, but it was speculated that a missile launching base was being built within easy striking distance of such Western allies as Italy, France and Greece, and all of Western Europe.

• **Rocket to the Moon**—A European news agency recently reported that Russia had attempted to launch a rocket to the Moon, but the effort failed when the first stage of the rocket exploded. The launching was reported to have occurred at a super-secret missile base in Siberia known as "Sputnikgrad."

According to the news dispatch, the explosion caused considerable damage, but no casualties. The experiment was reported to have failed because of a chemical fuel explosion in the first stage of the rocket.★



couplings and duct supports unlimited*

For aircraft and missile high pressure ductwork, Janitrol's wide line of couplings, flanges and duct supports can save weight . . . speed design work. They're already proved on the newest American and Canadian aircraft.

Both standard and Dubl-Lock® couplings feature positive metal-to-metal seal. Easy to install, they can be disconnected and connected repeatedly.

Stainless steel, aluminum, and titanium models save weight substantially. Integral or separate duct supports can be provided to your requirements.

* Newest additions to this line are couplings up to 36″ diameter for quick disconnects of jet engine tail pipes. Because of Janitrol's extensive experience in designing and producing reliable aircraft and missile hardware, prototypes come to you fast. Ask your Janitrol representative for a proposal.

Janitrol Aircraft Division, Surface Combustion Corporation, Columbus 16, Ohio.

JANITROL®

pneumatic controls • duct couplings & supports • heat exchangers

soviet affairs

by Dr. Albert Parry

So many inquiries have reached me on Moscow's experiments of using artificial ball lightning as a missile (the topic of my April column), that I am adding additional comments on this subject.

One comment, made to me by an American physicist, is that artificial lightning can indeed be created in an enclosed area, not only as Dr. George Babat and other Soviet experts have apparently done, but also as our General Electric experimenters achieved with resulting tremendous temperatures and power.

But, to obtain any such high power in open spaces, and to aim it successfully at definite targets as a missile, is quite another feat, and in the physicist's view, impossible.

My answer to this is—I am not saying that it is either possible or impossible. My intention is merely to report what the Russians are saying about their experiments, both officially and unofficially.

Dr. Babat stated in KOMSOMOLSKAYA PRAVDA (since my April column) that "mysterious ball lightning is a lump of high-temperature plasma, held in the state of a short-term balance by electromagnetic forces." He confirms that he began his experiments in 1940 by working with "non-electrode discharges" wherein he used high-frequency transformers, with armature "made not of wire, but of a ring of ionized gas."

Into this ring of plasma, freely floating ("like a ring of smoke sent up by an experienced tobacco smoker"), electric currents were introduced, and "under certain conditions, our ring of ionized gas was tightened into a fiery lump similar to ball lightning.

Dr. Babat's early experiments are connected with the later work of Professor Igor Kurchatov who, in the spring of 1956, spoke of the Soviet data obtained by discharging powerful electric currents through gaseous heavy hydrogen. The fiery "cord" of ionized gas or plasma, formed by these discharges, had reached temperatures of nearly one million degrees.

A short time ago, the Zeta installation at Britain's Harwell Atomic Research Center produced non-electrode plasma of temperatures up to five million degrees.

However, the Soviets do not lag far behind. On April 22, 1958, a Lenin Prize was awarded to a group of Russian physicists, headed by Academician L. A. Artsimovich, for successful researches in "powerful impulsive discharges in gas to obtain high-temperature plasma."

To harness thermonuclear power is of course the chief aim of all such experiments, Soviet or Western. In his latest statement, Dr. Babat promises that next September, at the Second Inernational Conference on Peaceful Uses of Atomic Energy, "Soviet scientists will tell about their new work" on thermonuclear reactions in connection with ionized gas or plasma.

We may then learn more about Dr. Babat's experiments with artificial ball lightning as one form of such plasma.

propulsion engineering

by Alfred J. Zaehringer

Propellant polarograph identifies rocket fuels at NOTS. The electrical method does not destroy the sample, requires only small amounts, and is accurate down to trace amounts measured in parts per million. Qualitative and quantitative results are rapidly given.

Chemical "kites" may use high altitude free radicals. Work done at Aerojet indicates that at about 60 miles altitude, there is enough atomic oxygen to give a heat release of 10^{-6} calories per cc of air. A chemical "kite" (ramjet), with a catalyst to effect oxygen recombination to molecules, might give a thrust of about 40 dynes per square centimeter of ramjet inlet area. The thrust of such a ramjet would be independent of the vehicle flight speed, but the low thrust would mean very light kite-like structures.

Boron "exotics" may remain specialty fuels. Cost will probably never run below $10 per gallon. Biggest use will be for modified turbojet engines (afterburners), ramjets (high altitude), or for high-performance liquid rockets.

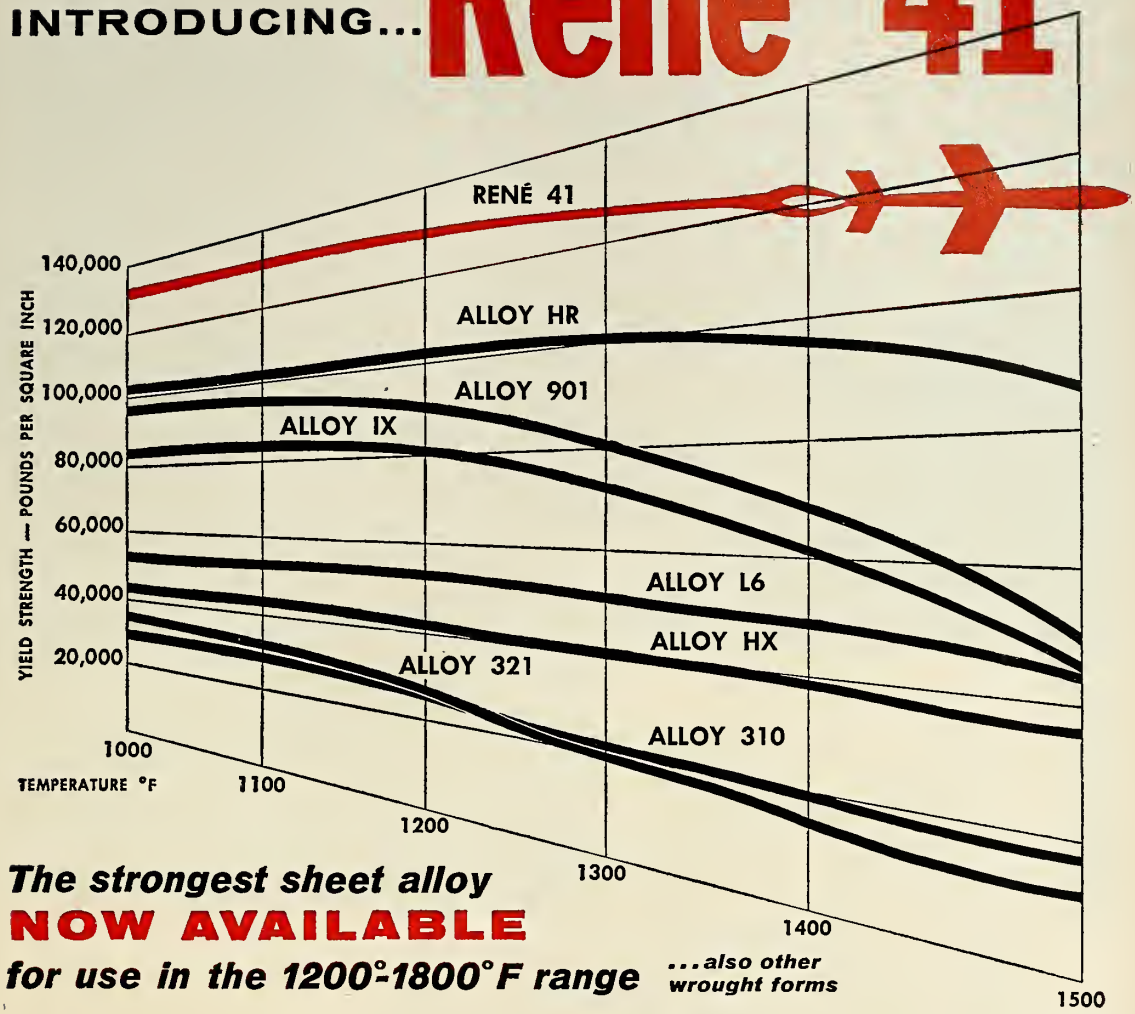
Big boron boom is now going on to adapt these fuels for solid-propellant use. First solid-propellant use will be as a solid additive to present organic fuel-binders. Next step will be to use a liquid boron hydride which can be polymerized to form a solid fuel-binder. Toxicity, reactivity, and aging characteristics in solids may prove to be formidable stumbling blocks in solids. These dangers, however, may be less critical than for liquid propellants.

What are the hottest-burning metals? Sponsored research at Temple University's Research Institute reveals that there are only four metals that have adiabatic combustion temperatures (at one atmosphere pressure in oxygen) of over 4,000°K. These are: beryllium, 4,300°K; thorium, 4,700°K; hafnium, 4,800°K; and zirconium, 4,800°K. Under the same conditions, aluminum flame is 3,800°K (4,400°K at 10 atm.).

Solids are expanding out West. Shell Development Co. at Emeryville, Calif. has been doing classified work on solids. This could involve Shell's "Epon" epoxies. Hercules Powder Co. (now operating Allegany Ballistics Lab) is locating a new propellant facility at Bacchus, Utah (near Salt Lake City). The B. F. Goodrich Chemical Co. is said to be doing fuel-binder work at its Rialto, Calif. location. More solid propellant activity may be shown by Atlas Powder, Dow Chemical, Goodyear, Monsanto, and Rohm & Haas in the near future.

Too much work on fuel-binders? High-level sources feel that not enough effort is being devoted to new solid oxidizers. Most of today's solid oxidizers have been known for over 100 years, while modern fuel-binders have been researched and placed into operation during the last ten years. Unless new oxidizers come along, solids will soon plateau at about 275 sec., and thus be below the fluorine or ozone liquids by about 50 sec.

INTRODUCING... René 41



The strongest sheet alloy
NOW AVAILABLE
for use in the 1200°-1800°F range

...also other wrought forms

The chart speaks for itself. No high-temperature sheet material in use today has the yield strength of René 41. And yield strength is just part of the story. This nickel-base, vacuum-melted alloy has definite superiority in tensile strength... oxidation resistance... stress rupture life... ductility... and other desirable properties.

In workability too, René 41 excells. It's easily formable by drawing, bending, spinning and other forming methods — can be welded to itself, similar or dissimilar materials.

René 41 is readily available from Cannon-Muskegon in sheet, bar stock and wire forms. Sheets may be obtained "as rolled" or polished... sizes up to 48 x 120 in.... thicknesses down to .010 of an inch. For complete details, mail the coupon below.

CANNON-MUSKEGON CORPORATION,
2895 Lincoln Avenue, Muskegon, Michigan

Please send complete information on René 41.

Name and Title.....

Firm.....

Address.....

City..... Zone..... State.....

ULTRA MET
VACUUM-MELTED ALLOYS FOR INDUSTRY

CANNON-MUSKEGON CORPORATION

2895 Lincoln Avenue • Muskegon, Michigan, U.S.A.

METALLURGICAL SPECIALISTS

Number Three of a Series

ARTHUR F. "ART" MATTHEWS has been an invaluable member of the F-101 "Team," serving as Assistant Project Engineer over power plant, hydraulics, controls and landing gear. Art and his group displayed a high degree of ingenuity in solving the many hundreds of mechanical design problems encountered in developing the F-101. He was recently appointed Project Development Engineer, and in this capacity monitors all development test programs related to the Voodoo airplanes.

From one basic design has grown the versatile Voodoo family of jet fighters pictured above. First, the long range all-weather fighter-bomber F-101A, the fastest operational airplane in the world. Second, the RF-101 reconnaissance Voodoo, holder of three transcontinental speed records. The third member of the Voodoo family is the F-101B, a supersonic atomic missile-carrying interceptor.

MEN OF PROJECT F-101

Our completely integrated facilities —all located in suburban St. Louis— plus our diversified activity in airplanes, helicopters, and missiles allows us to offer engineers a wide range of stimulating assignments. We encourage versatility in our engineers as well as our products.

McDONNELL *Aircraft Corporation*

world astronautics

by Frederick C. Durant III

On Capitol Hill an intensive short course in astronautics is underway. Chaired by Majority Leader John W. McCormack (D.-Mass.), the 13-man House Select Committee on Astronautics and Space Exploration has been sitting daily for several weeks (as this is written). The Committee represents influential members from both sides of the House, including Minority Leader Joseph W. Martin (R.-Mass.).

Armed with basic space flight literature, the Committee has been quizzing scientists plus top military and civilian engineers at the rate of four a day. For the most part, each witness reads a prepared statement airing his personal views and suggestions on the President's recommended NACA-NASA legislation, then submits to questioning and cross-examination.

These public hearings are one of the best shows and least attended affairs in Washington. Often members of the press will equal or outnumber the audience.

Chairman McCormack and his associates are tackling the review and consideration of the proposed NASA bill with heartening vigor. It is apparent that Congress appreciates the importance of legislation affecting U.S. development of astronautics. Most faithful attendee is Rep. James F. Fulton (R.-Penna.), and nearly all members question each witness.

The staff of the Committee is led by New York lawyer George J. Feldman, ably assisted by Dr. Charles S. Sheldon II. Head of the Committee's scientific evaluation group is Prof. S. Fred Singer, world-famed originator of the *Mouse,* and one of the most active and productive U.S. scientists in astronautics.

North of the border, a Canadian Astronautical Society has been chartered. Springing from the ashes of the Canadian Rocket Society (defunct since 1953), the CAS offers hope to many space-minded Canadians who were without an organized professional voice.

An initial meeting was held last March, attended by 61 persons representing 18 industries. Dr. Philip A. Lapp, senior electronics engineer at De Havilland, is acting president. Six men have been appointed to the 12-man council, including David Wallis of Avro.

The Society already has an active experimental program to develop a three-stage sounding rocket. A one-half to three-quarter lb. payload will be fired to 100,000 ft., telemetering three channels (temperature, pressure and acceleration). The first stage motor, under static test, uses a composite solid propellant.

For further information, address: A. E. Maine, secretary, c/o Guided Missile Division, De Havilland Aircraft of Canada, Toronto.

Quote of the month: Arthur C. Clarke, in a major British space-age conference for youth, looked out over the audience and said, "Some of you may have grandchildren born in space." In sixty years? It's conceivable!

THOMAS A.

EDISON'S

model 250 miniature time delay relays are shock and vibration resistant

As heater causes the expansion member to stretch, lever pivots on its hinge, compressing the bow spring at a high rate in the direction of contact closure. Matching expansion member compensates for external changes in temperature between −65 and +100°C.

Designed to meet military requirements, Edison's line of miniature time delay relays are available for a wide range of electronic applications.

The 250 Series Time Delay Relays combine in one unit superior design, top workmanship and performance at lowest cost. Check these advantages·

- Designed to withstand vibration frequencies to 500 CPS.
- Exceptionally high rate of contact closure.
- Permanent calibration and hermetic seal.
- Extremely rigid mechanical structure using high-strength, high-expansion alloys.

For bulletin #3046 showing timing ranges and operating performance write to:

Thomas A. Edison Industries
INSTRUMENT DIVISION
85 LAKESIDE AVENUE, WEST ORANGE, N. J.

McGRAW EDISON

Circle No. 26 on Subscriber Service Card.

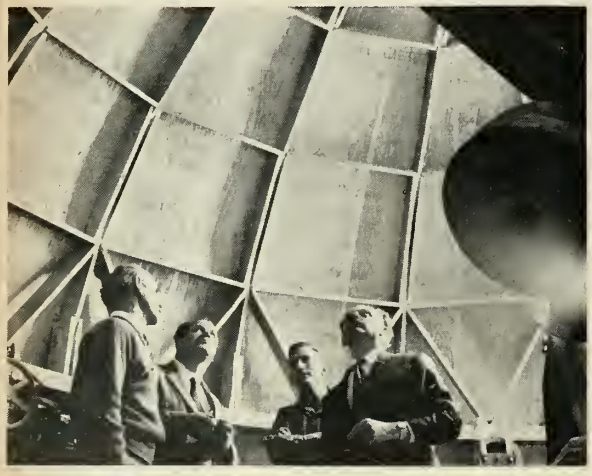
NATO Graduation

Last month, the first class of North Atlantic Treaty Organization students—12 officers and 48 enlisted men from the Italian Army—graduated from the U.S. Army's Ordnance Guided Missile School at Huntsville, Ala. The Italians return to Italy expert in NIKE AJAX and NIKE HERCULES. Altogether, including U.S. Army, Air Force and NATO students, OGMS will graduate close to 5,000 missileers this year in NIKE AJAX and HERCULES, CORPORAL, REDSTONE, LACROSSE and JUPITER. Next year, the number of graduates will exceed 10,000. Total NATO students will rise from a current class of 200 to over 2,000; representing 10 nations: Canada, Denmark, Norway, France, Italy, Britain, Turkey, West Germany, Netherlands and Greece. American students, upon graduation, for the most part go right into active service with their birds. NATO graduates, however, upon returning to their homelands, will play the double role of missile squadron personnel and instructors. The pictures on this page were taken recently and show some of the students and their activities. Instruction includes layout and theory in the classrooms, assembly and disassembly in the shops, field practice, and finally the actual firing. For more pictures of missile people at their work, see p. 166.

Photography by Seabrook Hull

"We want to see where we're going . . ."

In a secluded corner of Monte Sano state park overlooking the thriving city of Huntsville, Ala., there rises an unusual structure—a small masonry cube topped by a carefully-constructed silvery dome. This is the observatory of the Rocket City Astronomical Association, whose president is Dr. Wernher von Braun. Built entirely by the members of the RCAA, the star-gazing site boasts a 14-inch reflecting telescope, complete with synchronously rotated dome, reinforced concrete mounts, photographic capabilities and over a dozen moon-watch sites. To the members of RCAA, the observatory has a very special significance. Many of the hard core of working members and founders earn their living at the Army's Redstone Arsenal—where they make not only missiles, but the hardware to take man into space.



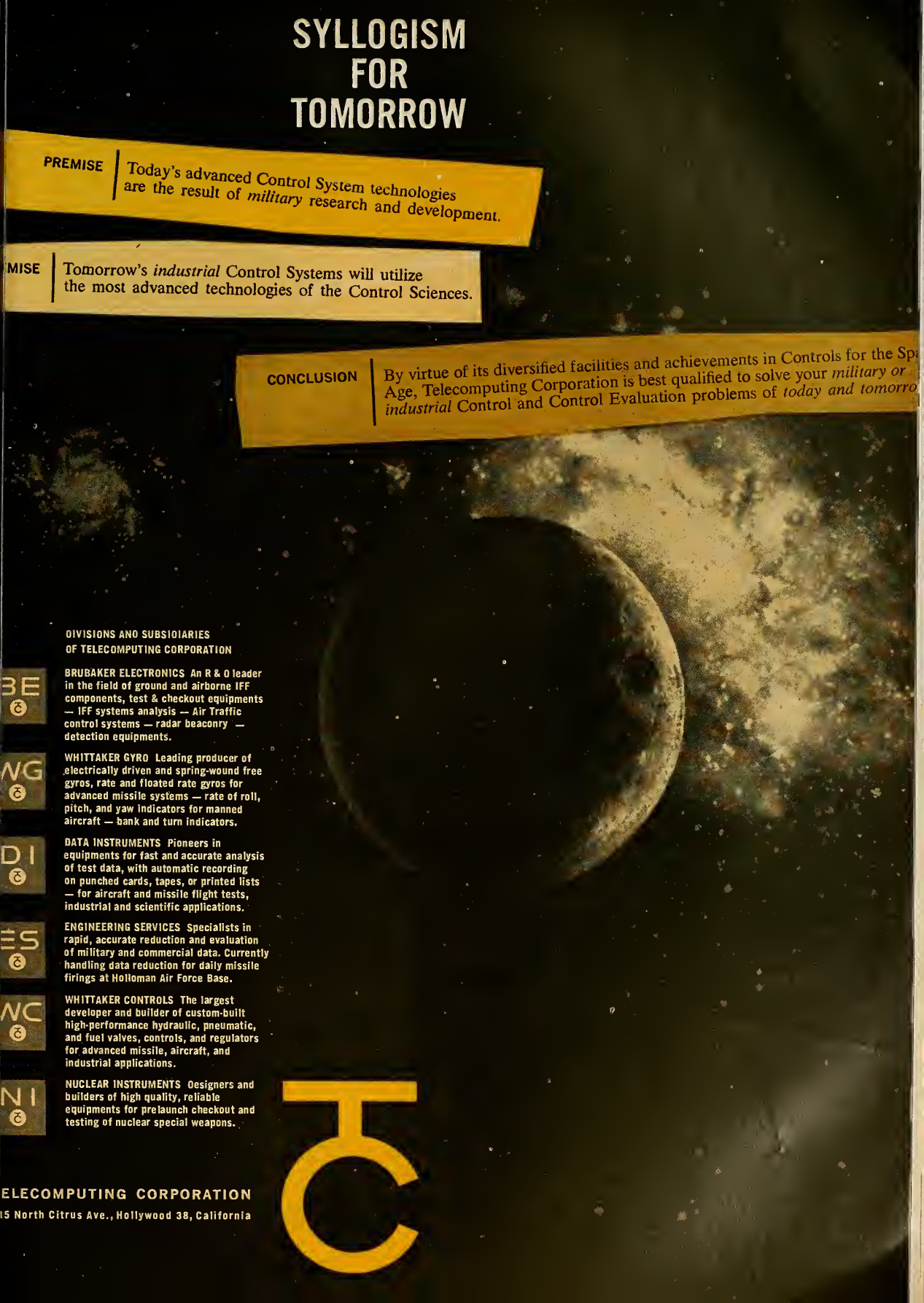
Now four of the men who "want to see where they're going"—in the picture of the moonwatch site, to the immediate right, stand four of RCAA's regular members (l. to r.): George A. Ferrell, RCAA Sec. and Engineer, ABMA Guidance & Control Lab.; Dr. Conrad D. Swanson, v.p. of RCAA and chief of Analytical Investigations Section of ABMA Structures and Controls Lab.; Wilhelm Angele, chief architect and Engineer for RCAA and chief of ABMA's Precision Instrument Branch; and last but not least, Dr. Ernst Stuhlinger, RCAA physicist and research consultant, and chief of ABMA's Research Projects Lab.

SYLLOGISM FOR TOMORROW

PREMISE | Today's advanced Control System technologies are the result of *military* research and development.

MISE | Tomorrow's *industrial* Control Systems will utilize the most advanced technologies of the Control Sciences.

CONCLUSION | By virtue of its diversified facilities and achievements in Controls for the Sp Age, Telecomputing Corporation is best qualified to solve your *military or industrial* Control and Control Evaluation problems of *today and tomorro*



DIVISIONS AND SUBSIDIARIES OF TELECOMPUTING CORPORATION

BE — **BRUBAKER ELECTRONICS** An R & D leader in the field of ground and airborne IFF components, test & checkout equipments — IFF systems analysis — Air Traffic control systems — radar beaconry — detection equipments.

WG — **WHITTAKER GYRO** Leading producer of electrically driven and spring-wound free gyros, rate and floated rate gyros for advanced missile systems — rate of roll, pitch, and yaw indicators for manned aircraft — bank and turn indicators.

DI — **DATA INSTRUMENTS** Pioneers in equipments for fast and accurate analysis of test data, with automatic recording on punched cards, tapes, or printed lists — for aircraft and missile flight tests, industrial and scientific applications.

ES — **ENGINEERING SERVICES** Specialists in rapid, accurate reduction and evaluation of military and commercial data. Currently handling data reduction for daily missile firings at Holloman Air Force Base.

NC — **WHITTAKER CONTROLS** The largest developer and builder of custom-built high-performance hydraulic, pneumatic, and fuel valves, controls, and regulators for advanced missile, aircraft, and industrial applications.

NI — **NUCLEAR INSTRUMENTS** Designers and builders of high quality, reliable equipments for prelaunch checkout and testing of nuclear special weapons.

ELECOMPUTING CORPORATION

15 North Citrus Ave., Hollywood 38, California

Thomas F. D'Andrade has been appointed National Sales Manager for the Components Division of Fairchild Controls Corp. **D'Andrade** will direct the sales program for all plants of the Components Division.

W. Wayne Hill has been assigned as executive technical advisor to the Toyo Communication Equipment Co. of Kawasaki, Japan by Packard Bell Electronics Corp.

Rear Admiral Ford Newton Taylor, Jr. USN (Ret.) has been named Director of Washington Operations by Fairchild Camera and Instrument Corp.

Hugh A. Young, has joined Packard-Bell Electronics Corp. as sales manager of the Technical Products Division. He will coordinate the activities of sales engineers and branch managers in Washington, D.C., New York City and Rome, N.Y., Dayton, Ohio, Fort Monmouth, N.J. and Los Angeles, Calif.

W. W. Roodhouse, Collins Radio Co., has been advanced to General Sales Manager, and **R. C. Frost** has been appointed Director of the International Division. **T. W. Sharpe** was appointed as Assistant General Sales Manager, and **R. M. Winston** as Assistant General Sales Manager, Administration.

Frank L. Spencer was appointed assistant manager of engineering program development for the Technical Products Division of Waste King Corp., Los Angeles.

C. Gould Wheeler, W. Ralph Wilcox, and **Michael R. DeLallo** have been named managers to the General Electric project team that will supervise the engineering, production and installation of the ballistic missile radar system. **Mr. Wheeler** will plan, organize, and implement all material purchasing and control for the super radar system. **Mr. Wilcox** will plan, organize, schedule and implement the production and fabrication of all equipments needed for the giant radar system. **Mr. DeLallo** will be in charge of administration for the Missile Detection Systems Section.

Robert J. Sloan has been elected president of Crouse-Hinds Co., Syracuse, N.Y. **Raymond W. Cummings** was elected to the position of secretary of the company.

Walter K. Deacon has been appointed Chief Engineer, Torrance Plant, of the Aero Hydraulics Div., Vickers Inc.

Charles F. Hoell has been appointed Controller of American Bosch Arma Corp.

Col. Benjamin S. Mesick, USA (Ret.) has joined the Grand Central Rocket Co., as Assistant to **President E. Bartley.**

Capt. Charles E. Trescott, USN (Ret.) has been appointed vice president and general manager of Zenith Plastics Co., subsidiary of Minnesota Mining and Manufacturing Co. **Trescott** will be responsible for all operations of the southern California plastics firm.

Dr. Robert Finn, associate professor of mathematics, **Dr. Yuan Cheng Fung,** associate professor of Aeronautics, **Dr. Guido Munch,** associate professor of astronomy, and **Dr. John Laufer,** JPL research specialist, members of the staff of California Institute of Technology and the Jet Propulsion Laboratory have been awarded Guggenheim Fellowships.

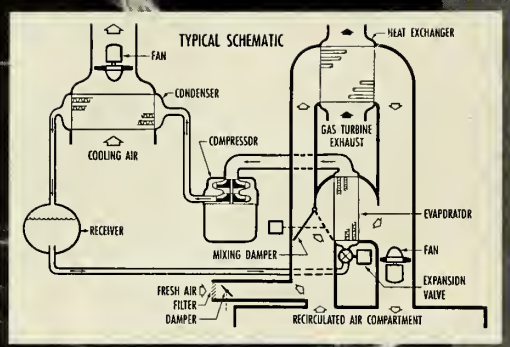
Dr. Roger S. Estey has joined the technical staff of Nortronics as a research scientist.

Ames F. Giordano has been appointed Chief Engineer to Blonder-Tongue Laboratories, Inc. He will be responsible for the development of the Company's products.

Robert H. Jewett has been named assistant general manager—chief engineer of the Boeing Pilotless Aircraft Division. **Jewett** will have charge of four divisional departments.

Dr. Milton U. Clauser, Allen F.

LIGHTWEIGHT air conditioning for missile support systems



The mobility problem in cooling electronic equipment in vans and for missile pre-launching has been answered by new AiResearch Freon air conditioning units. *One-fourth the weight and one-third the size* of conventional equipment, these lightweight, air-transportable units utilize highly efficient AiResearch Freon components (see diagram) originally developed for commercial aircraft applications.

Heat source for the circuit can be either electrical, or exhaust gas from an AiResearch gas turbine. When the gas turbine assembly includes an alternator, it supplies *400 cycle power to run both the refrigeration unit and all electronic gear in the van.*

Easily operated manually or automatically, this compact air conditioning unit provides from 5 to 12 tons cooling capacity and up to 85,000 BTU's per hour heating capacity. It operates on 400 cycles, 208 volts. The unit shown stands 54″ high, 52″ wide and 27″ deep, with a charged weight of only 452 lbs.! Your inquiries are invited.

SPECIFICATIONS

Performance Data:
Typical operation—cooling

Refrigerant	Freon 12
Evaporator tonnage	7.5
Ambient temperature	100F
Condenser air flow	5000 cfm
Condensing temperature	131F
Evaporator air flow	1230 cfm
External distribution ducting pressure drop	2 in H_2O
Evaporating temperature	48F
Electrical power	26KVA

ENGINEERING REPRESENTATIVES: AIRSUPPLY AND AERO ENGINEERING OFFICES IN MAJOR CITIES

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

. . . missile people

Donovan, and **William F. Duke** have been elected vice presidents in Space Technology Laboratories, a division of The Ramo-Wooldridge Corp.

Dr. Chuck Ching Ma, Dr. Ernest Mayer, and **Dr. Gadicherla Rao** have been appointed engineering specialists by Rocketdyne, division of North American Aviation. **Dr. Gadicherla Rao,** noted research psychologist, has been appointed design analyst.

Carl L. Lang was named Joint-Ventures Manager at Page Communications Engineers, Inc. He will direct telecommunication projects now under way in Korea, Libya, and Southeast Asia.

Curtis W. Symonds has rejoined Sylvania Electric Products, Inc. as controller of the company's Semiconductor Division.

C. J. Thompson has been appointed district sales manager for Aeronautical and Instrument Division of Robertshaw-Fulton Co. His territory includes California, western Nevada, Washington and Oregon. He is also in charge of foreign sales.

Richard A. Terry has been named manager, advertising and sales promotion for Telemeter Magnetics, Inc., Los Angeles, Calif.

Robert W. Dillon has been named West Coast sales representative for the Vitro Weapon Systems group, Vitro Corp. of America.

Carl J. Theken has joined the Cyril Bath Company as Treasurer and Assistant Secretary.

Dr. John R. Ragazzini has been named dean of New York University's College of Engineering.

William A. Stevenson has been named to direct design of the Navy's Polaris ballistic missile, being developed by Lockheed Missile Systems division. He will be in charge of structural and internal systems design of the missile.

Wilbur R. Hankes has been appointed Director of Military Relations by Avco Research Laboratory. He will represent the interests of the Laboratory in liaison with the various elements of the Department of Defense.

Col. Kenneth W. Klise (USAF-Ret.) has joined Page Communications Engineers as a project manager.

William N. Snouffer has been appointed manager of the Plato anti-missile missile system by Sylvania Electronic Systems, a division of Sylvania Electric Products Inc.

Paul Helweg has joined the Electronics Department of Hamilton Standard Division, United Aircraft Corp., Broad Brook, Conn. as assistant sales manager. He will assist in the development of the sales programs concerned

. . . missile people

with the design and development of missile weapons systems and airborne electronics systems and components.

Dan T. Buist was elected Vice President-Marketing by Turco Products, Inc. **Archie K. Beard** was appointed General Sales Manager and **Steward B. Van Dyne** was named as Assistant to Vice President-Marketing.

Tom J. Venator has been named chief applications engineer of the Electronic Systems and Equipment element of Nortronics, division of Northrup Aircraft, Inc.

Maj. Gen. Harry Reichelderfer, (ret.) was named assistant director of Southwest Research Institute by the executive committee of the Institute's Board of Governors. He was formerly an assistant vice president of the organization.

William M. Richardson has been named assistant to the vice president and will head the Washington office of BJ Electronics, Borg-Warner Corp. Formerly with Ramo-Wooldridge Corp. as Washington representative, Richardson will be responsible for technical liaison with Department of Defense, military services and other government agencies involved in electronic research and development.

William J. Seevers has been appointed assistant to the general manager by the Bell Aircraft Corp. Seevers, former assistant to President Leston Faneuf for industrial security and military liaison, joined Bell in September 1952, as staff assistant to President Lawrence D. Bell.

W. G. Lundquist, has been retained by Reaction Motors, Inc., Denville, N.J., as technical consultant and advisor on the Pioneer rocket engine. Lundquist has been vice president of engineering for all divisions of Curtiss-Wright Corp.

NEW PRESIDENT of the Huntsville Industrial Expansion Committee, Robert K. (Buster) Bell, here makes a point with Revis O'Neal, PIO of the Ordnance Guided Missile School. Bell replaces C. W. Jones as head of HIEC.

Meet the editors who have made
Missiles and Rockets the first,
biggest, and best magazine
in the missile market

1st

in readership

. . . 23,800 PAID subscribers.

in ad volume

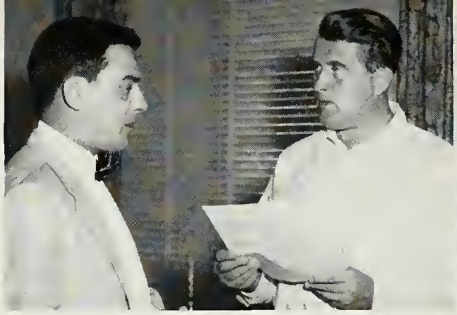
. . . over *twice* the advertising pages of its *nearest* competitor.

in weekly coverage

. . . of the zooming missile market, starting July 7, 1958.

Here are the men who provide fresh, vital, timely, informative, interpretative articles for Missiles and Rockets subscribers . . . the influentials of the missile market.

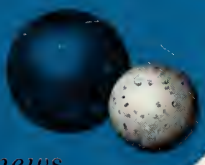
Here, at work, are the men who bring together a high quality audience . . . eager to learn more about the missile market.



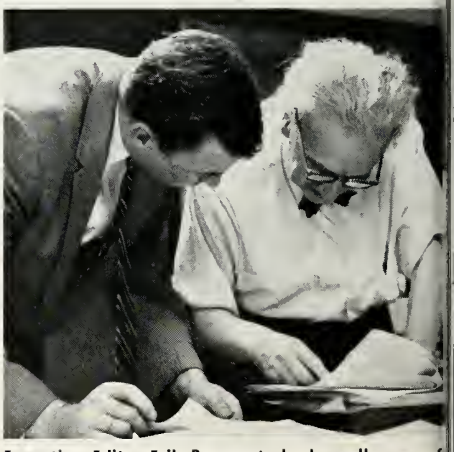
Assaciate Editar Seabraak Hull (Finonce & Business) visiting with ABMA's Technical Directar, Dr. Wernher van Braun (Chief Guided Missile Development Division, ABMA), right.

Assaciate Editar Narman L. Boker (Engineering on Productian) interviews Dauglas Aircroft's Presiden Danald W. Dauglas Jr., left, about missile produc bility.

these M/R editors have travelled more miles than from earth to moon



to get you on-the-spot news coverage since Missiles and Rockets was launched October 1956 . . .



Executive Editar Erik Bergaust checks galley proaf with Air Farce and NATO Chief Scientific Advisar warld renawned Professar Theodare von Karman right.

Assaciate Editar Alfred J. Zaehringer (Chemistry & Prapulsian) and "Mr. Redstane" — Chrysler's Lawell Lawrence, right — check new propulsion systems.

Assistant Editar Erica Cramley interviewing Rabe P. Haviland, left, Advanced Systems Engineer– Satellites, MOSD, Generol Electric Co.

Electronics Editors Peer Fassen, left, and Raymond M. Nolon, right, discuss interplanetory cammunicotian ond space guidonce with Convoir Astronoutics' Krafft A. Ehricke.

Monaging Editor E. E. Holmas, Jr., left, gaes over same lost minute news stories with Assistant Editor Donald E. Perry.

Assaciate Editor Williom O. Miller (Military & Legislative) checking out an underwater missile stary with Novy's Reor Admiral K. S. Mastersan, right.

Asssistont Editor Fronk G. McGuire, left, discussing arbits with Dr. Jahn P. Hagen, Director af Project Vanguard.

—check their exclusives

The first news story that m/r ever published indicated that the Army would launch a satellite before *Vanguard.* (m/r 10/56) ("Army to Launch 'Satellite' Before *Vanguard?*") • Jupiter-C Flight of 3000 miles (Nov. 56) ("Outstanding Army Rocket Record") • "Break-up in Army-Navy *Jupiter* Program" (1/57) • "Manned Rocket Bombers Underway." (2/57) • "USAF to Start Moon Rocket Program." (3/57) • "Undersea Warning System Underway." (5/57) • "Navy *Polaris* Test Vehicle Fired." (10/57) • "Russia's Moon Rocket Program." (11/57) • "SAC Gives U. S. Advantage over USSR." (1/58) • "Sweden Developing Atomic Missiles?" (2/58) • "Kapustin Yar Serves as Russia's Cape Canaveral." (2/58) • "*Snark* Disclosures Fit With Carrier-Base Plan." (3/58) • "Navy Pushing New Subroc Missile." (4/58) • "Extension of HERALD Systems Planned." (4/58) • "Polaris Details Revealed." (5/58).

—check their qualifications

ERIK BERGAUST, Executive Editor: BS in chemistry; Author of a number of books, including "Next 50 Years of Flight," "Rockets and Missiles," and (with a co-author) "Satellite." President of the National Rocket Club; Director of the Washington section of the Aviation Writers Association and Director and past President of the Washington section of the American Rocket Society; Chairman, Press Committee, International Astronautical Federation; Member of the Information Advisory Group of the President's Committee on Scientists and Engineers.

E. E. HALMOS, JR., Managing Editor: 16 years as Managing Editor and Senior Editor, Engineering News Record; newspaper experience including United Press Associations; The Salt Lake Tribune; Navigator, 8th Air Force, World War II. Member of the National Press Club.

SEABROOK HULL, Associate Editor: Union College; Naval Aviator USMC, World War II; Editor of "Foreign Letter," the Whaley Eaton Service; Chief of London Bureau, McGraw Hill World News.

NORMAN L. BAKER, Associate Editor: BS in Aeronautical Engineering; News Editor and correspondent for "Jet Propulsion." Development engineer in the Pilotless Aircraft Division of Boeing Aircraft Company; Secretary, National Capital Section, American Rocket Society; Past President of the Ft. Wayne Section of the American Rocket Society; Member of the Institute of Aeronautical Sciences, American Astronautical Society, American Ordnance Association and National Rocket Club.

RAYMOND M. NOLAN, Associate Editor: Formerly with Ford Instrument Company Division of Sperry Rand Corporation; Writer for USAF; Member of the Aviation Writers Association, National Rocket Club, American Society of Military Engineers.

WILLIAM O. MILLER, Associate Editor: Cmdr., USNR, recently on active duty as head of the Radio and Television Branch, Office of Chief of Information; over 10 years newspaper and editorial experience.

ALFRED J. ZAEHRINGER, Associate Editor (Propulsion and Chemistry); President American Rocket Co.; BS in Chemistry; Formerly Associate Editor "Jet Propulsion"; Rocket engineer, Thiokol Chemical Corp.; Chemical engineer, Grand Central Rocket Co.; Past president, secretary and technical director of Detroit Rocket Society; American Chemical Society; American Ordnance Association; American Rocket Society; Chicago Rocket Society; Gessellschaft fur Weltraumfahrt.

PEER FOSSEN, Associate Editor: Formerly with Page Communications Engineers, Inc.; Associated with Army and Air Force technical publications, member of American Rocket Society, National Capital Section.

DONALD E. PERRY, Assistant Editor: Public Relations with The Martin Company, Orlando, Florida; Served as Aviation Editor for several southern and midwestern newspapers; Member of Aviation Writers Association and the International Society of Aviation Writers.

FRANK G. McGUIRE, Assistant Editor: BA in Russian Studies and Journalism; member of American Rocket Society. Numerous articles in Encyclopedia Britannica.

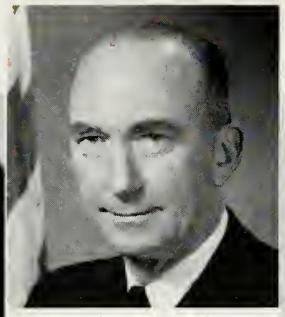
ERICA CROMLEY, Assistant Editor: Formerly with New York Daily News; Washington Bureau of Buffalo, N.Y., Courier Express; London Daily Express.

ELLEN ROSENBLOOM, Assistant Editor: Graduate Syracuse University with BA Journalism; Graduate Studies at Cornell University. Formerly with United Press Associations; Bureau of National Affairs.

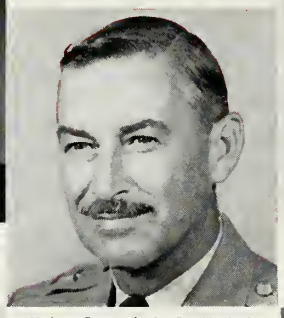
... over

plus *contributed* articles by such outstanding missile experts as these . . .

or General August Schom-
g (Asst. Chief of Ordnance,
earch and Development, USA)



Rear Admiral James S. Russell, USN (Chief Bureau of Aeronautics, USN)

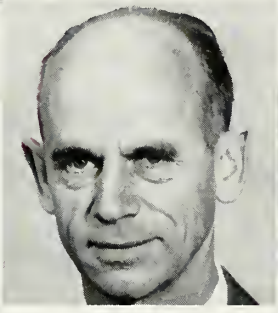


Major General J. B. Medaris (Ordnance Missile Command)

Brigadier General Hollingsworth F. Gregory (USAF — OSR)

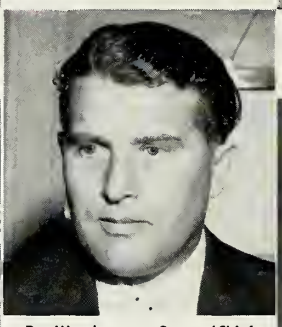
Rear Admiral John E. Cl
(Deputy Director, ARPA)

or General Otis O. Benson,
(Commandant, School of
ation Medicine)

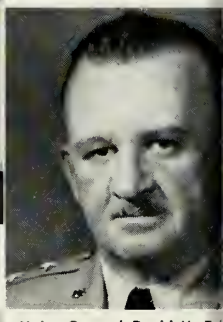


Dr. Ernst Stuhlinger (Director of Research Projects Office, ABMA)

George P. Sutton (Chief, Preliminary Design Section, Rocketdyne)



Dr. Wernher von Braun (Chief Guided Missile Development Division, ABMA)



Major General David H. Tu
(US Army Engineering Cen
Fort Belvoir, Va., USA)

r Admiral Rawson Bennett
ief, Office of Naval Research)

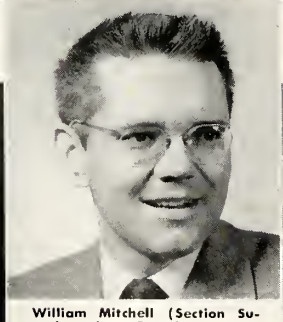
Commander George W. Hoover (Office of Naval Research, USN)

William P. Lear (Chairman of the Board, Lear, Inc.)

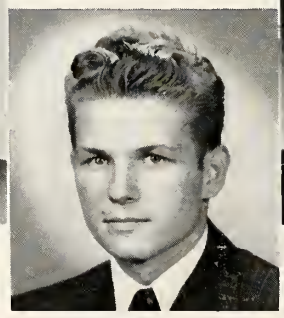
Major General B. A. Schriever (Commander, Western Development Division, USAF)

Brigadier General Don R.
trander (Assistant Deputy C
mander for Weapon Syst
Hq., Air Research and Deve
ment Command)

rt R. Stehling (Head of Pro-
lsion, Project Vanguard, Na-
l Research Lab.)



William Mitchell (Section Superintendent, Reaction Motors, Inc.)



W. C. Rous, Jr. (Senior Mfg Res.
Engineer Convair, Fort Worth)

D. C. Romick (Head, astronautics section Weapon System Dept., Goodyear Corp.)

Rudolf Reichel (Special V
pons Preliminary Design E
neer, Bell Aircraft Corp.)

book reviews

ADVANCES IN GEOPHYSICS, Vol. 4 by H. E. Landsberg and J. Van Mieghem, 456 pp., $12, Academic Press Inc., N.Y.

Public interest in the International Geophysical Year has brought an obscure area of science into the spotlight —geophysics—and keeping up with the rapid progress in the field, this volume furnishes new knowledge of earth science to student and teacher alike.

The book details atmospheric chemistry, theories of the aurora, effects of meteorites upon the Earth (including effects upon inhabitants, atmosphere, and satellites), smoothing and filtering of time series and space fields, and Earth tides.

The authors not only report progress in geophysics, but also indicate questions which remain open and avenues of future research.

SPACEPOWER, WHAT IT MEANS TO YOU by Donald Cox and Michael Stoiko, 262 pp. $4.50, The John C. Winston Co., Philadelphia, Toronto

Why go into space? Who owns space? Who owns the universe? These questions, and many others, are answered in SPACEPOWER. The book examines the problems which now face man—moral, legal, political, economic—in the fantastic new world of the Space Age.

This is not a technical treatise on rockets and missiles, nor is it science fiction. It offers a realistic analysis of the social, military and legal aspects of space penetration, plus the first concrete proposal for the control of space through a United Nations force. The book also offers a complete spaceflight timetable outlining man's ultimate conquest of the Universe.

SPACEPOWER is well illustrated with full-page diagrams and drawings.

ROCKET BUILDING FOR STUDENTS by Rocket Research Institute, Inc., Sacramento, Calif., $2.

This manual, an updating of a similar booklet published by the Institute in 1948, presents safe and inexpensive methods of preparing and launching rocket training devices for the student.

Due to the increased interest in rocket and space sciences, the Institute feels that youngsters will continue to construct rockets regardless of warnings, ordinances, or the difficulty of obtaining materials. This manual should enable experimenters to conduct tests without accidents, often sometimes tragic.

The manual gives good basic advice

. . . book reviews

and the fundamentals of rocketry. It covers safety precautions, organization of student groups under adult supervision, safe construction, launching of small-scale rockets, and preparation of fuse and electric ignition boxes.

THE OPTICAL INDUSTRY DIRECTORY, The Optical Publishing Co., Brewster, N.Y., 292 pp., $5.

This is a handy reference volume covering manufacturers, distributors and designers of the optical industry.

The book lists American optical sources and gives an item index of optical products and services; including instruments, components, raw materials, special services and manufacturing equipment.

Also included is an area listing of companies furnishing the indexed item. A valuable feature of the volume covers industry personnel and their affiliations.

A lens appendix lists commercially available lenses for photography, projection and optical instrumentation.

GUIDED MISSILES—OPERATIONS, DESIGN AND THEORY. Sponsored by U.S. Air Force, 575 pp. $8.00. McGraw Hill Book Co., New York.

This treatise does an impressive job of laying out the elements of current missile design and operation. In a style and format that is pleasantly presented, this book—except for the fact that there is no list of questions at the end of each chapter—could be an advanced college text book. Assuming that the reader has some knowledge of chemistry, electronics, areodynamics, etc., it sets out to introduce the interested and somewhat experienced student to the why's and wherefore's of the various approaches to guided missilery.

Employing a modern, clean, layout, liberally interspersed with drawings and diagrams, "Guided Missiles" covers in an orderly fashion all the unclassified details of propulsion major subsystems (such as guidance, control, aerodynamics, physics, optics, telemetry, etc.) as well as some of the detail sub-sub-system requirements—sensors, reference units, amplifiers, followup units, actuators, computors, hydraulic-electric systems, trajectory, short and long-range guidance, terminal guidance, etc.

Also covered is that all-important subject of guided missile tactics. However, it is primarily a book to introduce the reader, in quite a detailed fashion, to guided missilery.★

NEWS FROM FLEXONICS

DUCTING AND COMPONENTS ENGINEERING BRIEFS

One of a series of reports to help you make more effective use of Flexon products.

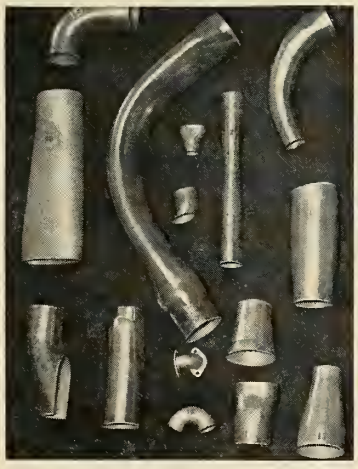
ENVELOPE PROBLEMS? VOLUME CONTROL PROBLEMS?

Solve them with Flexon Vari-Form Ducting Components

As the geometry of ducting becomes increasingly complex, forming problems are compounded. Maintaining equivalent volume becomes difficult through a variety of transitions in shape. These considerations added to the long standing problems of weight, strength, heat resistance, etc. make ducting system design a severe test of ingenuity in fabrication.

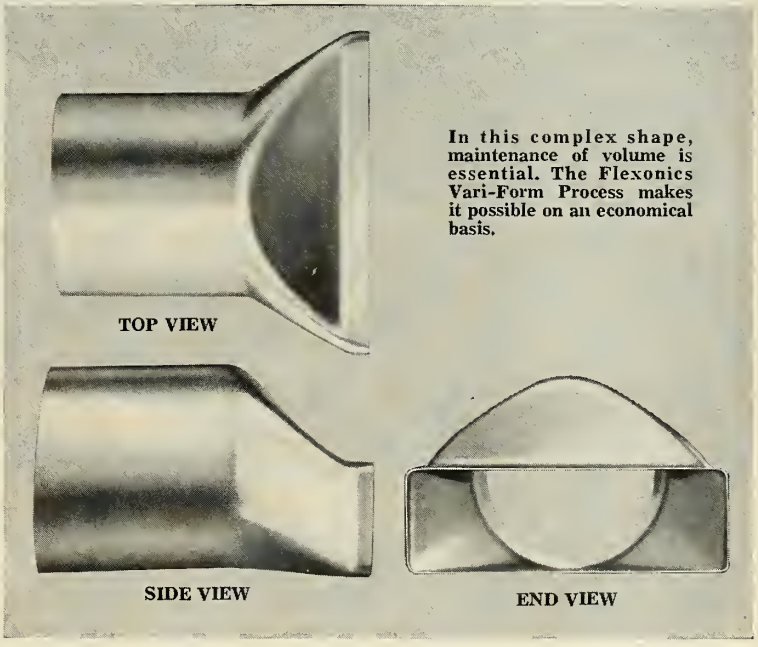
Flexonics Corporation's development and advancement of the Vari-Form Process is making the designer's job easier. The Vari-Form method produced from tube is more economical and superior to many half-shell types with burnt down welds.

Vari-Form ducting components are made by redeposition of material to all applicable MIL specs and in small or large quantities.



A representative group of shapes formed by the Vari-Form Process.

According to requirements, wall thicknesses ranging from .010 to .049 are made in daily production routine in such unusual shapes as 1:1 bends in stainless steel thin-wall tubing PLUS unusual shapes, transitions, elliptical, square—anything needed to meet the condition. All are high strength with ultimate yield of approximately 70,000 psi. Metals customarily used in M/R applications and aircraft are easily handled: CRES 302, 304, 316, 321, 347, Inconel X, 19-9DL, Monel and many others, including Titanium.



In this complex shape, maintenance of volume is essential. The Flexonics Vari-Form Process makes it possible on an economical basis.

Advantages to the Designer

By specifying Flexon Vari-Form Ducting Components, the designer frees himself from the severe limitations of conventionally formed components. He is not troubled by limitations in configuration. He is assured of maintaining volume when it is required. He is able to hold weight to a minimum. He need not sacrifice strength for other considerations.

Advantages in Production

Flexon Vari-Form Ducting Components are made to very close tolerances, eliminating bad fit-up. Costs are held in line because Vari-Form Components can be made in any quantity from 1 to many thousands with minimum tooling expense.

Engineering Assistance Available

If you have unusual ducting or piping problems, you can take advantage of Flexonics Corporation's experience. As the nation's most experienced manufacturer of metallic plumbing components for aircraft, rockets and missiles, Flexonics is qualified to help you in the most advanced design problems.

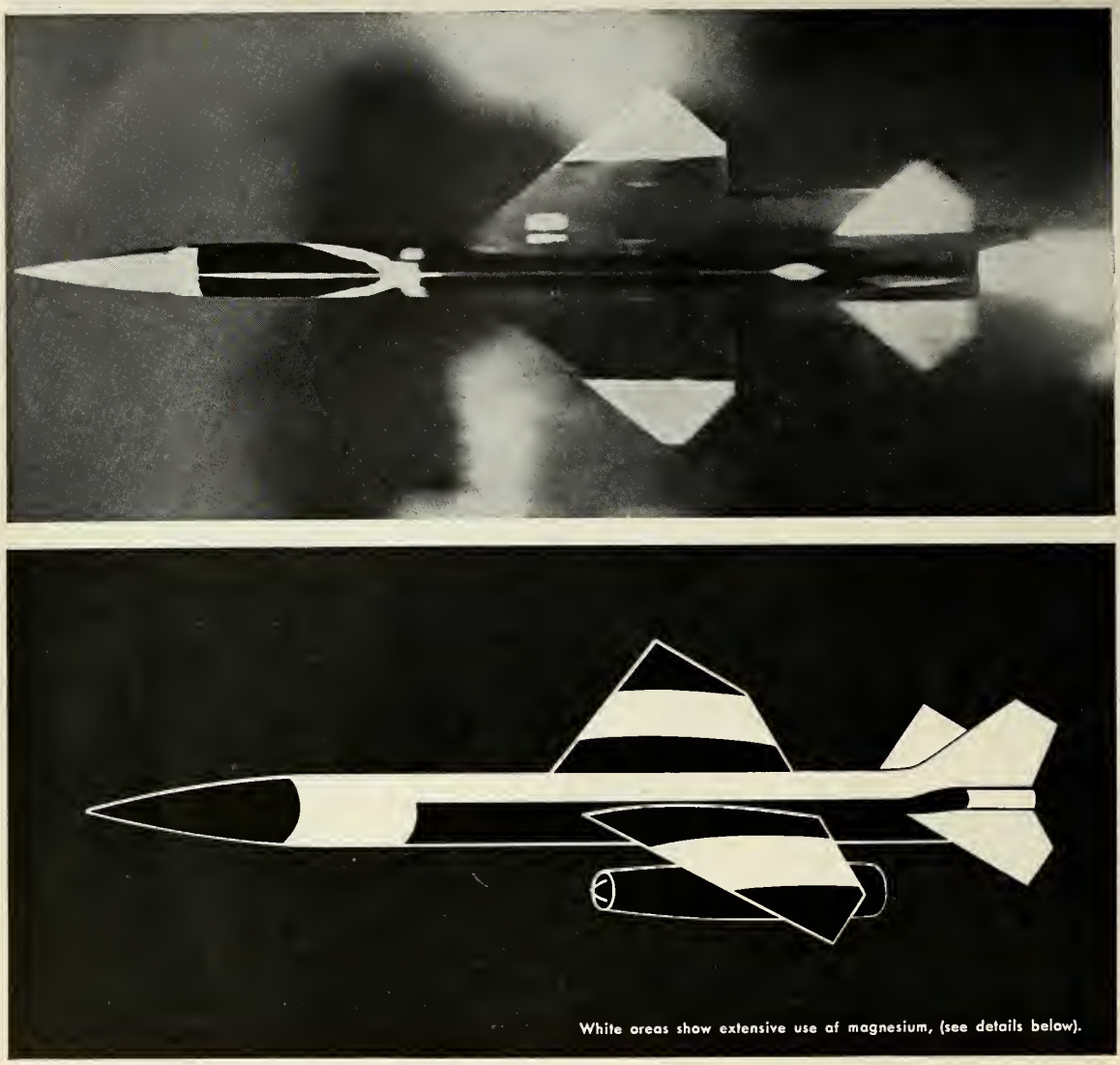
It will pay you to learn more about the Vari-Form Process and how it can serve you. For specific recommendations send an outline of your needs.

Flexonics *Corporation*

AERONAUTICAL DIVISION
A-39

1414 S. THIRD AVENUE • MAYWOOD, ILLINOIS
In Canada: Flexonics Corporation of Canada, Limited, Brampton, Ontario
Also Manufacturers of Rubber and Metal Hose Assemblies • Metallic Bellows • Expansion Joints

Circle No. 76 on Subscriber Service Card.



HOW ELEVATED-TEMPERATURE MAGNESIUM ALLOYS HELP BOMARC KEEP FIGHTING WEIGHT

Approximately 230 lbs. of magnesium is used in the airframe of the Bomarc, powerful surface-to-air missile. And for good reason: In each case, the specific application called for light weight and retention of strength, rigidity and other properties at elevated temperatures. The logical choice was sheet, extrusions or castings of elevated-temperature magnesium alloys.

EXAMPLES:

BODY. The body skin and doors of both nose and aft sections utilize 103 lbs. of HK31A sheet and castings. Resultant weight savings were 23 lbs., including a net reduction of 6 lbs. by using a magnesium casting for a door frame structure.

WING, FIN AND TAIL. 111 lbs. of HK31A sheet were used in the wing, elevators and elevator stubs, fin and rudder. All leading and trailing edges of control surfaces for wings and fin are HM31XA extrusions. Here another 8 lbs. were saved by using an elevated-temperature magnesium alloy.

These are but a few instances of how precious weight was saved in the Bomarc. For more information about the use of magnesium alloys in aircraft, rockets and missiles, contact the nearest Dow sales office or write directly to us. THE DOW CHEMICAL COMPANY, Midland, Michigan, Department MA 1407L-1.

YOU CAN DEPEND ON DOW

space medicine

by Hubertus Strughold, M.D., Ph.D.

As a result of several recent meetings, space medicine stays on top of the news.

A 24-lecture series on space technology for postgraduate students, completed in May, drew crowds of 400 to 1,800 students. The lectures, conducted by the department of Engineering and Physical Sciences, U. of California, in cooperation with the Ramo-Wooldridge Corp., were held in Los Angeles, San Diego, San Francisco, Lancaster (Edwards Air Force Base), and North Air Force Base, Calif.

Of special interest were the following lectures: "Physical Factors of Space Environment," by H. Haber, "Cabin Design and Personal Equipment" by A. M. Mayo, and "Man in Space Environment," which I delivered.

A recent report on interplanetary dust distribution advanced the theory that there is a localized increase in dust density around the earth due to the influence of the earth's gravitational field. This "blanket of dust" extends more than a million miles into space.

The report was presented by David B. Beard of the Lockheed Aircraft Corp., Missile System Division, at the spring meeting of the American Physical Society held in Washington, D.C. last month.

The million-mile "blanket of dust" figure is of special interest because it corresponds to the extension of the earth's sphere of predominant gravitational attraction. I called this extension "gravisphere" in "Spatiography: Geography of Space" (m/r, May, page 106).

It can be assumed that other planets show similar space dust concentrations within their gravispheres. The "gravitational territories" of the other planets are, of course, different in volume, and are dependent on their gravities and distances from the sun. The radius of the gravisphere of Mars and Venus is in the order of a half million miles; of the Moon about 30,000 miles, and that of Jupiter, 30 million miles.

The House Select Committee on Space Exploration heard testimony last month on the medical aspects of present and future space plans from Colonel Paul Stapp (now Chief of the Aeromed Lab, Wright-Patterson AFB, Dayton, Ohio) and myself.

Preliminary experimental results from US-IGY Satellite 1958 Alpha were reported last month at the National Academy of Sciences, under the chairmanship of Dr. Richard W. Porter. Of special space medical interest were the following findings: the picture of intra cabin temperatures by Dr. A. R. Hibbs, Jet Propulsion Laboratory, California Institute of Technology; and the problem of micrometeoritic impact by Dr. E. R. Manning, Air Force Cambridge Research Center. These findings look most optimistic.

We have more GSE* experience than anyone

...and now we can put it to work for you

***Ground Support Equipment—mainstay of modern weapon systems**

A strong statement? Yes. But we can back it up.

We were the first company to have complete responsibility for a major supersonic missile weapon system. The Navaho—America's pioneer long-range missile—produced such a wealth of technological data that the entire missile program now draws on it.

Ground support equipment for the Navaho and the X-10 developed a new concept for checkout trailers, engine run-up dollies, instrumentation checkout consoles, hydraulic servicing units, ground power units, jet engine starters, ground cooling carts, ground hydraulic power supplies, ground pressurization equipment, ground fire-fighting equipment, access and support stands, air transportation dollies, and a wide range of other test and launching equipment.

This was done through the ability to integrate numerous single elements into complete, smooth-running ground support systems.

Specialized engineering and production skill and facilities in this new field are available to do an outstanding job for you, quickly and economically—on individual items or complete, coordinated ground support systems—either military or commercial.

Interested? Write or call Manager, Special Products, Missile Division, North American Aviation, 12214 Lakewood Blvd., Downey, Calif.

MISSILE DIVISION

North American Aviation, Inc.

missile miscellany

The other day this page heard what must be the shortest definition yet of a highly complex (yet increasingly popular) subject: Operations analysis consists of reducing alternatives. Still on definitions, there must be some kind of missile significance to the description that a camel is a greyhound designed by committee. In the same vein, these comments on the missile business by a servo-minded missile businessman: Performance and opportunity are connected in a very non-linear fashion . . . The financial loop for systems management is closed through the headlines. And a suggestion to start a "Journal of Astro-Politics"!

Fascinated at the contrast, this page now discovers that Diversey Engineering is buying a Monarch air gage tracer lathe with Keller attachments, with a facing plate over 90 in. in diameter and a bed 25 ft. between centers. At the same time, Detroit Controls is ordering a gyro production lathe accurate to plus-or-minus five millionths of an inch. Down in oil-rich Houston, Cameron Iron Works thinks it can produce precision high-strength, thin-wall rocket motor casings with its 11,000-ton main ram, 6,000-ton double side ram forging press. But watch out: the real answer lies in a unique variation on the spiral wrap! And if anyone thinks solid fuels are running the liquids out of business, stop and consider: AF is buying large cryogenic equipment to handle liquid hydrogen and fluorine.

Ever wonder how a *Polaris*-launching submarine would know where it was when ready to fire its birds, what with precessing SINS gyros, etc.? Well, Navy wondered, and as a result will install in each *Regulus* and *Polaris* submarine one Type XI periscope that will be able to take celestial shots automatically without the submarine having to surface and a radio sextant enabling a surfaced submarine to shoot sun and moon in overcast weather. These will CX SINS.

And down in the old south, suh, Huntsville is booming. AOMC chief Major General Medaris forecasts that its population will top 100,000 by 1965. Could be, since the General also says that construction on the Arsenal will continue at the rate of $1-to-$1.5-million a month for the foreseeable future. Redstone's payroll nudges $100-million a year for 18,000 employes, and AOMC now controls almost $3-billion in funds annually for its operations at Redstone Arsenal, ARGMA, ABMA, Fort Bliss, White Sands, and the Army's activities at Cape Canaveral, plus its control of all Army missile procurement. Ordnance Guided Missile School, which is graduating nearly 5,000 missileers this year, will graduate double that number next year.

More on money! Somebody figured out that AF BMD is spending on ballistic missiles at the rate of $30 a second, 24 hours a day, 365 days a year. And while we're at it, this page looked up Argus in the dictionary and found that it's a mythical monster "with a human shape but with 100 eyes" . . . Just for the record, ARPA has budgeted $15-million for Project Argus in fiscal year 1959. And of the $72-million listed for "other advanced research", ARPA schedules $20-million for ABMA/JPL; $7-million for AFBMD; $3-million for NOTS; and $44.7-million for follow-up programs . . . which may point the way the wind blows for Army et al.

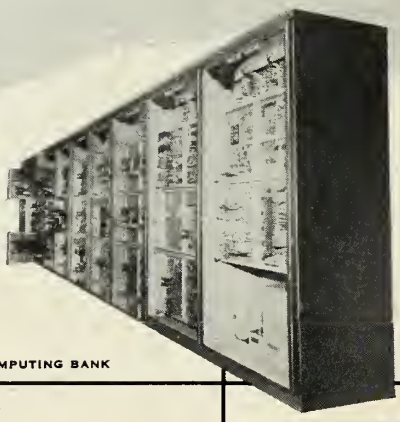
S.H.

FROM CIRCUITS TO CONSOLES
FROM BREADBOARD TO TACTICAL

ERCO has built electronic and electromechanical devices on a production basis — from subminiature transistorized servo amplifiers to complete computers for permanent installation or ruggedized for use in mobile units of all types.

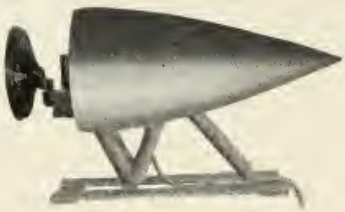
We can work to your specifications and we can supply the design and production engineering to further assist you.

No matter what your requirements are, we can help you. Send today for your brochure . . . "ERCO Production Facilities" . . . for a more comprehensive picture of our abilities.

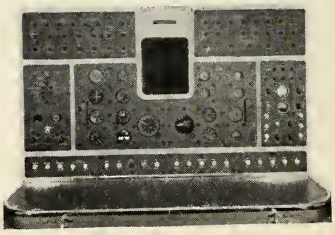


ELECTRONIC COMPUTING BANK

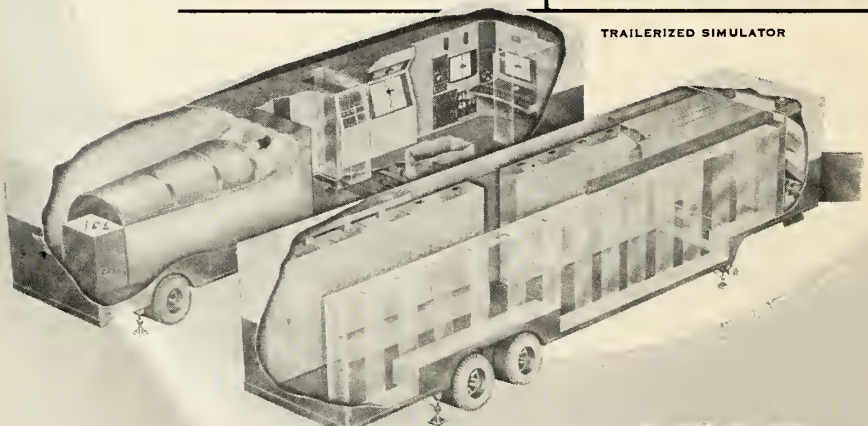
RADAR ANTENNA



TYPICAL CONSOLE



TRAILERIZED SIMULATOR



DESIGNED AND BUILT BY

NUCLEAR PRODUCTS - ERCO DIVISION, ACF INDUSTRIES INC., RIVERDALE, MARYLAND

AMERICAN CAR AND FOUNDRY • AVION • CARTER CARBURETOR • SHIPPERS' CAR LINE • W-K-M • ADVANCED PRODUCTS

Heat Control

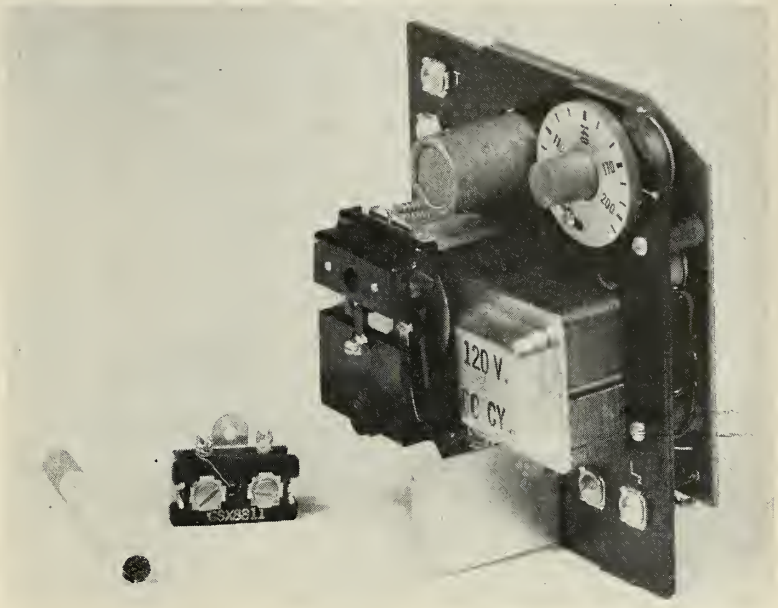
Transistorized Unit Is Versatile

A transistorized amplifier relay system for remote control of temperatures has been introduced by Minneapolis-Honeywell Regulator Co. The company describes it as the world's most versatile temperature controller.

The system consists of a compact transistorized amplifier which serves as the temperature controller, and a vibration-proof mounting containing a thermistor which acts as the sensing element. The thermistor mounting and amplifier relay can be located as much as two miles apart.

Mountings for the thermistors are available in sizes and shapes to fit any application. They can be as small as 3/32" in diameter and 2" long. The company claims that the mountings can withstand blows from a hammer without damages to the sensing element.

The system may be used to control air, surface or immersion temperatures. Amplifier relays are available in eight overlapping ranges of approximately 100°F to permit control from −60°F to 520°F. Control point is very stable, with shift of less than one degree for every 70-degree change in ambient temperature. One relay can be used with a variety of heat sensing units.



The amplifier relay can be either surface or flush-mounted, using a special box which is 5" x 7" x 2⅞". Wiring between sensing element and relay need not be shielded since the bridge circuit is dc powered and presents no capacity balance problem. The amplifier relay has a resistive load rating of 1,500 watts at 240 volts.

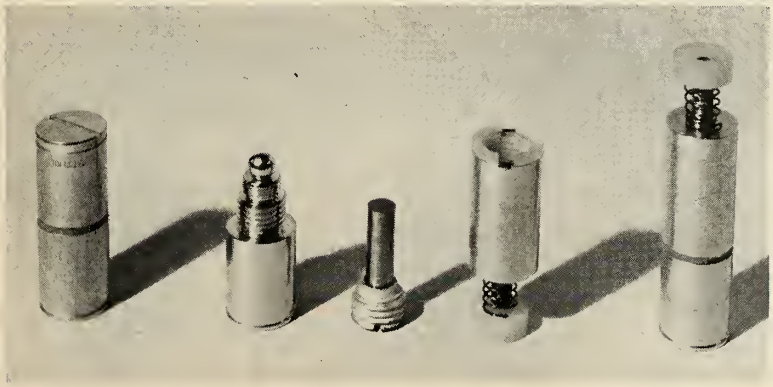
Circle No. 230 on Subscriber Service Card.

Inertia Switch Operates On Unique Basis

Miniature, and lightweight inertia switches that reportedly operate on a new principle, and require only one moving part, have been introduced by Safe Lighting, Inc. The principle of operation may be determined from the components of the reset type switch.

The switch body and a precision ground ball rest in an inverted cone. The Alnico magnet-screw assembly is threaded into the switch body to provide adjustable magnetic attraction to the steel ball. A reset switch cap, with a nylon insulating bushing and push-button, actuates the reset mechanism.

In the new reset type switch, the cap is made of steel. When the ball rolls outward on the cone and makes contact with the cap, it closes the electrical circuit between body and cap. At the same time, it closes an air gap in the magnetic field, which holds the ball in the closed circuit position until it is opened by the reset button.



In the momentary type switch, the cap is made of brass. In this class of switch, the ball will return to the open position.

Reset type switches can be used as one-shot closing devices without the use of a relay, or as memories indicating that a specific acceleration or shock level has been exceeded. Momentary type switches can be used with latching relays for many purposes, or in conjunction with counters to provide statistical counts.

Twenty-four standard models of the two classes of switches provide acceleration levels from .15 to 20 G's.

Circle No. 240 on Subscriber Service Card.

Motor-Alternator Set Serves Ground Equipment

A high performance motor alternator set designed to meet requirements for ground power, test and missile

← Circle No. 80 on Subscriber Service Card.

ground checkout equipment has been developed by General Electric. With its associated control, the set is capable of converting either variable voltage dc or variable voltage and frequency ac to closely controlled constant voltage and frequency ac.

According to the company, the set is designed for 5,000 hours continuous duty with only normal brush maintenance. The unit is usable as a power supply for laboratory test equipment, because it can operate from fluctuating inputs.

A dc drive motor makes it possible to hold the output speed and frequency nearly constant by controlling the motor with a static buck-boost field control. When input voltages are ac, rectifiers are used to supply dc voltage to the drive motor.

Accurate regulation of output voltage is performed by a static field control device coupled with the alternator field. This system incorporates a field control rheostat which permits selection of the nominal regulated output voltage. Plus or minus 7½% adjustment is possible.

The new high performance motor alternator set is about 8½" in diameter and 25" long. It weighs about 230 lbs., including rectifiers and necessary control mechanisms.

Circle No. 235 on Subscriber Service Card.

Small Servo Amplifier Entirely Transistorized

Kearfott Co., Inc. has developed a miniature, completely transistorized servo amplifier, that can deliver a maximum power of 2.5 watts, and drive Kearfott motors R119-5 or R124-5.

The unit is shock and vibration resistant, and suited to missile applications. The amplifier may be readily mounted inside individual servo cans along with other components of the servo with which it is associated. The amplifier is completely potted in its case, with a special potting compound having high strength, stability, and lightweight characteristics.

Gain of the amplifier may be easily established at various values between 150 and 1,000 merely by inserting one external resistor to achieve the gain desired. Should it be necessary to interchange one unit for another, gain tolerance between inter-changed units will not exceed ±12%.

Weighing only 1½ ounces, the amplifier measures 1½" x 1⅛" x 9/16", and operates through a chassis operating temperature range of −55°C to 110°C. Throughout that temperature range, gain stability is within ±2.5 db, power gain is 62 db, and voltage gain is adjustable between 43.5 db to 58 db by means of an input resistor.

Circle No. 234 on Subscriber Service Card.

Direct-Reading Knob Eliminates Errors

A knob that eliminates reading errors by single scale read-out and low ambiguity has been produced by Circuit Instruments Inc.

This direct reading, three-digit, turn-

Circle No. 129 on Subscriber Service Card.

Note—Commercial and Military Packaging Engineers:

LINK-LOCK

...is the rugged answer to your exacting container closure problems

LINK-LOCK plays an important role in the design of this container

Simmons' LINK-LOCK provides pressure-tight, impact-resistant closure, plus quick closing and opening, on this reinforced fibrous plastic product made by the new automatic pre-form process developed by Pressurform Container Corp. The two-section container will be used by the Light Military Electronic Equipment Dept. of General Electric Company for shipping airborne radar jamming units to the Air Force.

Of prime importance are the container's lightness, strength, rust- and mildew-resistance, ability to withstand high pressures without distortion, ease of locking and opening, and low cost.

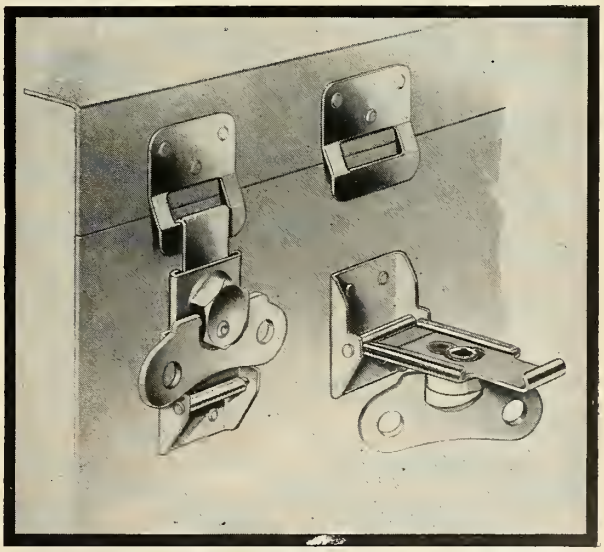
Here's why LINK-LOCK is ideal for use on military cases produced to exacting specifications as well as on inexpensive commercial containers:

- High closing pressure with light operating torque... insures pressure-tight seals where required.
- Impact and shock resistant (positive-locking).
- Compact design...lays flat against case even when unlocked.
- Available in 3 sizes, for heavy, medium, and light duty.
- Opening and closing by wing-nut, screwhead, or hex nut.
- Flexible engagement latch design...can be varied to suit different conditions.

Also available! Spring-Loaded LINK-LOCK... ideal for less expensive containers where costs won't permit precision production. Spring provides take-up to compensate for set in gasketing, irregularities of sealing surfaces, and mounting inaccuracies.

Where does the versatile Simmons LINK-LOCK belong in your design? For full information and specifications, send for LINK-LOCK DATA SHEETS today. Samples and engineering service available upon request.

Courtesy of Pressurform Container Corp., and the LMEE Dept. of General Electric Co.



SIMMONS
FASTENER CORPORATION
1791 North Broadway, Albany 1, New York
QUICK-LOCK SPRING-LOCK ROTO-LOCK LINK-LOCK DUAL-LOCK

See our 8 Page Catalog in Sweet's 1958 Product Design File

indicating knob is used to position any multi-turn device of ten turns or less. Attached directly to a precision potentiometer, it will accurately read the position of the device directly to within a hundredth of a turn.

Made as a companion to Circuit Instruments' line of precision potentiometers, it can be directly mounted on any device with a ¼" shaft.

Fingertip turn of the brake screw locks the dial at its setting. The knob requires only a 3/32" hole on the panel for locating the pin, and is attached by set-screw directly to the shaft of the potentiometer.

The knob is available in black or clear anodized aluminum with black numerals.

Circle No. 242 on Subscriber Service Card.

Test Table Developed for Missile Components

Ideal-Aerosmith, Inc. is manufacturing a new azimuth, rock and tilt test table for pre-testing of missile components. The motion table is ground equipment to simulate the attitudes of flight.

Moving parts are entirely housed, and consist of motor, gear train and levers to provide an angular motion in the azimuth, rock and titlt axes simultaneously. The rock and tilt motion provides a 15° included angle . . . the azimuth motion providing an included angle of 15°, plus or minus 1°.

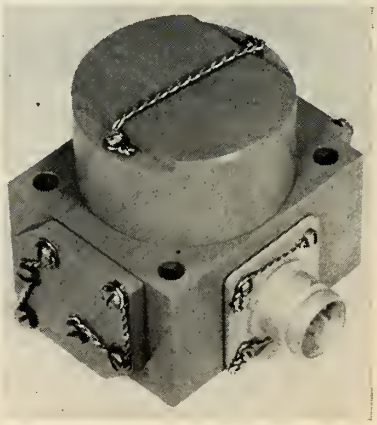
The quick-acting manual adjustment brings the table surface to a level position in a given azimuth with .1° in all axes, by action of a micro switch and preset stops or dogs.

The table can be adapted to remote control . . . the duty cycle is continuous operation . . . and the modular design provides that all major components, such as motors, relays and components boards, as well as functional modules can be installed or replaced using solderless connections.

Circle No. 248 on Subscriber Service Card.

Compact Servo Valves Feature Missile Needs

Lightweight, compact electro-hydraulic servo valves, designed to meet the requirements of missile hydraulic servo systems, are available from Pesco



Products Division, Borg-Warner Corp.

The valve design is said to feature fast response, low internal friction, minimum null shift, faithful reproduction of small input signals and insensitivity to variations intemperature and load or supply pressures.

The servo valve is a proportional flow control unit. According to the company, it operates on a dynamic continuous flow sensing principle, made possible by a unique flowmeter design.

Output flow of hydraulic fluid is linearly proportional to the amplitude of the electrical differential input signal. Flow-type feedback control in the

unit permits relatively large power spool overlap, allowing larger spool clearances and reducing costs.

This design configuration produces a high fidelity valve with dead zone held to an absolute minimum. Gain in the valve is constant despite variations in load and supply pressures.

Servo valves are available for rated flow capacities from ½ gpm to 7 gpm, and can be designed for use with any required system pressure 500 psi or higher.

Circle No. 238 on Subscriber Service Card.

Desk-Top Size Computer Developed for Research

Donner Scientific Co. is marketing a new desk-top size, high-accuracy analog computer for engineering analysis and research. The new Model 3400 computer offers 0.1% performance with chopper stabilized printed circuit amplifiers.

A typical computer contains 10 amplifiers, five initial condition power supplies, and supporting control and metering circuitry. Performance of the 3400 series compares favorably with that of larger computer consoles.

Among the key features of the Model 3400 are: positive and negative reference voltage available at problem

board; removable problem board with expanded jack field; repetitive or continuous operation for scaled and real time solutions; simultaneous control of multiple computer arrangements from any one computer or from remote station; individual overload indicators and amplifier balance controls; operation from 115/230 volts (±10%), 50-60 cps power.

Specifications for the chopper stabilized amplifiers are: dc gain in excess of 50 million; maximum offset of a unity inverter, less than 200 microvolts/day; drift of a unity integrator, less than 100 microvolts/second; phase shift of a unity inverter, less than 0.50 at one kc.

Circle No. 232 on Subscriber Service Card.

Tape Recorder/Reproducer Offers Range of Speeds

A digital magnetic-tape recorder/reproducer is now available from Consolidated Electrodynamics Corp. The instrument provides users with a wide range of standard tape speeds and tape widths.

Standard speeds range from 7½ to 100 ips. Two low speeds (0.4 and 0.8 ips) and a high speed of 150 ips are also available from this manufacturer.

Tape widths are ¼", ½", ¾", and 1". Start and stop times are less than three milliseconds with a guaranteed accuracy of 0.05" in both forward and reverse directions.

Digital recording inputs can be accepted from such sources as analog-to-digital converters, storage registers, punched paper tapes, punched cards and tape readers. The readout of the digital magnetic tapes may be used to feed digital computers, card punches,

LINK YOUR CAREER TO TOMORROW

we speak

your language

at Link

Sure, there's a lot of dreaming still to be done in electronics! But there's an awful lot that needs *doing*. Link Aviation, Inc., pioneer of flight simulation, is now operating fine new laboratories at Binghamton, New York and Palo Alto, California, for that very purpose... to put electronics to work at new exciting jobs. A selected number of engineers are needed at this time.

There are many reasons why Link chose these communities for their laboratories.

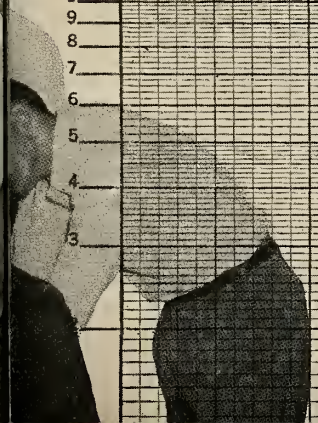
You can settle down and raise a family. And, if you intend to continue advanced technical study, you can benefit from the Honors Cooperative Program that provides advanced study, under regular University curriculum, during working hours with all tuition expenses paid by Link. The engineers Link selects will not be the type who have mere "competency" as their standard. Nor will they be the ivory-tower genius type (though some works of genius may be expected). What Link needs is men who will carry projects through from concept to development. In addition to providing you with a comfortable physical climate in which to live, an ideal mental climate in which to work, and an enviable academic climate in which to advance your studies, Link furnishes you with all those employee benefits you associate with the most advanced management practice. Fine pay. Good vacations. Generous hospital, health and retirement benefits. Link is right in believing "we speak your language" because management men are engineers. They understand your work and point of view. This kind of administration provides engineering thinking right up to policy level. If this stimulating climate appeals to you...

Write:
Mr. Ken Viall
Link Aviation, Inc., Dept. X-4
Binghamton, New York
Or:
Mr. Joe Larko
Link Aviation, Inc., Dept. X-4
P.O. Box 1313
Palo Alto, California

LINK

GENERAL PRECISION EQUIPMENT CORPORATION GPE

LINK AVIATION, INC.
Binghamton,
New York



LIGHTER!

STRONGER!

BRIGHTER, more attractive appearance

Another typical example of how

Hunter Douglas Aluminum Cold Forgings

improve product performance and saleability

This general purpose "WIG-O-FLEX" flexible coupling, manufactured by E. B. Wiggins Oil Tool Co., Inc., Los Angeles, is widely used in the aircraft industry for fuel lines, as well as air, oil and occasionally hydraulics. It operates over an ambient temperature range of −65°F to +450°F, usually within a 125 psi maximum operating pressure.

Formerly a permanent mold casting of 356 T-6 aluminum alloy, an alert engineering department saw product improvement possibilities by cold forging without increasing cost.

Hollow, closed-end blanks are now cold forged from 2014 T-6 aluminum alloy. Parts are subsequently finished using high-production "chuckers." The final advantages resulting from cold forging are as follows:

STRENGTH—Approximately 3 times greater than before.

WEIGHT REDUCTION—⅓ less weight than former coupling. Increased material strength permits thinner walls. Wall thickness now limited only by mechanical problems of turning and knurling.

HIGH SAFETY FACTOR—Operating pressure is 125 psi. Pressure tests actually exceed 850 psi.

IMPROVED APPEARANCE—Bright finish, uniform knurling and color anodizing has vastly improved eye appeal.

ECONOMY—All advantages gained with *no* increase in selling price.

If your components can benefit by high strength, precision tolerances, no porosity, no draft and improved surface finishes investigate Hunter Douglas Aluminum Cold Forgings!

FREE BOOKLET: A comprehensive treatise on cold forging is available to letterhead requests. Write for the "Story of Aluminum Cold Forgings."

Hunter Douglas Aluminum

DIVISION OF BRIDGEPORT BRASS COMPANY • Dept. MR-6 3016 Kansas Avenue, Riverside, California

Circle No. 172 on Subscriber Service Card.

billing machines, plotters, machine tool program control units and data printers.

Typical of the 5-680 series is the continuous operation (16-hour day, 5 day week) with a minimum operational life of 5,000 hours without a major overhaul.

The new series features built-in end-of-tape sensing, all-metal surface magnetic heads, and low-flutter characteristics. Fast forward and rewind speeds (250 ips, nominal) results in rewind time of three minutes for a full 10½" reel.

Circle No. 241 on Subscriber Service Card.

Insulator Mount Possible For Transistors, Diodes

New stud-type copper-and-ceramic insulator mounts for diode, rectifiers and transistors have been developed by Thermo Materials, Inc.

The insulator mounts, rated up to 4,000 volts, are designed for high altitude operation and to allow highly efficient heat transfer to the chassis or ground. In overall thermal drop the mounts are rated better than 1°C per watt.

Physically, the mounts consist of a copper alloy cylindrical heat sink, copper alloy flange and ceramic insulator brazed together into a unit. A copper alloy mounting screw is supplied in two thread sizes; the threaded mounting bore in the heat sink is available in four thread sizes.

Circle No. 231 on Subscriber Service Card.

Power Supply Provides Variable Voltages

Spellman Television Co. has introduced its model LAB-90, a high voltage regulated dc power supply with voltages continuously variable from 0 to 90 kv. Output current is at 1 ma. at 80 kv; 2 ma. from 40 kv down.

Voltage regulations are better than 1% throughout the range. Panel dimensions: 19" wide, 26" high & 18" deep. Available complete with HV meter in either positive or negative polarity output.

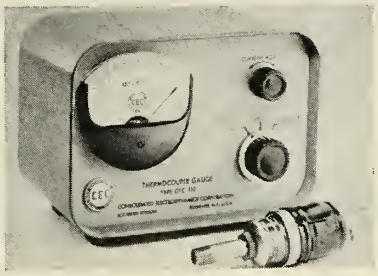
Circle No. 247 on Subscriber Service Card.

Thermocouple Gauge Now Battery-Operated

A single-station, battery-operated thermocouple vacuum gauge designated Type GTC-110 is available from the Rochester Division of Consolidated Electrodynamics Corp. Powered by a 1.5 volt size "D" flashlight battery, contained in the gauge housing, the GTC-110 covers the range from 0 to 1000 microns Hg on one non-linear scale, with 5 microns the smallest indicated marking.

Recalibration is accomplished without a reference gauge by setting the indicator at zero when the pressure in the system is below 1 micron.

Provision is made for checking the heater current setting by means of a potentiometer knob on the front of the



gauge. The compact cabinet-mounted gauge is operable as a moderately sensitive leak detector throughout its range.

The all-metal TG-77 sensing tube is rugged, inexpensive and not harmed by exposure to atmosphere.

Zero drift, in this particular product, has been reduced by using a lower heater current to decrease the rate of thermal decomposition of organic vapors with the tube.

The GTC-110 gauge is 4 7/8" high, 6½" wide, 3¾" deep and weighs 4½ lbs.

Circle No. 237 on Subscriber Service Card.

Tungsten Carbide Coating Has Extreme Hardness

A tungsten carbide material that provides a working surface hardness of approximately 98 Rockwell A is being marketed by Walmet Corp. under the trade name of Spra-Carb.

According to Walmet, the coating is an extremely hard tough layer of tungsten carbide particles bonded with nickel, chromium and boron alloy. The binder alloy imparts properties for toughness and strength, as well as bonding to the base metal. The carbide also contributes to the high wear resistance.

In machining, the coating can be worked with a good hard grade of tungsten carbide. In grinding, a green silicone wheel may be used for rough or finish grinding if suitable grit wheels are used.

About 0.010" extra stock is sprayed on the product for finishing purposes to provide a range of thickness of 0.010" minimum to 0.062" maximum after grinding or finishing.

Circle No. 254 on Subscriber Service Card.

Narrow Passband Filters Feature Miniature Size

High selectivity, stability and subminiature size are reported to be combined in the new Bulova Type 2E2SM6 narrow passband filters, manufactured by the Electronics Division, Bulova Watch Co. Operating in the frequency

. . . new products

range of 175 to 300 kc, they are said to be the smallest filters available that offer such steep rejection slopes.

In bandwidths from 20 cps to over 1 kc, the filters can be made with a

shape factor (60/6 db) of 3.5 to 1. Insertion loss (dependent upon bandwidth) can be as low as 1 db, while the ripple in the passband is less than 1 db. Drift is less than 10 cycles over the temperature range of 0°C to 75°C.

Circle No. 233 on Subscriber Service Card.

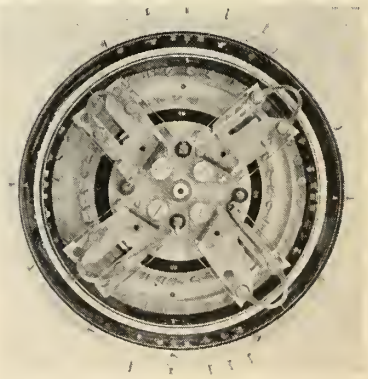
Precision Potentiometer Claimed Most Accurate

British Radio Electronics Ltd. is marketing the Colvern precision sine/cosine potentiometer No. 9600, for which the company claims a law accuracy of ±0.05% peak to peak.

The machined light-alloy case is fitted with resistance elements wound on shaped cards, each card covering 1800; pairs of cards being joined with metal bridges to give 360° of track.

Center taps of the potentiometer are on a single turn of wire and one or two pairs of concentric cards can be fitted, each carrying two brushes to give either one sine and cosine or two separate sine and cosine outputs.

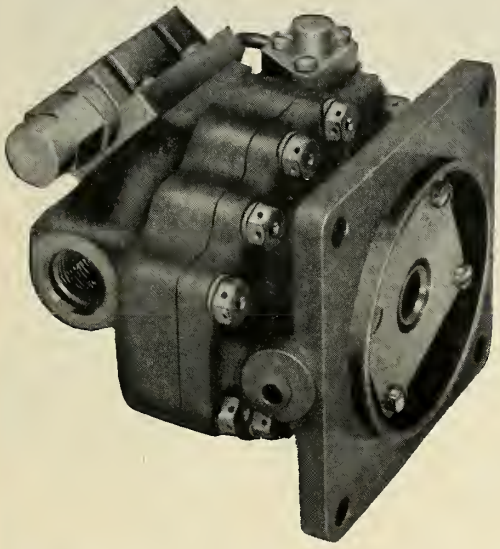
Resistance range of the unit is 12,-500 to 50,000 ohms, and the resistance

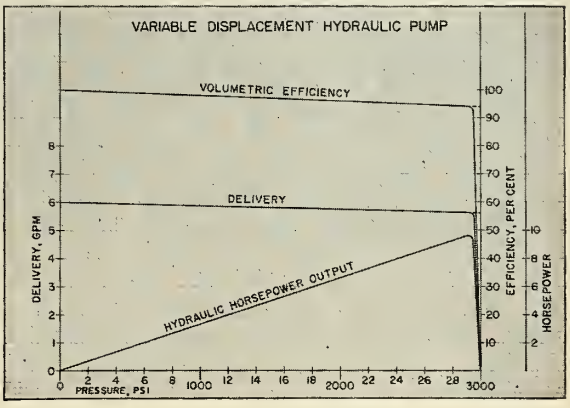


tolerance is ±5%. Dissipation is 5 watts, maximum working voltage 1000 vdc and maximum starting torque is 25 oz./in.

Life expectancy of the series 9600 potentiometer is dependent on the con-

New Hydraulic Pump for 550° F and 12,000 RPM Service





Sizes and capacities designed to meet your requirements

This new Sundstrand hydraulic pump successfully meets the need for a lightweight, compact unit capable of operating at elevated temperatures with high reliability. Note that it is rated for service to 550° F *inlet oil*, as well as ambient temperature.

In addition to the .125 cu. in pump illustrated, other sizes will be available as required.

The new pump is a result of a continuing Sundstrand program which is crossing previous temperature barriers for hydraulic components. Inquiries on requirements in high-temperature areas are invited.

Mail coupon for complete technical data on the new Sundstrand pump for high-temperature service.

Characteristics of Pump Illustrated

- **Flow: 6 gpm**
- **Speed: 12,000 rpm rated, overspeed to 18,000 rpm, rapid acceleration.**
- **Temp. Range: –65° F to 550° F *inlet* and ambient.**
- **Inlet Pressure: 60 psig.**
- **Discharge Pressure: 3000 psig.**
- **Cutoff: Maximum full flow pressure to zero flow pressure within 50 psi.**
- **Displacement: 0.125 cu/in. rev.**
- **Weight: 5.0 lb.**
- **Size: 4.344" over-all length, 4.452" over-all width.**
- **Lubricant or Fluid: Any of those common to aircraft applications.**
- **Volumetric Efficiency: 94% at rated speed and pressure.**
- **Mil Specs: Characteristics conform to MIL-P-7740B Type IV System.**

Sundstrand Aviation
2417 Eleventh St., Rackford, Ill.

Please send data on pump for 550° service.

Name_____

Title_____

Company_____

Address_____

City_____ State_____

☐ Immediate ☐ Reference

SUNDSTRAND **SUNDSTRAND AVIATION**

Division of Sundstrand Machine Taal Campany, Rackford, Illinois
Sundstrand Turbo, Denver, Colo. • Western District Office: Hawthorne, Col.

ditions of use, but at speeds of 30 rpm, a life on the order of 500,000 revolutions can be expected. The company maintains that the unit is the most accurate sine/cosine potentiometer available as a production item.

Circle No. 255 on Subscriber Service Card.

Indication and Control Devices Available

A series of synchros, resolvers and linear transformers for indication and control have been developed by Induction Motors of Calif., a division of Induction Motors Corp. The new units are for 26v and 115v, 400 cps operation. Stainless steel construction with high nickel laminations provides for corrosion resistance. Operating temperatures are from −50°C. to +125°C.

The size 8 Synchro is used to actuate a pointer to reproduce angular data at remote points, such as in trim flap and similar control surface applications. According to the company, in addition to position-indicating on valves, computer shafts and missile components,

the units achieve extreme accuracy as sensing elements and in servo mechanisms.

The weight of the synchros is 44 grams. Length of the size 8 is 1¼" and diameter is ¾".

Circle No. 236 on Subscriber Service Card.

Screw Locking Inserts Provide Sustained Torque

Groov-Pin Corp. has introduced a new NYLOK Series of self-tapping, screw-locking Tap-Lok Inserts. The nylon pellet imbedded in the insert provides a sustained locking torque to the fastening screw and at the same time provides a seal both to the internal and external threads of the insert.

The Nylon resists heat, cold, moisture and most commercial solvents according to the manufacturers. The inserts are applicable for military and civilian use, in aluminum, magnesium and other structural materials where a securely locked and stronger threaded connection is essential.

Available in cadmium plated case-hardened steel and stainless steel—

Wider variety of alloys than ever before now available for castings from Standard

From Standard, you can now enjoy the same superior, personalized service—and rapid delivery—on alloy steel castings as you have enjoyed in the past on carbon steel castings.

Our newly expanded facilities—including installation of a newest design electric furnace—make it possible for us to give you even more complete service than ever before.

We invite you to discuss your next casting needs with us. You will appreciate our personal interest in your problems—and our economical methods of solving them. Write Dept. 6-F.

Standard Steel Works Division

BALDWIN · LIMA · HAMILTON

BURNHAM, PENNSYLVANIA

Rings • Shafts • Car wheels • Gear blanks • Flanges • Special shapes

. . . new products

in regular and medium lengths. Inserts won't strip—will withstand severest vibration without loosening and meet all torque requirements of MIL N-25027 (ASG).

Circle No. 256 on Subscriber Service Card.

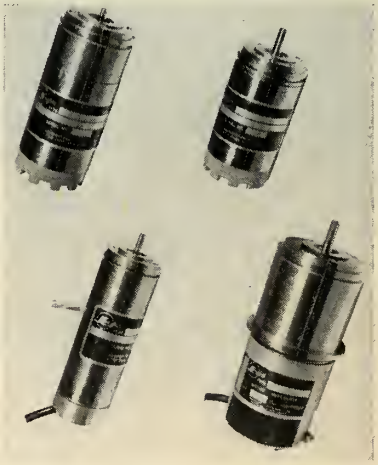
Precision Tachometer For Math Integration

A variety of servo motortachometers, produced by Kearfott, Co., Inc., will find application as integrators in mathematical computations demanding accuracies on the order of .01%.

Ranging from Size 11 (1.062" diameter) to Size 20 (1.950" diameter), these components exhibit a high degree of output voltage linearity, no frequency change between input and output voltages, stable output voltages over the temperature range specified, and extremely low harmonic distortion.

Typical linearities of output voltages range from .03% to .10%. Compensating networks are also available from the company.

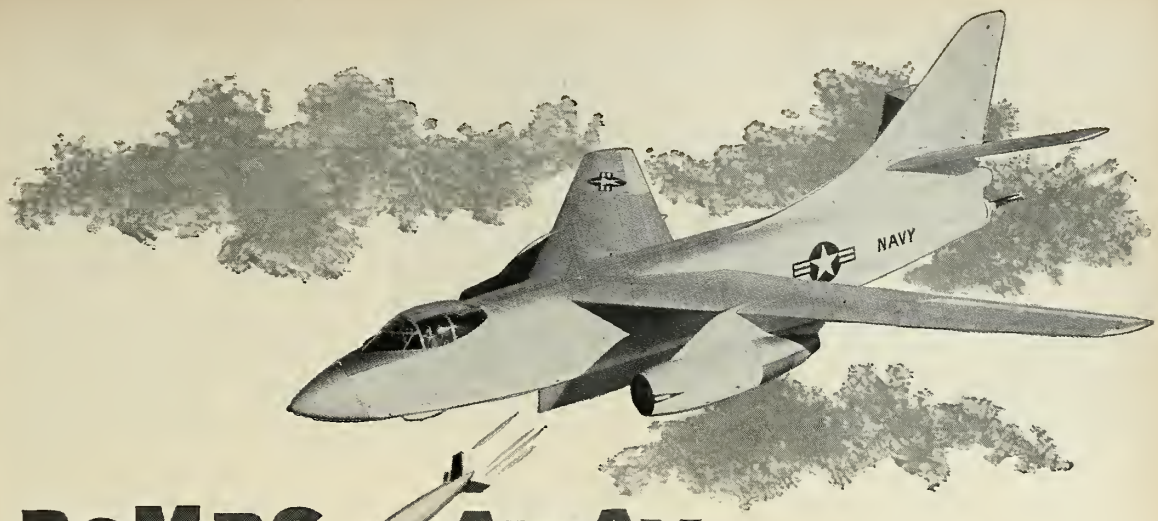
To reduce error caused by output variations due to temperature, either



of two methods is employed in these units. Temperature is controlled by thermostatic or mag-amp means, or temperature compensation through use of integral thermistor-resistor network's used, so no warmup time is required before operation.

Temperature-compensated tachometers do not need auxiliary power or equipment for heating. In certain special applications, heating and compensation are combined in a single unit to provide accuracy over wide ambient temperature ranges, without employing an accurate heater control device such as a precision thermostat or mag-amp.

Circle No. 239 on Subscriber Service Card.



BOMBS AWAY...

with the help of heat-treated TITANIUM ALLOY

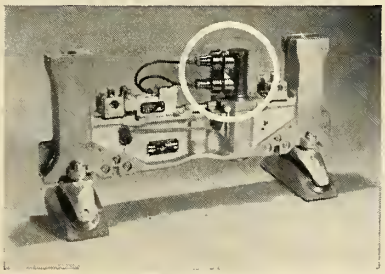
On high speed military planes, such as the Douglas A3D-2 Skywarrior and other jet aircraft, the bomb ejector rack is a complicated and critical mechanism. Any failure might endanger both airplane and pilot.

Three basic parts make up the ejector . . . cylinder, piston and breech. The latter presented the greatest design problem, due to its multitude of functions and irregular shape. Similar breeches made from stainless steel frequently heat-checked and failed, during test firing or hydrostatic testing.

Experience and design calculations suggested that 6Al-4V titanium alloy, produced by Mallory-Sharon, was the metal most likely to meet the exacting requirements.

Actual firing tests confirmed the advantages of titanium for this application. The titanium alloy breech withstood 300 firings before any evidence of heat checking appeared. No failures occurred in firing . . . and the breech withstood hydrostatic pressure of 27,000 psi without failure.

Here's one more example of titanium's outstanding performance in meeting critical design problems. May we help you explore its advantages for *your* product or application? Write for "Titanium Fact File".



Above: Bomb ejector rack, showing forged titanium alloy breech (circled).

Below: Titanium alloy ejector breech, before and after machining.

WHY TITANIUM WAS CHOSEN

1. High strength-to-weight ratio at elevated temperatures for short times.
2. Superior corrosion and erosion resistance.
3. Excellent forgeability.
4. Good machineability in the heat-treated condition.
5. Low susceptibility to hydrogen embrittlement.
6. Good thermal stability.

MALLORY SHARON

MALLORY-SHARON METALS CORPORATION · NILES, OHIO

Integrated producer of Titanium • Zirconium • Special Metals

missile electronics news . . .

Data Processing System Speeds *Thor* Static Tests

A $100,000 electronic data processing system which will automate static testing of the *Thor* intermediate range ballistic missile has been installed at Edwards Rocket Base near Boron, Calif., by the Systems Division of Beckman Instruments, Inc.

The system, ordered by Douglas Aircraft Corp., prime contractor, will speed missile ground tests by automatically recording temperatures, strains and vibrations from up to 350 sources at the rate of five samples per second. It also will alert test engineers the instant any monitored variable exceeds pre-set limits.

The system uses transistors and other semiconductor components instead of vacuum tubes. This enables the unit to record information continuously for extended periods of time without interruption for service.

The electronic unit records test information on perforated paper tape. The tape then is fed into a computer which converts data into form required for engineering study.

Manufacturer Plans Space Lab in Three Years

Northrop Aircraft has detailed its plan for putting a recoverable manned space laboratory into orbit within three years.

The space laboratory, to be used in preparation for U.S. military ventures into space, would be a bullet-shaped capsule, approximately 7 ft. in diameter and 10 ft. long. The passenger would be strapped in a near-reclining position to withstand the forces of acceleration and deceleration. The station would be boosted into an orbit by contemporary rocket engines.

While in orbit, the vehicle would be turned by attitude control jets so that its blunt end faced forward, providing a high drag to slow it as it hurtles back into the atmosphere. It would make several revolutions, and then reverse-thrust rockets would reduce velocity.

The capsule would reenter the atmosphere at a shallow angle which would keep the heating rate and deceleration at acceptable levels.

The blunt end would create high drag and slow the capsule from 25,000 ft. per second to 1,000 ft. per second by the time it reaches a 60,000 ft. altitude. A parachute would be used at a lower altitude for a gentle landing.

Amplifying Tube Covers 685-985 mc Frequencies

Tests have been completed on a wide-tuning range 10 kilowatt amplifier klystron, suitable for forward scatter communications and UHF television.

Known as VA-833A, the tube, developed by Varian Associates, delivered more than 10 kilowatts over a 1.4/1 range of frequencies from 685 to 985 megacycles. The tube is being scaled to cover lower frequencies of the UHF TV band and forward scatter portions of the radio spectrum.

During tests, conversion efficiency ranged up to 50%, and power output to 13 kw was reached without apparent strain. Power gain ranged from 40 to 60 db.

The four-cavity amplifier klystron requires about one watt of drive power and needs only addition of dc power supplies, cooling and counting magnet to form a complete microwave amplifier unit. The tube contains all the rf circuitry required to boost the one watt signal to 10 kw.

Four internal cavities tune with individual drive shafts over the full range from 685 to 985 mc. Noncritical klystrons of this type carry a wide band of frequencies composing the whole baseband of some 140 communication channels in lieu of cables and repeater stations.

Air Force Adds Ships To Missile Testing Range

The Air Force has added five ships to the "fleet" which is gathering telemetered data from missiles and satellites along part of the 5,000-mile missile test range, stretching from Cape Canaveral, Fla. to Ascension Island off the west coast of Africa.

The small cargo vessels with the maritime designation of CIMAVI are larger than the Air Force's six freight supply vessels which have been servicing the tracking range for more than a year.

The ships are operated by Pan American's Guided Missiles Range Division, and record impact data and chart the flight of missiles. The ships have headquarter bases at Recife and Trinidad.

They are a vital part of a vast system that watches the progress of U.S. "birds" from launch to impact.

(m/e news cont'd on p. 202)

. . . m/e news

Antenna Company Forms California Research Unit

D. S. Kennedy & Co. of Cohasset, Mass., designers and manufacturers of large antennas for radio telescopes, communications, radar and tracking, has established a Palo Alto, Calif. research affiliate company.

Satellite-Kennedy, Inc. will conduct electronic, electrical and mechanical design research and development. Fred W. Morris, Jr., vice-president, will direct research and development, and will serve as engineering consultant and assistant to the president.

Marshall E. Mower is business manager, secretary and controller. Charles M. Brown is engineering and production manager.

New Unit Can Handle 10,000 Measurements

A two-unit digital data recorder-transcriber is now available that can make 10,000 measurements, in one second, of temperature, pressure, strain and other variables—4,800,000 separate pieces of information in eight minutes.

Developed by Davies Laboratories Division of Minneapolis-Honeywell, the system consists of a recorder, which absorbs data as electrical signals and converts into digits; and a transcriber, which has an electronic playback and selects and rearranges information for further computer processing.

Western Electronic Show To Be Held in August

The Western Electronic Show and Convention to be held in Los Angeles August 19-22, is expected to attract more than 30,000 visitors. The exhibits will be held at the Pan Pacific Auditorium, and the technical programs and other events will run concurrently at the Ambassador Hotel.

For the first time, WESCON will be segregated into two separate exhibits. Three buildings will house the display of electronic equipment, test equipment and circuit components. The fourth pavilion will contain exhibits of electronic production equipment, raw materials and hardware. Hugh P. Moore, show director, said WESCON has grown to a size requiring that displays be categorized.

WESCON is the joint effort of the Los Angeles and San Francisco sections representing the 7th Region Institute of Radio Engineers and the West Coast Electronic Manufacturers Association.

(m/e news cont'd on p. 204)

. . . m/e news

Microsecond Camera Available for High Speed

An exposure time of 0.005 microsecond is now available with a high resolution camera manufactured by Electro-Optical Instruments, Inc., Pasadena, Calif.

The large aperture and high resolving power of the camera's electro-optical shutter unit permits photographic study of ultra high speed phenomena. Exposure can be synchronized to within 0.001 microsecond.

Designated Model KSC-50, it has a Crown Graphic "45" camera, electronically gated "Kerr cell" shutter unit, power supply, and a millimicrosecond electronic modulator.

The modulator has a high voltage "Kerr cell" pulse-forming network and an auxiliary synchronizing pulser, which gives a fast, high voltage pulse to trigger both the "Kerr cell" network and phenomenon under study. Adjustable delay can be introduced between the synchronizing pulser and "Kerr cell" network.

For versatility, alternate "Kerr cell" plug-in pulse forming networks allow a selection of exposure times from 0.005 to 0.1 microsecond. The modulator and "Kerr cell" module are separated by a flexible cable connection, allowing independent positioning of the camera and shutter unit.

Synchronous Motor Delivers High Torque

A hysteresis synchronous motor in BuOrd size 10 with a maximum length of 1 3/16", has been developed by the Mechatrol Division of Servomechanisms, Inc. It will operate directly from 115 volt line, 400 cycle, single or three phase, delivering .12 oz.-in. at 8,000 rpm pull-out torque.

The same unit can be supplied with a gearhead, with a maximum length of 2 1/8" up to a ratio of 200:1, and with a maximum length of 2 3/8" up to 10,500:1.

Space Weather Bureau To Track Meteoroids

Creation of an "outer space weather bureau" to track and avoid deadly clouds of meteoroids may be needed for man's successful conquest of space, A. Douglas Aircraft company scientist said.

A. M. Mayo, an equipment and safety research engineer, said the science of predicting and locating high concentrations of meteoroids or "space debris" may become "at least as im-

JUST OFF PRESS

AVIATION FACTS AND FIGURES

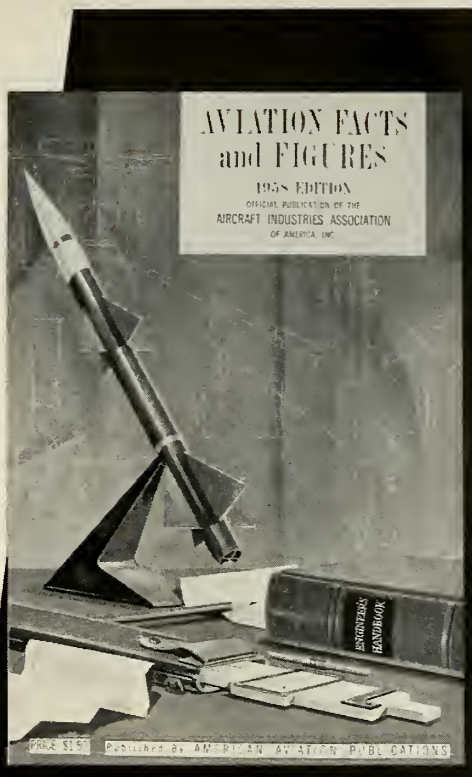
OFFICIAL PUBLICATION OF THE
AIRCRAFT INDUSTRIES ASSOCIATION
OF AMERICA, INC.

BRIEF, but thorough in it's briefing . . .

the new, completely revised 1958 edition of

AVIATION FACTS and FIGURES

concise, handy treasury of aviation data compiled and edited by the Aircraft Industries Association of America and published by American Aviation Publications, world's largest aviation publishers.



gives you over 100 pages of accurate, illustrated data:

— Size 6 x 9 —.

production and facilities • military aviation • guided missiles • research and development • manpower—finance • general utility aviation • helicopters • airlines and transportation • aircraft exports • aircraft companies and sources

- a Guided Missile section which reviews and points up all the outstanding developments of 1957.
- a new, enlarged Aviation Exports and Foreign Aviation section with more information than ever before.
- a Production and Facilities section covering the sequence of events affecting the aircraft industry.

Order copies for yourself, your organization and your associates.

CLIP THIS COUPON TODAY

AMERICAN AVIATION PUBLICATIONS
1001 Vermont Ave., N. W., Washington 5, D. C.

Send_____copies of AVIATION FACTS AND FIGURES @ $1.50 each.

Signed.....

Company.....

Mail Address.....

☐ Home? ☐ Bus.?

City..... Zone..... State.....

portant as that of meteorology or weather forecasting on earth."

Mayo disclosed that pitting, temperature rise, and penetrating effects of meteoroids present increasing problems as new count data becomes available. In addition, he said, heavier concentrations of debris are known to exist in the tails of comets and in the form of "space dust clouds."

Mayo also advanced a series of complex factors which could lead to a new theory on penetration of the structural skin of a space craft.

Explaining the phenomena created by minute meteoroids striking the skin at hypersonic impact speeds, the Douglas engineer said the energy from impact is dissipated in the form of radiation, ionization and evaporation of material, melting, heating and physical displacement.

In addition to designing the most effective primary penetration resistance into the outer shell of a space vehicle, Mayo indicated it may be desirable to incorporate another inner surface with automatic sealing qualities like those found in self-sealing tires and tanks.

He also revealed that data from satellite tests currently being conducted by the U.S. should soon be available in sufficient quantity to help science solve the meteoroid penetration problem.

Electronics

EIA Convention Hears Industry Report

In a recent annual report to Electronic Industries Association members, the president of the association, Dr. W. R. Baker, pointed out that despite some falterings in the U.S. military program and in the face of an economic decline, the electronics industry has continued to grow.

Dr. Baker's report was given at the annual EIA membership meeting at the organization's 34th convention in Chicago.

"According to estimates of our Marketing Data Department," Dr. Baker continued, "the dollar value of manufacturers' sale was $7.5 billion compared with $5.6 billion in 1956-57.

"Since the abortive cutback in military spending in 1957, Russia's *Sputniks* have reversed the trend, and today's military procurement program is at its highest peacetime rate. More significantly to us, the percentage of Defense Department funds being used to purchase electronic equipment and components has risen at an even more rapid rate.

(m/e news cont'd on p. 208)

. . . m/e news

"Before the Korean War electronics accounted for approximately 10% of military purchases. Currently the rate is 24%, and budget figures for the next fiscal year, now before Congress, indicate this figure may rise to 30% in 1958-59 and go higher thereafter," the EIA chief added.

"It now appears that the military electronic segment of our industry is now undergoing severe changes. Increasingly complex manufacturing requirements and military dependence on constant research and development have narrowed the field of qualified bidders. The need for small numbers of highly specialized components often has made it unprofitable for a manufacturer to produce them. The day when an electronic hardware manufacturer could turn out standard components or equipment in large volume for the military seems to have ended—at least for the present," Dr. Baker stated.

• **Roll with punch**—He reported that the industry is "never one to cry too long over spilt milk. Long accustomed to quick changes to meet competition, the electronics industry, I'm confident, will adapt itself to the changing times and market conditions, whether for the military or the commercial customer."

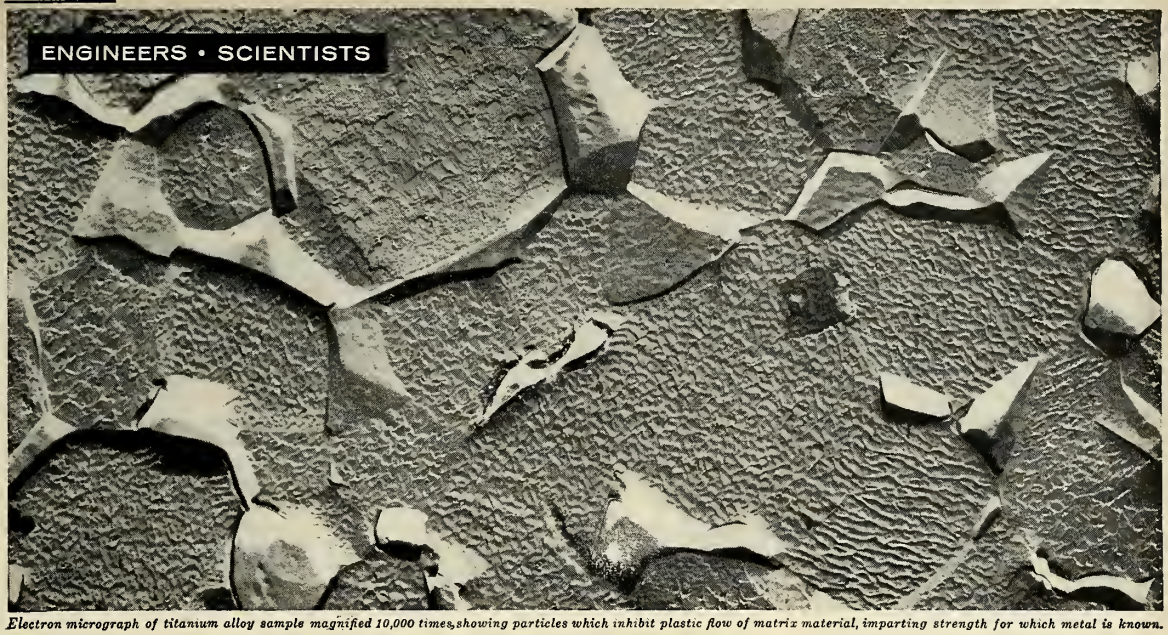
"In fact, the industry already has changed its production mix drastically since 1950. Between 1952 and 1957, the home entertainment business dropped from 58% to 20% of total electronic sales, while the military share rose from 20% to more than 52%. Industrial electronic sales, which were negligible a decade ago, now are running close to radio-TV-phono equipment in dollar volume."

Dr. Baker continued, "Perhaps the most significant EIA action during the past year was the decision of our Board of Directors to recommend that the Federal Government make a long-range study of the radio spectrum. The purpose of this proposal was to bring about a realistic readjustment of frequency allocations in the light of technological improvements and to avoid a chaotic condition in the future due to increasing channel requirements of both our military and industrial services."

"While the Government has not yet acted upon our request, it is being given serious consideration in high places and I hope eventually will be adopted. EIA stands ready to assist the Government in organizing industry cooperation in the study once it is authorized."

"Despite transitory setbacks such as we have experienced during the past

EMPLOYMENT



Electron micrograph of titanium alloy sample magnified 10,000 times, showing particles which inhibit plastic flow of matrix material, imparting strength for which metal is known.

AT EVERY STAGE FROM BASIC RESEARCH TO HARDWARE **REPUBLIC ENGINEERS & SCIENTISTS** REALIZE PROFESSIONAL SATISFACTION TACKLING SUPERSONIC & UPPER ATMOSPHERE PROBLEMS FOR AIRCRAFT & MISSILES

The multiplicity of programs in progress at Republic affords engineers and scientists the opportunity to express their individual talents in solving today's and tomorrow's problems for manned and unmanned supersonic and upper atmosphere aircraft and missiles. For over 25 years, Republic Aviation has been a vital leader in flight with a record of many significant firsts in advancing the state of the art.

▲ *The photomicrograph shown above is just one example of the thoroughness with which our research and development people explore vital new projects. Important positions are open immediately:*

SPECIALISTS — Engineers
5-7 years experience — BS, MS

Aeroelasticity — AE. To evaluate interactions of structural deformation and aerodynamic loading and their effects on structural design and stability and control of airplane or missile. Preliminary investigations on flutter requirements.

Propulsion Systems — Requires strong theoretical background in order to evaluate new propulsion systems for specific applications. Also responsible for general power plant and ejector performance analyses, formulation of engine control requirements.

Heat Transfer — AE or ME. Heavy experience in beat transfer, thermodynamics. To work in area of aerodynamic heating of aircraft or missiles and re-entry problems of space vebicles.

Air-Conditioning & Auxiliary Equipment — To establish heat load requirements for air-conditioning systems from study of functional usage and specific environment of flight vehicles. Supply technical data for the design of the selected system and its internal ducting.

Engine Air-Inlet & Exhaust — AE, ME. Experience in analysis of internal and external aerodynamics at supersonic speeds. Responsible for coordinating inlet design with airframe and engine configuration.

SPECIALISTS — Engineers — Physicists — Mathematicians
7-10 years experience — BS, MS or PhD

Operational Analysis — Reconnaissance & detection systems. MS with broad background missile or aircraft field (electronics, vehicle performance, armaments, structures or applied mathematics).

Operational Analysis — Reconnaissance & detection systems. MS. Requires extensive knowledge of probability & game theory.

Operational Analysis — Armament systems. (Advanced bombers) BS with 4-5 years relative experience. Understand current armament principles and damage criteria.

Guidance Systems — EE or Physics background in design and analysis of inertial navigation systems.

Reconnaissance Systems — MS, Physics. Application of optics and infra-red techniques.

Theoretical Fluid Dynamics — AE or Physics, MS or PhD. To conduct basic research in fluid dynamics related to hypervelocities of flight in rarefied atmosphere at orbital speeds. Requires strong aeronautics, understanding kinetic theory of gases applied to field, Reynolds number and dissociation effects.

Aerodynamics Development — AE. To perform parametric studies in preliminary design stage of aircraft, missile or space ship projects. Needs imaginative cast of mind plus solid background in propulsion, aerodynamics, stability and control, trajectory and wind tunnel testing.

Air Load Design Requirements — AE. To visualize and select critical design conditions essential in estimating air pressure distribution on various components of aircraft or missiles.

Send complete resume, in confidence, to:
MR. GEORGE R. HICKMAN
Engineering Employment Manager

REPUBLIC AVIATION
Farmingdale, Long Island, New York

. . . m/e news

year, the growth potential of the electronics industry is as sound as ever. It has expanded twelve-fold since World War II, and we are still just on the threshold of the electronic era."

"One reads a lot nowadays about the forthcoming space age which will replace the present missile age. It's too early to foresee accurately what effects this transition will have on our daily life and our economy. But, like the famed G-1 whose legendary "Kilroy was here" was reputedly found scrawled when troops landed in World War II, I'm sure that wherever man goes in his interplanetary flights electronic signals will have preceded him. Electronics also will guide his flight and keep him in touch with home base," the EIA chief concluded.

missile electronics briefs

The rush by many big companies to establish separate electronics divisions continues with the latest to report being Ryan Aeronautical Co. The new division is to be called Electronics Division, and will develop and produce doppler navigators and guidance systems at San Diego.

The recent lull in IRBM testing could be termed a gain for electronics reliability. In the past, big missile development almost always depended on guidance and control systems delivery and performance. Latest tests were delayed because of gear-box trouble. Reportedly, guidance systems had no part in the long layoff.

The furor about ion propulsion makes no mention of one basic fact—ion propulsion will only be practical, in the early days at least, as the propulsive means after the vehicle it is propelling has escaped the atmosphere. Practical systems will probably have to depend on engines using liquid for takeoff, solid for further acceleration, and plasma for escape velocity before any sort of an ion engine can take over. After that, the advantages of ion propulsion are spectacular—just figure the velocity of an object under constant acceleration for *THREE MONTHS!*

Lt. Gen. C. S. Irvine sounded the latest in a series of veiled warnings to contractors recently, when he criticized cost-plus-fixed-fee contracts as "the easy way out." He continued by saying that if contractors can't meet the general parameters of a contract, "we won't pay them a nickel." This, on top of indications that the Department of Defense is considering penalties for late delivery on CPFF contracts, might be the first step in a get-tough policy designed to save some of the battered dollars pumped into missile programs.

The recent partial unveiling of the new "Global Surveillance" system, (first reported in the May issue of m/r), by the Defense Department caused a minor furor in some companies where research towards the same goal had been proceeding on a company-financed basis for more than a year. Project ARGUS, reported elsewhere in this issue, is the code name designated by ARPA for studies in this area.

A new record level of electronic spending near $7.5 billion for FY 1957-58, up from $5.9 billion for the previous year, was reported by Frank M. Mansfield, chairman of Electronic Industries Association's marketing data policy committee. Military share of this amount is $3.9 billion, compared to last year's $2.8 billion. Replacement parts spending is up to $950 million and probably includes a good share of military spare parts procurement.

USAF contract to Electronic Specialty Co. for Project PANDA, described as being applicable to "several major missile programs" might mean that nuclear warheads are being considered for more than the presently-announced missiles. PANDA reportedly is an improved fuze for a nuclear warhead. Although PANDA was originally for *Genie* air-to-air missile, funding for the *Genie* has been stopped. PANDA will continue because of its technical advantages and lower cost, compared to existing fuzes of its type.

Chatham Electronics Division of Tung-Sol contract from the Signal Corps for evaluation and development of electron tube glasses resistant to radiation damage, is another indication of an almost all-nuclear missile arsenal. Only some of the older missiles use electron tubes. However, glass-enclosed transistors might be the reason for this contract.

AIEE, ARS, ISA, and IAS will cosponsor the National Telemetering Conference at the Lord Baltimore Hotel, Baltimore, between the 2nd and 4th of June. Program will include sessions on systems, data processing, components and equipment, and research associated with oceanography, astronomy, cosmic ray studies and rocketry. Banquet speaker June 3 will be Admiral Blinn Van Mater, USN (Ret.), whose subject will be "Telemetering in the I.G.Y."

Another prediction of growth in the electronics field was made recently by Don G. Mitchell, president of Sylvania Electric, when he estimated that the Armed Services would spend $4.33 billion on electronic defense this year. He attributes the record-breaking level to "amazing scientific breakthroughs" in such technical areas as missiles and anti-missile systems, electronic detection and warning systems, and a number of other electronic defense activities. He went on to say that "the entire concept of national defense has passed forever from the realm of being essentially an Armed Services responsibility, and rests equally on the shoulders of industry."

Barron's financial weekly reports Joseph W. Crosby, president of Thiokol Chemical Corp. as saying "The rocket industry is going to make a lot more money this year. As for others in this missile business—many of them our customers, of course—I don't think there's any question that most will also do well from here on out. After all, missiles have nowhere to go but up."

Advertisers Index

Advertising correspondence should be addressed to Advertising Sales Manager, Missiles and Rockets, 17 East 48th Street, New York 17, N.Y.

REGIONAL OFFICES:

New York City: 17 E. 48th St., New York 17. Edward D. Muhlfeld, Advertising Sales Manager; P. B. Kinney and G. T. O'Mara, regional adv. mgrs. Phone: PLaza 3-1100.

West Coast: 8943 Wilshire Blvd., Beverly Hills, Calif. Fred S. Hunter, manager; Walton Brown, regional adv. mgr. Phones: BRadshaw 2-6561 and CRestview 6-6605.

Chicago: 139 N. Clark St., Chicago 2, Ill. George E. Yonan, regional adv. mgr. Phone: CEntral 6-5804.

Cleveland: 244 Hanna Bldg., 1422 Euclid Ave., Cleveland 15, Ohio. Douglas H. Boynton, regional advertising manager. Phone: PRospect 1-2420.

Detroit: 201 Stephenson Bldg., Detroit 2, Mich. Kenneth J. Wells, regional advertising manager. Phone: TRinity 5-2555.

Canada: Allin Associates, 12 Richmond Street East, Toronto 1, Ontario. Phone: EMpire 4-2001. Allin Associates, 1487 Mountain St., Suite 4, Montreal, Que.

London: The AAP Company, 17 Drayton Road, Boreham Wood, Hertfordshire, England. Phone: Elstree 2688. Cable address: STEVAIR, London.

Paris: Jean-Marie Riche, 11 Rue Condorcet, Paris (9e), France. Phone: TRUdaine 15-39. Cable address: NEWS AIR PARIS.

EMPLOYMENT SECTION

SUBSCRIBER SERVICE
missiles and rockets

For additional information about any product or service advertised or mentioned in the editorial pages of this issue of Missiles and Rockets:

Use the attached prepaid reply cards. Circle numbers shown on the reply card that correspond with numbers appearing beneath items described. If no circle number accompanies the article or advertisement, give page number (and advertiser's name) on line provided at bottom of the card.

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

NEW PRODUCT BRIEFS

PNEUMATIC FILTER. Designed for 3300 psi lines, this pneumatic filter is rated at 10 microns and can be replaced without disengaging lines, indicating easy maintenance. Unit weighs ½ lb. Walter Kidde & Co., Inc.
Circle No. 225 on Subscriber Service Card.

TILT TEST TABLE. Three-axis test table is remotely operated and servo-controlled for precsie simulation of missile environmental conditions. Table and associated equipment will generate simultaneously three axis velocity and angular position data for test and evaluation of components and sub-assemblies. Thermal Dynamic Products, Inc.
Circle No. 243 on Subscriber Service Card.

PULSE EVENT RECORDER. Recoverable unit monitors events occurring aboard missiles, sleds and other test vehicles. Designed to withstand high impact forces, the device has a self-contained electrical system. In operation, a given signal fires a flash tube, which is recorded on a frame of photo-sensitive film secured in the armored, light-proof cap. Weight of the recorded is one pound; operating temperatures range from —40°F to +200°F. Aerophysics Development Corp.
Circle No. 244 on Subscriber Service Card.

DIGITAL LOGGING CLOCK. Used for recording and/or indicating time of day, this unit is designed for applications in digital data logging systems and control applications. Features easy-to-read, single-plane, in-line lamp bank assembly which can be remotely installed. Included are individual time reset buttons for each decade, providing a means for setting desired values in a particular column without interaction between columns. Parabem, Inc.
Circle No. 245 on Subscriber Service Card.

LEAD BENDING BLOCK. Improved fest-setting gauge for bending component lead wires so they will accurately register with the holes in printed circuit panel boards. Avoids plier damage to leads and out-of-line or twisted components in the final panel. It is possible to bend both leads as close as .070" to the ends of the component. By-Buk Co.
Circle No. 246 on Subscriber Service Card.

LIQUID HEATER. Unit with output variable from 0 to 1 million btu/hr, has been designed for missile ground support applications. The unit automatically maintains liquid at any desired temperature and operates as a complete heating system for such applications as missile fuel heating during transfer, vaporizing, maintaining liquid temperature during storage, providing personnel comfort heat in buildings and support vehicles. Janitrol Aircraft Division, Surface Combustion Corp.
Circle No. 228 on Subscriber Service Card.

ENVIRONMENTAL CHAMBERS. High-low temperature test chambers for use in combination with vibration test equipment are compatible with the high-force, hydraulically-powered Wyle Hydrashaker as well as with conventional electrodynamic vibrators. Optional configurations are available to utilize block dry ice, liquid CO_2 or mechanical refrigeration for coolant. Electrical elements provide heating. Various sizes and performance ranges are available. Model EP-125 has a 5 cu. ft. test space and a temperature range from —100°F to +600°F.
Circle No. 229 on Subscribor Service Card.

FLUOROCARBON HOSE. Hose lined with a tube made of Teflon fluorocarbon resins said to be capable of withstanding the chemical action and high temperatures encountered in the handling of fuming nitric acid. The fluorocarbon tube is reinforced with fabric and covered with a blend of natural and synthetic rubbers bonded to the tube.

The hose will withstand temperatures up to 500°F. It will be available with stainless steel fittings in diameters ranging from one-half to three inches and in lengths up to 75 feet. Hewitt-Robins, Inc.
Circle No. 226 on Subscribor Service Card.

POWER SUPPLY. A 72 channel strain gauge power supply for use in a rocket engine test stand features resistance to ground of more than 10,000 megohms, and internal noise level of the unit with respect to ground of less than 5 microvolts peak to peak. Known as Model 7P01-A, each of the 72 channels has 115 volts 60 cycles ac input. The nominal output of 10 volts is adjustable. In normal operation, used with a regulated power source, the output voltage varies less than 1/10 per cent. Designed to operate in a temperature range of 0-45° Centigrade. Output voltage is constant under this temperature variation plus or minus .025 per cent. Output voltage has less than 1 millivolt ripple peak to peak. Built for rack storage, each tray contains 6 power supply channels. Western Gear Corp.
Circle No. 227 on Subscribor Service Card.

NAME_____

TITLE/POSITION_____

COMPANY_____

Product Mfg./Service Offered_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

Card cannot be processed unless all information is given. Please limit requests to ten items.

MISSILES AND ROCKETS
JUNE, 1958
Expires 30 Days After Above Date

CIRCLE NUMBERS BELOW FOR INFORMATION ON PRODUCTS, LITERATURE OR ADVERTISEMENTS

● ● Advertisements

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

● ● Missile Literature

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

● ● New Missile Products

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

For Other Information Give Page Numbers:

POSTAGE WILL BE PAID BY ADDRESSEE

BUSINESS REPLY CARD
First Class Permit No. 2455-R (Sec. 510 P.L.&R.) Washington, D.C.

MISSILES and ROCKETS
1001 VERMONT AVENUE, N.W.,
WASHINGTON 5, D. C.

SUBSCRIBER SERVICE DEPT.

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

MISSILE LITERATURE

CERAMIC RADOMES. Three reports of Air Force-sponsored research into the possible use of ceramic materials in radomes to withstand high operational temperatures of future aircraft and missiles have just been released for industry use. The volumes are available from the Office of Technical Services, U.S. Department of Commerce.

Circle No. 200 on Subscriber Service Card.

FLIGHT ACCESSORY POWER. Publication GED-3325, 20 pages, an illustrated booklet which briefly discusses functions, features and applications of various flight accessory power equipment. Types of equipment included are electric power, hydraulic power, missile accessory power, starting power, turbopumping and turbo-actuation. Booklet is intended to give assistance in the selection of this equipment. General Electric Co.

Circle No. 201 on Subscriber Service Card.

TEST JIGS. Two page bulletin describes the use of Models 4021 and 4022 manual core test jigs, in quickly setting-up metallic tape-wound and miniature ferrite magnetic memory cores, for testing and analysis. Each model is illustrated, showing design and construction features. A circuit diagram and complete specifications are included. Rese Engineering, Inc.

Circle No. 202 on Subscriber Service Card.

SILICON HANDBOOK BIBLE. Sixty-four page book explains the technicalities of silicon rectifiers, how they are made, where they are used, and how to use them in many applications. Audio Devices, Inc.

Circle No. 203 on Subscriber Service Card.

SUBMINIATURE RELAYS. Catalog describes sensitive and high-speed miniature relays, as well as micro-miniature relays in both voltage-sensitive and current-sensitive models. Besides specifications, the catalog contains adjustment schedules, dimensional and circuit diagrams. A special section includes data and charts for computing the characteristics of relays under varying conditions of resistance, current, voltage, power and temperature. This section also graphically covers allowable limits of contact chatter and dynamic contact resistance under vibration and shock, together with methods for protection of contacts under inductive load. Iron Fireman Manufacturing Co.

Circle No. 204 on Subscriber Service Card.

PRECISION RESISTORS & NETWORKS. Four-page, two-color brochure lists facilities for design, engineering, production and quality control of precision resistors and resistor networks. Mepco, Inc.

Circle No. 205 on Subscriber Service Card.

ELECTRONICS R & D. Four reports of Armed Forces research include data on development of a Stable High Sensitivity Multiplier Phototube; Study of the Effects Produced by Asymmetries in the Two-Helix Backward-Wave Amplifier; Electrostatically Focused Laminar Flow Electron Beams; and Secondary Emission Ratio of Storage Tube Insulator Films. Dept. of Commerce.

Circle No. 206 on Subscriber Service Card.

FLOW RATE CALIBRATION. Service described in six-page folder listing facilities, calibration ranges and temperatures, special studies, accuracy, an other data. Cox Instruments.

Circle No. 207 on Subscriber Service Card

PLASTIC LAMINATES. Copper-clad plastic laminates for electronic printed circuits are covered in a technical bulletin now available. The laminates are described as a combination of high purity rolled copper on plastic base materials. Four-page brochure includes data on physical, mechanical and electrical characteristics of the four grades now in production. Taylor Fibre Co.

Circle No. 208 on Subscriber Service Card

BRAZED COMPONENTS. Booklet describes company facilities, personnel and production capabilities in design and fabrication of experimental, prototype and production quantities of components. Use of new super alloys and stainless steels, together with latest techniques of silver alloy and nickel alloy brazing in controlled atmosphere furnaces, is also covered. Ferrotherm Co.

Circle No. 209 on Subscriber Service Card

ELECTRO-MECHANICAL CATALOG. Features drawings and performance curves of over 120 electric motors, linear actuators, rotary actuators, solenoids, power units, screwjacks, gear boxes and electronic test equipment. Also contains considerable design data on guided missiles, ordnance and aircraft and industrial fields. Hoover Electric Co.

Circle No. 210 on Subscriber Service Card

CERAMIC CAPACITORS. Bulletin describes line of subminiature ceramic capacitors, including power factors, tolerances, temperature ranges and characteristics. Mucon Corp.

Circle No. 211 on Subscriber Service Card

ZENER SWITCHING CIRCUITS. High Speed zener switching circuits and their application to computers. Intended to illustrate that computers, limited in operation and performance when handling information rates in excess of 2.5 mc can circumvent the upper limit by use of silicon junction diodes. Permits a reversal time with speed theoretically as short as one one-billionth of a second. Hoffman Electronics Corp.

Circle No. 212 on Subscriber Service Card.

CONNECTORS. Illustrated bulletin gives specifications, outline dimensions and general information on connectors developed for aircraft/missile applications. Connector is available in 51 and 55 contacts, either hermetically sealed or with conventional contact mounting. Mineral-filled melamine plug insert is enclosed in aluminum anodized coupling shell. An O-ring seals mating surfaces of receptacle and socket. DeJur-Amsco Corp.

Circle No. 213 on Subscriber Service Card

LIQUID HEATER. Unit with output variable from 0 to 1 million btu/hr. has been designed for missile ground support applications. The unit automatically maintains liquid at any desired temperature and operates as a complete heating system for such applications as missile fuel heating during transfer, vaporizing, maintaining liquid temperature during storage, providing personnel comfort heat in buildings and support vehicles. Janitrol Aircraft Division, Surface Combustion Corp.

Circle No. 215 on Subscriber Service Card.

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

POSTAGE WILL BE PAID BY ADDRESSEE

BUSINESS REPLY CARD

First Class Permit No. 2455-R (Sec. 510 P.L.&R.) Washington, D.C.

MISSILES and ROCKETS

1001 VERMONT AVENUE, N.W.,

WASHINGTON 5, D. C.

SUBSCRIBER SERVICE DEPT.

NAME............

TITLE/POSITION............

COMPANY............

Product Mfg./Service Offered............

ADDRESS............

CITY............ ZONE............ STATE............

Card cannot be processed unless all information is given.
Please limit requests to ten items.

MISSILES AND ROCKETS

JUNE, 1958

Expires 30 Days After Above Date

CIRCLE NUMBERS BELOW FOR INFORMATION ON PRODUCTS, LITERATURE OR ADVERTISEMENTS

• • Advertisements

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

• • Missile Literature

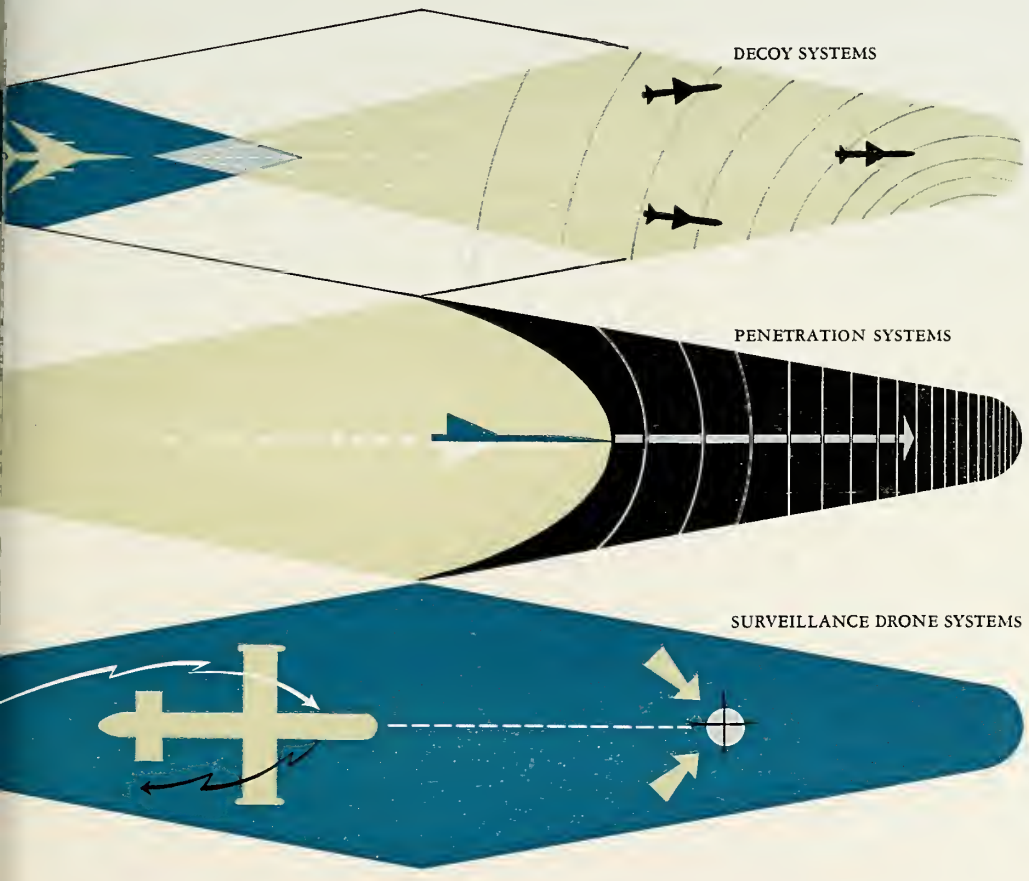
200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

• • New Missile Products

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

DRONE and SMALL MISSILE SYSTEMS

Research and Development at Rheem Aircraft Division has a record of achievement in the field of drone and small missile systems. The capability for complete "program management" is manifested in the list of current and completed projects and the areas of responsibility covered.



Conception

Evaluation

Design

Development

Testing

Production

Rheem Aircraft is a division of world-wide Rheem Manufacturing Company which operates 17 plants in the United States...and with its associated and licensed companies operates 18 plants in 12 countries abroad. These extensive facilities coupled with Rheem's years of aircraft production experience provide the capability for the quantity production of drone and missile systems.

RHEEM MANUFACTURING CO./AIRCRAFT DIVISION

11711 woodruff avenue, downey, california

Rheem

Engineers: Join Rheem in challenging technical work.

Ever hear of a thirty-five header?

Tandem locomotives, teamed to pull a train up a grade, are often called a double header. It would take a "35 header" to equal the power of the RMI rocket engine shown here.

RMI propulsion systems are now being perfected for use in ballistic and guided missiles as well as in the manned aircraft of the future. These advanced propulsion systems incorporate the principle which has guided RMI since 1941 . . . *reliability in application.*

Another reason why RMI's program of advanced research and engineering continues to be a good investment for taxpayers, government and industry!

RMI **REACTION MOTORS, INC.**

DENVILLE, NEW JERSEY

Circle No. 86 on Subscriber Service Card.