missiles and rockets

INCLUDING MISSILE ELECTRONICS

MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION

DECEMBER 1957

On the Nike Ajax . . .
the NARMTAPE®
goes along . . .
Not just for the ride!

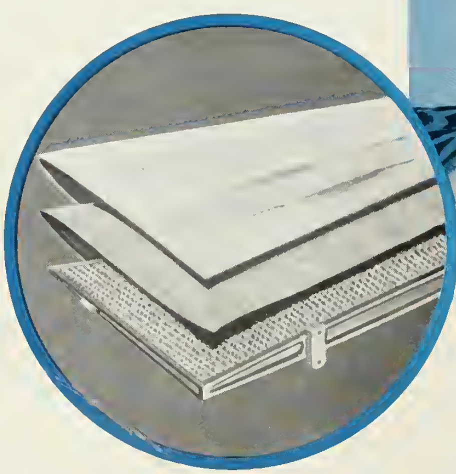
Missile engineers at Douglas Aircraft's Santa Monica Division chose bonded Aircomb* sandwich construction for the fins of the Nike Ajax because of Aircomb's superior strength-weight ratios, as well as its basic economy.

However, in selecting the proper adhesive for bonding the fins, several important factors were considered: First, the adhesive must retain its strength under anticipated air friction temperatures. Next, the adhesive must be impervious to temperature extremes, moisture and fungus... it was essential that the fins retain their designed load carrying qualities, no matter how, where, or for how long the missiles might be stored. Other important factors: ease of fabrication and uniformity of bonding.

Tests showed Narmtape® tops in every requirement. Narmtape's superior strength/temperature characteristics were more than adequate for the entire temperature range anticipated, and its moisture and fungus-resistant qualities were best in every way. Narmtape's even distribution of adhesive throughout the cotton supporting cloth was a distinct improvement over results attained by hand spraying, and was readily adaptable to volume production methods.

Narmtape is one of a family of outstanding adhesives developed by Narmco to achieve optimum performance in bonded sandwich structures. Facing a sandwich, laminate, or metal bonding problem? Let Narmco adhesives help point the way to an economical, performance-tested solution.

DOING JOBS
EVERY DAY
THAT METALS
ALONE
CAN'T DO!



Write today for specific performance and fabrication data on NARMCO ADHESIVES. Narmco technical field representatives throughout the United States and Canada can assist in solving your structural bonding design problems quickly, efficiently, economically.

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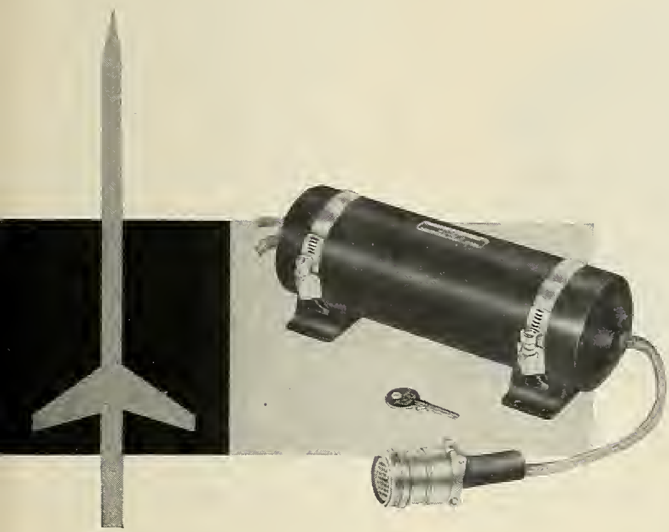
Aircomb, a lightweight sandwich core material, is a proprietary product of Douglas Aircraft Co.

ASCOP

Type AE Sampling Switch



The ASCOP Type AE multi-channel rotary sampling switch is designed specifically for airborne telemetering applications where precision high-speed sampling with the utmost reliability is necessary for accurate data. These rugged instruments are engineered to withstand the most severe environmental conditions. Because the switches provide a low generated thermal noise and a low contact resistance, millivolt signals may be fed through and then amplified with minimum error.

Specification Ranges

Pin and Wiper Arrangement:	1 to 7 poles. 30 to 60 pins/pole. In non-shorting applications alternate pins must "float", therefore 60 pins develop 30 non-shorting channels. 55 to 98% on time with non-shorting channels. 25 to 70% unshorted time with shorting channels. ± 5% phasing pole to pole.
Electrical:	20 microvolts generated thermal noise when sampling 40 millivolt signal and feeding into 250,000 ohms. 2 to 30 ohms contact resistance, maximum. 1 to 1000 megohms leakage resistance pin to pin. 2 to 20 micro-microfarads capacitance pin to pin. 2 to 15 watts maximum signal capacity (purely resistive.) No contact bounce.
Motor:	6, 12, 27.5 VDC governed, 60 or 400 cps 1 phase or 3 phase. ½, 1, 2½, 5, 10 and 30 rps switching speeds. ±5% speed regulation on governed DC units.
Environmental:	−55° C. to 85° C. ambient temperature range, +125° C. for ½ hour. 0-2000 cycles at 20 G's vibration, ½ hour sweep in each plane. 150 G's shock bi-directional in each of three planes (non-operative.) 100 G's continuous acceleration bi-directional in each of three planes. 0-200,000 feet altitude for ½ hour.
Life:	300 to 2,000 hours life, depending on speed, severity of environmental conditions, driving source and quality of switching required.

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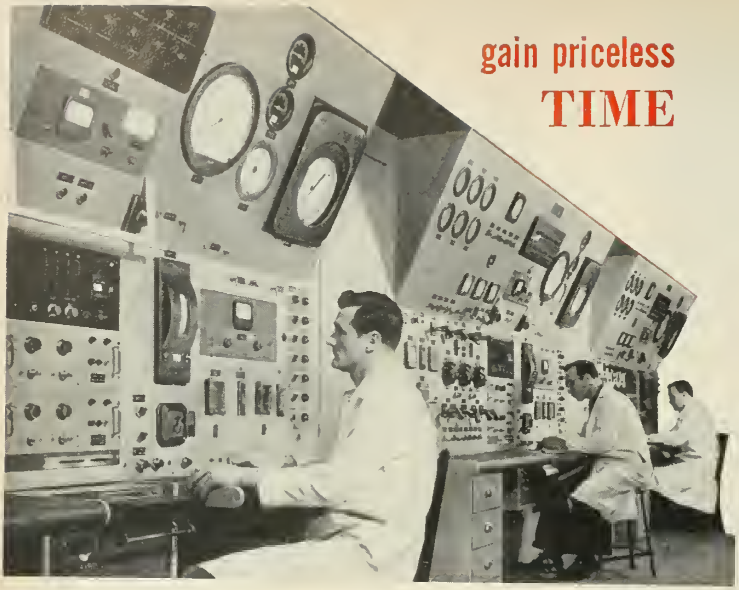

missiles and rockets

Magazine of World Astronautics

December, 1957 Volume II, No. 12

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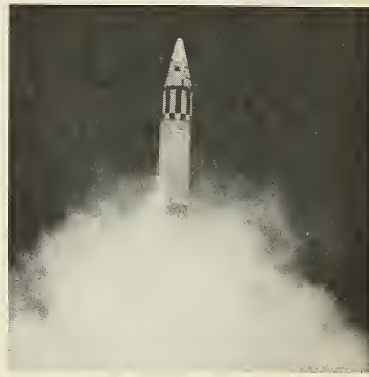

Jupiter, the Army's IRBM, resembling a huge artillery shell, leaves its launching pad at Cape Canaveral, Fla. *Jupiter* and its Air Force competitor, *Thor*, will both be put into production to bolster the U.S. and NATO nations' missile arsenal. This is the first outstanding result of the *Sputniki* launchings. Defense Secretary McElroy decided that although neither of the missiles is fully developed, "they are at a point where it is possible to make a sound decision to program additional production for operational purposes."

columns

departments

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Big Nozzles for Big Rockets

Behind the tailstock you see a Diversey craftsman ready to take a cut that will trace the bottom flange and taper of the O.D. of the nozzle. As nozzles go, this one is big . . . real big. It is the nozzle for one of the large rocket motors.

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Let's Listen to the Wise Men

At this particularly critical time in national affairs it is appropriate to analyze what the prophets of science have told us, to analyze the reasons why we paid them so little heed, and vow that our mistakes of the past will not be perpetuated.

The list of scientific and educational leaders who have warned, advised and pleaded with our military, legislative and executive planners for a change in direction is endless. Mere reflection on our woes—investigations, more reports, more committees—is not the answer. Such proceedings are very costly and, if mainly politically motivated, tend only to confuse the basic issues.

Certain names stand out. Dr. Hagen asked top priority for *Vanguard,* but his request went unheeded. Dr. Wernher von Braun has time and time again stressed the impossibility of maintaining the valuable research teams when forced to subscribe to wild variations in budget and personnel policy.

Reports were written by Dr. Louis Ridenour urging a divorcement of research from engineering management. Unsolicited recommendations by the score have been made by men of the stature of Vannevar Bush. Driven to frustration, capable Trevor Gardner simply decided to quit.

These warnings and recommendations are not new. Of great significance now are the prophesies of Dr. Theodore von Kármán, written in 1945 at the request of the late "Hap" Arnold. Von Kármán's report clearly cited the following needs: research training of officers, assignment at top staff level of officers with science training, a large budget apportionment for research in the basic sciences, changes in the military personnel rotation system, removal of scientists from under civil service personnel management, early emphasis, not on the development of hardware then in being, but on ramjets, exotic forms of propulsion, aerodynamics at high Mach numbers, rocketry and the unmanned missile for delivery of nuclear weapons.

Dr. von Kármán's prognosis was frighteningly accurate. He recognized that no long-range program could succeed unless the proper climate and conditions for its success were provided. We have not provided this climate. We have failed to recognize the challenge of Soviet science.

Let us now analyze the basic resistance to the continually urged programs. Let's do something about them. We know that procurement of science by current regulations is poor. We know we are losing trained government personnel. We know we have neglected the support of research and education. We know we have overinvested in wrong facilities.

We have been told this time and time again. We have been warned. We have investigated. Now let's listen carefully to our scientists and our planners, and, if nothing else, take action on the obvious problems which can be remedied now.

Finally, let us not forget that the wise men have told us over and over again that teachers' salaries have for many years lagged behind those of other fields. This is a grass-roots community problem which must be solved and is dependent on the general will of the public.

There is a decline in high school mathematics and science courses in this country. These courses are largely elective in American schools. There are no electives in the Russian high school system. The Russian student is basically trained to serve the State. If the State has need for more persons in a given field, the field is expanded to provide a sufficient number of people.

This is not Russia, thank God, but in the long run—without a sober change in our national thinking about what our priorities in national effort should be—we must eventually face losing the race to a nation far less complacent than we, just as intelligent, and whose youth is driven harder to the task of study and given the tools with which to work. ERIK BERGAUST

Rocket Logic in Retrospect

…t the Deacon finished the one-hoss shay.

Now in building of chaises, I tell you what,
There is always *somewhere* a weakest spot,—
In hub, tire, felloe, in spring or thill,
In panel, or crossbar, or floor, or sill,
In screw, bolt, thoroughbrace,—lurking
still,
Find it somewhere you must and will,—
Above or below, or within or without,—
And that 's the reason, beyond a doubt,
That a chaise *breaks down*, but does n't
wear out.

But the Deacon swore (as Deacons do,
With an "I dew vum," or an "I tell *yeou*")
He would build one shay to beat the taown
'N' the keounty 'n' all the kentry raoun';
It should be so built that it *could n'* break
daown:
"Fur," said the Deacon, "'t 's mighty plain
Thut the weakes' place mus' stan' the
strain;
'N' the way t' fix it, uz I maintain,
Is only jest
T' make that place uz strong uz the rest."

So the Deacon inquir… the village folk
Where he could fin… oak,
That could n't be sp…

Oliver Wendell Holmes never dreamed of intercontinental missiles or thermal thickets when he penned "The Wonderful One-Hoss Shay". Yet, a hundred years later, no sounder logic exists for the designer of rocket cases. In the ideal rocket design, where a pound less weight can mean miles more distance, all sections should be exactly of identical strength. No part should be one iota stronger or weaker than the rest.

Fulfilling Dr. Holmes' "picture of the impossible" to the ultimate degree has been M. W. Kellogg's aim from the time it began designing and fabricating rocket cases for the Navy Department in 1951. Since then the company has continued to participate in the research, development, and production of a wide range of missile and rocket propulsion systems.

Organizations interested in putting the Kellogg team to work on their specific rocket problems are invited to write.

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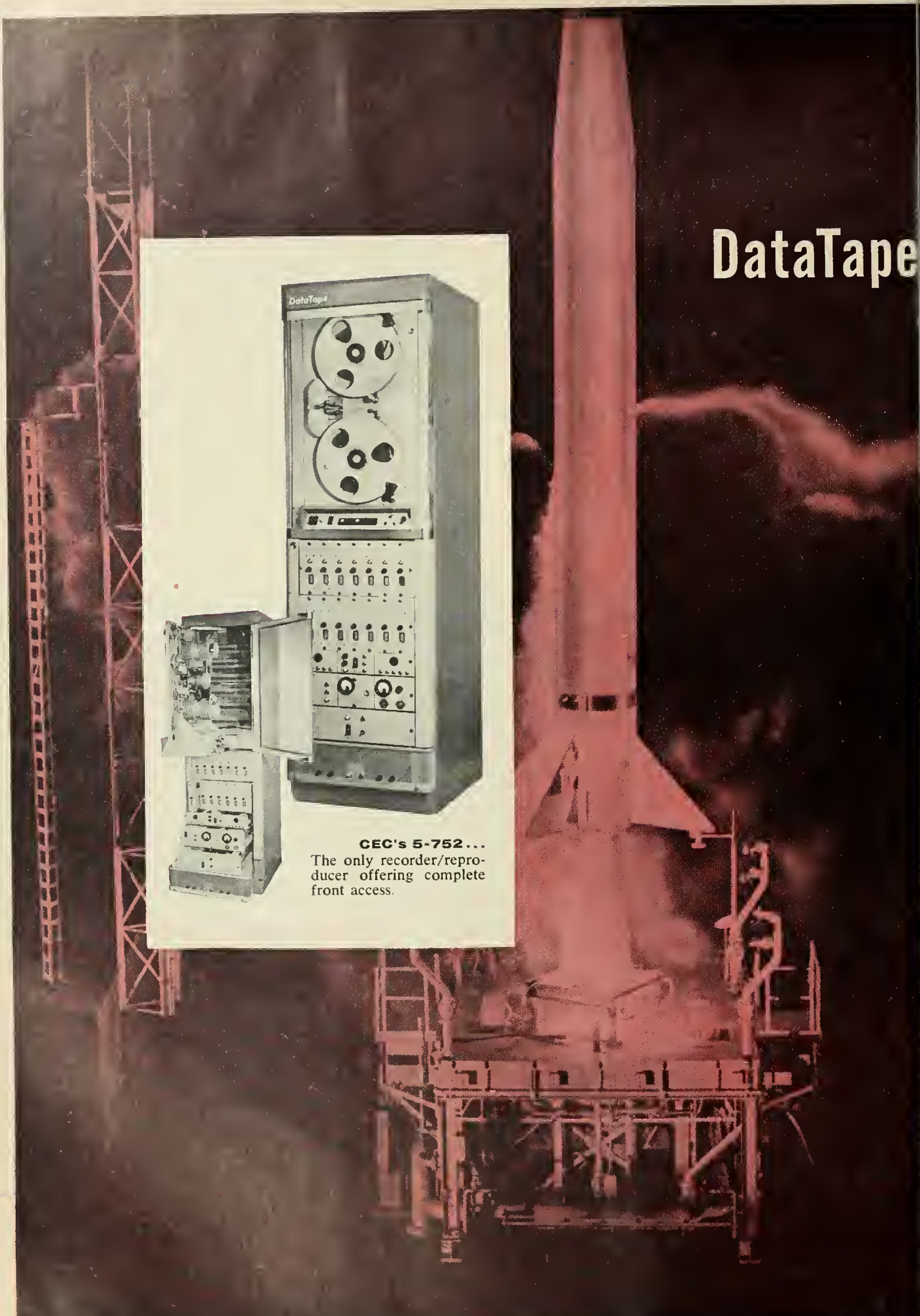
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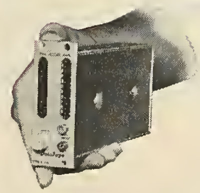

10-12 oz. Miniature Record Amplifiers feature printed wiring, combination subminiature-tube and transistor circuitry, modular construction, and high-temperature operation to 100°C. Aluminum die-cast packages, 6¼″ long by 3¼″ high and 1$\frac{3}{16}$″ wide, provide FM, PDM, and Analog recording.

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ENGINEERING REPORT

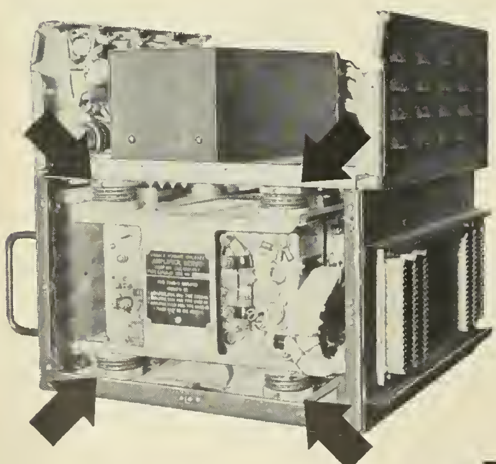
A Case History of Environmental Control

PROBLEM

VIBRATION • SHOCK AND COOLING

POWER TUBE FAILURE during environmental testing of the Servo-Amplifier in the flight stabilization system of Chance Vought's F8U-1 Crusader.

SOLUTION



ENGINEERED MOUNTING SYSTEM:

Robinson Model 1514 all-metal light-weight mounting system to protect entire Servo-Amplifier assembly. Highly damped Met-L-Flex resilient elements are incorporated in an opposed cushioning design. Resulting center-of-gravity suspension system assures all attitude protection for power tube and other electronic components.

The Servo-Amplifier assembly was isolated with no increase in over-all equipment dimensions.

SPECIAL FEATURE:

Range of environmental protection is extended by screened cooling apertures designed as part of the combined chassis and mounting.

PERFORMANCE:

Natural frequency of the mounting system is between 15-21 c.p.s. After 15 G drop tests on all six sides, there was no loss of isolation efficiency which remained as high as 90% at 55 c.p.s. with .060 inches excursion.

RESULT:

1. Increased operational reliability of Chance Vought's supersonic Crusader.
2. Another contribution to the weapons system reliability program pioneered by Chance Vought Aircraft, Inc. in cooperation with Robinson engineers.

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Army's Nike-Hercules
U.S. ARMY

when and where

DECEMBER

ASME Annual Meeting, Hotel Statler, New York, N. Y., Dec. 1-6.

American Rocket Society, Annual Meeting, Hotel Statler, New York, N. Y., Dec. 2-6.

IRE, (Philadelphia Section and Professional Group on Military Electronics) and the Human Factors Society of America on "Human Factors in Systems Engineering," Penn-Sherwood Hotel, Philadelphia, Pa., Dec. 3-4.

High Temperature Strain Gages Symposium, Aeronautical Structures Laboratory, Naval Air Materiel Center, Philadelphia 12, Pa., Dec. 4-5.

ARS Eastern Regional Student Conference, sponsored by the Polytechnic of Brooklyn Chapter, Hotel Statler, New York, N. Y., Dec. 6-7.

IRE, AIEE, ACM, Eastern Joint Computer Conference, Sheraton-Park Hotel, Washington, D. C., Dec. 8-11.

Eastern Joint Computer Conference and Exhibit, Sheraton-Park Hotel, Washington, D. C., Dec. 9-13.

Gas **Turbine Development** Meeting, Speaker: Rear Adm. S. B. Spangler, USN, Air Development and Materiel Center, Engineers Club, Philadelphia, Pa., Dec. 18.

JANUARY

Electronics Reliability and Quality Control, Fourth National Symposium, Hotel Statler, Washington, D. C., Jan. 6-8.

IAS 26th Annual Meeting, Sheraton-Astor Hotel, New York City, N. Y., Jan. 27-31.

American Astronautical Society, Fourth Annual Meeting, New York City, N. Y., Jan. 29-31.

College-Industry Conference, American Society for Engineering Education, University of Michigan, Ann Arbor, Mich., Jan. 30-31.

Instrument Short Course, sponsored by Southern California Meter Association and Los Angeles Harbor Junior College, Wilmington, Calif., Jan. 30-31.

FEBRUARY

Reinforced Plastics Division Conference, Society of the Plastic Industry, Edgewater Beach Hotel, Chicago, Ill., Feb. 4-6.

MARCH

1958 Nuclear Congress, International Amphitheatre, Chicago, Ill., March 16-22.

ASME Aviation Division Conference, Statler-Hilton Hotel, Dallas, Tex., March 17-21.

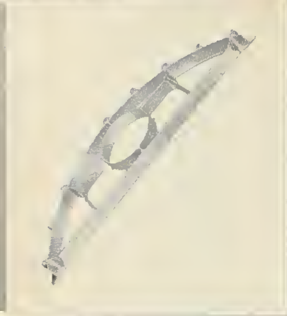
Atomic Industry Trade Show (in conjunction with the 1958 Nuclear Congress) International Amphitheatre, Chicago, Ill., March 17-21.

International Instrument Show, Caxton Hall, Westminster, London, March 24-29.

APRIL

ASME Division of Instruments and Regulators Conference, University of Delaware, Newark, Del., April 1-3.

ASME, Maintenance and Plant Engineering Conference, Penn-Sheraton Hotel, Pittsburgh, Pa., April 14-15.



A REPORT ON THE FIRST SUCCESSFUL PROCESS FOR CHEMICALLY MILLING LIGHT METAL CASTINGS

In high speed jets, rockets, and missiles the price tag on every ounce of excess weight is enormous. Even the use of lightweight aluminum and magnesium alloys wherever possible leaves room for improvement. For while part thickness is often determined by structural requirements, it is frequently a function of the metalworking processes used. Castings, for example, must have sufficient wall thickness to assure sound structure throughout. Thinner sections are generally achieved by machining the parts after casting. This is often an expensive and sometimes impossible task, especially where complex contours or double walls are involved.

Enter Chemical Milling

The first break came when a solution was discovered to the same problem as it affected wrought parts. The solution—familiar to every high school chemistry student—was based on the consumption of metals by powerful reagents. Its successful application to metalworking production presaged significant strides in weight reduction. But when the same techniques were applied to castings, results were extremely poor.

Rolle research immediately began laboratory tests to discover the reason for the failure, and found it often lay *in* the castings. Even minor imperfections in the casting surface unbalanced the process of metal removal—enlarging any defects present. Rolle also found, after much searching, that only certain reagents in certain concentrations—depending on both the part cast and the alloy used—could guarantee success. It has taken almost two years of exhaustive research to refine this process to the extent that it can now take its place as an accepted metalworking technique. Parts can now be designed for casting that could only be constructed by sheet fabrication techniques in the past.

Half The Wall Thickness

The major advantages of this chemical milling process are pretty much wrapped up in the single figure 0.060"—the wall thickness which Rolle can consistently meet by the process. The importance of this figure is readily comprehended by comparing with it the conventional limit on casting wall thickness—.125". Rigid control techniques, developed in the laboratory, even permit an overall improvement in dimensional tolerances of the part as a result of the chemical milling process. And at the same time, surface finishes of an order of 100 microinches or better can be consistently achieved.

There are two ways you can take advantage of this Rolle technique for chemical milling. One requires the controlled removal of metal from the entire surface area of the part. Allowance can be made in the pattern for holding heavy sections and critical dimensions despite chemical metal removal. The other method, useful where the areas to be lightened are relatively limited, requires masking of those areas not to be etched. The proper technique, of course, can only be decided on the basis of the individual part.

Since the success of chemical milling depends to a considerable extent on the soundness of the casting itself, Rolle cannot promise satisfactory results on any but a Rolle cast part. But Rolle will gladly examine your prints and parts in light of this new technique and make recommendations or quote prices, as you desire. Furthermore, we'll be happy to answer any further questions you may have relevant to chemical milling or the sand, permanent mold, shell mold, or investment casting of aluminum or magnesium alloys. Write Rolle Manufacturing Company, 313 Cannon Avenue, Lansdale, Pa., or call ULysses 5-1171.

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MIDWEST: BURNIE L. WEDDLE, 3219 W. 29th St., Indianapolis 22, Ind., WA. 5-8685
SOUTHWEST: MARSHALL MORRIS, 3515 Covert Ave., Ft. Worth, Texas, WA 3-8098
NORTHWEST: J. L. LARSEN, 5757 Oaklawn Place, Seattle, Wash., MOhawk 9311
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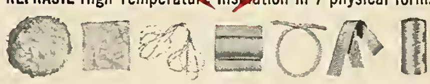

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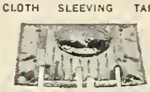

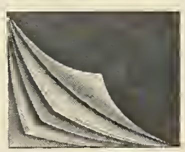

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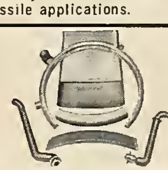

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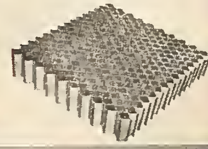

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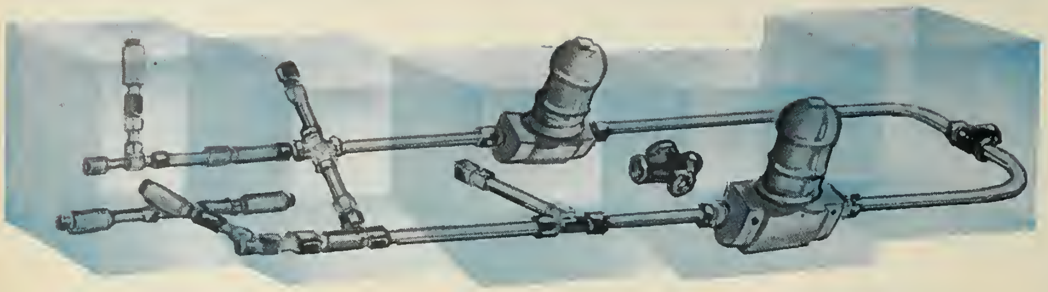

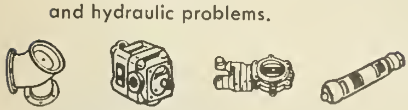

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PAUL D. CASTENHOLZ, Pacific combat veteran, graduated B.Sc. (Eng.), UCLA 1949. From research engineer his grasp of rocket engine work raised him through a supervisory post in experimental development to assistant group leader in combustion devices, and then to group leader of experimental engines. Recently completed requirements for his MSc. Relaxes with hi-fi, fishing and back packing.

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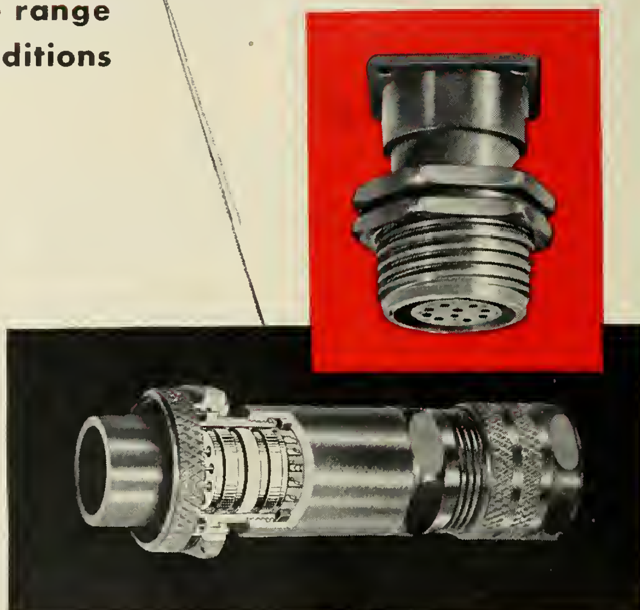

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letters

M/r Commended for Open Letter to President

To the Editor:

The letter, published on the same day as the report of work by Soviet scientists on a "photonnic" drive, focuses attention on the work that must be done by scientists here in the United States if we are to resume our lead.

Your proposal for a Secretary of Science is very interesting, and, if placed above political squabbles, could accomplish a great deal. A Secretary of Science could, for example, if given sufficient power, cut through a great deal of red tape, and decide, as you bring out so aptly, which of our mssiles to develop.

A point which you did not touch on is education of our youngsters. As long as Soviet education stresses the mathematical and physical sciences from elementary school onward, and our educational systems allows a great proportion of our students to get by with the minimum in these sciences, we cannot look forward to a steady and continuous flow of the young scientific talent that we need. Even if we should institute a "crash program," if we do not continue to develop scientific talent, the program will of necessity die down.

The letter is a great service to the public, and a copy should be sent to each Senator and Congressman.

I. A. Rothstein
1891 E. 7th St.
Brooklyn 23, N. Y.

To the Editor:

Bravo! Recommend followup rebuttal to Presidential speech to wake the gullible Gulliver of America. Suggest you ask Americans to mail copy they read to their Congressmen signing it "Me Too."

Schuyler Hamilton
149 East 34th St.
New York, N. Y.

To the Editor:

I was deeply impressed . . . I know the letter has wakened many complacent Americans to a new sense of urgency in advancing our knowledge in the satellite, rocket, and missile fields. For this great service to your country, I heartily congratulate you.

Robert Troy
660 Gibson Ave.
Kingston, Pa.

Congratulations. Magnificent. I fervently hope it gets results and soon.

Carl Friedlander
983 Park Avenue
New York City, N. Y.

To the Editor:

You are to be commended for your views in this matter of most important concern to the U.S.

Harold Moy
71 West 71st St.
New York 23, N. Y.

To the Editor:

It certainly puts the Sputnik-Eisenhower problem in its proper perspective. Congratulations!

James B. Kobak
J. K. Lasser & Co.
1440 Broadway
New York 18, N. Y.

To the Editor:

Congratulations. Constructive criticism most timely. Lethargy and penny-pinching in scentific fields totally indefensible. We could easily become the Communists' richest satellite.

Dena Connery
7714 East Jefferson
Detroit, Mich.

To the Editor:

I can find but one word . . . "Terrific."

Frank C. Beckert
Howard A. Harkavy, Inc.
341 Madison Ave.
New York 17, N. Y.

To the Editor:

I am in complete agreement.

I have taken the liberty to quote you in a letter to Senator Kefauver.

John W. Whitson
120 Cabrini Blvd.
New York, N. Y.

To the Editor:

. . . a distinct public service . . .

Murray W. Greif
Petroleum Solvents Corp.
331 Madison Avenue
New York 17, New York

Details Wanted

To the Editor:

I would like further details on rocket sleds and rocket propulsion systems . . . as reported in m/r, March 1957.

H. Paddon
2528 Jay Place
Colorado Springs, Colorado

He Should Know

To the Editor:

Our heartiest congratulations. Your open letter to the President . . . was read in full by Bob Sigrist of Station WENR in Chicago. I fervently trust and hope the President will give your letter full consideration. I am sure that you are being instrumental in formulating our future missile and space policy.

Joe Kauffman, President
Diversey Engineering Co.
Chicago, Illinois

Wants Encyclopedia On Guided Missiles

To the Editor:

Your magazine is excellent and far above any other magazine in this field. I read in your August issue you had reprints of your excellent First Annual Guided Missile Encyclopedia. I would like a reprint.

Allan Gary
317 Shadowmoor Dr.
Decator, Ga.

In the mail.—Ed.

To the Editor:

We enjoyed the information in the Guided Missile Encyclopedia. Since a considerable amount of our interest is in the missile field, I would appreciate it if we could obtain five reprints for distribution to our key personnel.

Dr. Lawrence Gould
Microwave Associates, Inc.
Burlington, Mass.

In the mail.—Ed.

Beg Pardon

To the Editor:

On receiving my August issue of m/r I was surprised to note on page 84 (under the author's name) that the Jet Propulsion Laboratory was reported located at Huntsville, Ala. We would greatly appreciate a statement in your next issue pointing out that the address should have been Pasadena, Calif. In reality, JPL is affiliated with the California Institute of Technology rather than Redstone Arsenal or the Army Ballistic Missile Agency, although we frequently work closely with these groups on certain programs.

John I. Shafer
Staff Engineer
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena 3, California

Additional Kudos

To the Editor:

I have been reading m/r since its inception, and truthfully state, I have never before encountered so informative a trade publication. To me it is a warehouse of accurate and authentic information. It's content shows a profound editorial insight, rarely, if ever found in a trade journal.

I eagerly await each issue and in view of current federal negotiations, trust it will become the unchallenged bible of the trade.

Frank J. Cunningham
142 Bellmore Road
East Meadow, N.Y.

Information Requested

To the Editor:

A friend and I are planning an exhibit on solid fuel rocket engines for the science fair in our area. I have obtained some information on this subject, but not enough. Could you refer me to any books or magazine articles where I might find something on this subject?

Gaylon Campbell
585 West Fourth North
Logan, Utah

We will forward some details that might be of use to you.—Ed.

To the Editor:

I have been interested in Thorium Ores and Yttrium Oxides and would like to ask of you as to what, if any, part they play in the missiles and rockets.

Danny Bogni
250 Columbus Avenue
Daytona Beach, Florida

Our propulsion editor has an answer for you in the mail.—Ed.

Missile Glossary Needed

To the Editor:

We are frequently asked by students of junior and senior high school grade for a hard and fast explanation of a rocket and a missile. Our impression is that the two words are used more or less interchangeably now, but we ask your advice so that we can pass out authentic explanatory information.

It would help us to know the difference between a rocket and a missile, and between a ballistic missile and manned and unmanned rockets and missiles, space ships, and guided and unguided missiles and rockets. As a matter of fact, probably a glossary of these space age terms

might be well to publish in one of your editions and in that way many other public relations people besides ourselves could become readily acquainted with the precise definition of each term.

From the very name of your publication we assume that there is a distinction and a marked one between a missile and a rocket. Where we become confused is when the terms are used together; for instance, as a missile which is fired into space by means of rockets.

Are we correct, for instance, in saying that a ballistic missile could be an H-bomb located in the nose of a two or three stage rocket and that when it reaches outer space the missile orbits by itself, divorced from the rockets which shot it there? Would it then correctly be termed an orbital ballistic missile, etc.?

Ballistics is said to be the study of the motion of projectiles; a missile is defined in some encyclopedias as something which can be thrown into space; and a rocket is defined as something which is fired under its own power.

More definitive information about all this would certainly be appreciated.

Arthur F. Joy
Public Relations Department
Raytheon Manufacturing Co.
Waltham 54, Mass.

A glossary of missiles, rockets, and space age terms is planned for the near future.—Ed.

Von Braun Reprints

To the Editor:

You have undoubtedly established your magazine as the leader in its field.

To echo another letter to the editor, you have indeed started something in granting m/r cover reprints. I, too, want a color reprint of the July cover of the Bell X-1E. I would also like reprints of Dr. Wernher von Braun's article, "Space Travel and Our Technological Revolution" and the very excellent article by Joseph G. Logan, "New Air for Engineers."

William R. Elliott
3367 Pio Nono Circle
Macon, Ga.

In the mail.—Ed.

To the Editor:

Add my congratulations for your excellent magazine to your growing list. It has filled a great need very admirably.

I would like a copy of Dr. von Braun's "Space Travel and our Technological Revolution." Also a copy of the Guided Missile Encyclopedia, both published in your July 1957 issue. As a recent subscriber, I missed this issue but discovered these articles through my colleagues and our engineering library at Minneapolis-Honeywell's Aero Division.

Reinhold V. Gaertner
5724 West Moore Lake Dr.
Minneapolis 21, Minn.

To the Editor:

I read with deep satisfaction "Space Travel and Our Technological Revolution" by Dr. Wernher von Braun in your July issue. I would appreciate a copy of the special reprint of this article.

May I also take this opportunity to congratulate the entire staff of m/r for the excellence of your publication and especially on the First Annual Engineering Progress issue. It was by far the most comprehensive, informative compilation of such data ever assembled. Keep up

the excellent work!

Calvin H. Conliffe

Flight Propulsion
Laboratory Department
General Electric
Cincinnati 15, Ohio

In the mail.—Ed.

Missile Machine Companies

To the Editor:

In the article on "Machining for Missiles," m/r September 1957, was mentioned that, including Diversey Engineering Co., there are some 16 missile machining companies in the country. It is requested that this Arsenal be furnished with a list of names, addresses and resume of work in and facilities for missile machining of these 16 companies.

A. Friedman
Contracting Officer

Ordnance Corps
Picatinny Arsenal
Dover, New Jersey

This list is in the mail.—Ed.

Reporting IAF Congress

To the Editor:

. . . your article on the last International Astronautical Federation Conference and your editorial "Washington Trends." I want to compliment you on a very complete reporting of the conference and a complete factual editorial highlighting many of the current problems we now face in the missile field.

Bill Timm

1920 Home Ave.
Bronx, N. Y.

Amateur Facilities

To the Editor:

I know of several teenagers here in the East with serious interests in rocketry, myself included, who would like to fire their own rockets. Unfortunately, being teenagers we cannot drive out to the Mojave Desert every time that we want to hold a firing because of the distance involved. Because of this I would like anyone with serious ideas on the subject to write to me.

I would like reprints of Dr. Wernher von Braun's excellent article, "Space Travel and Our Technological Revolution," the Guided Missile Encyclopedia and your beautiful June cover.

Frank Dishaw

1040 N. Ray Ex.
Manchester, N. H.

How About Inventors?

To the Editor:

What part do you expect the American Inventor to play in the new rocket & missile program?

Do you believe you can get the government or industry to accept the man that MADE the thing and who has something new and practical to offer?

In the past it has been: don't let any new ideas in, and if they do get in, don't pay for them and be sure that the inventor is not around to help or get paid.

George E. Barnhart

2228 New York Drive
Altadena, California.

German Rocketeers in US/USSR

To the Editor:

For the last two and a half years, I have been collecting detailed information, technical as well as nontechnical, about guided missiles, rockets and its allied subjects. I immensely appreciated Mr. Parrish's foresight, when he started "Missiles & Rockets" last October, although I think starting of this magazine a bit earlier would have greatly increased the tempo of U.S. progress in these fields.

The growing challenge posed by Russia, demonstrated recently by their ability to launch two earth satellites, has brought these obscure subjects to the front pages. It is not my intention to go into the political aspects of the situation; but the very fact that USSR has been able to master these difficult technical fields in relatively short time, shows beyond doubt that they have availed of to their fullest use the talents of the best German wartime rocket experts.

I have for sometime been collecting the names of German rocket and missile scientists working both in USSR and USA but due to very scarce information that is available in newspapers and other magazines, I have not gone far. I'm therefore, writing this letter in the hope that you will be able to give me in detail the names of top German, Russian and American rocket scientists working in USA and USSR mentioning the fields in which they have specialised.

Krishnanand M. Amladi
43-B Irwin Road
New Delhi-India

Check our next "Russian issue"—Ed.

What's the Story on ASMs?

To the Editor:

First, I would like to express our appreciation for the copies of your Guided Missile Encyclopedia that you sent us. We have subscribed to m/r since its founding and have thoroughly enjoyed each and every issue. We have recently directed our attention to the air-to-surface missile field and wonder if you could either briefly bring us up to date on further developments in that field (subsequent to your Guided Missile Encyclopedia), or direct us to some other source.

T. W. Merritt, Jr.
Chicago Title and Trust Co.
111 W. Washington St.
Chicago 2, Ill.

U.S. does not have much of a sophisticated program in this field. Other than Bell's RASCAL *and the new North American ASM, we don't know of any new developments.—Ed.*

Geschutenverbe Werdebake

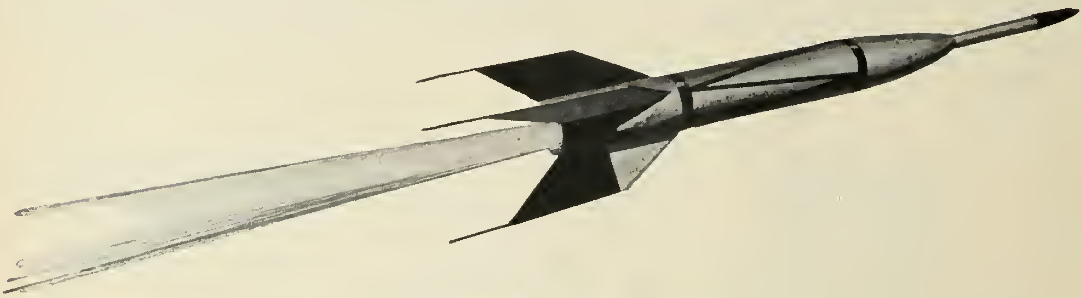
To the Editor:

I am a new subscriber and find your publication beyond what I had expected. It is the most comprehensive I've seen. I am employed at the Oak Ridge National Laboratory and some of my friends and I were delighted with the "Geschutenverbe Werdebake" in the September issue (p. 54). I see that Durant mentioned it again in his column, "World Astronautics." I would appreciate a copy very much. Also, can you tell me the address of the Deutsches Arbeitsgemeinchaft für Raketentechnik (DAFRA)?

Henry Phillips II
P.O. Box 974
Oak Ridge, Tennessee

Your letter has been forwarded to Durant; he will answer you within the next few days.—Ed.

WHEN YOU WANT IT...



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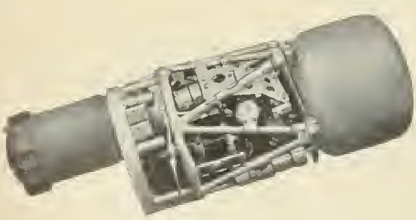

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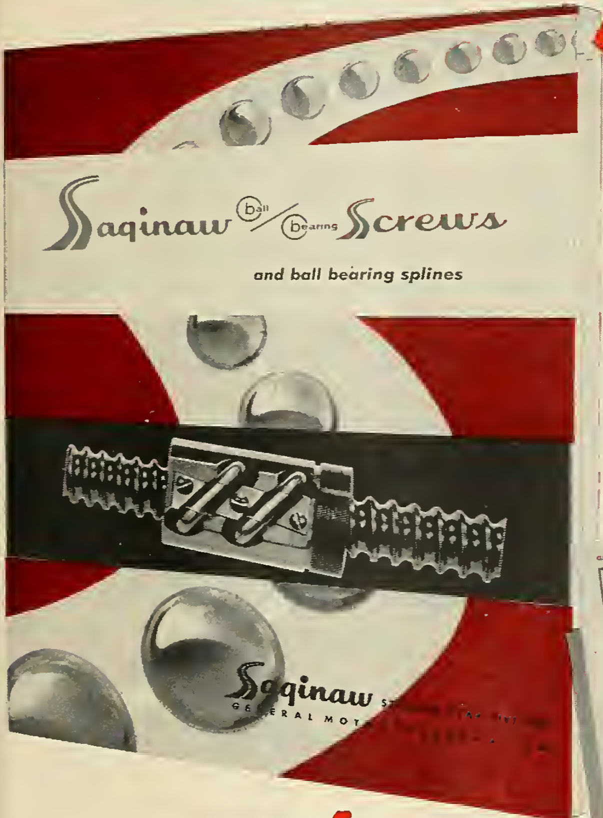

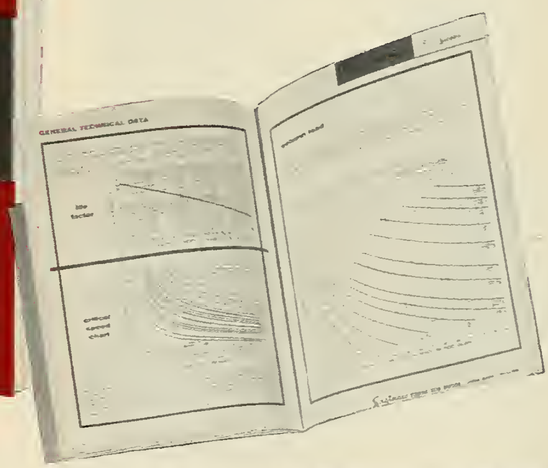

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Soviet Troops Get New Missiles

Present Red Operational Stockpile Twice as Large as U.S. Arsenal

by Frank G. McGuire

The Soviet Army paraded its missile muscles through Red Square recently and left little doubt that considerable technology backed up the mass of hardware shown. Although exhibiting little but tactical missiles, the Soviets answered any questions that existed about the variety or modernity of their missile arsenal.

The mobility of the missiles was in sharp contrast to the horse-drawn-cart days of World War II, and many of the models obviously fulfill the same missions as American counterparts—even to being quite similar in design. The largest missile shown was the T-1, which one magazine erroneously labeled the IRBM T-2. This T-1 was apparently the "80-foot monster" referred to in preparade press reports from the Soviet capital, although its actual length is much closer to 60 feet.

Design characteristics of the T-1 indicate that it uses a LOX system and is generally similar to the *Redstone*. The T-1 is undoubtedly vertically-launched and is equipped with four small fins for stability. Graphite vanes projecting into the exhaust stream indicate that the Soviets have not made use of the gimballed-motor technique. Range of the T-1, with its 77,000-pound-thrust engine, is about 400 to 600 miles.

Judging by the appearance of large-caliber rocket-launching guns, the Soviets have effectively rendered our atomic cannons obsolete. The atomic cannon, with its 20-mile range, is no match at all for the estimated 120-mile range of these tank-mounted guns. The rocket guns have 70-foot barrels, very small recoil mechanisms, and generally follow the Rheinbote design. The short crane, contrasted with a large missile carrier on one gun chassis, seems to indicate that the missile is loaded in stages. Another model utilized a larger crane, suggesting that a single-stage, solid-fueled rocket is used. As far as is known, there are no American designs of this large size following the Rheinbote idea, but several American companies (Aerojet and Armour) are working on smaller models.

Another impressive missile shown was the T-7A, a solid-propellant rocket with a range of about 25 to 30 miles. The weapon is 25 feet long, about three feet in diameter and is carried into battle on a tank. It is launched vertically.

The large size and weight of the missile, in addition to the clean lines and single motor, hint that the Soviets have mastered the manufacture of large composite grains. The design is distinctively Soviet and seems to incorporate greater punch and mobility than either our *Corporal* or *Sergeant* missiles. It could be submarine-launched without too much modification and may be a prototype model of the *Comet*.

Soviet Missiles

Model	Range (miles)	Length (feet)	Diam.	Mission	Thrust (pounds)	Power Plant	Status	Remarks
M 100A	S	7	10″	AAM	n.a.	n.a.	Operational	Standard U5SR air-to-air weapon
T-B	20	n.a.	n.a.	SAM	n.a.	SPR	Operational	In use for several years. Other rockets in this category are the T-6 and the GVAI
M-2	20	25	3′	SAM	n.a.	n.a.	Operational	Similar to ***Nike-Ajax,*** but larger
T-5B	25	30	2-3′	SSM	n.a.	n.a.	Operational	Free-flight artillery rocket, much like U.S. ***Honest John***
T-7A	50	25	2.5′	SRBM	17,600	SPR	Operational	Truck-launched
Comet III	100	15	n.a.	ASM	n.a.	SPR	Operational	Radar guided
Comet I	100	n.a.	n.a.	SRBM	n.a.	SPR	Production	May be launched from submarines against land targets
Comet II	600	n.a.	n.a.	MRBM	n.a.	SPR	Production	5ame as **Comet I**, above
T-1	400-600	50	5.5′	MRBM	77,000	LPR	Operational	Improved version of German V-2
T-4	1,000	50	5.5′	IRBM	77,000	LPR	Production	Version of T-1, uses wings to glide to target after burnout
T-2	1,B00	100	15	IRBM	254,000 77,000	LPR(2)	Operational	Many test flights reported
T-3	5,000	125	n.a.	ICBM	n.a.	LPR	Final Test	Test flights conducted by Red Army
T-4A	12,000	n.a.	n.a.	Skip-Glide Bomber	B20,000	LPR	Flight Test	Manned rocket bomber capable of operating at altitudes to 160 miles

n.a., not available; SPR, solid-propellant rocket; LPR, liquid-propellant rocket; AAM, air-to-air missile; SAM, surface-to-air missile; SSM, surface-to-surface missile; ASM, air-to-surface missile; SRBM, short-range ballistic missile; MRBM, medium-range ballistic missile; IRBM, intermediate-range ballistic missile.

A Martin Matador, big as a jet fighter, thunders into the air leaving a blazing trail as it roars toward its 40,000-foot operating altitude.

Safeway

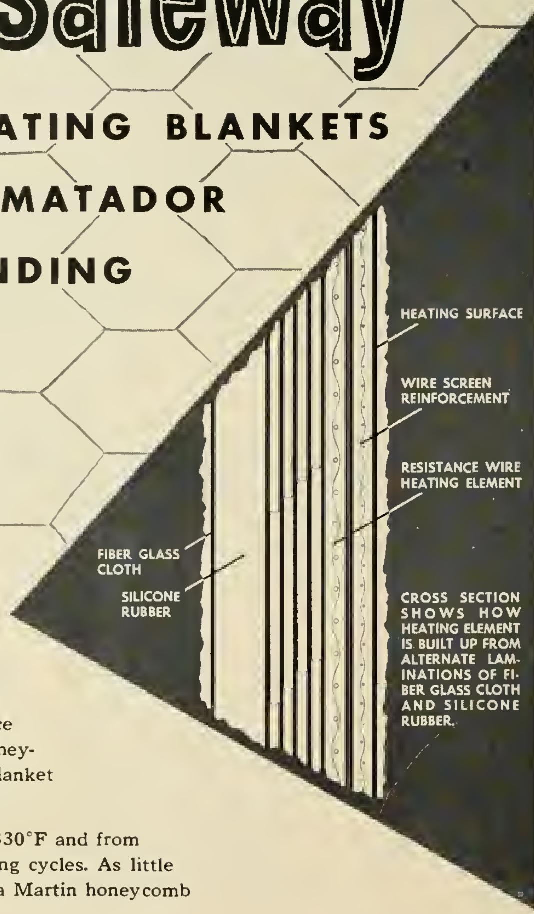
SUPPLIES HEATING BLANKETS FOR MATADOR HONEYCOMB BONDING

The Martin Company, in producing its bonded honeycomb airfoil surfaces for the Matador missile, uses an electric heating blanket which can withstand at least 100 bonding cycles without replacement.

The heating blankets, custom produced by Safeway Heat Elements, can deliver from 400 to as high as 1,200 watts per square foot. They are composed of alternate layers of glass-cloth-reinforced silastic sheets, woven resistance wire heating elements, and copper screening for additional reinforcement and heat diffusion.

The bonding fixture is closed on the airfoil surface and air pressure forces the skin in upon the honeycomb. At the same time, heat built up by the blanket sets up the structural adhesive resin.

The present cure cycle is 30 minutes at 310°-330°F and from 15 up to 100 psi plus preheating and aftercooling cycles. As little as 1 hour, 25 minutes is required to complete a Martin honeycomb structure.



If it has to be heated (and the "it" can be just about anything), you can rely on Safeway engineers to study your problem and — without obligation — submit an appropriate recommendation. For your copy of a fact-filled folder, write to:

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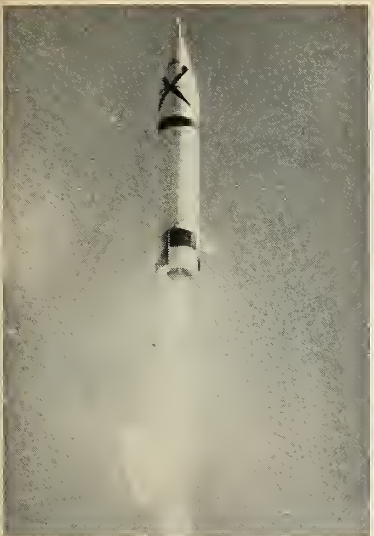


US Army JUPITER
. . . ordered into production by McElroy

Showing some similarity to our *Nike-Ajax* the Soviet M-2 is transportable and launchable from its truck-trailer. It is an AAM, probably an offshoot of the M-1, with shipboard AA defense capabilities. The M-2 does not require a fixed position from which to fire, as does our *Nike* series and may move with battlelines for use in combatting enemy aerial strikes and air reconnaissance. It is considerably larger than our *Nike-Hercules* and *Terrier* missiles and is a trim, two-staged rocket with several areodynamic control surfaces. The large booster-nozzle shows high thrust while the smaller second-stage nozzle indicates a long burning time. It undoubtedly has a range of about 40 miles, altitude capability of 60,000 feet, and is capable of combatting our B-47 and B-52 bombers. Although supporting guidance and control equipment was not seen, the nature of the rocket indicates that the electronic equipment is very probably on a par with ours.

Another new rocket displayed was the T-5B, which bears a striking resemblance to our *Honest John*. It has a similar-size warhead, but the solid-propellant motor is considerably necked down, giving a thin-waisted appearance. The booster motor features 6 canted nozzles.

The powerplant is in two stages, but the small rocket motor and large warhead indicate a support weapon with about a 15-mile range. A considerable number of small artillery rockets for infantry support and flak against low-flying aircraft were also shown in the parade.

The purpose of the show could well have been to impress on the NATO countries that Europe will indeed be swept by an avalanche of Soviet troops should war break out. Their missile mobility and flexibility is undoubtedly aimed at swaying the neutral countries in their determination to remain that way. The overall effect of the parade was to eliminate any doubts that the Soviet Union can handle small wars as well as an all-out effort.

As can be seen from the comparison charts, the Soviets have checkmated the U.S. in all areas of missiles, and in at least two cases (skip bombers and ballistic missile between 250 and 1500 miles range), we have nothing at all. Their infantry support weapons, anti-tank missiles and low-altitude antiaircraft missiles outnumber ours in types and undoubtedly in numbers. However, the figure of 20,000 operational missiles recently quoted for the Soviet IRBM is exaggerated.

USAF THOR
. . . big missile-maker Douglas is ready

The Soviet missiles seem to be supported by more mobile ground support equipment than their U.S. counterparts. A large number of the vehicles attendant to the missiles were tracked for greater cross-country mobility and provisions were made for protection of the crews.

Although there have been claims that Soviet missiles are crude, as is always the claim from this side of the fence, there is little doubt that they are practical, effective and operational. Many of ours are not.

United States Missiles

Model	Range (Miles)	Length (Feet)	Diam.	Mission	Thrust (Pounds)	Power Plant	Status	Remarks
Falcon	5	6.5	20″	AAM	6000	SPR	Operational	Two models—radar or infrared guidance. U.S. also has ***Sidewinder***
Hawk	15	16.3	14′	SAM	n.a.	SPR	Operational	In use since 1957
Nike-Ajax	20	20	1″	SAM	n.a.	LPR	Operational	Being replaced by ***Nike-Hercules***
Honest John	30	27	2.5′	SSM	n.a.	SPR	Operational	Reliable weapon
Redstone	250	69	6′	SRBM	75,000	LPR	Operational Production	Only U.S. SRBM in operation
Rascal	100	35	4.5′	ASM	6000 each	LPR (3)	Production	In operation soon
Corporal	75	40	2.5′	SRBM	n.a.	SPR	Obsolescent	Has been valuable for troop training
Regulus I	600	33	9.5′	SSM	4600	Turbojet	Operational	To be replaced by ***Regulus*** II
Polaris	1500	40-50	8.5′	IRBM	n.a.	SPR	Early Development	Launchable from submerged submarines; ready in five years
			U.S. has no ballistic missiles with range between 250 and 1500 miles.					
Jupiter	1500	58	8′9″	IRBM	135,000	LPR	Flight Test	Air Force's ***Thor*** is similar
Atlas	5000	80	9′	ICBM	(1) 100,000 (2) 135,000	LPR(1) Boosters	Flight Test	U. S. also pushing ***Titan***
No hardware	10,000	n.a.	n.a.	Skip-Glide Bomber	n.a.	LPR	Study Contracts Only	Many U.S. companies willing to tackle this task

U.S. Interim Underwater Missile Platform?

A worthy design approach for fleet ballistic missile warfare, which may be receiving top level consideration in light of recent disclosures of Soviet missile submarine might, has been proposed by the Wilford Aircraft Corp. of Merion Station, Pa. The proposal aims to put our fleet in a position of readiness in the shortest possible time. The missile carriers would use available submarine hardware until a substantial fleet of missile-launching submarines has been completed.

Although several broad configurations appear feasible, a design utilizing available submarine hardware as ballistic missile and aircraft carriers is the most promising from the standpoint of time and money. Two World War II type submarines would be lashed together with a detachable hanger-launching pod between them (see drawing). This catamaran-type vessel would be capable of great endurance on the surface or subsurface while carrying fuel, cargo and missiles with complete operational equipment.

Several *Polaris*-type missiles could be carried in a horizontal position inside the hangar. Two launching hatches are shown in the drawing where the missiles could be fired either from the surface or subsurface. Aft opening is hangar door for seaplanes. The hangar door, when open, becomes a landing ramp for bringing the aircraft aboard.

In addition to the ballistic missiles, several other types could be carried by the catamaran submarine, including air-breathing surface-to-surface, surface-to-air and subsurface-to-air. Wilford further emphasizes that the vessel would be ideal for launching manned vertical or near-vertical takeoff aircraft.

The immediate need for missile-launching submarines (the present development schedule indicates that a sizeable missile submarine fleet is years away), was recently voiced by Adm. H. G. Rickover.

"The nuclear-propelled submarine capable of launching intermediate-range ballistic missiles with nuclear warheads could make our Navy an even more effective deterrent force.

"There is no reason why intermediate-range ballistic missiles cannot be launched from floating platforms, surfaced or submerged. The Navy is, in fact, now developing such a missile, the *Polaris*.

"Armed with this missile, the nuclear-powered submarine will become an underwater satellite. It will be large enough to store, maintain and fire intermediate-range ballistic missiles, and it will be able to move anywhere at any time, completely submerged.

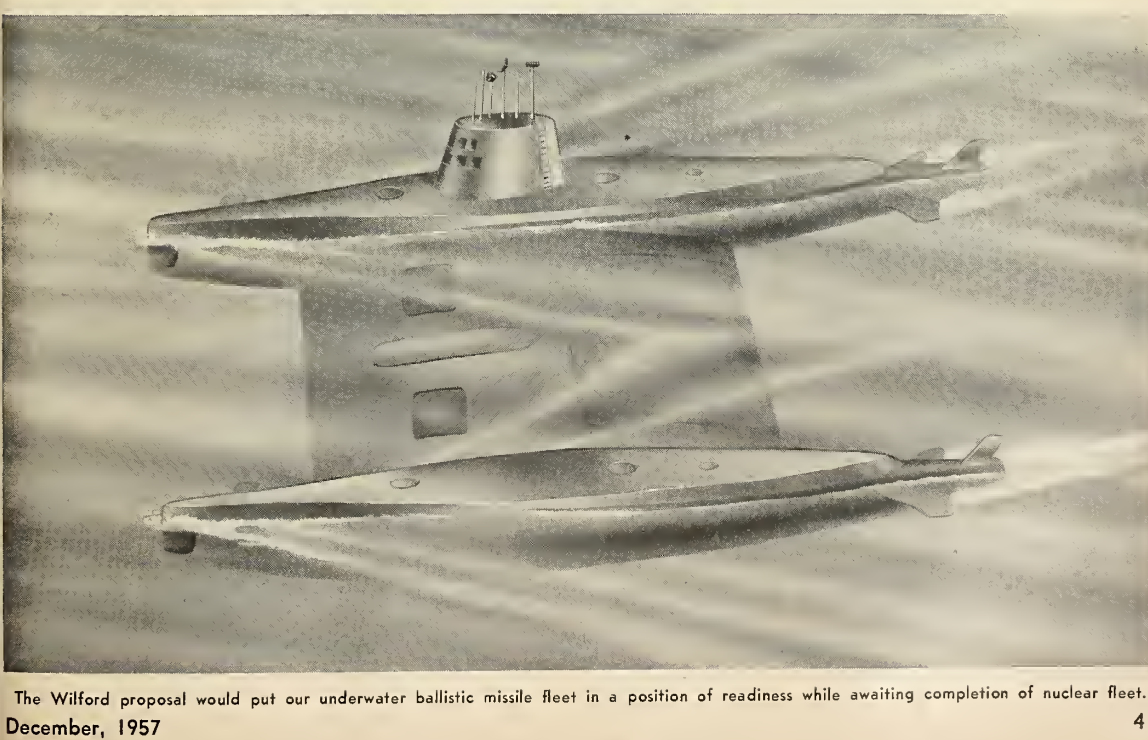
"These underwater satellites will launch their attack from far out at sea. They could be placed anywhere within 1500 miles of their targets.

"The problem of locating and destroying such an underseas fleet will be tremendous. Search radar will be helpless against it.

"The underwater satellite marks the closest approach now foreseeable to the ideal mobile platform. It could remain well hidden from the enemy. It would draw the enemy's missile and bombs away from our cities and factories and farms, and draw them toward the uninhabited seas. An aggressor could not escape destruction as long as this missile fleet remained intact. He would be forced to attack it, thus greatly reducing the number of missiles available to him for hitting our territory or that of our allies."

The true significance of the Wilford proposal for utilizing available, soon to become obsolete, submarines was emphasized by Rickover's remarks regarding development time for this entirely new missile system.

"I should make it plain that this weapon cannot be built by the day after tomorrow. It will be a scientific and engineering challenge, comparable in difficulty and magnitude to the first nuclear submarine."



The Wilford proposal would put our underwater ballistic missile fleet in a position of readiness while awaiting completion of nuclear fleet.

Soviet Space Agency Revealed

The bold accomplishment of satellite flight by the USSR did not spring from short-term intensive effort. Nor was it dependent on scientific breakthroughs, superfuels and metals or new sources of power. The Russian achievements were the product of a coordinated program, planned by a group of competent scientists comprising the Commission on Astronautics of the Academy of Sciences.

This body had the responsibility of organizing the program, assigning the appropriate research tasks and seeing that this work was carried out. Their job was to identify the basic problems which had to be answered before scientific research satellites could be launched and to obtain the answers. They were eminently successful.

These men were not engineers. The tasks of design, production, logistics and launching were left to the military. The controlling body, however, was the Commission on Astronautics.

Vast Science Organization

The Soviet Academy of Sciences is an elite organization composed of hundreds of scientists assisted by practical experts and technicians. Membership to the Academy brings a special stipend and great professional prestige. In essence it is the centralized body of control of all Soviet science. The interests of the Academy range from pure science through engine design to medieval history. In 1952 it had 40 commissions and committees, 14 museums, 4 observatories, 57 institutes, 38 research stations and 15 laboratories. Through these and other agencies it directs the work of thousands of scientists and technicians throughout the Soviet Union. Policy and direction flows from the Council of Ministers through the Chief Scientific Secretary, appointed by the Communist party. The current secretary is A. V. Topchiev. The president of the Academy is a respected organic chemist, A. N. Nesmeyanov.

Because Russian science is under state domination, heavyhanded, unenlightened administration might easily stifle progress and creative talent. Evidence during at least the last few years, however, indicates that great care has been taken not to demand practical results too quickly but rather to assign requirements, responsibility and authority and let the scientists run the show.

The Commission on Astronautics was officially established early in 1955 under the Academy's Astronomical Council. Its official title is the Interdepartmental Commission for the Coordination and Control of Scientific-Theoretical Work in the Field of Organization and Accomplishment of Interplanetary Communication of the Astronomical Council of the Academy of Sciences of the USSR. The fundamental task of the Commission is ". . . to assist in every way the development of scientific-theoretical and practical work in the Soviet Union concerning questions of studying cosmic space and the accomplishment of astronautics."

Responsibilities Spelled Out

The responsibilities and powers of the Astronautics Commission are specific and extensive. The Commission is charged with:

1) "Taking actions which secure the active participation of academic and branch scientific-research establishments in work for the investigation of cosmic space." (Direct appropriate institutes and laboratories to earmark personnel and time for research on problems assigned by the Commission.)
2) "Organization of work on drawing up problem plans and programs of scientific investigations on the fundamental trends of astronautics." (Draw up a long-range development program and identify the important areas of ignorance to be investigated.)
3) "Broad attraction of scientific-research establishments, of universities and individual investigators to the solution of problems to secure the realization of flight into cosmic space." ("Sell" astronautics as an exciting new field of research to the scientific fraternity.)
4) "Coordination of scientific activities of individual research institutions on the problems of astronautics." (Make certain that there is a "horizontal flow" of appropriate information between the various research institutes.)
5) "Popularization of the tasks and achievements in the field of astronautics." (Educate the population at various levels of intelligence in the technical feasibility of astronautics and

the potential value of satellite and other space research.)

In addition, the Commission shall:

6) Review the plans and reports of the "scientific research institutes which work on the program controlled by the Commission."

7) Sponsor scientific conferences on astronautical problems.

8) Serve as the award committee in stimulating the submission of scientific work in competition for the triennial K. E. Tsiolkowski Gold Medal, established in 1954.

9) Maintain, through the Foreign Section of the Academy of Sciences, contact with the scientific organizations in foreign countries which are concerned with high-altitude research and space flight.

The Chairman of the Commission on Astronautics is Academician L. I. Sedov. Sedov is a distinguished physicist who has been known for his works in analytical mechanics and gas dynamics.

One important announcement may be forthcoming in the next several weeks—the naming of the first recipient of the Tsiolkowski Gold Medal. This award will be made "to Soviet and foreign scientists for original work of major significance in the development of astronautics." The closing date for this competition was 1 April 1957. It could be expected that the individual (or individuals) named will be those who have played key roles in the development of the first *Sputniks*.

With the successful accomplishment of the initial steps in astronautics the Commission on Astronautics is undoubtedly at work on the more obvious follow-up projects—namely, more and larger satellite vehicles, recoverable satellites, space medical research in satellites, lunar impacting vehicle, and circumlunar vehicles.

That these projects are technically feasible is no longer a question. The question is, rather, how far along is the USSR in their prosecution. If they are all accomplished in 1958 the United States will really have a hard time catching up. And a still harder time beating the Soviets to later "firsts" in space research.

Academy of Sciences

The Academy of Sciences of the USSR is the highest central organization which directs the entire scientific and industrial development of the Soviet Russia.

The Academy is divided into a

number of divisions, each of which has further subdivisions. In each of these subdivisions there is a corresponding institute which is constituted of an expert body of specialists, directing the work of laboratories under its cognizance.

The scientific and engineering activities of each industry are also under the direction of the corresponding institute.

The academy has the following scientific divisions: (1) physics-mathematical, (2) chemical, (3) geological-geographical, (4) biological, (5) technical, (6) historical-philosophical, (7) economical and (8) literary and linguistic.

To illustrate the mass of activities under the divisions, following is a breakdown of the activities of divisions (1) and (5):

Physics-Mathematical Sciences

The division of physics-mathematical sciences consists of:

1) Physical Institute (Moscow)

Atomic fission, cosmic rays, physical optics, spectroscopy, radio physics, propogation of electromagnetic waves, radar, acoustics, theoretical physics.

2) Physical-Technical Institute (Leningrad)

Semiconductors, electronics, polymers, physics of nuclei, properties of solids, dielectrics, synthetic rubber, etc.

3) Institute of Crystallography (Moscow)

Pursues a number of practical problems, for example, the use of different crystals such as dielectrics in oscillating circuits which have special features in selectivity, resonance, etc.

4) Mathematical Institute (Moscow)

5) Institute of Geophysics (Moscow)

Origin of the earth, seismology, earth's electric and magnetic fields, winds, cyclones, tides, ocean currents, etc. The institute has numerous laboratories and stations scattered all over the territory of the USSR.

6) Institute of Seismology (Moscow)

A kind of a subsidiary organization of the Institute of Geophysics.

7) Hydrophysical Laboratory (Moscow)

Another ramification of the Institute of Geophysics; study of ocean curents, winds, spectroscopy of ocean noise, means of reducing ocean waves by means of films of oil, propagation of oceanic disturbances in depth, etc.

8) Astronomical Observatory (Pulpovo)

Observation.

9) Institute of Theoretical Astronomy (Leningrad)

Perturbations, astronomical tables and purely theoretical work in celestial mechanics on the basis of data collected by the Astronomical Observatory.

10) Committee on Meteors
Subsidiary of the Institute of Theoretical Astronomy.

11) Laboratory of Astronomical Instruments

12) Laboratory of Radio-Physics and Radio Technique (Moscow)
Short waves, ultrashort waves, nonlinear oscillations, etc.

13) Spectroscopic Laboratory (Moscow)

14) Acoustical Laboratory (Moscow)

15) Committee on Cosmic Rays (Moscow)

16) Committee on History of Physics-Mathematical Sciences

17) Committee on the Development of Physical Methods in Geophysical Research

18) Committee on Astrophysics

19) Committee on Geodesy
Maps, profiles of the sea, soundings, etc.

Technical Sciences

1) Institute of Energy (Moscow)
Terrestrial electric field, lightning, production of gas, etc.

2) Institute of Fuels

3) Institute of Metallurgy (Moscow)

4) Institute of Mining (Moscow)

5) Institute of Machine Construction (Moscow)
Theory and construction of machines (jointly with the Institute of Metallurgy)

6) Institute of Mechanics (Moscow)
Stability, gyroscopes, dampers, plasticity, shells, aerodynamics, supersonics, propellers, jet, etc.

7) Institute of Automatics and Telemechanics (Moscow)
Control problems (particularly nonlinear ones), autopilots, etc.

8) Committee on Communications (Moscow)
Steam, diesel and electric locomotives, automatic blocking systems for railroads, traffic control, etc.

9) Committee on Waterways
Construction of canals, waterways, etc.

10) Committee on Radio Communications
Use of short and ultrashort waves propagation, taking into account the nature of the earth's surface, presence of iron ores, etc.

11) Committee on Welding and Electrothermal Devices
Welding, study of stresses in structures, etc.

12) Committee on Standardization

This data was prepared by the m/r editors, based on information from Frederick C. Durant III, L. I. Sedov, chairman of the USSR Commission of Astronautics, and William P. Lear.

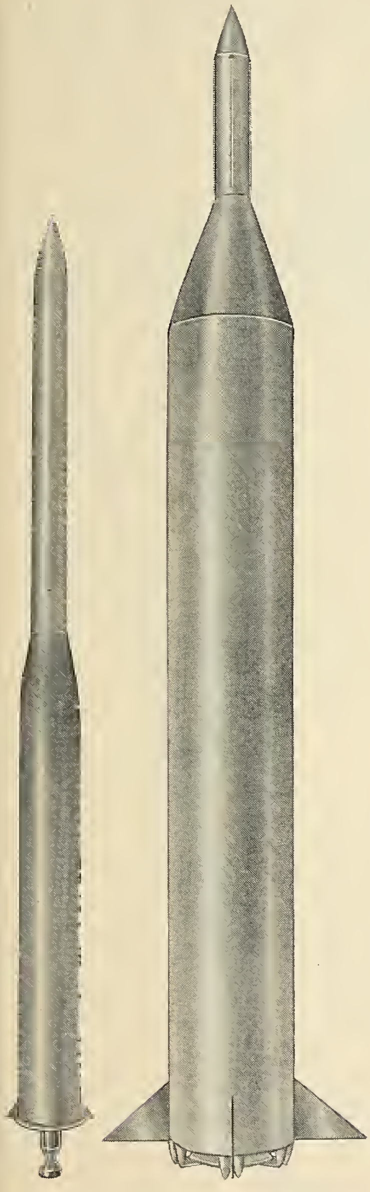
Reds Reveal Names of Their Space Dogs

The Soviet team of astronautic dog trainers and observers is reported to be headed by Professor Alexis V. Pokrovsky who is helped by at least five assistants, three of whom are men and two are women. The men are A. Seriapin, E. Yuganov and A. Genin. The women are E. Danich and Z. Voronkova.

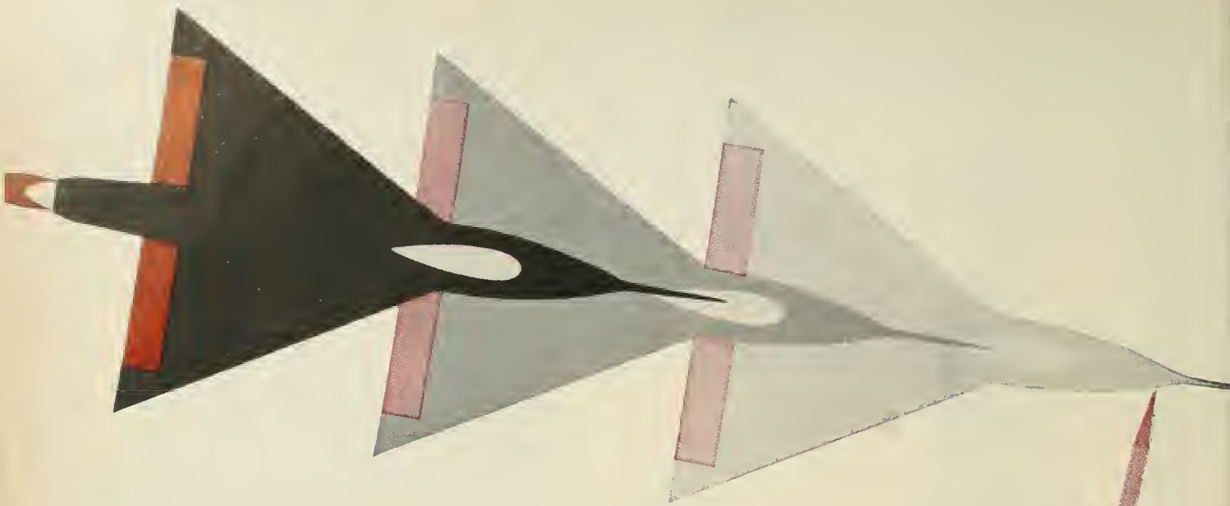
Of at least 12 dogs used so far in the space experiments, the following eight are known: Kudriavka (Curly), Koziavka (Tiny), Damka (Little Lady), Malyshka (Little One), Laika (Barking One), Limonchik (Little Lemon), Albina (Whitey) and Linda (a girl's name of Western, not Russian origin).

Until October 12 the dog handling staff referred to Damka as "the champion of height." The Moscow LITERATURNAYA GAZETA, reported she "was the first living being to reach the highest point without a helmet, in the hermetically sealed cabin of a rocket."

Satellite Carriers: *Vanguard* vs. *Sputnik*



The VANGUARD vehicle (left) will orbit approximately 270 lbs. of satellite (instruments plus empty third stage) at an average altitude of 900 miles. This will require an initial thrust of 100 lbs. for each pound of satellite. The T-2 IRBM SPUTNIK I vehicle (right) launched a total satellite weight of about 1000 lbs. (184 lbs. instruments plus empty T-7A third stage) to an average orbit altitude of 350 miles. SPUTNIK II, essentially a heavier SPUTNIK I with third stage attached, was orbited at an average altitude of 600 miles. Assuming that VANGUARD thrust requirements were met, both SPUTNIKs could have been launched by the T-2 IRBM, which has a thrust of 254,000 lbs.



Russian Space Savants Active In Egypt

The first Soviet astrophysical expedition in the Middle East has begun its activities in the Aswan (Asuan) region of Egypt. The expedition is headed by Academician V. G. Fesenkov.

The Cairo correspondent of Tass, the official Soviet news agency, reports that "the local authorities and inhabitants have met the Soviet expedition warmly and are rendering it all the necessary aid in its work." An Egyptian astronomer, Dr. Adli Salama, has joined the Russian group to participate in its research.

Castable Rocket Propellants Described

ESCH, Germany—Speaking before a German rocket society meeting, Dr. Götz von Francois described cast rocket propellants. Essentially thermoplastic, homogeneous propellant materials used are 50% trinitrotoluene, nitrocellulose, diglycol, and stabilizers. Another combination uses 50% trinitrophenyl glycol nitrate, also with nitrocellulose, diglycol and stabilizers. The cast propellants have a temperature range of 0-50°C and are somewhat less smoky than black powder. Rockets weighing 12-14 pounds, have attained ranges of over 20,000 feet.

Missile Association Makes Rapid Progress

The Association of Missile & Rocket Industries (AMRI) is constantly signing up new members and organizing for service.

After the second organization meeting in October, attended by representatives of 48 companies, AMRI was incorporated as a nonprofit association in the District of Columbia.

Under an initial board, headed by Adm. J. A. Briggs of the Research Laboratories, Cook Electric Co., the member companies are consulted as a steering committee pending the election of a larger board and a full slate of officers.

Adm. Briggs stresses the importance of "trade association services to help member companies find their place in the missile program." The industry is being canvassed for opinions both as to the AMRI program and questions of national policy.

Committees are being formed on Program, Membership, By-laws, and Statistics.

Kendall K. Hoyt, Executive Director, is opening a suite of offices for AMRI at 1079 National Press Bldg., Washington 4, D.C.

Soviets Now Preparing *Sputnik* Telescope To Probe Mars?

Once a *Sputnik* is beyond the limits of the atmosphere Prof. Y. A. Pobedonostsev of Moscow has announced, a telescope installed on such a satellite will magnify objects 10,000 times their size, instead of the 900-times magnification possible with man's earth bound telescopes. From a *Sputnik*, the Russian scientist said, "objects on the moon which have a diameter of only 12 meters" can thus be observed, and the questions on the so-called "canals" on Mars can be answered. In addition, the character of the surface of Mercury, Venus, Jupiter and Saturn can be studied.

Russia Appoints Space Watchers

The Soviet Union's newest and mightiest ionosphere observing station has recently been installed at Voyeikovo in the Leningrad region. It is manned by a staff assigned to the task by the Leningrad Electrotechnical Institute headed by Prof. M. P. Dolukhanov and Candidate of Technical Sciences E. V. Ryzhkov.

A new meteorite-tracing radar installation is now being built at the Astronomical Institute in Ondrjeev, Czechoslovakia.

Ehricke Proposes Astrophysical Decade

Krafft A. Ehricke, assistant to the technical director of Convair Astronautics, has proposed a ten-year space study program, patterned after the current International Geophysical Year for study of the earth's immediate interplanetary environment and preparation for human travel in space. Ehricke suggested 1965-1975 as an appropriate period for this International Astrophysical Decade.

Power to send IAD research vehicles throughout the inner solar system can be achieved with moderate increases in the capabilities of rocket engines now being built for long-range missiles, Ehricke said. He estimated that these "instrumented comets" can be developed in the next five to ten years.

Space research with instrumented comets holds a tremendous technical, scientific, political and cultural potential, Ehricke stated. He said much fundamental information on the nature of nearby interplanetary space can be learned by launching simple, lightweight bodies capable of reflecting

Pneumatic controls

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sunlight, carrying telemetering equipment similar to that to be used in the *Vanguard* satellite project, or carrying hydrogen bombs which, upon detonation, would emit a flash that could be studied spectroscopically from the earth.

One such vehicle proposed by Ehricke could explore interplanetary regions at relatively small expenditures of power. This vehicle, a gas-inflated polyester sphere, could be propelled away from the earth by detachable rocket boosters, then accelerated further by radiation pressure from the sun.

Radiation-propelled spheres 500 to 1000 feet in diameter could carry several hundred pounds of instruments. These vehicles would be useful in exploring the distribution and density of interplanetary matter such as comets, meteors, cosmic dust and gas. Their silver, reflective coating would make it possible for astronomers to follow their progress optically.

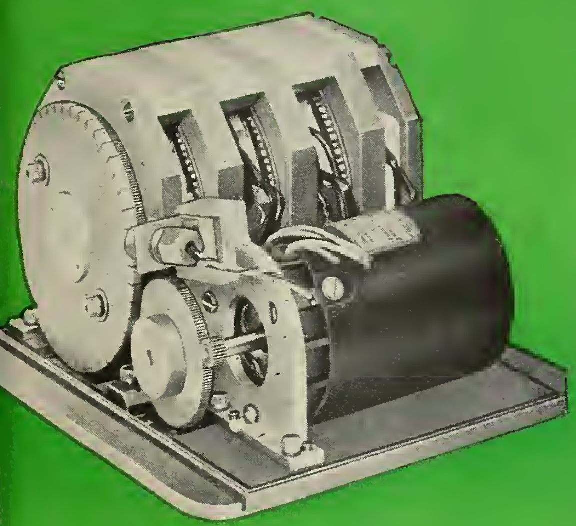
H-bomb probes of space would require increased propulsion but could yield much information. These vehicles could be fired on a collision course at the Moon, Mars or Venus and the H-bombs set to explode either on impact or above the surface of the target body. Spectroscopic study of the flash could provide data on atmospheric composition.

Princeton and Detroit Universities Study Superperoxide Propellant

It has been learned that studies related to the formation of hydrogen superperoxide, H_2O_4 have been underway for several years at at least two U.S. universities—Princeton and the University of Detroit. The Princeton work is being carried out by J. D. McKinley at the Forrestal Research Center under a chemical kinetics project. The project is headed by Dr. Donald J. Kenney of the missile and rocket section.

The USSR has been attempting to synthesize the potential propellant for at least five years. Latest work may indicate that the superperoxide is not a true compound or polymer of ordinary peroxide but may be free oxygen radicals dissolved in H_2O_2. If the theory is proven true it would mean that free radical solutions might be combined with ordinary oxidants or fuels. In this way hydrogen peroxide or nitric acid with free radicals could give substantially higher performance than liquid fluorine or ozone. It might sound the death knell for the boron exotics since a hydrocarbon fuel could be "spiked" with methyl or ethyl radicals.

ESIGN ACHIEVEMENTS WITH **SUPRAMICA*** ceramoplastic



MYCALEX TM Commutation Switch for Telemetering, Using Precision-molded SUPRAMICA* 555 Ceramo-Plastic Commutator Plates.

Precision-molded SUPRAMICA* 555 Ceramoplastic Commutator Plate, CP-346, With 360 Contacts and 2 Slip Rings. Other Standard Plates Are Available.

OVER 1000 HOURS SATISFACTORY OPERATION AT 1200 RPM

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Mycalex* TM commutation switches with SUPRAMICA ceramoplastic commutator plates have introduced a degree of accuracy and sustained dependability never before approached in telemetry. Evaluation tests show completely satisfactory performance for more than 5500 hours at 600 rpm, with unattended life in excess of 1000 hours. Exhaustive testing under severe conditions demonstrates consistent noise level performance as low as 0.2% peak-to-peak of signal into a 500 ohm load.

Where warpage of only .0002" of the commutator plate will distort and destroy the value of the signal, these precision switches withstand extremes of temperature, altitude, shock and vibration and deliver a clean, unvarying pulse.

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Solar Activity Confab Held by Reds

IZVESTIA reports a successful conference held at Lvov, western Ukraine, by Soviet scientists concerned with the problems of solar activity and its effect on the Earth. Participants were representatives of scientific organizations of Moscow, Leningrad, Stalinabad (Soviet Central Asia), Irkutsk (Siberia), Riga (Latvia) and other Russian cities.

Members of Commission on Astronautics, Academy of Sciences, USSR

Sedov, L. I., Academician, Chairman
Petrov, G. I., Corresponding Member, AS, Vice Chairman
Levin, B. Yu., Doctor of Physics-mathematical Sciences
Lavrent'ev, M. A., Academician, Mathematical Institute, AS
Kapitsa, P. L., Academician, Physical Laboratory, AS
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Blagonravov, A. A., Academician, Mechanical Engineering, AS
Ambartsumyan, V. A., Academician, AS, Armenian SSR
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Karpenko, A. G., Scientific Secretary of the Commission

AS—Academy of Sciences.

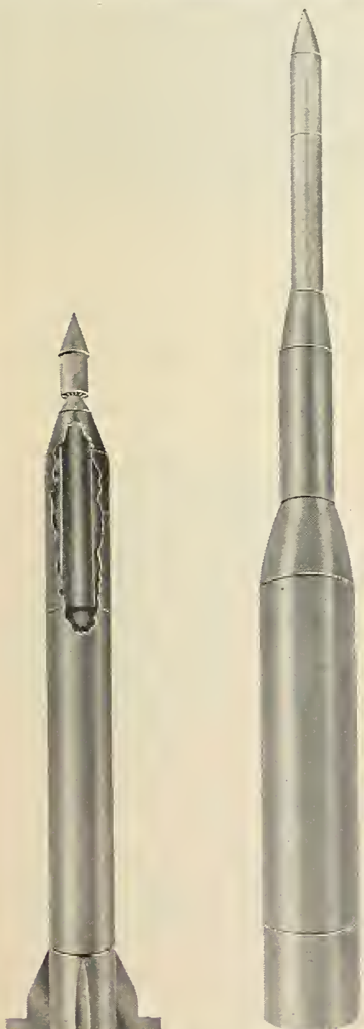
U.S. Army's *Jupiter-C* Becomes Satellite Carrier

The long-awaited decision to place the Army *Jupiter-C* research rocket into the satellite service may not put the United States into space any sooner than was originally planned but it is indicative of a progressive acceptance of the importance of space science. Also, this addition to the U.S. program guarantees only that we will place *a satellite* into an orbit during the IGY.

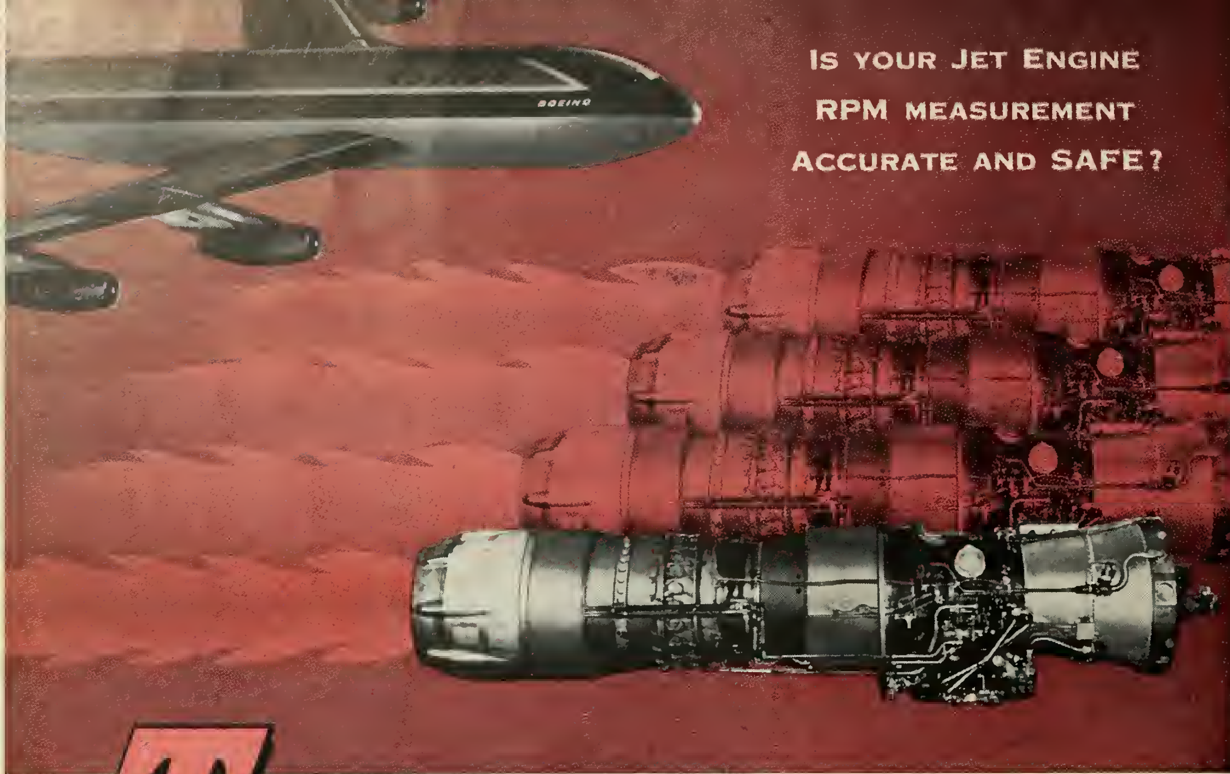
If *Vanguard* and *Jupiter-C* are both successful, it means that we will have *more* satellites of practically the same weight and for basically the same scientific experiments. No plans have been disclosed for placing larger and more varied instrument carriers into space. In addition early reports indicate that the possibilities of the Army orbiting a satellite before the Navy's *Vanguard* are very slim.

The Navy is confident that its first test satellite, to be launched within a matter of days after m/r goes to press, will be successful. If so, the remainder of the test spheres will be shelved and preparations undertaken to launch the first full-size 20-inch satellite immediately. Dr. Hagan, project director, stated this could happen shortly after January 1st.

Meanwhile the Army has the task of completing and checking out three *Jupiter-C* vehicles that were left over from the successful nose cone re-entry program. Gen. Medaris emphasized that after the rocket vehicle has been delivered to the launching site, at least 30 days are needed to test and check out the launcher before actual firing. The utilization of the military test vehicle as a carrier has imposed a cloak of security on most of the operation. Sifting of the meager information available indicates that pad-



JUPITER-C (left) alongside JUPITER satellite launcher (JUPITER plus three SERGEANTs, second stage, and one SERGEANT, final stage).



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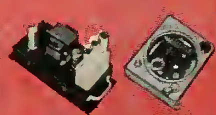

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readiness of satellite-carrier *Jupiter-C* 1 is still several days away.

Army officials further stated that the 20-pound cylindrical satellites are not ready. Jet Propulsion Laboratory will supply the packages. First satellites will be six inches in diameter and over two feet long. Transmitters will broadcast on 108 mg in order that existing Minitrack stations can be utilized. Three to nine launchings have been planned—all "live." Gen. Medaris expects at least a 90 per cent successful orbit capability.

There have been reports that a change in the propulsion system would be necessary before the *Jupiter-C* would be capable of orbiting a satellite. Army officials stated this might involve nothing more than the addition of a fourth stage. The original *Jupiter-C* nose cone re-entry vehicle reached an altitude of 600 miles, a range of 3600 miles and a speed of about 15,000 mph. A configuration and propulsion change could easily force an agonizing stretchout in the program's schedule.

The *Jupiter-C* vehicle is about 70 feet in length with a maximum diameter of six feet. At least three stages will be lashed together in the final configuration. The *Redstone* 300-mile liquid-propellant rocket will comprise the first stage. A cluster of 11 "scaled-down" *Sergeants* will make up the second stage with a cluster of three of these solid-propellant rockets for the final stage. JPL will supply second- and third-stage rockets. Copper Development and an unknown division of General Motors are fabricating the lash-up components. Chrysler and Reynolds Metals will produce the body of the vehicle.

Second- and third-stage rockets and the guidance system will be enclosed within the 29-foot warhead and control section of the modified *Redstone* first stage.

Snark Hits Target At 5000 Miles

The U.S. Air Force's Northrop *Snark* SM-62 has demonstrated ability to send a nuclear warhead to any target in the world with a 5000-mile flight made under simulated operational conditions.

The *Snark*, launched from the Air Force's Missile Test Center at Cape Canveral, Fla., was programmed to impact a target near Ascension Island in the South Atlantic. The subsonic surface-to-surface missile delivered its payload, a simulated hydrogen warhead, on the target with "unprecedented" accuracy.

Sweden Shows Its New Missile Designs

Sweden's first guided missile press demonstration, with the exception of some smaller exhibits at a recent defense exposition in Gothenburg, was held in Stockholm on Nov. 4. At Barkarby outside Stockholm, the Air Force showed its newest weapon, the Type 304 air-to-surface missile developed for the Saab-32 *Lansen* transonic all-weather attack aircraft which is now standard equipment with all Swedish Air Force attack units.

The 304 is currently undergoing extensive trials prior to its introduction into service. It is already in limited production. The new missile was developed by the Swedish Guided Weapons Bureau in collaboration with other governmental and civil organizations. Its production is handled by the Air Force's own central workshops and civil subcontractors.

Two Type-304 air-to-surface missiles are shown mounted on Saab-32 LANSEN fighter.

Very little technical information has been revealed on the 304 except that it is rocket-powered and is fitted with an all-weather guidance system. The missile, two of which can be carried by a *Lansen*, was demonstrated both on the ground and in the air. A fly-by of a *Lansen*, carrying two of the approximately 13-foot-long missiles, showed that the reduction in the airplane's speed is not very great.

The 304 is regarded as an extremely important weapon in Sweden's defense against an invasion over the sea. It will enable the *Lansen* units to fire with utmost precision against enemy naval vessels well outside the range of conventional antiaircraft artillery.

In addition to the Air Force 304 missile, a new naval surface-to-surface guided missile, known as the 315 was shown for the first time. The 315 has been designed for use from destroyer-type vessels against other vessels.

The new missile, now undergoing trials at sea, will initially equip the two new destroyers *Smaland* and *Halland*.

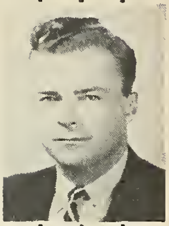
Acceleration to flight speed is provided by four built-in booster rockets. For cruising it uses a special type of jet engine, presumably an advanced type of pulse-jet engine. The missile has an all-weather guidance system. The greatest advantage of the new missile is that it permits firing at targets outside the range of conventional artillery. The missile is 26 feet long.

In general, Swedish guided missile development is handled by the Guided Weapons Bureau. In the future, however, new missile projects will be handled by the aircraft industry, notably Saab. The Swedish policy is to develop only such missiles that cannot be purchased abroad. Guided missiles that can be obtained from abroad will be acquired. One type that will certainly be needed is the surface-to-air missile.

Latest addition to the Swedish fleet is the 315 all-weather surface-to-surface missile.

Washington Trends

by Erik Bergaust



PHILLIPS PETROLEUM HAS TEST FIRED AND DELIVERED several solid-propellant rocket motors of over ¼-million lb./sec. total impulse. Much of the work in progress is directed toward high-energy propellants containing ammonium perchlorate. The company's fabrication processes and techniques permit great grain scale-up with the same plant equipment. This column erroneously reported in September that Phillips was not too interested in these high-energy propellants.

SEVERAL CONGRESSMEN WANT TO KNOW WHO IS FOOLING WHO with all this talk about instant retaliation with an ICBM. The LOX-filled *Atlas* takes over two hours to ready for launching. This time probably will never be reduced to less than an hour. Flight time of a Soviet ICBM is about 30 minutes and our ICBM bases will be the first targets. We could instantly retaliate, assuming our bases are not blasted, only with a solid-fueled ICBM already zeroed in.

CENTRAL INTELLIGENCE AGENCY REPORTS SHOW that the Soviet fleet is now larger than ours. When is the Navy going to tell the public this? The Soviets are not retiring their capital ships. Their submarine fleet (now nearing 600) is unquestionably a major threat. In addition, many of their surface ships can launch rockets and are protected by antiaircraft missiles.

ONE OF PRESIDENT EISENHOWER'S ADVISERS says the Russians have committed a "colossal blunder" by launching their *Sputniks*. We agree that recent events may have awakened the U.S. before the point of no return was reached, but perhaps Mr. Clarence Randall, author of the statement, would like to explain this "colossal blunder" to the millions of people who know little except that two *Sputniks* are up there. As far as these people are concerned, our six-inch satellite will be a "silly bauble" compared with the Soviet versions. And our 21-pounders will be launched at least six months later, at that.

NOW THE PENTAGON IS WISHING that it had paid more attention to the report that Dr. Theodore von Karman prepared for Gen. Hap Arnold in 1945. The report foresaw many of the problems with which we are now faced. It is particularly significant that the general requested the thoughts of Dr. von Karman on two areas of future planning: what assistance should we give to the educational and commercial scientific organizations during peacetime, and what proportion of available money should be allocated to research and development.

Dr. von Karman's prognosis was frighteningly accurate. "No long-range program can possibly succeed unless the proper climate and conditions for its success are provided." We have not provided this climate and 1) we have failed to beat the Soviet Union in the development of an ICBM; 2) we have failed to launch the first earth satellite; 3) we have failed to launch the first earth satellite with an animal aboard; and 4) we shall fail to beat the USSR to the moon.

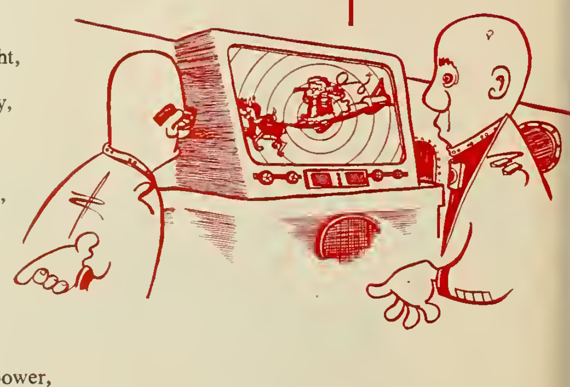
A THEORETICAL METHOD OF KILLING ICBMs involves the use of a cylindrically bundled photonic beam. Its spectrum lies primarily in the ultraviolet region and it can deliver up to 80 per cent of its energy to the target, despite having to penetrate the atmosphere by as much as 75 miles. Because the reflection of metal is small in the ultraviolet spectrum, the impinging energy of the ray is transformed into heat which vaporizes the body.

ONE UNUSUALLY WELL-INFORMED CONGRESSMAN wants to know why we don't show the Russians a thing or two by shooting down their *Sputniks*. With what, may I ask?

the flight before Christmas

by Jim Carr

'TWAS the flight before Christmas and through outer space,
Not an object was stirring; support was in place.
The dials were all set in the blockhouse with care,
Checked out were components located there.
Our crew well-secured by a strap in each lap,
The rhythmic countdown had soon caused them to nap.
With the Captain in charge and I on his right,
We blasted away on elliptical flight.
When out in the orbit, there rose such a clatter,
We leaped to our console to check on the matter.
Checked out was each rocket quick as a flash,
A glance at the LOX dial there on the dash.
Moonlight reflecting on earth far below,
Showed nothing amiss in the cold winter's glow.
When what to our wondering eyes should appear,
But a miniature rocket with eight stage of deer.
And manned by a pilot, so lively and quick,
We knew in a moment it must be Saint Nick.
With speed hypersonic, his coursers they came,
He whistled and shouted and called them by name:
"Now Ramo! Now Wooldridge! Now W Dee Dee!
"On Rocketdyne, Convair and ARDC.
"From orbit to orbit to the top of it all,
"Now dash away, dash away, we'll have a ball!"
And then in a twinkle on the scope did appear,
The prancing and pawing of each little deer.
Smooth as a jet stream above a high cloud,
Gathering speed as he nodded and bowed.
He was dressed up for space from his helmet to boot,
With snowflakes adorning his gravity suit.
A bundle of toys he held strapped to his back,
He looked like a Martian adrift from his track.
His visor how frosted, his dimples how merry,
His thrust-reddened cheeks and his nose like a cherry.
With his eyes on the screen of a small radar set,
He was off on the flight plan already pre-set.
Since the course was set up in advance of the flight,
He relaxed with his pipe for the rest of the night.
He had tightened his seat-belt around his fat belly,
But it vibrated some like a bowl full of jelly.
A mighty good spaceman that jolly old elf,
He was better than Schriever—or even myself.
With a little more thrust then applied to the sled,
He dropped off his booster and darted ahead.
A wink of his eye and a wave of his glove,
He aimed for a planet in orbit above.
The flight was prepared in advance on a "brain,"
He would find all the stockings without any strain.
To visit all planets in just one night's tour,
He had to be confident, had to be sure.
So he closed a few switches, and turned on the power,
And was out of this world in less than an hour.
But I heard on our set 'ere he soared out of sight,
"HAPPY CHRISTMAS TO ALL AND TO ALL A GOOD FLIGHT."



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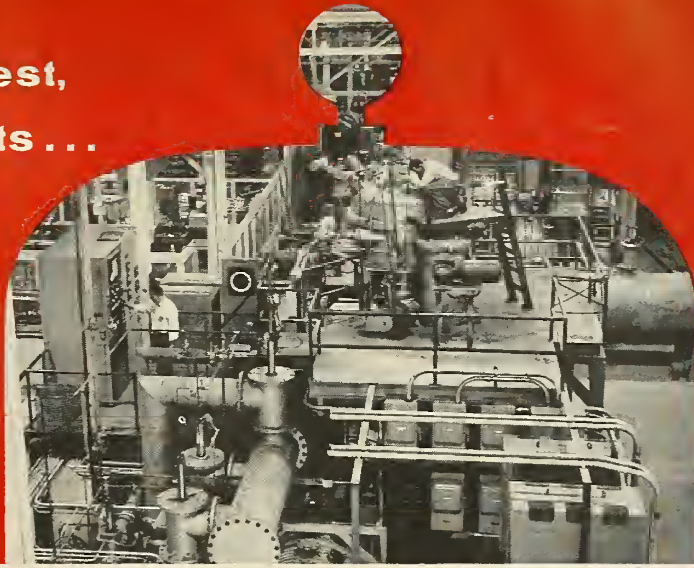

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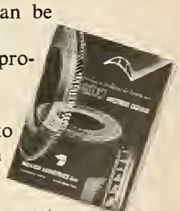

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missile miscellany

This page heard the other day a quip that must be old but is nevertheless worth noting: The Pentagon is the only institution run by its own inmates. All of which leads to a question: If the Army has had missile launching vehicles in being and if it's had its own satellites all ready to go, why is it now changing the vehicle and rebuilding the satellites? Seems as though by doing this, they risk a goof—which it can ill afford at the moment.

Meanwhile, this page also hears reports that Army Ballistic Missile Agency may be set up as the Government's nonservice missile research and development center. This means it would be run by the Department of Defense.

Government must have plenty of selection in space flight projects. A quick check reveals that no fewer than 30 U.S. companies have proposals for putting everything from TV cameras to men into outer space. Some even have suggested ways of getting them back!

Speaking of space, preliminary analysis of telemetered Far Side results indicates that gravity, rather than decreasing simply as the square of the distance from the center of the earth, actually "wobbles"—i.e., both decreases and increases with distance. No attempt to explain this has been made, but there seems to be a possibility that the earth's very strong electrical field and the relatively dense "atmosphere" of charged particles up to 40,000 miles may be a factor.

"What we need in Washington are more eggheads and fewer fatheads" . . . Dr. Fred L. Whipple, "The advancement of science in the U.S. is not up to the scienists, but to top Government planners." . . . Trevor Gardner suggests we drop Vanguard and fire more ICBMs . . . Navy Captain Irwin S. Moore, says the next war, if it comes, will cost the U.S. $4,000,000,000,000 (that's four trillion) . . .

NACA is reported to have given up on magnesium and boron slurries with hydrocarbons as high-energy fuels. Meanwhile, Vitro Corp. reports that it has solved problem of boron deposits in zip-fuel systems. Sounds like another round we had, where no fewer than three different companies claimed credit for having solved Jupiter nose cone re-entry problems. Actually Jupiter nose cone is of machined metal coated with Rockyde. Companies participating in its development include Jet Propulsion Laboratory, Cooper Development, Cook Electric, Norton Abrasives. Contrary to reports, Jupiter nose cone is capable of full velocity re-entry—uses Cook parachute recovery system only after it has re-entered. This is a device designed primarily for research and development rather than for incorporation into an operational weapons system.

Meanwhile, the other day this page was asked what it knew about Sargo, "a transitional missile fired from underwater . . ." Also, if it could put any light on Big Bear, Middle Bear and Little Bear, another missile project series.

From the West Coast, word that Lockheed has been given a contract or letter of intent to go ahead with a moon rocket; also word of a go-ahead on Pied Piper, that same company's proposal for a reconnaissance satellite. And now a suggestion that homing pigeons raised in Moscow be used as guidance systems for ICBMs. And a note of incidental intelligence—slowing of meson decay at high velocities provides proof of Einstein's General Relativity Theory that things slow down when near-light velocities are reached—clocks run slower, etc. Another relativity calculation—a rod going 161,000 miles per second would shrink to half its length in the direction of flight. Good to know for a flight to Alpha Centauri!

PARIS PRESSE correspondent, Albert Ducrocq, after an extensive visit to Russia reports that Reds are using boron and lithium for propulsion already; also that they've discovered how to store monatomic hydrogen and are using it too. And a suggestion from elsewhere that they have done considerable work—successfully—on propellant systems that emphasize effluxes of greater mass, lower velocity . . . and no doubt anywhere that they're doing quite well at the game.

Many methods of manned re-entry are being suggested and developed. AVCO and Cook Electric are working on parachute devices. AVCO thinks in terms of steel (or other high-temperature material) parachutes—admits structure poses problems. Cook claims it can be done with cloth 'chutes in series. Two Russian re-entry proposals are: Continuous dereefing of a cloth parachute—starts out small and gets bigger as velocity is slowed. Other method would use steel 'chute and come in like a falling leaf. It's been calculated that Sputnik II, if it had popped a 'chute system at its perigee, would have returned safely to earth within 24 hours. Another approach to manned re-entry is much more sophisticated—now in the laboratory development stage—involves magnetohydrodynamics. This works on the principle that a strong magnetic field will bulge out the shock wave in the ionized layer ahead of the re-entering body with double results: drag to slow it down; and less heat transfer due to pushing away of hot air at nose. Also, system can generate its own electric power, picking up current from ionized layer with magnetic coils.

Back to Vanguard again: Stewart Committee that selected Vanguard over Orbiter did not do so with a unanimous decision. Three members of the committee voted against Vanguard, including C. C. Furnas and H. J. Stewart. Minority report is point-by-point and is alleged to make very good reading. And a question: Why has the R&D balance been so much this way . . . . . r&D

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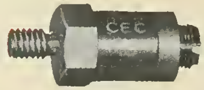

Subminiature Type 4-242-2 (shown at left) weighs 20 grams, and features a quick-disconnect cable. The Type 4-242-1 (flange mounting) weighs only 8 grams, including 18" attached cable. The Type 4-240-1 (pictured above) operates from 3 cps to 60 KC.

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Soviet Affairs

by Dr. Albert Parry

Long before their spectacular triumph with *Sputnik* II, through the years of their preliminary experiments with sending dogs up in rockets, Soviet astroscientists insisted that they were achieving better results than we did with monkeys, mice and guinea pigs. The Soviets said that they were not only reaching higher altitudes with their animals than we with ours, but that we were drugging our animals while Russian dogs were never under narcotics and were thus observed under far more normal conditions. Therefore, Moscow claimed, Russian experiments with "cosmic dogs" were of much greater benefit to space medicine than those made with our monkeys and mice.

So far, this Red claim has gone largely unanswered by our side. If our experimenters have made any reply to the Soviets on this score, the American answer has not been properly publicized. But it should be.

The outburst of indignation from dog lovers regarding *Sputnik* II's passenger is quite puzzling to Russians. As a people they are not so tender hearted toward animals. America's very first Society for Prevention of Cruelty to Animals owes its founding to precisely this Russian hardhearted attitude to animals. The Society was first chartered by the New York State Legislature in 1866 at the suggestion of Henry Bergh, a U.S. diplomat, on his return from Russia. While serving in St. Petersburg as our secretary of the legation (1862-64), he had been outraged by the sight of Russian cabmen mercilessly flogging their fallen horses to bring them back on their feet from the snow or mud. He had also been incensed by the prevailing indifference of Russian passers-by to this cruelty. On coming home to America, and mindful of Britain's legislation and her Royal Society to prevent such cruelty (1822-24), Bergh started a similar movement here.

•

Academician L. I. Sedov, on his return to Moscow from the astronautical meeting at Barcelona (Oct. 6-12), declared that he was "definitely interested" in the papers by U.S. participants at the meeting on "the possibility of building new ion-rocket engines for interplanetary flights;" on "obtaining and utilizing high temperatures up to 30,000 degrees"; on "the development of heat in rockets and artificial satellites while descending and entering into denser strata of the atmosphere."

Sedov also expressed "indubitable interest" in "reports devoted to oriented artificial satellites and certain other problems of aerodynamics" such as the report on sending plastic balloons up to great heights.

On his return from a visit to the United States, Prof. Anatoly Blagonravov also expressed his interest in American rocket firing from balloons (Operation *Far Side*). These experiments were "worthy of attention" of the Soviets, he said.

The above list can tell us just where the Russians now feel they are either behind us and can learn things from us, or are on a par with us but should be ahead.

•

The latest Soviet humor at our expense includes the quip that Americans piled up mountains of talk and preparations and haven't produced even a *Mouse*.

And why should Americans worry so much about Syria, jests a Moscow humorist, when they had better do something about flights to Sirius.

Sirius, we may add, is also known as Canis Majoris or Dog Star.

World Astronautics

by Frederick C. Durant III

Details have just been received on the First Polish Scientific Conference on Rockets and Astronautics held in Warsaw last Spring. Host and organizing body was the Polskie Towarzystwo Astronauticzne. After hearing a tribute by Prof. Dr. E. Olszewski to the 100th anniversary of the birth of Russian rocket pioneer K. E. Tsiolkowski, about 200 "specialists in rocket technology, thermodynamics, aerodynamics, physics and biology and astronomy" settled down to listen to 21 technical papers. Prof. Z. Paczkowski detailed current problems in rocket development and Dr. K. Zarankicwicz (president of the Polish Astronautical Society) outlined the current status of astronautics. All meetings were held at the Warsaw Polytechnic Institute.

Subsequent topics treated in technical papers included ion propulsion (Prof. M. Lunc, L. Bobrowski); nuclear propulsion (O. Wolczek); water-steam rockets (J. Walczewski); turbojet engines (Dr. S. Wojcicki).

Thermodynamics and technology of liquid and solid propellants were covered in papers by M. Zembrzuski, Heger, Bodaniuk and Chrzanowski. Inertial guidance systems were treated by A. Kaczmarczyk. M. Subotowicz presented a concept for achieving propellant economies in a step-rocket system.

Ballistics and guidance systems were discussed by W. Biwan, J. Pie-Kielny, F. Wolnica and Lizon. Rocket jet throttling was treated by Ulam and materials of construction by H. Muster. .

On the final day the future was examined and applications of nuclear energy to space flight were considered by S. Wilk. The Polish Society Secretary, W. Geisler, introduced the possibility of using asteroids as earth satellites. An analysis of the case of the planetoid Hermes was treated in particular. Dr. Gadomski presented the results of his calculations on the existence of ecosphere about other stars. His conclusions were that of the 50 stars nearest to the solar system, only 13 could possess an ecosphere which could result in organic life similar to the Earth's. Space medical problems were treated by Dr. Oginski, W. Ciechocinski and Col. Dr. S. Marczewski.

The rocket and astronautical exhibition which had attracted 80,000 people in Silesia (m/r February, pp. 74, 75) was opened in the Warsaw Museum of Technical Science.

In summary, the Polish Astronautical Society gave evidence of deep interest and a sophisticated appreciation of astronautics.

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In Boston last month re-entry expert Dr. Arthur Kantrowitz, Director of the Avco Research Laboratory announced that Avco had been "studying the problems of manned re-entry for more than a year." He went on to state that "a manned satellite vehicle could be accomplished much more quickly than commonly supposed."

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For those who still are looking for justification of scientific research in space, we give you the opinion of famed Russian scientist Peter L. Kapitsa:

> ". . . if in any branch of knowledge, possibilities of penetrating a new virgin field of investigation are opening, then it must be done without fail, because the history of science teaches that, as a rule, it is precisely this penetration of new fields that leads to the discovery of those very important phenomena of nature which most significantly widen the paths of development of human culture . . ."

Space Medicine

by Hubertus Strughold, M.D., Ph.D.

U.S. highlight of the International Astronautical Congress in Barcelona, Spain, from 7 to 11 October 1957 was—without question—the report on the recent balloon flight to 102,000 feet by Major David G. Simons. Dr. Simons, Chief of the Space Biology Branch of the Aeromedical Field Laboratory, presented a paper giving his observations during the flight.

Dr. Jan Gadomski, a member of the Polish delegation, delivered a paper on "Star Ecospheres Within a Distance of Seventeen Light Years from the Sun." Dr. Gadomski had screened the numerous stars within this area, and had concluded that only 20 of them could have ecospheres—that is, zones containing planets with conditions favorable to life.

In her paper on "Preparations for Visual Observation of Artificial Earth Satellites," Dr. Alla T. Masevich, an astrophysicist and member of the Soviet Academy of Sciences, who heads about 24 satellite-tracking stations, mentioned that she had some difficulties in persuading an optical factory near Moscow to build special telescopes of the small size needed by her moonwatchers. The factory officials felt that simple binoculars would serve the purpose. After Dr. Masevich and her colleagues gave the factory staff a series of lectures on the meaning and importance of the satellite-tracking project, they not only supplied the telescopes but also established a moonwatch station in their territory.

Prof. Leonard Sedov, leader of the Soviet delegation, made an interesting remark in the course of conversation at the Barcelona meeting. He said: "The important question is not whether a country has a bureaucracy. The question is how much of a bureaucracy the country has."

Dr. Ingeborg Schmidt of the Department of Optometry at the University of Indiana in Bloomington presented a paper at the same meeting on the visibility of satellites in an equatorial orbit. The nucleus of her research was a concept of "areas of potential visibility." The calculations given by Dr. Schmidt for the visibility of equatorial satellites have also turned out to be correct for a satellite of the polar or semipolar type.

In Wiesbaden, Germany, a few days after the Barcelona Congress, Maj. Gen. Harry G. Armstrong, Surgeon of the U.S. Air Force in Europe, arranged a press conference with Maj. Simons and the writer on matters of space medicine. The fact that 60 newspapers from all over Europe sent correspondents to this conference indicated a great deal of popular interest in the subject.

During the week of 27 January 1958, at the meeting of the Institute of the Aeronautical Sciences in New York City, a symposium on "Aeromedical Considerations in Space and Space-Equivalent Flight" will be held. The chairman will be Maj. Gen. Otis O. Benson, Jr., Commandant of the School of Aviation Medicine.

Seven papers will be presented in the symposium. They include "Medical Challenge on the Vertical Frontier," "The Environment of Space in Human Flight," "Supersonic and Hypersonic Flight," "Biodynamics in Human Flight," "Cybernetics in Human Flight," "Future Prospects in Human Flight," and "Interrelation of Space Medicine with Other Fields of Science."

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32B21	27.5	3	115	1	20	50,000	5	—
MG-93	27.5	12	115/200	1 3	100 100	65,000	10	E5134
MG-54	27.5	22	115/200	1 3	250 250	50,000	17	E5109
12142	27.5	22	115	1 3	250 250	35,000	13	E1617
12143-1	27.5	22	115	3	250	35,000	13	—
12143-2	27.5	22	115	1	250	35,000	13	—
*32B15	27.5	22	115	3	300	50,000	14	—
32E01	27.5	35	115	3	500	50,000	26	AN-3533-1
32E00	27.5	51	115	1 3	500 750	50,000	34	AN-3534-1
MG-65	27.5	52	115/200	1 3	750 750	50,000	35	E52805-2
MG-61	27.5	126	115	1	1750	50,000	54	53C6767
1518	27.5	126	115	1 3	1500 1800	20,000	37	—
32E06	27.5	160	115/200	1 3	2000 2250	50,000	56	E1725
32E03-3	27.5	150	115	1	2500	50,000	58	53B6227
*32E03-8	27.5	160	115	1	2500	50,000	65	53B6227
*MG-77	27.5	150	115/200	3	2500	50,000	65	—
*32B49	27.5	160	115/200	1 3	2500 2500	50,000	65	E54807
MG-81	27.5	160	115/200	1 3	2500 3000	50,000	61	E1725
MG-95	27.5	160	115/200	1 3	2500 3000	50,000	58	E54807
32E09	27.5	160	115	1 3	2500 3000	50,000	60	—
32B27	27.5	285	115/200	1 3	3500 4000	50,000	76	—

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missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

m/r exclusive:

Education and Industry

An m/r sampling of missile job requirements

EDUCATION means a great deal to your business. If you're in the market for competent, technically trained men, you know the problem. They're hard to come by. And, if you think it's bad now, look ahead: it's going to get worse.

Here are some figures worthy of consideration: The year 1950 shows the highest number of college graduates ever to receive their bachelors' degrees—434,000. By 1955, however, the total had dropped to 287,000, as those delayed by World War II completed their education under the G.I. Bill and the number of students entering college returned to normal.

This story is in three parts. One you've just read. The next is a brief rundown on universities with an interest in the missiles and rockets field. The last part concerns itself with a sampling of missile industry recruiting needs.

What Colleges and Universities are doing in Rockets and Missiles

By the end of the war three universities had established courses in rocketry and related subjects at various levels. These "big 3"—California Institute of Technology, Princeton University and Purdue University—are now being joined by a growing number of schools around the nation.

California Institute of Technology, Pasadena, Calif.: Through its Guggenheim Aeronautical Laboratory (GALCIT) and Jet Propulsion Laboratory, this technology center was the pioneer in fostering the rocket sciences in the U.S. under Theodore von Karman. Present staff consists of Clark B. Milliken, professor of aeronautics (also Chairman of the Board of JPL). E. E. Sechler, A. L. Klein, H. W. Liepmann and H. J. Stewart, all professors of Aeronautics.

Although JPL is administered quite separately from GALCIT, close contact and cooperation are maintained.

University of California at Los Angeles: Recently instituted is a full-scale course in space technology which is being coordinated by H. S. Seifert (Guided Missile Div. of Ramo-Wooldridge Corp.). The course will consist of 2½ hours of lectures each week. Each lecture will be presented in Los Angeles, San Diego and San Francisco, in order to reach the widest possible audience. The lectures will run from Jan. 13, 1958 to May 19, 1958.

All students taking the course must have a technical degree for this first-year graduate-level course.

Following the last lecture, Simon Ramo, H. G. Stever (MIT), Arthur Kantrowitz (AVCO), and R. W. Porter (GE) will form a panel to discuss the progress and problems in the space sciences.

Case Institute of Technology, Cleveland, Ohio: A technical school, Case is interested in the propulsion sciences. H. W. Burlage is director of the Propulsion Laboratory and D. W. Steel heads up the Nuclear Center Project.

Columbia University, New York City: Columbia is interested in materials and has an Institute of Flight Structures, directed by Hans H. Bleich.

Cornell University, Ithaca, N. Y.: The Cornell Aeronautical Laboratory is a nonprofit organization which is wholly owned by the university. Dr. Clifford C. Furnas directed the laboratory operation from its inception in 1946 to 1954, when he became Assistant Secretary of Defense for Research and Development. In 1956, some 1,200 persons were employed here on missile and related projects. The budget is currently at over the $1-million-per-month level.

University of Detroit, Detroit: Currently organizing its Missile and Rocket Section (MARS) to include the research facilities of the 26 other Jesuit schools in the United States. Instructors include: Dr. D. J. Kenney (chemistry) and monopropellant expert Dr. J. A. Hannum (reaction kinetics).

Illinois Institute of Technology, Chicago: Two of the exotic projects at Armour Research Foundation (independent from but associated with Illinois Tech) are stabilization of liquid ozone and boron hydride research. The 24-block Technology Center near south side Chicago has more than 7,500 undergraduate and graduate students in engineering and liberal studies.

Johns Hopkins University, Baltimore: Operates the famous Applied Physics Laboratory at Maryland locations in Silver Spring and nearby Howard County. Organized in 1942, for work on guided missiles, the laboratory has worked on *Terrier* and *Talos* missiles. Of the staff of 1,300, 525 are scientists and engineers.

University of Maryland, College Park, Md.: Sparked by Prof. S. F. Singer, the Physics Department has played a leading role in high-altitude and satellite research. Projects have included: MOUSE, *Terrapin* and *Far Side*.

Massachusetts Institute of Technology, Cambridge, Mass.: In addition to conventional instruction and training in the pertinent phases of missile technology, MIT also has available a unique student-operated test facility. The MIT Rocket Research Society designs, constructs and tests liquid and solid rockets.

University of Michigan, Ann Arbor, Mich.: Through its Engineering Research Institute (R. G. Folsom, director) and Willow Run Research Center, Michigan has allowed students to participate in such early projects as *Bomarc* and *Wizard*. Its aeronautical center is now located in a new north campus site and under the direction of Professors T. C. Adamson, R. B. Morrison (shock tubes and ramjets) and D. E. Rogers (rockets).

New Mexico College of Agricultural and Mining Arts, State College, N. M.: Fast rising is this missile-minded school, which offers courses related to missiles and rockets in math, physics, and engineering. It operates a program in cooperation with White Sands Proving Grounds. About 250 students are involved. The Physical Science Laboratory has a budget of $2 million for work on satellites, rockets and ECM.

New York University, New York City: This Manhattan school has been particularly active in the propulsion sciences under its chemical engineering department (J. Happel, C. J. Marsel and P. F. Winternitz).

Northwestern University, Evanston, Ill.: Strong point has been fluid mechanics under Prof. Ali Bulent Cambel.

Ohio State University, Columbus, Ohio: Research activities in rockets has included liquid hydrogen rockets and premixed propellants.

Polytechnic Institute of Brooklyn, Brooklyn, N. Y.: Starting in the Fall of 1957, Brooklyn Poly offers a graduate course in rockets and rocketry. Under the directorship of Dr. T. P. Torda, professor of chemical engineering.

Princeton University, Princeton, N. J.: Through its James Forrestal Research Center, Princeton offers the student a chance for graduate research. Operates a rocket test facility. Notable staff members are: Profs. Martin Summerfield and Luigi Crocco, both Robert H. Goddard professors.

Purdue University, West Lafayette, Ind.: In Sept. 1946, Purdue offered its first undergraduate course in jet propulsion. It also offers graduate instruction and research in rockets. Operates a rocket test facility and has done much work in nitric acid systems.

Temple University, Philadelphia: Its Research Institute has been working on high-temperature flame reactions for several years, *viz.*, ozone fluorine.

Wayne State University, Detroit: Dr. G. P. Loweke teaches the course, "Mechanics of Space Flight Orbits."

That, in brief, is what you can expect to find in the way of formalized educational opportunities in missile engineering and associated fields. A few colleges and universities have taken steps to adjust their curricula to the changing times, but it's a spotty effort at best.

Now take a look at the kind of people that industry needs now and you get an idea of the magnitude of the problem 10 years from now. What follows is a sampling of industry's demands for technical help. A survey of every company in the entire industry would reveal even more critical needs.

Lockheed Aircraft Corp.
Missile Systems Division
Sunnyvale, Calif.

Lockheed Aircraft Corp. has positions generally available for engineers and scientists with training and experience, preferably in the missile field, in the following branches: aerodynamics, thermodynamics, guidance and controls, weight systems analysis, antennas & propagation, propulsion, flight dynamics, instrumentation, telemetering, basic loads and structures.

The company has new facilities in the Bay area at Sunnyvale and in Stanford's Industrial Park, Palo Alto, as well as a plant in Van Nuys, Calif. In addition a 4000-acre static test site, located in the Santa Cruz mountains, and flight test bases at the Air Force Missile Development Center, Alamogordo, N. M., and Patrick Air Force Base, Florida.

Flexonics Corp.
1315 South Third Avenue
Maywood, Ill.

Flexonics Corp. was founded in 1902 as the Chicago Tubing and Braiding Co. and at first manufactured only Kantleke gas appliance hose. The company pioneered the development of flexible metal hose in America.

These positions are available or likely to be available at the Research and Development Division, Elgin, Ill., and the Santa Ana Division, Santa Ana, Calif—engineering and product design. Salary open.

Employe relations features include: promotion from within whenever possible; progress reviews twice yearly, paid vacations, retirement (profit-sharing plan), credit union, group insurance, hospitalization, lost time, major medical and dread diseases. Working hours, 40 per week; overtime when authorized.

Raytheon Manufacturing Co.
Waltham 54, Mass.

Raytheon's president, Charles F. Adams, says: "The employment outlook at Raytheon is good. In the fast-moving missile field, our own experience, coupled with national and international events in recent weeks, leads me to believe that there will be a steady expansion of activity in the foreseeable future. This growth calls chiefly for high-caliber, creative engineers in the electronics and aeronautical fields, as well as mathematicians and physicists, and for experts in production engineering who can adapt the electromechanical developments to manufacturing processes.

"Raytheon is seeking electrical engineers, mechanical engineers and physicists for research, development, design and application engineering positions in the fields of guided missiles, electronic equipment (radar, communications, etc.), electron tubes and semiconductor devices. We have a particular need at the present time for engineers with experience in microwave circuitry and/or components. Salaries range up to $12,000. Most of these positions are at the various Raytheon plant locations in Eastern Mass."

Consolidated Electrodynamics Corp.
300 North Sierra Madre Villa
Pasadena, Calif.

Missile expenditures, the electronics industry, according to a recent report, may account for more than $750 million of the $2.5 billion presently allocated for the missile program. In looking ahead, needs will accelerate for development engineers having training and experience in the fields of data reduction, magnetic-tape data processing and transistor circuits. Openings in the categories mentioned will be in the Pasadena, Calif. area. Meanwhile, there is not much in the way of immediate employment opportunities at this time.

Republic Aviation Corp.
Farmingdale,
Long Island, N. Y.

Present openings are for electronics engineers, flight control engineers, engineering laboratory technicians and missile test engineers.

Future openings are in all fields, particularly for engineers with experience in missile guidance, advanced electronic techniques, radar, IR, UHF, SHF, power plants and boosters, nuclear physics, antennas, aerodynamics, thermodynamics, operations research, human engineering, production cost analysis, weights and balance, computer systems, telemetering, structural analysis, servomechanisms and navigation systems. The salary ranges in these fields will be $120 to $250 per week for nonsupervisory positions. All the above positions will be at the Guided Missile Division facilities at Mineola and Hicksville.

Guided Missiles Division has in the past and will continue in the future to make advancements from within whenever possible. All the benefits applicable to the other divisions of Republic Aviation Corp. are available to the employes of this division such as: paid vacation, eight paid holidays per year, liberal pension plan, company-paid medical, surgical and hospitalization insurance.

The Garrett Corp.
9851-9951 Sepulveda Boulevard
Los Angeles 45, Calif.

At present, due largely to unsettled financial conditions in the Department of Defense, it is not likely that this company will be hiring any new engineers at all for some time except in isolated cases of necessity.

Acoustica Associates, Inc.
Shore Road
Glenwood Landing, L. I., N. Y.

This company is an associate contractor in the Atlas ICBM program and has been engaged in development work for the Air Force for almost two years. Positions open for trained personnel range from electronic technicians to project engineers. Positions are available at our main plant in Mineola, L. I., at our testing station in Glenwood Landing, L. I., and our west coast office in Los Angeles. Salaries range from roughly $75 per week for beginning technicians to over $15,000 per year for professional people. All the usual employe benefits such as company paid hospitalization and paid vacations are in effect.

Key employes participate in a stock option plan. Engineers are given every opportunity to expand professionally and to assume greater responsibilities.

Aro, Inc.
Tullahoma, Tenn.

Aro's managing director, R. M. Williams, says: "During the next eight months, Aro, Inc., will probably hire from 15 to 20 recent college graduate engineers for junior staff positions and from 30 to 35 experienced engineers. Our requirements are mainly for those with aeronautical, mechanical and electrical degrees and for physicists. There will be little change in our work force of 2,100 people."

Aro, Inc., is a private corporation, a subsidiary of Sverdrup and Parcel, Inc. of St. Louis, Mo. It was formed in 1950 and is directly concerned with the task of developing new and improved wind-tunnel testing techniques and equipment. There has been a steady, gradual growth from a payroll of less than a hundred to the current 2,100 level. Salaries range from a starting level of about $5,000 to more than $15,000 for top engineering staff assignments.

Advantages of working for Aro, Inc. are as follows: semiannual salary increases, moderate climate and good geographical location, excellent housing, graduate program (resident faculty) providing an opportunity to earn master's degree, relocating expenses, two weeks and two days vacation per year, excellent technical library, assignment to test projects involving advanced and future trends in missiles.

Aerotest Laboratories, Inc.
129-11 18th Ave.
College Point 56, N. Y.

Employment outlook for this company is good. It is expanding its facilities to accommodate the new and additional missile-component testing, which require a new type of employe, one who must be highly imaginative and have a solid analytical and theoretical background.

Advancements are based upon ability, experience and length of service. Salaries are reviewed periodically and raises are given on merit and length of service. Employees receive two weeks vacation yearly. The company provides an insurance program, including medical benefits. A Blue Cross program is in effect. For engineering personnel there are graded overtime payments, unlimited sick leave. For technical personnel, time-and-a-half overtime payments with limited sick leave. Annual bonuses are given to all personnel.

Marquardt Aircraft Co.
16555 Saticoy St.
P. O. Box 2013—South Annex
Van Nuys, Calif.

With respect to technical personnel requirements, Marquardt is interested in quality, rather than quantity of engineers and scientists. The fields of work in which this company is engaged present such a scope and challenge that it requires technical people of superior ability who have the initiative and imagination to push forward into unexplored technological areas. As to numbers of technical people, requirements are based somewhat on the contribution offered by the individual. The man often makes the job and, if the right kind of talent comes along, Marquardt is in a position to create the job to utilize these talents.

All promotions and salary increases are made on a merit basis. Each employe is evaluated twice a year to insure that his contribution is recognized. The benefits plan includes group insurance, retirement, paid vacations and sick leave.

The Electric Storage Battery Co.
12 South 12th St.
Philadelphia 7, Pa.

The Electric Storage Battery Co., Philadelphia, seeks qualified personnel for its expanding missile battery program. Needed are electrical, mechanical and metallurgical engineers and technicians to join its staff of missile and battery experts. Jobs are available at Exide Industrial Division's Philadelphia plant. Engineers and technicians wishing to join in this expanding program may send applications to: Manager of Industrial Relations, The Electric Storage Battery Co., Box 8109, Philadelphia 1, Pa.

The company has a schedule of eight holidays and paid vacations for periods up to four weeks, depending upon length of service. A job evaluation plan and annual salary review assure that no employee is overlooked.

For employes who wish to further their education and enhance their value to the company, a system of tuition refunds is in effect. A patent award system and a suggestion system provide other means of recognition and remuneration.

Convair
A Div. of General Dynamics Corp.
General Office
San Diego 12, Calif.

Employment at Convair-Astronautics is about 6800 at the plant and 1700 at the various test bases. Under present programming for the *Atlas* the level probably will stay at 8500 for some time to come. The division is looking for senior level engineers in such fields as electronics and operations analysis.

Engineers' salaries are reviewed for increases twice yearly. Vacations are two weeks annually (three weeks annually after 12 years). Full group hospitalization insurance that extends to the entire family is available. A retirement plan under which employe contributions are matched by the company is reputedly one of the most generous in the industry. Overtime pay is somewhat restricted.

Narmco Resins and Coating Co.
600 Victoria St.
Coasta Nesa, Calif.

Narmco Resins and Coatings Co. is a member of a group of companies, first founded in 1944 by Dr. G. G. Havens as a research and development organization.

The company is presently devoting considerable time to the research and development of higher-temperature resistant adhesives for missile application. As the demand for missile materials increases, it is natural to assume that the demand for more highly skilled technical people will also increase.

The Narmco philosophy relative to advancement is to develop its own people within the company and grant advancement in accordance with ability and performance. The company is nonunion, rates of pay are equal to or higher than the average rates being paid by similar companies. Narmco grants a two-week paid vacation to all employes after one year; three weeks after ten years employment.

Burroughs Corp.
Defense Contracts Organization
Detroit 32, Mich.

Total employment has increased from 300 in 1954 to nearly 2000 scientists, engineers and technicians today. The Ballistic Missile Division employs more than 200 people. They are engaged in the design, development and prototype construction of the large-scale special purpose computer, which forms the nerve center of the controls in a ballistic missile system.

A Military Field Services Division now numbers more than 1000 people. Its work includes the preparation of detailed technical manuals, specialized training of technical manpower, site planning, preinstallation preparation of equipment, delivery, installation, and listing. These facts indicate the opportunities for scientists, technicians, engineers, and staff people in this area of the business.

Ronan and Kunzl, Inc.
Marshall, Mich.

This is a medium-sized company well established as a leader in the missile field producing cryogenic equipment.

There are no specialists at Ronan & Kunzl, Inc. Well-rounded and fully developed engineers result from this policy.

As ability is shown, advancement is certain.

Starting salaries are based on experience and range from $400 to $700 per month for a 40-hour week. Overtime is paid on a straight time rate. A profit-sharing bonus has been in effect during the past three years. Also offered is an excellent hospitalization and major medical insurance plan, partly paid by the company. Paid vacations are: one week after one year's employment, two weeks after three years and three weeks after ten years.

Chrysler Corp.
Defense Operations Division
P. O. Box 1687
Detroit 31, Mich.

Five years ago, Chrysler Corp. established a Missile Operations Branch in Sterling, Mich., and began working under the direction of the Army Ballistic Missile Agency in the Redstone Ballistic Missile Program. In June 1956, Chrysler was awarded an engineering and production contract on the *Jupiter* intermediate-range ballistic missile. At present, the *Redstone* and *Jupiter* missile systems projects and the ground-handling and launching equipment programs are expanding.

Positions are available in research, fabrication and assembly, and field operations. Expansion in development work has provided new opportunities for electrical, mechanical, power plant, structures and production engineers in design, laboratory and fabrication and assembly activities. Positions are also open for technical writers with electronic specialization, project planning engineers and field service engineers.

North American Aviation Inc.
Missile Development Division
International Airport
Los Angeles 45, Calif.

The Missile Development Division, following the *Navaho* cancellation, has been pretty well shaken down and is trying to project what jobs are available. It has shrunk from about 7100 to approximately 2100 at the present. The ASM is now our major missile project. It's growth potential looks good, but the division only now is entering the development stage.

North American Rocketdyne
6633 Canoga Ave.
Canoga Park, Calif.

This company is in the market for:

Analytical and theoretical engineers with master's degree in physics or mechanical engineering, and substantial theoretical work in mathematics, fluid flow, heat transfer, thermodynamics, servo and control systems, combustion, and elasticity.

Graduate mechanical engineers with substantial course work in vibration, heat transfer, and mathematics.

Research engineers possessing advanced degrees and considerable study of heat transfer, fluid flow, and mathematics.

Engineering specialists with master's degrees in mechanical engineering and study in advanced thermodynamics and/or aerodynamics.

Design and/or research engineers with M.E., E.E., or Ch.E. degrees for electrical, pneumatic, mechanical and electronic control devices.

Research engineers with advanced degrees in physics or mechanical engineering and strong theoretical background in mathematics; experience in analytical development of complex physical phenomena observed in propulsion systems and component development.

Mechanical engineers with strong background in analysis of complex design proposals of advanced concepts of rocket-engine systems.

Research engineer with advanced degree (master's degree and preferably a Ph.D.) in the field of compressible flow, gas dynamics, fluid mechanics, with experience, associated with some aspect of internal flow regimes.

Physicists or electronic engineers with Ph.D. degree and strong theoretical mathematics, and electronic background, capable of original thinking.

Ph.D. in mathematics or physics, with a strong background of training in quantum mechanics, classical mechanics, thermodynamics, kinetic theory and electromagnetic theory.

Physicists with Ph.D. degrees and experience in nuclear engineering to study the application of nuclear power for propulsion.

Sperry Gyroscope Co.
Division of Sperry Rand Corp.
Great Neck, N. Y.

Sperry Gyroscope Co. is extensively involved in missile work and pioneered a number of employe relations and employe benefit activities dating back a number of years.

The company will have a decrease in work force of about 300 by the end of the year and an additional 200 to 300 in the early months of 1958, after which, Sperry Gyroscope predicts a building-up again so that they will return to, or above, their present work force of 17,400. Part of this build-up is based upon increased activity in the missile field.

At present, the company is involved in 12 missile projects ranging from complete weapon system responsibility through development and production of subsystems on down to inertial devices, instrumentation and automatic checkout equipment.

Ampex Corp.
Redwood City, Calif.

Ampex Corp. is not a prime contractor in the missile field, but manufactures major components, *e.g.*, magnetic-tape recording systems for telemetry and test. Employment levels are not directly responsive to defense business since the company manufactures magnetic-tape recording equipment for consumer and professional broadcast and television use.

Robert Sackman, vice president and general manager, says: "I feel that after a period of reappraisal at top level in the Administration, probably by the President himself, the missile program will take its place in fact, not just in words, as the Number One defense job of the country. All firms directly and indirectly connected with this industry will feel the impact of increased business in the late winter and early spring as the result of this decision."

Phillips Petroleum Co.
Bartlesville, Okla.

The growth of Phillips Petroleum Co. has been phenomenal—from a $3-million corporation with 27 employes in 1917 to a corporation with assets of more than a billion dollars and more than 27,000 employees. The company's planned expansion and diversity of products should provide for continued, steady growth and a high level of stability.

In 1951, with extensive investigations of rocket fuels from petroleum-based materials already accomplished, Phillips was selected by the U.S. Air Force from more than 30 firms as contractor-operator of Air Force Plant No. 66 near McGregor, Tex., for the development and production of solid fuels for rockets of the "jet-assist-take-off" (JATO) type. This is the only solid-propellant rocket engine employing this kind of fuel which meets all Air Force performance requirements.

Other work under way includes development of large booster rockets, air-to-air missiles and plastic cases for solid-propellant rockets.

The Joclin Manufacturing Co.
Lufbery Ave.,
Wallingford, Conn.

Positions will need to be filled in all departments, particularly in development and sales. Salary ranges and employe benefits are comparable with the most progressive in industry. Particularly important is the growth curve of the company which has tripled in the past two years and promises to continue at this rate for at least the next five years.

Boeing Airplane Co.
Pilotless Aircraft Div.
Seattle, Wash.

This company foresees a continuation of the trend toward increasing the proportion of procurement funds which are spent for missiles as compared to aircraft. Employment in missile work will continue to increase. Boeing expects its Pilotless Aircraft Division to double in size within the next five years. Right now—in line with most of the rest of the industry—Boeing is not hiring any except highly skilled people in specific job areas. This is a situation which probably will change rapidly.

It is company policy to advance a man according to his ability and accomplishments. Boeing has established comprehensive programs for graduate study, scholarship awards, a voluntary training schedule and a management development program.

An invention incentive plan and a suggestion award system are two ways an employe can earn big bonus dollars. If the patent is granted, the employe receives an additional payment plus 20% of any royalties received. Individual awards have gone as high as $11,500.

A large majority of employes subscribe to the Group Life Insurance plan. Boeing offers the best available medical, surgical and hospital coverage to fit the needs of the employe in each area.★

Time grows short for meeting

The Red Education Challenge

by Dr. Albert Parry
Colgate University

TECHNICAL EDUCATION in the Soviet Union starts early and is thorough.

Until 1955, Soviet children spent 30 per cent of the first four years of schooling on science. In the next three to six years they spent 46 per cent of their time on science. Currently, time devoted to science study has been upped to 53 per cent.

In the 10-year Soviet school, from the ages of seven to 17, all students have to take 10 years of mathematics; five years of biology; five years of physics; four years of chemistry; and one year of astronomy.

They begin the study of biology at the age of 10; algebra, geometry and physics at 12; chemistry at 13; trigonometry, calculus and astronomy at 16.

During a typical recent year (1955) less than one-third of our high school graduates had taken a year of chemistry, about one-fourth had had a year of physics, and only one graduate out of 15 had taken advanced mathematics.

Rigors of the College Level

In a number of our high schools, some of the exact sciences are not available even for those boys and girls who may want them.

Although most of our high schools offer a general science course, it is considerably watered down compared with the solid training Russian youngsters get. And at that, only a little more than one-fifth of our American students take that feeble course.

Soviet secondary-school students receive about five times more hours in science and mathematics than the minimum required for entrance by a high-caliber American college.

So good is the technical-scientific preparation of a Soviet student that at the end of his 10-year schooling he knows more than an American science major at the end of 13 years of schooling.

On the college level a Russian student spends 27 per cent of his time in general science and 67 per cent in his field of specialization. The remaining six per cent is devoted to the study of Marxism-Leninism (which, incidentally, used to have a more important part in the curriculum, but has yielded in recent years to science).

Soviet engineering schools require five and one-half years of study compared with the American four-year college program. While our engineering colleges give our student 3700 to 4000 instruction hours in 22 to 25 subjects before graduating him, Soviet engineering schools cram the student with 5200 to 5500 instruction hours in 35 to 40 individual subjects.

As in their middle and lower schools, their college and university classes meet six days a week. The Russian school year on all levels is 10 months long, not eight as in our colleges.

In the Soviet Union foreign languages are taught primarily to enable budding Soviet engineers and scientists to read engineering and scientific literature in those languages.

The study of a foreign language is compulsory in Soviet schools. A student is started at the age of 11. By the time he graduates from a secondary school at the age of 17 he has had six years of either English, German or French. Forty per cent of all primary and secondary-school students and two-thirds of Soviet college students take English.

Only 14 per cent of all our public school students study a foreign language. Only about 10 U.S. high schools or preparatory schools teach Russian and only a handful of the students at these schools take Russian. The situation is not too much better in our colleges and universities—less than 200 of them teach Russian. The classes are small and the dropout rate of such courses is high.

Advanced Training and Research

There are only 33 universities in the Soviet Union, but, unlike ours, these schools do not concentrate on liberal arts. Instead, they emphasize advanced scientific training.

In addition, there are some 800 specialized colleges or "institutes" as the Russians call them. Of this impressive number, 177 are engineering institutes covering every conceivable field and specialty.

A typical engineering college, such as the Novocherkassk Polytechnical Institute in the Don River region, graduates 1100 to 1200 specialists of several kinds annually. The Kalinin Polytechnical Institute in Leningrad alone graduates more than 500 metallurgical engineers each year compared with some 660 metallurgists graduated by all our American colleges together.

Last spring all Soviet colleges graduated a total of 265,000 technical specialists, of whom 80,000 were engineers, or two and one-half times as many as we did. Our total annual engineering graduates number 32,000.

A great deal of Russia's top-level research is done at the Academy of Sciences and its numerous institutes. These have comparatively few students, presumably the best of each year's crop culled from the general run of colleges. But the country's outstanding savants are usually attached to the Academy's institutes where they are given well-equipped laboratories, ample staffs and any other necessary equipment.

Tuition on all levels of Soviet schooling is free, and in addition college students who excel are rewarded with scholarships and fellowships. A college student who gets mostly "A" grades and only a few "B"s is given such a scholarship, but with the very first "C" this monetary aid ceases.

While not sumptuous, such assistance enables the student to finish his courses without working on the side. Very few Soviet students ever take any side jobs. But in the summer they either serve as apprentices in their future professions or help with the crops in Western Siberia and North Kazakhstan as "volunteers."

Straight "A" records bring with them higher scholarships. The more advanced and specialized a student, the more of a stipend he receives from the Soviet state. Similarly, among Soviet professors, the more learned an expert, the more salary and extras he gets. Full professors in the USSR are paid 16 times the average laborer's wage. In the United States a full professor gets only two and one-half times the average laborer's wage.

The Coin's Reverse Side

The Soviet 10-year schools are not as prevalent as would appear from their propaganda. The Moscow government says that such schools will be universal in the USSR by 1960. Right now seven-year schools are far more general, while 10-year schools are found mainly in cities and in only a few rural areas. Only 15 per cent of all Soviet children complete those 10-year schools.

Graduation from a 10-year school does not guarantee a chance to go to college. Only one out of every 12 applicants to Russia's better engineering schools and the science departments of her universities is accepted. Nor does the Soviet government feel it has enough other college facilities for all those young men and women who want a higher education.

There is now an all-out government campaign in Russia to convince the nation's youth that they can be useful and happy without going to college, that for many of them lifelong careers as mechanics, plain workers or collective milkmaids can also be very satisfying. Much dissatisfaction and restlessness among the USSR's lower-strata youth can now be noted, traceable among other things to this exclusion from higher schooling and better careers.

Only some 30 per cent of those now graduating from Russia's 10-year schools go to colleges and universities. Others, both seven-year and 10-year school graduates (the vast majority of Soviet youth and girls), are directed to secondary technical schools, to manual-training schools (called "labor-reserve" schools) or straight to low-paid factory and farm jobs.

The "Privilegentsia"

Complaints are heard increasingly in the Soviet Union that sons and daughters of important Communists such as political bosses, well-heeled managers and engineers, army marshals and generals and navy admirals get undeserved good grades in schools, that they gain college entrance while gifted children of lower classes and poorer families have to quit school after the seventh or 10th year at age 14 or 17. There are stories of the rich and powerful bribing school directors and examiners. Some such complaints find their way into the Soviet press.

The charge frequently is made by the Russians themselves that much Soviet training in secondary and high schools is theory only, resulting in little practical knowledge, chiefly because both teachers and pupils have new "upper-class" reluctance to dirty their hands on machinery. On one occasion KOMSOMOLSKAYA PRAVDA wrote bitterly: "Some graduates boast of their 'deep' knowledge of physics, yet don't know how to change a burned fuse."

Inefficiency of teachers and laziness of students are another theme of lament. In a letter to the editor of LITERATURNAYA GAZETA, two professors of a teachers' college near Moscow charged that much foreign language study in Soviet schools is nominal only because of this inefficiency and laziness: "Secondary-school students complete their education with very weak knowledge in this field. Also, many specialists graduating from colleges know foreign languages poorly."

Only six out of every 10 Russians who go to college graduate, and of these (the criticism is made), not all deserve their diplomas.

On graduating from college, young Russians are given five days to rest up and pack before they are sent off to jobs which they have to stay with for a minimum of three years. A picked handful from each graduating class are kept at school for advanced postgraduate study as *aspiranty* for a candidate's degree, the equivalent of our master's degree or slightly higher. Eventually a few may become doctors of philosophy.

There is an intermittent wail in the Soviet press that some of these "chosen few" are picked not for their talents or efforts but because of their fathers' pull. Another frequent complaint is that graduates assigned to jobs in the provinces use their families' influence to have the assignments changed. They want to remain in Moscow and other large cities, amid the bright lights and comforts that go with the bureaucratic or technocratic privileges of their parents.

That the Soviets are ahead of us in certain very important phases of rocketry is all too evident now. But this does not mean that, because of their educational system, they are ahead of us in every field of science and engineering. Even the statistics on the number of Soviet specialists, now cited as proof of overall Russian superiority over us, may be misleading.

In our figures of American engineers and technicians graduated annually, we do not usually include the vast numbers of workers and foremen trained on their jobs to handle machinery. But these are the skills for which the Soviet authorities often issue special diplomas or certificates. We do not. Much Soviet training is in schools, not on the job, as is our practice. This makes a difference in the statistics of skilled "graduates."

Our farmers can drive and fix tractors without needing diplomas and are not counted in our rolls of school-trained "specialists." Nor do we give diplomas to those who can mix the right feed or medicine for farm animals. But in Russia, tractor drivers and mechanics are in a definite "skilled" category, and so are "higher-grade" cattle tenders, called zootekhniki.

It is true that in our country not enough effort, time, money and manpower go into basic research. In some fields of research the Soviets handle things differently and better.

However, on his recent return from a visit to Russian laboratories, one of our scientists, Dr. Donald J. Hughes of the Brookhaven National Laboratory in Long Island, reported surprising gaps in Soviet atomic research.

This suggests that while pouring the best of their basic research forces into one field—rocketry—the Russians disregard certain other vital branches of science and technology.

Propaganda Aspects Important

The most crucial deficiency in Soviet education, however, is the fact that it produces narrow experts lacking well-rounded knowledge and understanding of the world around them.

The Kremlin gives its young training that is technical and scientific, a thorough and often excellent education in blueprints and machinery, but instead of liberal arts it feeds them propaganda, in lieu of humanities it tries to imbue them with hatred for humanity.

A young Russian who defected to us once said:

"The Soviets want people to be brilliant in their field, but nonthinking insofar as politics and propaganda are concerned. When they succeed in creating a brilliant man who cannot think, they will have achieved their ideal society."

As we meet the Soviet challenge by changing certain aspects of our mass education, we must take care not to repeat the bad Soviet error of swamping young minds with technology to the exclusion of everything else. Our spirit of broad inquiry and of freedom in quest must be preserved. Such is the other challenge of Soviet education which also must be met if we are to survive as truly free men and women.★

Minuteman to Missileman

by **Capt. George T. Cahill, Jr.**
U.S. Army Air Defense Command

SINCE THE HISTORIC era of the Minuteman, the increasingly impersonal aspect of warfare has presented a problem in regard to manpower procurement for the Armed Forces. The National Guard and the Reserves have probably more closely approached the hometown defense appeal and purpose as exemplified by the Minuteman. In wartime the National Guard and Reserves fight away from home whenever the tactical situation dictates.

In early 1954, Army antiaircraft artillery guided missile sites began to supplement, and in some instances replace, antiaircraft gun sites around our great metropolitan and strategic defense areas. The number of these sites is increasing monthly. During the past year alone, the number of *Nike* battalions has increased by 51 per cent.

The sites, stretching from coast to coast, are under the direct operational control of the Army Air Defense Command (ARADCOM) with headquarters at Colorado Springs, Colo., and comprise the Army element of a joint headquarters known as the North American Air Defense Command (NORAD). The Army Air Defense Command is led by Lt. Gen. Charles E. Hart, a veteran of more than 33 years artillery experience.

Establishment of missile sites within metropolitan areas has created daily community relations problems on a scale seldom encountered by the armed services. The Army and the Army Air Defense Command use every available medium to create and maintain harmonious community relations and to educate the public to the necessity for antiaircraft guns and guided missiles being situated in their communities.

Early this year, an announcement of tremendous significance to the American public was made by former Secretary of Defense Charles E. Wilson. He divulged that *Nike-Hercules* will be capable of being armed with an atomic warhead. This will enable a single missile to knock down entire fleets of enemy aircraft and certain guided misiles.

It is now a fact that the atomic package will be stored in proximity to communities throughout the country for immediate use. The Department of Defense has explained that accident danger from nuclear air bursts is practically nonexistent. The answer is relatively simple and based on common sense: missile bursts will occur at such high altitudes that no injury will be inflicted on those on the ground.

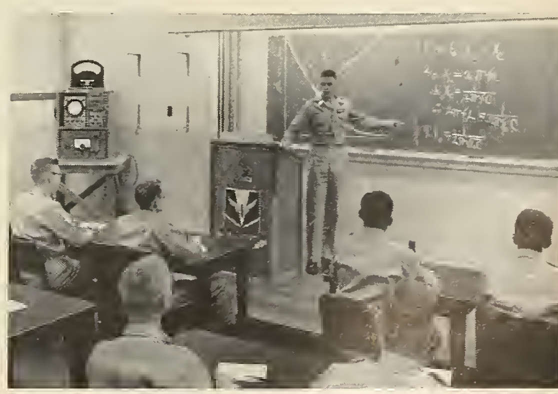
In some instances, when *Nike* began to appear in public parks and the suburban areas, considerable opposition was expressed by the local citizenry. Fear of the unknown initially alarmed the property owners near *Nike* sites.

But due to the fine spirit of cooperation by the majority of the news media outlets and the admirable work accomplished within the communities by young *Nike* battery commanders, initial opposition has been overcome.

It's difficult to visualize the deadly *Nike* in beautifully landscaped surroundings. Yet, the Army has deliberately encouraged this incongruous setting for the *Nike* by carrying on an extensive and continuing site-beautification program. Local property owners and real estate brokers were reassured when beautification of the sites blended the batteries into the communities in which they are located.

Extensive safety precautions make the *Nike* missile exceptionally safe to handle. Underground storage facilities, and the fact that *Nike* is not capable of detonation until fired, increases the safety margin. Once *Nike* is fired during an actual aerial invasion, any malfunction will automatically detonate the missile in midair. Each site has a standard supply of missiles, and is ready to fire in a matter of seconds. It has been said that a *Nike* site is less dangerous to the community than the local gas station.

Nike is never fired from permanent sites during practice alerts.



Schools like this at Fort Bliss, Texas, use modern facilities, top-notch instructors and modern equipment to turn out first-class missilemen.

Instead, every *Nike* crew in the country attends and competes in practice firing once each year at Red Canyon Range Camp, N.M. Here, the Missilemen maintain proficiency by firing live *Nike* missiles at jet drone planes and by theoretical firing at actual Air Force bombers.

With all the headlines about superweapons, we frequently lose sight of the men who create and use them. Without a driver, an automobile is a useless inanimate object. Man is indispensable and his degree of skill is an intimate correlate to the effectiveness of the weapon.

The days of drafting unskilled and uneducated men into the services is rapidly becoming a matter of history. It ended before the conclusion of the Korean War a scant four years ago. Today's army must be comprised of well-educated, fast, alert thinkers able to act and reason for themselves.

In recognition of the tremendous strides made by industry in wage scales and welfare programs for its employees during the past 20 years, the Department of Defense continues to press Congress for legislation which will increase the attractiveness of a military career. Much favorable legislation has been enacted and still more is pending. However, to date, the severe inconveniences encountered by the soldier are not compensated at a rate commensurate with that of his civilian counterpart.

Frequent assertion is made from within and without the services that the military must compete with industry for skilled manpower; that industry is stealing, outright, technicians trained by the services. To a degree, that is true. However, the situation must be looked at objectively.

Both the services and industry are striving toward the same goal—development of the best possible weapons to be utilized in the defense of this nation. By the same token, the military must not be deprived of the ability to employ these weapons effectively.

Procurement and retention of personnel with potential to absorb the highly technical and specialized training necessary to man complex weapons is a challenge which merits the attention of the top manpower procurement officials of the Army.

As previously emphasized, a weapon, even in this age of hydrogen bombs and electronic brains, is never so self-sufficient that it does not require the direction and guidance of trained electronics specialists. Because of the tremendous outlay of government monies for the procurement of highly developed radar and other electronics equipment, it is imperative that the personnel recruited for assignment to the Army Air Defense Command be of the highest caliber obtainable from the manpower resources of the nation.

The thousands of dollars it costs the taxpayer to train a *Nike* specialist includes work with the latest type equipment and from 38 to 42 weeks of instruction at the Army Antiaircraft Artillery and Guided Missile Center, Fort Bliss, Tex. It adds up to an invaluable technical education.

In the spring of 1956, Charles E. Wilson appointed a committee to study the servicewide problem of skilled personnel retention. This committee, officially designated the Department of Defense Advisory Committee on Professional and Technical Compensation, is referred to as the Cordiner Committee, after its chairman, Ralph J. Cordiner, president of General Electric.

The program proposed by the committee recommends far-reaching legislative and administrative actions for the revision of pay grades to permit additional remuneration for jobs requiring combat leadership and technical, scientific and management ability.

In the meantime, the Army is doing everything possible to create incentives to attract high-caliber youths and, above all, to retain those already in the Army.

Harking back to the day of the Minuteman, who protected his own community, the Army Air Defense Command is striving to develop a recruitment program which is based on the same principle of hometown service.

Photogenic, deadly NIKE-AJAX is examined.

Since its inception in January 1956, through this program alone, more than 12,000 volunteers have entered the Army Air Defense Command for service with missile units. This influx, still in progress, includes many experienced noncommissioned officers bringing into the command leadership qualities vital to the accomplishment of any task, military or civilian. A group of these noncommissioned officers had been serving elsewhere in the Army in career fields.

The results of this type of procurement have proved so gratifying that plans are now under study to permit choice of assignment for non-prior-service personnel.

Young men enlisted under this program will be accepted for a minimum of three years in the Regular Army. This will provide longer retention of trained Missilemen and minimize the present rapid turnover of trained personnel in *Nike* batteries. Each enlistment will save the Government and taxpayers considerable money.

By having men from the local communities serving at *Nike* sites, community relations should be maintained on the highest level attainable. News media and the public as a whole should have a more comprehensive idea of the purpose, mission and problems confronting the *Nike* units in their communities.

The Army Air Defense Command is ready for the sound of the bell signifying the opening round of hostilities, a bell it devoutly hopes will never ring. Her highly trained *Nike* crews, proudly wearing the red shield-shaped *Nike-Ajax* patch, stand alert 24 hours of every day to unleash their destruction against the foe should this become necessary.

ARADCOM, with its *Nike* and other surface-to-air weapons teamed with its sister air defense forces—the sleek jet interceptors of the Air Force, Navy and Marines, the Navy radar picket ships, the Ground Observer Corps and the National Guard—serves grim warning to potential aggressors bent on the invasion by air of the United States.

The Marquis of Queensberry rules will go out the window at the start of the fray. To achieve the knockout, anything goes. Man of the day will be the modern Minuteman—the Missileman. ★

US-USSR Educational Systems—a Comparison

by **William P. Lear**

Chairman of the Board, Lear, Inc.

MOST PEOPLE are prone to look down on and underestimate the intelligence of persons whose political faith is at variance with their own. Due to this attitude we get a fairly good idea of how the average American is likely to regard the technical and scientific progress of research in the Soviet Union.

Again, most people in this country are apt to look on our plethora of modern conveniences, such as automatic electrical appliances, radio and television, automobiles, etc., as indicative of scientific progress. They feel this is an indication of our ability to cope better than anybody else with the problems of modern science, including the building of satellites and space ships. We are apt to regard our cherished system of "higher" education for everybody as the correct climate for achieving a dominant position in science and technology.

We cannot evaluate the scientific standing of Soviet Russia against a background of political prejudice and mass-produced comfort. Rather, it behooves us to appraise objectively the Soviet scientific progress during the last several years.

Nothing significant transpired in the USSR during the first decade after the revolution (1919-1927). The condition of the sciences in Russia was very bad since industry was nonexistent. Therefore, they decided to direct their first effort toward science and to make it self-supporting.

About 1927 many Russian scientists working as a gigantic team initiated a project of study which by 1939 had developed into a new science—nonlinear mechanics.

What was surprising, on closer scrutiny of this stupendous work, was the extraordinary harmonious cooperation between the different specialties—pure mathematicians developed new methods which were inspired from engineering developments, while physicists and engineers were dealing freely in the most abstract branches of mathematics, etc.

It is unbelievable that such a gigantic project (four institutes in Moscow, Leningrad, Kiev and Gorky working jointly) was started without any definite objectives. It created a new science which ultimately opened entirely new horizons in almost every direction—electricity, mechanics, electronics, astronomy, biology and econometrics.

How much is there that we do not know about Russian development? Perhaps here is the real reason for occasional surprises, such as when we hear about developments in guided missiles, artificial satellites, etc.

In our democracies, developments like these are likely only in wartime, but in the USSR such organizations work continuously. It is no wonder that scientific developments are reported from the USSR far ahead of our estimated schedule.

This error in judgment very likely arises from the fact that we measure things in terms of the industrial development in the United States. In this respect we are far ahead of the USSR. But this yardstick is hardly applicable inasmuch as in new discoveries the scientific accomplishments are far more important than developments in industry. Also, a highly synchronized and well-coordinated work of a number of well-equipped laboratories, through war and peace, can produce spectacular results simply because the question of money does not come up in a country in which the standard of living is so low. The lack of industry (on the U.S. scale) may be a very adverse factor when mass production is required.

At present there are 306 journals published by perhaps 30 to 40 various

institutes under the supreme direction of the USSR Academy of Sciences. The Academy is unique in that it directs the whole scientific activity of the country—from H bombs, transcontinental missiles, and satellites to growing tomatoes above the Arctic Circle, breeding of animals, etc.

One gets the impression that the number of scientists in the USSR is far greater than here, a fact which has been discussed many times in recent years. In Russia the children are followed up very closely and vocational selection operates very efficiently. If a child shows interest, say, in mathematics, he is pushed systematically in this direction and if he shows good results all expenses are paid by the State. If one takes into account that there is no other outlet than the Government service, it is no wonder that there are so many young scientists of the very first order.

Whether the system is good or bad politically is another story, but as far as the supply of good scientists is concerned, the system of "vocational guidance" and subsequent free training seems to work well, judging from the results achieved during the last three decades.

The present technical superiority of the Soviets is, in my opinion, not accidental, but was bound to happen as a consequence of their superior system of higher technical education.

To enter institutions of higher learning in Russia, as well as in most of the European countries, the individual has to pass very stiff tests to prove that he is entitled to professional treatment. Obviously, such a system weeds out the mediocre ones, before they have a chance to crowd into the universities and drag down the quality of teaching to a level commensurate with their own limited intellect. By setting these rigid standards for the right to pursue higher education, the Soviet has built up a body of engineers and scientists, capable of outstanding achievements.

Slowly and inexorably the Russian system of higher education has overcome the tremendous handicaps imposed on it by the revolution and has now caught up with us, if not surpassed us, in the military sciences.

As a corollary, let us now take a look at the American educational system, and see how it compares with the Russian.

First of all, let us consider our high school education. To attend high school seems to have become the inalienable right of every American youth, regardless of whether or not he has the will and the mental powers to absorb higher learning. As a result, the curricula of the high schools are, with a few exceptions, adjusted to be commensurate with the average level of student intelligence and, perhaps, in order not to impose too much restraint on their extracurricular activities.

Mediocrity and mental impotency are nursed along to the detriment and depreciation of an intelligent minority that should, and will some day, be the leaders in their chosen fields. Therefore, your embryonic scientist enters the university with about two years deficiency in basic education, as compared to the Russian high school student.

He now also faces the task of learning to think independently, which had not been part of his high school curriculum, probably because of the inconvenience this would have imposed on the minds of the greater number of students. Many of his instructors are uninspiring, and have not much more to offer than the text book they are following.

There are, of course, many exceptions in this respect, but, as a rule, the quality and depth of learning among our college and university teachers is greatly below the standards of their European counterparts. *Low salaries* and the *general lack of esteem* in which college professors are generally held in this country are undoubtedly contributing factors in this respect.

And, as in the high school, we find also in the college the tendency, although not to the same extent, to adjust the level and pace of the instruction to suit the slow march of the average intellect.

This state of affairs is literally suicidal in an era in which the survival of a nation depends on its intellectual forces, rather than on its armed might.

If we pursue the present system of higher education, the consequences will, ultimately, be disastrous for this nation.

Some expert opinion holds that the United States ran the risk of losing the last war (World War II), because of a general lack of competency in the fundamental sciences. The production of weapons rather than the superiority of weapons gave us the victory. We won that war, not because of our scientific level, but in spite of it.

Our development of the atomic bomb was an outstanding technological achievement, but without the European educated scientists, such as Einstein, Bohr, Von Neumann, Fermi and Gamow, just to mention a few, the result would probably have been fizzle instead of fission.

We cannot hope to maintain a comparable level of scientific achievement as long as we persist in using the same mold to shape the mind of the future scientists as that of the future clerk, salesman, storekeeper, and what not.

It should be obvious to intelligent and right-thinking Americans that we must revamp our system of higher education to seek out and give special training to those who offer the best chance to insure our supremacy in scientific thought and development.

First, we must reorganize our high school system so as to separate the boys from the men. At the end of an eight-year elementary school, common to everybody, a separation must be effected on the basis of aptitude and intelligence tests.

Those who pass certain minimum requirements should then, provided they wish to do so, be transferred to what we may call preparatory school, while those who don't pass the tests, or don't wish to go in for higher education, would be transferred to a high school of very much the same make-up as at present. The present four-year course should be compressed into a three-year course and more emphasis be laid on vocational training.

The curriculum of the preparatory school may conveniently be split along two major lines which we may term the modern line and the classical line.

In the modern line, designed to accommodate those who intend to pursue studies in the natural sciences and engineering, the emphasis should be on mathematics, physics, chemistry, German and Russian. The classical line should be designed to further the interests of those who wish to become physicians, lawyers, teachers, etc., with the emphasis on such subjects as philosophy, literature, history, English, French and, perhaps, Latin. The teachers in these preparatory schools should all have advanced college degrees, be adequately compensated, and have a genuine interest in education and the dissemination of knowledge.

Next, we will have to raise the standards of teaching in our universities in order to exploit to the fullest the much higher intelligence and basic knowledge of those coming from the preparatory school. In cases where the cost of university study is beyond the means of the student, and provided his scholastic record warrants it, the Government should advance the necessary funds in the interest of the nation.

Most people will say that these changes in our higher education are extreme but so are the times in which we live.

We must acknowledge that unless we first lay a broad foundation for scientific development, the resulting structure will be limited in height. One cannot build a skyscraper on the foundation for a one-story house.★

overall length 42 inches

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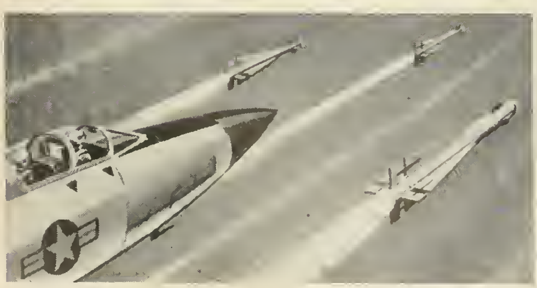

The Falcon is an air-to-air missile built by Hughes Aircraft Company for the U. S. Air Force. Its light weight die cast stabilizer fins resist severe strain during course changes. It uses other Doehler-Jarvis die castings also.

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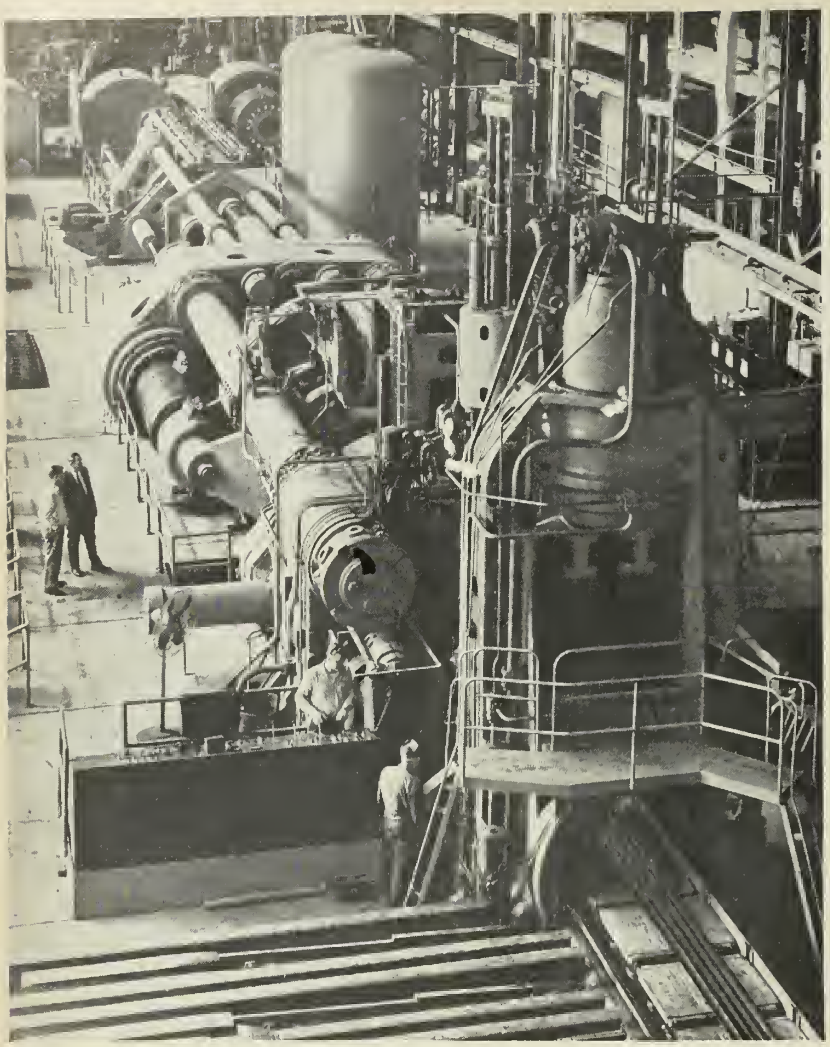
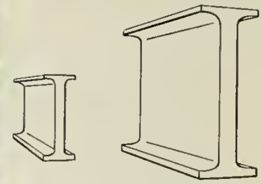
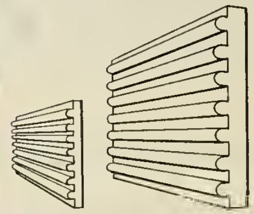


HOW THE 13,200-TON PRESS BOOSTS EXTRUSION CAPACITY



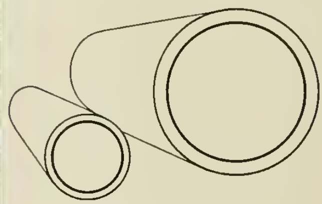
FROM 11″ TO 28″

STRUCTURAL SHAPES



FROM 9″ TO 20″

STIFFENED SECTIONS



FROM 10″ TO 24″ O. D.

TUBING

DOW'S NEW EXTRUSION PRESS PACKS 13,200-TON PUNCH

Here's a whole new range of large magnesium extrusions:

24-inch O. D. Tubing   28-inch I-Beams   80-foot-long sections

This mammoth press, newest addition to The Dow Chemical Company's rolling and extrusion mill at Madison, Illinois, is the world's largest magnesium extrusion facility. Its vastly increased capacities afford new opportunities for designers working with light metals. A wide variety of new magnesium applications for aircraft, missile, military and general industrial use are now possible and practical. In addition to extruding magnesium, the press is also available for large aluminum extrusions.

Here's how the big press will increase maximum dimensions of representative magnesium extrusions: Integrally stiffened sections, from 9 to 20 inches wide; I-Beams from 11 to 28 inches high; round tubing from 10 to 24 inches outside diameter; and maximum lengths of 80 feet. A large number of shapes and forms can be produced, limited only by the design of the die through which the metal is extruded. Many complex shapes that formerly required separate operations can now be formed in one operation.

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Propulsion Engineering

by Alfred J. Zaehringer

FREE RADICAL WORK is underway at Catholic University. Hydrazoic acid has been thermally decomposed to give the NH radical or its polymer, which is a stable, blue paramagnetic solid at liquid nitrogen temperatures. No success has yet been reported in finding a solvent for the free radical, which is among the most stable yet known. Most other free radicals are unstable even at temperatures near absolute zero. Scientists at the Washington, D.C., university have also prepared the dimethylamino radical which reacts to form tetramethyl hydrazine.

FLUORINE COMPOUNDS AVAILABLE for propellant investigators are elemental fluorine, halogen fluorides, nitrogen trifluoride, oxygen difluoride and perchloryl fluoride.

BORON REACTIONS: Iowa State University chemists have decomposed diborane in an inert atmosphere under silent discharge to yield 40% B_4H_{10}, 20% B_5H_9, 30% B_5H_{11}, small amounts of B_6H_{10} and an unknown hydride with nine boron atoms per molecule. The work was sponsored by Callery Chemical. Burning rate of boron metal rods was reported by Experiment, Inc. At 15 psi, the rate is about 2 cm/min and the burning surface temperature was estimated at 2040°C. Rensselaer Polytechnic and Eastman Kodak have teamed up to study the explosive oxidation of pentaborane. Surfaces coated with oxidation products act as catalysts and broaden the explosive-limit range. Carbon monoxide and iron carbonyl inhibit the reaction.

BLOWOUT VELOCITY FOR BORON HYDRIDES IS HIGH. Under same conditions of combustion, NACA illustrates that ethylene combustion with flameholder will blowout at about 47 ft/sec while diborane will go well over 100 ft/sec, without flameout. This means ramjets using boron fuels could cruise at much higher altitudes than with conventional hydrocarbon fuels.

PLENTY OF LITHIUM. Foote Mineral Co. estimates the concentration of lithium in the earth's crust at $4x10^{-3}$%, or about as abundant as lead or six times as plentiful as tin. The company calculates that the reaction of lithium and fluorine could give an I_{sp} of 336 sec and 318 for lithium and oxygen. Lithium hydride is also suggested as a superfuel. Lithium perchlorate also figures high since, on a volume basis, there is 29% more oxygen in $LiClO_4$ at room temperature than in liquid oxygen at the boiling point. It looks like Foote Mineral will team up with Hooker Electrochemical (Niagara Falls, N.Y.) to produce lithium perchlorate by a *direct* electrolytic method. Cost could come way down. This might make it competitive with ammonium perchlorate. Hooker is looking over a site at Montague, Mich., for the plant.

LONG-BURNING SOLID-PROPELLANT MOTORS are in the works. Jet Propulsion Laboratory is working on a water-cooled nozzle for a large solid-propellant rocket motor.

EXISTING SOLIDS WILL BE BOOSTED by three new developments. One firm has built and flown a solid motor that is 97% propellant. Hopes to hit 98% in another six months. Studies going on indicate that burning rates can be jacked up by a factor of 10 without pressure increase. On the other hand, there is one proposal out for operation of combustion pressures of 250,000 psi!

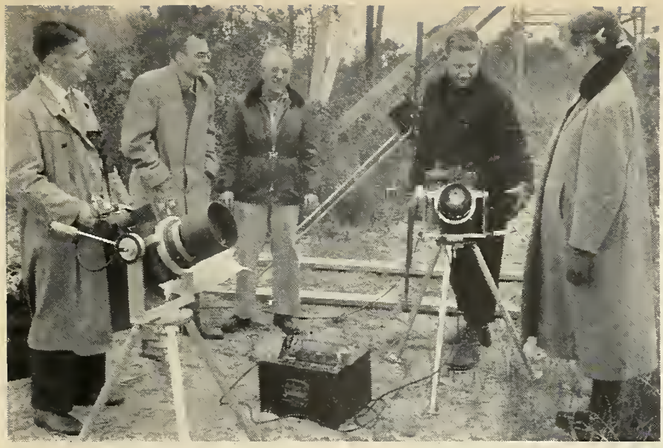
TETRANITROMETHANE IS BACK. Small-scale pilot plant manufacture is underway again. Oxidant or monopropellants would be the logical application

LOX FOR REDSTONE: Army has shown its 4-trailer, mobile, 20 tons/day LOX plant. The low-pressure unit (100 psi) was built by Air Products, Inc. and cost is $1 million. The product is 99.5% pure and the plant can operate at temperatures of −25° to 125°F. It takes one pound of diesel fuel to grind out two pounds of LOX. The four units are for intake, compression, heat exchange and separation.

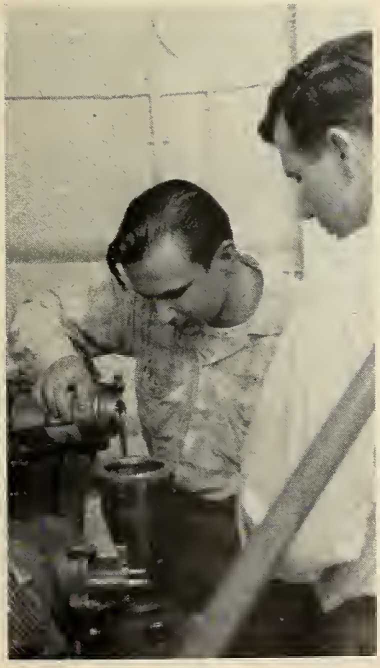
ORIOLE . . .

a really low-cost research missile

Men learn by doing, and by learning they produce for the good of all men. On this page you see the various steps involved in the assembly for launching of the ORIOLE, a recently proved high-altitude research rocket developed by the University of Maryland and costing less than $300 per copy—except for the booster, a surplus LOKI, which is free. This sting can carry scientific payload to an altitude of 80 or 120 miles, depending solely on its diameter. It has no motor of its own but relies only on its LOKI booster. The ORIOLE sting completely lacks either fins or flare, thus reducing drag to a minimum. It achieves aerodynamic stability because its center of gravity is placed very far forward. The sting lets go from the booster immediately after it has completed its 0.8-second burning time.



Actual designer of the ORIOLE is Richard Bettinger, shown on these pages in the plaid shirt. A graduate student at Maryland, he works under the direction of Astrophysicist Dr. S. Fred Singer (in sports cap). These pictures were taken off Cape Charles, Va., aboard the U.S.S. Launcher where the ORIOLE was successfully tested. Shot to the left shows one of two mosquito-infested ground stations. ORIOLE is fired in a conventional TERRAPIN launcher—shown in the shots right below. Development of the ORIOLE solves one major problem facing U.S. universities—the availability of a simple, low-cast research rocket. Next, a series of readily available launching sites is needed so that students can launch their rockets more or less at will. If it were not for the full cooperation of Navy, Army and Air Force, ORIOLE would still be waiting for its first test.



High-energy George P. Sutton

Backstage with the New ARS President, Booster of Scientific Education

by Erica Cromley

IF THE NEW American Rocket Society president has his way, America will move quickly to close the gap on Russia's impressive output of scientists and engineers.

George P. Sutton, 37, who takes over the ARS reins this month, feels strongly that the government should set up a committee to recommend steps which would: (1) attract more students into scientific and engineering training, (2) expand the number of courses available, (3) raise the quality of available courses, (4) encourage graduates to continue postgraduate studies and (5) raise the level and number of competent instructors.

"It is extremely important that we roll up our sleeves and tackle the problem at the foundation—the schools," he says.

A key scientist in Rocketdyne's early design of the nation's first high-thrust, large rocket engines, Sutton has made prolific contributions to technical education. His book, ROCKET PROPULSION ELEMENTS, standard text in many technical colleges, has been termed *The Book* for rocketry training by many of the country's top missile experts. The Russians were impressed with it too, published a USSR edition, and sent Sutton a free copy.

Throughout the 15 years of his brilliant career Sutton has taken time out to write many technical magazine articles. In 1951 he received the G. Edward Pendray award of the ARS for his outstanding contributions to the literature of jet propulsion.

The current chief of preliminary design for Rocketdyne fell into the rocket business "somewhat by accident," after scuttling a boyhood dream of becoming a doctor.

It happened during a job interview at Aerojet. He was told only that the "highly classified" work involved thermodynamics and hydraulics. Sutton figured he'd be working on hydraulic and heating equipment for aircraft. He accepted and inadvertently began a career in rocketry which has brought him worldwide recognition.

He did have one brief and unexpected fling at his first love—medicine—when he assisted an impatient stork. While working his way through Cal Tech as maintenance engineer at a city hospital, a hurried call for help brought him racing across the street to the hospital's parking lot, which is as close as a new mother got to the delivery room. He used a laboratory clamp ("nonsterilized," says Sutton) to bind the squalling newcomer's umbilical cord and wrapped him in his lab jacket ("also nonsterilized").

As in doctors' families, the Suttons are reconciled to periodic fatherless homelife. Sometimes Mrs. Yvonne Sutton wonders whether she wouldn't see more of him if he had gone into medicine. He is frequently called on

Left—George assists daughters Marilyn (left) and Christine in the study of astronomy. Right—George, Marilyn and Yvonne study the sky.

to lecture and is away from home on about 10 week-long trips each year.

Because he now travels so much, the Suttons are not as active in community affairs as they had been, preferring to spend as much time as possible in family activities. They are, however, active in the Woodland Hills, Calif. community band to which daughter Marilyn, 10, contributes her clarinet-playing talents. There's a band at home, too. Mrs. Sutton plays the marimba, Pa Sutton is the accordianist, Christine, 12, is pianist while Marilyn tootles.

"It took us a year and a half before we could play together so it sounded like anything," Mrs. Sutton laughs. "But we're real 'cool' now." Lately, Henshaw Street, Woodland Hills has been jumping to the strains of "True Love" and "Tammy", favorite numbers of the Sutton Swing Quartet.

Life with this scientist is seldom dull. Mrs. S. recalls a recent evening when they came home from a party, at one a.m., grabbed the telescope and went out on the lawn to check the positions of the stars. Then they set the alarm for four a.m., and with bathrobes flying, rechecked them. Before they settled back to bed for good Mrs. S. recounts, "George looked up his astronomy book to make sure the stars were where they were supposed to be. He was very pleased to find they were."

The Sutton family agree on one family project each year. This year it's Operation "Skywatch" with a German telescope bought during the rocket experts recent International Astronautics Federation meeting in Barcelona. Last year, it was Operation "Mountain Climbing." The Suttons are skiers and plan one ski vacation each year without the children.

High-energy George P. Sutton

Mrs. S. describes her spouse as "clear-thinking, concise and able to sum up any issue quickly to a sound conclusion." He has two pet peeves: lack of organization and weeding the garden.

"He's easy to work with and a bug on waltzes," says Rocketdyne's Assistant Chief Engineer Paul Vogt. "Once he jarred the car pool by waltzing the car down an empty street in time to a Strauss waltz coming in over the radio."

In his "spare time" Sutton keeps abreast of things by reading avidly: m/r, *Business Week, Time, Reader's Digest* and ARS publications.

Sutton began his career in rocketry in 1943, after graduation from California Institute of Technology with a Master of Science degree in mechanical engineering. His earlier studies included an Associate of Arts degree in mechanical engineering from Cal Tech in 1942. Today he continues advanced studies in several fields.

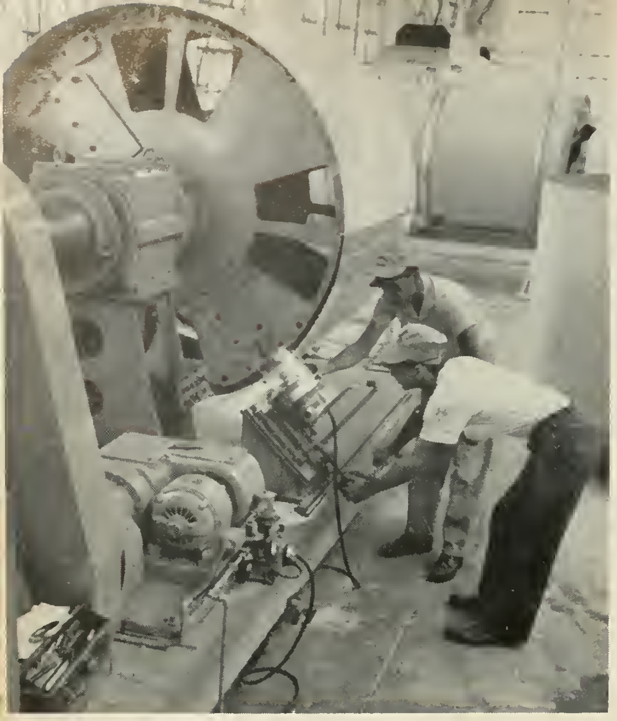
Sutton joined a nucleus group of North American Aviation guided missile scientists in 1946 as a research engineer. He subsequently has held successive prominent roles in that group's development of high-thrust rocket propulsion systems and has been the chief of Rocketdyne's preliminary design section since 1953.

He has served on the faculties for Mechanical Engineering at the California Institute of Technology, the University of Southern California and the University of California at Los Angeles.

Among his current contributions to science is his active participation on the Nomenclature Subcommittee of the American Standards Association. The group has developed the first nationally accepted standard symbols and terms for rocket propulsion.

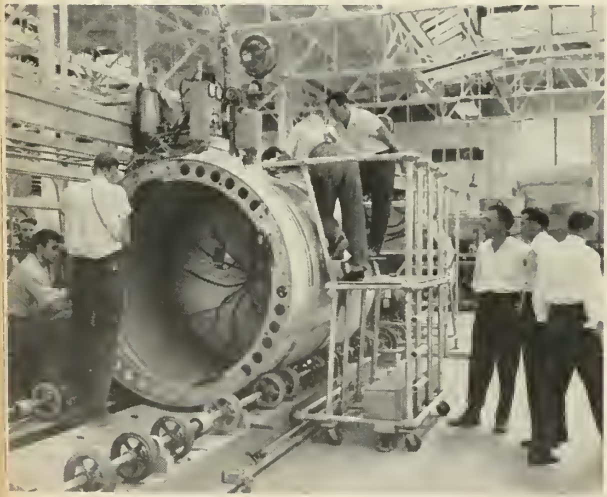
Sutton is a founder and the first president of the Southern California Section of the American Rocket Society and currently is a national director of the society. He has served three years as a director of the society, as Chairman of its National Membership Committee, and Awards Committee. He is the 1957 Vice President and has been nominated for ARS president in 1958. He also is a member of the American Society of Mechanical Engineers, the Institute of Aeronautical Sciences, the British Interplanetary Society and Deutsche Gesellschaft für Raketentechnik und Raumfahrt (the German Rocket Society).★

Left—The Suttons enjoy an evening at home with the family pet. Right—The Sutton Swing Quartet demonstrates its "cool" talents.



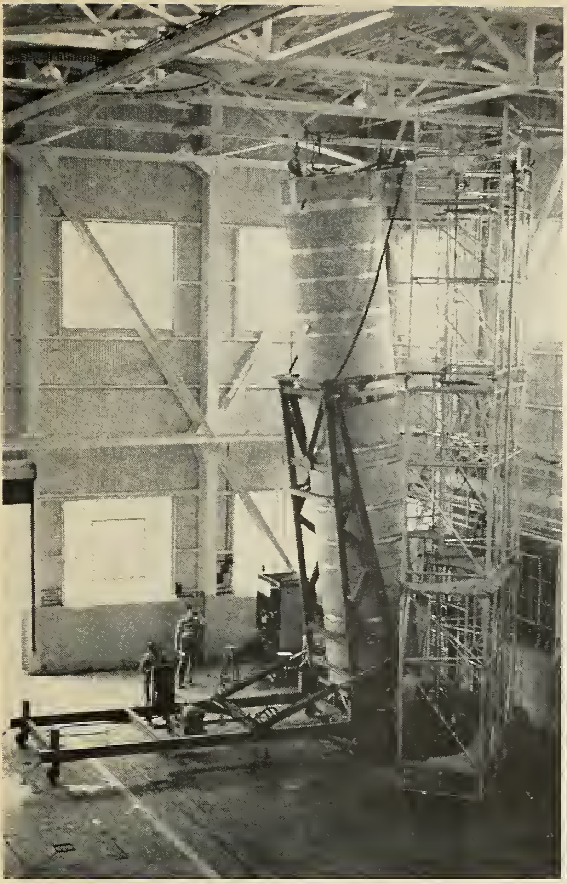
Fabricating the REDSTONE

Reynolds Metals Co. has been fabricating and assembling REDSTONE missile fuselages at its Sheffield, Ala. plant since 1952. The plant fabricates the nose, fuel body, rocket-engine housing and tail fins, and assembles the complete fuselage. Engines, guidance systems and controls are installed elsewhere by Rocketdyne, Ford Instrument Co., Chrysler and ABMA. Left—A horizontal mill cuts sections of the missile fuselage to length.



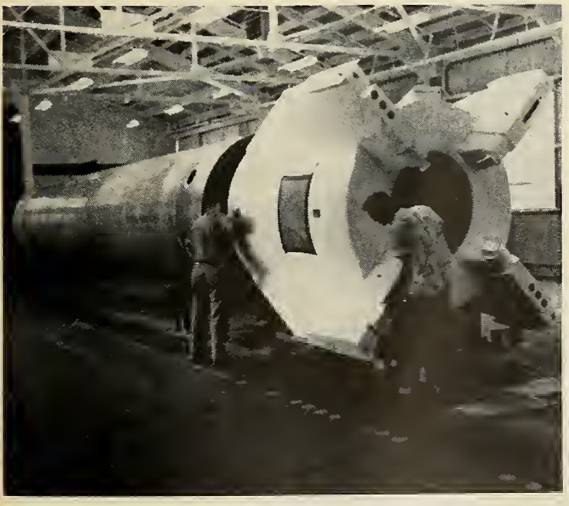
The JUPITER IRBM is also being fabricated and assembled at the Sheffield plant. Sheet material for the REDSTONE is from McCook and Listerhill, tubing from Phoenix, stampings from Louisville Plant 12. The advanced nature of the program demands a high degree of skill from the engineers and production men. Currently, more than 200 people are employed at the plant. Left—Body sections are welded together on automatic welding machine.

Exacting quality control techniques are employed throughout the entire fabricating operation. All welds are X-rayed and each component is protected constantly from dirt or damage. Above—Through a port opening at the aft end of one of the missiles, two employees are shown inside the fuel tank installing fuel and wire conduits. Left—View of welding machine in operation. After the joint has been completely welded a radiographer inspects the bead.

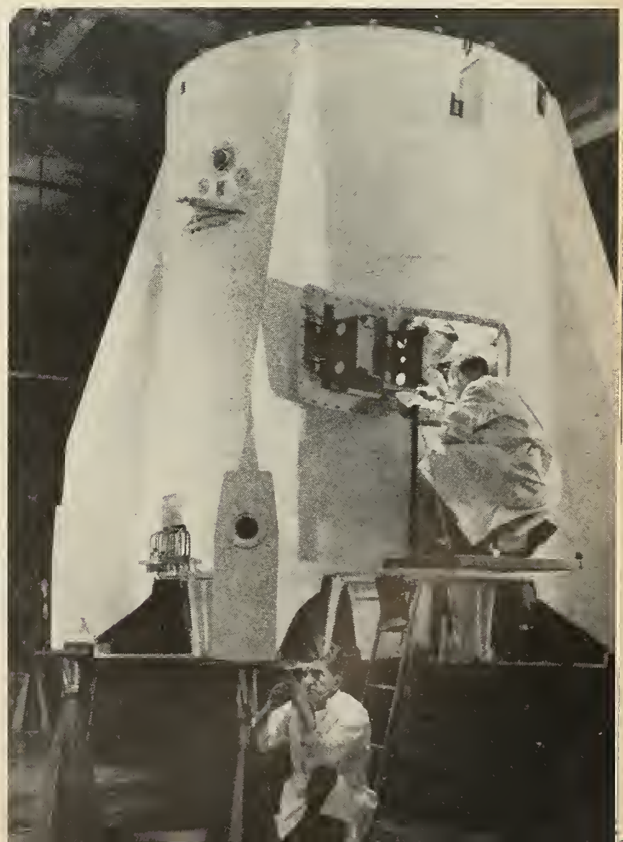


The REDSTONE is assembled into three major component parts, one consisting of the rocket engine and fin section, one, the tank section and the other, the control-system and warhead section. Control and warhead section is approximately 29 ft. in length, the tank section 24 ft. and the engine housing 10 ft. Left —A tank section of the body is raised into position for a hydrostatic test. Water, under pressure, is used to check for leaks.

The ruggedness of the REDSTONE is apparent in these photos of the rocket-engine housing and fins. It is controlled in flight by graphite vanes attached to the fins and protruding into the exhaust stream of the rocket. Above—Tail sections of the missile in various stages of assembly at the Reynolds Sheffield plant.



The REDSTONE is rapidly becoming the workhorse of the infant space age. Its role as the first stage for the three-stage JUPITER-C research rocket and the recent decision to put the JUPITER-C into the satellite service have made the REDSTONE's task extremely vital. Above—Reynolds workmen wheel a tail section into place behind the center section. Right—Chrysler workers install mechanisms in missile tail section after delivery by Reynolds.



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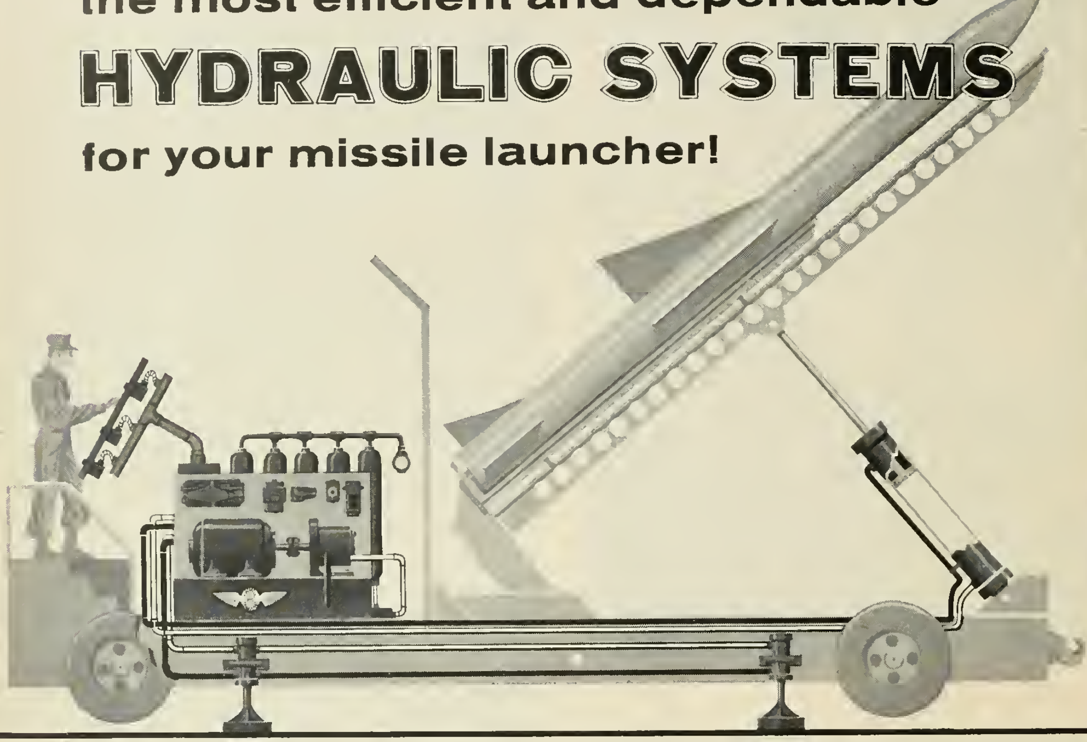

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Greer's important contribution in the guided missile field includes major work on the Bomarc, Redstone, Talos, Terrier and Thor. Greer has provided systems and components for these operational and experimental missiles since the inception of the program.

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Missile Age Machining

by **A. B. Albrecht**
Monarch Machine Tool Co.

BECAUSE so sizeable a portion of our production efforts is not devoted to the machining of missile, rocket and jet components, rapid engineering advances in materials and designs have challenged manufacturers to produce precision parts on short notice for use in development models. In addition, these manufacturers have had to supply reliable and interchangeable parts for rocket powerplants and missiles already in service.

To meet these vital defense needs on a competitive basis has required the use of the most modern contouring equipment, along with good machining practice. The Monarch air-gage tracer lathe is an example of the type of tracer-controlled precision contouring machine that has been found best suited to the needs of missile and rocket contractors.

The services of resourceful and diversified manufacturers in producing missile components has contributed greatly to our nation's defense programs. However, a major factor in the ability of these manufacturers to produce lies in the development work and the advances which have come from the machine tool industry.

"Until they start building square rockets, an engine lathe of 48-inch, or more, swing plus air-gage tracer equipment for precision contour control will still be the tool most needed in the production of guided missiles." These were the words of a man who has been intimately associated with the business of producing rocket hardware practically from the outset of our nation's program of missile development. He is head of a concern which currently has contracts for machining parts for over 15 major missiles.

We already have available in our current tracer lathe designs most of the features that missile machining experts are finding essential for this exacting type of metal removal. This involves not only complex contours and ultraclose tolerances, but critical surface finishes as well. The machines are precision-built engine lathes featuring a sensitive duplicating device, called the air-gage tracer, which automatically controls contour turning, facing and boring cuts using a single-point tool.

Most components for rockets and missiles now in production, or in the advanced development stage, demand extensive machining and the application of special techniques in the contouring of complex shapes from rough forgings. Common materials are A-286, Inconel, 17-7 Stainless and heat-treated AISI-4130.

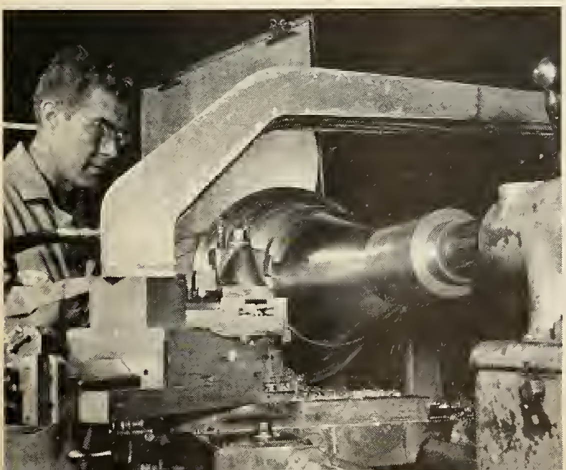
Because a missile is subjected to extensive stress under flight conditions, quality and reliability of finished components are vital considerations. Design often compels the use of materials up to their ultimate strength. This necessitates close control of machining operations so as to obtain a finished part dimensionally stable and free from residual stresses. Continued close quality control is required to meet military specifications.

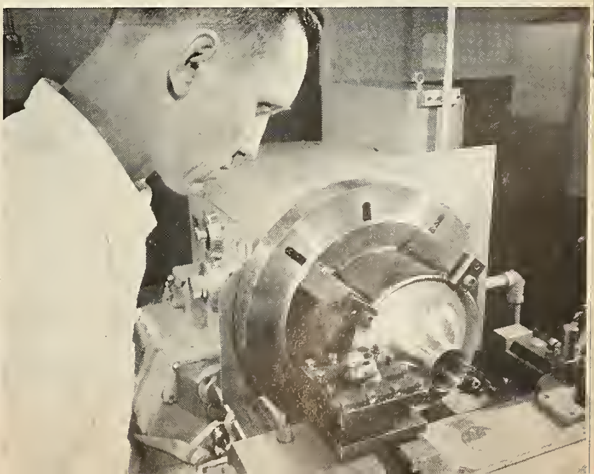
The troublesome machining problems in the missile field stem primarily from the required turning of larger parts of varied contour and extremely thin wall sections. A part 30 to 60 inches in diameter with a wall thickness of 0.076 to 0.187 inch is not uncommon. The initial forging is often a solid blank and considerable metal must be removed in producing the desired contour.

Machining Practice

Machining techniques, already well established in turning jet aircraft parts from high temperature superalloys, have been effectively applied in the missile field. At Steel Products Engineering Co., for example, turbine discs for the J-79 engine are turned on right angle lathes to close tolerances, using constant surface cutting speed. A 23-microinch finish is obtained on the A-286 alloy on the finish pass. Cutting speeds of 275 fpm are used for both the roughing and finishing operations. This method is currently used by Steel Products Engineering to produce smaller parts for a missile ramjet. Grinding is eliminated, and stress re-

Representative air-gage tracer-lathe controlled machining operations. Lathes are (left) 20-inch Series 61 and Series 62 (right).





lieving after machining is unnecessary.

A major contractor in the field of missile hardware, Diversey Engineering Co., has utilized the maximum versatility of the air-gage tracer lathe in producing parts for prototypes, as well as for production programs. Nozzles, bulkheads, rings, adapters, etc., are all entirely contour turned on Monarch equipment. Exacting complex contours are obtained with the swivel slide in a single machining set-up. Tracer pressure against the template is light, thereby eliminating template wear which ensures a high degree of accuracy.

Accurate template reproduction assures built-in inspection on complex contours which would otherwise require costly gaging fixtures.

Major components for rocket motors by Reaction, Thiokol, and Aerojet General must be completely machined to a 63-microinch finish or better. Because of the complexity of these and other missile parts, grinding such shapes would be costly and difficult, if not impossible. Thus, final finish is entirely dependent on the performance of the air-gage tracer, the nature of the tooling, and the properties of the material. On heat-treated and age-hardened materials a 20- to 26-microinch finish is easily obtained on these lathes with carbide tooling.

Many smaller shops, such as United Aero Products, have shared in the responsibility of producing components for development models to meet engineering test schedules. Tracer templates can be changed quickly from one job to another, and design changes can be made directly on the flat template, thus eliminating costly delays for later production orders on difficult parts.

A new application for the air-gage tracer lathe has been in the area of machining large, thin-walled, nonmetallic parts. Fabricated components, such as nozzle liners produced by Haveg Industries, all require finish machining to close tolerances so that they properly blend the contour into the metal section in which they are mounted. These temperature-resistant materials are somewhat abrasive and are normally turned at reduced cutting speeds, using light feeds and harder tungsten grade carbides.

Tooling Practice

In practice, contouring of today's missile parts normally starts with the roughing out of the basic forging on heavy duty lathes. This involves the removal of one-half to three-quarter-inch stock on a side. The roughed blank is then given a thorough hardening or solution treatment under strict metallurgical control.

Material requirements vary, but the most common alloys currently used are AISI-4130 and C-1020 steel. The specified hardness for alloy steels after heat treatment normally is R_c 32/36. Solution-treated, high-temperature alloys are machined in the range of 300-360 Brinell. In this hardness range, these alloys are very abrasive and difficult to turn. Finish turning is accomplished with K7H carbide, using light feeds and surface speeds of 200 to 280 fpm.

A knowledge of the properties and machinability of the material is a major requirement in machining the many new metals used in the missile field. Specific cutting speeds and feeds are required for each alloy. Some plastics and nonferrous alloys may be machined at high speeds; while the super-alloys, including titanium, plutonium, 17-7Ph, and Niomic, all require cutting speeds under 100 fpm. A new addition to the above group is heat-treated tool steels in the range of R_c 42/56.

General turning practice involves selecting the proper cutting speed, which is determined by the machinability of the alloy, and then balancing the feed rate in relationship to the rigidity of the workpiece and capacity of the machine. Finishing cuts are sometimes limited by thin wall sections and by the extreme hardness of the material. Roughing feeds generally range from 0.010 to 0.016 ipr. Finishing feeds depend on the finish requirements and the tendency for chatter to occur. The high-temperature alloys require the use of positive rake tools with minimum nose radius, and show more tendency to work harden. The depth of cut on finishing normally is held below 0.040-inch.

Monarch is prepared to offer tracer-controlled lathes of greater swing as the needs of missile manufacturers ultimately increase. However, our newest design of lathes now offers many of the features which machining experts are finding essential for this exacting type of metal removal.

In addition, we and other machine tool manufacturers are carrying on considerable research on the machining of new alloys and on developing new contouring techniques. Basic metal cutting studies have already shown the correct cutting conditions and tool geometry for profiling critical parts.

Engineering and demonstration facilities are available to help contracting firms obtain a working knowledge in the contour machining of metals. Combining good machining practice with air-gage tracer equipment results in one of the most important teams in our rocket and missile program.★

By Norman L. Baker

Manned Re-entry: A Technical Barrier of the Past?

While *Laika, Sputnik* II's space passenger, was still alive and orbiting the earth several hours after launching, the world asked: will the dog be returned to earth, and if so, how?

It was this concern over *Sputnik's* passenger that spotlighted the tremendous advances that have been made by industry and government research centers in the field of missile re-entry research. Representatives of two companies engaged in re-entry research were unshakably convinced that the present advances in the state of the art made it feasible to return *Laika* to the earth alive.

The advances are basically the result of ballistic missile nose cone reentry research. The announcement that the Army had solved the re-entry problem by returning to the earth intact the nose cone of a *Jupiter-C* test rocket was the first report of this breakthrough.

Two distinct but basically similar approaches have been employed by the Army and the Air Force.

The Army nose cone used a combination of devices many of which were for the sole purpose of retrieving the cone from the ocean. Cook Electric Co. of Skokie, Ill., developed a parachute-drag device for reducing the re-entry velocity. Device was either a series of rip-away parachutes, increasing in size as velocity was reduced, or a single parachute controlled in resistance area by a reefer apparatus that released the parachute as a function of velocity and drag.

The nose cone was manufactured by Cooper Development as a machined stainless steel unit. This was covered with a Rockide ceramic coating by Norton Abrasives.

Avco, engaged in Air Force nose cone research, may be employing the parachute technique, but unlike the Army technique, the "parachute" utilizes steel for overcoming high temperatures.

For example, a satellite weighing 250 pounds (the approximate weight of the *Sputnik* II payload) could be returned safely with a stainless-steel drag area of approximately 500 square feet. By opening the parachute at the satellite's perigee—say 150 miles—the payload would return to the earth in about 15 orbits. Inhabited vehicle deceleration must be held below nine g's.

General Electric has been employing the drag-brake principle for deceleration, orientation and separation of the "live" portion of the nose cone. Basic difference in the techniques apparently is the velocity of re-entry. Avco and Cook techniques indicate subsonic velocities while the GE approach would probably be high supersonic.

A. J. Eggers of NACO has proposed a satellite-recovery technique with a ceramic-coated hemispherical satellite of 10-feet diameter that would enter the atmosphere and decelerate at less than eight g's. Satellite weight would be in the neighborhood of *Sputnik* II or approximately 1200 pounds. After subsonic velocities had been reached, parachutes would lower the satellite to the earth.

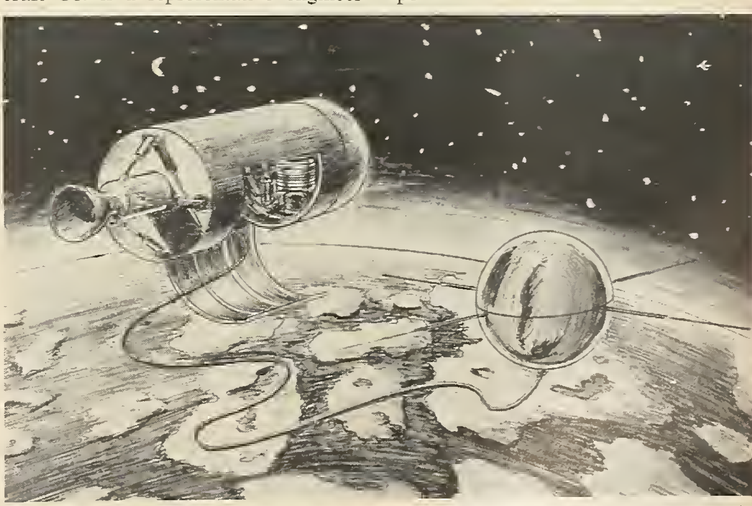
Two other firms actively engaged in re-entry research are the Arnold Engineering Development Center and the Lockheed missile systems division. Both employ far-hypersonic shock tubes for model "flight" tests.

A satellite recovery proposal by Horace S. Solliday of Douglas Aircraft Co. is a representative engineering approach to the problem. Solliday's design would use the third-stage launching rocket as the initial reentry phase vehicle. The satellite would be ejected from the rocket for making scientific measurements while joined to the rocket by a cable. Later, the satellite is winched in and the rocket oriented for retrofiring the engine for deceleration.

The orientation and retrofiring of the rocket would be a very complex and difficult operation for an unmanned satellite. In addition, 50-80 per cent of total weight to be decelerated would be needed as rocket fuel.

The rocket, which would have an ICBM-type nose cone, would again be turned around and exposed to the high-temperature shock layer. After ribbon chute speed is reached the satellite would again be ejected, this time by explosive action, to enable it to penetrate the supersonic slip stream. Finally, by ejecting a series of increasing-diameter parachutes, the payload would be lowered to the earth undamaged.

Russia announced the solving of the re-entry problem by using "sweating walls" and a form of ceramics called "metallo-ceramics." Composition is silicon and 10 to 20 per cent cobalt powder.



A satellite recovery proposal by Horace S. Solliday, Douglas Aircraft Co., marries the satellite and final-stage rocket for launch, scientific measurements and during re-entry.

Mach 17 Shock Tube Tests *Polaris* Design

A 13,000 mph shock tube for testing ballistic missile design is in operation at the Lockheed missile systems division research and development labs at Palo Alto, Calif. The 40-foot-long tube is being used for advanced design work on the *Polaris* flat ballistic missile.

The tube, made of stainless steel, has an inside diameter of three inches and walls an inch and a half thick. Two separate techniques will be employed in the tube to produce shock waves. One will be the use of high-pressure helium. The other will be the use of a mixture of hydrogen and oxygen, which will be triggered into explosion by a spark.

The shock tube works on the build-up of gas under pressure at one end of the tube which ruptures a thin diaphragm when the pressure reaches a certain level. The high-pressure gas then speeds down the tube behind a hypersonic shock wave.

Lockheed scientists will study heat transfer, shock wave shapes and other details of airflow around missile models. In addition they will perform basic research in high temperature gas dynamics.

Lockheed is the missile system manager of the *Polaris*, a solid-propellant weapon to be launched from submarines, and provides technical direction to several other firms working on the program.

Martin Creates *Vanguard-Titan* Division

The Martin Co., has formed a new division for speed up of the on-the-spot arrangements for launching both *Vanguard* and the Air Force *Titan* ICBM.

G. T. Willey, the company's corporate vice president-manufacturing, will assume additional duties as vice president and general manager of the new division. This division will have equal status with Martin's Baltimore, Denver, and Orlando divisions. He will have charge of all Martin activities in the Patrick Air Force Base and Cape Canaveral area, including the continued testing of latest versions of the *Matador* surface-to-surface missile.

Martin's *Titan* project, involving a contract in the amount of $358 million for the second of two mutually supporting Air Force ICBM programs, got under way early in 1956 with construction of the company's Denver division near Denver, Col.

Ceramic Radomes Designed for Re-entry

Gladding, McBean & Co., has just completed the first ten prototype high-alumina ceramic radomes designed to withstand the high temperatures generated when ballistic missiles re-enter the atmosphere.

First, many formidable obstacles had to be overcome. The major difficulty lies in the fact that a radome must be as transparent as possible to radar waves. This meant finding a material that would have the right electrical properties as well as the required temperature resistance and strength. More important, it meant devising a manufacturing method which could hold the wall thickness to a tolerance of 0.001 inch.

The technique finally worked out by Gladding, McBean starts with high purity alumina (Al_2O_3) with which is mixed a small amount of organic binder to give some strength before firing. This results in a final body of 97 per cent alumina. This is made up in the form of a slurry which is prayed on a chrome-plated steel mandrel with a spray gun. Later fabrication operations subject the radome to a pressure of about 30,000 psi and temperatures of above 3000°F.

Major *Hawk* Subcontractor Is Northrop Aircraft

Northrop Aircraft holds contracts amounting to approximately $20 million which were awarded by Raytheon for work on the *Hawk* surface-to-air missile sytem. Contracts are for research, development and manufacture of airframe components and support equipment for the *Hawk*, including appropriations for facilities, engineering services and procurement.

Raytheon Manufacturing Co., Andover, Mass., is the prime contractor for Army Ordnance, with Northrop in the position of major subcontractor. Northrop has the responsibility for structural integrity and aerodynamic performance of the missile, design and fabrication of major airframe portions, the mobile launcher, missile loader, pallet and reusable container.

About 70 per cent of the total dollar volume of the Northrop work on the *Hawk* is for support-equipment items such as the integrated launcher and missile loader for field use. The integrated loader-launcher is said to employ an extremely lightweight and compact design concept. It is self-propelled, can ford streams up to 30 inches in depth, and could float if required.

Manufacture of portions of the *Hawk* is underway at the company's Anaheim, Calif., facility, while engineering activity is under way at both the Anaheim and Hawthorne facilities.

Specifically designed for defense against low-flying aircraft, the *Hawk* uses a Thiokol solid-propellant rocket motor.

AP&C Production Exceeds Demands

HENDERSON, Nev.—America's only large-scale producer of high-energy ammonium perchlorate is still undergoing the gradual transition toward large, high-performance solid rockets. Virtually all U.S. high-performance solid rockets utilizing composite propellants use ammonium perchlorate as the oxidizer.

The large, Navy-financed, American Potash & Chemical Corp. plant is still operating below its estimated 1200-tons-per-month ammonium perchlorate (AP) capacity.

The plant has had a rough time selling AP. The market was originally small and because of the low production, nobody wanted to swing toward this item. Despite shutdowns, however, the employment figure for the Henderson operations has grown from 75 in 1945 to over 400 at the present time. Present operation theory appears to be, work on the smallest efficient schedule and/or make limited large runs and stockpile.

Orders are still sporadic for AP but the trend for larger solid missiles may at least make the future more certain for AP. As yet, the American AP market for missiles has not been pinched by a competing Norwegian firm.

Atlas Engines In Production At Neosho

Rocketdyne's Neosho, Mo., plant began production last month on engines for the *Atlas* ICBM.

Atlas work at Neosho supplements extensive research and development activities being carried out on the ICBM program at the main plant of Rocketdyne in Canoga Park, Calif., and at its nearby propulsion field.

The recently occupied plant is scheduled to become a prime source for missile propulsion systems during the next year. It has been in build-up production of the developmental engine and components since February. Testing began at its 200-acre field complex early last month.

West Coast Industry

By Fred S. Hunter

An illuminating example of today's weapons trend is Northrop's report that 57 per cent of its present $216-million backlog is in guided missiles and related equipment. Northrop has two big missile programs in the *Snark* SM-62A and a major subcontract from Raytheon on the Army *Hawk*. Its Radioplane Division also is engaged in development work on a classified Air Force missile weapon system. Pointing out that it has demonstrated its long-range accuracy in numerous successful test flights, Northrop anticipates the *Snark* will continue to occupy a significant position in its weapons roster for several years. Approximately 35 per cent of the company's total work force is engaged in the *Snark* program.

•

Even though it is subsonic (Mach .94), the *Snark* is a more sophisticated bird than many people think, and has a growth element built into it. Its maximum altitude is in the range of 60,000 to 75,000 feet. Performance of its Northrop-designed *Mark* I celestial and inertial guidance system is unimpaired by night or bad weather. It is designed to carry a nuclear or other priority warhead and incorporates a separable nose cone. The company is able to claim that it has "the longest range and the greatest accuracy of any missile in the free world today." The missile, now in production and scheduled to become operational in early 1958, is the "A," but there also are "B" and "C" versions in the program.

•

Delays in settling zoning variances and other details have held up the start of construction on Hughes Aircraft's new $6-million plant for its ground systems division near Fullerton. But the division is functioning in several leased structures, including two located at the Fullerton Airport. Hughes purchased 430 acres of Sunny Hill ranch, a 650-acre tract near Fullerton, for the project. The remaining 220 acres are to be used for a housing subdivision and 20-acre shopping center.

•

President George I. Long reported in San Francisco that Ampex Corp. has revised its projected sales for the fiscal year to April 30 down to $27.5 million from $29.8 million because of the slowdown in defense spending, which, he said, has hit the electronics industry, too. Ampex also sees its September 1 payroll of 2100 cutting back by about 240 by the end of the fiscal year. But for the long pull there will continue to be substantial spending "particularly in the missile area in which we are vitally interested," Long said.

•

We'll make one comment on *Sputnik*, and then subside. There can only be one first. Columbus was such a first. Others followed in bold journeys to America, but who remembers them? The Russians marked up a first with *Sputnik*, and it may very well be in the same historical category as Columbus.

•

Rocketdyne's new film on rocket development history, "Road to the Stars," is about as strong a nontechnical pitch for liquid propellants as it is possible to make. It figures, of course. Rocketdyne is in the business. The film, however, sets high standards.

•

Aerojet-General reports its investment in new facilities in the next year will total $5 million.

Painting by Chesley Bonestell from the book *The Exploration of Mars* by Willy Ley, Wernher Von Braun and Chesley Bonestell, published by Viking Press ($4.95). © C.B.

How do you control temperature on space ships?

The answer is — you don't. The controls do — controls that act many times faster than a man can react. Controls are the real key to all problems beyond sound and heat barriers.

It would be easy to list here the part Fenwal has played in the ever-progressing field of aircraft temperatures, over-heat detection and other controls. But this would only be repetitious. The aircraft industry is well aware of it.

Rather, Fenwal prefers to restate its position for the future. Fenwal is prepared by *experience . . . with equipment . . .* and *through its manpower* to work ahead with you whatever the stage of your current problems. Of this you may be sure: Fenwal's present equipment already enables the most modern advances in its field.

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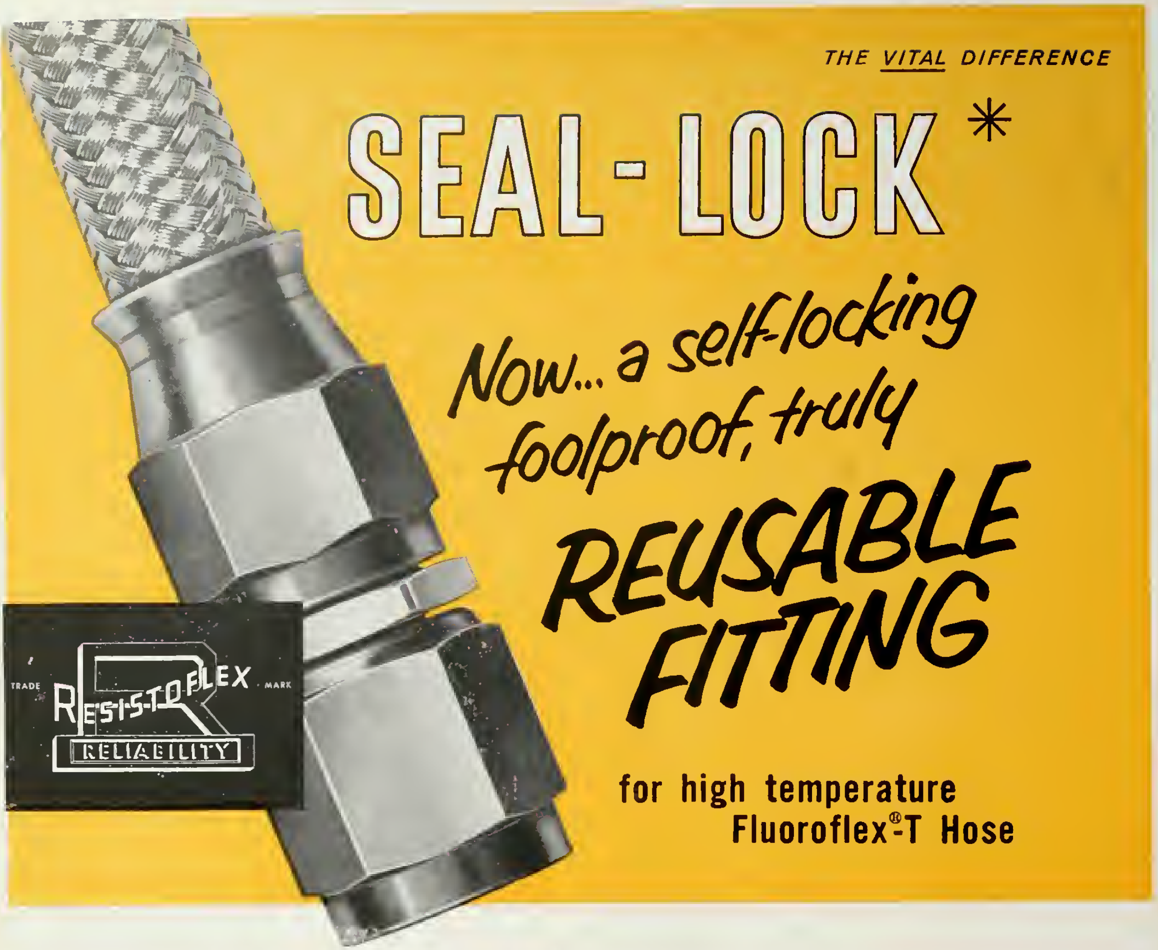

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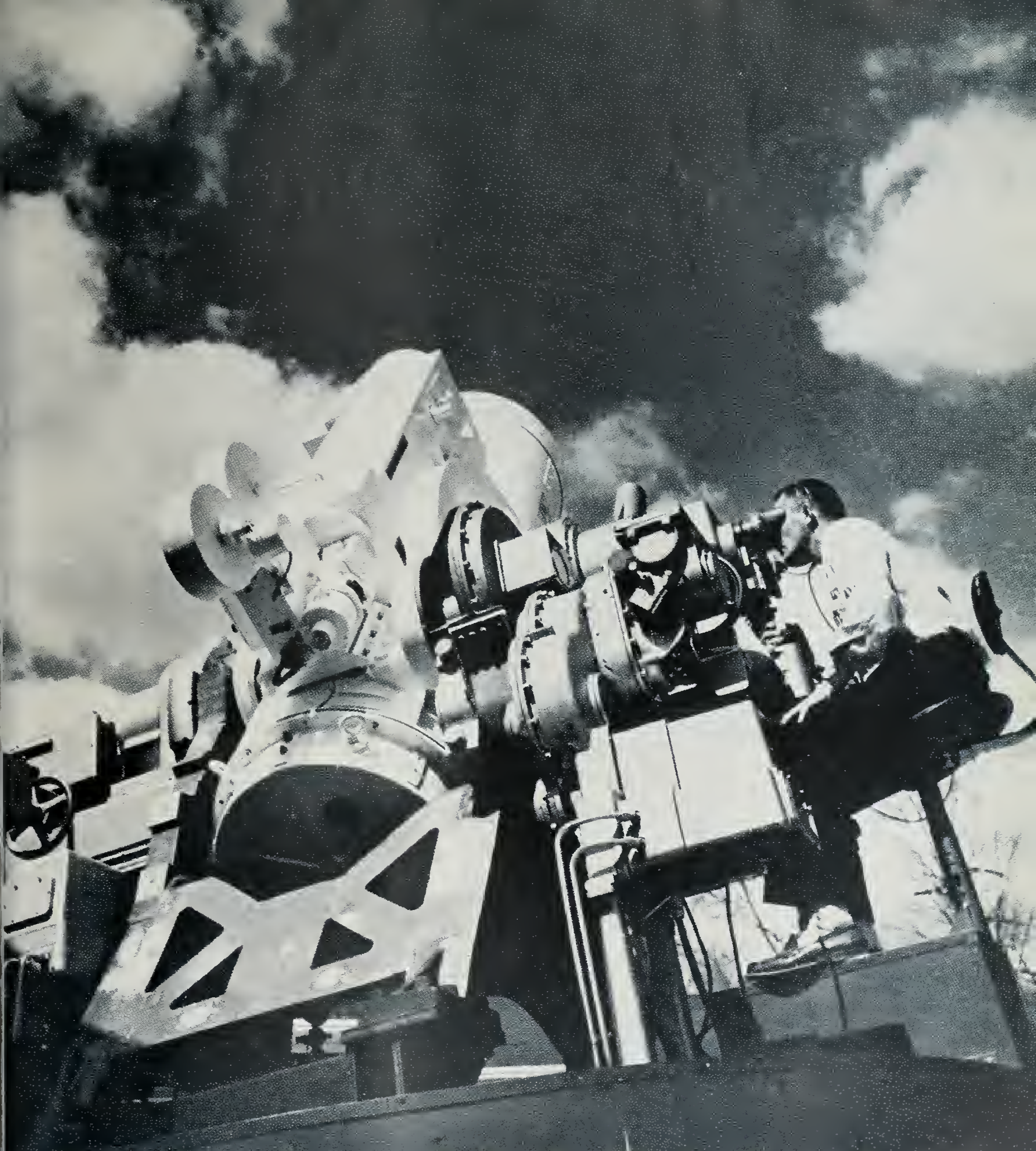

missile electronics

STRIONICS · GUIDANCE · OPTICS · TRACKING · TELEMETRY · COMPUTING

DECEMBER 1957

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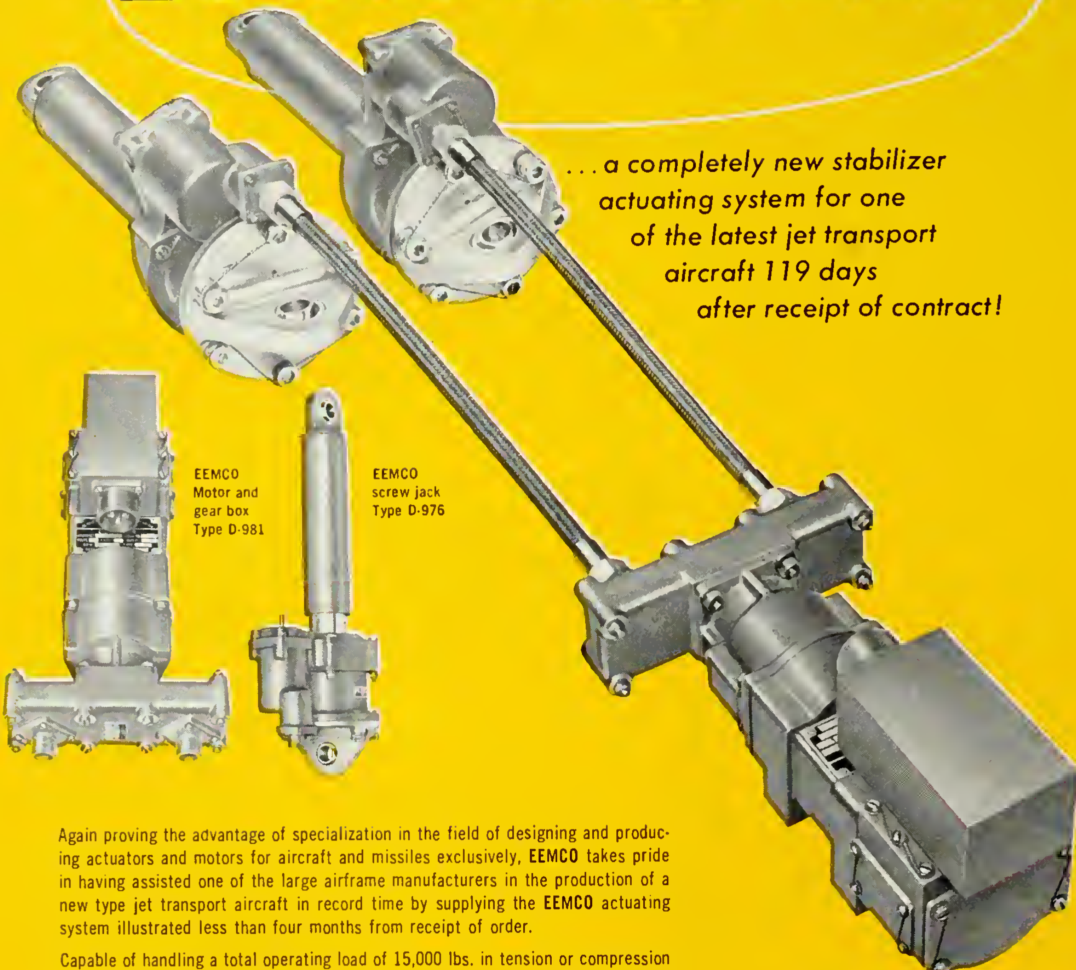
. . . a completely new stabilizer actuating system for one of the latest jet transport aircraft 119 days after receipt of contract!



Again proving the advantage of specialization in the field of designing and producing actuators and motors for aircraft and missiles exclusively, **EEMCO** takes pride in having assisted one of the large airframe manufacturers in the production of a new type jet transport aircraft in record time by supplying the **EEMCO** actuating system illustrated less than four months from receipt of order.

Capable of handling a total operating load of 15,000 lbs. in tension or compression on both jacks, this new **EEMCO** actuating system corrects the aircraft's stabilizer in flight. It will operate many times during an average flight, therefore hundreds of thousands of operations will be performed during the life of the unit. **Extreme reliability** of the system was therefore a prime specification in the contract.

The 28-volt motor is equipped with radio noise filter, magnetic clutch and brake, and an integral gear box with dual output shafts that drive the synchronized screw jacks at loads up to maximum capacity. Ultimate load on each jack, which is equipped with non-jamming stops, is 50,000 lbs. tension or compression. The jacks, with a stroke of 8.25 inches at .3 inch per second at maximum load (15,000 lbs.), are equipped with an auxiliary reduction for a control mechanism.

The proven elements of this efficient **EEMCO** actuator system, motor with gear box and the jacks, can be adapted for other uses individually or in similar assemblies.

Your inquiry is invited.

SPECIFICATIONS

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.

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missile electronics vol. 1, no. 3

contents

missile electronics news

special features

Are radical changes in design concepts necessary to solve reliability problems?

Two engineers who helped design the higher reliability into the Navy's *Terrier* system discuss the problem of reliability design. Russell R. Yost. Jr. and Fred Dreste, of Motorola, Inc., give a clear picture of how quality can be designed into electronic components (page 114).

What is the best method for training personnel to operate high-performance missiles?

Since production-line missiles are not designed for frequent assembly and disassembly by students, they often require extensive overhaul that rivals a new missile in cost. Solution of this problem is the synthetic missile, which is the concept of the Navy's Training Devices Center at Port Washington, New York. J. Gordon Vaeth and Lt. Cmdr. John Huson explain the concept (page 119).

What can we expect of communications systems in outer space?

Recent test vehicles have brought back information about the conditions we can expect to encounter—communication-wise—in space. AAP Electronic Editor Henry Steier gives a run-down on the question in his article on page 121.

cover picture:

This recording optical tracking instrument is being used by the Air Force at Melbourne, Fla., for photographing the flight of missiles fired from Cape Canaveral. It is manufactured by Perkin-Elmer Corp., well-known for its work in this field. Working as part of the overall missile-test-data net, the Melbourne installation will be able to more accurately position missiles than methods previously in use. Controls on the telescope will be adjustable by use of a hand-control stick. The ROTI is complete with its own electronic and mechanical equipment, computers, dark room for film development, maintenance section and air-conditioning system. Automatic correction will be made for parallax and for the earth's curvature. The unit may be operated through remote-control by range personnel, and then operation will be transferred to the ROTI operators when the missile comes into sight.

departments

WASHINGTON IS WATCHING THE HANDWRITING ON THE WALL. Many small firms in the electronics industry are experiencing very rough water in the wake of defense cutbacks—*Sputnik* notwithstanding. The administration knows that it is in a jam. There is no question but that many markets for small electronic-specialty firms are drying up. The rise in future defense spending will not come in time to prevent considerable hardship. Aircraft companies, looking for their own business, are cutting the business that keeps many small contractors going.

NEARBY MARTIN CO. WOULD LIQUIDATE and go out of business if peace broke out tomorrow. This statement by Martin's president shows the basic problem now affecting subcontractors tied to companies like Martin. The statement by Martin's president was made in light of the company's total commitment to defense contracts.

THE PENTAGON IS PUSHING THE ICBM DEW LINE PROJECT now being planned by U.S. and Canada. Research studies are under way which will determine the feasibility of such a line. An American-loaned radar has been installed in Saskatchewan and the Pentagon is watching the results of research stemming from use of the radar. It has long been acknowledged that the present DEW line is inadequate for ICBMs.

THE NAVY DEPARTMENT IS IRONING BUGS OUT OF *POLARIS* with use of a new electronic computer capable of "flying" the missile while still on the drawing board. Known as PACE, the computer is being used by Lockheed engineers to eliminate unworkable designs.

DEFENSE DEPARTMENT IS DELUGING THE PRESS with news, any news, about recent rocket developments in the U.S. The latest is an electronic instrument that can analyze an instantaneous sequence of chemical reactions such as take place in the explosion of rocket fuels. Called a "time-of-flight mass spectrometer," the device is being produced by Bendix Aviation Corporation.

ARMY SIGNAL CORPS HAS GREATLY INCREASED RADAR POWER by development of an amplitron tube, which doubles the power efficiency of the magnetron tube presently being used in many radars. This is one of a series of recent steps that considerably boost the usefulness of our radar.

THE AIR FORCE HAS ESTABLISHED unusually high requirements for instrumentation cable, 11 miles of which is now being produced by Rome Cable Corp. for gauging performance of the *Titan* ICBM's rocket engine.

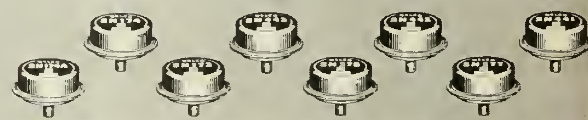
NAVY DEPARTMENT NOTIFIED its major contractors to sharply limit hiring of new employes, except those essential to replace key personnel. The Navy asked that hiring of other employes be cleared by BuAer first.

AIR FORCE'S AIR MATERIEL COMMAND has awarded a contract for "side looking" radar to Texas Instruments, Inc. The system presents a three-dimensional picture of terrain, and a continuous-strip photo is made from the radar scope.

MARTIN'S NEW ELECTRONIC COOLING SYSTEM has impressed Pentagon officials considerably. The system uses water to cool components. The new technique affords an essential constant temperature of components, even though the outside temperature climbs more than a hundred degrees.

DELCO'S FAMILY OF HIGH POWER TRANSISTORS

Typical Characteristics at 25°C



	DT100	** 2N174A	2N174	2N173	2N443	2N278	2N442	2N277	2N441
Maximum Collector Current	13	13	13	13	13	13	13	13	13 amps
Maximum Collector Voltage (Emitter Open)	100	80	80	60	60	50	50	40	40 volts
Saturation Voltage (13 amp.)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7 volts
Max. Square Wave Power Output at 400 ~ P-P*	400	310	310	225	225	180	180	135	135 watts
Max. Sine Wave Power Output at 400 ~ P-P*	180	140	140	100	100	80	80	60	60 watts
Power Dissipation (Stud Temperature 25°C)	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°	1.2°	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	-19	-19	-13	-24	-13	-24	-13	-27 ma

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Long-range Optics Track Missiles

Photographing a ballistic missile from the time of launch until it is over 100 miles down range is the task of an optical tracking instrument recently installed at Melbourne Beach, Fla. The instrument called ROTI *Mark* II (Recording Optical Tracking Instrument) will soon go into operation as a part of a guided missile data-collection station of the Air Force Missile Test Center tracking net.

ROTI *Mark* II will permit the Air Force to measure the position of a missile moving in space and time with a greater accuracy than has heretofore been possible. The ROTI series of instruments were designed, developed and are being built by the Perkin-Elmer Corp., a leading supplier of such systems. The *Mark* II unit will be used in conjunction with the firings of *Jupiter, Thor, Polaris, Atlas, Titan* long-range ballistic missiles.

The Melbourne Beach ROTI Data Collection Station will operate as an integral part of the Patrick range communication and tracking net. Information from radar and other communication nets will be fed into the station when a missile is fired. Computers at the station will convert this into information that will activate and adjust the ROTI. Corrections will be made automatically for parallax (difference in distance and line of sight from the radar to the station), and for the earth's curvature. ROTI will be focused automatically and will also make automatic corrections as the sky background changes.

The ROTI station can be operated by remote control or by range personnel employing "aided tracking." When operated by range personnel, the same information will be fed into the system. However, when the missile comes within sight, the operators will take over. With aided tracking, the operators need make only the simplest mental calculations and the slightest physical movements to follow the missile. The slightest hand pressure on a stiff-stick control will enable the operator to adjust the acceleration, velocity and position of the telescope.

The ROTI station is a complete, self-sufficient unit, with its own electronic and mechanical equipment, computers, dark room for developing film, maintenance section and air-conditioning system. The tower housing ROTI is very similar to that of an astronomical observatory.

Instruments Analyze Ion Flight Time

A new electronic instrument that can analyze an instantaneous sequence of chemical reactions, such as takes place in explosion of rocket fuels, is in production. The new device, called a "Time-of-Flight Mass Spectrometer," will have numerous applications in the science of missiles and rocketry.

It can complete a chemical analysis in one ten-thousandth of a second, operating on the principle of instantly identifying vaporized gases, liquids and solids (including metals) by revealing their respective molecular masses.

The heart of the new instrument is a four-foot metal vacuum tube that scientists call an "ion gun." Ionized molecules of the elements being analyzed are pulsed like radar signals from one end of the tube to the other and their speed, or "time of flight," is measured electronically and appears as a wave pattern, or spectrum, on an oscilloscope.

Components Reliability Plagues IRBMs, ICBMs

All the fundamental scientific problems for producing long-range ballistic missiles have been solved, Dr. Simon Ramo, executive vice president of the Ramo-Wooldridge Corp. recently announced. He said the major problem of most weapons systems which continues to plague the ballistic missile is the achievement of component reliability.

The approximately 300,000 separate components which go into a ballistic missile must undergo an extensive and intensive test program before a missile flight.

To illustrate the importance of the testing process in providing the exceptional reliability demanded by every part and mechanism of a ballistic missile, Dr. Ramo pointed out that each of the 300,000 components which go into an IRBM or ICBM is first tested individually. It is then fitted into a combination of 75 or 750 components.

Sapphires used for Infrared Detectors

Synthetic sapphires are playing an important role in the fast-growing field of infrared instrumentation. The unique characteristics of high-transmission properties at elevated temperatures—its strength and corrosion and abrasion resistance—make it an ideal infrared-system material.

As a heat sink, sapphire provides high electrical resistance and high thermal conductivity—both important qualities for fast, sensitive response.

As a window, sapphire is used in detector applications which require transmission of the visible spectrum with a cutoff of about 6.0 microns in the infrared band. In addition, sapphire is readily sealed to metals and ceramics, thus it can be made of any electronic assembly.

Synthetic sapphire is grown as a boule in a small oxy-hydrogen furnace in which aluminum oxide in power form is fed through the flame and the melted material collected in crystal form on a pedestal. Single crystal sapphire windows are fabricated from annealed white sapphire disk boules in diameters from one-half inch to five inches.

Sapphire components are being produced by the Linde Co. division of Union Carbide Corporation, New York, N. Y.

Cameras to Track Earth Satellites

The task of photographing a golf ball thrown from a plane at 60,000 feet is an apt description of the job assigned to the 12 satellite-tracking cameras that will be used to follow the U.S. satellite when it is launched sometime in the near future.

The three-ton, Schmidt-type wide-angle telescope cameras, designed for the Smithsonian Institution Astrophysical Observatory, will be located at 12 stations throughout the world. They are all on the orbit the satellite is expected to travel, and will be able to photograph the "moon" approximately once a week.

A master control unit containing a crystal controlled clock, a master Cathode ray tube calibrated in time increments and a direct numerical time readout unit will supply control information to the camera and its operators. Provisions have been made for slave tubes and a slave clock as may be required.

Talos Features Traffic-light System

The *Talos* surface-to-air missile features a "go, no-go" test system that tells when the weapon is ready for firing. *Talos* uses the automatic test equipment designed and built by the York, Pa. division of Bendix Aviation to determine whether all of its systems are operating properly before it is launched.

The results are recorded by lights, indicating which components have passed, or failed. A master light on the system called *Talos* Tactical Test Equipment (TATTE), will give the go-

ahead, once all components have passed inspection. This automated test equipment reduces the technical training requirements of military personnel assigned to the missile.

Talos was the first missile to employ a dual guidance system, resulting in precise accuracy at both short and long ranges. In addition, the *Talos* development program also pioneered the introduction of atomic warheads into antiaircraft missiles. *Talos* is approximately 20 feet long, and 30 inches in diameter. It weighs about 3000 pounds. The missile is accelerated to supersonic flight by a solid-fuel booster rocket about 10 feet long. The booster rocket is jettisoned when the missile reaches cruising speed.

Guidance Plant Eliminates Vibration

The world's most vibration-proof slant for the development of missile inertial guidance systems has opened in St. Petersburg, Florida. It has been so thoroughly shockproofed—through unusual scientific and construction techniques—that vibrations so small they would barely "tickle a fly's foot" can be measured inside its antiseptically clean testing laboratories.

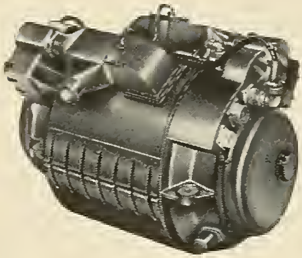
The $4.5-million structure was erected by Minneapolis-Honeywell Regulator Co. to develop the most advanced type of inertial guidance systems yet devised for missiles and rockets. Inertial guidance is a navigational concept that permits automatic guidance—of intercontinental ballistic missiles, for example—without reference to radar, radio beam guidance, star tracking or human pilot.

Exide Creates Missile Department

Exide Industrial Division of the Electric Storage Battery Co., Philadelphia, Pa., has created a new department to concentrate special company efforts in the rapidly growing guided missile field.

Called the missile applications department, the new unit will handle all phases of development, engineering, manufacturing and sales of missile batteries.

Heretofore, most of Exide's activities in the missile battery field were handled through regular departments. Effect of the reorganization is to merge all such activities into the one new department under the administrative direction of General Manager M. G. Smith.



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astrionics

by Henry P. Steier

INTEREST IN GRAVITY PHENOMENA AND THEORIES IS GROWING. At the annual Gravity Day meeting of Gravity Research Foundation, New Boston, N. H., George M. Rideout, president, reported an attendance growth from 22 in 1949 to 178 in 1957. He pointed out that discussion of these matters "had become respectable and was no longer the basis of facetious comments." Included among attendees was Igor Sikorsky of Sikorsky Aircraft Division, United Aircraft.

AN INTERESTING EXPERIMENT was described during Gravity Day by Joel E. Fisher. He rotated two 15-inch disks, separated about four inches, at 2500 rpm while 60 alnico magnets were mounted between the disks. Magnets were parallel to the shaft supporting the disks and poles were in direction of the shafts. Rotation caused a gravimeter placed two and one-half feet above the rotor to show an increased reading of five milligals (0.005 cm/sec^2) of the normal acceleration of gravity.

Explanation of the effect is difficult, says the Foundation, and cannot be attributed to eddy currents. An iron manhole cover between the rotor and gravimeter produced no change in the gravity reading. Needed condition for producing the effect was surrounding the rotor with a massive nonmagnetic material. In this case it was a pit formed by two tons of cement blocks and slate slabs. Anyone have an idea?

SECOND WORLD CONFERENCE ON GRAVITATION was held this year. According to Agnew H. Bahnson, Jr., president of the Institute of Field Physics, physicists, mathematicians and astronomers in attendance discussed the problem of the quantization of the theory of relativity. This, they decided, at present seems the best approach to an understanding of gravity.

NEAR INSTANTANEOUS ANALYSIS of chemical reactions can be made with a new time-of-flight mass spectrometer produced by the Cincinnati division of Bendix Aviation Corp. Analysis of such reactions as rocket fuel combustion, high-temperature instability of nose cones, etc., can be made in 1/10,000th second. Device uses a four-foot vacuum tube called an "ion gun." Molecules of elements under test are pulsed like radar signals from end to end of the tube, and time of flight is measured and appears as a wave pattern on a cathode ray tube. Miniature versions are expected to be used in missiles and satellites to examine composition of "space."

IMPROVEMENT IN THE RANGE OF RADAR, communications equipment and other electromagnetic devices by "three times" is said to be possible through a breakthrough in the technology of noise-free amplification. The new device which permits this long-sought goal is called a VERSITRON by Electronics Division of Advance Industries, Inc., which produced it.

AIR FORCE SAYS ADVANCES in powerplant technology and aerodynamics has completely outstripped advances in the electronics field. Col. J. S. Lambert, ARDC, told the IRE Electronic Devices meeting in Washington, D. C., that in the matter of high-temperature problems with electronics, available materials and techniques have been exhausted. He said our electronics designs are predicated upon available and understood techniques rather than limitations of materials or basic physical laws. What is needed are new materials research, new techniques and new design concepts.

ATTITUDE OF THE AF toward future high-temperature transistors is that they will not be available in the near future and electron tubes must be used. Despite good success with gallium arsenide, indium phosphate and silicon carbide materials for semiconductors, it appears ceramic-metal electron tubes will be the best high-temperature devices available for some time.

TERRIER electronic reliability

Reliability-orientation major contributor to missile electronics reliability

by Russell R. Yost, Jr. and Fred Dreste

Motorola, Inc.

RELIABILITY must be designed into electronic equipment; it cannot be implanted by test and inspection, though it can be maintained by them. The early dollars invested in a reliability program are most wisely spent to originate and enforce certain disciplines in design thinking.

Several years ago Motorola, Inc. contracted to re-engineer an electronic control system employed in the Navy's *Terrier* surface-to-air missile. The redesign was aimed at higher reliability and simpler producibility.

Both aims were met. During flights of design-approval models at the Naval Ordnance Test Station, China Lake, Calif., no failure has ever been attributed to the control system. Significant reductions of factory and field checkout time have been achieved. In addition, during a two-year production run only a few—and quite minor—electrical design changes have been made.

The disciplines that paid off in the *Terrier* project can be told simply. Taken singly, they seem unremarkable. Together, they are powerful and comparatively inexpensive in channeling design effort to an impressive reward. Not as much time nor money could go into these as a reliability engineer might wish. In particular, there was no ambitious program to learn precise quantitative reliability (though estimates were kept current), nor radical departures from conventional design in pursuit of reliability. Perfection in missile controls is still so far away that reliability effort is more profitable when spent in attending to the simple tasks to be described than when given over to exact measurements.

Reliability Disciplines

A reliability coordinator was appointed at project inception, reporting directly to the project leader. He was given an engineering staff whose only concern was reliability.

The coordinator made preliminary appraisals of all components in the categories from which large component totals were expected to be drawn. These categories—tubes, diodes, resistors, capacitors, transformers and several others—are the major factors in electronic equipment failures, not because the components in themselves are peculiarly weak, but because they constitute nearly all of the component equipment. It is vital, in these categories particularly, to choose the soundest components sold.

An appraisal was made based on past Motorola experience, other manufacturers' experience and an evaluation of the vendor's engineering ability, production facilities and quality control measures—and finally on the vendor's published ratings and data.

The coordinator then published a preliminary list of components recommended to designers for most applications. These components were used in breadboards (the information gained being worth the expense), as well as in engineering and development models. An entry in the list was accompanied by Motorola-assigned tolerances and deratings, related to expected environments and to wanted component reliability.

The tolerance assigned to each component was stated separately for factory and flight conditions. Moreover, each tolerance included two values, the first expressing a nonrandom shift of the mean of the distribution, and the second the random scatter effects. (In combining such tolerances, the first values are added algebraically while the second values are added in a statistical manner.)

Finally, two such tolerance pairs, one combining all positive nonrandom shifts resulting from likely simultaneous environments, and one combining all such negative shifts, were established.

Life tests were begun for all commonly applied components in the preliminary list and for certain special components foreseen as essential to the system but expected to be unreliable. Some life tests were run with components subjected only to the initially recommended loadings, and to an environment duplicating that expected as a rule in the missile for components of that category. It bears emphasis that a component environment was estimated as it would be related to the component. It was not assumed simply as the environment which, by specification, the whole missile control had to withstand.

Even when a component's environment was duplicated in tests, however, tests at normal loadings would in some components have produced too few failures to let component mean lifetimes be calculated with worthwhile accuracy. In these categories the only meaningful test possible was a "torture" comparison of similar components from various vendors. Most damaging elements of their environment—temperature extremes, vibration and shock or humidity—were exaggerated to hasten failures.

It was not generally possible from torture test data to say what a component's mean lifetime would be at normal load and in the actually expected environment. However, torture tests were considered at least to isolate for use the strongest components sold, and so to be the best use of available test time.

Component tests led to some changes in the list of recommendations and so to some discarding of stock purchased from the initial list. Made early enough, discards are a small entry in the whole price of reliability.

In addition to circulating application data to all designers, the coordinator himself reviewed all component applications in developmental circuits.

Failures Analyzed

Every component failure, in either an experimental or developmental circuit, was promptly reported to the coordinator, with the circumstances and the direct evidence of failure described. Analyzing failure reports, and where possible deducing underlying failure causes, the coordinator was impelled in some cases to change component recommendations, in others to suggest alternative circuitry or, least often, to correct suspected misapplications.

The coordinator monitored (and his approval was required on) all drawings and specifications for purchased components.

Component specifications should include tests of three types: (1) initial qualification tests, which demonstrate whether or not the component design can meet requirements, (2) acceptance tests, which briefly check each received component or (by sampling) each lot of components for freedom from gross defects, and (3) quality reassurance tests, which amount to requalification tests, and aim to expose design weaknesses which have escaped the initial qualification test because samples were statistically too few, or because of slight changes in component design.

Component specifications should include all requirements imposed by the overall system requirements even when some seem farfetched at the component level or when tests to verify compliance with them seem impossible or hopelessly expensive. When a vendor objects, the requirements can be waived if they must be, but stating them at the outset firmly impresses the vendor with the designer's problems.

Much time spent communicating with the vendor by means apart from the specification can be saved by a shorter time spent in writing a more detailed specification in the beginning.

Responsibility for specifications should be vested in a specific individual or small group, rather than scattered among design engineers.

The coordinator educated the design task leaders in rules for tolerance calculations, both to furnish them with a valuable tool and to encourage reliability consciousness in design decisions. These rules are too complex to describe in detail here, but they were based on statistics and enabled the designers to calculate system flight-performance capabilities with 99.7 per cent probability as well as similar factory-performance capabilities.

The reliability of a circuit is usually the product of the individual reliabilities of all circuit components. As components are operated more conservatively, their individual reliabilities increase, but the required component total tends to grow too, increasing the number of factors in the circuit reliability product. Bearing this in mind, circuit designers sought maximum circuit-reliability compromises between the opposed objectives of conservative component operation and a low component count.

At the start of a design it is difficult to say how an electrical tolerance placed on a whole assembly should be subdivided among the constituent subassemblies, or that of a subassembly among its components, etc. A useful rule of thumb was found to be the initial assignment of one-tenth of the overall tolerance to each "piece" of a design.

Circuits were sought which did not depend on accidental characteristics of nonlinear components, or on component characteristics not controlled by the specification for the component. For example, circuits were chosen that controlled the direct current through tubes, rather than the dc voltages applied, since tube transconductance is more stable at a specific current than at a specific applied voltage.

In a few instances a circuit was adopted, seemingly the least unsatisfactory among limited alternatives, the function of which was suspected of depending to some degree on an uncontrolled component characteristic. In these circuits special effort was made to accommodate the widest possible latitude of the characteristic in question. For example, a needed system gain control was located where it automatically compensated for the lot-to-lot variations of such a parameter.

Automatic Gain Control

Circuit functions were made independent of as many electrical factors as possible. For example, a fast-acting automatic gain control (AGC) arrangement was used both for the familiar purpose of making carrier-signal rectified output nearly independent of received signal level and to abstract a low percentage amplitude modulation from the carrier signal.

Early designs provided only one AGC loop. Unfortunately, a change of received signal level, though followed by a gain change that preserved the original carrier output, altered the amplitude of the abstracted modulation voltage on which system control sensitivity depended. An improved design provided separate AGC feedback paths for carrier and modulation frequencies, rendering control sensitivity independent of received signal level.

Adjustments and trim points were kept to a minimum. These features frequently reflect avoidable design imperfections. Components generally used as trimmers incline to be mechanically weak and to suffer wide electrical value drifts with aging.

All circuits were tested individually and early in simulations of their expected operating environments. Humidity effects were especially borne in mind. Breadboarded circuits were checked for humidity tolerance by subjection to steam and by temporary connection of shunt resistances similar in value to leakage resistances foreseen in printed circuits.

Tube application information was treated seriously. Control-grid biases were kept more negative than −1 volt. Operation at very low plate currents was avoided. Heater-to-cathode resistances were assumed no higher than 0.1 megohm. Electrode dissipations were kept within normal test-condition levels rather than within maximum ratings. Tube mountings were devised that kept envelope temperatures far below those specified in vendor's test conditions. Circuit designs allowed realistically for variation of tube parameters with heater voltage variations.

No major reliance was placed on tests using limit-value tubes, since these were long-delivery items when available at all. Rather, consultations were held with tube vendor applications engineers to learn the statistical probabilities of various departures from nominal tube-characteristic values, and then theoretical calculations and simulation of tube variations were relied on to show whether circuits would function with tubes exhibiting the expected statistical variations.

Wherever possible, circuits were operated at the highest signal levels allowed by component rating to enhance signal-to-noise ratios (noise here including dc drift, microphonics and hum, together with the commoner tube noises).

Moderate negative feedback was used often, with loop gains of 10 or 20 as a compromise between the benefits of feedback and an excessive component count.

Much attention was given to connectors and harnesses. Connectors were used that provided multiple spring-loaded current-carrying bearing points in each individual female contact. Also, connectors were chosen that included rugged shells to forestall pin and insulator damage on rough handling. Wires emerging from connectors were sealed to the shells with a rubber potting compound; flexure of cables leading to connectors was rigidly limited. All female contacts in connectors were individually checked at the vendor's factory by a pull test using a standard male pin. Wire harnesses assembled to connectors were tested for high-voltage breakdown and for continuity by an automatic tester.

Space restrictions prohibited the use of point-support vibration isolators, and so low "Mechanical Q's" (vibration amplification factors) were imperative in all packages. Structures were made stiff with high natural resonant frequencies, experience until then having shown that this was the most practical way to realize low Q's. It should be said that more recent techniques incline rather toward the use of "lump" structures with layers of dissipative materials sandwiched into the structures to absorb vibratory energy.

The system's packages were to be mounted on a T-beam in the missile. An early mockup of this beam, loaded with dummy packages, disclosed a fundamental beam resonance at about 120 cps. Package internal resonances accordingly were kept well above 200 cps to avoid any risk that they might coincide with the beam resonance.

Much thought was given to heat flow. The primary problem was cooling during test, where the outside skin of the missile control served as the heat sink. The high temperature reached by the skin during flight was not of concern because the flight duration was small compared to the thermal time constant of the control.

Because of mechanical design requirements, metal heat-conducting paths to the outside skin were not possible. Instead, heat was transferred metallically from hot components (such as tube envelopes) to larger surfaces such as chassis or tube blocks, and normal air convection was then relied on to transfer heat from these "couplers" to the outside skin.

An early model of the control system that accurately represented the final model in heat transfer characteristics (but which included only preliminary circuitry) was built in order to evaluate the design. Thermocouples were embedded in first-sample potted assemblies ordered from vendors for use in this model. Tests showed that during the specified test cycle, the maximum temperature rise above outside ambient was only 45°C; many areas exhibited only a 35° rise.

Work to gain immunity to high humidity centered chiefly on improvements to printed circuit boards. Numbers of board materials and coatings were investigated, and conductor spacing was standardized at .062 inch. Even after an optimum selection of materials, however, electrical designers were obliged to observe certain restrictions rarely met in other wiring. Among others, circuit impedances exceeding 0.5 megohm required special approval; guard circuits were required in many instances.

Establishment of a design does not end the reliability tasks. As engineering models are built, all designers responsible must perform or witness the evaluation tests, particularly environmental tests, analyze failures and make design corrections. Complete reporting and exhaustive analysis of all failures is the duty of the designers. The insight gained must "feed back" and culminate in design refinements for as long as the schedule permits.

Certain factory tolerances on parameters of subassemblies, assemblies or whole systems, are not predictable from component tolerances in any simple way. They must be assigned after direct measurements of the parameters of a number of subassemblies, etc., normally in late-engineering model systems when these and production models are expected to be nearly identical. (The route from measurements to tolerances is not recited here.) These assignments are of interest both to the reliability coordinator and to the quality control department.

Quality control must be arrived at or be furnished with tolerances early in a first production run in order to monitor manufacturing processes. The reliability coordinator and all designers of a system are concerned because the agreement of tolerances finally set is some measure of the perfection of a design. This process, in the case at hand, was notably successful. Of the hundreds of such tolerances most were set on the basis of 15 design-approval models, and less than 2 per cent were changed during the following pilot and production runs.

Sufficient Data

Sufficient data to establish the exact flight reliability of a missile control is not readily available and does not yet exist for the *Terrier* control. (However, as mentioned earlier, no reliability failures have been noted in design-approval flight tests.)

The emphasis placed on reliability at every phase of the re-engineering of the *Terrier* guidance control system has resulted in a marked improvement of system producibility and tactical effectiveness. The engineers "lived" reliability on this project, acknowledging its importance in the selection and application of components, in the choice of circuit designs, in the mechanical design approach and in the production support effort. The techniques were simple but required constant emphasis. The application of statistics to electronic design was new to most of the engineers when they started but became second nature before they were through.★

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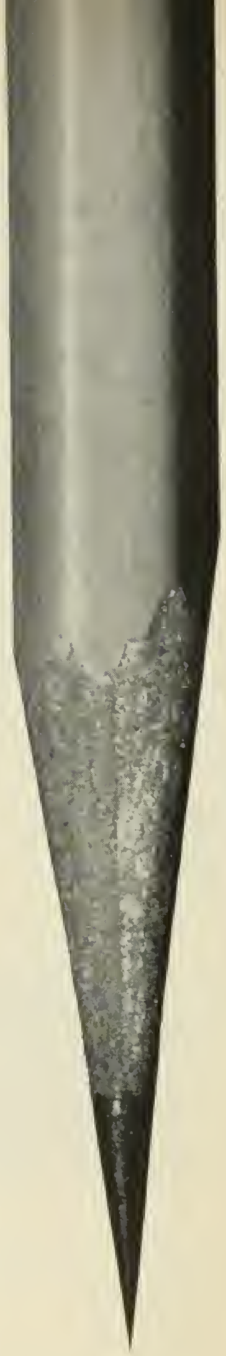


training potentialities of synthetic missiles

Missile management is recognizing the need for training priority and budgetary support

by J. Gordon Vaeth and
Lt. Cmdr. John Huson, USNR
U.S. Naval Training Device Center

MISSILEMEN in both government and industry increasingly are recognizing the importance of training to the effectiveness of weapons now in development or production.

Regardless of the development and refinement which go into it, a missile is still at the mercy of the men who handle, assemble, checkout, "troubleshoot," fuel, fire and, perhaps, control it. As such, its reliability and performance are subject to human failings and errors.

And whereas ordnance personnel mistakes with weapons of pre-atomic days might have been destructive and tragic, when made with nuclear arms they can be globally catastrophic.

A new concept in missile engineering—a concept intended to reduce or eliminate training degradation of costly and short-supply missiles—has recently been advanced by training specialists of the U.S. Naval Training Device Center, Port Washington, N. Y. It emphasizes maximum and, if possible, total use of synthetic equipment.

Industry is beginning to see training as a critical, yet often overlooked, factor which is essential if a stockpiled missile is to become a live and effective weapon of defense or offense. Missile management is aware that training requirements must form an integral part of any weapon system, if that system is to be complete or effective; long-range planners are giving training considerations priority attention and budgetary support as never before.

Yet even when training problems are correctly anticipated, the solutions are usually stereotyped. The usual procedure is to establish a service school for instruction on the weapons and to divert a number of operational missiles from the production line to be used for this purpose.

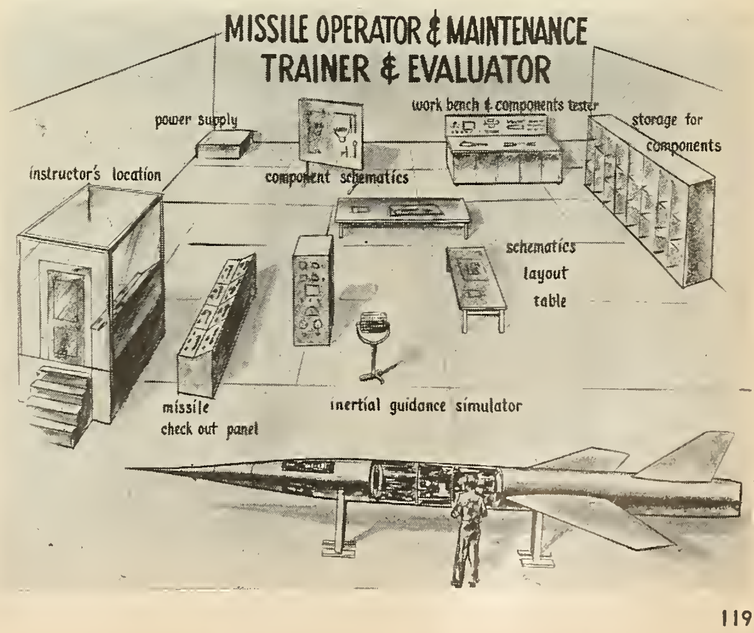
Operational missiles, however, are not designed, engineered or intended to undergo continual classroom disassembly and reassembly by inexperienced trainees. As a result components soon wear out. The missile is rapidly degraded until finally it has to be scrapped or completely overhauled at a cost approximating the price tag of a new missile itself.

Experience has shown that complex operational missiles are good for about three months of classroom usage; then they must be replaced. Experience has also proven that long before the missile reaches the "replace" stage, it is heavily subject to "down time" which can seriously disrupt orderly scheduling of classes and efficient instruction.

Formal school training with operational missiles suffers from still another disadvantage. Using production-line hardware, it is difficult for instructors to illustrate any variety of controlled malfunctions. Since the best way to evaluate a missileman's competence is to give him a number of different type troubles and check his ability to detect, isolate and remedy them, this means that technical training on operational equipment is, without considerable modification of that equipment, only partly adequate at best.

The concept evolved by the Office of Naval Research's NAVTRADEVCEN seeks to overcome these difficulties. It proposes to do so by substituting synthetic equipment for operational gear wherever possible.

Cornerstone of this new concept is a full-size dummy missile. Every component of the operational bird vis-



ible or accessible to maintenance men or to firing crew members is reproduced to exact size and appearance. Access hatches and check points are realistically duplicated. The dummy is a detailed "live" mockup.

Systems and components which launching, operator or maintenance personnel have to check, adjust, repair or replace on the actual missile, are synthetically activated by simulation techniques. The black boxes are all there, their inputs and outputs reading the same on the missile test equipment as if they were operating in the genuine weapon itself. Yet the boxes are dummies, activated to give correct responses by straight electrical, rather than electronic, simulation means.

The dummy, with its synthetically "live" components, is connected to the appropriate missile checkout or fire-control panels. These, too, are synthetic and duplicates of the actual panels in every external or visible detail. They provide the correct light and meter indications as dictated by the "condition" of the dummy missile. This "condition" is controlled by an instructor who can introduce from his console a variety and number of typical malfunctions. He must determine how quickly and accurately the trainees can spot and repair the troubles. If component replacement is required the dummy offers the same difficulty of access as does the real missile. The time it takes for the malfunction to be remedied and the actions taken by the trainees are automatically recorded for post-exercise critiques.

The national economy cannot long endure the wholesale degrading, wearing out and expending of costly, complex missiles for strictly routine training purposes. Less costly ways must be found, although it is recognized that a certain number of proficiency or "confidence" firings will always be required.

New simulation techniques and synthetic equipment can provide these ways. Missile fire-control radars can be activated and moving targets synthetically generated on their scopes. And by using the latest in the simulation engineer's bag of tricks, the missile itself can now be synthesized—for formal technical training, for the exercising of firing crews, and for evaluating the readiness and ability of Army, Navy, Marine Corps, and Air Force unts to checkout, troubleshoot, and launch the missiles which industry is placing at their disposal.★

(Opinions and assertions are those of the authors and are not to be construed as official or as reflecting the views of the Navy Department or the naval establishment at large.)

space communications tested with X-17

By Henry P. Steier

COMMUNICATIONS between space ships or missiles and earth probably will not pose too much difficulty once they are free of the earth's atmosphere. It is in the region between sea level and a few hundred miles altitude, which contains gases, that radio transmission difficulties occur.

These transmission problems are associated with aerodynamic heating. The shock wave that exists around the nose cone of a hypersonic missile causes intense heating of the air round it.

Between the shock wave and the missile surface is a shock layer in which "aeromolecular" effects occur. These are induced by the high temperature. Among these effects is production of free electrons. This causes communication interference.

Very little has been revealed about findings thus far collected on radio transmissions from hypersonic missile tests. Probably some of the most significant information about the problem has been collected by Lockheed Aircraft Corp.'s Missile Systems Division.

About a dozen flights were made by Lockheed's X-17 re-entry test vehicle. Much information about what happens to radio signals in flights from sea level to about 100 miles altitude is believed to have been collected.

The radio information was, of course, relative to re-entry phenomena in connection with nose-cone research. However, some of the vehicles were fired specifically to develop telemetry systems suitable for the X-17 flight environment.

Tight Military Security

Some time ago, Lockheed engineer N. Turveen admitted (m/r, April 1957) his company had experienced "a peculiar phenomena observed in the variation of radio frequency field strength under X-17 flight conditions."

Beyond that, he said, military security was tight-lipped on exactly what happened. However, the company is continuing its studies in this problem area, as evidenced by recent announcement of a Lockheed Space Communications Laboratory.

The new facilitiy located at Sunnyvale, Calif., is a three-story, 10,000-sq.-ft. building in which space conditions as they exist hundreds of miles above the earth can be re-created.

According to the company, antenna design and installation for the Navy's *Polaris* ballistic missile are among the projects being studied in the new laboratory.

In a recent report on missile aerophysics phenomena of electronic import, Lockheed engineer Daniel Bershader discussed some of the features of environment surrounding missile-type vehicles in hypersonic flight.

On a theoretical basis, Bershader said, effect of ionization of the compressed and sheared air of a boundary layer around a vehicle on transmission of microwaves can only be calculated approximately.

The boundary layer is an area around a missile which exhibits a velocity profile of air extending from zero to near-free-stream value of air around a vehicle. Air is brought to rest by impact with a nose cone. The kinetic energy is transferred to thermal energy.

At Mach 22, at 150,000 feet altitude, the temperature created would be 13,000°F. From the highest boundary-layer temperature point on the nose cone to points along the afterbody of a missile, the temperature profile changes.

At about 2,200°F, which corresponds to a stagnation, (or zero air molecule velocity condition) for Mach 6, energy balances in gases composing air come into play. Near Mach 10 oxygen disassociates. Chemical reactions occur. Nitric oxide is among the formations produced.

Disassociation of nitrogen starts at about 10,000°F, corresponding to a stagnation temperature for Mach 17, and at this point ionization becomes significant.

Heat and Light Produced

At the higher Mach numbers much of the energy released goes into atomic-molecular processes. These are dynamic and accompanied by recombination and de-excitation phenomena. Heat and light are produced. This occurs at certain rates depending upon boundary-layer temperature profiles. The reactions, however, require time, since there is a mean-free-time between particle collisions in a gas.

Meanwhile, the surface layer of a hypersonic vehicle is inhabited by free charges of ions and electrons. It is these, Bershader said, that one would expect to effect the radiation pattern of a transmitting antenna on a vehicle body. Also, the impedance match between antenna and atmosphere would be affected by the local environment.

In considering theoretical solutions to this problem, the parameters would be electron concentration distribution, which controls the attenuating path length; frequency of transmitter, reflection and refraction, and electron collision frequency.

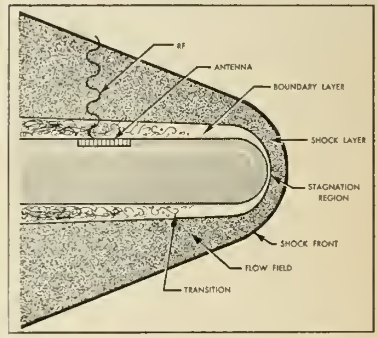


Diagram showing complex environment around a blunt-nosed vehicle at hypersonic speed. Transmission of RF energy through boundary-layer region of atomic-molecular process activity poses frequency dependent problems.

The relationship between transmission frequency and the effect depends upon the "plasma" frequency, which in turn is a functon of electronic charge and mass.

Although the determination of attenuation factor can be approached mathematically, much more information is needed on what goes on in a hypersonic vehicle's surface layer. It is known that at velocities of about 20,000 ft./sec., ionization of sheared and compressed air of the boundary layer yields a conductivity equivalent to that of fused sodium chloride, Bershader said.

The loss of radio energy in db per inch is directly proportional to a complex propagation constant for wave passage through the ionized medium.

To minimize the attenuation, it was noted, it is necessary to make the transmitting frequency "appreciably larger than the characteristic plasma frequency of the boundary layer."

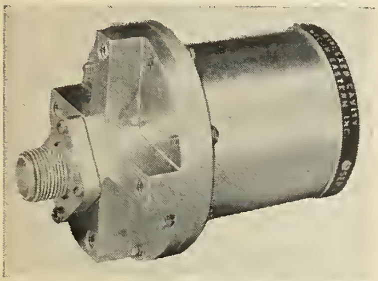
Recently it has been reported that attempts are being made to use ionization trails from aircraft and missiles as low-frequency antennas. In this case high electrical conductivity of the ionized paths is used for coupling. ★

NEW MISSILE PRODUCTS

TELEMETERING DIPLEXER

Hycon Eastern, Inc. has introduced a high-power telemetering diplexer, type 1231. The instrument feeds signals from 2- to 100-watt transmitters into a single antenna system and is designed to satisfy military requirements for use in test missiles and telemetering.

Environmental specifications are: shock to 100 g, vibration to 200 g at 2000 cycles, temperature —70°F to 350°F. Units made of Invar may be provided at extra cost for use up to 500°F.



Other specifications include frequency range: fixed-tuned between 215 to 250 mc/s; isolation: 28 db with 10-mc separation, 25 db with 6-mc separation; attenuation: less than 0.3 db; power-handling capacity: rated at 100 watts cw, size: each cavity approximately 3"x4"; weight of total system: 3.7 lbs, pressurization: diplexer cavities are filled with dry air and permanently sealed.

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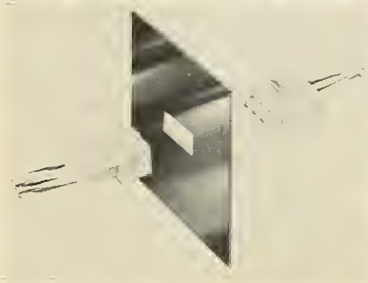
EPOXY COMPOUND

An epoxy compound has been developed by Minneapolis-Honeywell for potting transformers. The compound featuring a patented hardener, is a low-coefficient-of-expansion material exhibiting unusually high electrical resistance at temperatures up to 350°F.

Circle No. 216 on Subscriber Service Card.

MULTIPLE CONNECTOR

Amp, Inc. is producing a new type of self-anchoring through-panel multiple connector that eliminates the necessity for supplementary mounting devices. The product is polarized to eliminate circuit error, and the contacts with the mountable and disconnect units are identical, self-cleaning, and recessed for safety. The connector may be used for free-hanging, multiple connecting of circuits, as well as for through-panel mounting.



Circle No. 203 on Subscriber Service Card.

SOLID STATE BATTERY

The Patterson, Moos Division of Universal Winding Co. has developed a miniature, high voltage, solid-state battery that is capable of delivering high current drains for long periods of time.

Called the "Dynox 95," the first model of the new battery is 1¼" long, ⅜" in diameter, and has a potential of 95 volts in 0.14 cubic inch. It can supply a steady current of 1×10^{-9} amperes for 176,000 hours at 70°F with only a 10% voltage drop, or a flash current of 20 microamperes. It can be stored for 20 years without losing its power. Other characteristics include resistance to extreme shock or vibration, performance at extreme temperature ranges, including the ability to operate after temperature cycling between —100 and 170°F.

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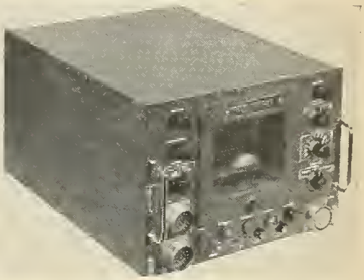
MONITORSCOPE



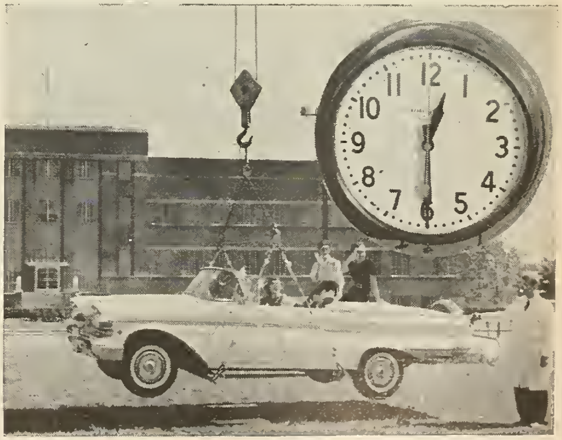
Applied Science Corporation of Princeton has developed an electronic tool enabling engineers to test 86 test point variables at a glance. The instrument may be used for flight instrumentation, production-line testing and for monitoring. Test data can be observed as a varying line display on an oscilloscope screen, while individual data samples are presented in bar-graph form. The device is available for field or laboratory use.

Circle No. 200 on Subscriber Service Card.

PORTABLE POTENTIOMETER

A new type portable potentiometer featuring interchangeable scales, and automatic compensation has been introduced by Technique Associates, Inc.

ADHESIVE LIFTS 5000 POUNDS AFTER 30-MINUTE SET



Eastman Chemical Products, Inc. has developed a new adhesive with rapid-set characteristics and capable of bonding a wide range of materials. Designated Eastman 910, the new material is shown supporting over 5000 lbs. after one drop of it was placed between two pieces of steel rod 30 minutes previously. The adhesive requires no heat, pressure, evaporation of solvent, or long curing time. It bonds wood, metals, glass, ceramics, rubber, plastics, porcelain and other materials. Eastman 910 has proven valuable in joining small intricate assemblies and is in limited production at the company's laboratory.

Interchangeable scales permit measurements of a wider range of temperatures and voltages.

Known as the Thermotest-I, the instrument is an all-purpose testing device for making highly accurate temperature measurements from −200°F up to 600°F. Ordinary thermocouples are used. The instrument will also measure voltages from zero up to 21 millivolts. Scales which are calibrated in degrees centrigrade are also available.

Circle No. 208 on Subscriber Service Card.

RADAR INTERFERENCE BLANKER

A radar interference blanker, Model RB-128, which eliminates "main bang" interference in a group of normal and MTI radar sets, or reduces it to a negligible value, has been developed by Empire Devices Products Corp.

In operation, the interfering signal is bracketed with a negative blanking gate to eliminate it from the protected radar's display. Since the PRR of the protected radar and that of the interfering radar are usually not synchronized, any loss

of displayed information is unimportant.

The RB-128 blanker system is self-contained; no additional transmitters, receivers, telephone lines or coaxial cables are required, irrespective of the number of interfering radars. Distance from the offended radar is not a factor, so interference from shipboard or airborne radars is also eliminated.

The blanker may be added to existing radar installations without appreciable modification of operating equipment. The use of instantaneous automatic gain control circuits and very low time constants in grid circuits reduces the guard-band receiver's susceptibility to jamming well below that of the radar being protected.

Circle No. 215 on Subscriber Service Card.

HELIUM DEWAR

Information is now available on design of Hofman Laboratory's new solenoid dewar flask for the study of the effects of magnetic fields on various properties of solids at liquid helium temperatures in the laboratory.

Circle No. 217 on Subscriber Service Card.

ACTUATOR MOTOR

Viking Tool and Machine Corp. has developed an actuator motor featuring high starting-torque that is suited for remote control switching, homing devices, valve operation and other applications. It operates at temperatures up to 500°F at 60 cycles ac, or 400 cycles ac as well as pulsating dc.

The motor is basically a compact, lightweight ac rotary solenoid with a vibrating rate of 120 cycles/second when operated on 60 cycle ac. This rapid vibratory motion is translated into rotary stepping motion through a fast-acting one-way clutch.

The company says the device features higher torque for its size and input power than normal solenoids since it is always vibrating within the most efficient portion of a solenoid's stroke and does not have a relatively low torque initial pull-in. The device operates at moderate speed and at either 60 cycles or 400 cycles will operate at free speeds of less than 300 rpm.

Circle No. 209 on Subscriber Service Card.

CRYOGENIC PUMP

Sundstrand-Denver has developed a compact, lightweight, piston-type pump suitable for pumping liquefied gases such as nitrogen and oxygen. The pump has the capability of pumping liquid nitrogen at pressures of over 3000 psi at speeds of over 3500 rpm. Sustained operating periods of over one hour have been obtained repeatedly without any form of lubrication. The performance data for the pump are: capacity @3500 rpm, 1.75 gpm; horsepower @3500 rpm, 3.8 hp; weight 2.5 lbs.

The pump has nine axial pistons and is of the fixed displacement type. Metal parts have been selected to be compatible with liquid nitrogen. Minor material changes can be incorporated to permit satisfactory operation using liquid oxygen. Since this pump is a modification of a standard Sundstrand hydraulic motor, larger capacity pumps can be provided with relatively little development.

Circle No. 210 on Subscriber Service Card.

IGNITOR DEVICE

Electronic Specialty Co. has introduced a new product to check the ignition and squib circuits in guided missiles and rockets. Designed to be more effective than previous methods of testing these circuits, the device takes the current for the normal time and then breaks the circuit just as an ignitor or squib would. The unit can be used for thousands of test firings.

An additional feature is the indicator arrangement. A small translucent button pops out to show that the firing circuit has operated. A mechanical reset makes the device ready for the next test immediately after firing with no part replacement. The device is available in a variety of maximum current ratings and operating time characteristics. Because of the nature of simulation and test devices, the units are produced to customer requirements.

Circle No. 204 on Subscriber Service Card.

PITCH-YAW INDICATOR

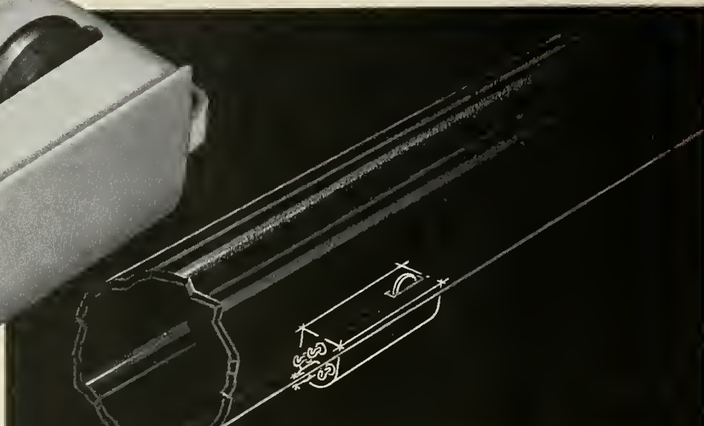
Edcliff Instruments now has its Pitch-Yaw Indicator in full production. The free-swiveling aerodynamic head provides potentiometer output linear with angles of pitch and yaw.

High-temperature components used throughout the instrument permit operation at high Mach numbers. The Model 4-1 is available in ranges up to 27½°, with an indicating accuracy of 0.1°. Overall length is 4".

Metering is provided by two precision wire-wound potentiometers with single-wire function taps. Static or total head probes are available, either singly or combined.

Circle No. 205 on Subscriber Service Card.

new ROCKET SAFETY SWITCH



Sketch shows typical switch and rocket tube application. Rocket switch controls various indicator, sequence and other electrical circuits. Several models now in production. Send us your design requirements.

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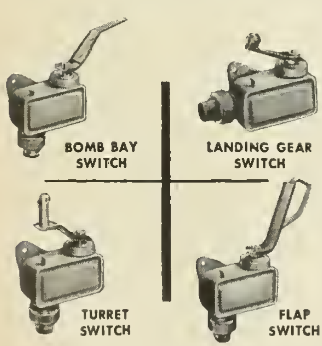
of HERMETICALLY SEALED LIMIT SWITCHES



Electro-Snap bas developed a complete line of hermetically sealed limit switcbes to bring the ultimate in environment-free switcbing to aircraft control circuits. With a record of dependability totaling millions of hours, Electro-Snap Hermetically-Sealed Switches have heen used as original equipment hy major aircraft producers—on standard and experimental aircraft for botb commercial and military use. They are also being widely used for retro-fitting, to modernize existing control circuits for the more exacting demands imposed on today's aircraft. If aircraft switching is your responsibility, you sbould know about this modern line of switches for modern aircraft. Write for specifications.

To meet modern aircraft requirements, Electro-Snap has developed and perfected this, the first truly hermetically sealed rocket switch. Because both the basic switch and the operating mechanism are sealed in an inert gas, the switch is unaffected by extreme heat, or cold, humidity, water, oil or temperature cycling. Tipping action of the actuator prevents jamming by ice. Completely environment-free, the dependability of the switch and its operating action have been thoroughly proved on today's newest fighter aircraft.

IMPORTANT CHARACTERISTICS

Contact Arrangement................SPDT, 1 circuit

Capacity........4 amps. resistive, 2.5 amps. inductive at 30v DC.

Electrical and Mechanical Life................150,000 operations min.

Vibration and shock resistance..Excellent

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Missile Business

by Seabrook Hull

NOTHING COHERENT will be done about the U.S. missile program before the start of the new year. Between January 1 and February 1, 1958, these things will happen: Congress will return; the President's Budget and State of the Union Messages will be presented to Congress; tax payments January first will begin to swell the Treasury's cash balance. Until all of these things are done, little is possible in the way of reorganization of the U.S. missile program.

One exception, of course, is that Congress can and will start its investigations earlier. Lyndon Johnson's Senate Preparedness Subcommittee held five days of hearings starting November 25. Witnesses from both inside and outside the Government were heard. Johnson wants to have a report ready for Congress when it reconvenes.

UNSPECIFIC THOUGH THEY WERE, the President's security and science talks do give a pretty clear indication of Administration thinking in some of the more costly defense areas. For example: No plans to kill off Strategic Air Command any time soon; means more planes will be bought; SAC bases further dispersed. Also, SAGE is relatively worthless (some experts say completely worthless) for in-time interception of large ballistic missiles; means more and better early warning gear. Anti-missile missile: Both Army and Air Force projects will be pushed. The President, in talking about future missile spending, pointed out that we are now spending "more than $1 billion" on missile research and testing. Production, deployment and installation of the birds, particularly the big ones, will really run costs up. For example, ICBMs will certainly be deployed underground; IRBMs, probably. These installations will require extensive facilities.

PAYMENTS HAVE BEEN LIMITED to 80 per cent on cost-reimbursement contracts, according to an order of Defense Secretary McElroy. The other 20 per cent contractors will be expected to put up out of their own working capital or borrowed funds. Cost of using their own money for working capital will be taken into account in costing the contracts. Meanwhile, the Air Force (but not Army and Navy—yet) will attempt to rewrite some $250 million in cost-reimbursement contracts now outstanding. They will be made to conform to the 80 per cent provision.

This device will limit cash outlays now, and thus help the budget. But the Government must pay sometime; means things will be tougher at the end of the contract when final settlements are made.

BASIC RESEARCH WILL GET ANOTHER BOOST IN FUNDS. This is being ordered by Defense Secretary McElroy in another move reversing the trend begun by his predecessor, Mr. Wilson. Not only are more funds being voted, but an effort will be made to institute management practices to encourage a greater amount of basic research.

DON'T BELIEVE ADMINISTRATION ASSURANCES that no substantial increase in missile spending will be necessary. It's virtually certain that the President will ask to have the statutory debt ceiling raised. It's also virtually certain that before the current fiscal year is out the Pentagon's missile and space-flight program will be overplanned rather than underestimated. The administration cannot risk another setback such as that incurred with the *Sputniki*. And some of these programs will be greatly accelerated in order to quickly achieve a major space flight "first" ahead of Russia.

people

John R. McAllister has been promoted to manager of purchasing for Philco Corp.'s government and industrial division. He previously was assistant manager at the division.

Five appointments have been made at Thiokol Chemical Corp.'s Utah division. **John Higginson** has been named general manager. Other management appointments include **V. H. B. Wilhite,** technical director; **Anthony T. Guzzo,** head, manufacturing department; **William D. Kelley,** head, quality control department; and **J. E. Dieter,** head, administrative department.

Dudley B. Hartung has been named applications engineer by Sanders Associates, Inc. for its line of electrohydraulic servo valves and servo systems.

Ben L. Ettelson has been appointed turbo division project manager for American Machine & Foundry Co.'s participation in the *Atlas* ICBM program.

Lt. Col. George R. Steinkamp has been named head of the Department of Space Medicine at the Air Force School of Aviation Medicine. He succeeds **Dr. Hubertus Strughold,** who has been appointed advisor for research to the commandant of the school.

Frederick N. Mayer has been appointed manager of contract sales and **John P. Thompson** as manager of product sales for the electronics division of F. C. Huyck & Sons. Other appointments by the company include **Leonard Rose,** head of airborne instrumentation section; **Sidney Herman,** head of semiconductor products section; and **Arthur Schlang,** head of simulator systems section.

Robert A. Jewett has been appointed product sales manager of chemicals, phosphors and semiconductors for the chemical and metallurgical division of Sylvania Electric Products Inc.

James E. Shondel has been named government sales manager for International Research and Development Corp. He formerly served in Air Force procurement.

Paul J. Case has been appointed controller at Stavid Engineering, Inc. He previously was manager of the accounting division.

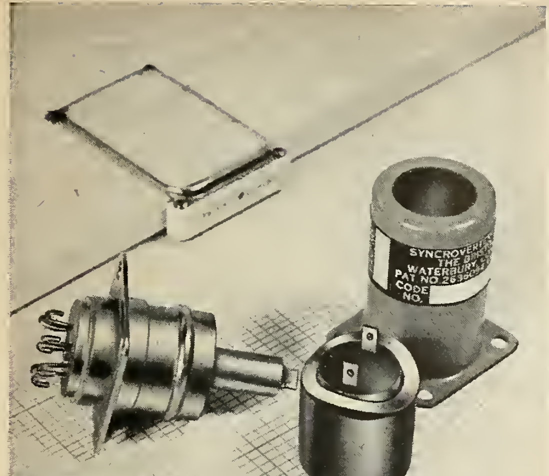
George P. Brandt has been appointed production manager of the new Callery Chemical Co. plant at Lawrence, Kan.

Herbert R. Keith has been named director of marketing services for International Business Machines Corp.

Donald M. Miller has been elected executive vice president of Airborne Instruments Laboratory. He had been vice president in charge of the engineering and production division of the company.

Col. Benjamin G. Holzman has been appointed director of research at the Air Research and Development Command, and will have staff supervision of the research effort at all the ARDC centers including the Office of Scientific Research.

Lloyd E. Stires, formerly a project planning group supervisor for the California division, has been named manager of the project planning department for the Van Nuys branch of the Missile Systems division of Lockheed Aircraft Corp. Another appointment at the Van Nuys branch is that of **Orbrey O. Burns** as acting manager of master scheduling. He succeeds **E. R. Proctor,** who has been transferred to the San Francisco Bay area where he is assigned to the office of **Wilbur D. Snow,** director of the product planning department.



NEW LOW-NOISE CHOPPER

Bristol's Syncroverter† chopper is now available in a low-noise, external-coil model for critical dry circuit applications.

This new external-coil chopper virtually eliminates capacitive coupling between signal-circuit contacts and driving coil leads. Peak-to-peak noise levels are usually *less than 100 microvolts* across a 1 megohm impedance (rms noise, in the order of 10 microvolts).

LONG LIFE and immunity to severe shock and vibration are outstanding characteristics of the new Syncroverter chopper. Withstands vibration, 5 to 2000 cps, up to 30G, and up to five 30G impacts on any major axis. SPDT switch action. Nominal contact ratings: up to 10 V, 1 ma.

Write for complete data on this latest addition to the Bristol Syncroverter line. The Bristol Company, 173 Bristol Road, Waterbury 20, Conn. 7.31

†T. M. Reg. U. S. Pat. Off.

TYPICAL CHARACTERISTICS

Driving Frequency Range:	0—1800 cps
Coil Voltage:	6.3 V sine, square, pulse wave
*Coil Current:	70 milliamperes
Coil Resistance:	52 ohms
*Phase Lag:	60° ± 10°
*Dissymmetry:	15° max.
*Switching Time:	15° ± 5°
Temperature Ranges:	—55°C to 100°C or —65°C to 125°C
Operating Position:	Any
Mounting:	Flange; 2-hole or 4-hole Plug-in; fits 7-pin miniature socket

*These characteristics based on sine-wave excitation, 400 cps.

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Weapon systems management programs at Lockheed Missile Systems call for achievement of a high order in these fields. Assignments are on the Polaris Intermediate Range Ballistic Missile program and other extremely important activities.

Aerodynamics

Theoretical and experimental investigations of the aerodynamic characteristics of missiles at Mach numbers through the hypersonic range; optimization of controlled missile performance; specification and supervision of experimental aerodynamic investigations required to verify and improve missile and weapon system design; analysis and interpretation of aerodynamic flight test data.

Flight Dynamics

Analysis of missile dynamic motion and establishment of stability and control systems criteria for trajectories with 3 or more degrees of freedom; development of techniques for the analysis and interpretation of flight dynamics test data at hypersonic speeds; study of special dynamics problems arising during preliminary design and development of missile systems.

Thermodynamics

Boundary layer and heat transfer analysis in hypersonic flow fields such as pressure gradient- and real-gas effects; analysis of thermodynamic performance of missiles in continuum flow, slip flow and free-molecular flow; calculation of transient structural and equipment temperatures resulting from aerodynamic heating and radiation; specification of ground tests and flight tests required to verify and improve thermodynamic design of missile and weapon systems; analysis and interpretation of thermodynamic ground test and flight test data.

Engineers and scientists are invited to address inquiries to: Research and Development Staff, Sunnyvale 7, California.

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Bomarc Switches to Solid Rocket Booster

An advanced model of the *Bomarc* surface-to-air missile will employ a solid-propellant rocket booster (m/r Sept., p. 164). Present IM-99, recently ordered into production, is boosted to altitude and ramjet-engine velocity by an Aerojet liquid-propellant engine.

The switch to the solid-propellent system will improve logistics and provide a possible increase in range, altitude and velocity. The liquid system now used forms the major portions of the missile's weight and volume. It cannot be cropped after burnout, a feature which undoubtedly imposes performance limitations that would not be present with a droppable solid-propellant booster system.

Northrop Missileers Report for AF Duty

Twelve missile specialists from Northrop Aircraft's customer field service section have reported for duty with 6555th Guided Missile Squadron at Patrick AFB to assist in training of the Strategic Air Command for *Snark* SM-62A operations.

The proficiency training team, whose members have undergone a rigorous training program over the past months, is headed by Jim McFarlane. McFarlane formerly was an engineering assistant on *Snark* guidance tests and later worked as guidance test engineer during launching tests at Cape Canaveral.

Additional Helium Production Requested

The Interior Department feels that increased missile needs warrant the construction of an additional helium-producing plant. The plant, costing $14 million, would increase output by about 240-million cubic feet.

The government now has four plants producing about 365 million cubic feet annually. Present missile systems use an extensive volume of the gas for propellant pressurizing systems.

Thiokol Motors Score 97.5% Reliability

Flight performance records for large solid-rocket motors, powering missiles approaching the IRBM and ICBM class and developed and manufactured by Thiokol, have achieved a 97.5 per cent reliability record.

Thiokol first broke the "size barrier" for large solid-propellant motors with its successful engine for General

Electric's RV-A-10. To date, 130 engines developed in this general size, or larger, have been fired. Ninety static tests were completely successful. In forty actual flight tests, only one missile failure was partially attributed to the rocket engine.

The missile most extensively proven in flight tests has been the huge 3-stage Lockheed X-17 developed for the Air Force as a test rocket for its ICBM program.

Curtiss-Wright Expands Missile Effort

Curtiss-Wright Corp.'s latest acquisition in the missile field is the H. A. Wagner Co. of 14707 Keswick St., Van Nuys, Calif. It will operate the company as a wholly-owned subsidiary of its Aerophysics Development Corp. Latter is located at Santa Barbara, Calif.

FMC Corp. Develops *Hawk* Loader Vehicle

The completion of design and development of a new lightweight, self-propelled track vehicle for the *Hawk* loader, the first mobile missile handling unit of its kind, is the latest achievement of the ordnance division of Food Machinery and Chemical Corp.

The track vehicle was built for Northrop Aircraft, Inc., by FMC as part of the U.S. Army's *Hawk* surface-to-air missile system. FMC produced the track vehicle under contract to Northrop.

Aerophysics Awarded *Dart* Missile Contract

An additional contract, totaling $826,963, has been received by Aerophysics Development, Santa Barbara, Calif., for continued development of the *Dart* antitank missile.

Operational status of the *Dart* has not been officially announced. Development is by Aerophysics with production by Utica-Bend Corp. (subsidiary of Studebaker-Packard).

Marquardt Test Facility Under Way

Marquardt's Ogden, Utah, facilities, which started delivering production ramjet engines for the *Bomarc* missile over two months ago (m/r Sept. '57, p. 168), has broken ground at the site of its ramjet-engine test facility. The test facility will operate in conjunction with the production plant.

Marquardt now holds a total contract award of $30 million for its Ogden plant.

Mack Trucks, Inc. Forms Electronics Division

The electronic research and manufacturing facilities of Mack Trucks, Inc., are being formed into a single division. Called the Mack electronics division, it will permit greater coordination of effort in the rocket, missile and aircraft fields.

Advertisers Index

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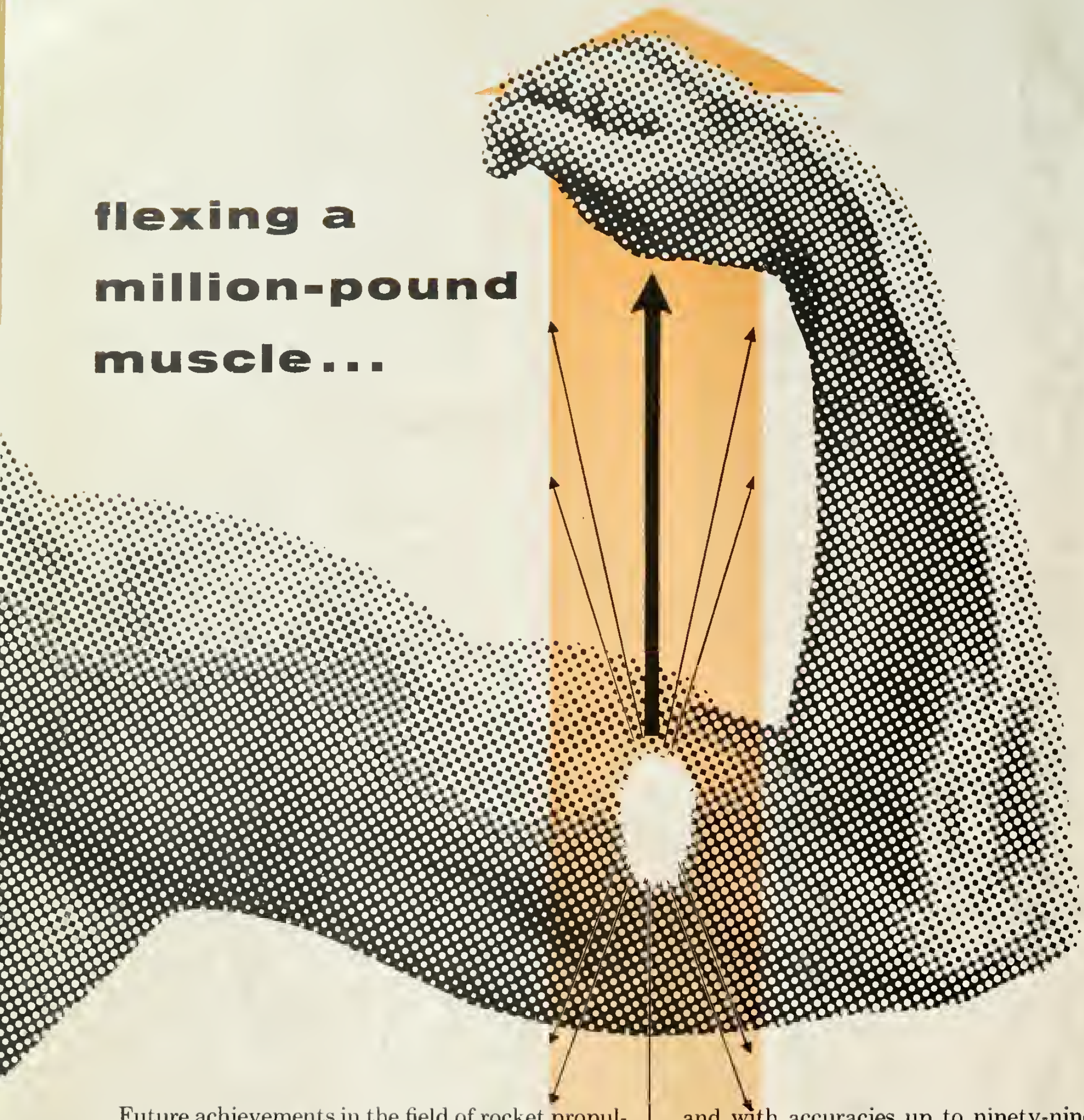

Future achievements in the field of rocket propulsion depend upon the ability to test prototype engines at rapidly increasing power levels. To keep pace with these higher power requirements, RMI is completing work on a giant rocket test stand.

The new RMI test structure is capable of testing rocket engines in the million-pound thrust class. Its massive rotating system provides firing attitudes from vertically downward to 45 degrees above horizontal. The control center contains a maze of instruments that continuously record separate events occurring, within the engine, at intervals ranging from one-tenth of a second to less than one millisecond . . . and with accuracies up to ninety-nine per cent.

This addition to RMI's already-extensive test facilities paves the way for tomorrow's more powerful and more efficient rocket powerplants. It's another example of how RMI — America's *first* rocket family—is continuing to pioneer in the development and production of new engines for supersonic manned aircraft . . . helicopters, catapults and test sleds . . . and missiles for defense and space exploration.

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