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missiles and rockets

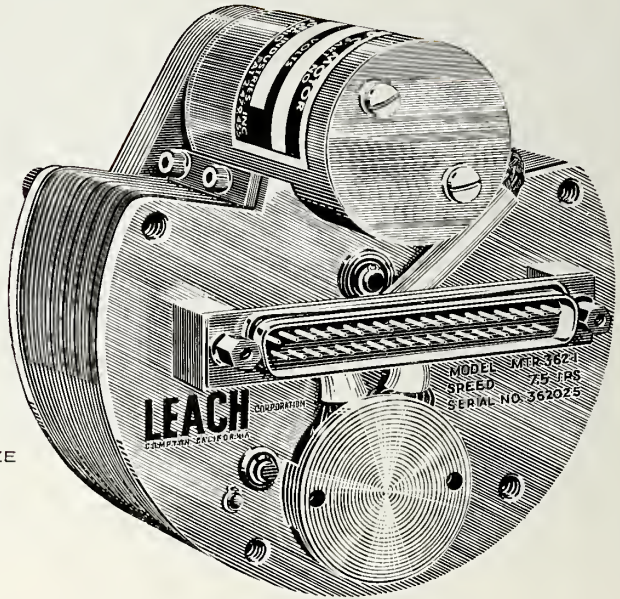
MAGAZINE OF WORLD ASTRONAUTICS

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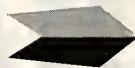
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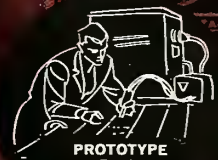
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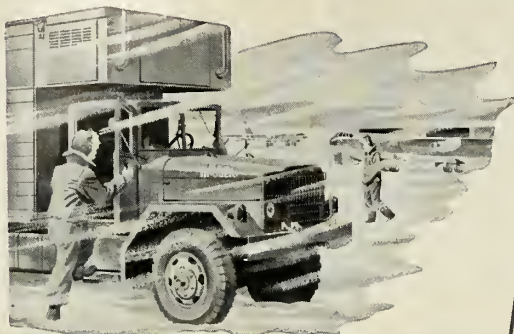
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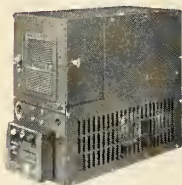
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missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS



COVER: This large antenna is part of radar network on Army's missile tracking ship SS AMERICAN MARINER.

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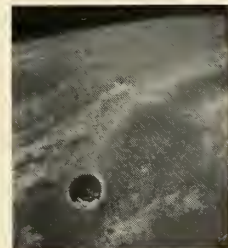
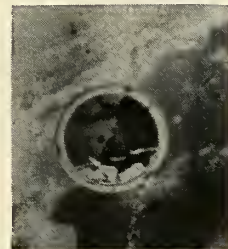
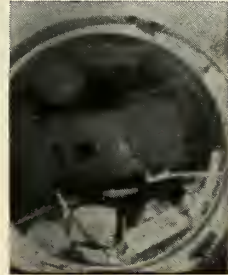
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AND AWAY IT GOES!



125 MILES UP: A special ACR Electronics Corp. 16-millimeter camera snapped these sensational shots as the nose cone of a *Thor* separated over the Atlantic. Camera is of compact design capable of safeguarding film during impact with ocean. Pictures were taken through a quartz window of General Electric Co. recovery capsule located in the cone-shaped afterbody of the *Thor* nose cone. Capsule was ejected from nose cone shortly after it hit the water, 1400 miles from Cape Canaveral.



RUGGED

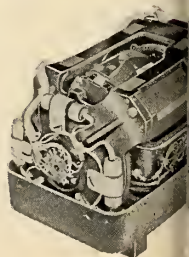
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The Remarkable City of Huntsville

One of these days the technicians of the Army Ballistic Missile Agency at Huntsville will bolt a circular cluster of H-1 Rocketdyne engines to a modified *Jupiter* test stand and push a button. The act will unleash some million and a half pounds of thrust and the most horrible roar that has ever been heard in Alabama.

ABMA announced this week that it had received the first of the new engines (see page 36) and that the entire system, named *Saturn*, would be light tested in 1960. Work has already begun on modification of the test stand to accommodate this monster of the Space Age and now it is a matter of forging the eight engines together in the approved configuration. This work cannot be done, incidentally, in the ABMA "fab lab" where other missile construction goes on. The three-story high ceiling is too low to accommodate the cluster.

Huntsville, Alabama, is probably the only town in the country where such a test could be carried out with the consent and approval of its citizens. ABMA will simply inform Huntsville to hold its collective ears, say, between 9 and 10 a.m., on the designated day and Huntsville will cheerfully, even enthusiastically, run whatever risk to its *tympanum* that may be involved. Anyone who has ever stood a quarter of a mile away during the testing of one 150,000-pound-thrust engine can imagine the noise a cluster of eight will make. Yet, Huntsville will probably be both hurt and incensed at any suggestion that the testing should be done elsewhere.

In many ways Huntsville is quite a remarkable place. Settled during the early days of America because a big gushing spring provided ample fresh water, it became important, particularly in Civil War days, because it was the junction of north-south, east-west rail lines. But it was never really anything more than a sleepy Southern village until the Army decided to get into the missile business and chose Huntsville and the Redstone Arsenal there for its operating site.

Huntsville then blossomed and boomed from 15,000 to its present hundred and some thousand, depending on how far into the environs you want to go. It has been a relatively orderly boom with roads, housing developments, schools and law and order keeping pace under a remarkably wise municipal government. (In schools, for instance, the rate of progression has been one classroom a day for the past several months.) A solid local newspaper has helped immeasurably, too.

Chiefly, Huntsville cannot escape being notable

for the enthusiasm it constantly displays for its missile and spacecraft building tenants. A new assignment for a new project in the cosmos brings cheers from the town—mayor, merchant and mill-worker. A cancellation, a setback or an adverse decision from the Pentagon brings corresponding gloom along Main Street. Roles and missions aren't involved. Huntsville is for the home team.

If this is a reflection of Huntsville's economic dependence on the Army's vast complex in the town's back (or front) yard, it is also a reflection of some highly-inspired labors in military-civilian relations with model results. Every military installation in the world could wish for such support.

A great deal of this amicable blending is, of course, traceable to the nature of the military establishment—the U.S. Army Ordnance Missile Command under the leadership of Maj. Gen. John B. Medaris. His organization at Huntsville is divided into two lesser commands—the Army Ballistic Missile Agency under Brig. Gen. John K. Barclay and the Army Rocket and Guided Missile Agency under Brig. Gen. John G. Shinkle. The redoubtable Wernher von Braun is, of course, director of development operations for the former, ABMA. Another occupant of the Huntsville complex, although a tenant, is the Ordnance Guided Missile School.

Obviously, the calibre of both military and civilians working in the three agencies must be and is a cut considerably above the norm in both education and intelligence. The Missile School, for instance, trains both Army and Air Force personnel in the operation of the *Jupiter*. It also trains NATO soldiers and airmen, both as individuals and in operational units, in the operation of Army missiles which have been or will be stationed overseas. (The curriculum is all set for the first Italian teams who will man the *Jupiter* IRBM stations in Italy.)

The 2000-person teaching and administration staff of the school, incidentally, averages (from secretary to commander) two years of college. Twelve months once passed without a court martial among the military personnel. The school introduced for the first time into military usage the Tele-Prompter System of visual teaching and later added closed television circuits.

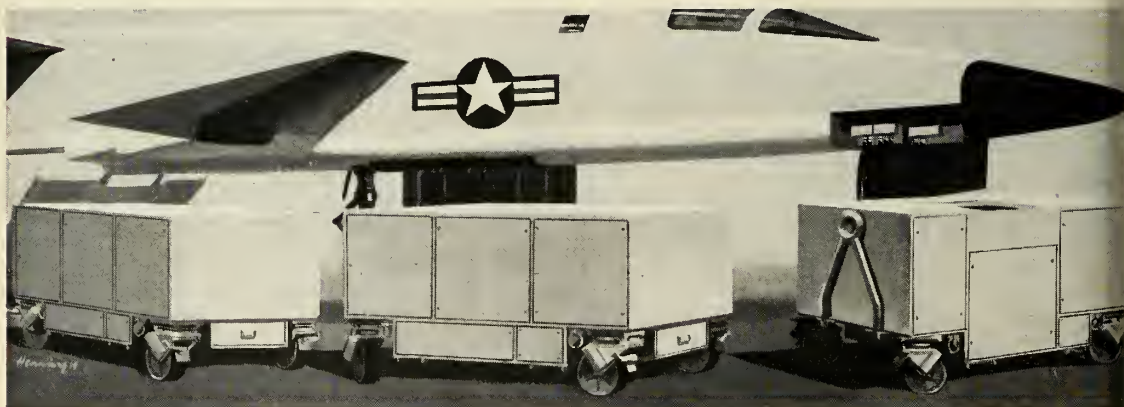
All in all, both Huntsville and the Army can be proud of military command and civilian population. Together they make a good team which, one of these days, will be holding its collective ears against the sound which will signal another step in man's adventuring in space.

Clarke Newlon

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washington countdown

IN THE PENTAGON

The death of Deputy Defense Secretary Donald A. Quarles can—and probably will—have far-reaching effects on the future of the Pentagon's widespread development set-up. Some of the effects of his death already showing up are . . .

In Dr. Herbert York's new Development & Engineering organization: The powerful centralized organization—a Quarles favorite—was just about to be given final approval by Defense Secretary Neil H. McElroy. Now a serious drive by the services and others is underway to lessen the power of York's office. But his chances of holding most of his own are considered good . . .

In top Pentagon development offices generally: The release of Quarles' strong hand is felt in many places. Once greatly-concentrated authority is flowing back into a more distributed pattern . . .

In Roy Johnson's ARPA: Many have thought that ARPA was headed for fairly rapid extinction. But now that McElroy has decided to stay on "indefinitely," it looks as if Johnson and ARPA will stay on "indefinitely," too.

The meaning: Control over development tightly held by Quarles could go to York . . . or partly to Johnson . . . or partly to the services. An inner struggle is on.

However, don't expect any drastic policy changes because of the appointment of Navy Secretary Thomas S. Gates as the new Deputy Defense Secretary. Like Quarles, Gates is known as an Administration man and will not try to alter the existing presidential party line.

A decision is expected very soon on selection of a prime contractor for *Dyna-Soar*, the boost-glide space missile launching platform. Competition is between Boeing and Martin. As M/R went to press the USAF Air Council had not received an evaluation report from Air Materiel Command but knew it was on the way.

Alterations on the *Redstones* which will be used to send the astronauts on their first trip into space will be made at Huntsville. The same capsule being developed by McDonnell for later use on the *Atlas* will be fitted to the early Army missile. First flight is expected before the end of 1959.

Watch for more big changes at Air Research and Development Command under new leadership of Lt. Gen. Bernard Schriever. Among those already announced: Maj. Gen. James Ferguson as ARDC vice commander, succeeding Maj. Gen. John Sessums who is expected to retire . . . Maj. Gen. William Canterbury as deputy commander for research, succeeding Maj. Gen. Leighton I. Davis.

ON CAPITOL HILL

One of the most significant moves by the 86th Congress is the attempt to tighten Congressional control over both missiles and space. Earlier this month the Senate Armed Services Committee called for requiring authorization of all missile programs as well as approval of appropriation requests. Now the House has called for authorization of all space programs for the next five years. All-out fights can be expected.

The Joint Congressional Atomic Research Subcommittee is preparing to crack down on the Administration over delays in development of the nuclear-powered plane—a proposed deliverer of the ALBM. The subcommittee understood a speed-up was planned. Then it was told that this was incorrect. If no speed-up is forthcoming, the subcommittee is all but certain to stage some of the hottest hearings of the year.

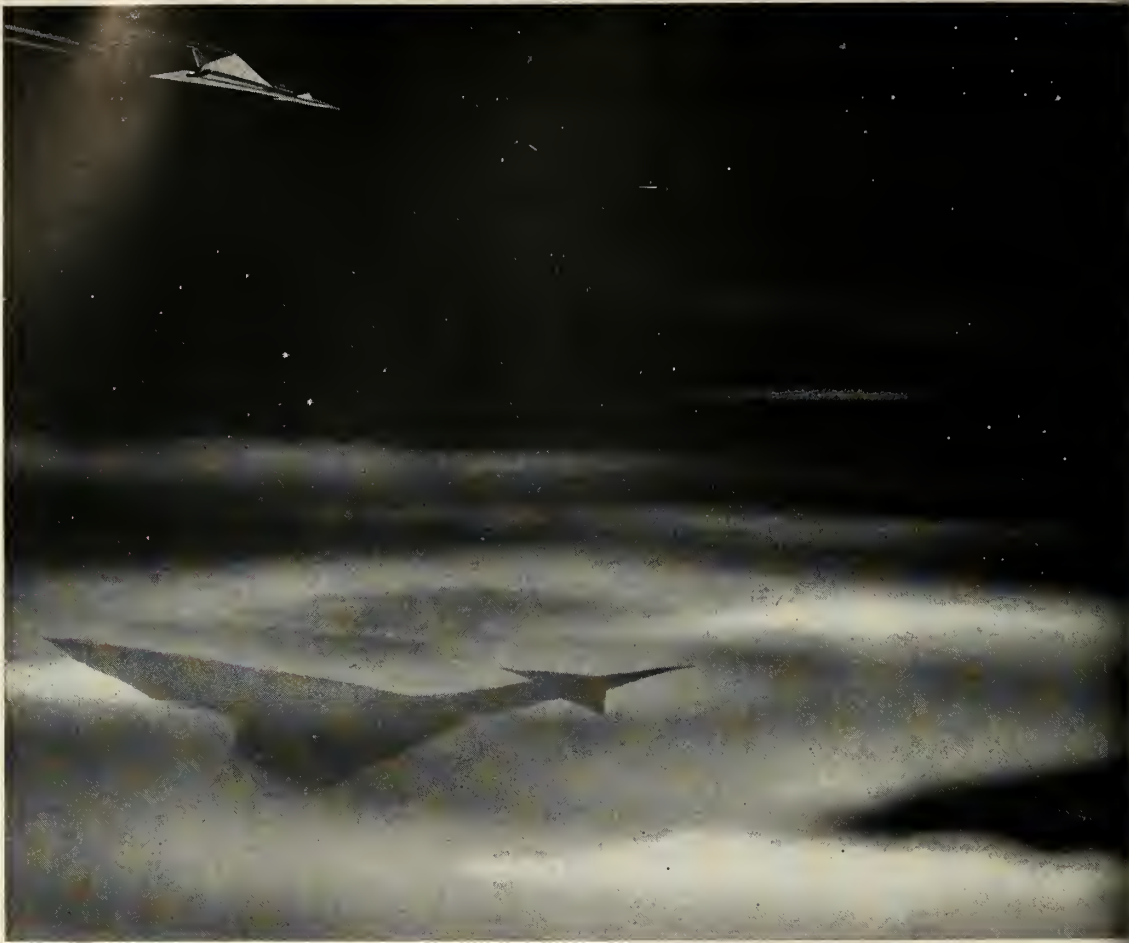
AT NASA

NASA is soon to announce the location of a site in North Dakota for one of four polar-orbit tracking and telemetry stations. Selection of the other three sites—in Alaska, Newfoundland, and Europe—is also supposed to be at hand.

NASA also is speeding up its search for an appropriate site for the proposed \$5 million high-energy rocket development and test center. The center was cut from the NASA FY '60 budget by House members because NASA couldn't tell the Congressmen where the center would be located. Ideally, NASA would like to build it near the Lewis Propulsion Laboratories in Cleveland.

AROUND TOWN

The National Aviation Club is going to honor Dr. Theodore von Karman, one of the world's top scientists, as man of the month for May. Von Karman is chairman emeritus of the USAF Scientific Advisory Board.



8497-V

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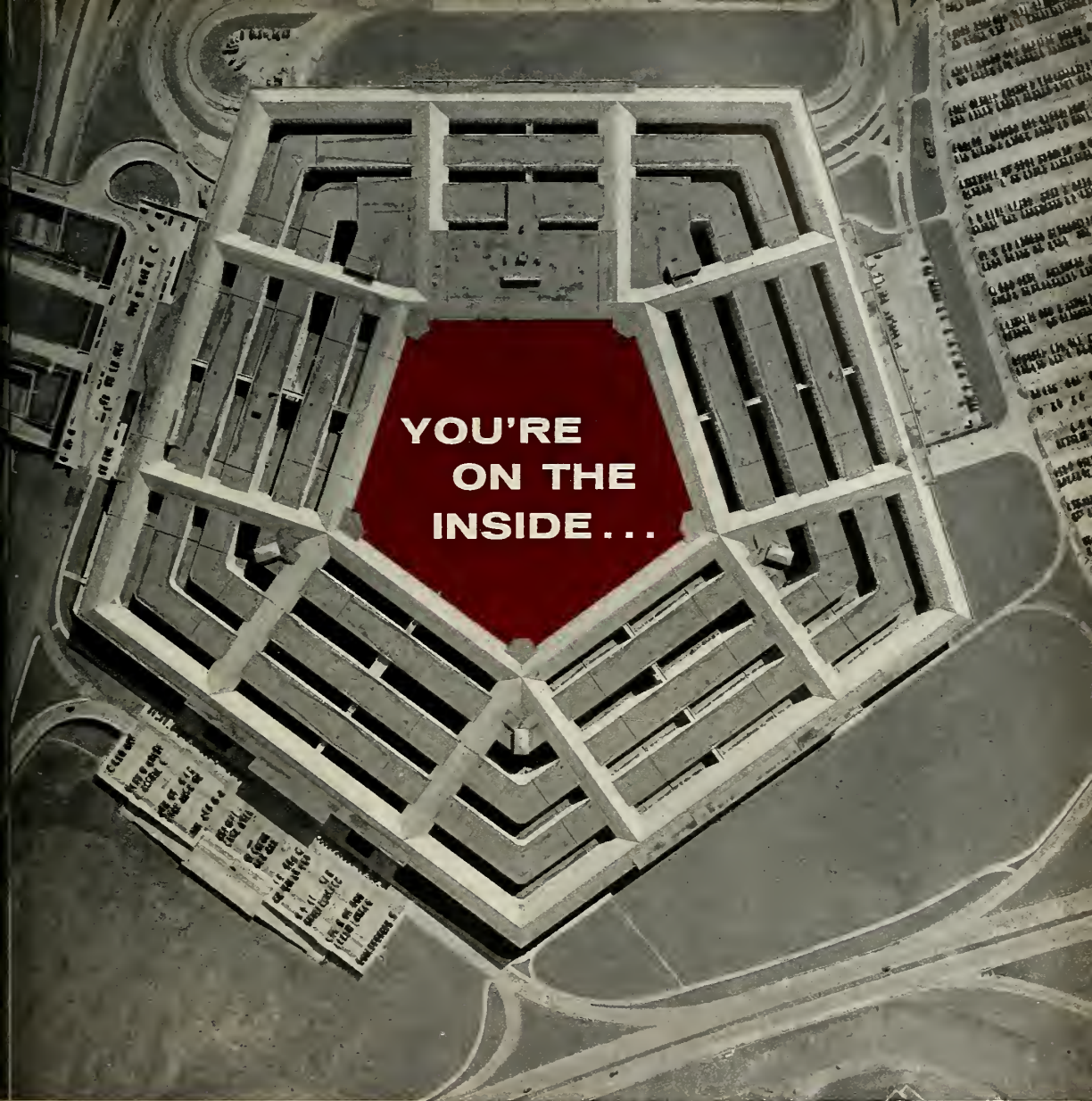
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BRAIN POWER



RAMJETS

THE PROBLEM. To realise for civil and military use the staggering potential of the ramjet engine—the jet engine with no moving parts that promises to prove the most efficient method of propulsion inside the earth's atmosphere.

THE ANSWER. Bristol teams designed and developed efficient ramjet engines. They flew many hundreds of supersonic test vehicles, since, of course, ramjets must be tested in the environment in which they are destined to operate.

This work culminated in the Bristol Siddeley Thor, the powerplant for the Bristol/Ferranti Bloodhound Guided Missile. But in producing Thor, Bristol built up Europe's most extensive experience of the ramjet and the most complete facilities for its further development.

And developed it will be. For today, the world's designers are beginning to see in ramjet engines the

means of making *civil* supersonic travel a practical economic reality.

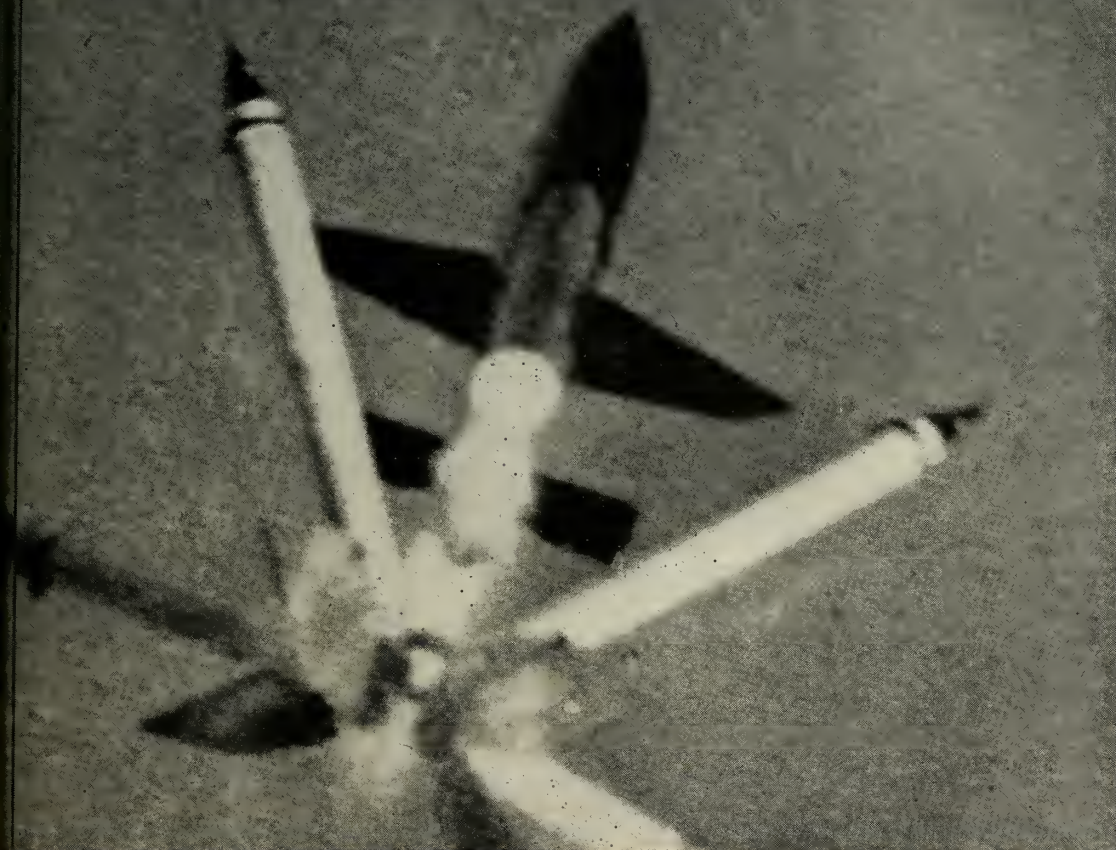
How well has the brief been fulfilled? The Bloodhound can best answer for the military application.

Security forbids publication of the full facts of how much can be said. The Bloodhound already approaches full operational status with the RAF and has been ordered by Sweden. With the range and speed imparted by its Bristol Siddeley ramjets, the Bloodhound has greater effectiveness than any other supersonic to-air guided missile in the western world. And as future defence needs dictate even higher speed and longer ranges, even heavier armament, these needs can be met without major alteration or redesign of the ramjet-powered missile and its system.

Ramjet power for manned aircraft is the next

missiles and rockets, May 25, 1955

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amous Bristol Siddeley engines :-

RE—turbojet . . . high subsonic and supersonic speeds
powerplant of the Handley Page Victor bomber.

ES—most powerful jet-prop in airline service . . .
able mechanical excellence and exceptional reliability
the Bristol Britannia.

R—turbojet . . . exceptional handling qualities . . .
the Hunting Jet Provost, RAF's basic jet trainer, and
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US—outstanding lightweight medium-thrust turbojet
already specified for 14 different aircraft in 8 countries.

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reliability and long overhaul life.

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ENGINES LIMITED

RAIN POWER translated into FLIGHT POWER

The advertisement features a large, stylized illustration of a rocket engine. The upper portion is a dark, angular shape, while the lower portion is a bright, multi-pointed starburst. A Hawk missile is shown in flight, leaving a white smoke trail, positioned between the dark and light sections. The background is a mix of dark and light grey, suggesting a sky with clouds. The overall design is bold and graphic.

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rocket
power:

ARMY'S HAWK

Solid-propellant
rocket engines
for the Army's ground-to-air
HAWK were developed
and are being
manufactured at Aerojet's
Solid Rocket Plant
near Sacramento,
California.

AEROJET-GENERAL CORP.



A SUBSIDIARY OF THE GENERAL TIRE & RUBBER COMPANY
Engineers, scientists—investigate outstanding opportunities at Aerojet. (Plants at Azusa and near Sacramento, Calif.)

missiles and rockets, May 25, 1955

industry countdown

STRUCTURES

First nuclear-powered missile cruiser—Long Beach (to be commissioned in FY 1961)—will have two extremely high-speed fire control systems to launch the supersonic surface-to-air *Talos*. Mark XII magazine and mechanized loader being developed by General Electric under \$8 million contract will weigh 350 tons—reportedly the largest single piece of ordnance ever ordered by the Navy. It is bigger than the fire control system for a battery of 16-inch guns. Two other nuclear cruisers also are programmed and will be similarly equipped for the Bendix-RCA *Talos*.



In the 1960 budget, the Navy discloses it is buying enough Raytheon *Sparrow III* air-to-air missiles to “provide slightly more than a month’s combat usage.” Amount for Martin air-to-surface *Bullpup* will last for “a little less than a month’s combat.”



Look for NASA to back off somewhat from its original decision to keep exclusive rights to inventions conceived under its contracts. Permanent regulations upcoming soon are expected to allow contractors to retain proprietary rights—but the final decision as to who gets the patent rights will come after the invention, and not before the contract is signed.

PROPULSION

North American engineers predict the missile-launching B-70 bomber may use 50 to 75 tons of steel products, mostly thin-gauge alloys and stainless sheets and honeycomb sandwiches. Plane will be built like a “flying fuel tank” with the basic load-carrying structure containing the fuel to eliminate internal tanks. Structure may be assembled by fusion welding to meet 400°F to 650°F temperature requirements.

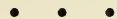
ELECTRONICS

Competing for \$12 million NASA contract to construct and manage *Mercury* range are: Thompson Ramo Wooldridge, Reeves Instrument, Aeronautics Systems, Cubic Corp., Austin Corp., IBM, Convair, Vitro Laboratories, Milgo Electronics, Temco Aircraft,

Aircraft Armaments, Sylvania, J. G. White Engineering, Nat Harrison Associates, Chance Vought, Ralph M. Parsons Co., ITT Laboratories, Page Communications, Philco, RCA, Space Electronics, Collins Radio, Aerojet-General, Chrysler Corp., Westinghouse, Cook Electric, Western Electric, Brown & Root, Lockheed, Burroughs Corp. and Underwood Corp. Contract will be let July 1.



The Pentagon is earmarking \$118.1 million in the 1960 budget for purchase of ECM (electronic countermeasures) equipment. ECM embraces both defensive countermeasures to help aircraft penetrate enemy defenses and electronic reconnaissance to obtain information on enemy missiles and other weapons.



Best guess of the Air Force is that it will be sometime in 1963—four years from now—before SAGE (semiautomatic ground environment) combat command system is completely finished. It is now operational from Bangor, Me., to Washington, D.C.

ASTROPHYSICS

Russia is reported to be very actively researching the dynamics of outer space travel, which some day may be scheduled around solar storm activity. Avco’s Dr. Arthur Kantrowitz is urging more U.S. research to open up this entirely new field of meteorology.



Soviet astronomer Nikolai Barabashov refutes the “green cheese” theory about the moon. He says the moon is not one color but many—brown, yellow, blue and red as well as green. Instead of being covered by cosmic dust or volcanic ash, as suggested by other observers, the Russian says the lunar surface is covered by a layer of rock grains.

SPACE MEDICINE

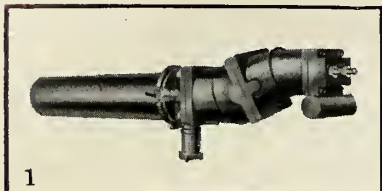
Strictly paper combination of medical facilities at Brooks AFB and Lackland AFB in Texas and Gunter AFB, Ala., will be made soon to form the AF Aerospace Medical Center. All facilities will remain at their present locations.

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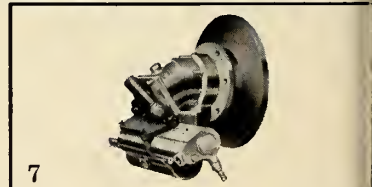
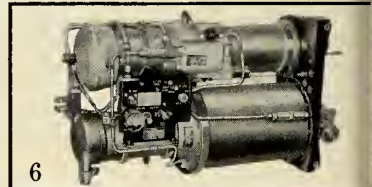
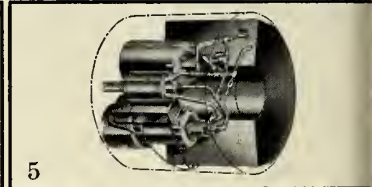
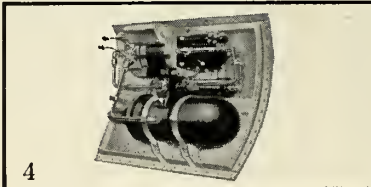
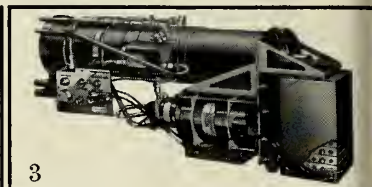
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Pitfalls of Missile Business Financing

*Growth can be deadly. But here's where to get capital
—while you still can!*

WASHINGTON—Need money? Final-
get that first really big contract only
find you can't finance it? Short of
ital for expansion, market develop-
nt, new business, in-house R&D,
? Got backlogitis (symptom:
ched bank account)?

In a word, are you suffering the
ncial growing pains of a growth
npany in a growth industry? If so,
a money doctor—right away.
erwise, lacking time to effect a
e, you may end up being embalmed
der the terms of the Federal Bank-
cty Act—for without a diet of bal-
ed management and proper finan-
nourishment, growth can kill.

More and more companies in the
siness are beginning to realize that
hological posers aren't the only
daches plaguing missilery. There are
ney problems, too, that can be every
as tough as developing a leak-tight
rine joint, a 283,000-psi solid rocket
tor case, or a continuous space
wer source rated at one kilowatt per
ce of weight. What many compa-
s don't know is that there is a good
er's dozen or more of ways to ward
these money troubles.

In 1950 the missile market came to
mere \$500 million. Today, if you
lude missile, space and related sup-
rt procurement, it's nudging \$9 bil-
l. For 1965, half a decade hence,
n conservative estimates peg the
al at \$30 billion a year. It's one of
most rapid growth patterns in peace-
e history.

And with the growth of the indus-
many companies are growing too—
ne at a more rapid rate than they
n afford. Too many—particularly
all businesses plunging headlong into
; business—find this out too late.
en they lose an important contract,
ause they can't finance it, and thus
mage their reputation; are forced to
erge with a larger, moneyed com-
ny, with loss of identity and too
en loss of the creative secret of their

An M/R Staff Report

success; or, worst of all, are driven into
bankruptcy.

The basic financial hazards of
growth all add up to too little money
to finance: expansion, current business
(cost of materials and labor in servic-
ing too big a backlog can be, and
often has been fatal), new business,
contract termination (other bad times),
modernization, research and develop-
ment, etc. And to these general hazards
of growth must be added the numerous
specific handicaps of current defense
business policies. Here are just a few
of these:

- **Tight competition** (sometimes
from companies *buying* their way into
the missile market) for advertised bid
contracts, with resultant skinnier profit
margins.

MANAGEMENT TRAPS

A. Poor Financial Planning

1. Inadequate Records
2. Cumulative Losses
3. Neglected Tax Payments
4. Expansion Beyond Resources
5. Excessive Fixed Costs

B. Poor Coordination Between Manu- facturing and Selling

6. Lack of Product Development
7. Lack of Diversification
8. Lack of Data on Own Cust-
omers
9. Contracted Entire Output to
Single Buyer
10. Lack of Market Research
11. Continued Policies of Bank-
rupt Predecessor
12. Legal Problems

C. Poor Other General Administration

13. Family Factors
14. Lack of Administrative Co-
ordination
15. One-Man Management
16. Lack of Technical Knowledge
17. Absentee Management
18. Internal Conflict

- **Nature of CPFF contracts**, particu-
larly in missilery, where often as
not changes in requirements and tech-
nological modifications force the cost
way, way up with no commensurate
increase in the fee which, as the term
says, is cost-plus-FIXED-fee. This re-
duces earning power of both working
capital and equity investment.

- **Need to finance 20% of inven-
tory of certain cost-type contracts.** This
gets particularly worrisome during the
shift from development to production
phase when, again, change orders may
pile up that inventory perilously high.

- **Contract termination**, sometimes
with cancellation coming with the quick
brutality of a telegram. This not only
means loss of business, but you will
have to finance termination costs until
the red tape permits final payment.

- **High cost of much missile R & D**,
where you may have the best technical
qualifications in the world but, lacking
evidence of financial ability, you lose
the business.

- **Chances of losing the production
contract** to someone else, after you
made a profitless low bid on the R&D
phase just to get into the program—
figuring to make your money on the
production run.

- **Obsolescence of a technology**
in which you were leader, because of
development of a newer, better method.
Unless you've got the capital as well
as the know-how to diversify or im-
prove your own techniques, you're in
trouble.

- **High materials costs** relative to
processing costs, which could force you
to give up a particularly lucrative piece
of business. A recent example was a
monstrously big, devilishly complex
nozzle for a development rocket motor.
Use of a so-called "exotic" metal
pushed materials cost to over \$400,000,
compared to only \$80,000 in process-
ing costs—just for one nozzle. Business
like this takes some heavy financing.

Dangers of payments slowdown . . .

This usually happens because Washington doesn't want to upset its cash expenditure budget system—or, maybe, because (if you're a subcontractor) one of your best customers may be maneuvering for a merger and wanting to make his cash position look as good as possible.

• **Performance bond requirements** on some especially large contracts, such as engineering, manufacture and assembly of, say, a hypersonic wind tunnel—where the bond may run \$500,000 or more.

• **Need to finance in-house R&D** if you're going to have any kind of favorable patent position. If developed under contract, patent rights usually belong to the government.

All these add up to increase the dangers of doing business in the missile market, and tend to make financial collapse, when and if it comes, all the more sudden. They also make it pretty obvious that defense business, in itself, does not always provide an easy route to expansion.

But for the company that looks to its financial future in time, there are many roads to relief. This is particularly true of smaller companies, due to Federal small business legislation. They range from going to the public with a stock issue, to a 100% government loan from the Small Business Administration.

Large companies face virtually the same financial problems as small companies—government limitations on earnings from defense business, renegotiation, taxes, hazards of CPMF contracts, etc., versus continuing and expanding needs for both equity and working capital.

Big company management, however, is usually well enough balanced between technological, administrative and financial know-how that it becomes aware of financial troubles at their onset. And, knowing of the impending danger, it is also aware of the various alternative solutions.

Small companies, however, are often built on the technological and/or sales abilities of one or two men who frequently don't recognize the impending danger until it's too late or, if they do, may be aware neither of the various solutions available to them nor of how to go about taking advantage of them.

• **Many sources**—There are many sources of money, both direct and indirect. Direct sources of capital break down between investment and borrowings. Indirect sources evolve from competent corporate management. Here are

some of the direct sources open to both big and small companies:

• **Public stock issue**—Even if profit and loss and balance sheets seem to leave something to be desired, so long as you're in the missile business and not obviously bankrupt, your stock should be in good demand.

Look at the prices some missile stocks are bringing, and it's obvious that more often than not the public is buying on romance, rather than statistics. And the newer the "find," such as a missile stock on the market for the first time, the hotter the demand. By "missile company," we mean any company demonstrably connected with the business—not necessarily one of the big prime contractors. Some recent new issues have been over-subscribed tenfold or better.

Going to the public for money doesn't mean you have to give up control. You can usually keep control—and it doesn't require a majority interest. And of course there are many different kinds of stock—preferred without voting rights; common stocks that have a first call on dividends up to a certain point, with limited voting rights and which may be convertible to full voting shares; and many more. One currently successful money-raising technique is the issuing of subordinate debentures with stock warrants enabling holders to buy common stock at a favorable price. If you're interested in these possibilities, consult a recognized expert in the field.

• **Private investment**—This can be done by one of the big financial houses or an individual. Examples of the former are the Lehman Bros.-General Dynamics relationship, which has been very profitable for both, or the Johnston-Lemon-Atlantic Research relationship. This approach usually means participation in the management of your company by the investment house, but at least you'll get top financial advice—which may be just what the doctor ordered.

One problem missile companies may run into in going to, say, a Wall Street financial house, is that people there may not have a ready technical appreciation of just what it is your company is so good at. One financial consultant puts it this way: "You're trying to raise money for a bizarre and unestablished product on a whimsical money market." However, this problem is rapidly disappearing with the mounting business acceptability of missile and space flight.

Two notable individuals in the business of picking up and backing

"golden opportunities" are How Hughes and Laurance Rockefeller. What kind of deal you can make such an arrangement depends on individual, and individuals vary greatly. But odds are that one thing they have in common is a desire to fol their money with their control.

• **Long-term borrowings**—This can be from an insurance company or, again, an individual. Banks are help, since long-term business loans aren't bankable. Long-term loans usually mean issuing first mortgage bonds, general mortgage bonds (both of which must be more or less secured) or debentures, which are little more than interest-bearing promises to pay. Usually it's tough for a small company to raise capital this way, unless it can present a really convincing picture of good management and good prospects.

In any case, make certain you don't borrow so much at such an interest rate (on bonds now running at 5%) that you eat up the meager profit allowance (7-14%) permitted on government business.

• **"V" loans**—These are primary working capital loans whereby the military services (and certain other government agencies) with ultimate responsibility for your defense contract will guarantee up to 90% (excepting up to 100%) of a bank loan amounts limited by an "asset formula" but not to exceed 90% of the borrower's investment in defense production operations."

Maturity dates are set to "conform reasonably to the borrower's financial requirements for defense production contracts on hand at the time of guarantee."

These are available to both large and small business and to both prime and subcontractors. What you're doing must be essential to the national defense. The responsible military service, the local Federal Reserve Bank and bank that's going to actually loan the money all participate in approving first, of a certificate of eligibility, a second, of the actual guarantee.

One real advantage of this system is that it can be arranged as a revolving account—moving up or down with your volume of defense business.

• **State and local development**—These are privately-owned corporate entities set up in states and local communities for the double purpose of bringing new business to the area and fostering the growth of companies already there.

These are eligible for long-term loans from SBA up to the amount of their borrowings from other sources. This money they can use, in turn, to provide equity capital and long-term

to small business. However, unless their charters they can also help business in other ways—provision low-rent plant space, for example. There are over 2000 such development companies in the U.S.

• **Agreements with larger firms**—The larger company supplies both working capital and back-up production capacity. You may ask: But why would a big company make such an agreement? Why don't they go out and do the business themselves?

The answer will usually be: Because they can't. They don't know their way around the missile business yet and don't have a technical familiarity with its problems and requirements. Your company, on the other hand, may have an intimate knowledge of all these things. If so, you probably pass up more sales opportunities than you go for—because you haven't the physical plant and cold cash. So, you trade business and know-how for cash and liquidity.

It's a good deal—if it works. But you will work out over a profitable period of time only if there's a rare meeting of minds and temperaments. Realize also that the larger company may work with you only long enough to get the necessary know-how and then pull out of a sudden he's no longer benefactor, but competitor.

Nevertheless, it may give you the magic spell you need. Should you enter into such an arrangement, be prepared to demonstrate both joint and individual responsibility to your partners.

• **Special financial aids**—The government usually defines a small manufacturing business as a company with

250 employees or less, but with numerous exceptions up to 1000. Small service companies are those that gross \$5 million or less—again with some exceptions. As a result of various acts of Congress there are now a number of special financial aids to small business—nearly all administered directly or indirectly through the Small Business Administration. Here are some of the aids it offers:

• **Participating loans**—In this case SBA goes in with a bank in loaning you long-term money (up to 10 years at 5½% interest) for working capital, expansion, research and development, modernization, consolidation of accounts payable, etc. In these SBA will supply up to 90% of the joint loan, up to \$350,000 as its share.

• **Direct loans**—In this case, SBA supplies all the money. Maximum maturity is still 10 years; interest, 5½%. The top limit of an SBA direct loan is also \$350,000. Actually just over three-quarters of the loan applications coming into SBA are for amounts under \$50,000. During the July-December, 1958, period, 262 loans over \$100,000 were approved, including 21 over \$250,000.

However, few were missile companies. In March, of over 1000 loan applications coming into SBA, fewer than 10 could even be remotely connected with the missiles and space flight effort. Of this situation, SBA says:

"With exceptions, it is the opinion of the study team that the prime contractors were not familiar with SBA nor have they sought the assistance of SBA."

For an idea of how small business in general avails itself of SBA's loans, in the last six months of calendar 1958, 34.2% of the approved business loans were for working capital; 19.2% for facilities; 36.7% for consolidating obligations, and 9.9% for equipment.

Kinds of companies to whom loans go include: chemicals and allied products, fabricated metal products, machinery, electrical machinery, etc., as well as a wide variety of wholesaling, retailing and servicing companies.

• **Equity capital investment**—This is possible by one of the new Small Business Investment Corporations authorized last year by Congress and just now being set up. Seven have been established. Sixty applications are pending, of which 30 have tentative approval. Albeit indirectly, this puts government into equity financing for the first time.

SBIC's are authorized to supply equity capital in return for common stock not exceeding 20% of the SBIC's own capitalization, or to make loans in return for debentures that may be later convertible into common stock at the sound book value as of the day of the loan. SBIC's also make long-term loans secured against assets. On some of the money it lends, an SBIC may get between 8 and 12% interest—which may or may not be any bargain, depending on your need.

To be eligible for help from an SBIC, a company must be privately owned; not dominant in its field; not have over \$5 million total assets; and must not have had annual earnings after taxes in the past three years in excess of \$150,000. If its stock is traded or it has had a public stock issue of \$50,000 or more, the company is not eligible.

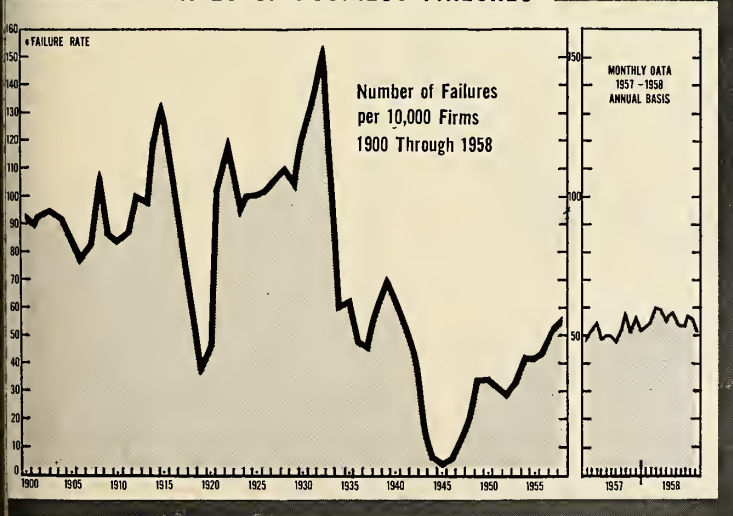
Exceptions to all these regulations are possible through application to SBA, which has close control over the SBIC's due to the fact that (a) it licenses them, and (b), it puts up part of their capital.

To get this kind of aid, no change in Securities & Exchange Commission registration is needed, and you must buy stock in the SBIC up to 2% of the loan or \$50,000, whichever is less. The investment company will not acquire control of your company unless your management turns out to be inadequate or its investment is jeopardized.

• **Dollars not answer**—For all these many ways to raise money, dollars alone won't assure a healthy maturity for the growth company. If its management isn't good, more money only means a more expensive funeral—if not today, then tomorrow.

Up to a point, sound management
(Continued on page 47)

RATES OF BUSINESS FAILURES



1958, there were 56 failures per 10,000 firms compared with 52 in 1957, but the number of failures was 55 in the second half compared to 57 in the first half of 1958.

Solid Rockets in Space: Where Do We Go?

*Bright future seen for deep space probes
where more than a simple ballistic trajectory
is needed for exact astronavigation*



by Paul Means

WASHINGTON—A strong argument for the suitability of solid rockets for space missions—even with the advent of some of the more exotic propulsion systems—has been made by Ben F. Wilkes, an applications engineer with Astrodyne. Speaking before the national aeronautical meeting of the Society of Automotive Engineers in New York, Wilkes said the basic advantage of solids in space work is their reliability, and the fact that solid propellants and motors can be designed to handle specific jobs during the various

phases of a space vehicle's flight.

Whether solids will be used as a primary propulsion system in space vehicles 10 years hence depends on many undeterminable factors, principally on the relative progress made by other types of rocket motors. If ion, fusion, plasma, or nuclear rockets approach operational status within this period, they could be used for the upper stages, and conceivably for the boosters. Without them, rocket makers will have to rely on the more advanced liquid and solid chemical rockets.

Along with development of other

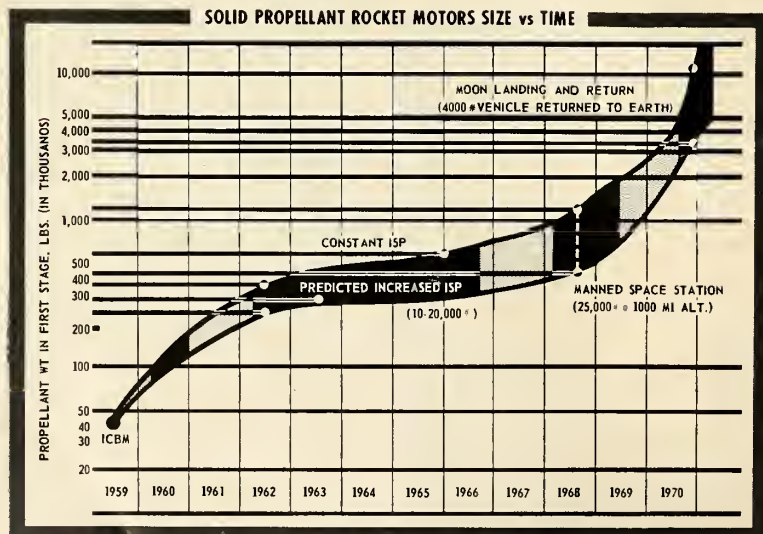
propulsion systems, Wilkes believes following factors will help decide fate of solids as a prime propellant space vehicles:

- The upsetting of the space rocket development timetable due to special problems not now known—such as unexpected radiation levels encountered by the *Explorer* satellites.
- Changes in national and international politics (and space research budgets) which could accelerate slow down developments.
- Changes in military objectives plans versus, or in conjunction with commercial uses which could affect types of propulsion systems to be used as well as time scales.

• **Upping energy**—As a space vehicle launcher, solid propellants have the disadvantage of being at the end of the energy spectrum of primary energy sources (see table). Some improvement can be expected, Wilkes believes, in the ability to convert a solar reaction energy to kinetic energy.

He is supported in this conclusion by H. W. Ritchey, vice president of the Thiokol Chemical Corp. In an article in the House Astronautics Space Committee's staff report on *Next Ten Years in Space*, Ritchey stated: "Although a 1 million-pound thrust liquid combustor may be feasible, solid engines developing through 10 to 100 times this figure present a straightforward engineering problem."

• **Strong points**—Solids also cannot be considered as space vehicle launchers, Wilkes feels, because of their reliability, simplicity, quick response start, and the ease with which they can be staged. Using five or six solid sta-



VERSATILE SOLIDS for space vehicles can grow in the next decade. Top curve assumes no change in available energy; bottom assumes increase.

a space vehicle launcher, he reduces, allows increases in the payload with less going to gross load.

The other advantage in using a multi-stage solid space vehicle launcher, according to Wilkes, is that "if the operational and environmental requirements for these motors are carefully considered beforehand and one motor is not expected to be everything, then propellants and motors will be found to handle specific jobs. For example, a motor that is to operate in space should not be required to meet the same handling and storage requirements that an everyday rocket motor or artillery use must meet."

The various stages, Wilkes believes, could be designed to optimize performance, i.e., "propellants with different burning characteristics, propellant weight ratios, nozzle designs, chamber pressures, throat area ratios, etc."

Low motor weights could be utilized in the final launching stages, after the rocket has reached an altitude where there are near-zero drag losses, because the vehicle at that point could be accelerated to theoretical maximum velocity independent of thrust.

Problems yet to be solved before solids become effective space vehicle launchers, Wilkes believes, are those of achieving close dimensional and weight tolerances of hardware and propellant charge, and possible close tolerances of ballistic parameters and thrust termination.

• **For moon trips**—An area in which solids have an advantage over liquid, greater-specific-impulse liquid propellants is in proposed manned, unpowered, round trips to the moon. High projection velocity, Wilkes points out, would not allow the space vehicle to use the moon's field as a source of substantial trajectory shaping. The idea is to keep initial velocity low so that the unpowered vehicle will travel behind the moon and then be deflected around its return trip to earth.

Low projection velocity, and its resulting increase in payload, would be advantageous for missions needing great increases in payload weight, such as missions requiring the expenditure of large amounts of electrical energy in flight, or manned flights where the demands of nutrition and a suitable environment increase with flight duration.

Low projection velocity solid rockets would also give the "marked sensi-

tivity of flight duration to small errors in this velocity," Wilkes asserts. The close scheduling needed for an unpowered flight into deep space and return to earth would "require very close control of projection velocity simply to prevent variation in flight time," and solid motors could be used "to give the minute corrections."

One area in which solids may have a promising future, according to Wilkes, is in deep space probes to planets or space stations where more than a simple ballistic trajectory is needed to allow the space vehicle to arrive at the exact point in space at the exact point in time.

• **Disturbing forces**—Besides the minute exactness of burnout velocity and position necessary for a space vehicle to start on its way into space, Wilkes lists 16 forces at work in the universe for which the rocket will need counteraction or thrust correction.

These are:

- (a) The last-minute aerodynamic forces escaping from any atmosphere;
- (b) Errors in burnout velocity and position of the vehicle—any residual propellant or unnecessary weight could affect the whole trajectory;
- (c) The geomagnetic field of the earth, sun, planets, asteroids, etc.;
- (d) Electrical forces, both known and unknown, and even the magnetic fields generated by induced currents in conducting parts of the vehicle itself;
- (e) Radiation forces from the sun;
- (f) Cosmic rays;

(g) Radio noise from the sun and other space objects;

(h) Temperature changes;

(i) Meteor impacts;

(j & k) Einstein Mechanics and Newton's Laws—will they hold true in space?

(l & m) Navigating in space, and the refraction and aberration of the instruments used for navigation;

(n) Bulge perturbations in the gravitational forces in the planets, sun, etc., and their effects on the space vehicle;

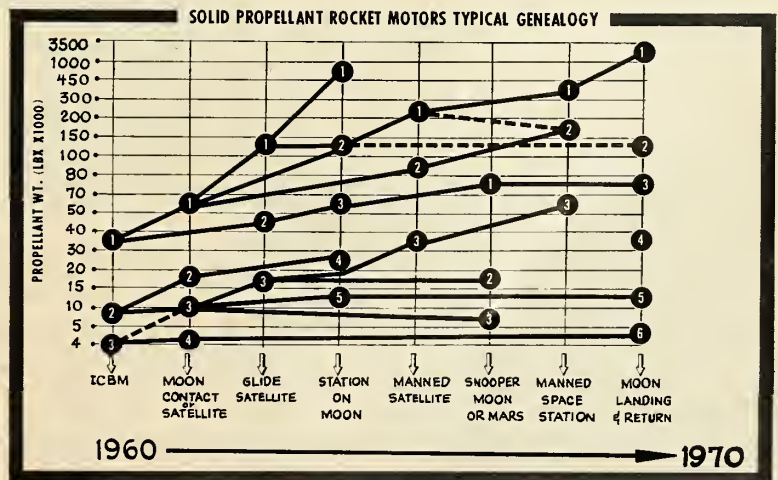
(o) Errors in earthly calculations and observations of mass and gravity of space vehicles;

(p) And the motions of the internal masses of the space vehicle.

Thrust correction and counteractions by solid-propellant rockets, Wilkes believes, could compensate for, and even eliminate, the effect of some of the forces. Others, he believes, could even be used to stabilize and orient the vehicle. Other forces, such as the effect of radio noises on guidance control from earth, would need man in the vehicle itself to correct.

• **Mars and back**—Wilkes describes how simple, reliable, solid-propellant rocket motors could provide the necessary guidance control for a space vehicle travelling from earth to Mars and back:

After arriving at an earth satellite space station, the vehicle would then make 377 revolutions about the earth until it arrived at the point where its



HERE'S HOW solids will grow in size and number of stages during the next 10 years of rocketry advancement in space exploration.

total energy would be equal to that of a body falling to infinity from that point.

Shortly after this point is reached, after 108 days of flight, the trajectory would start its hyperbolic path as the vehicle accelerated.

The problem now is to put the vehicle into a trajectory which will allow it to arrive at Mars. If thrust is shut off before reaching the escape point from the earth's pull, the rocket would continue its elliptical orbit around the earth. If thrust is shut off after the escape point is reached, the rocket would go into orbit around the sun.

But by cutting off thrust slowly, the rocket's trajectory can be changed from a spiral to a circular one. As soon as the correct position is reached, thrust is switched on and the vehicle continues on a spiral path about the sun towards Mars.

The advantage of using solid rockets for thrust corrections during heliocentric departure, according to Wilkes, is to counteract the possible errors due to (1) technical cutoff errors in the escape hyperbola; (2) uncertainty in knowledge of the combined mass of Earth-Moon-Sun System; and (3) the uncertainty with which the mean Sun-Earth distance is known, which is detrimental to the accuracy of the transfer orbit because of its sensitivity to inaccuracies in tangential velocity.

• **Bending trajectory**—Guidance, which could be provided by small solid rockets motors, is needed during mid-course, and at the end of 194 days of flight, when thrust direction is reversed 180 degrees and the rocket decelerates.

Series	Type	Wt. Pr. plnt. Lbs.	Thrust Lbs.	Dia. In.	Length Feet	Duration Sec.	Isp Lb. Sec./Sec.	Propellant Fraction
1	General Application	4K-10K	10K-100K	38-54	4-13	40-90	> 225	> .89
2	Single Unit Lg. Total Impulse	120K 200K	500K 4500K	72-96	20 60	10-90	> 245	> .90
3	(4) Clustered Series 1 or 2	100K 1000K	1000K 5000K	(1)	(1)	10 90	> 245	> .90
4	Specialized Hi Perfmc Might Be Used For Series 1 or 2	.1K 10K	2K 50K	10 48	2 10	6 60	> 255	> .90
5	Accessory Power	0 < 1K	.5 50	Small	Short	2 Sec. 3 Hrs.	100 to > 245	High

NOTES:
Reliability desired = 100%.
Operating temperatures always reaching for greater spans = <-65 to > 160°F.

FIVE DIFFERENT families of solids could handle most of a space vehicle's propulsion needs. Ultimately envisioned is 4.5 million pounds of thrust.

After 275 days, thrust is again reversed and the ensuing acceleration bends the trajectory toward the Martian ellipse. Wilkes estimates that correction impulses of only 200 to 400 fps will be sufficient to generate encounter distances of about 10,000 nautical miles.

Correction thrust is used again if the vehicle heads for the Martian ellipse too early or too late. If too early, according to Wilkes, it directs thrust first rearward then slowly toward the sun to compensate for the sun's attractive force. If it arrives too late, it reverses this process.

Solid rockets could also be used on the final approach, when the rocket needs some thrust to force it closer to Mars, and some side thrust to create

a spiral so that it will not fall straight into Mars. The solids also would be ideal as the retros and/or verniers which decelerate the rocket into circular orbit around Mars.

An analysis of this projected trip to Mars, according to Wilkes, "adds up to the need for guidance control. Simple, reliable, solid-propellant rocket motors used all along the way will make sure the desired terminal orbit is reached . . ."

• **Solid versatility**—Wilkes admits that liquid propellants probably will be ahead of solids in the available propellant energy or specific impulse, and that for this reason liquid will probably be the primary propellant used for a large space vehicle booster's first stage. But because of their instant readiness and reliability, he thinks that solids will be used more and more for the rest of the stage. And their great advantage is that they can be used in all areas of space flight.

The accompanying tables indicate how solid rocket motors will grow during the next decade to propel some of the space vehicles now in the planning stage. Still to be overcome are large solid rocket engine design and problems of making the propellant retain its shape and reliability throughout burning.

Wilkes foresees solid rocket motors developed up to a scale where they would be 200,000 lbs. in weight, 500,000 lbs. in thrust, 60 ft. in length, 96 inches in diameter, 90 seconds duration, and a .90 propellant (to weight) fraction.

Clustering rockets of this size, smaller ones, according to Wilkes, could go on ad infinitum, until structural material can't withstand the strain

Energy Source	Theor. Max. Isp Lbs. Sec./Lb.	Relative Energy Release (Ergs./Gm.)	Fraction of Annihilation Energy
1. Chem. (Solid or Liquid)	225 to 300	1.0 x 10 ¹⁰	1.1 x 10 ⁻¹¹
2. Super Chemical (H ₂ + O ₂)	364	1.3 x 10 ¹¹	1.5 x 10 ⁻¹⁰
3. Free Radical Chemical (H + H → H ₂)	2140	2.2 x 10 ¹²	2.5 x 10 ⁻⁹
4. Nuclear Fission	200 to 1 x 10 ⁶	7.1 x 10 ¹⁷	8 x 10 ⁻⁴
5. Thermonuclear	5 x 10 ⁵ — 3 x 10 ⁶	3.6 x 10 ¹⁸	4 x 10 ⁻³
6. Matter Annihilation	∞	9 x 10 ²⁰	1.0
7. Solar	1000 to 3 x 10 ⁷	3.3 x 10 ²	Calories/Sq. Cm./Sec.

INDICATION OF low energy of solids compared to other primary energy sources. However, this can be overcome by staging and clustering.

Space Technology Laboratories is responsible for the over-all systems engineering, technical direction and related research for the Air Force Intercontinental and Intermediate Range Ballistic Missile Programs and for the highly successful Thor-Able series of ICBM range re-entry launches. ■ In addition, STL carries out special experimental projects for such agencies as the National Aeronautics and Space Administration and the Advanced Research Projects Agency. On behalf of these agencies and in conjunction with the Air Force Ballistic Missile Division, STL designed and produced the Pioneer I payload, one of the most sophisticated fact-finding devices ever launched into space. In addition, STL provided systems engineering and technical direction for the Air Force satellite, the Atlas SCORE. ■ In support of these and future requirements, STL's activities provide a medium through which scientists and engineers are able to direct their interests and abilities towards the solution of complex space age problems. STL invites inquiries regarding staff openings in any of the five major areas of the company's activities.

Physical Research Laboratory

...conducts basic research including analytical and experimental investigations in magnetohydrodynamics, thermonuclear power, plasma physics, and low temperature solid state physics.



Electronics Laboratory

...provides technical direction for, and conducts studies leading to, design and specifications of advanced guidance, control, and communication systems; also packaging, environmental testing and over-all checkout.



Astrovehicles Laboratory

...conceives, evaluates, designs, develops, and tests space vehicle systems; provides technical direction of propulsion, nose cone, and airframe subsystems; explores new propulsion, airframe, re-entry, and ground handling techniques.



Computation & Data Reduction Center

...provides a centralized mathematical and computing facility and engages in advanced research in data systems, information theory, computation systems and automatic programming, systems and hardware simulation, and applied mathematics.



Systems Engineering Division
...has the over-all responsibility for the system integration of the Atlas, Titan, Thor, and Minuteman weapons systems, in addition to responsibility for technical direction of the airframe, sub-system, assembly and test, and ground support activities; evaluates proposed future weapons and space systems.





...NEWS IS HAPPENING AT NORTHROP

Now being produced and delivered to the U.S. Army Signal Corps, the Radioplane SD-1 gives greater battlefield surveillance flexibility to combat units than ever before. (This photo of terrain was actually taken from an SD-1 at 1,000 feet.)

RADIOPLANE PRODUCES FIRST COMBAT-READY SURVEILLANCE DRONE

Meeting tough Army Signal Corps requirements and being produced in operational quantities, the SD-1 is proved and ready to fly unmanned photo reconnaissance missions for tactical troops.

Highly mobile, the camera-carrying SD-1 may be zero-length launched in rough terrain from a camouflaged position. It is flown by remote control over enemy installations on surveillance missions without risking a pilot's life or man-carrying

aircraft. Within minutes after the SD-1 returns from its mission, photographs are delivered to the requesting unit.

Other specialized sensory equipment may be carried by the SD-1 depending on particular mission requirements.

This Army-Radioplane achievement exemplifies Radioplane teamwork with all of the U.S. Armed Forces. Radioplane provides a complete drone family spanning medium speeds through supersonic performances.



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What's the future for electronics in GSE?

Electronic Output to Double by 1965

by William E. Howard

WASHINGTON—Plotted on a graph, fortunes of the Nation's electronic industry resemble the upward arc of ICBM's trajectory. For the next decade the outlook is for the industry to keep on expanding at an even dizzier pace.

Propelling the industry on its headlong flight are demands to produce more and more complex missile systems and in with a growing and extremely intricate "decision-making" alarm network to give the U.S. a capability for instant response to Soviet attack.

And as missiles become operational, the industry is being pressed to manufacture in greater and greater quantities the equipment to back them up on the ground. Seventy-five percent of man's guidance and control system is on the ground; *Minuteman's* is expected to be in a 90-10 ratio.

Taking a looking into the future this week, Electronic Industries Association President David R. Hull told ENR that the Nation's electronic output must double by 1965. This will mean at least 50% increase in existing plant capacity, he said.

He sees the government spending a total of \$30 billion on missiles between now and 1965—with more than half that amount going into missile electronics.

The EIA estimates for the electronic share of the missile budget for the 1960 fiscal year is \$2 billion. This is more than half of the \$3,922 billion total EIA expects the armed forces to spend on missiles.

For the period through 1970, the association says "a total of over \$100 billion" will be available for electronics expenditures from this source alone. "By the end of the period," it adds, "70-75% of the defense dollar will be earmarked for electronics."

• **Space funding**—General increases in procurement by the government for electronic equipment, for commercial aviation and space activities are also expected to boost the industry's output. EIA believes ARPA's appropriations

Estimated DOD Authorizations For Electronics
(Fiscal Years in Billions of Dollars)

		Operations & Maintenance											
		59	60	61	62	63	64	65	66	67	68	69	70
Dollars	Authorized	9.4	9.6	9.8	10.0	10.3	10.6	10.9	11.1	11.3	11.5	11.8	12.1
	Percent for Electronics	9	9	10.5	11	11.5	12	12	12	13	14	15	16
Dollars	for Electronics	.85	.86	1.03	1.10	1.18	1.27	1.31	1.33	1.47	1.61	1.77	1.94
		Major Production & Procurement											
Dollars	Authorized	14.3	15.3	16.0	16.7	17.8	18.2	18.7	19.2	19.7	20.0	20.3	20.6
	Percent for Electronics	29	30	31	32	32.7	33.2	33.8	34.5	35.0	35.8	36.4	37
Dollars	for Electronics	4.15	4.59	4.96	5.34	5.82	5.86	6.32	6.62	6.90	7.16	7.39	7.62
		Research & Development											
Dollars	Authorized	2.6	2.7	2.8	3.0	3.8	4.6	5.4	5.9	6.2	6.5	7.0	7.5
	Percent for Electronics	19	21	24	27	29	31	32	33	34	35	36	37
Dollars	for Electronics	.49	.56	.67	.81	1.10	1.43	1.73	1.95	2.11	2.28	2.52	2.78
TOTAL DOLLARS FOR ELECTRONICS IN ABOVE CLASSES		5.49	6.02	6.66	7.25	8.11	8.56	9.36	9.90	10.48	11.05	11.68	12.34

will fall off from \$455 million in 1959 to about \$170 million in 1964. But, says the association:

"NASA will probably finish fiscal 1959 with authorizations of about half a billion dollars, and will triple this by 1964. By 1970 space programs are expected to be operating at a level over \$3 billion.

"FAA (Federal Aviation Agency) is expected to nearly double its 1959 fund level, reaching \$1.2 billion by 1964. Increasing air activity will maintain this trend. By 1970 authorizations may exceed \$2 billion."

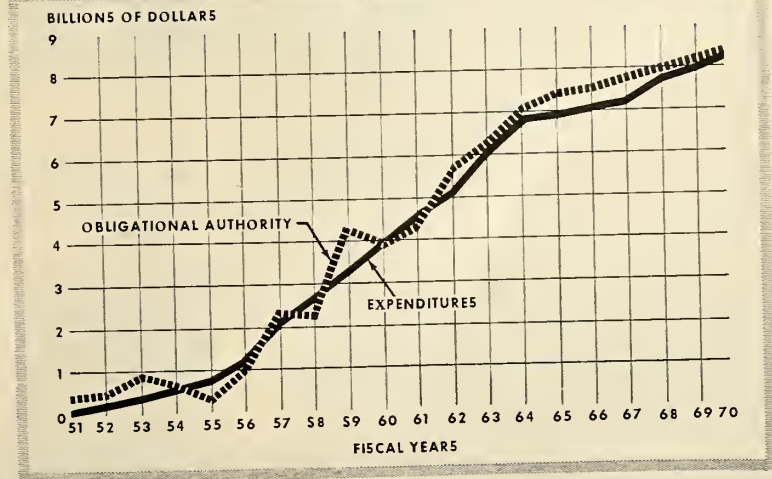
EIA experts are inclined to discount suggestions that the defense budget will be enlarged abruptly by

Congress short of an emergency. The current defense budget of close to \$41 billion, they point out, along with the non-defense budget of about \$36 billion is already pushing Federal credits to the limit.

Accordingly, these experts believe actual defense spending will rise slowly over the next 10 years—in step with the gross national product—to a top of about \$57 billion.

• **Ready to grow**—Individual electronic companies, Hull says, already are planning ways of coping with the expected expansion. He said a number have considerable reserve facilities and the government has some backup plants.

MISSILES



Third of a series on
Missile Support

THE GRAND CENTRAL REPORT

Tennessee Gas Transmission Company and Food Machinery and Chemical Corporation, the parent companies of Grand Central Rocket, have extensive investments in the energy field. In addition to their interest in Grand Central, TGT is in the oil, gas, and petrochemical fields, while FMC has three other divisions in dimazine, peroxygen chemical and boron propellants as well as other fuel and related products.

It is the long-range plan of both parent companies to build a strong position in the energy field. Grand Central Rocket Co., as a developer and producer of solid propellants and solid rocket motors, is a vital part of this plan.

It is our goal to make Grand Central Rocket, under new and aggressive management and with the addition of major facilities, one of the strongest and most capable solid propellant rocket organizations in the country.

Joe J. King

JOE J. KING
Chairman of the Board
Grand Central Rocket Co.

(If you have the qualifications that a fast-moving space propulsion team needs, contact our Director, Personnel. Openings now for chemists and engineers.)

Grand Central
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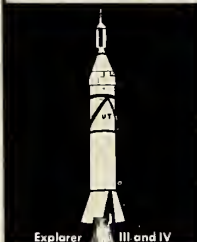
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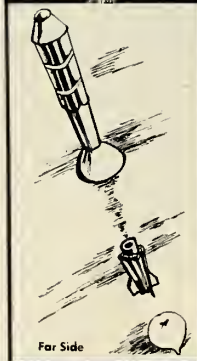
Mercury



The Dart



Explorer III and IV



Far Side



Vanguard



Nike-Zeus



Test Sled

Most firms presently are operating one shift and a step-up to two and three shifts a day alone might boost output by over 100%. However, Hull said training personnel looms as a major problem and it has been industry experience that second and third shift operations are not as effective productionwise as the primary day shift.

To finance required additional facilities, Hull said the industry would be able to lay out the capital for brick and mortar, but "we may have to call on the government for special tooling and test facilities."

Hull feels any future expansion will follow the present pattern. New companies will be formed by "break off" of personnel. "They will merge and re-amalgamate."

"There are amazingly few failures," said Hull, pointing out that most new companies are founded on know-how in a specialized area of electronics. He said he does not anticipate a "radical expansion in any one area; advancement of tubes and semiconductor products probably will be balanced."

• **Ratio climbing**—The electronics industry currently is devoting 52% of its energies to military requirements. In 1958 this translated into factory sales of \$4.1 billion for military products and \$3.8 billion in industrial and consumer goods.

Increasing demands from the military, EIA believes, will shift the ratio to 60-40 by 1965, with missiles accounting for most of the difference.

Pentagon procurement officials say their figures bear out the fact that electronics companies are getting a bigger and bigger share of the defense budget dollar. At present, 11 cents of every DOD dollar is spent on some electronic component or service, and out of every "hard goods" dollar, 28 to 29 cents goes into electronic equipment.

In addition to missiles, this expenditure covers everything from walkie-talkie to wholly-transistorized computers for SAGE supercombat centers and giant radar dishes for BMEWS.

The actual number of components produced by the industry for missile systems alone is staggering. It runs in the hundreds of thousands—from 35-ton Talos fire control systems to miniature components so small that 600,000 may be crammed into a density of one cubic foot.

• **Challenges**—Hand in hand with the exploding technology and expansion of the industry is the creation of new opportunities in both the military and civilian markets. Missiles offer the greatest challenge.

Right now Hull says there is a need for the industry to come up with smaller, more complex and more reliable test devices for system check-

missiles and rockets, May 25, 1959



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GE Offers New Micro-Modular Concept

Company claims eraser-size device named TIMM utilizes heat losses and lends itself to stacking for varied uses

PHILADELPHIA—A different concept of building several radio tubes and their circuits in one tiny, ceramic, stacked module for space electronics has been announced by General Electric Research Laboratory.

The laboratory has produced new devices called TIMM's, for "thermionic integrated micromodules." Instead of trying to eliminate the heat in tightly-packed electronic equipment, GE scientists have confined this heat and put it to work operating vacuum devices.

A complete circuit, such as an amplifier or multivibrator, occupies a space no larger than that of a pencil eraser, said GE. Operating at nearly red-hot temperatures, it takes full advantage of the high-frequency and reliability features of thermionic electron tubes.

• **New twists**—The design and operation approach embodied in TIMM's differs chiefly from other micro-modular concepts in that (1) tiny heaterless electron tubes are used instead of transistors, and (2) auxiliary cooling is reduced or eliminated and the heat losses generated within an equipment are utilized.

This serves the purpose of increasing the overall efficiency of operation and contributes to the extended life and reliability of the equipment. The TIMM's can be stacked, like building blocks, to provide a variety of electron circuit functions.

Resistors built into the ceramic modules consist of a resistive film on the inside of evacuated and sealed ceramic insulators. Laboratory reports indicate resistances of 5K per square are possible, and resistors made in this fashion of from 1 ohm to 500K have operated stably at 700°C.

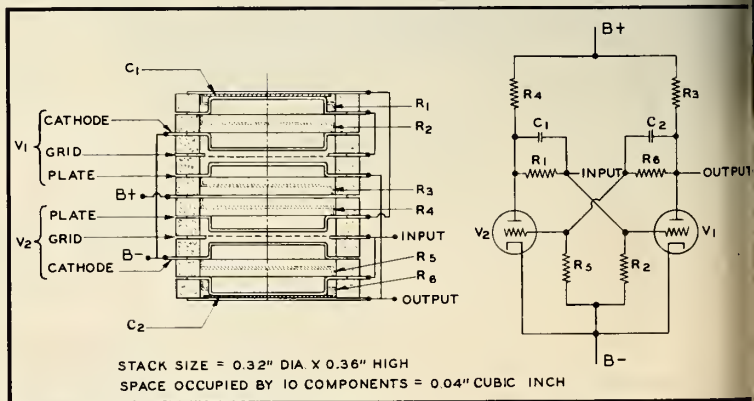
The preliminary data have shown changes of less than 3% in resistance in an operating temperature of 550°C, and similar stability in operation with a nuclear pile.

Built-in microminiature capacitors, with synthetic mica as the dielectric, in operation have shown a change of less than 5% over a temperature variation ranging from zero to 700°C.

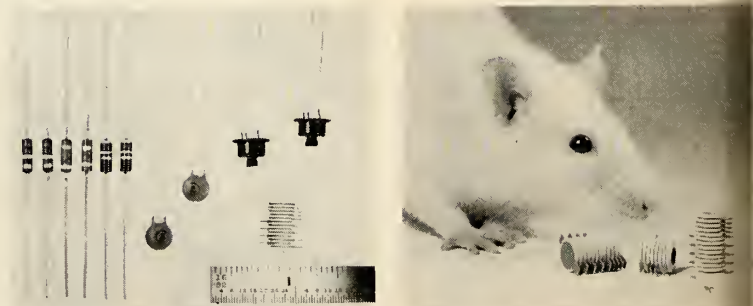
The heaterless electron tubes built into the stacks have a self-biasing characteristic—no grid current flows until the grid is at least two volts positive with respect to the cathode—thus eliminating the necessity for an external bias battery or a cathode-bias resistor and capacitor.

• **Component density**—A typical circuit module 1/3 inch in diameter and 2.6 inches in length can contain 14 diodes, 14 triodes, 14 resistors, and capacitors. This total of 44 components yields an operating circuit density of 250,000 components per cubic foot. With different operating requirements, densities of 1,000,000 components per cubic foot are possible, said the company.

A circuit function capable of 10 megacycle operation, selected as a



CROSS-SECTION and schematic diagram of a typical GE TIMM.



TINY CERAMIC micromodule (just above ruler in photo at left and investigated by mouse at right) is less than 1/3 inch in diameter, can be stacked several inches. It comprises equivalent of conventional units shown in the left-hand photo.



suit-ability

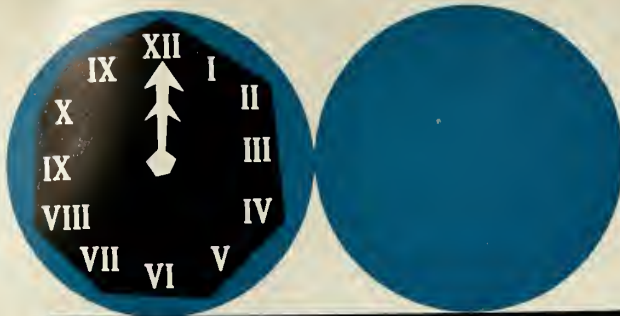
FROM PHILOSOPHY — TO FEASIBILITY STUDY — TO DESIGN AND PRODUCTION

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GUIDANCE SYSTEM FOR THE ATLAS MISSILE
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Certainly other ambitious engineers and scientists will find no more unique challenge for professional achievement than through an early appointment in the space age with Pan Am. If you are one such man, we invite you to investigate our career opportunities by addressing a brief resume to Mr. J. B. Appledorn, Director of Technical Employment, Pan American World Airways, Inc., Dept. B-8, Patrick Air Force Base, Florida.

**Guided Missiles Range Division
Patrick Air Force Base, Florida**

...missile electronics

example only, includes a pair of triple input "and" gates, a bistable multivibrator, and dual cathode follower outputs. It contains 30 parts and represents a circuit density of 250,000 components per cubic foot.

The circuit generates its own operating ambient temperature of 58°C and requires less than ¾ of a watt of power from an external source. A comparable epoxy-encapsulated semiconductor version of the same circuit, capable of 5-mc operation and built by present methods, would contain 300 parts and with a circuit density of only 33,000 components per cubic foot would be limited in operation to a temperature range of minus 55 to plus 71°C.

• **Advantages**—GE believes that ceramic micro-modules make possible circuits which are smaller, lighter and generally require fewer components than their conventional encapsulated semiconductor counterparts.

Also, they seem to offer fewer temperature problems, higher reliability, longer life, greater ruggedness, resistance to nuclear radiation and higher operating speeds without sacrificing the signal power levels of their printed board or encapsulated predecessors.

In systems applications, their compactness should lead to improved electrical performance and greater efficiency through the useful application of circuit power dissipation, said company spokesman. It also tends to reduce both weight and volume in systems where elevated temperature environments are encountered.

The GE Receiving Tube Dept. in Owensboro, Ky., has announced that it already is planning the necessary applied research, development and production engineering procedures to make the devices, and engineering samples could be developed in a relatively short time. Production in quantity may be possible after another year, depending on the requirements of particular applications.

NCR to Research Photochromic Memory

HAWTHORNE, CALIF.—A one-year, \$90,000 contract from the Wright Air Development Center Aeronautical Research Laboratory for photochromic memory research has been awarded to the National Cash Register Company Electronics Division.

Photochromic memory techniques and devices leading to possible future application in an ultra-high-density memory will be investigated theoretically and experimentally.

Studies will be based on the encapsulation of photochromic materials in missiles and rockets, May 25, 1955

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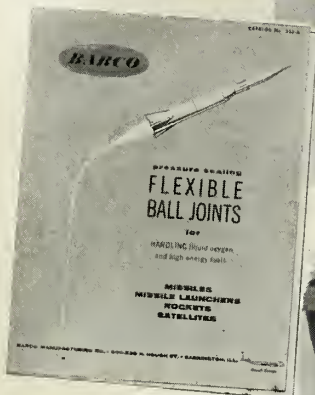


The earth from 100 miles up, taken by Navy camera, shows 2,000 miles of U.S. and Mexico.

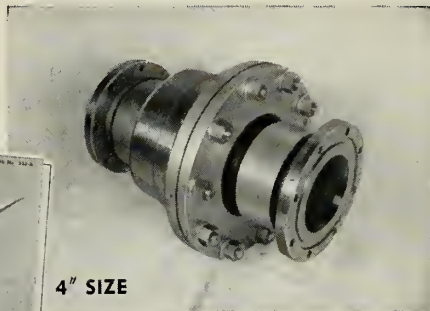
1912

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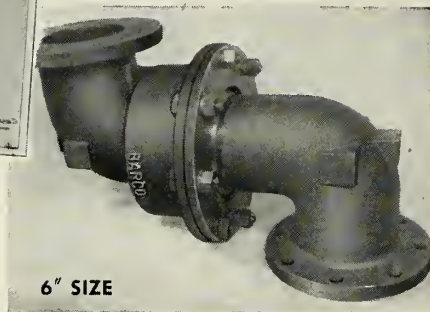


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ASK FOR NEW CATALOG 269-A.



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AIRCRAFT DIVISION

. . . missile electronics

sulation technique developed by Navy research laboratories in Dayton, OH in which a light-sensitive liquid dye stored in a gelatin capsule only a millionths of a meter in diameter, cause the fluid has the necessary stable states for switching, the microscopic chemical memory cell can store or give up information instantaneously in response to a beam of light. The small size of the cells points to computer memories of unprecedented density for airborne and spaceborne applications, said NCR. It is believed possible to coat a square inch of film with 1,000,000 of the capsules.

Eventual application of the research findings will be in automatic command and data systems for high-altitude vehicles. The immediate goal is to obtain all necessary data for a detailed preliminary design of a feasible model having optimum photochemical memory. The program will be concerned with simplicity of design, increased reliability, minimum read access time, high storage density, weight, low power consumption, sensitivity to severe environmental conditions, and low cost.

Unit Cools IR Gear to As Low As 60°K

CAMBRIDGE, MASS.—A tiny cool device which super-chills infrared detection (IR) equipment to 60°K by a new refrigerating technique has been developed by Arthur D. Little, Inc., Cambridge research and engineering company.

The 8-ounce unit is the result of the company's two-year research project into extreme low-temperature equipment. Known as the min-cooler, it will be shown at the National Missile Industry Conference (May 28) in Washington.

Believed to be suitable for airborne operation in missiles or airplanes, the current closed-cycle IR detection system is designed to weigh less than 10 pounds. Further development with the new device is expected to reduce weight to less than 10 pounds, ADL.

In operation, helium gas expands from 300 psi in a $\frac{1}{4}$ -inch-diameter cylinder, 2 inches long. A tiny piston is the only moving part below room temperature. The cold end of the tube refrigerates an IR cell to 60°K .

Cooling IR detectors to extremely low temperatures increases their sensitivity and makes them responsive to a wider range of wavelengths. This makes it possible to detect small radiation differences between the "target" and its background.

RTV (room temperature vulcanizing) silicone rubber being applied as sealant in Douglas DC-8. RTV cures without application of heat; won't shrink (no solvents); forms no voids. It has excellent bond strength, plus resistance to high temperatures, moisture, weathering, ozone, aircraft fuels and solvents.

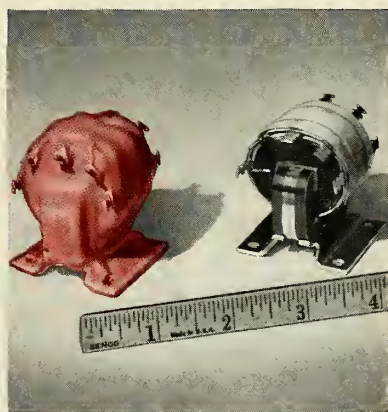
G-E RTV silicone rubber—a superior material for tooling, encapsulating and sealing



Prototype jet engine nose cone (right) cast in RTV mold. Epoxy parts cast in flexible RTV molds have a bright, glossy surface and reproduce extremely fine detail. No parting agent is required for even the most complex parts. High tensile and tear strength is retained even after prolonged heat aging.



Close-tolerance, non-standard helix gear cast complete in low-cost, one-piece RTV mold. Previously such replacement parts had to be machined by hand. Now they can be quickly and inexpensively replaced by using the broken part as a master.

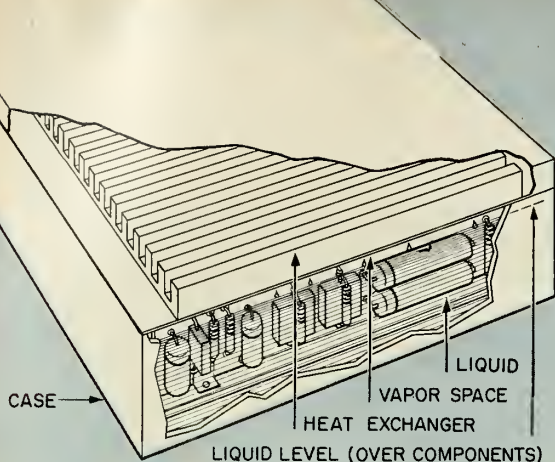


Potting and encapsulating of electrical components, such as this aircraft transformer, are easy with RTV. It can be poured, sprayed, painted or applied by dipping. Temperature resistant from -60°F to $+600^{\circ}\text{F}$; excellent resistance to high altitude arc-over and corona. Comes in wide viscosity range.

For application data and samples of General Electric RTV silicone rubber, write to General Electric Company, Silicone Products Department, Section 052, Waterford, N. Y.

GENERAL  **ELECTRIC**

Silicone Products Dept., Waterford, N. Y.



In Raytheon's "EV-GRAV" system, liquid refrigerant boils off the surfaces of the individual electronic components, rises as vapor, condenses on the heat exchanger, and drops as liquid to repeat the cycle.

"EV-GRAV" COOLING

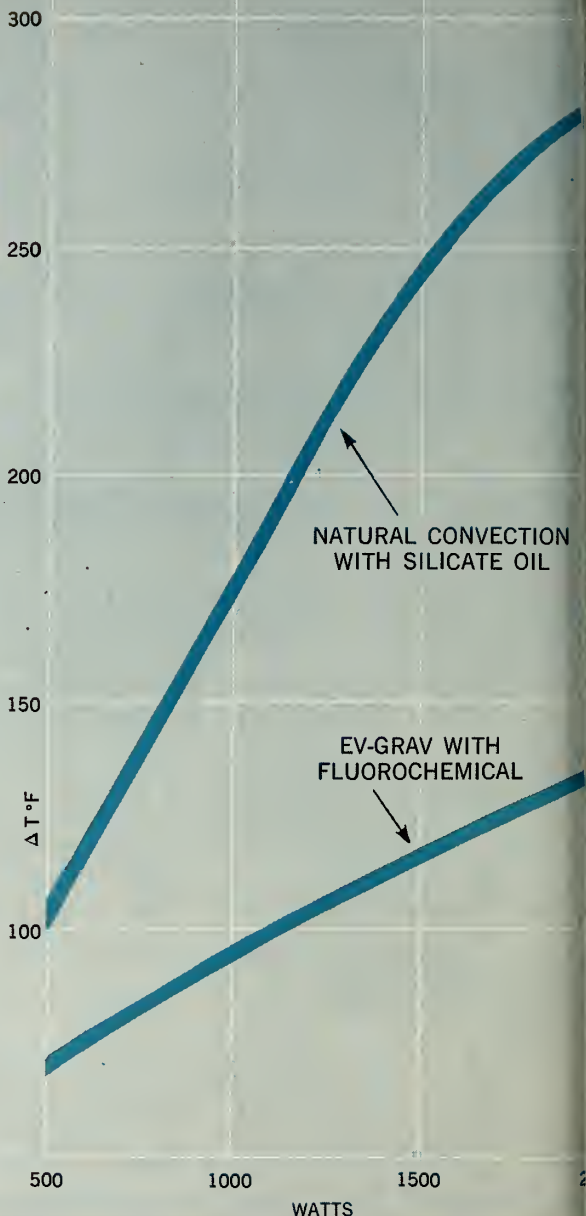
IN THE DESIGN OF HIGH HEAT-DENSITY ELECTRONIC EQUIPMENT

Performance requirements for electronic equipment in supersonic aircraft and missiles place particular emphasis on the need for more efficient heat transfer techniques.

The use of fluorochemical refrigerants in an "evaporative-gravity" cooling system is a novel method of removing heat from electronic components. The refrigerant boils at the surfaces of submerged heat-dissipating components and condenses on the surface of a heat exchanger at the top of the package.

This technique has proved more efficient than free convection in oil dielectrics or forced convection with gas dielectrics. The high dielectric strength of the fluorochemicals permits the achievement of higher density packaging.

Contributions such as this are typical of the Heat Transfer Group in Raytheon's Government Equipment Division . . . assisting design engineers in developing the complex weapons systems of tomorrow.



PROFESSIONAL ASSOCIATION WITH A FUTURE

Qualified engineers and physical scientists with BS or advanced degrees interested in systems, development, design or manufacturing engineering of complex electronic equipments are invited to write Donald H. Sweet, Government Equipment Division, Raytheon Manufacturing Company, Wayland, Massachusetts.

Engineering Laboratories: *Wayland, Maynard, Sudbury, Mass.; Santa Barbara, Calif.*
 Manufacturing Facilities: *Waltham, North Dighton, Mass.*



Excellence in Electronics

GOVERNMENT EQUIPMENT DIVISION



LAND



SEA



AEROSPACE

U.S. Seeks Ways to Close Translation Gap

by James Baar

WASHINGTON—Hundreds—possibly thousands—of scientists working on U.S. space and missile programs are wasting their time. Much or part of the work they are doing already has been done by Russians . . . or Czechs . . . or Red Chinese . . . or other Iron Curtain scientists.

Moreover, the Iron Curtain scientists have published papers on their work. But their American counterparts may never know about it. The papers may never be translated. Or, if they are, the Americans may never see them until too late—if at all.

The solution to the problem may lie in a new Spage Age weapon: The electronic translator.

Or it may be a far broader coordinating and distribution system for what already is being translated. Or it may be a long-range Russian language training program. Any one of these would cost millions but America's missile industry can provide the ingenuity.

The House Space Committee within the coming weeks will hold a series of hearings to determine the scope of the problem and what ought to be done. Most experts will tell the committee that the problem is very great. But, they disagree as to the solution.

• **Soviet lead**—The Russians began a mass attack on the problem of translating foreign scientific literature in 1952 with establishment of the All Union Institute for Scientific and Technical Translation (VINITI).

It has a full-time staff of 2300 editors, publishers and assorted experts who screen the world's published scientific output. They draw on some 10,000 Russian scientists to translate and abstract scientific papers and books.

VINITI publishes the vast *Referativnyi Zhurnal* which provides Russian scientists each year with almost a half-million abstracts of scientific works—80% from outside the Soviet Bloc. The sections of the *Referativnyi* divided according to field are distributed throughout Russia. Full translations are provided by VINITI on request.

Besides VINITI, Russia also has three other types of organizations abstracting, translating and distributing foreign scientific material. However, VINITI acts as a centralizing point for most of the other abstracting services.

The speed with which the Russians translate and distribute foreign scien-

tific papers varies greatly.

U.S. experts say many Russian scientists complain that sometimes they don't see a translation until more than a year after publication of the original article.

However, the Russians also provide an extremely rapid express service for articles and books considered to be of top importance. Such an article may be translated and put in the hands of a Russian scientist in Moscow one or two weeks after its original publication in New York.

• **Steps taken**—The United States within the last year has made two major steps toward improving the translation, coordination and distribution of scientific literature of Russia and other Soviet Bloc nations.

The National Science Foundation in December established the Science Information Service to help make foreign scientific literature more readily available to Americans through a variety of programs.

One of the main roles of the Foundation in carrying out the program is the subsidization through grants of more than 20 societies and universities for cover-to-cover translation of 35 of the most significant Russian scientific journals.

Meantime, the U.S. Office of Technical Services has undertaken a broad program of selling translations of Russian scientific work made by all government agencies. These include translations of the Soviet *Referativnyi*.

Among other OTS offerings are:

- Bi-monthly lists of translations of Russian scientific material available from government agencies or private translating firms.

- Abstracts of about 140 Russian journals.

OTS expects to provide abstracts of more than 170 Russian journals by the end of the year. It also expects to provide abstracts of about 30 Red Chinese journals.

At present, OTS is spending about a half-million dollars a year on its program. National Science Foundation is spending more than a million.

Finally, considerable quantities of Russian translating are being carried on throughout the country by private industry. Much of this is never distributed beyond the firm doing the work in order to avoid tipping off competitors as to what the firm is working on.

In all, Science Information Service officials estimate that the United States is doing about as much translating as Russia. Also, they say about the fastest translating jobs being done in the United States take about five months—although as in Russia there are exceptions.

"Where we're behind," one expert said, "is in distribution. It's harder for the average scientific working staff to find and get the stuff in the United States."

Moreover, the United States is behind in another vital area: reducing the need for translations.

More and more Russians today speak English. They begin studying a foreign language in the first years of school. The language they most often choose is English.

On the other hand, only about 2 per cent of U.S. scientists read Russian.

• **Electronic help**—One of the most hopeful immediate solutions is the possibility of developing electronic translators out of huge computers. Study programs at a half-dozen American universities have shown that the idea is promising. And the Machine Translation Research Project at Georgetown University already has claimed a reasonable degree of success with an IBM 704 computer.

Georgetown research workers have been able to translate both French and Russian texts at a rate of three words a second. They expect far better results with the much faster IBM 709 and 7090.

However, they say the principal drawback in computer translation today is the cost of having the foreign text punched on cards, making the entire operation more expensive than human translating.

"What we need to develop is an electronic scanner or reading machine," one said. "Then we'd have something."

Some officials say the best approach to the whole translating problem probably would be twofold: perfection of the electronic translator plus a Russian language training program.

They say this would solve both the problem both for the present and the future. And they stress that the problem must be solved as quickly as possible.

As one Russian-speaking expert put it pointedly: "Rossiia dumayut! (Russia is thinking!)"

ABMA Receives First of Saturn Engines

Jupiter test stand being modified to accommodate cluster of Rocketdyne H-1 liquid engines

HUNTSVILLE, ALA.—The Army Ballistic Missile Agency has received the first of eight Rocketdyne H-1 liquid engines which will be clustered to produce 1.3 million pounds of thrust and has already begun modifying a *Jupiter* test stand for static tests here.

The entire project, dubbed *Saturn*, is on schedule, project officers say. But they have yet to name a date for first tests. Since *Saturn* is due to be flight-tested at Cape Canaveral in 1960 it is entirely possible that the first static tests may be made sometime this fall.

The H-1 engine is a refinement of the device now powering both the *Thor* and the *Jupiter* IRBM's, somewhat more compact and probably slightly smaller. Components were repackaged to achieve better grouping and the turbopump is slung "side-saddle" on the thrust chamber in contrast to its former position on top of the chamber.

Each of the eight clustered engines, will, of course, have its own turbine. LOX and RP-1 will be supplied from a common fuel tank, a combination of present *Redstone* and *Jupiter* frames.

• **Departures**—Contrary to previous speculations, the engines will be clustered in a circle, with each engine gimballed separately and possibly in

staggered depth. Provision is made for jettisoning the booster engines—with recovery by parachute a later development.

The engines are hypergolically ignited. Safety devices which will be built into *Saturn* include a provision that all eight engines must be functioning normally before the missile can be released, and compensating factors to keep the missile on course should one or even two of the engines fail during flight.

It is believed that the more compact H-1 engine will also produce a greater thrust, probably from 180,000 to 190,000 pounds, producing a combined total of the 1.3 million pounds desired. The big booster is intended to lift into satellite orbit loads of some 20,000 pounds. Under its present design, the cluster will be so high that it cannot be assembled in ABMA's "fab lab" where such work is normally done. It would almost touch the ceiling cranes necessary to move it.

In September ABMA was authorized by the Advanced Research Projects Agency to develop the super booster. During the same month, Rocketdyne received the contract from the Army Ballistic Missile Agency to develop the basic engine. ARPA said that

the cluster concept has been utilized because of the proven "extreme reliability of the Rocketdyne engine."

The entire *Saturn* system, which enters flight test in 1960, will answer the nation's urgent demand for a relatively inexpensive, reliable delivery of an extremely high-thrust booster capable of lifting into satellite orbit outward to space journeys, a multiple load of instrumentation. The thrust will be nearly four times that of the nation's currently most powerful flight-test propulsion system, the *Atlas* IC cluster of engines.

No details of the overall configuration of the *Saturn* space vehicle have been released, but in other multi-stage rocket powered vehicles the booster is jettisoned after operating for the programmed duration, permitting the upper stages and instrumentation to continue on the space journey. Parachute recovery of the booster is under study.

The start sequence is the simplest yet provided in the family of Rocketdyne engines. Safety devices have been built in; one of the safety factors is assurance that all eight engines must function normally before the missile can be released.

Hypergolic ignition (self-ignition) will further increase the reliability of the H-1. Combustion within the thrust chamber occurs above 500°F.

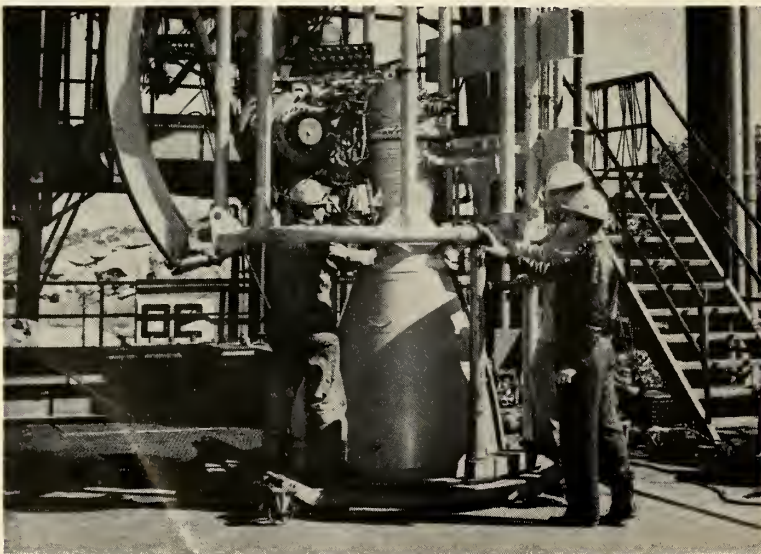
Army Redesigning Air Supply Tank for Corporal

LOS ANGELES—The Army will use a redesigned internal air supply tank for the *Corporal* and other missiles which eliminates multi-cell structural characteristics.

The tank, developed by the Firestone Tire and Rubber Co. guided missile division here, is called a "unit cell." It is comprised of two half-shells joined longitudinally and welded to 30-inch-diameter hemispherical draft heads.

Fabrication costs of the steel unit cell are estimated at about 50% less than multi-cell construction. Weight will be reduced by about 50 pounds.

In redesigning the tank, Firestone says it considered increased safety for operating personnel, cost reduction, improved reliability and higher production rate.



THE FIRST of eight H-1 Rocketdyne engines arrives at the Army Ballistic Missile Agency for clustering into Project *Saturn*.

letters

'Optik' or 'Vel'?

To the Editor:

I have read Maj. W. C. Mannix's article on the "optik" (M/R, April 27) with considerable interest and applause. My solicitation for comment prompts me to suggest a velocity unit based upon the escape velocity which, for earth considerations, approximates 7 miles per second. A monosyllabic term "vel" could be used to denote this equivalence.

Unlike the optik, the vel does not have the advantage of being absolute. However, the vel would seem to have a flexibility and convenience not shared by the optik. For example, the Mach unit has proven to be useful since it is associated with and automatically defines certain aerodynamic phenomena. By the same token, the vel would automatically define certain astronomical characteristics. For earth considerations, this table depicts the relationship between a space vehicle's orbital velocity at perigee (in vel units), and orbital eccentricity:

Units	Eccentricity	Orbit
Between 0.7 and 1	less than 1	Elliptical
1	1	Parabolic
Greater than 1	greater than 1	Hyperbolic

As a matter of interest and information, the following equivalences are slide rule approximations:

miles/hour	feet/sec	einsteins (roemers)	Orbit	
25.2	25.2x10 ³	37.0x10 ³	3.76x10 ⁻⁶	37.3
level 25.2x10 ³				

(*By coincidence, this figure yields a minor convenience in that it approximates the earth's circumference in miles.)

Reuben B. Moody
Lt. Col., USAF
622 Upchurch Circle
Montgomery, Ala.

To the Editor:

Please accept this note as representing my approval for Maj. William C. Mannix's efforts to introduce the "Optik" system related to measurements of speed and velocity in the missile era.

His article on this subject in the April issue of Missiles and Rockets was a most concise presentation of the problem; it should be commended on the clarity of thought which he set forth.

Ray Okonski
Director of Sales
Dynamic Filters Inc.
Detroit

Sec Writers Defended

To the Editor:

After reading your editorial "Six Lines for the V-2" in the March 23 issue, I feel that it could not be let pass without my comment on my part, specifically

because I have a background in both industry and government.

The editorial unfortunately conveys the impression that:

a. Government specifications are written arbitrarily by people not as "realistic" as industry engineers.

b. A manufacturer will provide an optimum piece of equipment on a government contract regardless of availability of previous tooling, availability of components, engineering time etc.

Having observed and operated on both sides of the fence, I have found that both of these are dangerous generalizations. In most cases, military equipment specifications are written by an engineer who has considerable background on the equipment for which the specification is being written. He also has a reasonably good background on the applicability of the various new types of components. Many engineering reports on research contracts are available to him to help him keep his specifications realistic. These reports are seldom immediately available to industry.

In my opinion, the engineer writing military specifications is probably closer to the equipments than most of the contractors who bid to manufacture the equipment. He must consider having to "live" with the equipment for many years and must be "realistic" in both his specification and the design for which he must give final approval. Because of these facts, I believe the government engineer must be at least as realistic as his industrial brother.

As to point b., it is quite obvious that a manufacturer is not in business as a philanthropic organization—he must make a profit. He is required by contract to meet only the minimum requirements of the specification. He would be a poor businessman indeed to discard previously developed tooling, engineering and components if they could be used on a new equipment with a minimum of change. This approach, while good business, does not lead to improvement of equipment by application of new techniques, ideas and components.

I would suggest that you investigate the difference between a research and development contract, an applications engineering contract and a production contract. I believe that you would find that spec. writers are as flexible as the situation allows insofar as the use of components, new designs, etc., is concerned in both R&D and applications engineering. In production there is very little allowance for flexibility . . .

John F. Hyland
914 Timber Lane
Vienna, Va.

Miscredit

To the Editor:

I am writing in regard to the article:

"Story Behind The Death of a Missile" which appeared in your May 4, 1959, issue.

I note that the photograph facing the first page of the article is credited, by implication, to your photographer, Mr. Cornell Capa. This photo illustrates the actual explosion of the Convair missile in the test stand at Edwards Air Force Base.

I wish to state that I am the photographer who took the picture at great personal risk and I feel that crediting this photo to another photographer, by implication or any other means, is a gross violation of existing ethics.

Allen D. Rice
1209 W. Milling St.
Lancaster, Calif.

Our apologies to the Air Force, which released the picture, and to Photographer Rice. Cornell Capa was, of course, taking pictures in the blockhouse at the time of the explosion.

Suggestion Box?

To the Editor:

Your editorial of May 4th and the statement by Dr. Walter Dornberger on page 30 touch on two aspects of one idea. The editorial points out that since every Minuteman missile will need a hole in the ground 100 feet deep, the military is looking for a more efficient and economical way to do it than by present methods. You quote a Pentagon official predicting that if a solution is found it will probably come from "a little guy with an idea."

In the profile on Dr. Dornberger, he is quoted as speaking up for a financial slice for the scientists who come up with ideas: "Creative thinking and imaginative engineering should be paid for . . . the government should guarantee a share in the profit of later production for the original creative mind."

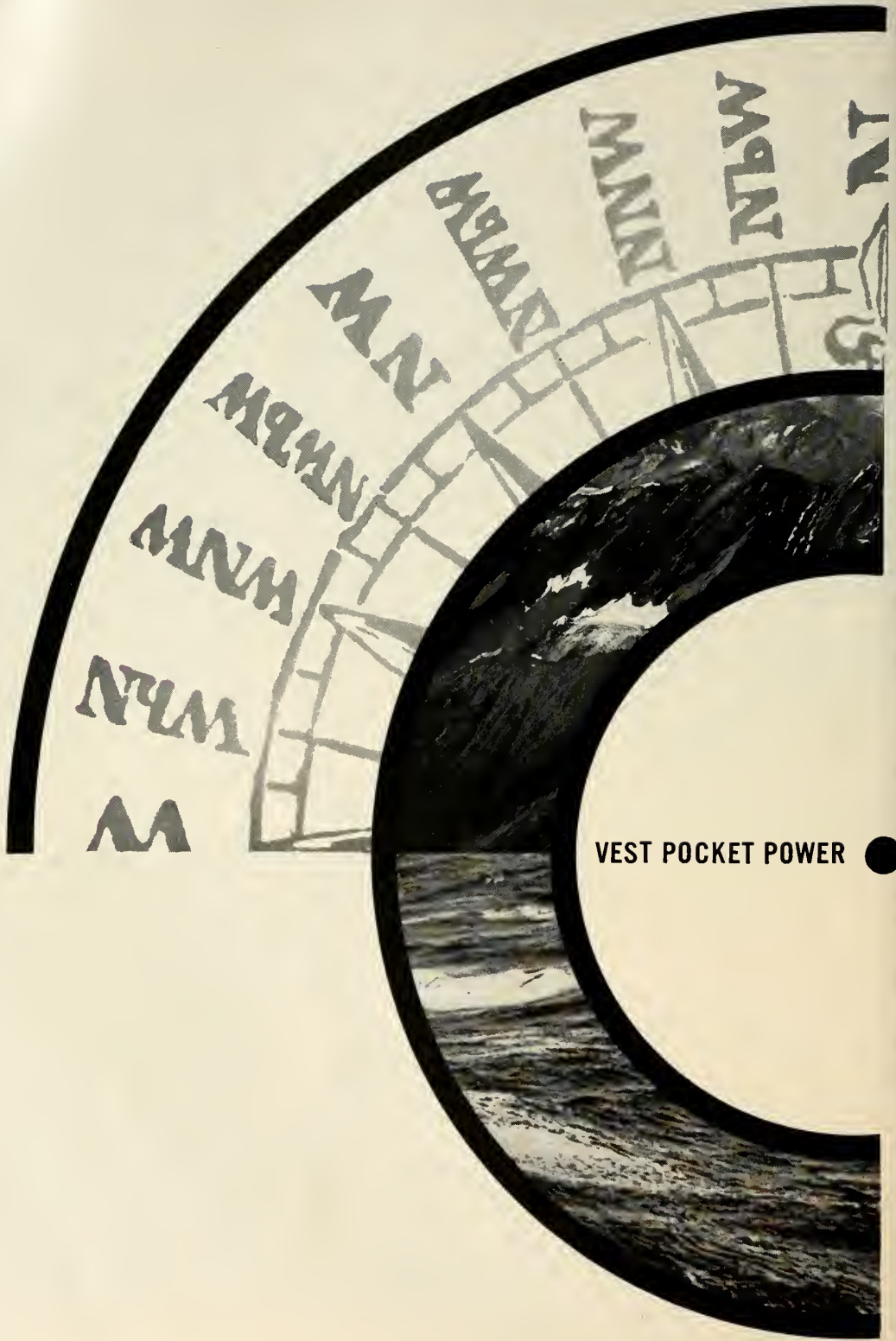
Occasionally some obscure "little guy's" idea does get used, but the lack of a channel for submitting ideas is still a major problem. Why not marry the two concepts above with a missile problems program based on the breakfast food contest idea? They set out a problem, state their rules, tell where to submit, when it will be judged and the reward.

It seems to me that Missiles and Rockets is in a position to arrange such a plan on missile problems. You are in closer contact with military leaders—which is the first obstacle for the "little guy." You might even be able to act as receiving and forwarding agency for submitted problem solutions suggested. The military agency could be contest judge.

What do you think?

H. E. Manning
Value Analyst
Convair Division
General Dynamics Corp.
San Diego

We're not sure.



VEST POCKET POWER ●

From vest-pocket nuclear generators for ocean, arctic and wilderness stations—or satellites and space systems—to portable power reactor systems meeting the large-scale requirements of military installations, the products of Martin's five-year nuclear development program are now making news... Developed under the direction of the AEC, the pint-sized 4-pound Martin SNAP III thermo-electric generator was recently singled out for commendation by the scientific community. Meanwhile, Martin is at work on a portable nuclear power plant, designed for transport by air, to provide power and heat for an Air Force installation at Sundance, Wyoming.



MARTIN

BALTIMORE · DENVER · ORLANDO

The Nuclear Division is one of the seven divisions of The Martin Company

—contract awards—

AIR FORCE

- \$29,300,000—**General Electric Corp.**, for further development of the J93 jet engine. (This is in addition to the \$8,300,000 contract previously announced.)
- \$510,000—**United Enterprises, Inc.**, New Orleans, for construction of an assembly hangar at Cape Canaveral for the *Mace* tactical missile.
- \$350,000—**Burroughs Corp.**, Detroit, for coordinating data on transmitting set compatibility to Montgomery sector radars.
- \$326,500—**General Electric Corp., Defense Electronics Dept.**, Syracuse, N.Y., for miscellaneous telemetric components.
- \$170,700—**Douglas Aircraft Co., Inc.**, for technical services.
- \$151,300—**General Motors Corp., AC Spark Plug Div.**, Milwaukee, for technical services.
- \$131,500—**North American Aviation, Inc., Rocketdyne Div.**, for technical services.
- \$83,093—**Hallamore Electronics Co., Div. of Siegler Corp.**, Anaheim, Calif., for data insertion converter rack.
- \$64,815—**Bendix Aviation Corp., Freiz Instrument Div.**, Towson, Md., for miscellaneous replacement parts for airborne weather equipment, radio-sonde receptor and radiosonde dispensing sets.

ARMY

- \$6,462,384—**Independent Contractors & Engineers**, Dallas, for construction at the *Atlas* site, Forbes AFB, Topeka, Kan.
- \$3,370,000—**Douglas Aircraft Co.**, Santa Monica, Calif., for launching equipment for the *Nike-Hercules*.
- \$1,442,315—**Industrial Metal Fabricating, Inc.**, Wayne, N.J., for 500 prefabricated buildings.
- \$1,375,010—**General Electric Co.**, for generators.
- \$777,886—**Douglas Aircraft Co., Inc.**, Santa Monica, Calif., for launching items (four contracts).
- \$510,618—**Rheem Mfg. Co.**, Downey, Calif., for fuzing system for warheads (two contracts).
- \$450,000—**Firestone Tire & Rubber Co.**, Los Angeles, for modification of guided missiles.
- \$180,499—**Harvey Aluminum**, Torrance, Calif., for study of weapon systems.

\$169,512—**Data Instruments Division, Telecomputing Corp.**, for fixed camera reader.

\$74,886—**Giffillan Bros., Inc.**, Los Angeles, for repair parts.

\$56,419—**Ordnance Engineering Associates, Inc.**, Chicago, for testing including thruster XM-11 PMTS, cartridge and load assembly.

\$46,651—**Hufford Corp.**, El Segundo, Calif., for spherical heads.

\$46,047—**Librascope, Inc.**, Glendale, Calif., for tape cartridge memory system.

\$38,205—**Airtemp Div., Chrysler Corp.**, Dayton, Ohio, for engineering orders applicable to ballistic missiles.

\$30,000—**University of Utah**, for investigation of chemical reactions.

NASA

\$175,000—**Callery Chemical Co.**, Pittsburgh, for evaluation of a new classified solid-liquid rocket propellant.

\$135,480—**Consolidated Electrodynamic Corp., Datalab Div.**, Pasadena, Calif., for design and development of airborne magnetic-tape recorders to monitor the first manned orbital space flight under Project *Mercury* (a subcontract from McDonnell Aircraft Corp.).

(The instrumentation will record physiological reaction of the pilot and monitor environmental conditions of the McDonnell space capsule.)

(Because of military applications, NASA scientists said only that the propellant was of a new non-cryogenic type that would permit substantial increase in payload weight. Callery is expected to explore feasibility of the new concept, which has both liquid and solid applications, and report its findings to NASA in about eight months. A major subcontractor in the evaluation is **Reaction Motors Inc.**, of New Jersey, a division of **Thiokol Chemical Co.**)

\$46,000—**Space Electronics Corp.**, Glendale, Calif., for a study of requirements for the proposed Project *Mercury* control center.

(The center will serve as the basic decision-making facility of the project's world-wide range of tracking, telemetry and computation centers. A scale model of the center will be developed under the contract, and requirements and specifications for the center's equipment will be assessed.)

Fellow Engineers and Scientists:

My company has asked me to tell you of the unusual opportunities in operations research at System Development Corporation. These range from positions for engineers and scientists who would like to develop their skills working in a team under an experienced leader to opportunities for those who are looking for positions of leadership. I hope that the following account of our work will lead you to inquire for further information.

Briefly, SDC's business is automated decision-making systems. More fully, we develop large scale, computer-based information processing systems in which the computer is used as an on-line, centralized control element for a system operating in real-time. At this stage of the art these systems are semi-automatic, the man-machine type in which man shares the repetitive control function with the computer. Our work is concept-oriented, rather than hardware-oriented, and deals with problems of overall system design, data processing development, and man-machine system training.

The most fully developed large-scale semi-automatic system is the SAGE (Semi-Automatic Ground Environment) Air Defense System. We have a major responsibility in the development of SAGE. Our experience and unique team skills have led to diversification of our activities; we now have important contracts for other major military and government systems vital to our country. The demand for our services is reflected in our growth from 70 to more than 2,700 employees since 1955, and the intriguing possibilities of automated decision-making are only beginning to be realized.

In this brief message, I can only suggest the variety of operations research problems at SDC. Perhaps the most important point is that this variety is limited only by the imagination and initiative of our scientists.

Some examples of areas of work are: (1) allocation of decision-making functions between man and machine for optimal system performance; (2) measures of system capacity and system performance; (3) exploration and evaluation of design changes by operational gaming; (4) quality control and testing of operational computer programs; (5) allocation of computer capacity among several system functions; (6) scheduling and costing of production of operational computer programs; (7) optimal assignment of mixed weapons to targets.

SDC recognizes the importance of a well planned research program for the vitality and future of the company, and we are carefully organized to carry out such a program. The following are some areas our operations research people are involved in: (1) simulation and operational gaming techniques in problems of control systems; (2) information retrieval and theory of information processing; (3) medical data processing; (4) universal language for computer programming; (5) logistics. We have unusual facilities for research at SDC—these include one of the largest computer facilities in the world and outstanding simulation laboratories.


We have given considerable thought to organizing the activities at SDC to provide for professional development and self-expression. Operations research professionals are carefully assigned so that their individual talents are matched with company needs. These assignments are reviewed regularly to make sure that developing talents are directed into new company opportunities. We regard the publication of research articles and participation in professional societies as activities important to the company. We encourage new ideas and provide the time and means to explore them.

SDC is one of the leaders in a field which will have a remarkable technological and scientific development. It is a new and vigorous company with a bright future. I encourage you to join us.

Please write Mr. R. W. Frost at the address below if you wish to pursue this invitation.

William Kaulich





William Karush
Assistant Director for Research
Operations and Management Research
System Development Corporation

SYSTEM DEVELOPMENT CORPORATION



QUARTERBACKING THE EAGLE PROJECT

Bendix Aviation Corporation will be prime contractor for the Eagle missile—and Bendix Systems Division will quarterback the project.

Latest in a series of important defense projects to be assigned Bendix Systems, the Eagle will be a long-range, air-to-air missile designed for fleet air defense and interception missions.

Responsible for systems management and engineering in connection with the project, Bendix Systems Division will also direct the development of the Eagle missile, electronic guidance, and fire control equipment in the launching aircraft.

Engineers and scientists with missile experience may find that their talents are suited to the special-

ized work involved in the Eagle project and other important system programs at Bendix Systems Division.

Located adjacent to the Engineering campus of the University of Michigan, Bendix Systems Division offers the better man an outstanding opportunity to join an organization with full facilities for encouraging his finest work. Ann Arbor is a wonderful place to live and raise a family, a town which combines life in a college community with the nearby advantages of a large city.

If you are interested and qualified in weapons system planning, research and development, write today for our new recruitment brochure. Bendix Systems Division, Dept. K5-25 Ann Arbor, Michigan.



Bendix Systems Division

ANN ARBOR, MICHIGAN



President Eisenhower has nominated **Joseph V. Charyk**, chief Air Force scientist, to be an assistant secretary of Air Force succeeding **Richard E. Holt**, now Associate NASA Director. Charyk formerly was with the Jet Propulsion Laboratory at Cal Tech.

A. C. DeAngelis has been elected vice president of Dynamics Corp. of America. He is president of Dynamics Corp. of America's communications subsidiary, Radio Engineering Laboratories, Inc. Before joining DCA in 1950, DeAngelis was president of General Armature and Manufacturing Co.



DeANGELIS

General K. J. Nichols, former Atomic Energy Commission general manager, and **Dr. Jerry Afee**, vice-president-engineering in Conoco Oil Corp's manufacturing department, have been elected to Callery Chemical Co.'s board of directors.

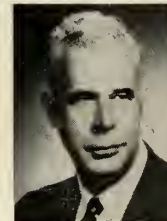
Gordon S. Burroughs has been



BURROUGHS

appointed vice president of CBS Laboratories in charge of the newly-expanded Military and Industrial Electronic Systems Department and will direct special projects as military application of the division, high-resolution reconnaissance and surveillance systems. Formerly president of Burroughs Engineering, assets which were acquired by CBS Laboratories. Burroughs previously served as Head of the Electronic Systems Department, Olympic Development Co.

John F. Kawling is the new general

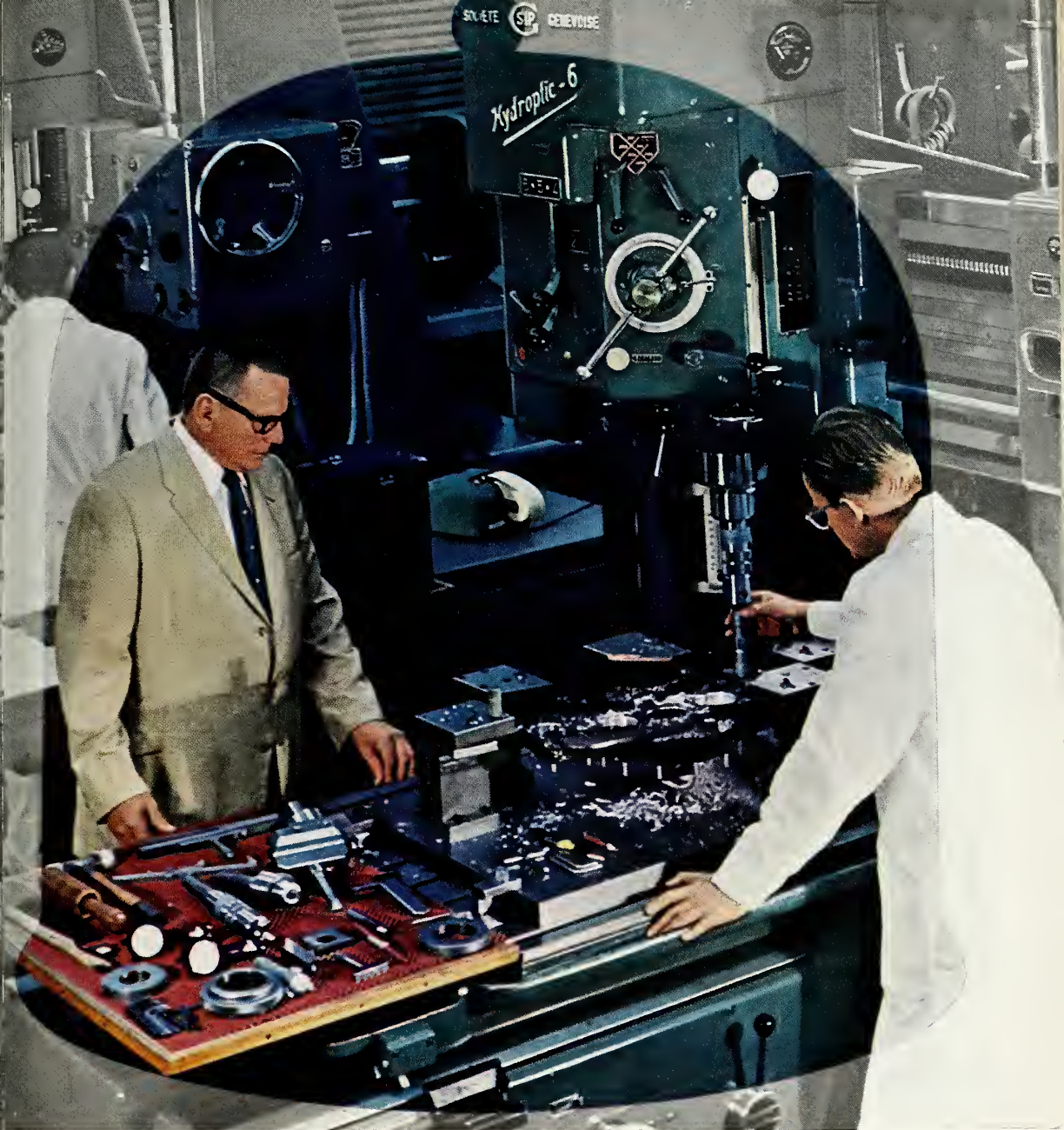


KAUWLING

manager of Electronics Division of Elgin National Watch Co. He joined Elgin in 1948 as operations manager of the Electronics Division; prior to that he was plant manager of Standard Coil Inc.

Hughes Aircraft Co. has tapped **Thomas D. Hanscome**, former U.S. Naval Research Laboratory scientist, and **Walter G. Wadey**, former Yale University research physicist, for its nuclear electronics department. Hanscome, as chief scientist for the Chesapeake Bay area of the Naval Research Lab, prepared for experiments for several nuclear tests in Nevada and the Pacific and was project officer on weapons tests for nuclear radiation measurements. Wadey worked at Yale on design and development of high current linear electron accelerators, nuclear

missiles and rockets, May 25, 1954



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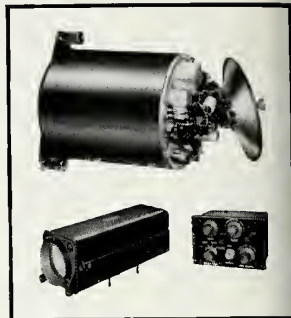
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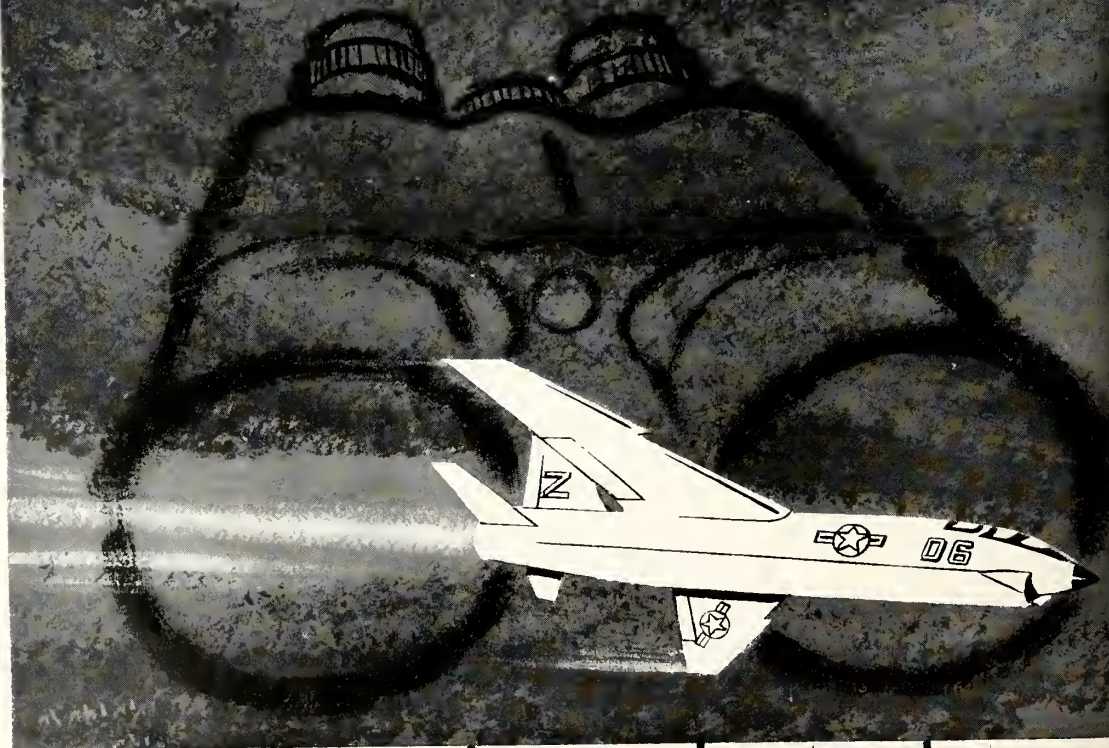
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COMMUNICATIONS



RADAR



DATA HANDLING



ASW



MISSILES

and gamma ray spectroscopy and research laboratory design. Dr. Roger Adelman has joined Hughes as head of physics department of the materials research laboratory, semiconductor division. He was formerly with General Electric's research labs.

Barnet R. Adelman and Herbert R. Lawrence have been elected vice presidents of United Research Corp., subsidiary of United Aircraft Corp. Both scientists have been active in the missile propulsion field and have worked on development of the engines for the Titan, Thor and Minuteman missiles.



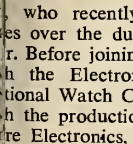
ADELMAN American Rocket Society's 1958 C. Hickman award for outstanding contributions to solid-propellant rocketry awarded to Adelman. Lawrence played a leading role in the development of the first shock wave engine and the pulse jet capable of operating at supersonic speeds.

Dr. Koto Matsudaira, Japan's ambassador to the United States, was elected chairman of the 18-nation committee on peaceful uses of outer space. Dr. Mario Amadeo of Argentina was chosen chairman.

Recent changes at Space Technology Laboratories: Dr. Richard D. De Lauer, former director and Harold Hirsch, associate director of the Vehicle Development Laboratory, Research and Development Division; Dr. Robert Bromberg appointed director and Arthur F. Grant, assistant director of the Propulsion Laboratory, Research and Development Division.

Robert E. Root, former manager of Rheem Manufacturing Co.'s Military Research and Development Laboratories, has been appointed division manager of the Electro-Mechanical Division of American Electronics, Inc. At one time, Root worked in the Ordnance Division of Northrop Aircraft.

Appointment of Wilhelm F. Juptner and Gilbert Heavin to executive engineering and production posts, respectively, has been announced by Babcock Relays, Inc. Juptner has been promoted from chief engineer to engineering vice president and chief engineer, and Heavin, who recently joined the company, has taken over the duties of production manager. Before joining Babcock, Juptner was with the Electronics Division of Elgin National Watch Co. Heavin was formerly with the production department at Halla Electronics, Inc.



missiles and rockets, May 25, 1959

HADLEY

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Pioneers in Cryogenic Valves

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The House has passed (294-128) and sent to the Senate a \$480 million authorization bill for NASA. The measure does not carry any appropriation.

High-strength steel sheets from .005 to .100 inches thick and up to 125 x 240 inches in size are being evaluated at request of Air Materiel Command by 16 propulsion and missile/aircraft manufacturers. Aerojet-General and National Northern will apply series of explosive forming techniques to determine if sheets can be deep drawn for missile applications.

NASA contracts for April amounted to \$27.6 million—the largest \$24 million to Douglas Aircraft Corp., for three stage launching vehicle *Delta*. Other contracts went to: MIT, \$50,000, for the development of a cesium vapor atomic clock, and gamma ray detection instruments; University of Maryland, \$60,000, to investigate the forces between atoms, molecules, and ions; ITEX Corp., \$170,000, for development of upper-atmosphere sounding rocket in-

struments; New York University, \$100,000, to instrument two *Aerobee-Hi* rockets for neutron intensity measurements; AOMC, \$150,000, radiation satellite payloads; Univ. of Chicago, \$300,000, to build cosmic ray measuring instruments; General Mills, \$60,000, for nine 100-foot diameter plastic balloons for communications satellite tests; RCA, \$60,000 for *Mercury* ground tracking and instrumentation studies; American Potash & Chemical Co., \$50,000, for 161,000 pounds of ammonium perchlorate for solid research; Rensselaer Polytechnic Institute, \$80,000, for mathematical investigation of control systems; and Rice Institute, \$150,000 for wind tunnel studies and research into physics of solid materials at high temperatures.

Lockheed Aircraft is moving into the missile electronics field with the acquisition of Stavid Engineering Inc., Plainfield, N.J. Terms are 2½ shares of Lockheed stock for every share of Stavid. No changes in management or policies of the smaller firm, which has 1000 employees and 1958 sales of \$11.2

million, are contemplated. Stavid contracts have covered scale model launching, silo instrumentation for *Minuteman*, airborne radar beacons for the *X-15* and guidance and controls for several other weapon systems.

Labor troubles have hit the missile ranges. An *Atlas* shoot at Vandenberg AFB was delayed by a May 18 walkout of machinists protesting Convo living allowances. On the same day there was a double failure of an *Atlas* and a *Polaris* during a work stoppage by carpenters at Cape Canaveral.

Test stand at Martin's Denver plant was severely damaged May 15 by explosion of *Titan* first stage. No personnel injuries were reported and the missile's second stage, only 10 feet away at the time, also escaped unscathed.

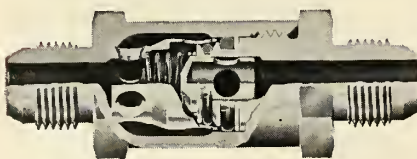
Air Force is now investigating Raytheon's proposed "sky station"—disposable structure to be kept aloft by beaming high-powered microwave energy to run mechanical rotor. Key item is amplifon microwave tube which eliminates need for bulky reflectors and power converters. Potential early applications are missile and aircraft detection, skypath link for long-range, large capacity communications and meteorological observation.

Space Recovery Systems Inc. is being formed by the Columbia Broadcasting System jointly with Steintal Co. Inc., a parachute R&D and manufacturing concern. The new venture will specialize in equipment to track, locate and recover missile and space vehicle components and payloads.

Name changes: Yielding to the Space Age, Aircraft Industries Association has switched to Aerospace Industries Association. Henceforth CD Control Services Inc., Hatboro, Pa., manufacturer of advanced computer integrated electronic controls, wishes to be known as the CompuDyne Corp. And stockholders of Mid-Century Instrumental Corp., New York City, have voted a change to Computer System Inc.

What makes plastics crack? The Wright Air Development Center has awarded a \$28,000 contract to Brooklyn Polytechnic Institute to find out—particularly on plastics subjected to space flight conditions.

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James, Pond & Clark, Inc.

(Continued from page 19)

carry-forward, carry-back tax provisions; whether or not to take quick amortization (where there's a choice—fast write-off certificates for vital lease facilities); general management of capitalization techniques; etc. Other aspects of good management include knowing and calculating capex needs against growth and planning to meet them; building of a balanced management—between administration, finance, sales, production technology. Perhaps the most precious corporate structure is the one company. Odds are he's not as good as he should be in all the basic management areas. Even if he is, it's really certain there aren't enough men in the week for him to give attention to all of the areas that need it. And what if he's suddenly unavailable (as in illness or death)? The year 1958 saw two records set. There were 150,268 new business incorporations, an all-time high—compared to 136,697 in 1957. And there were 14,964 business failures—the most since the end of World War II compared to 13,739 in 1957. How many of these companies were among the 50,000-odd now calculated to be participating in missiles, spaceflight and sporting activities the figures don't say.

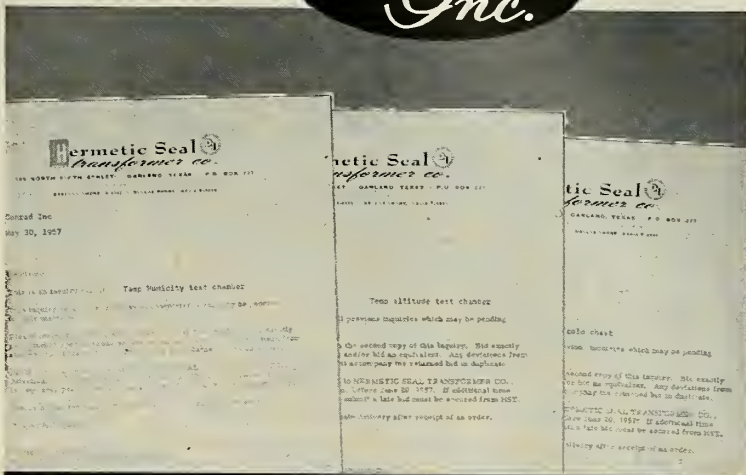
However, you need only to look at the continuing rash of mergers attempted to know that no small number are running into financial problems on their growth. More often than not this is the basic reason for at least half of the mergers—though you've seen cases of companies merging for a merger, that looked like a thought the other had money! In the theory that no one is too old to learn, SBA has developed a number of programs to provide management know-how. They include a series of regular publications, a series of management courses and other services. The agency has 14 regional and field offices around the country. A check with SBA may be worth the time effort.

The basic point is: If you've reached the point where you're having to get musical chairs with your creditors' demands, you'd better start thinking about remedies. There are many different approaches, most of them outlined above. Almost all of them take a long time—SBA and "V" loans, for example, take from three weeks up. A stock issue takes even longer to be organized and cleared through SEC. And, of course, the development of a good management team—the most elementary of all—sometimes takes years.

files and rockets, May 25, 1959

ENVIRONMENTAL TEST CHAMBERS

FROM THE FILE

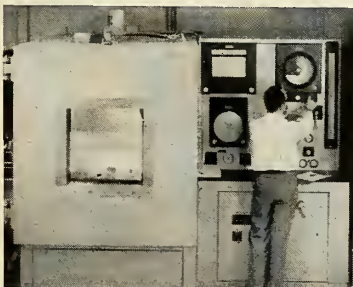


THE INQUIRY FROM THE CUSTOMER

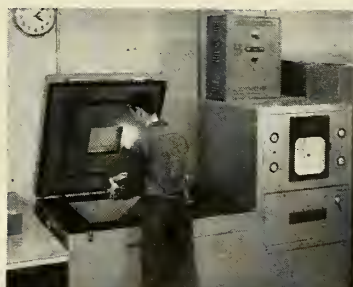
Sometimes we build chambers to our own design, sometimes to customers' specifications. Here's a case of the latter. Hermetic Seal Transformer Co. sent us their standard inquiry forms and specifications for three chambers — temperature-humidity, temperature-altitude, and temperature. Conrad's engineering and estimating departments took over, without obligating Hermetic in any way.

THE RESULT FROM CONRAD, INC.

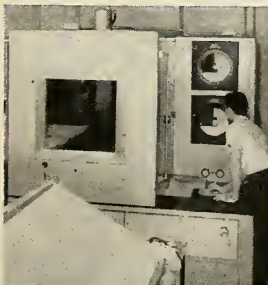
Conrad's product, performance, and pricing looked right to Hermetic. These three chambers are now key units in Hermetic's up-to-the-minute environmental test laboratory, enabling them to maintain a complete check on prototype and production models of their products. These facilities are also available for testing products of other manufacturers.



FH 36-5 TEMP.-ALT. — Temperature range -100°F. to +500°F., altitudes to 200,000 ft. (from atmospheric to 150,000 ft. in 11 minutes).



CB 8-2-2 TEMP — Electrical units may be operated within this chamber at temperatures from -100° to +250°F.



F0-36-2 TEMP.-HUMIDITY — From -35°F. to +250°F., up to 98% relative humidity. Temperatures stabilized within 2°F.

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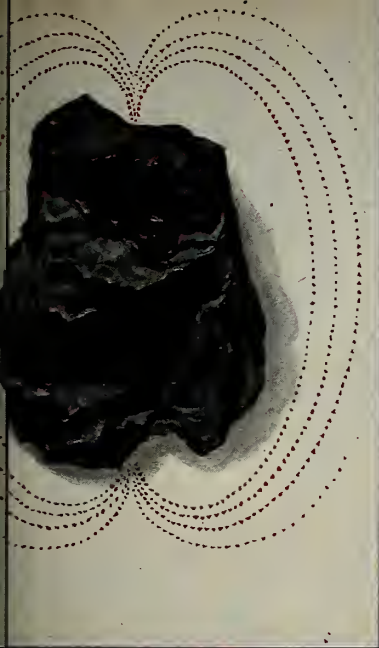


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MAGNETOHYDRODYNAMICS

EXPANDING THE FRONTIERS OF SP



MAGNETOHYDRODYNAMICS: Lockheed's 3rd Annual Symposium* on this important new field—which deals with the behavior of conducting fluids in magnetic fields— attracted physicists from all over the world. As portrayed by the artist, man's earliest experiments with magnetic forces involved the use of the ancient lodestone. Solar prominences are a dramatic example of such forces under investigation today.

Lockheed Missiles and Space Division has complete capabilities in more than 40 areas of science and technology—from concept to operation. Headquarters are at Sunnyvale, California, on the San Francisco Peninsula, with research and development facilities located in the Stanford Industrial Park in nearby Palo Alto and at Van Nuys in the San Fernando Valley of Los Angeles. A 4,000 acre, company-owned test base, 40 miles from Sunnyvale, conducts all phases of static field testing. In addition, complete flight testing is conducted at Cape Canaveral, Fla., Alamogordo, N.M., and Vandenberg AFB, Calif. as an integral part of every stage of missile and space programs at Lockheed.

The Division's advanced research and development programs now under intensive study provide a fascinating challenge to creative engineering. These programs include: man in space; space communications; electronics; ionic, nuclear and solar propulsion; magnetohydrodynamics; oceanography; computer research and development; operations research and analysis; human engineering; electromagnetic wave propagation and radiation; materials and processes and others.

Lockheed's programs reach far into the future and deal with unknown environments. It is a rewarding future which scientists and engineers of outstanding talent and inquiring mind are invited to share. Write: Research Development Staff, Dept. E3-29, 962 W. El Camino Real, Sunnyvale, California. U.S. Citizenship required.

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Lockheed / **MISSILES AND SPACE DIVISION**

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*Copies of the proceedings of the first two symposiums were published by the Stanford University Press, Palo Alto, Calif. and are available in book form. Results of this year's symposium will be published shortly by the same house.

NOLOGY

by William E. Howard

Anemia, insofar as the Defense Department is concerned, apparently is no cause for alarm. Missile makers must show acute starvation before the Pentagon will even consider changing the policy line it adopted toward profits in 1957 and still does today.

Precisely what the profit factor should be when doing business with the government is one of those questions not easily resolved. As matters stand now, the government holds virtually complete control. And its decision is to keep profits as low as possible, regardless of the fact that the economic health of its suppliers is critically important to the defense effort.

In essence this is the DOD position set forth for a House Appropriations subcommittee recently by Perkins McGuire, Assistant Defense Secretary for supply and logistics. The aircraft industry early last year asked for a higher profit factor. It said the money was needed to expand industry's research and development facilities for defense. "The Department gave this recommendation considerable study," McGuire said, "which resulted in our conclusion that our profit objective for the industry as a whole was not too low considering all of the factors under which the industry operates."

The assistant secretary's statement left unanswered in the text the question of whether the R&D effort might be too low. Industry spokesmen have long claimed that R&D—particularly basic research—is underfunded. Many companies admit they are skimping their stockholders to put all the money they can into R&D now, and it still isn't enough.

Interestingly, McGuire's statement was accompanied by some figures from the Air Force graphically indicating the profit-shrinking trend. The Air Force compiled published financial statements of Boeing, Douglas, Lockheed, Martin, McDonnell, North American, Northrop and Republic. It found the profit ratio on sales before taxes had slipped from 4.9% in 1957 to 4.1% in 1958 and after taxes the ratio was 2.45% in 1957 and 2.02% in 1958. The Air Force estimates the 1959 profit ratios will be the same as last year.

Reporting on another industry recommendation to increase the return on DOD R&D cost-plus-fixed-fee contracts, McGuire told the lawmakers that a study showed these fees: Army—4 to 9% with most less than 7%; Navy—token fee of \$1 to a high of 10% with the average about 6.5%; ARDC—4 to 10% range with the average 6.1%; Air Materiel Command—4 to 7% range, average on small business contracts 6.25%.

"On the basis of these fee ranges, coupled with the fact that the payment of these fee levels did not hamper efforts to obtain research and development or adversely affect expeditious performance and quality of research and development work, the conclusion was that no general increase in the DOD fee objective was indicated," McGuire said. "Accordingly," he added, "there has not been any general increase in our profit objectives in 1957, 1958 and 1959, and, although the final pricing results are not generally available, we do not believe that the final negotiated prices showed an increase. With respect to the fees allowed, our studies definitely establish the fact that there has been no general increase."

What's ahead for 1960? The defense official doesn't say. But several airframe manufacturers aren't waiting for an increase from the government. They are in the process of diversifying to broaden their profit base, which may make the DOD happy. But unfortunately diversification takes money, too—money that otherwise might go into research vital to winning the technological race against Russia.



VOUGHT DESIGNS QUARTER FOR SPACE EXPLORERS

Chance Vought's qualifications have directed the company into one of the most challenging areas of space exploration: the control compartments manned space vehicles.

Responsible is Vought's reputation "human factors"—the pilot considerations that must be designed into advanced aircraft. Vought showed an appreciation for human factors, employing biochemists, psychologists and human engineering specialists in developments such as that of the Crusader fighter.

In spacecraft, these factors are even more important. They affect the design of the entire vehicle. They bring in focus the tremendously hostile environment of space, and a completely new regime of aeromedical problems.

In preparation, Chance Vought has marshalled space age research and design aids. A "hot-shot" wind tunnel, for example—capable of duplicating terrific re-entry heats; and high-speed computers to calculate trajectories for orbits for solar system flight.

Vought is a member of the Boeing Airplane Company team in the Air Force competition to produce the highly advanced Dyna-Soar boost-glide vehicle.

At the same time, additional intensive company research programs are underway for putting man into space.

Astronautics is just one in the broad spectrum of Chance Vought fields of activity. Other areas include: design and production of high performance aircraft, electronics, advanced weapons, and submarine warfare, range systems management, commercial process control systems.

CHANCE
VOUGHT
DALLAS, TEXAS

missiles and rockets, May 25, 1959



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A missile comes "of age"—reaches operational status—as a result of many influences. Vital among these influences is the rapid incorporation in the test vehicle of modifications required by evaluation of flight performances. The faster these modifications are made, tested, and become incorporated in the design, the faster the vehicle is declared operational.

The completion of this cycle is dependent too upon the speed with which vast amounts of test data can be reduced, analyzed, evaluated, and reported to the military and to the cognizant weapon systems contractors.

So, with the advent of missiles has come a revolution in data processing techniques—a revolution in which the Engineering Services Division of Telecomputing Corporation has been highly successful in greatly reducing the elapsed time for complete processing of missile flight test data.

This is an invitation to join the data processing specialists who comprise the Engineering Services staff—a staff which establishes the state-of-the-art in data processing techniques and methods as we go about our job of computing the performance of missiles under test at the White Sands Missile Range.

Join us and work with high speed digital computers and other modern data processing equipment in reducing the test data from scientific data measuring systems such as, cinetheodolites, electronic measuring systems, precision optics, and telemetering systems.

Join us—and grow with us—as our advanced processing techniques are employed in this fascinating field of missile flight testing so important to our national defense effort.

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propulsion engineering

Binders of future solid propellants may be oxidizers instead of fuels. At least that is the line of thought opened up in the chem industry by the recent announcement that the Army Rocket Guided Missile Agency's \$750,000, one-year study contract on solid propellants went to Allied Chemical's General Chemical Division. The division makes fluorine, chlorine trifluoride, and bromine pentafluoride—all under study, or in development, as super oxidizers. At present, binders are fuels that hold together such oxidizers as ammonium perchlorate or ammonium nitrate.

That the roles of fuels and oxidizers in solids may reverse has been heard several times in recent years. Allied's entry into solid propellants in a big way (it has been in the business "through the back door" for several years as a supplier of fluorine and oxygen chemicals) almost certainly means that at least one solid propellant will feature a fluorine-based oxidizer-binder holding an unspectacular fuel. The result could be a fluoro-plastic oxidizer-binder homogenized with a rubber or urethane fuel-binder. Allied will conduct the work in its General Chemical research laboratory, Morristown, N.J.

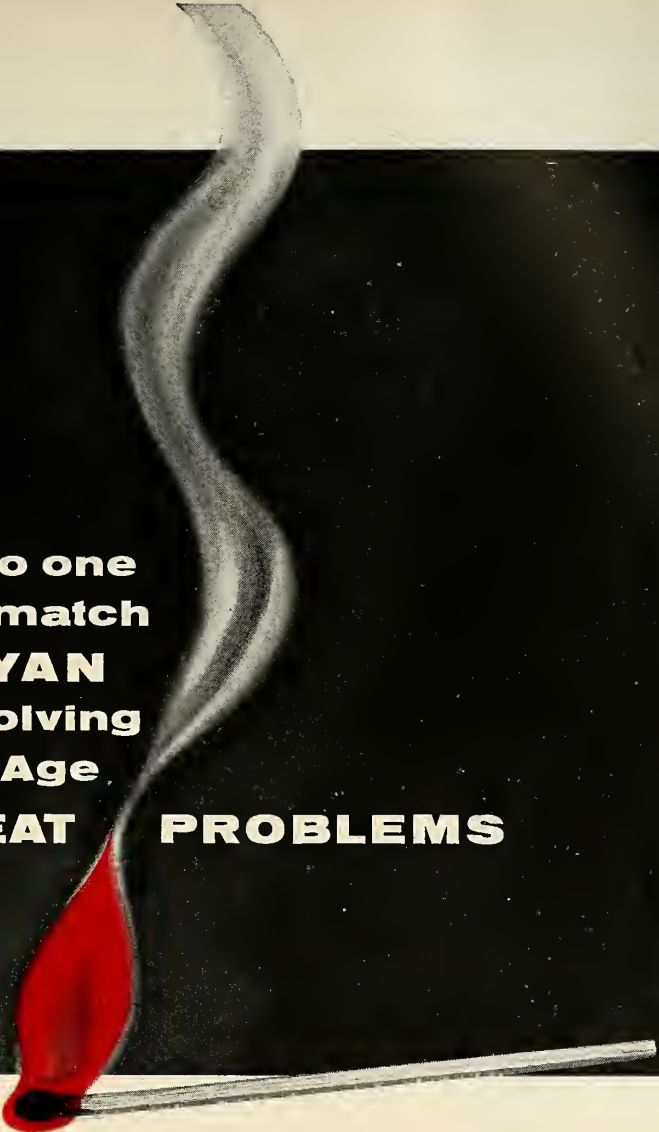
Look for a major research effort to push chlorine into missile use, possibly as an ingredient in a synthetic structural material, maybe as a propellant system. Reason for the chemical industry push: Capacity. The industry was caught in a bad squeeze when methylene glycol manufacturers switched from a chlorine process over to the ethylene oxide route of producing the glycol.

Further overtures to missile business by the chemical industry seen in several of the newest chemical plants now in production or under construction. Examples: Air Reduction's new oxygen-nitrogen facility has started production at Denver; National Cyanide Gas Division of Chemetron Corporation has put its new \$1,750,000, 35 ton/day liquid oxygen, nitrogen, and argon plant on stream in Los Angeles; Texas Alkyls, Inc., has begun a new \$1 million minimum alkyls plant at Houston.

The Texas Alkyls plant is a joint venture of Stauffer Chemical and Hercules Powder, both already in the missile supply business making mostly fuels and oxidizers. The aluminum alkyls will have two major uses in the missile industry: They will be highly effective catalysts in vital chemical process operations; and they will be used as, or in, self-igniting hypergolic propellants for upper rocket stages. Initial production will exceed 1 million lbs./year, beginning late this year or early next.

Footo Mineral Company still is chafing under the Atomic Energy Commission's order ending purchases of lithium hydrides, but expects to make a major comeback almost immediately. Footo chemist and under research director Dr. E. M. Kipp, have developed a new lithium hydride—or type of hydride—that is a much more reactive reducing agent than present commercial lithium hydrides. Footo says not to worry about the missile applications, but in a propellant system the oxidizer is complemented by the reducer as a fuel.

Lithium nowadays almost always gets into fuel conversations wherever missilemen meet. Footo is part owner of HEF, Inc., which is gearing up for a major role in propellants. However, Footo says it will be several years yet before HEF contributes substantially to Footo's income. In the meantime, Kipp and his associates have been busy with two more items of missile interest: A new series of highly reactive and very uniform lithium dispersions (metallic); and a cheap, controllable process for turning out lithium butyl as catalyst for several reactions.



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British Astronautics

U.K. is Developing
A-Warheads for T

by G. V. E. Thompson

LONDON—At present the only ballistic missile in Britain capable of being fired is the *Thor*, supplied by America with its atomic warhead that Britain can be completely dependent in the manufacture and of atomic weapons, British warheads are being developed.

In addition to those for the A artillery and for bombs, there will be H- and A-bombs warheads for the *Blue Streak* ballistic missile, the *Pol/Ferranti* surface-to-air *Bloodhound* and the English Electric surface-to-air *Thunderbird*.

• **Upper atmosphere densities**—G. King-Hele of the Royal Aircraft Establishment, Farnborough, has analysed the orbits of artificial earth satellites to estimate the mean density of the atmosphere at heights between 200 and 400 km. The chief difficulty in this analysis is the evaluation of the quantity SC_d , (in which S is the mean cross-section of the satellite perpendicular to the direction of motion, and C_d the drag coefficient). Its value depends on the shape of the satellite, the manner in which it is rotating, and the way in which the air molecules are deflected from its surface.

It is particularly difficult to determine the mean density for cylindrical satellites (*Explorer 1, 3, 4* and *Atlas*). King-Hele thinks that these, and the rockets and the Russian satellites, have rotated about their axis of maximum moment of inertia—that is, about an axis perpendicular to their length. The angle between this axis and the direction of rotation has varied—the extreme cases are motion like a propeller and tumbling end-over-end. The following values for mean density were obtained:

Height, km.	Air density/- sea level density	Mean density (g./cm. ³)
200	3.4×10^{-10}	4.1×10^{-12}
220	2.0×10^{-10}	2.5×10^{-12}
240	1.2×10^{-10}	1.5×10^{-12}
260	7.6×10^{-11}	9.3×10^{-13}
280	4.6×10^{-11}	5.6×10^{-13}
300	2.9×10^{-11}	3.6×10^{-13}
320	2.0×10^{-11}	2.4×10^{-13}
340	1.4×10^{-11}	1.7×10^{-13}
360	9.7×10^{-12}	1.2×10^{-13}
380	7.1×10^{-12}	8.7×10^{-14}
400	5.3×10^{-12}	6.5×10^{-14}

The actual density naturally varies from day to day. The factor of error for

missiles and rockets, May 25, 1958

figures is not greater than 1.5.

Missile secrets plane lost—A
ered Avro Tudor plane carrying
missiles (believed to be the *Fire-*
) and secret documents to the
nera rocket range was recently re-
d missing in Eastern Turkey. It
at first feared that the plane might
been captured by the Russians,
flight path lay close to the Soviet
er, but its wreckage was later
ed on a snow-capped plateau 1000
low the crater of the extinct vol-
14,434 ft. Mount Subhan. The
F. mountain rescue team sent to
te were impeded by snow, difficult
ing conditions, bears and wolves;
eaching the wreckage they found
all twelve occupants were dead.
t material was removed and the
ish army has been asked to ex-
the missiles.

n enquiry into the accident will
ld, and in future such flights will
bly be routed via Africa to avoid
g too near Russian territory.

Underwater escape tests—Since
five-sevenths of the earth's sur-
is covered with water, the possi-
of a manned satellite vehicle des-
ing in the ocean is quite high. A
of experiments made by the U.K.
rality Hydro-Ballistic Research
plishment is of interest in this con-
on.

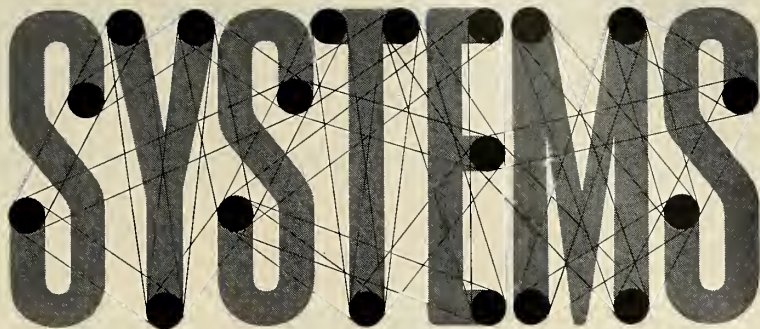
standard aircraft ejection seat
ement was fired under water and
urements were made continuously
e acceleration of the seat and of
ummy it contained; the pressures
e gun, at various points close to
e the gun separates, and at the
and abdomen of the dummy.

the maximum velocity of the seat
etermined by using it to move a
permanent magnet over equally-
d coils fitted to the fixed frame-
. The dummy was ejected satisfi-
rily under water, but the pressures
ed may be too high for a pilot.
gun pressure dropped from 2000
o 1000 psi. at discharge; an en-
d bubble then formed and water
ance maintained the pressure for
ger period than in air. Near the
ay, the pressure varied from 0 to
si.

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es and rockets, May 25, 1959

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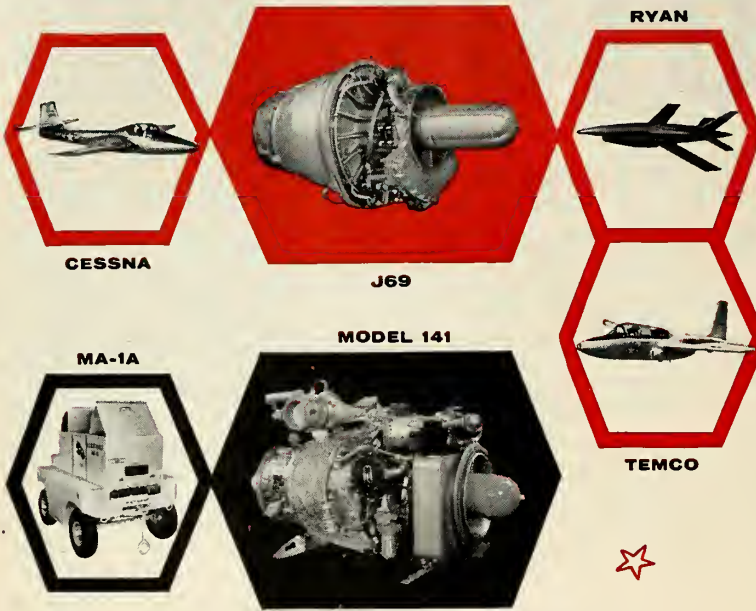
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Spacecraft Materials Probed by Symposium

by Frank G. McGuire

PALO ALTO, CALIF.—Technical aspects of temperature, erosion, spalling, lubrication and vacuum effects on materials were thoroughly discussed at the first Symposium on Surface Effects on Spacecraft Materials, co-sponsored by Lockheed and ARDC. Over hundred scientists from throughout the country attended the meeting, the first of its kind to deal with thermal and surface effects exclusively.

• **Vacuum effects**—Dr. M. R. A. of the Naval Research Laboratory reported on research involving changed characteristics of materials under high vacuum conditions. The creep strength of some metals goes up when in a vacuum, Dr. A. says, but with high temperatures they actually be weaker in space than on earth. This reversal will have to be considered in designs of future spacecraft.

Changing many of the parameters of testing could completely reverse the results of a test, according to A. The loading of the sample, as well as great changes in temperature, could substantially alter the end result in creep-strength or fatigue test.

Other researchers, discussing the sublimation of materials under high vacuum, stressed the need for low vapor-point materials in the construction of spacecraft, because vacuum effects them less than other materials. As one extreme example, it is possible for a spacecraft to vanish due to "evaporation" of the metal, and resulting changes in the bulk properties.

Experiments on plastics and certain metals have been conducted to study this effect at various temperatures. So far, these experiments have shown important changes in materials following prolonged exposure to vacuum. More subtle effects due to absence of surface gas layers include changes in the coefficient of friction, fatigue and creep rupture characteristics.

• **Lubrication**—It probably will be necessary to use solid-film lubricants in space, but graphite has virtually been ruled out due to the necessity of having water vapor in the environment surrounding the lubricant. Dr. Bruce D. of the Midwest Research Institute, at the symposium that the best solid-film lubricants found so far are molybdenum disulfide and tungsten disulfide, but they are not as efficient as desired under high-temperature conditions.

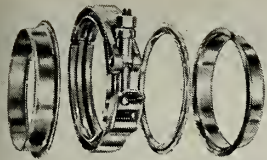
Work is under way at Midwest Research Institute to determine the actual mechanics of friction by use of graphite whiskers. These hard-to-prod-

missiles and rockets, May 25, 1961

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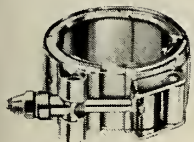
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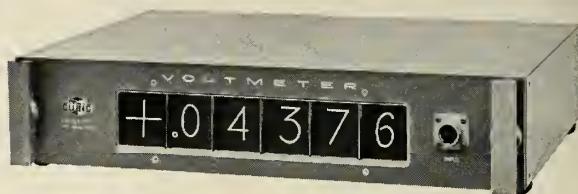
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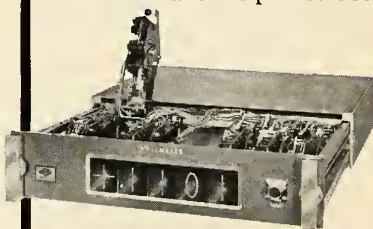
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strands of graphite are used as specimens for tensile-strength tests, and for examination into the crystalline structure.

The crystalline structure of graphite is similar to that of molybdenum disulfide and tungsten disulfide, but where graphite needs water vapor in its environment in order to act as an efficient lubricant, the other two use sulphur.

• **Erosion**—The action of particles of varying sizes in space on the surface of a spacecraft was looked at from a number of angles: micro-meteorites, dust, and individual atoms and molecules. (Results of a collision with a full-scale meteor were so obvious as to eliminate need for discussion.)

Erosion by interplanetary dust, reported Dr. David B. Beard of the University of California, probably will amount to negligible damage to a satellite. The actual amount is calculated to be 10^{-5} to 10^{-6} particles larger than 4 microns impacting cm^2/sec . (i.e. 30 to 300 impacts/ cm^2/year).

Calculating the origins of comets within the solar system has indicated they are "balls of fluff" generally found in the cold regions of space until a passing body sets them in motion. When these comets pass near the sun, dust is thrown off and gradually populates the solar system. The dust, which also comes from other sources, is the cause of the "Zodiacal light" observed at night, since it reflects the light of the sun to the dark side of earth in minute quantities, leaving a milky haze over the sky.

To remain in the solar system, these particles must be at least 3 microns in size—a smaller particle would be forced out of the system by radiation pressure. Density of this dust is greater near the earth due to gravity, where it reaches about 10^{-12} particles per cubic centimeter, as compared with an average density of 10^{-14} or 10^{-15} per cubic centimeter throughout the solar system in general. A particle of 4 microns or larger, therefore, is needed to register appreciable damage on a surface.

A particle having a mass of 10^{-13} grams (low mass but high velocity) would immediately vaporize upon striking a satellite surface. However a greatly prolonged exposure might show appreciable damage, and in some cases could surpass that inflicted by larger, but less frequent, particles.

To gain more knowledge of this dust, consideration is being given to exposing a sheet of sticky mylar film on a rocket or recoverable satellite to capture some and bring it back for analysis.

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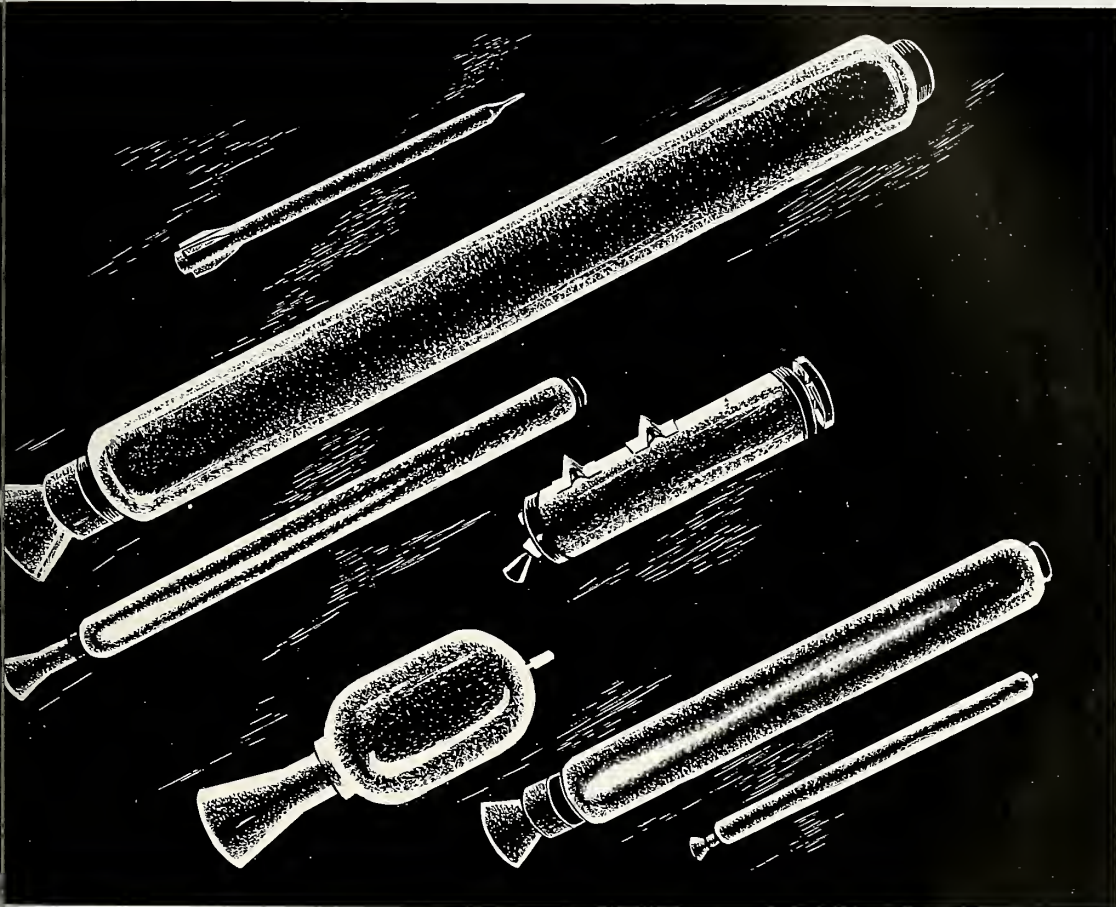
JUNE

- Institute of Radio Engineers' Professional Group on Microwave Theory & Techniques, National Symposium, Harvard University, Cambridge, Mass., June 1-3.
- Armed Forces Communications and Electronics Association 13th National Convention, Sheraton Park Hotel, Washington, D.C., June 3-5.
- Institute of Radio Engineers' Professional Group on Product Techniques, Third National Conference, Villa Hotel, Mateo, Calif., June 4-5.
- The Pennsylvania State University's Missiles System Engineering Seminar, University Park, June 7-13.
- Aero Club of Michigan, Industry Missile and Space Conference, Sheraton-Cadillac Hotel, Detroit, June 8-9.
- American Rocket Society, Semiannual Meeting, El Cortez Hotel, San Diego, June 8-11.
- United Nations Educational, Scientific and Cultural Organization, UNESCO House, Paris, June 15-20.
- Cornell University Industry Engineering Seminars, Cornell University, Ithaca, N.Y., June 16-19.
- Institute of the Aeronautical Sciences, National Summer Meeting, Ambassador Hotel, Los Angeles, June 16-19.
- Institute for Practical Research on Operations, The University of Connecticut, Storrs, June 21-July 3.
- American Institute of Electrical Engineers, Air Transportation Conference, Olympic Hotel, Seattle, June 24-26.
- Nuclear Industry Division, Instrument Society of America, Second National Symposium, Idaho Falls, Idaho, June 24-26.
- Institute of Radio Engineers' Professional Group on Military Electronics, Third National Convention on Military Electronics, Sheraton Park Hotel, Washington, D.C., June 27-31.
- Pennsylvania State University, Summer Seminar on Plasticity: Its Mechanical Properties, Design and Applications, University Park, June 29-July 3.

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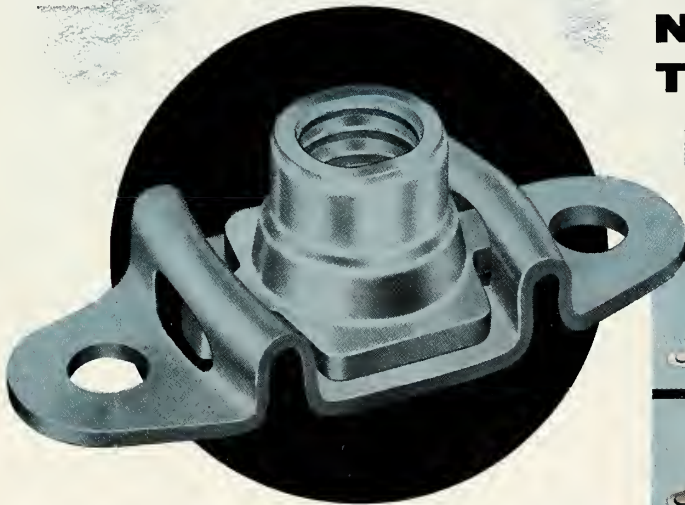
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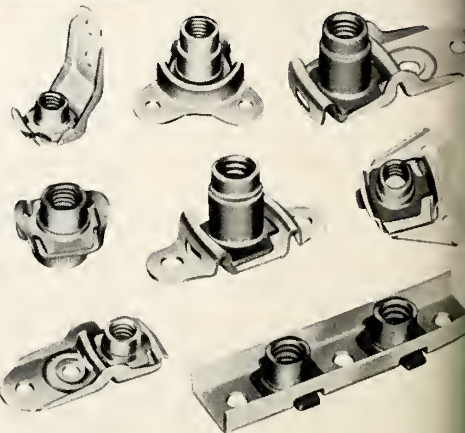
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