AUGUST 31, 1959

LITTLE JOHN—MODERN ARTILLERY

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION

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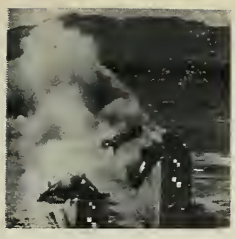
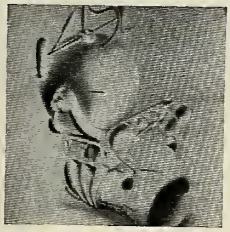


COVER: *Little John* is test fired at White Sands Proving Grounds, N.M. Although it has yet to be declared operational, the Emerson artillery missile is being used in troop training.



SOLARIS vehicle retrieves a missile booster engine in an Artist's conception of the versatile underwater system being developed by Vitro Laboratories. See story on p. 16.

LANDING on the moon with last two stages of a five-stage space vehicle. Artist's sketch shows spare return vehicle at left. Case for direct, manned moon flight is reported on p. 24.

IMPROVED XM50 *Honest John* undergoes test and evaluation firing at White Sands. Emerson Electric Manufacturing Co. is prime for *Honest John* and *Little John*. See story on p. 28.

missiles and rockets ®

MAGAZINE OF WORLD ASTRONAUTICS

AUGUST 31 HEADLINES

MISSILE SUPPORT
U.S. Reg. Pdg.

ASTRONAUTICS ENGINEERING
U.S. Reg. Pdg.

ASTRIONICS

NEW MISSILE PRODUCTS

THE MISSILE WEEK
U.S. Reg. Pdg.

DEPARTMENTS

Industry Countdown

MANUFACTURING

Contract for secret missile . . .
is reported in final negotiation stage for **Fairchild Engine & Airplane Corp.** Recently set back by cancellation of *Gander* and *Goose* drones, Fairchild is in the process of lining up subcontractors for the new missile project.

• • •

Re-entry test of . . .
McDonnell's *Mercury* capsule is set for Sept. 2 from Cape Canaveral. **Convair** *Atlas* booster will fire unmanned capsule to orbital height where it will stay only long enough for tip-over after stage separation and then begin descent.

• • •

Missile steel supplies . . .
generally are holding up despite the stretch-out of steel strike. Commerce Department's Business and Defense Services Administration says it is filling some requests for help from defense steel users.

• • •

Good solid booster . . .
market could develop if Air Force decides to go ahead with large-scale program of zero-launched interceptor aircraft from atom blast-proof shelters.

PROPULSION

Look for huge new . . .
research program to be launched soon by the Army into materials for solid-propellant rocket motor casings and nozzles.

• • •

Composite solid fuels . . .
will be produced at **Amcel Propulsion** plant, Asheville, N.C. **Celanese Corp.** recently purchased the facility from **Oerlikon Tool & Machinery.**

• • •

Prepackaged liquid . . .
Guardian motor series by **Thiokol Chemical Corp.** will go into the Navy's air-to-air *Sparrow III* and air-to-surface *Bullpup.*

• • •

Aerojet-General is teaming . . .
with **Acoustica Associates** to explore application of sonic burning control to rockets for advanced space vehicles.

ASTRIONICS

First thermal-electric . . .
air conditioner will be developed by **Westinghouse** under Navy contract to be announced late in September. Compact 1-ton unit will have missile and space vehicle applications.

• • •

High-speed digital . . .
plotter newly developed by **Lockheed's** Missile and Space Division permits space program flight evaluations to be made 17 times faster and 12 times cheaper than with old reduction methods. They are being used to accelerate development of the *Discoverer Agena* satellite and *Polaris* IRBM.

• • •

In operation . . .
new radar antenna test range 1½ miles long by the **Special Products Division of I-T-E Circuit Breaker Co.,** Philadelphia. New range allows pattern tests on antenna up to 60 feet wide at frequencies through 2000 mc. Equipment to be tested includes I-T-E's 60-foot DEW line antenna and NATO's Ace-High troposcatter 60-foot dish.

WE HEAR THAT—

Interest is picking up . . .
in $1.5 million to $2 million graphite pilot plant being sought by the Air Force. It would be used to develop missile components . . . **AC Spark Plug** decided to build a laboratory at Wakefield, Mass., (for *Titan* all-inertial guidance) because scientists hired for the program wouldn't relocate away from Boston to Flint, Mich. . . . Steel casings for missile structures with tensile strengths up to 300,000 psi are being built by **American Brake Shoe Co.** . . . Air Force's *Atlas* adaptation of Army *Jupiter* re-entry ablation nose cone uses glass-phenolic tape wrap—instead of downwind shingle design . . . **North American Aviation** president J. L. Atwood is predicting NAA's 1959 net will exceed $28 million, or $3.50 a share, compared to $3.43 last year . . . A nuclear electronics lab is being set up by **Hughes Aircraft** . . . The **Western Electric** *Nike-Zeus* anti-missile missile is approaching the complete systems test stage . . . and the National Bureau of Standards has established a vibration pickup calibration service for the range of 10 to 2000 cps at accelerations up to 10 g.

More About the Missile Week on page 49

Armco PH 15-7 Mo Stainless Steel Provides Structural Efficiency for Long-Range Mach 3 Aircraft

New precipitation-hardening stainless combines strength at 2000 mph temperatures with producibility, availability and economy.

Armco PH 15-7 Mo Stainless Steel has been selected as the primary sheet metal for the dramatic new air weapon systems—the B-70 Valkyrie bomber and the F-108 Rapier manned interceptor—being developed by North American Aviation, Inc. for the Air Force. Most of the honeycomb panels and other structural parts will be made of this special stainless because it possesses the required strength at anticipated temperatures and a unique combination of advantages that facilitate the design and production of dependable and economical structural elements.

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Washington Countdown

IN THE PENTAGON

Cutting the defense budget pie . . .
for FY 1961 is expected to begin in earnest during the early part of September. During these weeks, Defense Secretary McElroy is expected to begin making some of the key decisions on which service gets what.

• • •

Long faces . . .
will be the uniform of the day no matter what the decisions are, however. The defense budget is clearly frozen for the Presidential election year at $40 billion or less—a figure widely considered by military officials to be inadequate.

• • •

***Discoverer VII* . . .**
is scheduled as another attempt to perfect the ARPA Air Force system for recovering capsules from orbit. The launching of the satellite is expected to take place sometime toward the end of September. Capsules from *Discoverers V* and *VI* apparently burned up during reentry over the Pacific. (See M/R this issue page 48.)

• • •

Name changing dept. . . .
Lockheed's *Sentry*, the ARPA Air Force reconnaissance satellite project, has been rechristened. It's now called *Samos*—as in the ancient Grecian island. However, same project, same contractors, same purpose.

• • •

Missiles for Japan . . .
are in the cards within the next few years. The Japanese are reported to be planning to build an air defense system around **Raytheon** *Hawks* and **Western Electric** *Nikes*. Timing and the political atmosphere in Japan apparently have a lot to do with when the *Nikes* and *Hawks* are set up.

• • •

Missiles from Switzerland . . .
were imported by the Japanese last year for study. Great internal controversy resulted. So far, the 10 **Oerlikon** ground-to-air missiles have never been fired since they were delivered. However, Japanese engineers have dismantled three for study.

• • •

The first operational *Atlas* . . .
firing from Vandenberg AFB, Calif., is expected within the next two to six weeks. The Air Force is still deciding when to try it. However, the Air Force feels sure it has found and cured the *Atlas* ailment—a malfunction of the fuel disconnect valve.

One of the hottest . . .
of ARPA's future space projects—Project *Orion* studies on development of a nuclear-blast powered rocket—has been extended for another year. The $1 million contract went to **General Atomic** which has been conducting the studies.

ON CAPITOL HILL

A new blast . . .
at Defense Department handling of news on missiles and space exploration is included in the latest report from the House Information Subcommittee. The subcommittee particularly is hitting at the withholding of information on space monkeys and a picture of **Martin's** *Titan* as typical mismanagement of the news.

• • •

A new series . . .
of nuclear tests may be sought by Congressmen if East-West disarmament talks at Geneva continue to produce only hot air. Both Congressmen and military officials see the U.S. slipping in development of nuclear warheads for missiles and a possible nuclear-blast powered rocket because of the voluntary suspension of tests.

AT NASA

Drastic cuts . . .
in the billion-dollar-a-year future once envisaged for NASA is the interpretation being put on recent remarks by NASA Chief Glennan. The immediate outlook: A NASA budget ceiling of probably about a half-billion dollars.

• • •

The huge *Saturn* . . .
1.5-million pound thrust cluster being developed by the Army for ARPA probably will be used first by NASA. NASA Chief Glennan as much as said so in recent testimony before a House committee.

AROUND TOWN

Some of the reports . . .
being passed as "the latest" in the Nation's Capital:

. . . South America is seen as a likely future market for U.S. tactical missiles armed with conventional warheads.

. . . Top space experts say they still have no reason to disbelieve the Russian boast that they will be on the moon by October, 1967.

. . . Congress will be the stage next year for an all-out drive to increase the size of the Army.

PRODUCT SUPPORT ENGINEERS

Urgency - Speed - Reliability. These words describe Convair-Astronautics' top-priority program of activating Atlas ICBM bases throughout the United States. Included in this immense task is the job of training Air Force personnel, developing and producing hundreds of technical manuals and providing technical assistance to the Air Force. The Product Support department at Astronautics is responsible for this assignment and to fulfill it must double in size within the next two years. Engineers qualified to participate in this long-range program will find excellent growth opportunities in the following areas:

CUSTOMER TRAINING – Service Training Instructors—Engineers with degrees in ME, AE or EE, or equivalent hardware experience are needed to prepare and conduct continuing 4-6 month courses to Air Force personnel on the Atlas ICBM. This training will include classroom theory and hardware manipulative skills to a high level of proficiency.

Service Training Planners – Men with 2-5 years experience in the planning of industrial and/or armed services training programs are needed for the planning, preparation, editing and publishing of training material for the Air Force. This assignment will also include training standards, syllabuses, lesson plans and training projects.

TRAINER DESIGN – Trainer design engineers (electronic and mechanical) with degrees in ME, AE or EE are needed to design simulators to be used in the training of Air Force personnel on the Atlas weapon system.

FIELD SERVICE – Engineers, preferably with degrees in ME, AE or EE, and field or in-plant hardware experience are needed to act as technical representatives to the Air Force on the Atlas ICBM. Most assignments will be at Vandenberg AFB, Santa Maria, Calif. There will be other assignments as additional Atlas bases become operational. A limited number of San Diego openings also exist in the areas of Field Service Support. A field service bonus is authorized for field assignments in excess of six months. Per diem paid for assignments under six months.

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Army Faces Exodus from Space

To get the facts behind the following story, M/R editors interviewed top-ranking Army officers and officials of the Defense Department and allied U.S. agencies. While no person interviewed would permit the use of his name, all agreed on the basic facts concerned. M/R carries the story after serious consideration, conscious that it will be regarded as highly controversial by many readers.

by James Baar

WASHINGTON—The Army is facing the possibility of having to get out of the space business.

It also is facing the possibility of sharp curtailment or death of the *Nike-Zeus* anti-missile missile.

The cause is two-fold: lack of money and the pressure on DOD and the Joint Chiefs of Staff to stabilize the missions of the three services.

Linked to both is the Army's increasing drive to modernize its divisions with new tactical missiles and all the advanced panoply of Missile Age nuclear and conventional war.

For a long time a minority of the Army's high command has felt the Army space effort was a costly side effort. Now there appears to be a growing feeling in at least part of the high command majority that the Army may be forced out of the space business by the Defense Department.

These officials are understood to be arguing that it might be best for the Army to take the initiative, give in gracefully, reap whatever financial benefits might be had and concentrate on tactical missiles and the scores of almost startling innovations in the horizon for equipping ground troops.

The soul-wrenching problem is understood to be already on desks at the Pentagon's highest levels. A decision is expected within a matter of months at most—possibly in time for the annual autumn commanders' meeting.

Here are some of the key factors:

• The Army for some time has been low man on the Pentagon budget totem pole. Lack of funds has hobbled Army procurement of modern weapons—particularly missiles.

• An extra $1.5 to $2 billion will be needed in the new budget if the Army is to keep development and production of **Western Electric's** *Nike-Zeus* on schedule.

• NASA so far has placed no orders for space work with the Army in 1960 and probably won't in excess of $20 or $25 million. ARPA business with the Army outside of the huge *Saturn* 1.5 million-pound-thrust booster is relatively small.

• The Defense Department is understood to be pressing the joint Chiefs of Staff in earnest for an end to the grab-bag approach to assigning space projects.

Place all of this in the context that the Administration has again frozen the FY 1961 budget at $40 billion or less and you begin to get the sticky feeling of the situation.

The Army itself is clearly torn until it hurts.

It feels that it has a great past and should have an even greater future in space. Its plans for the years immediately ahead have included a whole series of satellites for reconnaissance, weather forecasting, mapping and communications. Beyond these, Army space team thinking had encompassed such projects as spaceports and construction of bases on the moon and planets.

The Army has felt that its Ballistic Missile Agency centered at Huntsville has tremendous capabilities that should be thrown into this work.

Moreover, Army has contended that not to use its capabilities for space work is pure waste. This argument is based on the contested ground that savings resulting from ending space work at Huntsville would be relatively slight. In fact, the costs of tactical missile development at Huntsville—the bulk of the work at ABMA—might go up.

However, many in the Army fear that they face the end of the road into space. Some dozen space projects have been submitted by the Army to NASA in recent months. So far, none of them has been taken up.

This points to another potential question—the disposition of the Huntsville space team should the Army cease space operations. NASA sought to incorporate it once when NASA was organized. The chances probably are that NASA would still be interested, but possibly cooler. But regardless of who runs ABMA, the *Saturn* will keep the space team there busy for some time.

The second big Army problem is *Nike-Zeus*.

Debate on the big missile cuts the Army with a keen double blade. Some feel that *Zeus* is vital to survival; others see it as a costly static weapon that may well never be fired in anger—a weapon that would provide only a defensive role for much of the army of the future.

Zeus—the nation's only foreseeable anti-missile missile for the next decade—is scheduled to be operational by 1963. But this schedule can only be met if funds are provided in the new budget for going into production.

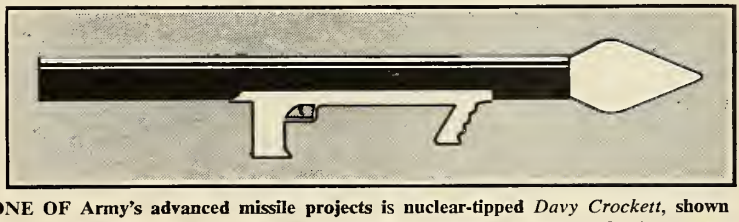
Unfortunately, this is no bargain basement program. The $1.5 to $2 billion which would be needed in FY 1961 is only the first payment. The total price tag would be from $5 billion up depending on how much protection the government wants to buy.

Also, unfortunately *Zeus* is no absolute defense. Therefore, the question arises: Can you buy more defense with $5 or $10 billion by putting your money in more offensive weapons such as ICBM's, *Polaris* submarines and intercontinental bombers.

The Army says no. It says we have enough offensive power planned and in existence. But it says that if the United States is without *Zeus* it will be wide open to Soviet ICBM attack. Moreover, the price of admission will be kept cheap: The Russians will not be forced into improving their ICBM's and will be able to devote the effort to other weapons.

Therefore, some top ranking Army officers feel—although others disagree—that *Zeus* is so vital to American defense that the money for it must be found at almost any sacrifice.

As one official put it: "We could lose an entire Army and it would be a



ONE OF Army's advanced missile projects is nuclear-tipped *Davy Crockett*, shown in artist's conception. Money is lacking to push development of this and other weapons.

great disaster. But we could recover as a nation. But if we are attacked by a large number of ICBM's and have no defense against them we could cease to exist."

If you buy this argument—and it's a tough one to fight—you come directly back to the earthy question of who is going to pick up the bill. Even a casual study of the defense budget makes clear that the billions needed must either come out of the hide of some other program or from a very unlikely budget increase.

This leads directly to the Army's third big problem area: The needed modernization of its scanty divisions to meet the requirements of missile and nuclear warfare.

The Army has not been able to come anywhere near to effecting such a program for lack of funds. It contends it needs millions of dollars more for R&D work on tactical missiles and for their procurement.

Because of funding shortages the Army has been forced to drag out to great lengths the time between development of these relatively short-range missiles and other new equipment and placing them in the hands of large numbers of troops.

At the same time, there is no question that lack of funds has slowed R&D work on the next generation of tactical missiles that will be needed in the mid and late 1960's.

The Army 1960 budget as submitted to Congress originally called for $407 million for procurement of missiles including such newer, advanced weapons as **Martin's** *Pershing* and *Lacrosse* and the **Jet Propulsion Lab/ Sperry Rand** *Sergeant*.

Congress, at least mildly appalled by the lack of speed in procurement of newer weapons, gave the Army an extra $146 million for procurement of equipment including missiles. How much of this money will ever be released to the Army by the Administration is open to question. And, even if the Army were to get it, still more was considered needed and will be again for 1961.

The same thing is true for R&D. Congress gave the Army $1.05 billion —exactly what the budget called for. This includes insufficient funds for development of such advanced missiles as *Davy Crockett* and **Convair's** *Redeye*. And even less for work on the third generation missiles beyond them.

These are the missiles that the Army is depending on to give its divisions the tremendous punch that would be necessary to stand up to the much larger Red forces in any limited war.

For example, nuclear-tipped *Davy Crockett*—an in-house project at Rock Island Arsenal—is designed to be fired from a bazooka tube. The sub-kiloton warheads will vastly increase the firepower of the infantryman.

Convair's *Lobber* is another good example of an advanced weapon that is much needed. The missile, for which no funds at all are available, can serve as both a carrier of cargo or napalm.

It is most significant that these funding shortages are not confined to missiles, but run the whole gamut of weaponry. Among some of the most notable skimping is in the field of tanks. Russia today is producing five times as many tanks as the United States each year. In fact, Russia is reported to give its satellites as many tanks each year as are produced in the United States.

Of course, it is against the yardstick of what the Russians are doing that American military power must be measured in the end. Unhappily, the Russians are doing much. Army intelligence says that Russia has completely modernized equipment for its 175 line divisions. These divisions are equipped for fighting either nuclear or non-nuclear wars.

The United States has 14 divisions—most of them incompletely modernized.

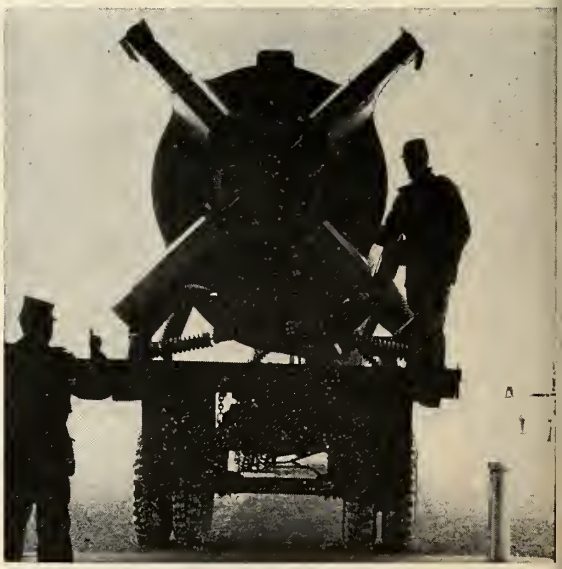
Torn by these problems, faced with shrinking dollars, the Army is confronted with far-reaching decisions on these problems as the annual budget battle in the Pentagon nears its height.

The Army has a capability in the space business. The Army sees *Zeus* as vital to national survival. The Army feels that the development and procurement of its own tactical missiles and other equipment is a burning, overdue necessity.

But somewhere something must give sooner or later under the present situation.

Possibly the Army in the end may accept an exit from space in favor of its sister services as a way out. Possibly it might receive in exchange from the Defense Department other considerations. Dollars, for instance.

ARMY wants to develop Convair's *Lobber* to deliver cargo or carry napalm. So far, no funds are available for the bird.



TWO Army groups armed with *Redstone* are on guard overseas. But the service lacks money to proceed with modernization.

Pressing R&D on Refractory Metals

Hundreds of firms are blazing new trails with the heat-resistant materials that promise to answer many big missile-space problems

by S. David Pursglove

WASHINGTON—One of the nation's top missile research efforts is in refractory metals. These are metals distinguished primarily by extremely high melting points. They range from chromium with a melting point of 3430°F to tungsten, which melts at 6170°F. In between are zirconium (3360), niobium, columbium, (4380), molybdenum (4760), and tantalum (5425).

Some chemists, physicists and metallurgists—the primary researchers on refractory metals—also include beryllium (2340), titanium (3020), and vanadium (3450).

Not all metals so classified by melting point are useful refractory materials. Some are too reactive. Some become too brittle. Others are too scarce to merit extensive research that would lead only to demands that cannot be met.

Refractory metals are called the answer to our major space and missile problems. But the metals themselves have some problems that must be solved before they can go to work for us. Research now is directed toward reducing costs, making the almost unmanageable metals easier to handle and fabricate, and devising alloys that bring out the metals' best features. Refractory metals are the subjects of large amounts of basic research. We need to know more about their properties, why they behave as they do (often in very strange ways), and what happens under various conditions.

Wherever refractory metals yield to research effort, scientists, industrialists, and military planners see new horizons beyond what they had thought were natural limits. Refractory metals must have these important qualities.

- They retain their strength at high temperatures.
- They resist oxidation at high temperatures.
- They resist corrosion.

This means that refractory metals can make possible aircraft and missile flight at hypersonic speeds that breed ultrahigh temperatures. It means great increases in specific impulse of conventional fuels may be had, since the hydrogen contained in all these chemical fuels (including kerosene) dissociates above 5000°F—a temperature and effect impossible to achieve with ordinary metals. This means that important, but corrosive, chemicals may be used more readily.

Hundreds of firms—industrial and research, profit-making and institutional—are engaged in refractory metals research.

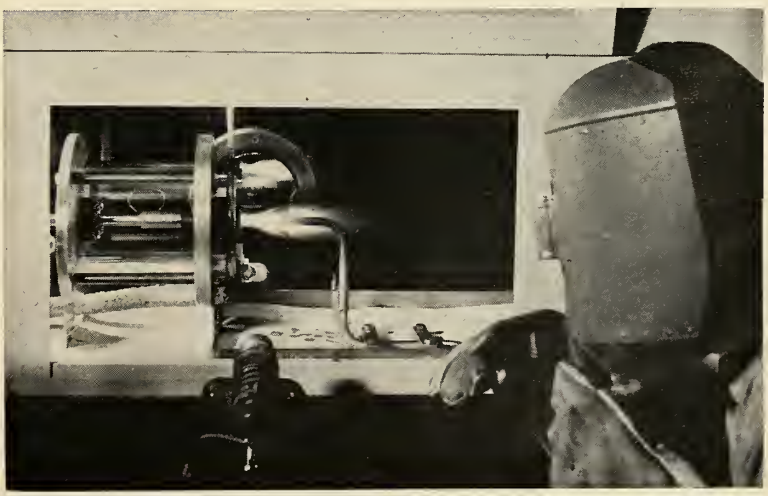
Research organizations blazing new trails include **Arthur D. Little, Atlantic Research Corp., Battelle Memorial Institute, Stanford Research Institute, Armour Research Foundation, National Research Corp.**

National Aeronautics and Space Administration, Department of Defense, National Bureau of Standards, and the Bureau of Mines are some of the government agencies engaged in some phase of research or development work on the metals.

Private firms working on refractory metals include most of the metals companies, many chemical companies, aircraft firms and missile prime contractors, and several companies that specialize in refractory metals. The latter group includes **Wah Chang, Alloyd, Nuclear Corp., Union Carbide Metals, Beryllium Corp., Brush Beryllium Co., Nuclear Metals, Fansteel Metallurgical** and **Titanium Metals Corp. of America.**

Here is what some companies are doing, at a glance:

- **Marquardt Aircraft** is developing and testing sheet metal structures, particularly those fabricated from molybdenum.
- **North American Aviation** is working with two new compounds that will improve processing of titanium and steel alloys. One compound inhibits formation of scale on stainless steel, nickel-chrome, and alloys of cobalt, titanium, and copper during heat treatment. The other compound prevents



PLASMA JET of ionized air, hotter than the surface of the sun, disintegrates a small aircraft model at NASA's Lewis Research Center, site of much metals research.

gaseous contamination of titanium undergoing heat treatment in an air atmosphere.

• Nuclear Metals is developing casting techniques for beryllium alloys, techniques for working beryllium and zirconium, and extrusion data on most refractories.

• Nuclear Corp. of America is taking a quantitative look at a long-known misch metal phenomenon. Years ago, metallurgists discovered that small amounts of misch metal—mixed rare earths—increased the performance of steels. Later, the same was discovered to be true in the case of some refractory metals. Now, Nuclear Corp. is trying to determine which single ingredient in misch metal is the responsible agent. So far, it looks like the hero is neodymium. And there might even be a villain: cerium. Neodymium alone increases the desirable properties much more than does the misch metal mixture. Cerium seems to decrease creep resistance.

• Alloyd Research is streamlining old processes for vapor phase deposition of tungsten, molybdenum, and chromium on metal and even nonmetal surfaces.

• Fansteel Metallurgical is doing further work on its methods for spinning and drawing larger tungsten pieces.

• **Douglas Aircraft** is conducting basic and applied research in high temperature areas on tungsten, molybdenum, and niobium. Special interest is in niobium alloys for ultra-high temperature leading edges of high velocity aircraft and missiles.

• **Du Pont** is building a center for development research in niobium, niobium alloys and titanium at its Baltimore plant, to be completed in 1960. The center also will have facilities for work with other refractories.

• **National Research Corp.,** Cambridge, Mass., is investigating tantalum and tantalum-tungsten alloys. One promising Ta-W alloy has three times the tensile strength of Ta at 4000°F and is easily fabricated.

• **Bell Aircraft Corp.** is studying refractory metals as candidates for use in the leading edge of *Dyna-Soar* (M/R Aug. 3, page 24).

• **Sylvania Electric Products Inc.** is expanding production of molybdenum, tungsten and other refractories at its Towanda, Pa., plant. Molybdenum ingots weighing 275 pounds are now available and, with a high-temperature sintering furnace being installed, ingots weighing more than a ton will be produced this month. Until recently, tungsten and molybdenum ingots available commercially have weighed less than 100 pounds.

Here are typical comments from government agencies:

Naval Ordnance Laboratory—We are doing some work with refractory metals, but only as they apply to some of our primary projects. Bureau of Aeronautics has a strong interest in this field.

Air Force—Future weapon systems will call more and more on the refractory metals as structural materials. We shall use these metals in hypersonic strategic weapons, ballistic weapons, satellite weapons. (See M/R, July 20, p. 90, for detailed discussion.)

Army—We have a strong interest in refractory metals for rocket motors, and as structural alloys with steel.

• **NASA's work**—For a better idea of how government agencies are approaching this research, look at the program at NASA.

The civilian space agency is interested in refractory metals as a means of overcoming problems that develop at high temperatures, for use in hypersonic aircraft and missiles, and in connection with nuclear-powered vehicles. NASA also recognizes that one way to achieve higher specific impulse from fuels is to heat them above the 5000°F dissociation point of hydrogen. Refractory metals are obviously needed for the containing vessel.

NASA's principal research effort is on niobium and tungsten, with some applications studies on molybdenum structures. The latter work is conducted at Langley Research Center, Va. Actual research work is done at Lewis Research Center, Cleveland.

At Langley, NASA is studying the performance of molybdenum simulated wing panels coated wth nickel-chromium. Out of this work will come one-shot protective coatings for use on leading edges of wings and missile fins above Mach 4 or 5.

Propulsion materials engineer Harold Hessing, of NASA headquarters, says the agency's main interest in refractory metals is in connection with propulsion.

NASA and other organizations have studied niobium for a number of years. Hessing says NASA likes niobium because it has certain advantages over molybdenum: it is easier to fabricate, has better resistance to oxidation, and greater resistance to high-temperature heat transfer fluids.

NASA metallurgists see two major uses for tungsten:

• As a nuclear rocket engine material. NASA is doing some work on tungsten, but the AEC has the primary responsibility in this field.

• As a nozzle or nozzle liner in a chemical rocket.

There are other possible future uses for tungsten, such as in ion beam propulsion and other advanced systems, but any work NASA does in this connection will be incidental to the main effort.

As an example of the immediate need for research on tungsten or other refractory metals, Hessing points to large solid rockets. As these engines become larger, graphite nozzles become inadequate. Metals added to fuels to control resonant burning form oxides that deposit on the nozzles and change their configurations.

However, because of the cost of large, complicated tungsten shapes, NASA and the military agencies are looking at tungsten not as a nozzle structural material, but as a protective coating for graphite nozzles and liner for heat sinks.

As part of its basic research effort on refractory metals, NASA recently awarded a small contract to the University of Denver to study the effect of rare earth additives on the melting of tungsten and molybdenum. If the study sheds new light on ductility, Hessing says, then it may be extended to cover other areas, such as high temperature.

Refractory Metals

Metal	Symbol	Atomic Weight	Atomic Number	Melting Point (F)	Remarks
Beryllium	Be	9.0	4	2340°	Very light; heat sink; reactor moderator.
Titanium	Ti	47.9	22	3020°	Light and strong; cheap as raw material but costly to fabricate.
Vanadium	V	50.9	23	3450°	Very expensive tool steel alloy.
Chromium	Cr	52.0	24	3430°	Retains strength, resists oxidation at high temperatures.
Zirconium	Zr	91.2	40	3360°	Reactor structural material.
Niobium (Columbium)	Nb (Cb)	92.9	41	4380°	Shows most promise; must be coated to prevent oxidation above 2500° F.
Molybdenum	Mo	95.9	42	4760°	Most widely used refractory metal; needs foolproof coating to prevent high-temperature oxidation.
Tantalum	Ta	180.8	73	5425°	Close chemical relative to niobium; higher priced but stronger.
Tungsten	W	183.9	74	6170°	Most important refractory; properties well established through experience in use for light-bulb filaments.

Here, in brief, are the refractory metals' properties:

Be, Ti, V

Beryllium, titanium, and vanadium are not always considered refractory metals since their melting points are somewhat lower than those of the clearly distinguished refractories. However, their melting points are sufficiently high and their properties are similar enough to those of such metals as chromium and molybdenum that they are included in this discussion.

Beryllium is more important as a nuclear fission moderator than as a refractory metal. Until recently its primary metallurgical use was as a hardening agent in copper alloys. Its two outstanding gifts to missiles—low density and high melting point—are offset by its chief fault: beryllium is very brittle at room temperature; it is difficult to work. However, once fabricated, beryllium shows good ductility at high temperatures.

Tonnage quantities of titanium have been available from a number of companies for several years. Titanium, as a raw material, is inexpensive. However, it is so difficult to work that the prices of finished products are too high for many otherwise ideal applications. Titanium alloys give good service in normal air up to about 1200°F. Titanium offers good strength-to-weight ratios up to about 1000°F. The largest present consumer is the aircraft industry.

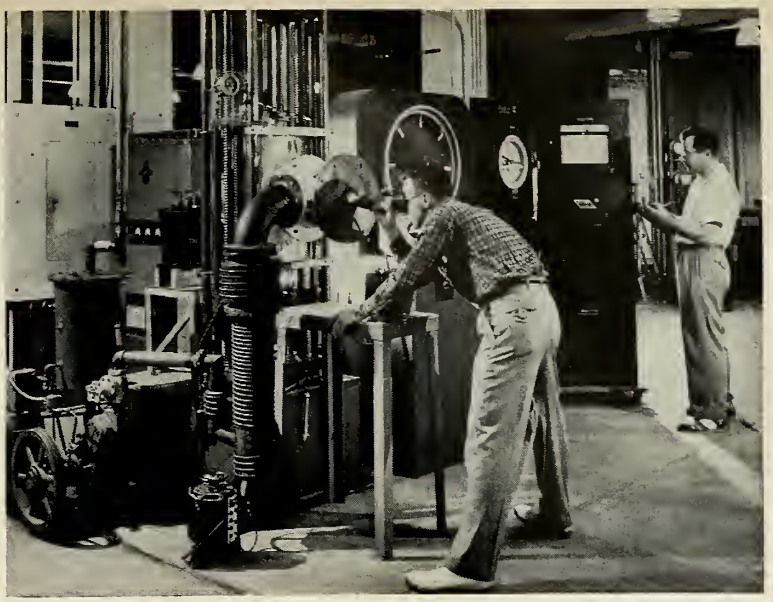
When the price of vanadium is reduced considerably from its present $80 per pound, it will find wide use as an improved replacement for stainless steel around 1700°F. It has a high melting point, is light in weight and is stable in normal air atmospheres up to about 1250°F. As important as any other feature is the fact that vanadium is easily welded.

Chromium

Chromium offers good resistance to oxidation even at very high temperatures. It maintains structural strength at high temperatures. However, nitrogen dissolved in chromium makes the metal brittle. The nitrogen can be removed on a lab scale, but no process so far is suitable to tonnage production. Chromium's major missile use is in alloys for service at 1800-2000°F. The bluish-tinged, silver-white metal is prepared either by electrolytic reduction of chromic acid in water, or by reduction of chromic oxide with aluminium. Stainless steel contains about 15% chromium.

Zirconium

The zirconium industry is well established, producing tonnage quantities for atomic energy uses. Zircalloys—dilute alloys of zirconium, tin and iron—offer the corrosion resistance needed in pressurized water reactors. Alloys for use at higher temperatures in more corrosive surroundings—as in sodium reactors—are in development stages now.



TENSILE STRENGTH of metals is tested at temperatures as high as 4000°F on this apparatus developed at Lewis lab. Results are applied to production of rockets.

Niobium

Niobium, also called columbium, joins molybdenum and tungsten as the three most important refractory metals. Already it has found wide use as an alloying material for nuclear reactor fuels, and the nation's research effort on the metal is just beginning to pick up momentum. It offers high strength at high temperatures, corrosion resistance, and is easily alloyed with many other metals. Mill-run niobium's properties vary with the production technique. However, research is underway to discover the exact factors and means of controlling them.

Niobium often is compared with molybdenum. Actually, it has certain advantages over molybdenum: lower density and greater resistance to oxidation. However, even niobium oxidizes too readily at extremely high temperatures to be used without protective coatings. It is fine up to around 2500°F.

Molybdenum

Molybdenum has been in wide use and has been produced in tonnage quantities for over a dozen years in the U.S. It is best known for its high melting point and the even higher melting points of some of its alloys. Its drawbacks are brittleness at room temperature and ease of oxidation at high temperatures. The big research problem is development of fool-proof, easy-to-apply anti-oxidation coatings. In the case of niobium, when the protective coating ruptures, the metal's strength fails slowly. However, even a tiny crack in molybdenum's protective coating leads to immediate failure of the piece at high temperatures. This calls for several separate coatings to assure absolute coverage of the surface. Sprayed or plated alternate coats of nickel and chrominum are the best bet.

Tantalum

Niobium and tantalum are sister metals, almost always occurring together in nature. Chemically they are very much alike and are therefore difficult to separate. However, tantalum has a higher melting point and is generally stronger than columbium. Despite high cost, tantalum finds many uses where corrosion is a problem.

Tungsten

Tungsten is by far today's most important refractory metal. A large industry is well established. Its properties are well defined, thanks to many years of research. It has the highest melting point and recrystallization point ("freezing point" if you please) of any metal. Its drawbacks are a high melting point that makes it extremely difficult to work with, its ease of oxidation and room temperature brittleness. Tungsten also has the highest density of any refractory metal. In some cases, this is good, but it's a drawback where weight considerations are important.

SOLARIS Might Salvage Missiles

Its designer, Vitro Laboratories, says the weird-looking undersea device could be used for a wide variety of missions at 'low' cost

by William E. Howard

WASHINGTON—Like some weird creature of the deep, the ball-shaped "fish" with a mechanical claw bolted to its belly glides silently through the sea. Depth: 1900 feet.

A pair of lights projecting from metal arms pierce the total darkness, illuminating a patch of ocean floor. Positioned between the lights in a pressure case, the unwinking eye of a small television camera stares glassily downward, hunting.

A small squid foraging on the bottom is caught in the light for a moment and quickly scuttles into familiar darkness.

Suddenly the "fish" stops. Twin hydraulically driven propellers mounted on the upper side keep it hovering in the current. Just below, half-buried in the mud, the light plays over the first-stage booster of a big *Saturn* space vehicle.

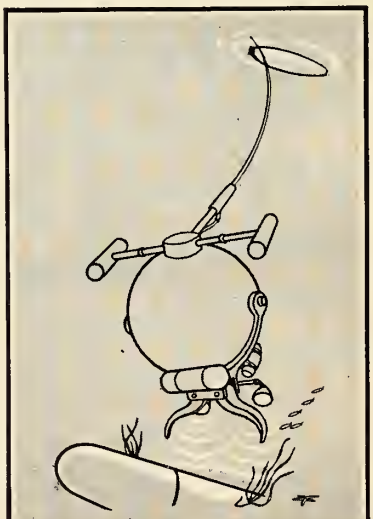
Slowly, the "fish" descends on the booster; the claw opens and then closes over an engine cluster support ring. At the touch of a switch by a console operator aboard a surface ship, a shipboard winch whines into action and the "fish" holding its catch is reeled in by a steel cable.

• **Exploration and detection**—Salvaging valuable rocket boosters in this manner is but one of many missile support and undersea applications of the remotely controlled SOLARIS (submerged object locating and retrieving/-identification system) now being developed by **Vitro Laboratories,** Silver Spring, Md., a division of **Vitro Corp. of America.**

The system has a wide range of peaceful, as well as military uses. Ultimately it may be a key to gaining important knowledge about the vast unexplored regions of the sea.

Designed originally by Vitro to retrieve valuable experimental torpedoes and mines being developed for the Navy, more applications are being visualized for SOLARIS every day. Equipped with sonar, it could be used to sweep wide areas of the sea to detect hostile submarines (M/R Aug. 10, p. 24).

The TV "eye" will permit finding and recovery of missile nose cones and underwater cables, and placing and observing the effects of explosive charges. It can inspect ship bottoms, bridge pilings, river channels and bouys; survey and clear harbors of obstacles and assist the work of divers.



SOLARIS retrieving system in operation could recover missile nose cones.

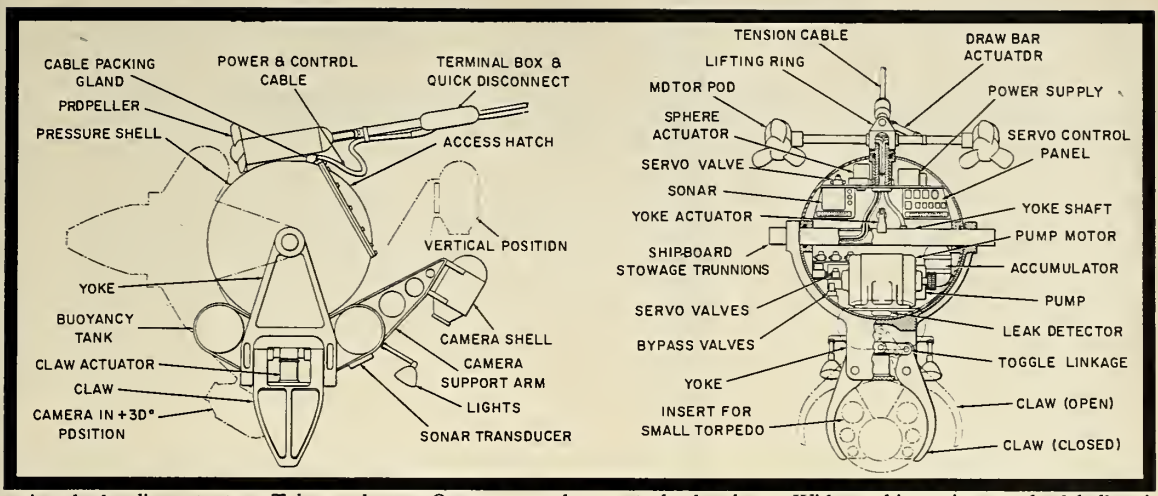
As presently conceived, the system is capable of hauling to the surface loads up to 5000 pounds weight in water. At 1200 feet SOLARIS can search a semicircular area 250,000 yards square—without moving the controlling surface vessel.

The device comes with a number of specialized attachments. One—an over-center toggle action claw—is designed to clamp around cylindrical surfaces, like nose cones of known diameter, without crushing them. Another special claw is intended specifically for cable maintenance. There are special attachments for placing explosive charges and for a stud gun to fix the device to an object. The general purpose claw can grasp a wide variety of objects. Servo control of the actuating cylinder allows varying pressure to be applied.

• **Wire-guided history**—Maker of the *Mark 39* wire-guided torpedo—an ASW weapon—Vitro says SOLARIS is a "logical development" of another (classified) underwater vehicle which it has made for the Navy, which employs a "television camera for positive identification of underwater objects."

Control of SOLARIS is by means of a power cable which pays out along with the steel support cable. The power cable contains two co-axial TV cables, conductors, and signal, control and power leads.

Motive power for the sphere, which is 42″ in diameter, is provided by an electrically powered hydraulic pump. This drives a pair of propellers mounted in pods on the ends of a transverse tube at the top of the sphere. A drawbar, to which the cables are attached, pivots laterally about the center of this tube. It is controlled by a double



acting hydraulic actuator. Tube and drawbar remain at right angles to each other except when steering to the left or right.

The propeller pods rotate individually about the tube in parallel vertical planes, enabling the propellers to thrust upward, down or forward. System stability is obtained by balancing vehicle drag and cable tension against thrust. A slight change in thrust angle is sufficient to move the vehicle slowly in the direction of the unbalanced force component, according to Vitro. And greater changes in thrust angle allow the vehicle to maneuver quickly in any direction. Distance limits are controlled by the winch paying out cable.

• **Sphere detail**—The sphere hangs vertically and is free to rotate about the propulsion and control assembly. Fabricated of 6061-T6 aluminum alloy, the sphere is formed in two hemispheres welded together. It has a 22″ watertight hatch for interior access. Shell thickness is 0.45″ for 2000′ depth.

A 15 horsepower electric motor located in the bottom of the sphere drives a 3000 psi hydraulic pump at a flow rate of 8 gallons per minute. The pump supplies all the mechanical power for propulsion and the control of the vehicle and its accessories. An accumulator provides extra capacity during cylinder actuation. Seven servo valves and an electric by-pass valve control the flow to motors and actuators.

One servo valve controls the flow to propulsion motors, and regulates thrust. The motors use 7 gallons per minute at the maximum of 10 horsepower, leaving 1¾ horsepower available for control actuation. Two servo valves individually control the vertical plane thrust angle of the propellers.

One servo valve controls drawbar angle and, thus, the thrust angle in the lateral plane. Two more servo valves control rotation of the sphere and the pitch angle of the claw accessories and the television camera assembly. A seventh servo is available for actuation of the accessory device. An electric bypass valve frees the attachment positioning actuators after securing the object, insuring that the attachment and its load do not disturb the stability of the vehicle.

In addition, the sphere contains a leak detector and a depth measuring sonar. Built into the sphere is 100 pounds reserve buoyancy for various special equipment which may be added.

VEHICLE retrieving a missile booster engine with its mechanical "claw."

Without this equipment, lead ballast is added to preserve the sphere's 50 pounds net positive buoyancy.

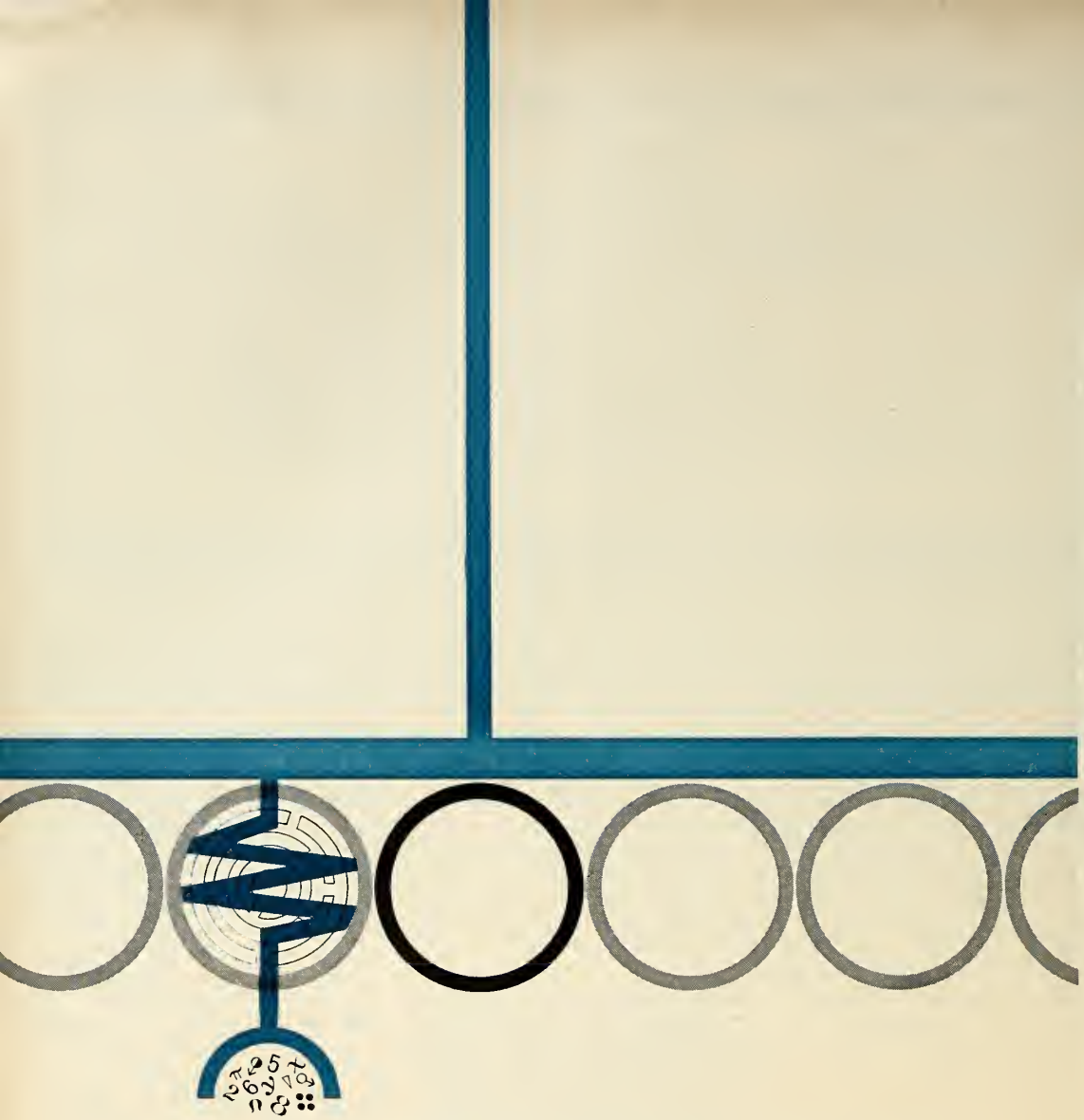
• **Closed circuit TV**—For normal salvage and inspection work, Vitro says a Dage Model 60-BR television camera is satisfactory for depths up to 1200′ further down an image-orthicon camera would be preferable.

Power supply for the camera and 1000-watt diving lamps is located inside the sphere and operates from a 600-volt power line. The camera is mounted in a pressure vessel on a rigid boom attached to the yoke in a position to center its field of view through, and a little below, the jaws of the accessories.

The 400-pound console, measuring 5x3x4½′, displays information on the vehicle's heading, depth, height above bottom, claw azimuth, claw pitch angle, propeller rpm, illuminating current, and time on lights; there is a monitor screen for the closed-circuit television. It also gives information on winch speed, motor current and the amount of cable paid out, as well as temperature, voltage and current of the power supply.

Two hydraulic winches with hydraulic drive handle the power cable and support cable individually. The support cable winch is controlled by the operator and the power cable winch is slaved to it by a constant tension clutch driven a 10% slippage.

In comparison to other systems designed for the same purpose, Vitro says SOLARIS offers greater speed, compactness and versatility. And although the price of one is not disclosed, the company says initial and operating costs for the system are "low."



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The Capital's Top Private Industry

Area's R&D firms double in five years to provide much of the brains for production done elsewhere —last of a series on Middle Atlantic area

by William E. Howard

WASHINGTON—Around the Nation's Capital the saying goes: "You can hardly swing a cat downtown without hitting a Ph.D."

Since it is the pivotal nerve center for the nation's entire defense program, it isn't surprising that the town is aswarm with scientists. Thousands have been uprooted from distant college laboratories and are now working for the government in the great post-*Sputnik* proliferation of missile and space agencies. Hundreds more from industry pass through daily on Pentagon and Capitol Hill missions.

But what does astonish many a blasé Washingtonian is something which has become apparent only recently. Very quietly—and suddenly—the city's metropolitan area has turned into one of the country's major *private* research and development centers. Although it may be small next to the mammoth federal government establishment, nevertheless this missile/space R&D activity is the area's Number One private industry.

Realization of this important new addition to the local economy has come with a just-completed nose count by the Washington Board of Trade, which reports that as of today there are 128 of these enterprises—double the number five years ago. This year alone four new ones have gone into business; last year 17 were added.

These companies have a combined annual sales volume estimated at well over $200 million. They employ 16,000 persons—most of them engineers and scientists. And there are thousands of scientists working for such government agencies around town as the Naval Research Laboratory, Naval Ordnance Laboratory, Naval Weapons plant, Diamond Ordnance Fuze Laboratories, Corps of Engineers Research and Development Laboratories and the National Bureau of Standards.

STARS show areas of concentration of R&D work in the capital and its suburbs.

All this new activity, says the Board of Trade, has made Washington the country's fifth largest scientific community in overall size and "first in the number of scientific and professional personnel per 1000 population."

• **Missile manufacturing**—Proximity to the Pentagon is one main reason for the upswing in private laboratories and highly specialized small companies. But there are other contributing factors, such as a broad scientific community existing in the area's colleges and universities and a wealth of engineering talent that has been attracted by the cultural advantages of a large metropolis.

Moreover, Washington is located in the middle of the lower mid-Atlantic's busy missile manufacturing region extending all the way from Wilmington, Del., to Norfolk, Va. Hundreds of big and small companies scattered along this seaboard section are heavily engaged in missile manufacture. Many of them are working hand-in-hand with Washington R&D firms.

Total missile-related manufacturing for the entire area is estimated at over $1 billion and total employment in the field is well over 100,000.

As some Washington experts point out, the area's R&D firms are providing much of the brains for the production brawn being carried on nearby and elsewhere across the country. A notable instance is the Navy's family *of Tartar, Terrier* and *Talos* shipboard missiles.

The Applied Physics Laboratory of Johns Hopkins University, developer of the anti-aircraft shell proximity fuze, is in charge of the technical direction of the entire program for all three missiles. **Vitro Laboratories,** a division of Vitro Corp. of America, which has a plant not far from APL in Silver Spring, Md., is in charge of systems engineering the three surface-to-air weapons for BuOrd.

A rundown of contractors for *Talos* shows **Allegany Ballistics Laboratory,** Cumberland, Md., prime for propulsion design, development and pilot production; Naval Ordnance Laboratory prime for warhead design; launchers made by the Naval Weapons plant; fuze by **Melpar Inc.,** Falls Church, Va.; warhead fabrication by the **ERCO Division, ACF Industries,** Riverdale, Md.; and boosters by the Naval Propellant Plant, Indian Head, Md. NOL and the Naval Weapons plant also are providing warhead design and launchers for *Terrier* and *Tartar.*

• **Martin's** *Mace*—Biggest concentration of missile manufacturing in the area is at Baltimore, where **The Martin Co.** is prime contracting the Tactical Air Command's surface-to-surface *Mace.* The Baltimore operation is also supporting **Martin-Orlando** in the production of *Bullpup* and *Lacrosse* and the *Titan* ICBM program at Denver.

Following Navy cancellation Aug. 22 of its Seamaster contract, with a layoff of 3000 employes, most of Martin's 14,000 employes now are working on missiles. Baltimore division missile sales are running at $500 million a year with a payroll of $56 million.

Martin leads area contractors . . .

Martin has hundreds of subcontractors nearby. The Naval Propellant Plant provides propellant loading for Martin's air-to-surface Navy *Bullpup*. *Bullpup* power supply is being made by **Catalyst Research Corp.**, Baltimore. In Virginia, the Navy Proving Ground at Dahlgren developed the missile's warhead design and the naval Weapons Station at Yorktown is loading the high-explosive warhead.

At Baltimore's Friendship Airport, **Westinghouse Electric Corp.'s** Air Arm and Electronics Divisions and Ordnance Division, Lansdowne, employ around 6000 persons in production of missile guidance and control systems and in development of underwater missiles, including the Navy's nuclear-tipped *Astor* torpedo. The Air Arm is principal subcontractor for the Air Force *Bomarc* homing radar flight control.

• **Delaware's duPont**—Much of the basic material, like Teflon, and chemicals which go into the production of components for today's advanced missile and space systems is produced at the huge **E. I. duPont de Nemours** plant in Wilmington. The company has a large campus-style research headquarters where hundreds of scientists are conducting basic research into "exotic" new compounds.

Another big employer in Wilmington is **Hercules Powder Co.**, which has a NASA contract to produce third and fourth stages for the solid-propelled *Scout* space vehicle. The company also is working on propulsion for the solid-fueled **Boeing** *Minuteman* ICBM.

Hercules in addition runs the Radford Arsenal, Radford, Va., which makes JATOS for *Nike-Hercules* and motors for the Army's *Honest John* and *Little John*.

• **From $15 to $29**—Typical in some ways, but highly unusual in others, is the story of **Atlantic Research Corp.**, just across the Potomac from Washington in Alexandria, Va. In 1949, Arch Scurlock and Arthur Sloan left the Office of Naval Research and with $1000 capital opened a laboratory in a warehouse.

Now, a decade later, they have more than 600 employes and contracts running into the millions on a score of highly complex missile/space projects. ARC is one of the leaders in solid-propellant rocketry and is the builder of the *Arcas* atmospheric sounding rocket. On June 30, just before the opening of a new $1 million building, ARC made a public offering of 100,000 shares of stock. Space-conscious local investors quickly snapped it up at $15 a share and drove the price the same day to $29. It is now selling for $34.

Five years ago two former Bureau of Standards scientists sold **Emerson Radio & Phonograph** on starting a research laboratory. Today Emerson Research Laboratories in Silver Spring, Md., is making the target detection device for the Navy's *Corvus*. It has nearly 400 employes and a $4 million-a-year operation.

Vitro Laboratories, which is hard at work in the anti-submarine warfare area, expects sales to hit $7 million this year—up 10% from last year—and now has nearly 700 employes.

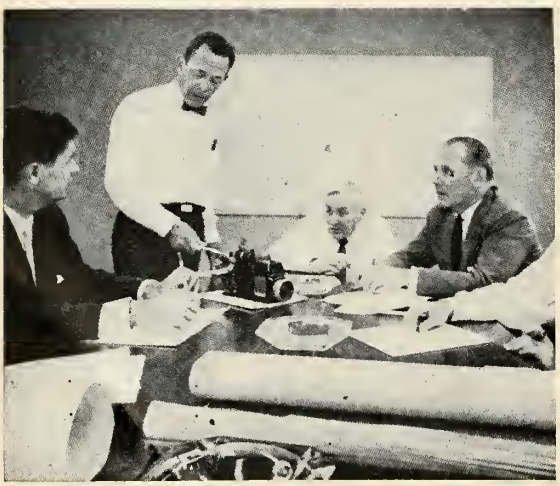
Melpar Inc. is the Washington area's biggest private employer—with 5000 skilled technicians and scientists making electronic equipment. Its products go into *Talos*, *Atlas* and *Jupiter* missiles in addition to space vehicles.

Other suburban Maryland R&D companies which are growing rapidly include **Washington Technological Associates,** which is developing the automatic strikedown and mating system for *Talos*, and **Systems Planning and Research Corp.**—in the same building—which is developing an advanced range instrumentation system for the White Sands Army Missile Range. There are others like **Airtronic Inc., Advanced Research Associates Inc., American Instrument, Andromeda Inc.,** and **Robinow Engineering.**

Applied Physics Laboratory was founded by Johns Hopkins during World War II and succeeded within two years—from late 1940 until late 1942—in developing the antiaircraft proximity fuse. It now has 1300 employes—525 of them engineers and scientists.

Right in the District of Columbia there are many more. **Page Communications Inc.**, a subsidiary of **Northrop Corp.**, has just won a $10 million contract for a 1700-mile troposcatter Air Force communications complex in western Europe. **Wellings-Reed Inc.**, is working on astronautic systems and missiles and **Spacetronics Inc.** is designing spacecraft and air cushion vehicles.

• **And Richmond, too**—Much of the recent dramatic growth in missile/space R&D has taken place in Virginia. While a large portion of the new industry has tended to congregate in Fairfax County and Alexandria within sight of



EXPERTS AT Washington Technological Associates—one member of area's R&D community—work on missile support.

TWO OF the Nation's guided missile cruisers, USS Boston and USS Canberra, side by side at Norfolk Navy shipyard.

the Pentagon, many more firms are spreading out across the state.

A survey by the State Division of Industrial Development shows that Fairfax County (Melpar, Atlantic Research, etc.) is the state's leading missile and electronics center with a total of 15 firms in the field. Other centers—chiefly in electronics—are Norfolk, Richmond, Lynchburg, Roanoke and Charlottesville.

General Electric Co. has plants in Lynchburg, Roanoke and Waynesboro. The company employes 1000 in communications equipment production at Lynchburg, which is tied in with GE-Syracuse, N.Y., on troposcatter systems.

At Richmond one of the big missile age employers is **Reynolds Metals Co.,** with 1400. The company produces aluminum extrusions and a sheet aluminum foil laminate with duPont "Mylar" film which was used to make the 12-foot inflatable satellite which NASA tried unsuccessfully to orbit earlier this month. Another is **Robertshaw-Fulton Controls,** with annual sales running at the rate of $80 million.

Experiment Inc., recently acquired by **Texaco,** has been designing ramjet engines since 1945. It built and flight tested the first monopropellant ram-rocket propulsion system in 1954. Today it has about 110 employes and a missile R&D sales volume of approximately $1.3 million. Producing missile tracking photographic equipment is **Flight Research Inc.,** with 50 employes.

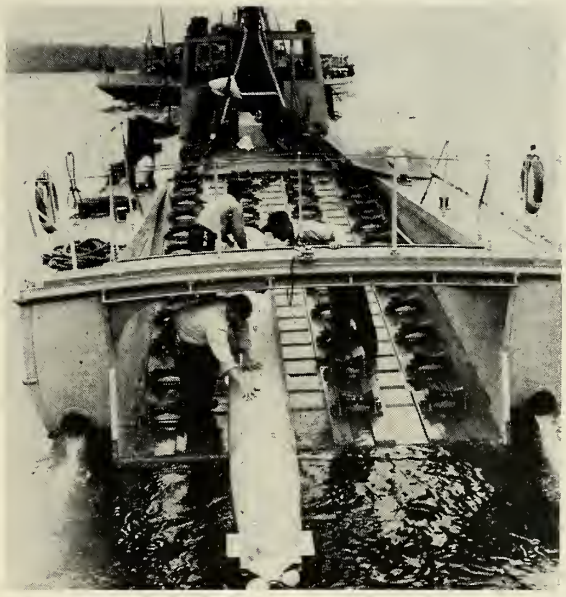
Dominating the Virginia defense installation picture is Norfolk—home of the biggest concentration of naval power in the world. At the **Newport News Shipbuilding and Dry Dock Co.** four fleet ballistic missile *Polaris* submarines are being built. The yard on July 1 was awarded a $63 million contract for two of the subs of the Ethan Allen class.

At the naval shipyard, warships are undergoing conversion to missiles. Some 35,000 civilians are employed by the Navy at Norfolk and the city is home base for 100,000 men of the Atlantic fleet and another 50,000 on shore duty. This year the Navy will spend about $800 million in maintaining its Norfolk facility.

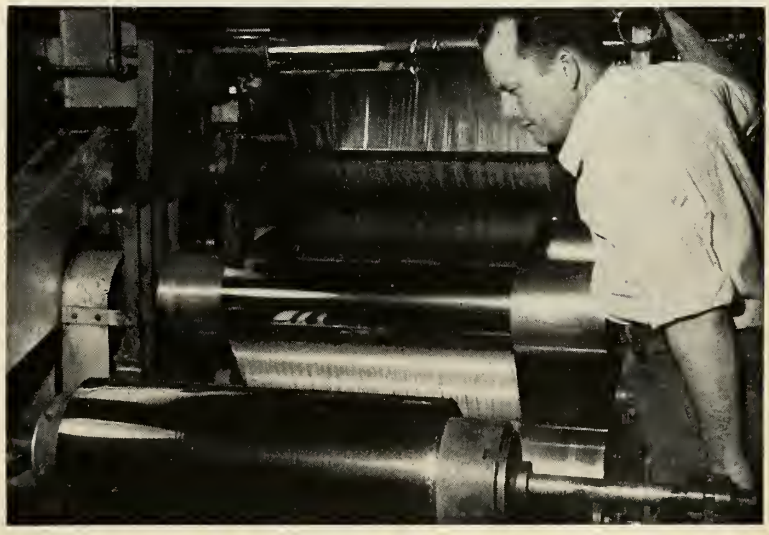
Included in this amount will be the operation of the Navy Missile School at Dam Neck just outside of Norfolk where seamen and officers are learning how to shoot *Polaris, Talos* and other birds.

Topping off the state's new-found role in the Space Age are NASA's high-altitude experimentation station at Wallops Island, and Langley Field—where the nation's first astronauts are in training for a ride in the *Mercury* space capsule.

ACROSS Potomac River in Alexandria, Va., is new $1 million building of the Atlantic Research Corp., which doubles in research work and *Arcas* rocket production.



U.S. NAVY retriever recovers an *ASTOR* torpedo, in development by Westinghouse Ordnance Division, Lansdowne, Maryland.



ALUMINUM foil and plastic skin for the 12-foot inflatable satellite which NASA tried unsuccessfully to orbit this month was produced by Reynolds Metals, Richmond.

NEWS IS HAPPENIN

NOW IN THE AIR–NORTHROP'S N-156F FREEDOM FIGHTER– HIGH-PERFORMANCE TWIN JET THAT DELIVERS MORE FIGHT PER DOLLAR

Successful flight tests prove the high performance of the N-156F. Created especially to fit the specific tactical and economic requirements of the Free World, the N-156F Freedom Fighter is a multi-purpose weapon system. It offers total combat effectiveness–more fight per defense budget dollar–than any other American front-line fighter. The N-156F costs far less to buy, to fly, to maintain, and can be produced outside the U to aid the economies of those countries it will defend. T Freedom Fighter typifies the years-ahead thinking of Northr Corporation and all of its Divisions. The Corporation's conti ing goal: design concepts for tomorrow, hardware for today developed, produced, delivered on time – and at minimum co

NORTHROP CORPORATION *Beverly Hills, California*

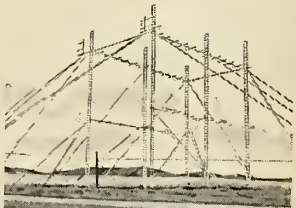
AT NORTHROP

NEWS FROM OTHER MEMBERS OF THE NORTHROP FAMILY

ORAIR produces airframes, ce vehicles and weapon sys- ns. In production: Snark SM-62 l the T-38 Talon, first low-cost, h-performance twin-jet to in America's space age airmen.

NORTRONICS makes news with America's 2 most advanced inertial and astronertial guidance systems, LINS and A-5 – is also a leader in automatic test equipment and mechanical ground support.

RADIOPLANE, foremost producer of drones and space age recovery systems, is delivering unmanned aircraft that train men, evaluate today's weapon systems, and fly on surveillance missions.



PAGE Communications Engineers, the leading authority in worldwide telecommunications, is currently employing these advanced techniques to plan and set up networks throughout the Free World.

The Case for Manned Lunar Flight

NASA officials, speaking for themselves, argue that man can accomplish more than instruments and outline plans for flight direct to moon

LONDON—Two NASA scientists are taking exception to the general scientific philosophy that early lunar exploration should be undertaken by instruments rather than man.

In a paper to be delivered at the 10th annual Congress of the International Astronautical Federation which opens here this week, the scientists—M. W. Rosen and F. C. Schwenk—contend that it is historically and economically unsound to limit early exploration to instrument probes. And—they say—it will be immeasurably more expensive to attempt to duplicate with instruments what could be accomplished by a few men on the moon.

Taking note that their opinions are their own and not necessarily those of NASA, Rosen and Schwenk say the importance of the simple data that instruments can collect is unjustifiably magnified. In addition, they argue, there are millions of things that instruments cannot do. They point out that no combination of mechanical or electronic devices exists that can duplicate the sensing capabilities of man—nor replace his ability to record, remember, interpret and discriminate.

Rosen and Schwenk advocate a direct flight vehicle as the most likely approach. They say an orbital rendezvous program involves accumulating in an earth orbit the required hardware and fuel for escape, landing on the moon and return to earth. While a smaller booster is required for the orbital rendezvous method, the program offers some disadvantages, they say, including the need to perfect rendezvous techniques, man the orbital station, build an equatorial launch site, and produce a number of space vehicles for one mission.

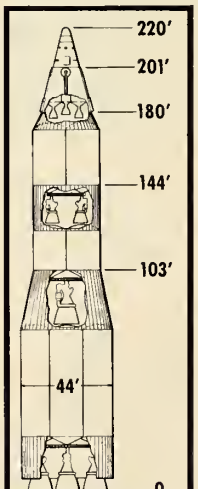
• **Design factors**—A 2½-day flight was proposed for the manned mission. The first three stages would accelerate the payload and remaining stages to an inertial velocity of 36,000 feet per second. After coasting to the vicinity of the moon, the fourth stage would lower the remainder of the vehicle to a landing. At departure, the fifth stage would propel the vehicle toward the earth, and after 2½ days, the payload would approach our planet. A sixth stage of propulsion could be used to slow the capsule to orbital speed, or the vehicle could enter the atmosphere at hyperbolic velocity.

• **Propellants**—A major concern is the selection of propellants for the various stages. High-energy propellants—liquid oxygen and hydrogen—were cited as the most desirable to achieve the mission with the least vehicle gross weight. Rosen and Schwenk add, however, that this propellant combination can be used only if the necessary engines are available and the techniques for handling liquid hydrogen are developed.

For a return capsule weight of between 8000 and 9000 pounds, the vehicle at lift-off must weigh more than 4 million pounds. A sea-level thrust rating of over 6 million pounds is required. NASA is developing an engine capable of producing 1.5 million pounds of thrust with liquid oxygen and kerosene propellants. A cluster of several of these engines was cited as a logical choice for first-stage propulsion.

A hyperbolic velocity re-entry is assumed. A powered sixth stage could be employed to first slow the vehicle to orbital speed; thereupon the landing would be similar to that of NASA's Project *Mercury*. However, retro-to-orbit is a costly maneuver and its use would require a vehicle so large as to make the task of a manned lunar landing too ponderous unless nuclear or electrical propulsion schemes are considered.

• **Vehicle characteristics**—The outline drawing of a typical direct-flight vehicle shows that it stands about 220 feet high and the first stage is 48 feet in diameter. The conical portion at



AT LEFT, crewman sets out to explore the moon from the proposed direct flight vehicle, remaining stages of which will be used for return. At right, drawing of vehicle.

the top contains the landing or fourth stage, the take-off or fifth stage, and the manned capsule or payload. Upon return to the earth, the payload will weigh 8000 pounds including men, equipment, capsule, guidance and control, and parachute. Two or three men will constitute the crew.

Six engines, each of 1.5 million pounds of thrust, power the first stage. Liquid oxygen and kerosene are carried in a cluster of seven tanks, each one 16 feet in diameter. One altitude version of the 1.5 million-pound-thrust engine propels the second stage. This stage uses a cluster of four 16-foot-diameter tanks. The high-energy third stage also consists of a cluster of four of these 16-foot tanks and a thrust level of 600,000 pounds is produced by four engines.

The fourth, or landing stage utilizes high-energy propellants with throttleable engines to provide variations of thrust for the landing maneuver. The landing stage must be able to hover while the pilot makes his final choice of a landing spot. Approximately one minute of maneuvering or hovering time is provided. Retracted landing legs appear on the side of the fourth stage. When extended for landing, the legs span a distance of 40 feet for purposes of stability.

The fifth stage is placed in a cylindrical tube that pierces the tankage of the landing stage. At take-off from the moon, the fifth stage slides out of the landing vehicle on rollers. This arrangement was chosen because it presents a vehicle with a low center of gravity, reducing any tendency for the vehicle to topple on the surface of the moon. In addition, the propellant tanks of the spent landing stage which surround the fifth stage serve as meteor bumpers and shielding against thermal radiation. Furthermore, no landing loads are transmitted through the return stage, thus minimizing the danger of a rough landing.

• **Two-story capsule**—The manned capsule is an enlarged version of the one used in Project *Mercury*. It is a truncated cone, with a maximum diameter of 12 feet and a height of 14 feet. Inside the capsule, two levels are provided. The lower level contains contoured couches for the crew, controls, communications, and a folding air-lock for use on the moon. The upper level contains food, power supply, exploration gear, and work space.

The outer surface of the capsule is covered with ablative material for insulation against and removal of heat generated during atmospheric re-entry.

• **Guidance systems**—Guidance requirements normally are divided into three phases: initial, mid-course, and terminal. For this mission, these three functions must be provided for both the moon-bound and the earth-bound trips. In addition, the pilot's capabilities in performing major guidance tasks or in monitoring an automatic system are considered. An unmanned return vehicle—a spare—should be placed on the moon prior to the manned flights to provide an escape route should the manned vehicle be damaged upon landing.

The initial guidance phase from launch to earth-escape can be accomplished with sufficient accuracy by inertial systems now under development. Mid-course guidance by means of earth-based radio can direct the vehicle to an accuracy of 50 miles for a lunar impact trajectory. The terminal phase involves the final approach to the moon and the luncar-landing. These maneuvers require vehicle-contained guidance; however, lunar-based radio beacons will assist.

A combination radar-optical system will sense altitude and velocity components relative to the lunar surface. In all but the initial guidance phase (during launching), the pilot can effectively monitor and override the automatic system if necessary. During the mid-course phase, in particular, he can make optical observations of the lunar disk for distance and path angle measurements. The pilot will also be very effective in the final phase of the landing on the moon.

Launching from the surface of the moon will be guided by an inertial system that is aligned and calibrated by the pilot on optical sightings of stars and earth. The proper re-entry corridor in the atmosphere is reached by a combination of optical sightings from the vehicle and earth-based radio signals. During re-entry the lift of the capsule is utilized to modify the trajectory so that the vehicle follows a prescribed deceleration program and lands within the recovery area. The first phase of the re-entry maneuver will utilize vehicle-contained guidance monitored from the earth. After the initial slow down to orbital speeds, earth-based radar in the landing area will control the vehicle.

The mission described is based on a preliminary design study of the type conducted by many agencies to assess the feasibility of a vehicle design. All of the engines are either being developed or programmed for development in the next few years.

PROJECTED mission would include (bottom to top): launching from earth; third stage firing; approach to moon (under jet control), and fifth stage takeoff from moon.

Proceed- OPERATION EXPANSION

September 1, 1959 — Raytheon Government Equipment Division today announced a major expansion into five operating subdivisions: Submarine Signal, Airborne Electronic, Systems Management, Heavy Electronic, and Santa Barbara.

Made necessary by expanding product activity, the decentralization has created managerial and technical staff positions in all areas.

Engineers and scientists of established technical competence are invited to investigate the several opportunities present in the area encompassing their particular interest.

Inquiries should be forwarded to Mr. Donald Sweet, Engineering and Executive Placement, Government Equipment Division, Raytheon Company, 624C Worcester Road, Framingham, Mass.

H. R. OLDFIELD, JR.
Vice President & General Manager
Government Equipment Division

GOVERNMENT EQUIPMENT DIVISION

RAYTHEON
EXCELLENCE IN ELECTRONICS

SUBMARINE SIGNAL | AIRBORNE ELECTRONIC | SYSTEMS MANAGEMENT | HEAVY ELECTRONIC | SANTA BARBARA

UBMARINE SIGNAL

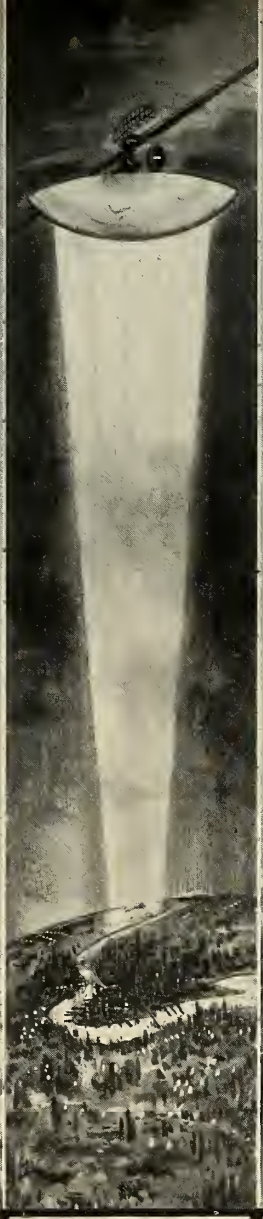
rt, Rhode Island
ers Hamel,
Manager

ering, Marketing, roduction of com- ensive anti- rine warfare sys- Major products: water detection, tion, communica- and fire control ient.

AIRBORNE ELECTRONIC EQUIPMENT

Maynard, Sudbury, Waltham, Massachusetts
Glenn R. Lord,
General Manager

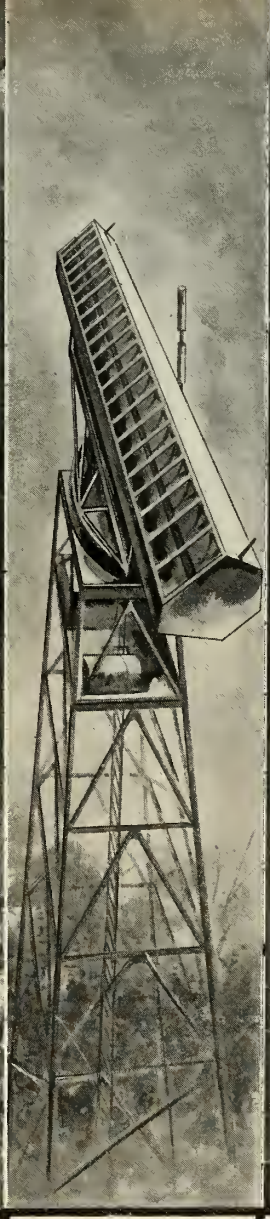
Engineering, Marketing, and Production of advanced aerospace systems. Major products: navigation, search, and fire control apparatus for manned aircraft, unmanned aircraft, and space vehicles.



SYSTEMS MANAGEMENT

West Newton, Massachusetts
Harold M. Hart,
General Manager

Engineering, Marketing, and Management of major electronic system programs. Activities include systems synthesis, learning machines, weapons studies, microwave supported platform.



HEAVY ELECTRONIC EQUIPMENT

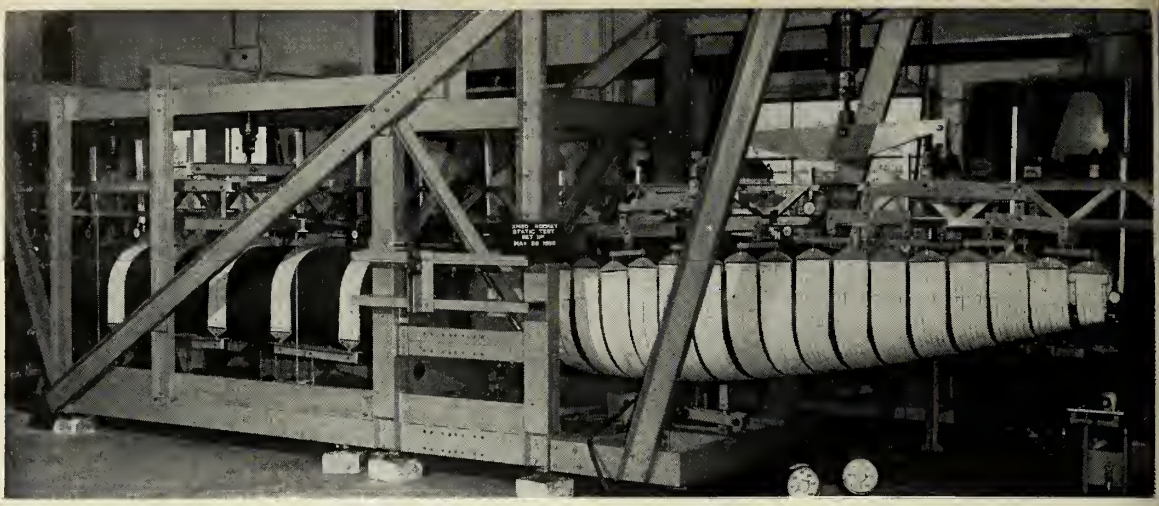
Wayland, North Dighton, Massachusetts
Fritz A. Gross,
General Manager

Engineering, Marketing, and Production of long range surface radars, ordnance and communications sytems. Products encompass 800-ton ground warning systems, missile fire control radars, 96-voice channel pulse code modulation equipment.

SANTA BARBARA

Santa Barbara, California
Gordon S. Humphrey,
General Manager

Engineering, Marketing and Production of infrared and countermeasures devices. Projects involve active and passive ECM equipment for aircraft, missiles, and satellites, infrared guidance, mapping, and fire control components.



SIMULATED load test of improved *Honest John* for maximum flight conditions is carried out by Emerson.

astrionics

Emerson's Prolific E&A Division

Company compiles an enviable record in missile work and comes up with startling developments for the future while bucking 'decentralization' trend

by Charles D. LaFond

ST. LOUIS—Controlled diversification, scientific and technical initiative, production competence, bold product development, capable management, continued growth—these are attributes without which today's manufacturer surely will die.

Typical of those medium-sized firms which have survived business uncertainties is the **Emerson Electric Manufacturing Company.** A 69-year-old electrical manufacturer, it not only has survived but has enjoyed steady conservative growth and parallel prosperity.

Maintaining roughly a 3:2 ratio of commercial-to-defense sales, the Company is a strong arm for the missile industry—and it is strengthening its position steadily. Some startling developments have been achieved through the efforts of its Electronics and Avionics Division, and some of those recently revealed should serve as a catalyst to speed its ascent.

For example, one recent development by the division could revolutionize missile and space-vehicle cooling. Called Thermolag, this paint-like substance, utilizing the principle of sublimation, may provide nose cone reentry protection cheaply and more efficiently than an ablation material.

Total sales by the corporation—both defense and commercial—have doubled in the last five years. This fiscal year (ending Sept. 30, 1959) sales are estimated to reach $90 million. Present backlog in defense orders alone is $35 million. Emerson's president, W. R. Persons, anticipates sizeable business expansion in the forthcoming year with the E&A Div. accounting for from 40-45% of total corporate gross sales of well over $100 million. Sales this year in the division will represent 36% of total sales.

Development and production facilities of the division were expanded and modernized in 1958 and 1959. This included completion of a new environmental test facility at the St. Louis plant. Employing between 2700 and 2800 personnel, the E&A division is steadily improving its production work-to-R&D ratio. According to division general manager, C. G. Gulledge, most of the R&D work is now with government-financed cost-plus-fixed fee or cost-plus-incentive fee contracts; company-sponsored work represents approximately 28% of the total R&D effort.

• **Management and operations**—In contrast to the "decentralizing" trend in industry so popular just a short time ago, Emerson maintains a strongly centralized management structure.

This is the result of a company philosophy that recognizes the need for long-range planning for its research, development and production. This emphasis, demanded by its board of directors and implemented by each key manager and supervisor down the "chain of command," is intended to provide a tight but realistic control of all operations and budgets. Emerson believes it also permits the most efficient use of manpower and facilities.

To further implement the best possible performance and return, whether under contract or company-sponsored,

an intermediate staff level monitors each project.

Monitors control several projects. They exert managerial control over the various project leaders, watch workload and expenditures, serve as consultants, and provide knowledgeable liaison between projects and division general manager.

Emerson's E&A Div. maintains a sizable operations-research group. Its studies provide top management with long-range technical recommendations that could not be obtained any other way—that is, without a crystal ball.

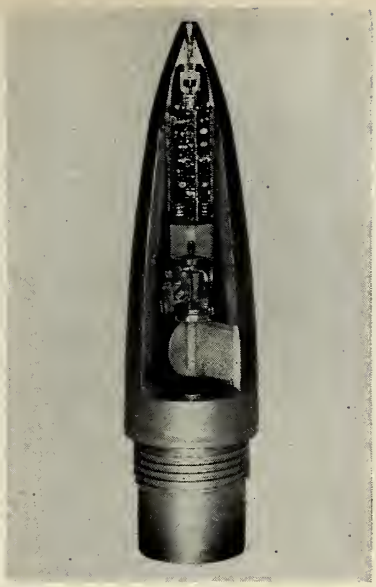
The application of the "scientific method" to help guide executive decision is a costly tool, but its benefits can be far-reaching. Years often can be saved when management has reasonable assurance that each of the roads it is taking is correct and that the pot of gold at the end of each road justifies the journey.

Needless to say, the government also has found such groups indispensable for its long-range defense planning. Because of this need, the E&A operations-research group is not a luxury item—it pays its own way.

Much of the division's efforts in missilery is by now well known. A great deal still is veiled by DOD security classification.

• **The past and present**—The division's success in missile development has been notable. In January, 1954, Emerson was awarded one of two prime production contracts by U.S. Army Ordnance for the complete *M31 Honest John* artillery rocket. Quantity deliveries were made on schedule in August 1954, to the Army's Redstone Arsenal.

In September, 1956, the company was awarded the task of design, development, and fabrication of the motor metal parts and certain airframe components for the *XM50* improved *Honest John* rocket. A letter of commendation from Redstone followed the successful completion of all subsequent tasks.



EMERSON-developed 2.75-inch warhead contains radar-initiated command fuze.

Last July, a $300,000 contract was received to perform a preproduction engineering and ordnance support study for the complete new *XM50* rocket.

Emerson is also prime contractor to the Army Rocket and Guided Missile Agency at Huntsville for development and production of the *Little John* 10-mile range artillery rocket. In support of this program, a 14-man crew of Emerson technicians is stationed at White Sands Missile Range.

For the Navy, Emerson produced the Mark 108 rocket launcher and performed the design study for the *Terrier* launching system for cruisers.

Additional missile work includes subcontracts to the following: **Thiokol**—for *Pershing, Project Able, Minuteman,* and *Falcon* motor cases; **McDonnell Aircraft**—for *Green Quail* decoy missile umbilical linkage.

Considerable advancements have been made by the division in miniaturizing electronics for ordnance and special ammunition. To provide a simple, inexpensive and reliable proximity scoring system, a subminiature microwave receiver was developed for 20-millimeter projectiles. Included also were an electronic firing circuit, electrical primer, safety and arming mechanism, and spotting charge.

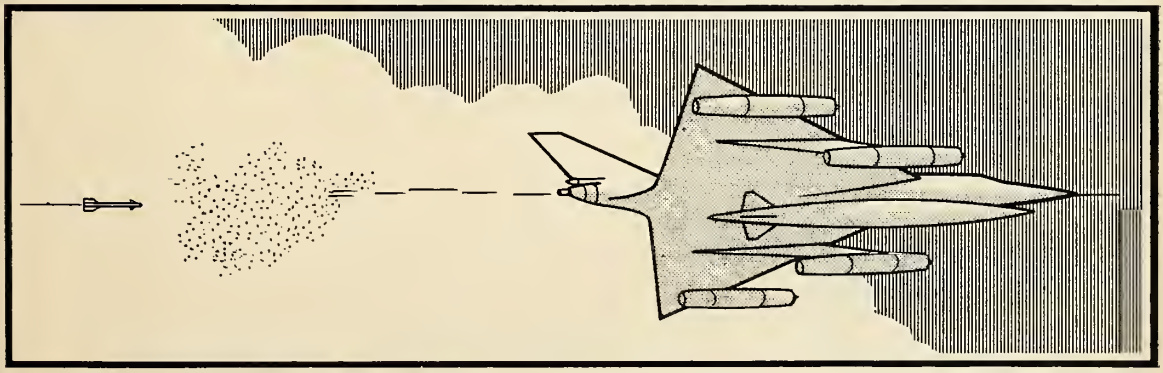
A microwave transmitter in the target directs a signal which triggers the projectiles when they enter a coplanar field perpendicular to the projectile path. Thus, firing error and dispersion can be photographically recorded for subsequent analysis.

A radar-initiated command fuse for the 2.75″ FFAR warhead permits accurate timing of operation, and hence, accurate evaluation of the fire control system. Rounds, fired in a cluster, may be selectively exploded. Out of this development, a nose-located receiving antenna evolved that is capable of receiving energy 180° from the course of a rocket.

Based on its long experience with fuzing and small caliber ammunition, including many types and sizes of fragmenting ordnance, Emerson is presently engaged in a highly classified study program for bomber missile defense. A principal problem, it can be assumed, is how to damage the sensitive guidance systems in anti-aircraft missiles most efficiently and with the highest kill probability.

• **The present and future**—As a result of the research performed by the E&A Div., new methods in missile cooling and radical concepts in long range warfare may be initiated.

• Thermolag—Thermolag, mentioned earlier, was developed for use as a heat dissipator for hypervelocity flights and has been extremely successful. Mixed and applied like a paint, the substance sublimates (vaporizes directly



M/R artist's concept of a possible antiaircraft missile defense employing small-particle, high-velocity fragmentation.

from the solid state) at a constant rate. Because the temperature of sublimation is not a function of the rate or quantity of heat input, it appears to be superior to ablative processes currently in use on some missile nose cones.

In addition, Thermolag can be conveniently applied on any contour. It cures at room temperature, bonds well to properly cleaned surfaces, and resists metal corrosion. Its vapors are non-toxic. But its greatest virtues are producibility and control. By varying the constituents of the mixture and the application thickness, the sublimation temperature and total vaporizing time can be altered and predicted with relatively good accuracy (within about 100°C).

Lockheed Missiles and Space Division, Thiokol Chemical Corp., the Army Ballistic Missile Agency, and National Aeronautics and Space Administration all have tentative missile or aircraft applications for the material.

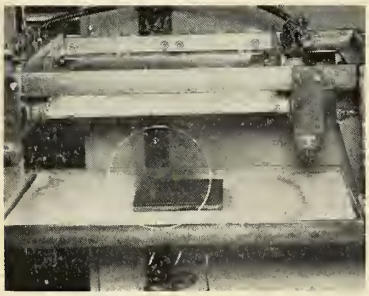
The commercial applications of Thermolag could be tremendous.

• Penetration aids—The E&A group's work involving strategic bomber aircraft has been accompanied by intensive investigations for improving their survivability. Continuing and thorough review and evaluation of new concepts, systems and techniques against the backdrop of mission requirements has established a need—at least for some years to come—for manned strategic aircraft.

With world technological growth, penetration vehicle survival strategies and techniques are continually changing. In general, initial advantage is attained with a new and radically different offense which normally assures a vital time advantage. As the new weapon's capabilities become understood by the enemy and countermeasures are developed, the penetration assistance required to insure mission success changes.

Engineering of a special weapons technique, employing long-range radar, shows great promise. The advantages and disadvantages of infrared techniques—and the problems associated with an environment dominated by nuclear ordnance—have generated unique systems requirements which are undergoing detailed analysis at Emerson.

• Anti-submarine warfare—In another area, the search for improved and higher-power sound sources for certain sonar problems, Emerson physicists are studying devices of a unique, non-linear type sound source which indicate considerable improvement over conventional sources of the same class. Laboratory experiments are in progress to investigate details of the phenomena so that design refinements can be achieved. Additional details are highly classified, but the program has been funded by the Navy's Bureau of Aeronautics for over a year.



THERMOLAG sublimation in process employing heat from 26,000-watt infrared heat facility.

APPLICATION of Thermolag demonstrates simplicity of operation. Vapors are non-toxic.

Process Promises To Raise Transistor Limits

MENLO PARK, CALIF.—A new process has been developed here for preparation of high-temperature semiconductors, according to **Stanford Research Institute,** producing high-purity, single crystals of silicon carbide, and promising to raise transistor and diode operation limits from 400°F to about 1800°F.

Two years ago, Nobel laureate William Shockley theorized that silicon carbide crystals might be grown from solution in alloy melts. SRI put his theory into practice under a subcontract from the Navy's Bureau of Ships and the **Shockley Transistor Corporation.**

By modifying a standard crystal-pulling furnace, pure silicon is melted in a carbon receptacle. The carbon of the crucible diffuses into the molten silicon and saturates the solution. A "cool spot" is produced in one area by controlled temperature. A localized area of supersaturated solution results from which the crystals can be grown.

SPACE WILL HAVE ITS ACES

Cadets at the Air Force Academy use a loose-leaf textbook on space. In it goes up-to-the-minute knowledge on research rockets and satellites. Soon the book will include accounts of manned vehicles for upper atmosphere, orbital and space flights. In early flights man and his vehicle will descend to earth by parachute. Next, pilots will return by controlled, glider-like landings. One day, true space cruisers will explore our solar system. The cadet has a vital role in these forthcoming pages for the book on space. He has an exciting place in manned research vehicles . . . a tremendous future in space!

AERONAUTICS · ASTRONAUTICS · ELECTRONICS · GENESYS CORP. · RANGE SYSTEMS · RESEARCH

CHANCE VOUGHT
DALLAS, TEXAS

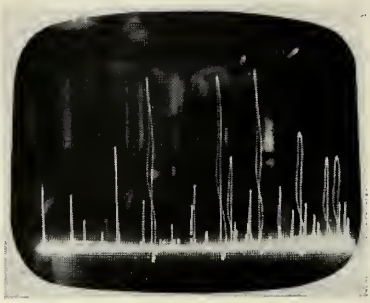
RCA System To Ease Interference

CAPE CANAVERAL—A new spectrum surveillance system recently installed at the Atlantic Missile Range promises to alleviate some of the interference problems plaguing the missile complex. The system was designed by **RCA Service Co.**

Silencing of electromagnetic interference was recognized early as an involvement of the complexities of missile launching, tracking and controlling. The role of an electromagnetic control function was settled in 1950 by the establishment of an Interference Control Office as a major activity of the Air Force Missile Test Center here.

When the scope of electromagnetic control changed and system capabilities increased, Interference Control was expanded and became Frequency Control and Analysis. Not only was suppression of interfering signals required, but analysis and control of all range operating frequencies became a major problem.

By 1959, a new spectrum surveillance system, designed on functional concepts through exploratory engineering, was needed. In June, a rudimentary system with automatic search capabilities was implemented for the frequency range from 50 to 1000 megacycles. The system provides frequency measurement, signal strength measurement, direction finding and a detection threshold of –120 dbm.



TYPICAL spectrum conditions at the Atlantic Missile Range.

• **Versatile system**—Each antenna, a modified version of a discone, is connected to an individual octave of preamplifiers. Using high-gain, low-noise preamplifiers, it is possible to multicouple various signal sources and receivers on each band (octave) without loss of system performance.

Tunable receivers are used with signal analysis equipment to determine the type and modulation characteristics of received signals. Conversely, injection of signal or power standards, at the multicoupler, results in simplified frequency and signal strength measurements.

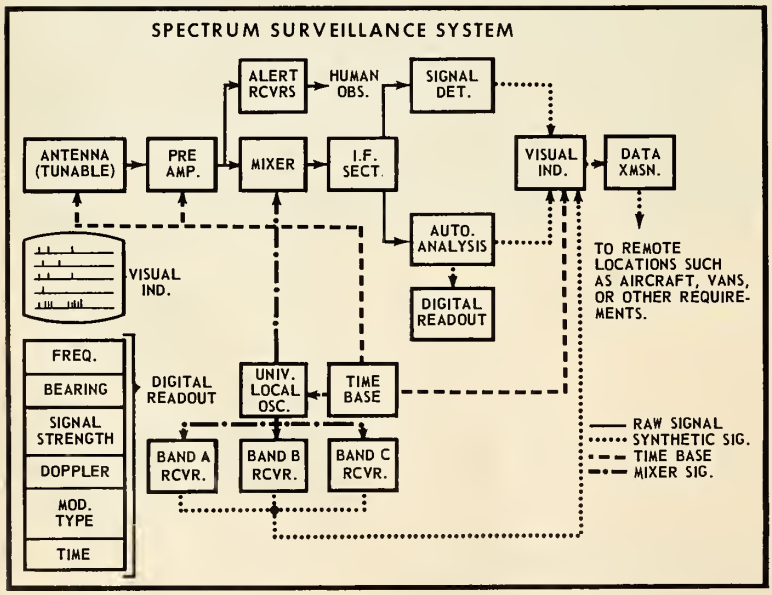
The converter will accept either a sweeping signal or a fixed signal. In the sweep mode, the system can "observe" any part or all of the band on which it is employed. By insertion of a fixed signal generated from a precision frequency source, the system can be converted to a secondary frequency standard when multicoupled to a frequency stable receiver, such as the 51J or R-390A.

• **Continuous recording**—In the sweep mode, the variable bandwidth receiver provides information for panoramic display of specific signals and alarm circuits. The alarm circuits can either alert operating personnel to a signal intercept or stop the sweep oscillator and start recorders. Other variations and combinations are possible. The alarm circuits are invaluable for detecting and recording intermittent or keyed transmissions. All signals present on any band are continuously recorded. A 17-inch monitor oscillograph provides real time presentation of all signals for visual observation.

Coarse position of the radiation source is obtained by comparing signal intensities from individual antennas "receiving" different sectors. When reception from a given sector is expected, the antennas are oriented for maximum signal. Four such antennas, searching different sectors, form a two-baseline interferometer antenna system. In operation this system is similar to Minitrack. Accuracies of 5° are achieved. This will be improved to 2 or 3 mils when suitable phase measurement equipment is installed.

The system is designed to accomplish the intercept and rapid readout of radiation characteristics by use of high-gain, electronically sweeping, tunable antennas in synchronism with the universal local oscillator. The oscillator provides a mixer signal which permits each receiver to scan a band while all maintain a known relationship to each other. Spectrum density indications and signal search capabilities cover the spectrum from 20 mc to 10 kmc.

The time base which is the syn-



SYSTEM designed by RCA provides a detection threshold of –120 dbm.

chronizer of the system activates frequency shifting in the universal local oscillator, provides timed oscillograph traces, and feeds the frequency tunable antennas to provide azimuth and elevation data.

The received signals are fed through the IF section to the automatic analysis equipment which will indicate "modulation type."

• **Maximum sensitivity**—The signal detector provides the maximum sensitivity possible to establish the presence of a signal. It also provides a shaped pulse for visual indication. The alert receivers provide the capability of signal observation by operating personnel for fine analysis or manual data recording. In automatic analysis, the characteristics of radiations will be read out in digital form for simplified observation, identification and recording.

The facility at the Atlantic Missile Range was developed and installed in less than two months, using off-the-shelf components. It was implemented to evaluate parameters for future frequency control and analysis programming but has simultaneously provided immediate support for various programs at AMR.

Battery Maker's Report Clobbers Hot-Gas APS's

by Charles D. LaFond

DENVER—" . . . the status of Hot Gas APS System for the ICBM programs was such that the failure of at least one out of every ten operational missiles, if required to perform, was practically guaranteed due to the Hot Gas-APS System alone."

In essence, this statement helped to precipitate the recent cancellation of hot-gas APS programs at **Sundstrand** and **Aerojet-General** for the *Atlas* and *Titan* ICBM's according to the **Frank R. Cook Company** (first reported in M/R, Aug. 24).

Beginning in late 1958, Cook began a study and analysis of auxiliary power sources on the *Atlas* missile. A summary of the results is provided in the accompanying table comparing hot-gas APS versus battery APS..

In addition to this disheartening conclusion ($23 million had already been spent on the hot-gas APS program by **Convair-Astronautics),** there was no reason to expect that improved design might substantially brighten the picture. With the *Atlas* scheduled to become operational in September, 1959, development—for all practical purposes—was completed. This meant that the existing reliability of the hot-gas APS system was a "frozen" actuality. Production design units were in the process of being fabricated for use in the first operational missiles. Tight scheduling and a limited production capability, in addition to the obvious high cost, thus prevented the authorization of any major design changes.

The report also indicated that, even though many millions of dollars had been spent on the hot-gas APS program, no design effort ever had been authorized for a parallel battery-APS program.

According to company president Frank R. Cook, a weak effort had been made to produce a "breadboard" battery system for comparative purposes. Yet, said Cook, even though the comparison was an unreasonable venture, the battery system's inherent reliability was apparent.

Based on its three-year experience period with the *Atlas* program, the Cook report revealed that the following advantages would be effected through a battery APS system:

- 10:1 improvement reliability;
- 2:1 reduction in weight;
- 4:1 reduction in unit cost;
- 50:1 reduction in sustaining costs (maintenance, logistic support, spares, etc.);
- elimination of extensive maintenance;
- elimination of specially trained personnel requirements;
- 30:1 reduction in activation time;
- 10:1 reduction in remove-replace-verify time;
- 100:1 reduction in spares requirements; and
- elimination of contractor depot requirements.

Cook has stated that in its experience where ever comparison has been made between the two systems, hardware for the battery-type missile APS has proved to be lighter in weight.

Further, all of these advantages would be obtained without the sacrifice of any of the existing performance requirements.

Following a review of the Cook report (dated July 31, 1959) by the Air Force's Ballistic Missile Division and Ballistic Missile Office, the hot-gas APS program was cancelled for both the *Atlas* and *Titan* missiles.

The company noted also that besides the units it is providing now for all eight of the *Atlas* type batteries, it produces units for four battery types in *Polaris* and two for *Minuteman.*

Comparative Data (Atlas)

ITEM	HOT GAS APS		BATTERY APS	
	TODAY	12/59	TODAY	12/59
DEVELOPMENT COSTS EXPENDED TO DATE	10's of millions	.....	10's of thousands	.....
PRESENT LABORATORY RELIABILITY STATUS	approx. 85%	95% (est)	approx. 95%	99.5%
OPERATIONAL RELIABILITY (ESTIMATED)	85%	92%	93%	99.5%
APPROXIMATE COST PER UNIT	$40,000	$20,000	$10,000	$5,000
ESTIMATED GROUND SUPPORT EQUIPMENT COSTS	.....	$500,000	.....	none
TRAINING COSTS (CONTRACTOR)	.....	$1,500,000	.....	none
OPERATIONAL SPARES-QUANTITY (LINE-ITEMS PER SQUADRON)	.....	2,000	.....	20
SPECIALLY TRAINED PERSONNEL REQUIRED	.....	9/sqdn.	.....	none
WEIGHT PER UNIT (INCLUDES TANKAGE AND FUEL)	150 lbs.	140 lbs.	100 lbs.	75 lbs.
TIME TO ACTIVATE AND VERIFY SYSTEM	.....	1 to 2 min.	.....	2 to 5 sec.
TIME TO REMOVE, REPLACE AND VERIFY UNIT	.....	2 hr.	.....	12 to 15 min.
ESTIMATED MAINTENANCE MAN-HOURS (PER MO./SQUADRON)	.....	1500 hr.	.....	none
ESTIMATED CONTRACTOR DEPOT COST (PER YEAR AFTER 1961)	.....	3,000,000	.....	none

WESCON Show Emphasizes Design

by Frank McGuire

SAN FRANCISCO—A major Space Age accomplishment ran slightly afoul of human factors at the 1959 WESCON Show here, and made a mildly frustrating failure of efforts to open the show with an appropriate bang.

With the *Explorer VI* satellite orbiting high over South Africa, the Jodrell Bank radio telescope facility in Great Britain sent a command signal to begin transmission of stored telemetry data. The received signal was to be used in the official WESCON opening ceremonies. A loud and clear signal was received by Jodrell Bank and sent to **Space Technology Laboratories** in Los Angeles, which in turn relayed it to San Francisco.

However, the story goes that a young lady in the downtown office of the teletype company pulled the wrong plug and so the signal did not get from downtown San Francisco to the WESCON show at the Cow Palace.

It was a good show anyway.

• **Vast exhibition**—New products reigned supreme, and great emphasis was placed on design appearances of equipment. Exhibits by 37 young future engineers displayed equipment like plasma arcs, electron accelerators, and parametric amplifiers. Just about 1000 industrial exhibitors filled the huge Cow Palace with every type of electronic equipment that was imaginable —and some that wasn't.

Technical sessions, held every day of the four-day meet, covered things like reliability, antennas, ultrasonics, computers, semiconductors, vacuum tubes, component parts and production techniques, circuit theory, propagation, engineering management, nuclear science, and even medical electronics.

Miniaturization, sub-miniaturization and microminiaturization occupied a major spot at the show; most manufacturers demonstrated that they are pushing the lightness and compactness of their equipment, while still maintaining high performance.

An indication of this trend was seen in the 10-ounce, 14-channel tape recorder developed by **Leach Corp.** for airborne applications. This unit surpasses Leach's previous world's-smallest tape recorder by a considerable margin.

• **Throw-away on the way?**—In the reliability field, but still related to unit design—one of the more significant developments at the meeting was a paper by R. O. Stone of the National Bureau of Standards in Washington, D.C.

Stone pointed out that design trends like printed circuits, miniaturization, encapsulization and modular construction are tending to make disposal-at-failure a policy to think about. It has been generally assumed that this would be a prohibitively expensive method, but cost comparisons contained in Stone's paper show that this is not necessarily the case; throw-away modules of electronic equipment, instead of complicated, serviceable gear, may be on the way.

Another paper in this line, by N. L. Kreuder of **Burroughs Corp.,** cited the conflicting philosophies faced by the design engineer who is concerned with reliability: keep the duty of each part light, even though it means using more parts, and thus keep up reliability; or hold the number of parts to a minimum, even though some carry a greater load, and hope the low number of parts will maintain reliability.

Successful equipment has been designed under both theories, Kreuder said, but he cited a method for determining an optimum between them, so that a combination of the two methods would make for greater reliability than either philosophy alone.

• **Prize winners**—All in all, design considerations were heavily brought out in this year's show, and 18 awards based on industrial design were given to electronics firms—the first such competition sponsored by WESCON. The winners will be authorized to use an official label in connection with sales of the winning products.

Awards of excellence, based on "good design, equipment reliability, and how the products and their features are related to people," were given to **Ampex Corp.,** for a digital tape handler; **Hewlett-Packard,** for a clip-on DC current probe; **Cannon Electric Co.,** for an audio/electronic connector; **Electronics International Co.,** for a precision power oscillator; the **Digitran Co.,** for a switch; **Santa Anita Engineering Co.,** for its electropak system; and **ITT** for a closed circuit TV camera.

Awards of merit were given to: **Ampex Corp.,** three awards; **Autonetics; Electronic Associates** (two awards); **General Electric Co.** (two awards); **Librascope, Inc.; Tally Register Corp.;** and **Voltron Products.**

In the semiconductor area, a development by the Ceramics Technology Group at **Stanford Research Institute** promises to raise the temperature limits for transistor and diode operation from 400°F to 1800°F. The development, a new process for preparation of the devices, was carried out under subcontract from the Bureau of Ships and the **Shockley Transistor Corp.**

• **First for Schockley?**—The name Shockley also bounced into the semiconductor picture with a new "compensated avalanche diode" type consisting of a three-layered disk of silicon with extreme voltage-regulation precision. The unit, expected to go into full production in October, is designed for use in missile control systems and other applications. It was invented by the Shockley firm, where its principal developer was Dr. G. Smoot Horsley, assistant director.

A bit of a storm arose over the Shockley diode announcement: a number of firms cited similar devices that had come about as the result of production accidents in their plants. William Slusher of **Transitron Electronic Sales Corp.,** was quoted as complaining about the announcement's wording. "The Shockley organization has done an excellent job improving the dynamic resistance, but they do not have an extremely low temperature coefficient. To be useful as a voltage reference, the diode would have to be put in an oven," he said. Other companies voiced similar disgruntled feelings.

Texas Instruments showed a series of general purpose germanium transistors involving a glass-to-metal seal to allow use of automated equipment.

The Japanese electronics industry was well represented during the show, and received considerable attention. Various electronics equipment and components, including computer systems, were displayed by the Japanese. It was the only official foreign representation at WESCON.

EAGLE

symbol of a superior Navy

The United States Navy has traditionally been proud of its fighting men and superior weapons. The Eagle Missile System is a concept which will continue this tradition into the future.

The Eagle Missile System is an advanced long-range air-to-air weapon for fleet air defense and intercept missions. It is truly a second generation missile concept in which the performance is built into the missile itself rather than the carrier aircraft.

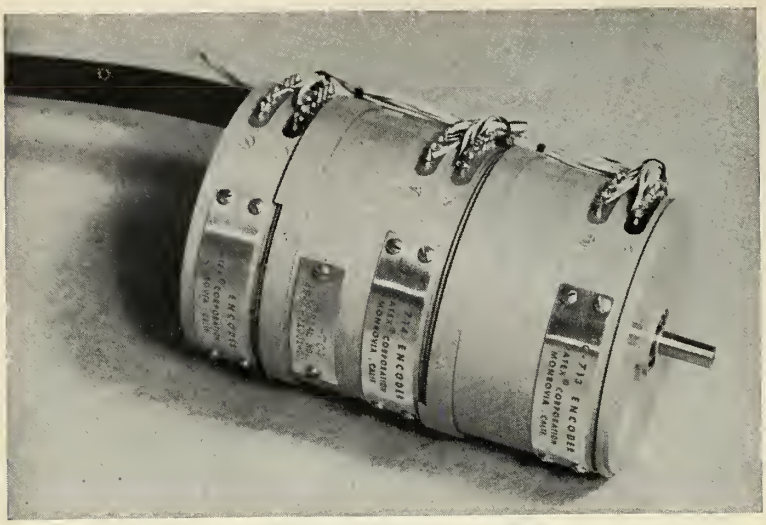
The Missileer will be the aircraft from which the long-range Eagle missiles are launched. This long-endurance aircraft will provide the ideal battle platform from which to carry out future aerial defense.

The Bendix Aviation Corporation, The Grumman Aircraft Engineering Corporation, Sanders Associates, Litton Industries, and the Westinghouse Air Arm Division are the key participants in the Eagle Program. The Bendix Systems Division has prime responsibility for systems management and engineering.

Better engineers and scientists interested in participating in such programs of the highest technical integrity are invited to write for further information.

Bendix Systems Division
ANN ARBOR, MICHIGAN

Bendix
AVIATION CORPORATION



New Encoder Has 1 Million Positions

One million shaft positions can be resolved with the Model CG-704 Geared Encoder Assembly now available from **Datex Corp.** Designed for use where minimum size and weight are important, the assembly uses three Datex shaft position encoders and two gear boxes.

The encoder used on the input shaft provides 1000 positions of the least significant digit per 360° rotation. Because the disc of this encoder is coupled directed to the input shaft, accuracy is that of the encoder used (1 count).

This input unit is then geared 100:1 to a 100-position encoder. This 100-position encoder is, in turn, geared to a 10-position encoder. One hundred revolutions are required for full-scale output.

Because of the step-down gearing, the inertia reflected back into the driving system by the low-speed encoder is a fraction of the inertia of this disc and, therefore, has negligible effect on the drive requirements.

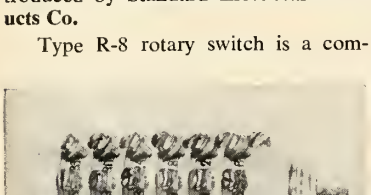
The CG-704 is 3″ in diameter, 5″ long (exclusive of shaft), and weighs less than 2 lbs. It will operate accurately at temperatures from +32° to +150°F and vibration up to 2000 cps under 8 g's.

Datex Corp.
1037 So. Myrtle Ave.
Monrovia, Calif.

Rotary Switch Gives Circuit Design Flexibility

A rotary switch for missile and ground control equipment has been introduced by **Standard Electrical Products Co.**

Type R-8 rotary switch is a compact unit which is said to allow great flexibility in circuit design. Up to 48 separate circuits may be switched with a 6-section configuration. The switch employs a contract roller which is driven independently of the operating shaft at high speed making a fast break and make. Entire switching action takes place within the enclosure.



Other features include a contact rating at 28 VCD or 115 VAC; continuous 25 amp, resistive 25 amp, inductive 15 amp., overload 50 amp., and maximum switching per section; 1 pole—8 position—8 circuit, 2 pole—4 position—8 circuit.

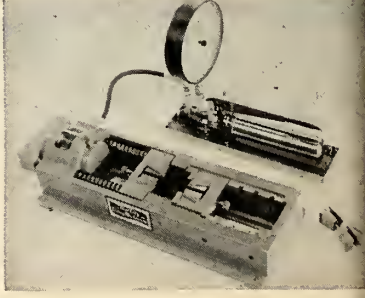
Contacts are fine silver with coin silver contact bars. Bridging or non-bridging contact bars can be supplied. Action is positive on maintained positions. Stops or continuous rotation can be supplied as specified. Torque to operate the switch is 2 lb./in. which will vary with number of sections and other requirements.

Standard Electrical Products Co.,
Costa Mesa
Calif.

Tensile-Tester Produced For Portable Applications

A new family of portable tensile testers—for bench or wall mounting—has been developed by **Steel City Testing Machines, Inc.** These testers can perform standard tensile tests when mounted horizontally and can perform either tensile or compression tests when the tester is mounted vertically. A lower compression plate is available as an accessory when compression tests are anticipated.

Tensile load is applied to the test specimen by manually operating the hydraulic pump. The applied load is shown directly on the 8½″-diameter gage, which includes a maximum-indicating hand. Connection between the pump and the tester is through a flexible rubber hose so the maximum reading will not be affected by fracture reaction. Since the pump and gage unit must be bench mounted, the length



of the hose can be specified longer than the standard 18″ when the tester is to be mounted on the wall.

Base of the tester is cast aluminum to minimize weight while the jaws, cylinder, slotted ways and stop keys are steel to increase strength. The stationary jaw holder can be positioned in any one of three locations by shifting the positions of the stop key and the jaw holder.

Designated the PT series, these testers are available in two general sizes. Model PT-20 units have capaci-

ies from 5000 to 20,000 pounds. Details of these models are the same except that a 5000-pound gage is graduated in 25-pound increments and a 20,000 pound gage is graduated in 100-pound increments. Model PT-40 units have capacities in excess of 20,000 up to 40,000 pounds. A 40,000 pound gage is graduated in 200-pound increments.

Several sizes of flat and round jaws are available for specimens up to ½" in thickness or ¾". in diameter. All testers have a maximum stroke of 2½", and can take 11" long specimens for PT-20 units and 12" for PT-40's. Maximum width of specimens is 2".

For Model PT-20 units, tester base dimensions are 10 x 28" with a height of 6". For Model PT-40 units, tester bases dimensions are 11 x 31", with a height of 7". For all models, the pump and gage unit base dimensions are 5 x 21", with a height of 18". Net weight of Model PT-40 testers is about 145 pounds, with Model PT-20 testers being slightly lighter.

Tenham & Company
925 Book Building
Detroit 26, Mich.

System Pumps Liquefied Gas Up to 12,000 psig

Dynamic Research, Inc., has a new automatic gas supply system that pumps liquefied gases at pressures up to 12,000 psig and stores the gas at room temperature after passing through a vaporizer. Higher pressures are available on request.

Model PLG-11-6 is a single cylinder, vertical pump complete with liquid nitrogen storage vessel and all controls necessary for automatic operation. It provides a continuous supply of regulated 6000 psig nitrogen gas at flow rates up to 5 standard cubic feet per minute. It supplies clean, dry gas automatically, with minimum power consumption.

The automatic gas supply system measures 30" x 36" x 22", weighs 400 lbs. dry and 450 lbs. filled, LN2. It comes in a cabinet mounted on casters for easy portability.

The new automatic gas supply—model PLG-11-6—was designed for lab testing, production line and ground support equipment.

Dynamic Research, Inc.
5701 Sepulveda Blvd.,
Los Angeles, Calif.

Circuit Equivalent Unit Has Flip-Flop Features

The first commercially available version of a "circuit equivalent" com-

ponent with characteristics comparable to a flip-flop or bistable multi-vibrator is the silicon trigistor (triggered bistable transistor). Developed by **Solid State Products, Inc.,** the trigistor is a silicon PNPN device with the unique property of triggered turn-off as well as triggered turn on control at its bases. It will turn on with the application of a low level positive pulse to its base.

Once on, the unit will remain on without the need for sustaining base current. A negative pulse to the base turns it off. It will then remain off until triggered on again. It is designed for operation in the range of 1 to 8 ma collector current. The trigistor is particularly useful for memory, counting, timing, gating, and logic functions.

The large board in the illustration is a two-transistor flip-flop circuit and the smaller board the trigistor equivalent.

Solid State Products, Inc.
One Pingree Street,
Salem, Mass.

Crystal-Can Size Relays Have High Sensitivity

Electronics Division, **Elgin National Watch Co.,** announces three new types of Elgin-Advance relays that feature high sensitivity—of 250, 100 and 50 milliwatts—in a crystal can size with 0.2" grid spacing.

Nominal operating voltages range from 1 to 110 volts, with coil resistances from 35 to 10,000 ohms. Units measure only .875" high x .800" wide x .396" thick, and weigh only half an ounce.

Relays are rated up to 3 amperes resistive at 28 volts DC or 115 volts AC. They operate under vibration as high as 30 g's to 2000 cos., with shock ratings of 50 to 100 g's. The temperature range extends from −65°C to +125°C.

Designated MQA, MQB and MZC, these relays are hermetically sealed to withstand rugged environmental conditions and meet all applicable military specifications.

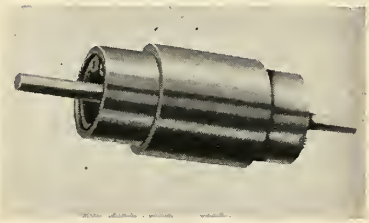
Units are DPDT (2 form C), and are designed for 0.1" grid printed circuits. Terminals are equally spaced in two rows at 0.2" apart, and are available with three-inch leads, solder hook, or plug-in terminals. All crystal can size mounting arrangements are available.

Electronics Div., Elgin National Watch Co.
2435 No. Naomi Street,
Burbank, Calif.

New Torque Transmitter Is Hermetically Sealed

Hoffman Electronics Corp. is now in production on a new hermetically sealed torque transmitter developed by the Electro-Mechanical Department of its Laboratories Division.

The torque transmitter is designed



to transmit rotary motion through a positive metal-to-metal seal by means of a flexible metal bellows. Electrical, mechanical and hydraulic controls, instruments, explosion-proof switches, and other apparatus requiring adjustment or control without disturbing hermetic sealing, may be regulated from outside a sealed area by using the new transmitter.

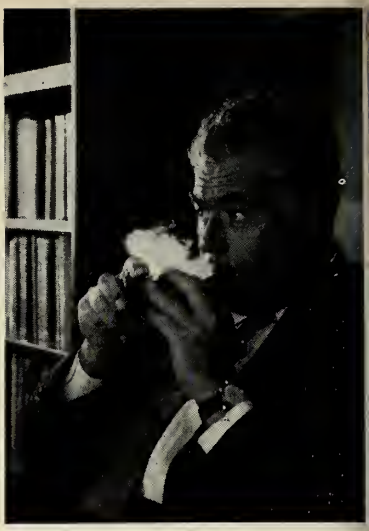
Weighing only .87 ounce, the transmitter is 2½" long and ¾" in diameter. It has a minimum life of 100,000 revolutions and an operating temperature range of −57° to 125°C. Input and output shafts are ball-bearing mounted to minimize friction. No gaskets or sliding seals are used.

Custom designed versions of the transmitter, with varying torque, pressure and backlash parameters, can also be provided to meet specific requirements.

Hoffman Electronics Corp.
3761 South Hill St.
Los Angeles, Calif.

specialist in 'impossible'

Scientist Finds Space Answers on the Ground



Avco's Dr. Arthur Kantrowitz, a former Cornell professor, has led ICBM re-entry work, saving Air Force time and money

by Erica Karr

EVERETT, MASS.—The Air Force Ballistic Missile Division, which recently celebrated its fifth birthday, owes much of its "before-schedule" ICBM achievement to a brilliant scientist who brought space down to earth.

In the fall of 1954, while the fledgling outfit was wrestling with the unsolved re-entry heating problem, Dr. Arthur Kantrowitz, then professor of gas dynamics and engineering physics at Cornell University, proposed simulating re-entry conditions in the laboratory. At a Cornell cocktail party, the idea found a receptive ear in Victor Emanuel, Avco Corporation board chairman, who saw to it that Kantrowitz presented his proposal to the Air Force.

Although there was strong opposition, Lt. Gen. Bernard Schriever, then head of BMD, was quickly sold on using the shock tube technique to provide some comparatively fast answers to the re-entry heating problem. Today Dr. Kantrowitz heads the Avco Research Laboratory at Everett, Mass.

Recalling Kantrowitz's original presentation to BMD, Schriever has written: "His enthusiasm was immediately apparent when he ventured the opinion that he could produce the first answers in six months, since some of our advisors were suggesting four years as a more nearly correct time, while others questioned the application of the shock tube at all for such a purpose."

Kantrowitz with typical confidence proved his point at Avco's new research laboratory at Everett, which he had set up after being tapped for the job by Emanuel. "According to our contract," the scientist said, "we had to set up the lab, recruit personnel, build the apparatus, conduct the experiments and deliver the information within nine months."

At the end of six months he sent BMD the first data from shock tube measurements of stagnation point heating under re-entry conditions. Dr. Kantrowitz had developed a special shock tube over 100 feet long to simulate the re-entry heating environment. Gas is fired through the tube simulating flight speeds up to 18,000 miles per hour.

Because the shock tube did not allow materials testing for long enough periods, the lab later developed the arc wind tunnel, a device which uses electric arcs to heat air to extremely high temperatures.

The work on re-entry heating neared completion by the end of 1956. The two major questions which Kantrowitz and his staff answered to solve this problem were:

1) How much heat would be transferred to an object during re-entry at speeds up to 18,000 mph? And later,

2) What kind of materials stand up best under such conditions?

The answers:

1) Up to 10 kilowatts per square centimeter.

2) Ablating materials.

Avco also provided information on the effect of heat radiation to the reentering vehicle and the electrical properties of the gas which surrounds it.

The lab pioneered in the use of ablating materials for nose cones and under the direction of deputy director Mac C. Adams, has completed tests under simulated conditions to determine the properties of ideal materials. In conjunction with Avco's Research and Development Division at Wilmington, Mass., the Everett Lab confirmed its theoretical predictions and came up with Avcoite, an ablative said to be three times more effective than those with a plastic base. The arc wind tunnel was used in the tests proving out Avcoite. Avcoite coated the first nose cone to be successfully recovered after a full-range ICBM flight—the *Thor-Able*, April 8, 1959.

This phase of the lab's work is largely finished and Avco's recent $73-million Air Force contract for *Titan* nose cones attests to its success.

The subject taking up most of Dr. Kantrowitz's time at the lab these days is high- and low-temperature magneto-hydrodynamics which he has broken down into these areas:

- High temperature: exploring the properties of gases and shock waves in the million-degree temperature range with three goals in mind—(a) fusion reactor applications (b) understanding the nature of the Van Allen radiation belt (c) propulsion of space vehicles using nuclear or solar energy.
- Low temperature: studying the possibilities of generating electric power from gases less than 10,000°K heated by uranium fission.

For the military Avco has tackled the double-barrelled challenge of developing an ICBM nose cone for the Air Force that is invulnerable to attack while working with ARPA and the Army on their anti-ICBM program.

- **A poor start**—The road to international recognition as one of the

world's top scientists in the field of magnetohydrodynamics was a devious one at the start. Dr. Kantrowitz, who has won Fulbright and Guggenheim Fellowships to Cambridge and Manchester Universities, and one from the American Academy of Arts and Sciences, was thrown out of school at age 11 for poor work. Some choice items from the principal's letter to his mother on his expulsion: "whenever Arthur makes an effort to work, he bungles it . . . poor in following directions . . . poor attitude . . . can't seem to hold himself to a steady course—no improvement."

"Rates of development vary," Kantrowitz says of this episode in his life. "I didn't worry about it, but my parents sure did."

He did better in high school, still better at Columbia University where he majored in physics and where he collected his B.S., M.A., and Ph.D.

Kantrowitz, who takes his work seriously, but not himself, views his success matter of factly. Asked how he got into his field in the first place, he smiled. "If you're not clever or industrious, you have to move off into new areas." He found his area, he added, "by listening to and participating in the speculations of astro-physicists who are trying to put together an astronomical picture on the basis of meager knowledge."

• **Ground Floor**—Kantrowitz had his initial taste of aerodynamics on his first job out of school at NACA's Langley facility. "I was hired as a junior scientific aide in 1935 and for a week I did nothing but sort nuts and bolts. Then they apprenticed me to the wind tunnel mechanic and I was told in time I'd make a good wind tunnel mechanic."

By 1938, he and Eastman Jacobs, distinguished aerodynamicist, were deep in a project to build a stellerator-type fusion reactor; they tackled it "with delicious enthusiasm." A year-and-a-half's work later, they had worked up a terroidal-shaped model but they were unable to sell the idea as practicable. Although it was somewhat premature, its rejection was a bitter blow. Most of the actual physical facts on which modern fusion reactor speculations is based, were all known then.

In the years following, his work led to:

—invention of a variometer to measure the total energy a glider gets from thermal updraft. (1940)

—experimentation to develop an efficient supersonic compressor for turbojets (1943) which resulted in models that showed it was possible to get high compression ratios (1945).

—spadework in the development of shock tubes to study high-temperature gases (at Cornell-1947) with first published work on the method of obtaining very high temperatures by converging shock waves (1949).

"We learned to produce gases at 25,000°F and studied them, and when the country needed this kind of information for the re-entry problem technique, it was there and waiting," said Kantrowitz.

Fusion reaction is still a priority subject to Kantrowitz, and he delivered a paper on it at the Mid-August 10th International Conference on Ionization Phenomena in Sweden. "We now think we understand the mechanism of collision-free shock waves, which is one area that has to be understood before we can build a successful fusion reactor. We are trying to do fundamental experiments with the plasma conditions which must be faced in controlled fusion reactors."

Recently the Everett Lab has produced shock waves over one million miles an hour with an electric shock tube.

• **Food for thought**—The Everett Lab, employing a staff of 270, is situated on 50,000 square feet of what was formerly a warehouse in the Boston suburbs. Kantrowitz, who chose the site, said that he decided on the Boston area after a teaching stint at Harvard "because the atmosphere was intellectually stimulating."

Kantrowitz, only 45, has surrounded himself with a staff who look more like college seniors than scientists. All of them are in their late 20's and early 30's.

In setting up his laboratory, Kantrowitz felt it was time the old division of the classical disciplines—chemistry, physics, mechanics and aerodynamics—was halted. Calling on many of his former Cornell students, he established scientific committees in which problems are thrashed out from an integrated point of view.

His enthusiasm is infectious and has been cited by his co-workers as his most outstanding characteristic. Dr. Hans Bethe, one of the world's top physicists and member of the President's Scientific Advisory Committee, says Kantrowitz's enthusiasm runs the range from the purely scientific to space travel and is behind "the high efficiency of his laboratory."

According to Bethe, who worked with Kantrowitz at Cornell, he won't start on a project until he is entirely sure of the scientific basis, but his confidence runs high and "everything scientific comes easy to him. Recently he wanted one of the men in his laboratory to build a complicated scientific tool similar to one previously built by a much larger organization which had taken eight years to build the apparatus. So Kantrowitz told his collaborator he could take as much as three months to do it. The young man did it in three months, using a very different design from the large laboratory."

Another scientist who has watched Kantrowitz operate at close range seemed to sum it up when he said "If you have a difficult problem, call an expert. If you want the impossible, call Kantrowitz."

The Growth of Avco

Avco started in 1929 as The Aviation Corporation principally a holding company with interests in Roosevelt Field, Waco Aircraft, American Airways forerunner of American Airlines, as well as other aviation interests, and helped launch Pan American.

By 1937, under Victor Emanuel, who still heads the company, Avco had diversified and ended up controlling 45 companies, including Consolidated Vultee (later Convair), Lycoming, Stinson and New York Shipbuilding.

During the war Avco controlled an industrial complex that ranked third among the nation's producers of war materials. Its output ran from Willys jeeps to B-24 bombers. A policy change after the war switched Avco to civilian-market emphasis and it acquired Bendix and Crosley. Largely because of distribution problems, Avco sold Bendix to Philco in 1956 and shelved the civilian side of the Crosley operation, while holding on to the defense products end.

Avco had started backtracking into government work by the early 1950's and in 1954 laid plans for a basic research and technical facility to support the company's research and development activities.

The electronics research laboratory opposite Boston University was established in 1954 under the Crosley division; a year later Dr. Arthur Kantrowitz was assigned by Emanuel to set up the basic research laboratory which has concentrated on high-temperature gas dynamics and which came up with the answers needed to solve the re-entry heating problem. As a result of this work, Avco's Research and Advanced Development Laboratory won the contracts to design and build Titan *and* Minuteman *nose cones.*

propulsion engineering . . .

By M/R STAFF

New fluorine compounds synthesis . . .
has been discovered at **Armour Research Foundation** by P. Y. Feng, operating under a contract from Air Force Office of Scientific Research. It is a radiation synthesis for preparing organic fluorine compounds. Patent applications have been made.

Basic research . . .
in chemistry, without any applications goals, led to the discovery, AFOSR officials say. Already, though, the synthesis has found a defense application: The Army is using it in munitions work at Picatinny Arsenal. Dr. Feng now has an Army contract calling for studies of radiation induced fluorination of nitro compounds. Dr. Feng's research contract with the Air Force OSR called for fundamental studies on the effect of radiation on organic compounds, and on the relationship between chemical structure and radiation chemical behavior.

New materials . . .
are expected to result from Feng's discoveries, AFOSR officials say. Already, the Air Force uses a wide variety of fluorocarbons as high- and low-temperature lubricants, gaskets, etc. The Feng discovery may result in even more materials—certainly should result in cheaper production. An AFOSR spokesman says: "The radiation induced synthesis is an excellent example of how basic research provides the scientist and engineer with the understanding and techniques necessary for the creation of new and improved materials."

Russian electrodeposition of alloys . . .
is described in a report to the Fourth Soviet Conference on Electrochemistry, Academy of Sciences of the USSR. R. F. Frantsevich-Zabludovskaia and A. I. Zaiats prepare alloys of molybdenum, tungsten, chromium, and titanium with iron, nickel and cobalt by dissolving the metals in ammino or oxyacido-ammino electrolytes and plating them out as solid solutions. The percentage composition of tungsten and molybdenum in the electro-deposit depends on whether the iron-group metal is iron, cobalt or nickel. It is highest with iron and lowest with nickel. The work was conducted in 1956, but the report was only recently made available.

Utilize beamed power two ways . . .
- Heat a propulsion fluid (e.g., hydrogen, ammonia, gasoline, water) which would then be expanded through a nozzle to produce trust.
- Convert it into electrical power for an ion or plasma rocket.

Lithium—new exotic fuel . . .
that's what the Pentagon is trying to say when spokesmen announce that the Defense Department will continue its studies on high-energy chemical fuels, despite cancellation of the many contracts associated with boron. Pentagon brass belatedly points out something that chemists have been screaming, unheeded, since all this talk about so-called exotic fuels started: boron is just one of many possibilities; some others are better. However, when the boron contracts were negotiated boron looked good, and lithium looked like it was going to be tied up almost exclusively in Atomic Energy Commission projects.

Lithium will get the green light . . .
as a fuel base for certain limited uses (kerosene-LOX will be used in about 99 out of a hundred situations) for several reasons:
- A large, established lithium industry is ready and waiting to provide all the metal that might be needed, and without further research and development.
- Lithium's chemical properties and at least one physical property —density—are much more favorable than are those of boron.
- Lithium and its compounds are easier to handle.
- Because of lithium perchlorate oxidizers, missile people already are geared to lithium procurement, handling, useage.

Air brake for a spaceliner

The earth's atmosphere, one of the biggest obstacles to getting into outer space, can be one of our biggest assets coming back. At Douglas we are investigating how we can use its braking effects on rockets returning from deep space trips at far faster than ICBM speeds. Success will allow us to increase payloads by reducing the weight of soft landing systems. This technique also will aid us in pinpointing landing areas. Current reports show real progress. Douglas is engaged in intensive research on every aspect of space planning, from environmental conditions on other planets to the destroyer-sized space ships necessary to get there. We invite qualified engineers and scientists to join us. Some of our immediate needs are listed in the column on the facing page. Please read it.

Arthur Shef, Chief, Advanced Design Section, Missiles and Space Systems, irons out a problem with Arthur E. Raymond, Senior Engineering Vice President of **DOUGLAS**

MISSILE SYSTEMS ■ SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND-HANDLING EQUIPMENT

missile business . . .

By WILLIAM E. HOWARD

Worth noting marketwise in Dr. T. Keith Glennan's report to the Air Force missiles and space technology symposium are NASA's future spending plans. Major area for placement of contracts for the next year or two apparently will be in R&D. With a stringent money limitation evidently being imposed by the Budget Bureau, the hardware outlook isn't too bright.

Glennan makes the point—candidly . . .

"We are not nearly as far advanced in space technology as we had thought or hoped." And he adds: "In thrust capability, in guidance-injection, midcourse and terminal—in thrust control—in all of these areas there is much that must be learned and applied before we undertake the difficult missions we all talk about so glibly." He implies hot firings will be held to a minimum until the chances for success improve considerably.

At the moment Glennan feels "we have used up much of our missile technology" and this knowledge must be replenished by basic research. Accordingly, he says NASA expects to support "greater" research in universities and other non-profit institutions. In industry NASA will back both more basic research and advanced development of systems components.

NASA is drawing a bead on the moon . . .

Initial efforts of the civilian space agency are being concentrated on deep space and lunar missions, with shots aimed at near miss, orbiting and hard and soft landings of payloads. The main corollary objective is to develop reliability in rocket boosters. Comments Glennan: "It will be cheaper to waste payload space in using an oversize booster that becomes reliable through continued use than to tailor boosters for each specific mission with the attendant lowered reliability that surely will result from infrequent use." Right now NASA is leaning toward the **Rocketdyne** 1.5 million pound booster. It is spending $12 million in FY 1959 on this first stage engine for *Nova*—a deep space or lunar vehicle—and expects development costs eventually to run to $200 million.

The enormous expense of space exploration . . .

confronting the United States—if and when it decides to plunge ahead—was analyzed last week at the Commonwealth Spaceflight Symposium in London. Derek W. Morley, scientific writer for the London Financial Times, estimates the total cost of developing *Nova* for a manned lunar roundtrip will be $1 billion. And he says the multi-stage 2400-ton rocket may cost $40 million per shot with conventional fuels.

To assemble in orbit a manned laboratory weighing 75 tons, using *Nova* to do it, would cost around $2 billion, Morley estimates. His figures, incidentally, support economic arguments in favor of developing manned recoverable boosters that can be reused.

With the proposed Goodyear *Meteor* . . .

Morley says the total system cost of 30 expendable boosters would be $98 million against $150 million for the same number of recoverable boosters. But if 1000 flights were made over 5½ years, "the picture would change and the total system costs using recoverable boosters would be $523 million against $1.3 billion for a system using expendable boosters."

The financial correspondent is convinced . . .

space exploration is not outside Britain's means—if it rigorously selects projects. His idea is to gain experience with inexpensive space flights, ignore chemical fuels and concentrate on long-term R&D of nuclear rockets. And to make the price rock bottom, he suggests early concentration of development work "in the area where testing, final assembly and launching must be carried out—namely (the Woomera range) in Australia."

contracts

NASA

$380,000—Bell Aircraft Corp., for reaction controls for Project *Centaur*. (Subcontract from Convair/Astronautics Div. of General Dynamics Corp.)

MISCELLANEOUS

$485,345—Servomechanisms, Inc., for the production of true airspeed computers. (Subcontract from Lockheed Aircraft Corp.)
$300,000—MB Electronics Div. of Textron Electronics, Inc., for advanced electronics and electromechanical test equipment. (Subcontract from Aerojet-General Corp.)

NAVY

$8,000,000—General Electric Co., Defense Electronics Div., Utica, N.Y., for *Sidewinder* guidance control units.
$1,000,000—Baldwin Piano Co., for production of *Sidewinder* fuses.
$1,000,000—Minneapolis-Honeywell Regulator Co., for production of *Sidewinder* fuses.
$194,000—Diversified Builders, Inc., Paramount, Calif., for construction of *Polaris* static test complex facilities.
$9,800—King-Cowles & Associates, Inc. dba Robert W. King Construction Co., N. Hollywood, Calif., for construction of AEC launch complex.

AIR FORCE

Filton, Inc., Systems Div., for control of electromagnetic interference on the extreme altitude AMQ-15 Air Weather Reconnaissance System. (Amount not disclosed.)
$22,000,000—General Electric Company, for production of radar course directing groups.
$2,000,000—General Electric Co., Defense Electronics Div., Utica, N.Y., for transmitter sets, transmitter groups and ALT-6B ECM equipment.
$1,400,000—BJ Electronics, Borg-Warner Corp., for signal generators.
$739,772—Goodyear Aircraft Corp., Akron, Ohio, for repair and modification of AN/DPQ-4 ATRAN nose package components applicable to *TM-76* weapon system (Two contracts).
$724,680—Raytheon Manufacturing Co., Newton, Mass., for magnetron tubes.
$622,493—Tung-Sol Electric, Inc., Newark, N.Y., for various electron tubes.
$415,000—Raytheon Manufacturing Co., Waltham, Mass., for various electron tubes. (Two contracts.)
$400,000—Space Corporation of Dallas, Tex., for equipment to be used in the GAM-77 *Hound Dog* missile program. (Subcontract from North American Aviation.)
$270,000—The A. W. Cash Co., Decatur, Ill., for missile fueling control valves. (Subcontract from Blaw-Knox Co.)
$213,255—Radio Corporation of America, Electron Tube Division, for various electron tubes. (Three contracts.)
$161,100—Kuthe Laboratories, Inc., Newark, N.Y., for electron tubes.
$134,303—Aerojet-General Corp., Azusa, Calif., for rocket launching towers.
$102,000—Republic Aviation Corp., for trajectory studies of space probes plus an analysis of data handling techniques and guidance requirements for changing the orbit of a satellite.
$96,710—Henry Spen & Co., Inc., Brooklyn, N.Y., for cradel aircraft-missile components.
$94,372—Sylvania Electric Products, Inc., N.Y., for electron tubes.
$70,771—Dynatronics, Inc., Orlando, Fla., for research and development of two-channel airborne telemetry transmitters and transistorized encoders.
$41,049—University of Rochester, for basic research on the optical and electrical properties of solids. (Two contracts.)
$27,950—Metco Inc., Salem, Mass., for electron pressurized band pass transmitting receiver.

ARMY

$4,900,000—Aerojet-General Corp., for surveillance drone systems.
$2,486,125—John H. Sellen Construction Co., Seattle, for *Bomarc* IM-99B facilities.
$1,952,873—Lawless and Alford, Austin, Tex., for *Nike-Hercules* facilities.
$1,858,211—Beacon Construction Co. of Mass. Inc., for construction of *Nike-Hercules* facilities at Offutt AFB.
$1,674,830—Browning Construction Co., San Antonio, Tex., for *Nike-Hercules* facilities, Dyess AFB.
$1,512,525—Control Data Corp., Minneapolis, for a computer.
$1,314,271—Douglas Aircraft Co., Inc., for technical services.
$959,251—Southern Construction Co., Inc., Augusta, Ga., for *Nike-Hercules* facilities.
$878,433—Nichols Construction Co., Inc., Baton Rouge, La., for *Nike-Hercules* facilities.
$841,495—Consolidated Constructors, Inc., Portland, Maine, for construction of *GAM-77/GAM-72* facilities.
$254,879—Arthur Rabkin Construction Co., Inc., Cincinnati, for guided missile field maintenance shop.
$47,676—Penta Labs, Inc., Santa Barbara, Calif., for electron tubes.
$34,972—Ohio State University Research Foundation, for research and development, study and analysis of methods and techniques for measurement of temperature of the earth's atmosphere above 120,000 feet.
$30,130—Hamilton Standard Div., United Aircraft Corp., for solid-propellant spin motor system for *Little John* Phase II rocket.
$26,950—Raytheon Co., Microwave & Power Tube Division, for electron tubes.
$26,180—International Telephone & Telegraph Co., for electron tubes.

reviews

DIELECTRIC MATERIALS MOISTURE RESISTANCE STUDY: FINAL REPORT, J. J. Chapman and L. J. Frisco. The Johns Hopkins University for BuShips. Order PB 151014 from OTS, U.S. Department of Commerce, Washington 25, D.C. 76 pps. $2.

Polyethylene and polytetrafluoroethylene were virtually unaffected by the tropical exposure in these experiments to determine the degradative effects of moisture on 10 dielectric material specimens.

The two materials also showed excellent electrical properties during long periods of exposure to humid atmosphere. Other materials were polystyrene, monochlorotrifluoroethylene, polytetrafluoroethylene-glass laminate, glass silicone laminate, glass bonded mica, mica-filled melamine resin.

Most of the materials affected by moisture showed a deterioration of volume properties. In most cases, the degradative effects which were observed were attributed to moisture absorption. Specific effects are given for each material.

MICROPHONIC EFFECTS IN IMAGE ORTHICONS; R. K. H. Gebel, WADC. Order PB 151588 from OTS, U.S. Department of Commerce, Washington 25, D.C. $.50.

Experimental and theoretical investigations were conducted on image orthicon tubes to determine the cause and the best solution to the microphonic problem.

It was found possible to eliminate microphonics in these tubes electronically. However, the best solution to the problem can be obtained by careful design and construction of vibration-proof internal tube components.

people

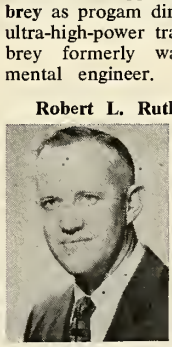

HOEPPNER

Conrad H. Hoeppner, chief scientist of Radiation, Inc., has joined the editorial advisory board of Missiles and Rockets. Hoeppner holds a B.S.E.E. and M.S.-E.E. from the University of Wisconsin, did graduate work at M.I.T. and received his professional E.E. from the University of Wisconsin. He was formerly associated with U.S. Naval Research Laboratories, The Martin Co., Raytheon Manufacturing Co., General Electronic Laboratories, W. L. Maxon Corp. and Stavid Engineering Co. Besides holding more than 30 patents, Hoeppner has authored many technical papers.


CLARKE

Dr. Edward N. Clarke, has been appointed vice president for operations of National Semiconductor Corp. He was research physicist and section head for six years at Sylvania Electric Products and recently of Sperry Semiconductor Div., Sperry-Rand Corp. Dr. Clark has published numerous papers and holds several patents.

Pacific Semiconductors, Inc., has announced the appointment of **Frank Steinebrey** as progam director on an Air Force ultra-high-power transistor project. Steinebrey formerly was company developmental engineer.


RUTH

Robert L. Ruth, has been appointed chief engineer of the Marine and Ordnance Dept. of Vickers Inc. Prior to joining the company in 1958 Ruth was involved in development of hydraulic systems and submarine missile launching systems at Sargent Engineering Corp.


MULLIO

William A. Mullio has been named project manager for the development of a general purpose mechanical timer for missile fuzing and programming systems by Bulova Research and Development Laboratories, Inc. Before joining Bulova, he was with Sperry Gyroscope, Arma, and Control Instruments.

WHO READS MISSILES AND ROCKETS?

Well, for instance ... ENGINEERS AT WESTINGHOUSE DEFENSE PRODUCTS

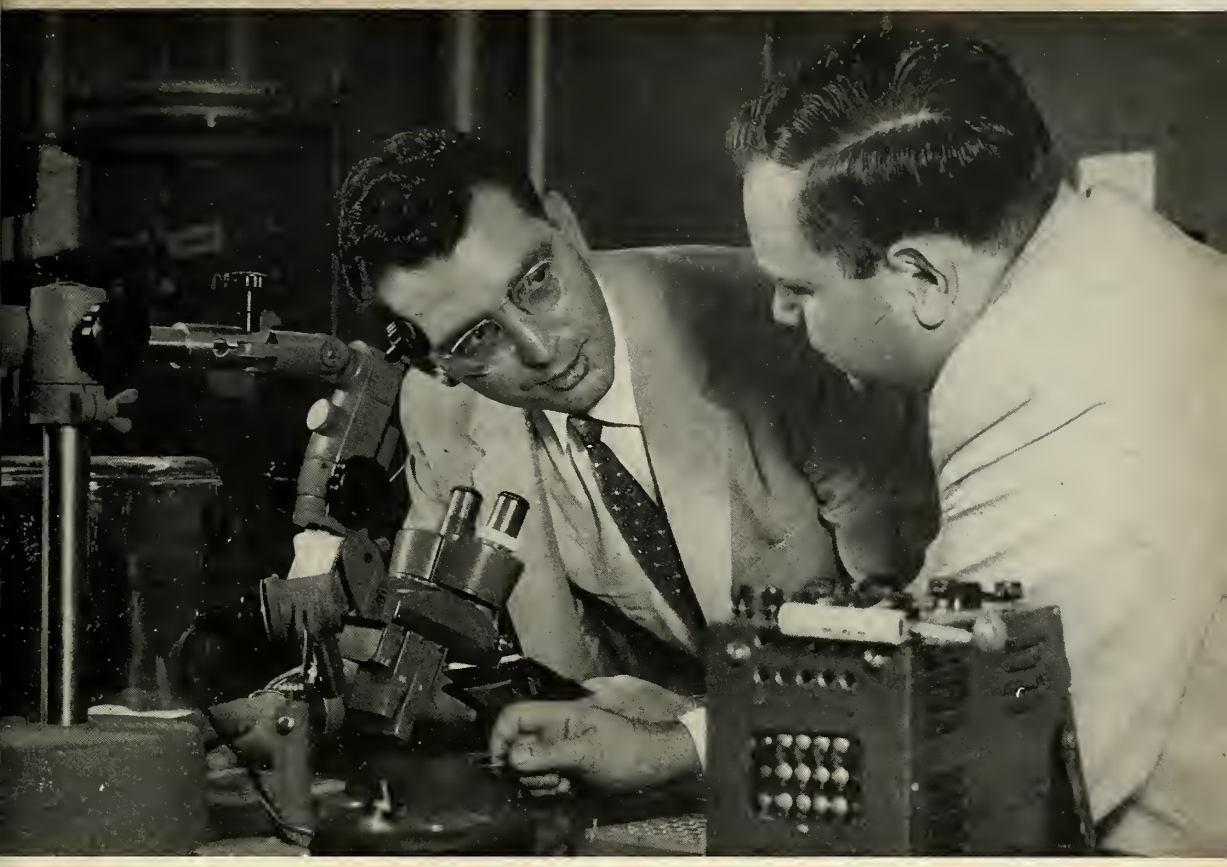
Molecular electronics—a technological breakthrough at Westinghouse—is producing electronic systems *1,000 times smaller and lighter* than anything now in existence.

Through molecular electronics, drastic reduction in weight, size, power and heat dissipation requirements will permit space vehicles and satellites to perform a greater number and wider range of tasks. Greatest advantage is the vastly improved reliability achieved by the replacement of numerous components by a single solid state unit.

Recently, the Air Research and Development Command of the U. S. Air Force awarded a development contract to Westinghouse as a part of a broad program effort in this new electronic area. Experimental "hardware" is being fabricated by Westinghouse for infrared, reconnaissance, communications, telemetry, flight control and other military applications.

"Missiles and Rockets deals exclusively with astronautics. Spawned by aviation, missilery and outer space exploration today is an industry by itself." — George Shapiro (right), Fellow engineer of the Westinghouse Astronautics Institute, located at Air Arm Division.

"One company can't build the entire bird ... it takes thousands of parts and scores of companies. Missiles and Rockets keeps us informed of the products and capabilities of the other companies throughout the industry — a most definite aid in selecting contractors." — Harvey Saldin (right), Manager, power systems, Westinghouse Advanced Systems Planning group.



r. Gene Strull (right), Manager of the Semiconductor Divi-
n's Solid State Advanced Development Laboratory at the
estinghouse Air Arm Division, discusses molecular elec-
onics with Charlie LaFond of the editorial staff of Missiles
nd Rockets magazine. Westinghouse engineers have devel-
ed on a single semiconductor wafer, a system that performs all the functions of much larger conventional and transistorized electronic systems. Typical application is a tiny light sensing device for satellite telemetry less than ½" in diameter and 1/100th of an inch thick, one of several subsystems including pulse generators and multiple switches, already built and demonstrated by Westinghouse.

This fast-growing, dynamic industry (missiles and
tronautics) demands week-to-week technical and
ws coverage. Month-old news and developments
e of little use to today's engineer." — Jim Currie
eft), Radar Engineering Section Manager, Westing-
use Electronics Division.

AFA Meeting to Attract 4000

MIAMI BEACH—*Titan,* the Air Force's second intercontinental ballistic missile, will headline a show of new weapons and industrial developments keyed to what has been billed as the second year of the Space Age. The first public display of *Titan* will be at the Air Force Association's annual convention to be held here from Sept. 2-6.

The big missile, manufactured at Denver by **Martin,** was being flown to Miami Beach at press time aboard a giant MATS C-133 turboprop cargo plane. It will be erected in front of the auditorium where the industry exhibits and most of the meetings will be held.

Convention plans thus far unwrapped indicate a program aimed at dispelling current confusion over buying policy and programs and the role that industry plays both in research and development and in procurement. There will be classified briefings for industry dealing with research and development. A procurement seminar will be open to all registrants.

The procurement seminar will be held Sept. 3. Moderator will be Gen. Edwin B. Rawlings (USAF, ret.), for six years the Air Materiel Command chief. Speakers include Donald R. Jackson, deputy secretary for procurement programs, and Lt. Gen. Mark E. Bradley, Jr., deputy chief of staff (materiel).

• **Guidance for industry**—AFA also has planned, with the cooperation of the Air Force, conferences between industrial representatives and the representatives of both AMC and ARDC. Their objective is to explain to individual companies what roles they may play in the ARDC picture and how they can find a place for themselves. In the case of procurement, AMC representatives will discuss individual problems as they relate to the weapon system philosophy. Specialists will answer questions relating to design, production and management. AFA said that these services will be available throughout the convention.

The overall Air Force story is to be told on Saturday, Sept. 5, in a panel discussion. Speakers include: Lt. Gen. William H. Tunner, Commander of MATS; Gen. Frank F. Everest, the new commander of the Tactical Air Command; Gen. Laurence S. Kuter, Commander of the North American Defense Command, who can be expected to discuss antiaircraft and antimissile missiles; and Gen. Curtis E. LeMay, vice-chief of the Air Staff.

Speaker at the annual Aerospace Banquet, Sept. 5, will be Gen. Thomas D. White, AF Chief of Staff. AF Secretary James H. Douglas will be the speaker at the annual awards luncheon on Saturday, Sept. 5.

Advanced registration at press time numbered 2600. A total of 4000 are expected to attend.

Venus Contact Will Be Tried—Minus Rockets

WASHINGTON—A NASA attempt to contact a rocket near the vicinity of Venus will be conducted next month—even though the rocket won't be there.

The program originally called for the Jodrell Bank radio telescope at Manchester, England, to track the two Venus probe vehicles—*Atlas Able* and *Thor Able IV*—which were to have been launched in June. The probes were cancelled when the payloads were not finished in time.

The telescope nevertheless will try to contact Venus at the time when the space vehicles should have arrived, when the planet is closer to earth than it will be again until January, 1961.

The Jodrell Bank team, headed by Prof. A. C. B. Lovell, hopes to learn more accurately how far Venus actually is from earth, how long it takes to spin on its own axis, and something about its cloud-shrouded atmosphere.

Mercury Escape System Won't Ignite Prematurely

WASHINGTON—NASA officials contended last week after the premature ignition of a Project *Mercury* capsule's escape system during a *Little Joe* test that "this could not happen" when man is put into the capsule atop an *Atlas* booster.

The escape rocket fired approximately 20 minutes before the vehicle was to be launched. The capsule's drogue chute opened, but the main chute failed to open as the capsule landed in the sea about 1000 feet from its Wallops Island launching pad.

Project *Mercury* scientists stated that the final capsule will have a more sophisticated electrical system than was used in the *Little Joe* test—"eliminating the possibility of a premature ignition."

No explanation was given for the main chute's failure to open. There were no injuries. The launch area had been cleared of all personnel some 10 minutes earlier. The *Little Joe* booster cluster of solid rockets remained on the launching pad.

House Group Questions DOD's Ban on Articles

WASHINGTON—The House Information Subcommittee is broadening its inquiry into the Pentagon ban on publication of Gen. Thomas S. Power's book on U.S. ICBM and bomber shortages.

The reason: The subcommittee has uncovered a recent general ban on the writing of signed articles by high-ranking officers for non-service publications.

Subcommittee Chairman John E. Moss (D-Calif.) has questioned the Defense Department's statutory authority for such a ban.

The subcommittee move followed an earlier inquiry into Defense Secretary Neil McElroy's banning of publication of SAC Commander Power's book "Design for Survival."

Power has repeatedly called for more ICBM's and bombers to keep U.S. deterrent strength from deteriorating. He is understood to have said in a preface to his book that it was a "report to our stockholders—some 175 million of them."

Moss disclosed that the military services were notified of the general ban in a recent memo signed by Chauncey Robbins, Deputy Assistant Defense Secretary for Public Affairs.

Lost *Discoverer* Capsules Have Scientists Puzzled

WASHINGTON—ARPA and Air Force scientists and engineers are still trying to solve the problem of their disappearing *Discoverer* recovery capsules.

Lockheed's *Discoverer VI* launched Aug. 19 from Vandenberg AFB—again performed perfectly up through the ejection of the capsule from the orbiting 1700-pound satellite over the Pacific. But again the capsule's radio went out and the capsule disappeared without a trace.

Discoverer V performed the same way only a few days earlier.

Both times C-119 cargo planes stood by, ready to attempt catching the capsules as they fell toward the Pacific. Ships stood by in the area near Hawaii to back them up.

Scientists feel the capsule may be burning up during re-entry—or else it's re-entering along an unexpected trajectory and ionization is blacking out the radio.

The failure to recover the 300-pound biomedical capsules is holding up plans to put more animals into orbit during the *Discoverer* series.

When animals are used again, they probably will be monkeys. Mice were used earlier.

——more about the missile week——

AIA Reports Need for Measurement Standards

American measurement capabilities are being seriously outdistanced by the requirements of fast-moving missile and space projects, according to a survey sponsored by Aerospace Industries Association. Results of the study made by **Sperry Gyroscope** has shown that a "measurement pinch" in the missile industry could threaten success of U.S. missile and space programs.

The problem uncovered by the AIA Quality Control Committee deals primarily with the increased need for extremely close tolerances and higher reliabilities. These requirements have forced introduction of a calibration program far beyond the needs of ten years ago. Today, missile components must be accurate to the millionth of an inch with proportionate standards in measurements of electronics, time, weight, temperature, pressure, shock, optics, and radiology.

The main purpose of the survey is to alert industry to the urgency of this measurement lack. The implication is that the National Bureau of Standards, with the support of industry, and sufficient financing can do the job. Consensus of the survey team is that this should not be the problem of NBS alone, however. Supporting work can be done by universities, industry research, and military calibration laboratories.

Air Force Air Material Command, for one, has already taken cognizance of the problem. Soon, the A.F. will have 163 centers equipped as precision measurement laboratories.

Second *Polaris* Sub Launching on Sept. 22

The Patrick Henry, sister ship of the George Washington nuclear-powered *Polaris* submarine, will be launched Sept. 22 at the **Electric Boat Division** of **General Dynamics Corp.,** Groton, Conn. The 380-foot, 5400-ton sub capable of launching 16 nuclear-tipped rounds will be ready for fleet duty in late 1960. The George Washington, first fleet ballistic missile sub, will be operational earlier next year.

Hot gas generator spin stabilization system weighing less than three pounds has been developed for *Polaris* missile by **The Garrett Corp.'s Airesearch Mfg. Co.** Generator incorporates an electric pyrotechnic ignition, time delay and composite base solid propellant in a single cartridge. Burning is at 1000 psi for .2 secs.

Industry Progress

Hazeltine Corp. heads up a team composed of **General Precision Laboratory, Radio Corporation of America, Sprague Electric Co.** and **Temco Aircraft** bidding on the Air Force's proposed airborne long range input (ALRI) system . . .AMC's Rome, N.Y., area has awarded **General Electric's Heavy Military Electronics Department** a $22 million contract for production of radar course directing groups . . . **Plastic Age Aircraft Corp.** and **Plastic Age Reinforced Products,** Saugus, Calif., are being merged into the **Plastic Age Mfg. Co.** . . . **Ling-Altec Electronics** has acquired all outstanding stock of **Consolidated Electronics Mfg. Co.** for $3.6 million.

Project *Mercury* procurement is shifting into high gear. **Chrysler** will provide eight Redstone-type missile boosters for the NASA vehicle that will put an American astronaut into orbit. **Waste King Corp.,** Los Angeles, has contract to manufacture gyro components for guidance system. And in a related area, **Chance Vought** is developing for Navy a space vehicle-type capsule for aircraft, utilizing shaped-charge explosive principle to separate cockpit section from remainder of aircraft.

Uses of gold and other precious metals for coating missile sections are increasing. **Engelhard Industries Inc.** reports gold is unequalled as a reflector of infrared. Company also is experimenting with platinum as a reflector.

Rocket engine generating about 15,000 pounds thrust was fired recently at Air Force's Arnold Engineering Center, Tullahoma, Tenn., in a wind tunnel at simulated altitude exceeding 100,000 feet. The ARDC installation said this marked the first time a rocket of its type and size had been tested under such extreme conditions.

WSMR Gets New Console

Complex communications and control console at White Sands Missile Range, N.M., has put the 4000-square-mile test center literally at the fingertips of the range operator. The new $150,000 console, with direct communications between all missile projects on the range, replaces outdated 6-year-old equipment.

Systems
Electronic / *Engineers*
Mechanical

NEWS OF ENGINEERING OPPORTUNITIES

OPEN ON MOST "TALKED ABOUT"

MISSILE OF THEM ALL

POLARIS

...and other diverse and complex weapons projects at General Electric's Ordnance Department in the Berkshires*

When the first operational Polaris missiles are installed in the "George Washington" —first atomic submarine specifically designed as floating platform for the Navy's undersea-launched IRBM s — it will be a day of great moment for the engineers and scientists at General Electric's Ordnance Department, who are now pouring their energies, imagination and technical skills into the development, design and production of Polaris Fire Control and Inertial Guidance Systems.

A day of celebration — but also one that ushers in new and other challenging problems — for the push to develop the next generation of long-range underwater ballistic missiles and kindred advanced weapons and weapon systems will be on.

There are openings now for engineers (*EEs or MEs*) with two to seven years' experience in these areas:

SYSTEMS DEVELOPMENT / SYSTEMS DESIGN OR EVALUATION
FIRE CONTROL ENGINEERING / INERTIAL COMPONENT DESIGN / COMPUTER DEVELOPMENT
ELECTRONIC CIRCUIT DEVELOPMENT / STRUCTURAL DESIGN AND VIBRATIONS
FIELD SERVICE & EVALUATION / QUALITY ASSURANCE & RELIABILITY ENGINEERING
ELECTRO-MECHANICAL DESIGN / ADVANCED PRODUCTION ENGINEERING
ELECTRICAL DISTRIBUTION SYSTEMS ENGINEERING / PLANT FACILITIES ENGINEERING
PRODUCT SERVICE INSTRUCTION / PRODUCT PLANNING / SALES ENGINEERING
CONTRACT ADMINISTRATION / TECHNICAL WRITING

Field Test Engineering (Florida, California and several naval stations in continental U.S.)
Also technician openings for graduates with missile experience

Write in strict confidence to: Mr. R. O'Brien, Dept. 73-WI
Ordnance Department of the Defense Electronics Division

GENERAL ELECTRIC

100 Plastics Avenue, Pittsfield, Mass.

Additional Projects Under Investigation at the Ordnance Department. Urgent, vital and engrossing as the Department's share in the Fleet Ballistic Missile Program is, it is just one of the diverse activities here that today offer engineers a progression of challenging assignments on: **Atlas Guidance Equipment • Talos Handling and Launching Equipment • Advanced Torpedo Development • Tartar Fire Control**

reviews

FREQUENCY RESPONSE FOR PROCESS CONTROL, Edited by William I. Caldwell, Geraldine A. Coon, and Leslie M. Zoss. McGraw-Hill Series in Control System Engineering. 400 pp. McGraw Hill, $11.50.

The book presents the fundamental methods of frequency response and their applications to the anaylsis, testing, and design of process control systems, along with an analysis of complete systems by means of highly effective techniques and typical solutions to many practical problems.

In a section devoted to theory, attentions is given to the distance-velocity lag, linear lag, and stability considerations. Methods of analysis are presented, with emphasis on the damped response method. The coverage of controller responses includes control charts for a variety of responses. Results are shown for variation of process and controller parameters. Closed-loop performances are explained, and disturbances are discussed with regard to their magnitude and location in the control loop.

ASBESTOS: ITS INDUSTRIAL APPLICATIONS, D. V. Rosato, Chief Engineer, Research Division, Plastics Plant, Raytheon Manufacturing Company, 214 p., $5.75, Reinhold Publishing Corp.

The book discusses various applications of asbestos, including its uses in the missile industry. It also serves as a guide to numerous industrial branches, including research and development groups, manufacturers, engineering schools, market research groups and sales management.

A census of asbestos products is included, along with reviews of asbestos materials available—asbestos cement, tile asbestos, heat and electrical insulation, asbestos friction materials, plastics, packings, gaskets, filters and others.

A MILITARY COLOR TELEVISION SYSTEM; R. K. H. Gebel, WADC. Order PB 151586 from OTS, U.S. Department of Commerce, Washington 25, D.C. $.50.

This pamphlet describes a color television system said to be superior for general military application and suitable for use with or without optical amplification.

The system, using a tri-color reproduction tube combined with either a two or three-color system, could be readily incorporated into a storage optical amplifier system. Field rate could then be changed without difficulty from one picture per second to 100 pictures per second.

The technical possibilities and limitations of color television systems are reviewed generally and the more important types of color systems are outlined, with emphasis on motion-detection limitation.

PERFORMING RESEARCH ON NEW APPROACHES TO PRINTED CIRCUITRY; Haloid Co., Rochester, N.Y. Order No. PB 135 502 from Library of Congress, Photo duplication Service, Publications Board Project, Washington 25, D.C. 27p. Microfilm $2.70, photocopy $4.80.

Performance tests have been carried out on vacuum evaporated chromium resistors and chemically deposited tin oxide resistors.

It was found that various overcoatings for higher temperature service and protection of ceramic-based components were tried unsuccessfully. Quantitative measurements of corona charging characteristics of materials for use in making electrostatic printing masters have also been made.

IMPREGNATION OF SILICON-CARBIDE ARTICLES WITH METALS; A. N. Novikov, translation of "Ogneupory" (USSR) No. 12, 1957. Order HB-4504 from Henry Brutcher, P.O. Box 157 Altadena, California. $6.60.

Gas-phase impregnation of silicon carbide articles with metals selected on the basis of the difference between their boiling point and the temperature of the active state of silicon carbide are prerequisites to successful impregnation.

Presented are details on an electric furnace used for gaseous impregnation of silicon carbide; methods of packing the impregnating materials; best composition of impregnating mix for ease of molding and performance.

Also in the translation are the experimental procedure and results; properties of silicon-impregnated silicon carbide; properties of various German and American silicon-carbide heating elements compared with those developed by the author between 1941 and 1956. The chief advantages of the new process are that workpieces may be air-dry and need not be recrystallized.

LITHIUM AND ITS ALLOYS; F. I. Shamrai, Translation of "Litiy i Ego Splavy," Moscow, 1952. Order AEC-tr-3436 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 230p. $3.

The contents include the general characteristics of lithium and its minerals, the chemistry of lithium compounds, the metallurgy of lithium, and its properties.

Also in the translation is material on the analytical chemistry of lithium and its binary and ternary alloys.

AN IMAGE ORTHICON WITH NARROW RANGE OF ELECTRON ENERGY IN THE SCANNING BEAM: R. K. H. Gebel, WADC. Order PB 151589 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 13pps. $.50.

A method of improving the low light level performance of image orthicon devices through basic design changes in tube geometry has been devised.

Electron-optical relationships for the scanning beam were developed and it was shown that for a scanning beam of narrow electron energy, the beam modulation factor can be made very low, improving the performance of the tube.

when and where

AUGUST

Army-Navy Instrumentation Program, Annual Meeting, Symposium and Industry Briefing, Statler Hilton Hotel, Dallas, Tex., Aug. 31-Sept. 2.

International Astronautical Federation, 10th Annual Congress, Church House, Westminster, London, Aug. 31-Sept. 5.

SEPTEMBER

Air Force Office of Scientific Research and General Electric Company's Missile and Space Vehicle Department, Conference on Physical Chemistry in Aerodynamics and Space Flight, University of Pennsylvania, Philadelphia, Sept. 1-2.

University of California, 1959 Cryogenic Engineering Conference, Berkeley, Calif., Sept. 2-4.

Air Force Association and Panorama: send Reservations to AFA Housing Bureau, P.O. Box 1511, Miami Beach, Sept. 3-6.

AFOSR/Directorate of Aeronautical Sciences, Office of Naval Research, National Science Foundation, Sixth Midwestern Conference on Fluid and Solid Mechanics, University of Texas, Austin, Sept. 9-11.

Society of Automotive Engineering, Display of USAF Ground Support Equipment for Manned and Unmanned Aerospace Vehicles, Milwaukee Arena, Milwaukee, Sept. 14-15.

Advertisers' Index

Another Threat to Our Space Program

For some time now there have been reports that Budget Director Maurice Stans could be expected to insist on heavy reductions in the Nation's missile and space program for Fiscal 1961-2. The speech which NASA's Dr. T. Keith Glennan made in Los Angeles on August 24 counseling a "go slow" program in space might appear to go along with this. Both could be considered to be obvious reflections of the Administration's attitude.

We suspect, however, that there may be a great deal of difference in how slowly Dr. Glennan wants to go as compared to how deeply Mr. Stans wants to cut.

The NASA administrator made several well-considered points: we have not advanced as far into the space field as we may think; our experience thus far has been less than satisfactory; there has been a lot of "glib talk" but there is still much, much to be learned before we advance farther than the short first step we have taken; reliability is our greatest problem; we lack manpower, facilities and funds to even begin all of the projects which have been recommended one way and another. Do we really believe, Dr. Glennan asked, that based on our past experiences, we have the skills to send a seven-stage probe to the moon for a soft landing and a safe return?

Mr. Stans, we have heard, would reduce or actually eliminate much of the current and projected military and civilian space program. *Nova,* the single chamber 1.5-million-pound-thrust engine under development by Rocketdyne, would be cut back to a theoretical research program. *Saturn,* the clustered engine of like power, would be curtailed. *Atlas* would be utilized as our basic booster as well as a major deterrent. Many of the current applied research projects in fuels and engines would be cut back or cut out.

We suspect that while there is some similarity in the tone of the two approaches, the point of interest may be quite different. We suspect that Dr. Glennan is interested and determined to produce a space program but wants to go about it sanely and reasonably. We suspect that Mr. Stans merely wants to reduce the budget.

Fundamentally, it is difficult to agree with the Stans approach, if it is correctly reported, and difficult not to agree with Dr. Glennan. It is also difficult to understand how any reasonable official, in reviewing the events of the past three years, can doubt that this country must have a space program and must have the best available, commensurate with the progress of our skills. When Russia flew *Sputnik* we were hopelessly behind; money immediately became no object. Now, by calling on the bulk and best of our brainpower and technical skills—and millions of dollars—we have managed to catch up or at least come within striking distance of the Russians in the space field.

Do we now sit back because of a forthcoming national election or for any other reason, and lose the ground we have gained by such effort? Do we wait for another Russian achievement—the first rocket to the moon, the first man in space—to shock us back into action and to start another crash program?

We know that the business of the Bureau of the Budget's bargaining process is an annual exercise which begins about this time each autumn; that the services, with their billions, can take a cut and find room to maneuver. And we know, too, that Dr. Glennan will fight for the program he and the dedicated men who work with him feel is right for the country. But NASA has already lost $28 million from its small budget for this year and any further stringency cannot help but have a drastic effect on the space program.

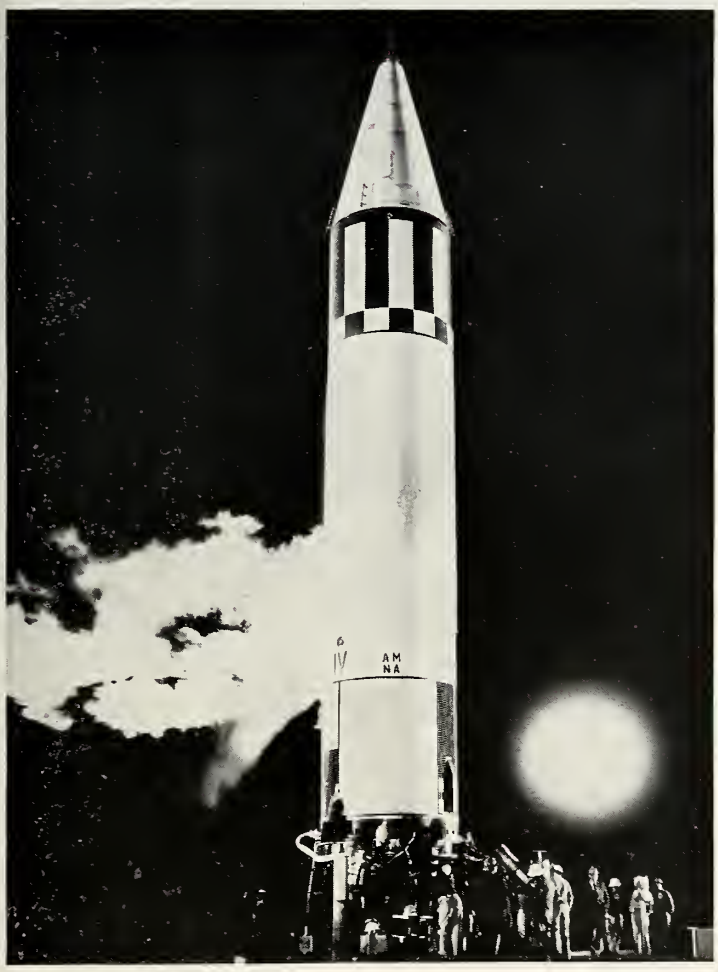
There was one paragraph in Dr. Glennan's talk which didn't get much attention in the daily press, but we suspect it reflects the opinion of Congress and the people. It said:

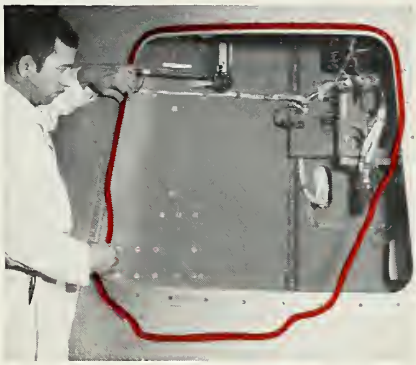
"We are the one nation in this world which has developed its position of leadership through the application of science and technology to the alleviation of man's back-breaking burdens, while continuing to protect the right of the individual citizen. For us to play second fiddle to this space business is to admit that we have lost a part of our genius for experiment—for taking a competitive risk—for searching out new facts about nature that ultimately will improve the well-being of mankind everywhere. No, we cannot and I am sure we will not, fail to demonstrate that once again free men—when challenged—can rise to the heights and overcome the lead of those who build on the basis of the subjugation of the rights of the individual as they dictate to him the path he must take in response to the demands of the state."

CLARKE NEWLON

SILICONE NEWS from Dow Corning

Sealing Zero...and 500 F





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