SEPTEMBER 19 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY

Polaris loading at Port Canaveral

THIRD ANNUAL GSE ISSUE

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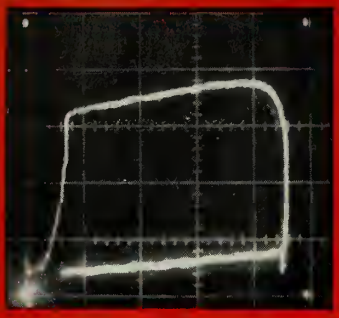
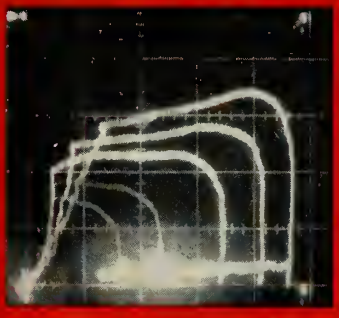


SPRING PLUS SHOK IN 1 UNIT
Used on aircraft arresting gear



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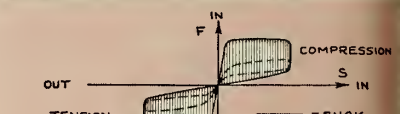
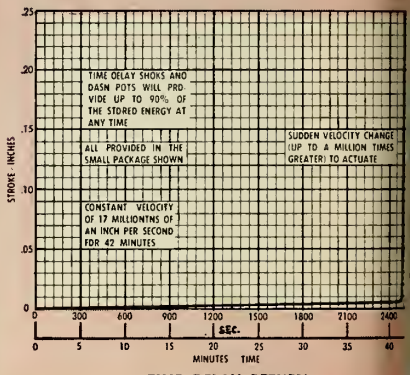


TENSION/COMPRESSION IN 1 UNIT
Used on radar stops



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THE MISSILE / SPACE WEEKLY

missiles and rockets

September 19, 1960 Volume 7, No. 12

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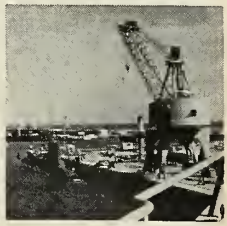

THE COVER

U.S. George Washington takes on Polarises at Port Canaveral for R&D shots (note temporary telemetry mast). M/R photograph by James Baar. See Polaris GSE story, p. 51.

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32,199 copies this issue

TRACKS MOVE WHERE NOTHING ELSE CAN GO

Modern concepts of battlefield tactics require a high degree of ground mobility for many new weapon systems. Whatever the requirement – missile transporter launchers – radar or communication equipment – ground support equipment – cargo vans – troop transport – all can have full mobility with one or more standard military vehicles of the new M113 family.

This family of vehicles in either armored or unarmored versions is lightweight to be airborne, amphibious to swim water barriers, tough and dependable for continuous heavy duty.

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lustrated below are the M113 ıd five vehicle adaptations of is basic tracked vehicle. All of e vehicles use the same military andard equipment, including gines, power train, and suspen- on components; thus reducing e military logistic burden and &D costs in weapons systems.

M113 Armored Personnel Carrier

Radar Vehicle

Van-type Vehicle

5th-wheel-type Prime Mover

Utility Crane Vehicle

Missile Launcher

FMC's Aluminum Alloy Welding Techniques Open New Horizons for Structural Applications

Machine welding heavy aluminum armor plate in FMC's Ordnance Division's shops.

Food Machinery and Chemical Corporation's recently developed welding techniques make economical heavy aluminum weldments possible. High strength, low weight, gas and liquid tight construction are a few of the characteristics available through modern welded aluminum fabrication. These techniques are ideally suited to the construction of vehicles — landing craft, barges, containers — on an economically sound basis.

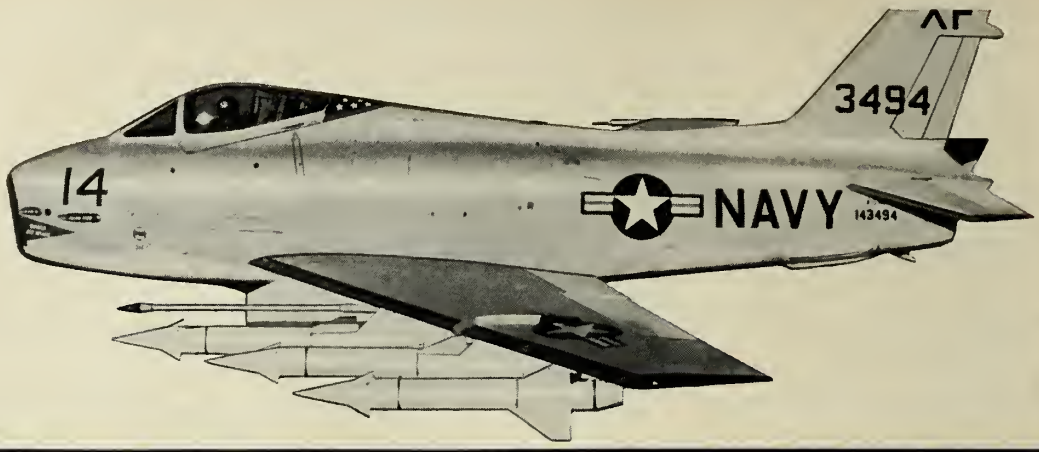
FMC's aluminum welding capabilities are the result of extensive research and development work performed in cooperation with military agencies to develop reliable, economical welding techniques for the production of the aluminum M113 Armored Personnel Carrier. Thousands of pounds of various aluminum alloys were formed, welded, machined and tested to select the best alloys and fabrication methods. Over a score of prototype M113's were then constructed and subsequently tested by military agencies to substantiate the vehicle's design and construction.

The economy realized through FMC's development of welding and fabrication techniques is an important factor...making the cost of the aluminum M113 competitive with the M59, its steel predecessor. Welding costs for this all aluminum vehicle were reduced through the use of—

Optimum joint geometry
Maximum use of welding fixtures
Maximum use of automatic plate preparation equipment
Maximum use of machine welding equipment
Maximum use of extruded shapes

These modern methods and facilities may provide the answer to your problems in procuring high performance equipment.

The new aluminum welding techniques developed for the M113 program and vehicle production, illustrates FMC's fully integrated capabilities and facilities.



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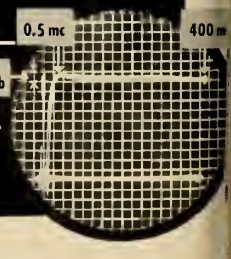

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letters

Judicious Reader

To the Editor:

I congratulate you on a fine magazine.

I am writing to say I especially enjoy your coverage of "blue skies" projects such as the recent coverage of NASA. In addition, peripheral subjects such as mechanical translation (M/R, July 11) deserve treatment.

Also, your coverage of foreign space projects is most informative.

A contented subscriber.
Lester W. Bunning
Hawthorne, Calif.

Optics Report Pleases

To the Editor:

Congratulations on your Special Report —Missile/Space Optics. We found it very informative and enlightening.

On page 31, we were happy to read your report on Avco's installation at Eglin Air Force Base. In the second paragraph you mention that there is a 0.50 usec Kerr Cell Shutter installed as part of the system. This actually is a *.05 usec* Kerr Cell Shutter, and it can photograph projectiles traveling over *14,000 feet per second*, not the 1400 feet per second that you report.

These projectile speeds are really very little challenge for a Kerr Cell Shutter of this kind. The significance of the whole system is, as you pointed out, wrapped up in the light source synchronization problem.

I appreciate some of your problems in publishing an issue of this complexity. I did feel, however, that you would not wish these typographical errors to slip by unnoticed.

Richard J. Burns
Research and Advanced
Development Division
Avco Corporation
Wilmington, Mass.

To the Editor:

Congratulations on your massive reporting job in the long-neglected field of optics (Special Report, M/R, Aug. 22). With the more glamorous areas of rocketry and space exploration getting all the play, optics has obviously suffered to the extent of becoming a backward science. Certainly, you have done . . . a real service by pinpointing an emphatic and continuing need for highly developed optic tools in the Space Age.

John L. Hammet, Project Engineer
Page Communications Engineers, Inc.
Washington, D.C.

Vidya and the OAO

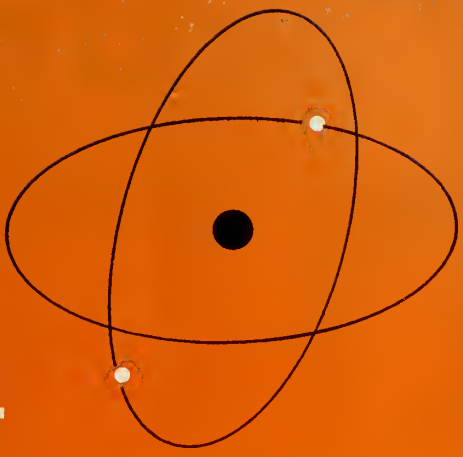
To the Editor:

I read with a great deal of interest the excellent report covering the Orbiting Astronomical Observatory ("NASA Eyes Standardized Satellite," M/R, Aug. 8, p. 25).

We at Vidya, Inc., are indeed proud to be part of the competition which will be certain to bring to the U.S. tremendous prestige and many valuable and perhaps world-staggering technological discoveries about the nature of the cosmos.

I would like to point out, however, a misprint in your article which is certain to cause confusion if it is not corrected. This occurs in the fifth paragraph on page 27, where the article reads, "Douglas Aircraft/Itek Corp./IBM/Vidya of Massachusetts Institute of Technology." This should show Vidya, Inc., and Massachusetts Institute of Technology as separate team members—so that the entire team, which we are sure is one of the most competent ever to be assembled, is Douglas Aircraft/Itek Corp./IBM/Vidya, Inc./Massachusetts Institute of Technology.

William E. Orr
Director of Programs
Vidya, Inc.
Palo Alto, Calif.



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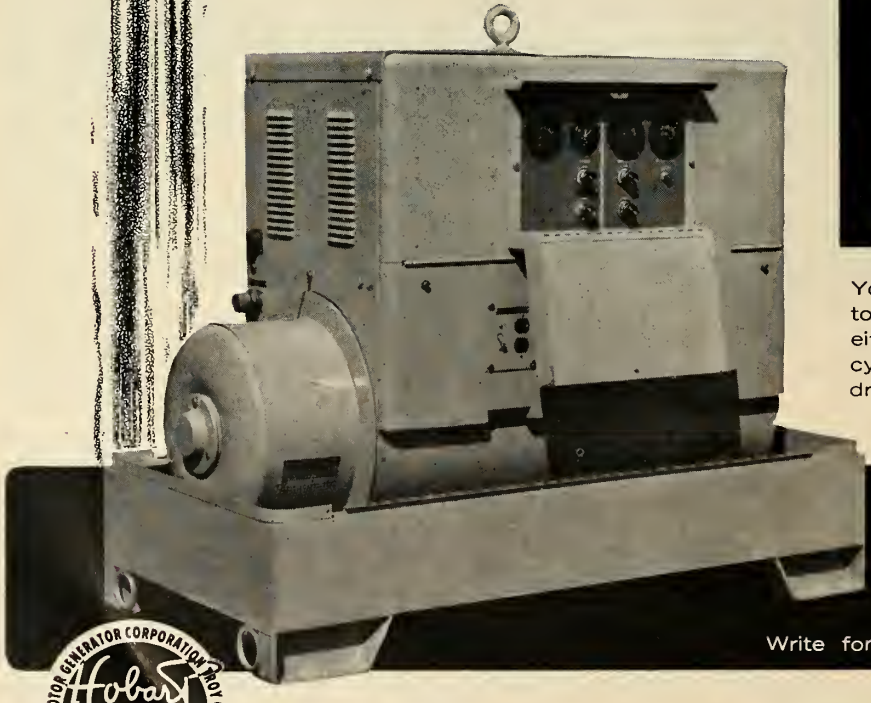

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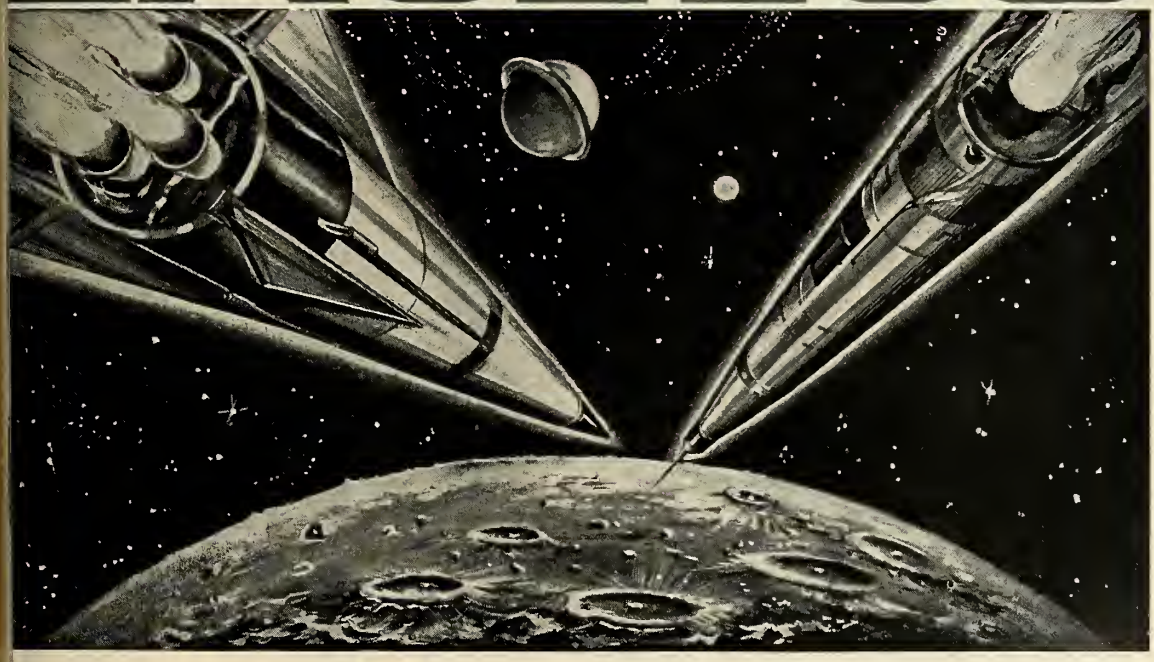

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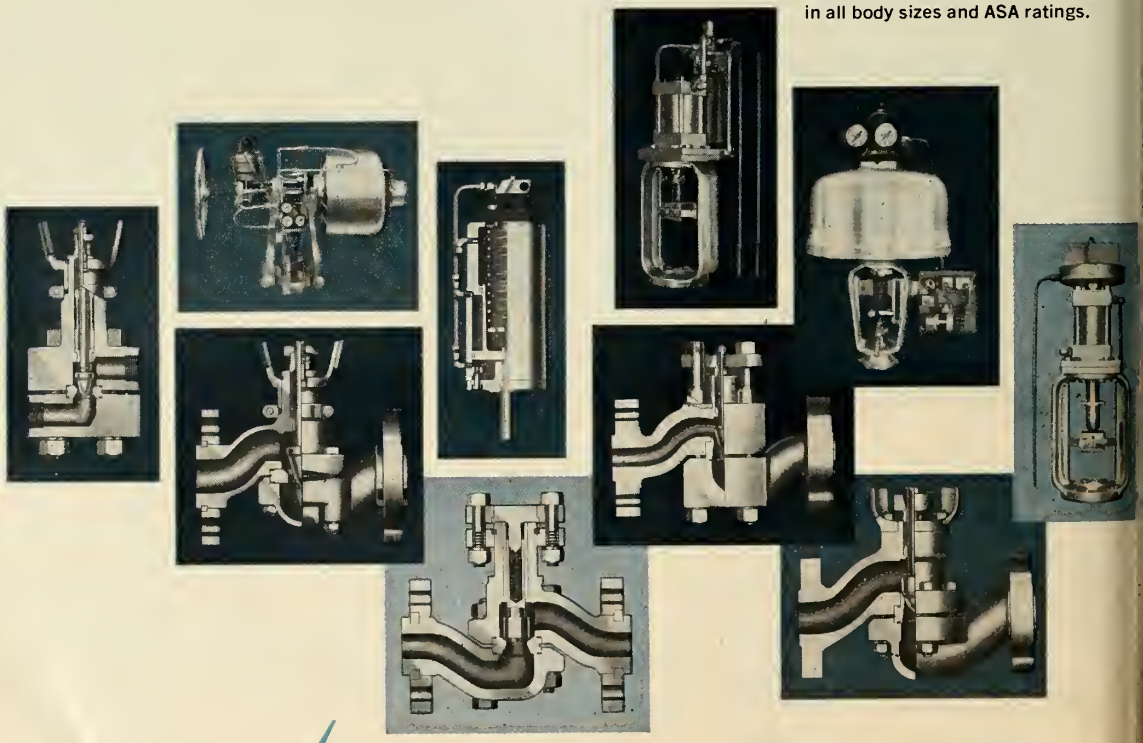

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The Countdown

WASHINGTON

SPACE BUCK PASSES ON

The spidery problem of defining clear-cut national objectives in space exploration is being passed on to the next Congress and Administration. Until these objectives are determined, all efforts at trying to eliminate duplication on an administrative level appear headed for failure. This includes a newly set up DOD-NASA "Aeronautics and Astronautics Coordinating Board" which is to fill the void created by Congress when it allowed Revision of the Space Act to die. Lacking any clear guidelines, the Board is expected to find the going just as mushy as have various other committees who grappled unsuccessfully with the problem.

Pressure for Samos Increases

Several current Pentagon staff switches in the Air Force appear to be intended to step up the *Samos* reconnaissance satellite program. The AF seemingly is bent upon making *Samos* operational at the earliest possible moment. Contracting in the program should take a jump shortly.

Leapfrogging Dyna-Soar

Several companies are trying to leapfrog the *Dyna-Soar* program with proposals for more advanced follow-on military spacecraft. One the AF is understood to be looking over seriously is an idea for a spaceship powered by a ramjet—both during early flight in the atmosphere and in space.

No Delay in Polaris Deployment

Speculation that a failure in a submerged *Polaris* launch Sept. 13 from the Patrick Henry will delay deployment of fleet ballistic submarines is said to be unfounded. The abortive firing reportedly was a random failure in the missile, which would not keep the first *Polaris* sub, the George Washington, from going on station late next month.

Minuteman ALBM Study

Cut-down *Minuteman* slung from the B-70 is being studied for the Air Force by North American Aviation as a possible ALBM. The *Minuteman* with a reduced first stage would still have a considerable range advantage over the *Sky Bolt* if fired at altitude.

Aeros to Watch Storms

The *Aeros* 24-hour weather satellite will be equipped with a Zoomar-type TV camera of variable focus for taking close looks at developing storm systems and hurricanes. *Aeros* will supplement a system of polar-orbiting *Nimbuses*, which will be launched about twice a year.

On the Pad

The Air Force is ready to flight-test its version of the *Scout*—the 609A . . . NERV shot at Pt. Mugu this week will be NASA's first shot down the Pacific Missile range.

INDUSTRY

STL Losing 10% to Aerospace

Only about 10% of Space Technology Laboratories' total business is being turned over to the Air Force's new management firm—Aerospace Corp. STL officials say 50% of their technical work will continue in the ballistic missile programs. As a strictly private company, STL expects this year to net $2 million on $85 million sales.

X-15 Flight Nears

First flight of North American Aviation's *X-15* with the 50,000-lb.-thrust Thiokol XLR-99 engine is now set for the last week in September. The test slipped from earlier this month when the engine had to be removed to replace a corroded hydrogen peroxide tank.

GSE Spending on Rise

Analysis of military gound support equipment needs shows an expected increase in the FY '62 budget by about $1 billion in this category. Mobility is the prime factor (See p. 25).

Papa Bear is Big

The Air Force discloses that its "Papa Bear" liquid hydrogen plant operated by Air Products Inc. at West Palm Beach, Fla., has a 60,000-lb. daily capacity. This is almost five times that of the next largest known plant—Linde's at Torrance, Calif.

INTERNATIONAL

Hope Rises for Space Program

The British government now appears to have made up its mind to approve a space research program, probably using *Blue Streak* and *Black Knight* rockets. Launching of the first British satellite is expected to cost between $220 million and $330 million. If the plan goes through, the Spadeadam Rocket Establishment would be rescued from oblivion (see p. 52).

Swedish Space Probe

The Swedish Committee on Space Research may buy Atlantic Research Corporation's *Arcas* rocket or the equivalent. Its space research projects include high-altitude turbulence, radio-wave absorption, proton flux, and electron density measurements.

The Overseas Pipeline

Engineer V. Gencic of the Yugoslav Astronautical Society says they will soon decide whether to buy Japanese *Kappa* rockets for their experiments or continue negotiations elsewhere . . . Friden International, S.A. is the California firm's new EFTA subsidiary in Fribourg, Switzerland. Highly successful defense and commercial systems here and increased sales abroad prompted the move.

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FORECAST

Major space age role for fluorine rocket fuel oxidizers

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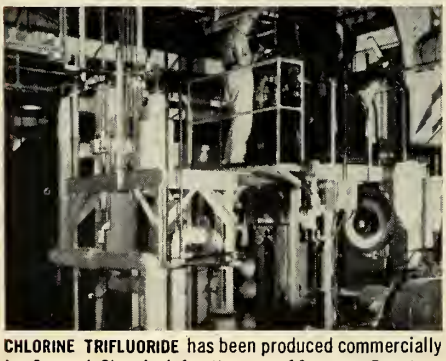
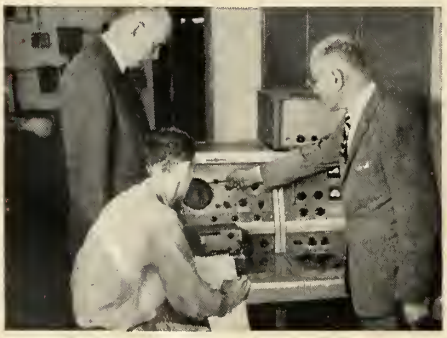


CHLORINE TRIFLUORIDE has been produced commercially by General Chemical for the past 10 years. Reactors like this one, located at General's Baton Rouge Works, have a capacity of more than 100 tons of CTF per year.



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For investigation of cryogenic systems in the super-high energy range, General supplies large quantities of liquid fluorine. For investigation of advanced, high-energy storable liquid propellant systems, General supplies chlorine trifluoride (CTF) and other halogen fluorides. To serve both these areas, General has large existing production capacity, and can meet volume requirements.

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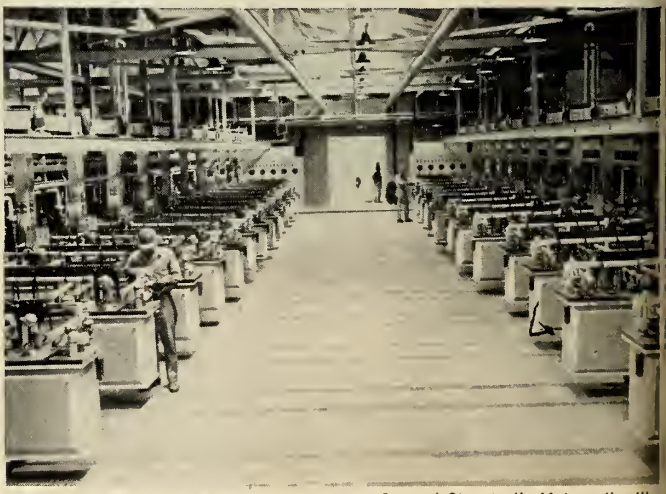

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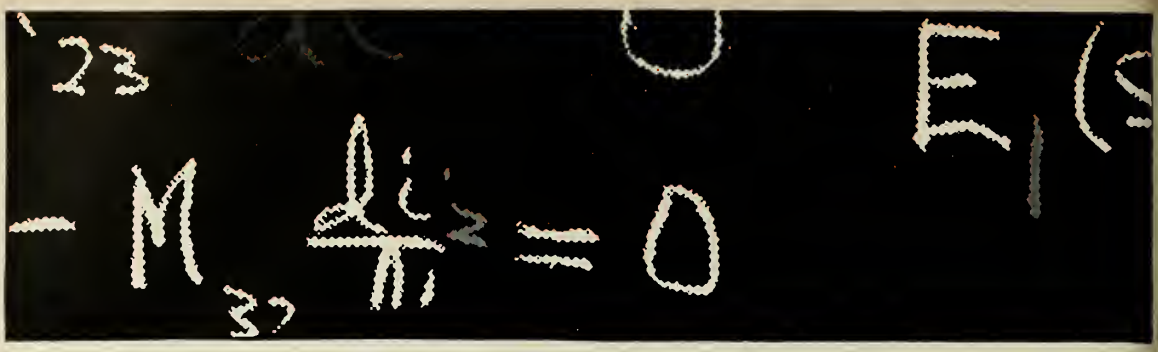
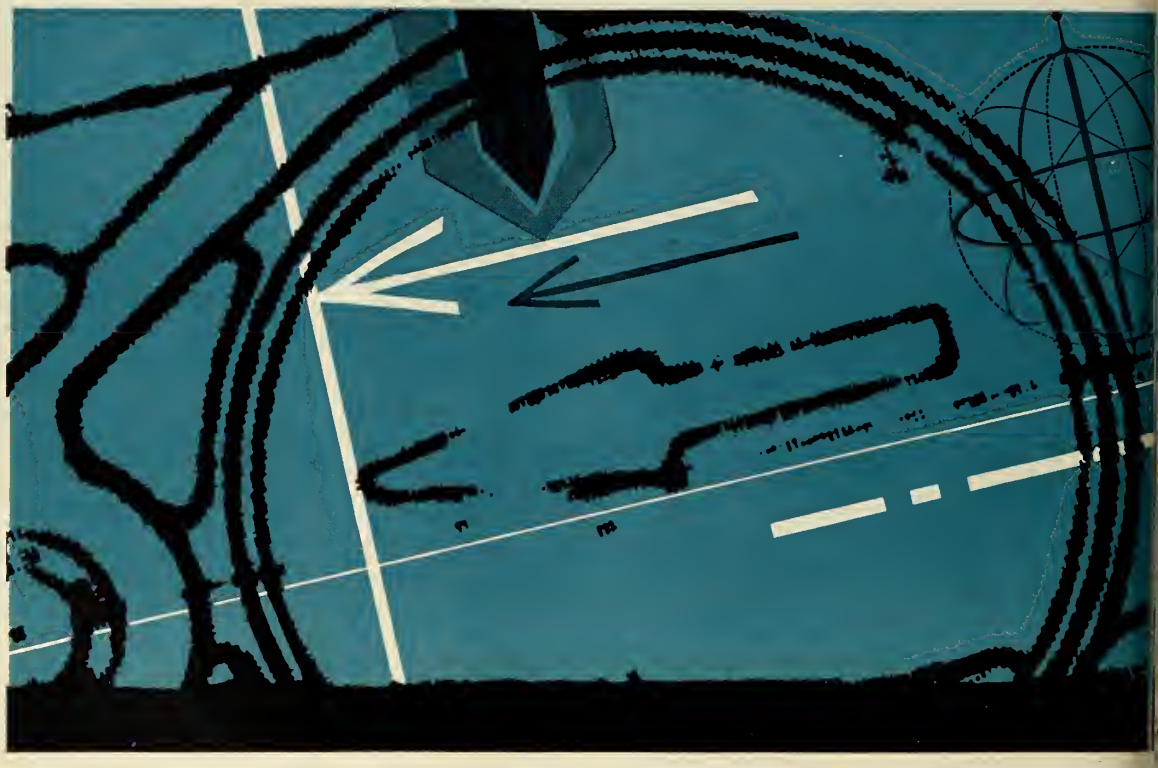


General Motors pledges

AC QUESTMANSHIP



AC Seeks and Solves the Significant—AC Design and Development is moving far ahead in new technology—the result of GM's commitment to make ever larger contributions to the defense establishment. AC plans to resolve problems even more advanced than AChiever inertial guidance for Titan / This is AC QUESTMANSHIP. It's a scientific quest for the development of significant new components and systems . . . to advance AC's many projects in guidance, navigation, control and detection / Dr. James H. Bell, AC's Director of Navigation and Guidance, sees this as a "creative challenge". His group takes new concepts and designs them into producible hardware having performance, reliability and long life. He strongly supports the fact that an AC future offers scientists and engineers "a great opportunity to progress with a successful and aggressive organization" / If you have a B.S., M.S., or Ph.D. in the electronics, scientific, electrical or mechanical fields, plus related experience, you may qualify for our specially selected staff. If you are a "Seeker and Solver", write the Director of Scientific and Professional Employment, Mr. Robert Allen, Oak Creek Plant, 7929 So. Howell Ave., Milwaukee, Wisconsin.

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Hard-based Minutemen vs. Mobility

Backers of fixed bases claim that an adequate force of Minutemen would cost far less than Polarises

by James Baar

THE FIXED-BASE *MINUTEMAN* is challenging the running trend toward missile mobility.

All signs point today toward the challenge becoming a heated interservice fight that will be one of the first major issues to confront the new Congress and new Administration in January.

At the center of the controversy are the long-range plans for construction of a 45-boat fleet of *Polaris* submarines and a vast complex of hundreds of hardened *Minuteman* sites.

At stake are major decisions affecting the nation's security in the mid-1960's and beyond.

The trend toward mobility in missile systems has become an onrushing wave in the last year.

The Army is putting on wheels or tractor treads any missile that a GI can't carry on his back. The Navy has always had all of its missiles mobile. The Air Force's new *Sky Bolt* will be launched from bombers and other aircraft and a sizeable portion of the *Minuteman* force will be on trains.

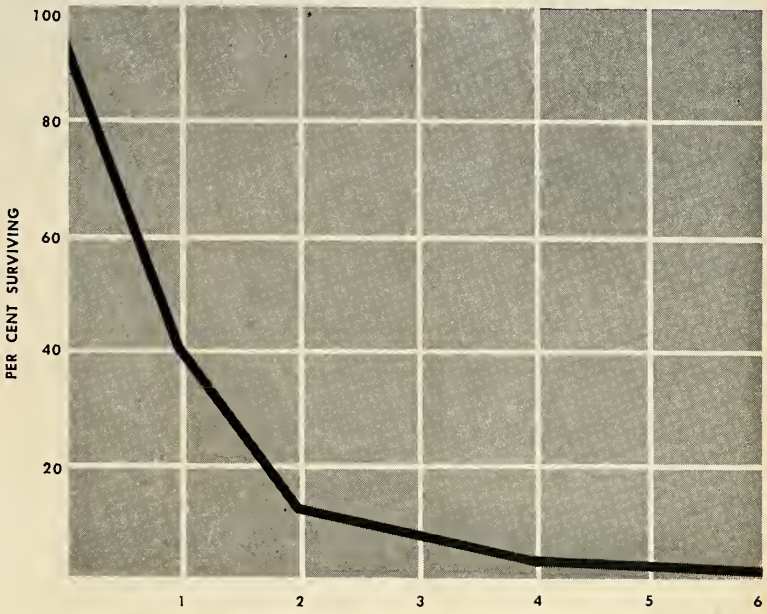
But mobility is a factor that greatly complicates a missile system—particularly for big strategic missiles. Costs rise sharply.

It is on this count—money—that the fixed-base *Minuteman* is making its principal challenge. There are other counts. But money is the main one.

• **Case for mobility**—The advocates of mobility argue that the day of the hardened fixed missile site will be brief at best.

The argument hangs on the accuracy of Soviet ICBM's. As that accuracy increases, the number of missiles that would be needed to knock out a hardened missile site will markedly decline. The vulnerability of hardened missile sites will rise accordingly.

For example, assume a Soviet attack on a hardened missile site built to withstand overpressures of 100 lbs. psi. Assume also that the Soviet attack will be made by ICBM's carrying 10 megaton warheads. And that it has 100% reliability.



Survivability of U.S. Missiles

MINUTEMAN'S CHANCES of surviving an attack by one or more 10-megaton ICBM's with a CEP of one nautical mile. Each Minuteman site has been hardened to 100 psi. The ratio and percentages given are applicable to a force of any size.

If the Soviet missiles' CEP—the radius within which 50% of the missiles can be expected to fall—is three miles, 14 would be needed to ensure a knockout within a probability of 90%. But cut the CEP to two miles: Only six missiles would be needed. Cut it to one mile: then only two would be needed.

A number of experts have predicted that the Soviets can be expected to have a one-mile CEP by about 1963. If they are right, a two-to-one attack on U.S. *Minuteman* sites would destroy some 80% of the force.

On the other hand, mobility advocates contend that such missile systems as the submarine-launched *Polaris* and the train-launched *Minuteman* are far less vulnerable to improvements in Soviet accuracy.

Unless there are great and unforeseen improvements in underwater detection systems, the *Polaris* submarines are considered extremely difficult to locate and destroy on an individual basis. They are considered all but invulnerable to mass attack.

The *Minuteman* trains also are considered extremely difficult to knock out. However, because they can be seen and because they are tied to the railroad net, it is conceivable that they could be destroyed on a mass basis if the Soviets were willing to pay the tremendous price of pattern bombing 100,000 miles of railroad—the trackage within *Minuteman's* range of Russia. But this is not considered likely.

• **Case for hard bases**—Advocates of hardened bases concede all of this. They center their case primarily on cost —and numbers.

The Navy has estimated that the entire cost of a 45-submarine *Polaris* program will be $8.6 billion. This is a

Mathematics of Survival

How to determine the approximate survivability of a missile system.

The fraction of a missile force expected to survive an attack can be arrived at by this equation:

$$S = (1-k)^{rE/M}$$

S is the fraction of the force expected to survive.
k is the probability of a one-shot kill.
r is the reliability of an enemy's missiles.
E is the number of attacking missiles.
M is the number of missiles under attack.

To determine the value of k another equation is needed. It can be expressed as:

$$k = 1 - (\tfrac{1}{2})^{R^2/C^2}$$

R is the radius of the effect of a particular attacking warhead. This can be determined from the unclassified AEC-DOD handbook on nuclear effects.
C is the Circular Probable Error.

The number of missiles that would survive an attack can be determined by multiplying both sides of the survivability equation by the size of the force under attack. Thus:

$$A = MS = M(1-k)^{rE/M}$$

total figure including $2 billion for R&D.

Such a program would produce a fleet packing 720 missiles. The all-inclusive cost of sending each missile to sea would be $12 million. However, the cost of each missile in the later submarines minus R&D and other one-time costs would be about $8 million.

Figures on the much newer *Minuteman* system are not as complete in the public record or as hard. However, the Air Force has estimated that the cost of each *Minuteman* in the ground will be about $2 million minus R&D.

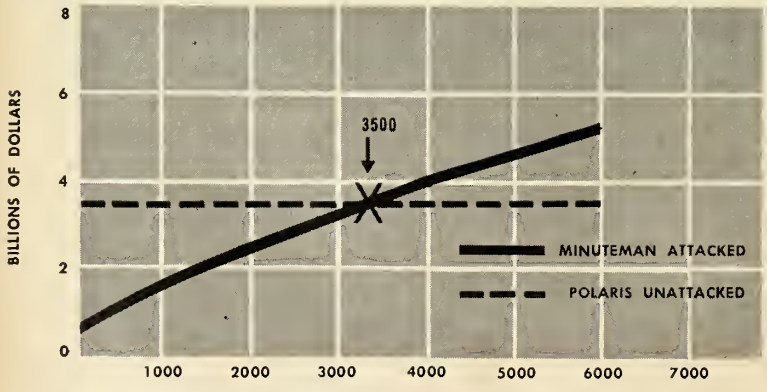
This is the figure that high-ranking Air Force officials have in mind when they speak of *Minuteman* being an "economic breakthrough." Some authorities contend the figure is low. However, this is still to be determined.

Given the $2 million *Minuteman*, the hardened base advocates contend that the nation can buy a larger surviving retaliatory force than if it bought either *Polaris* or train-launched *Minuteman*.

The secret is numbers—and the cost of surviving missiles. It works like this:

Give the Soviets a one-mile CEP. Give them a two to one superiority over the United States in the number of missiles. Give then a 10-megaton warhead on each. Give them an overall operational reliability of 80%.

An all-out attack on hardened and dispersed *Minuteman* sites with such a force would result in knocking out nearly 80% of the *Minutemen*.



Cost of 300 Surviving Missiles

POLARIS VS. MINUTEMAN on the basis of cost and survivability. Here 100-psi Minuteman sites are attacked by 10-megaton ICBM's with CEP of one nautical mile and reliability of 80%. The number of Minutemen on the curve represents the initial force required if 300 are to survive attack by the increasingly large enemy force. The Polaris force at sea is not attacked. Cost curves do not cross until the Minuteman force reaches a total of 3500 missiles.

• **Survivability's cost**—But if the *Minuteman* force numbered 1200, a retaliatory force of 300 could be expected to survive. The cost of such a force would have been about $2.4 billion.

The cost of a similar force of 300 surviving *Polarises* at sea would be about $3.6 billion.

The *Polaris* figure is based on the assumption that two-thirds of the *Polaris* fleet will be at sea at any one time. Furthermore the assumptions are made that the submarines in port are attacked and destroyed, but the submarines at sea are not attacked.

Operating the same formulae, approximate cost figures can be obtained for any size of friendly and enemy forces and any size of surviving force required.

It is not until the initial *Minuteman* force has reached 3500 missiles that the cost of *Minuteman* and *Polaris* becomes equal for a surviving force of 300. Beyond 3500, *Polaris* becomes cheaper.

On the basis of these figures, two conclusions can be drawn:

–Hardened *Minuteman* sites in large numbers can provide the nation with a sizeable, surviving retaliatory force regardless of gains in the accuracy of Soviet missiles now expected.

–*Minuteman* appears to be a much less costly system than *Polaris*.

• **Something to ponder**—However, these conclusions do not take into account several important matters.

One is the time between now and the period in late 1963 when *Minutemen* are scheduled to be available in large numbers. During this period, *Polaris* is the only mobile ballistic missile system available. Thus any decision as to whether more *Polaris* or *Minutemen* should be built is something that can affect only the mid-60's—not the missile programs of the next few years.

Another important factor is the argument that the installation of large numbers of hardened sites will cause the Soviets to build even larger numbers of ICBM's that would be aimed at the American homeland.

Also, there is the contention that ultimately ICBM accuracies and warhead sizes will improve to the point where direct hits are assured.

And, finally but far from last, is the strategic question of how many surviving strategic missiles the nation needs.

All of these factors are threads in the overall debate.

Little about it is simple. Much depends on the right decisions being made in the coming year. ⁂

GSE

SPECIAL ISSUE

Market Forecast: Up 25% in FY '62

Outlook for missile GSE is $1 billion more than this year; NASA expected to add $250 million for space support

HEAVIER EMPHASIS upon mobility for ICBM's and tactical missiles will be reflected in FY '62 military budget requests for ground support equipment.

A forecast by the M/R Research Department for the next fiscal year indicates a total missile GSE market topping $4 billion—up $1 billion over FY '61. Moreover, an additional $250 million is expected to be spent by NASA supporting space flight programs.

Biggest question mark in the forthcoming budget to be presented to Congress in January is the Navy's request for *Polaris* submarines.

Chief of Naval Operations Arleigh Burke has indicated a desire for 12 fleet ballistic missile subs costing an estimated $1.3 billion. However, the actual request is presently expected to be between six and nine. *Polaris* subs in the water and in varying stages of construction (including those for which only long leadtime items have been authorized) now total 19. The Navy wants a total of 45.

New money is expected to be earmarked for developing railroad mobility for the Air Force's *Minuteman* ICBM, estimated to cost $4.8 million per missile aboard a train. The AF eventually may buy up to 100 rail-borne *Minutemen* trains (see p. 29). The AF also is stepping up GSE for missile-carrying aircraft.

The largest single GSE item in the coming budget, however, will continue to be the fixed base-building program for *Atlas* and *Titan* and the silo-launched *Minuteman*. The AF is spending $696 million in FY '61 to construct ICBM bases and $802 million to equip them and support other missiles. With the ICBM base building program nearing the half-way point, these figures should rise in the coming year—particularly with both presidential candidates pledged to greater defense spending. Pressure also will be on to close the Missile Gap by speeding up the completion of the bases.

Missile Support Equipment Procurement
(millions of dollars)

	1960	1961 (est.)	1962 (est.)
Air Force ...	$642.5	$802	$850
Army	421	455.5	500
Navy	500	553	575
ICBM Bases .	550	696	720
FBM Subs ...	378	548	740

Note: Above totals do not include communications, warning systems or Navy missile ship conversions.

• **Total mobility**—With the Army, the emphasis has shifted almost totally to mobility. Buys of missile carriers such as the M-113 (for the *Pershing, Mauler,* etc.) are expected as various new missiles reach production status.

High on the Army's priority list is a mobile battlefield antimissile system. Although contracts are still only about to be let for studies of such a system, the Army can be expected to move quickly on this project once it decides what it really wants.

Indicative of the Army's all-out effort to obtain complete "shoot and scoot" capability was its decision in FY '61 to purchase 18,000 tactical trucks and increased air support. It also is making the *Nike-Hercules* air/missile defense missile mobile.

Still hanging fire is the decision to proceed with production of the *Nike-Zeus* A-ICBM. The Army is being obliged to wait until *Zeus* is tried against *Atlases* fired into the Pacific next year before it can expect a go ahead. Even at that late hour, *Zeus* could command a multi-million supplemental appropriation for its GSE.

An analysis of GSE spending shows that the electronic share of all military equipment is now running close to 90%, with the remainder classified as mechanical and automotive.

The Defense Department in the next budget is expected to ask for continuing high appropriations for various communications and warning systems, including BMEWS, SAGE and the Army's Missile Master. But a big upswing undoubtedly can be anticipated in satellite reconnaissance systems—both *Samos* and *Midas*. These two systems, expected to progress materially next year toward operational status—based on successes with the *Discoverer* and *Tiros* programs—will require major amounts of electronic GSE for interrogation, data reduction and communication.

NASA also is rapidly becoming a major market. Officials estimate that the space agency will spend an average of 25% of its annual budget in the future with industry on GSE.

Outside of R&D, little GSE money is being allocated beyond *Mercury* for either military or NASA manned space missions. But, as the U.S. space program slowly gathers momentum, this is rapidly emerging as the GSE market of the future.

• **Long-range outlook**—The Air Force's *Dyna-Soar* program is expected to approach nearly $1 billion for R&D alone, including GSE. And follow-on R&D programs for military spacecraft are already under consideration.

NASA's *Apollo* manned spacecraft program also is scheduled to get under way next year, along with other new NASA space projects.

Moreover, a number of Pentagon officials are looking toward development of advanced missile defense and space station systems. Such space stations would be both manned and unmanned.

But probably the heavies long-range thinking in GSE is being done by both the military and industry in the area of equipment that will be needed for establishing bases on the moon in the late 1960's or early 1970's.

Mobility Adds to Support Problems

Trend toward big-missile mobility vitally affects design, costs and maintenance of support equipment; services take different approaches based on missions

by Hal Gettings

THE ARMY, Navy, and Air Force agree on at least one thing: making missiles mobile costs money. In general, crews must be larger, maintenance is more of a problem, and there are rigid limitations on size and weight.

So the question of mobility boils down to first trying to decide how much mobility is required for the missile system to adequately perform its mission. Tactical systems demand mobility; strategic missiles may or may not be mobile, depending on many other factors.

Many feel that the hard base is already obsolete and the soft base—except in the protection afforded by sheer numbers—is a liability.

The limiting factor in big-missile mobility is the expected accuracy of enemy missiles. When accuracies of one-half mile CEP are attained, the day of hard-base survival is past. Fixed bases are desirable from many standpoints—including crew comfort—but the Maginot line has little place in Space Age defense. Mobility definitely has a future.

Even real estate problems enter into the mobility picture. Land available for fixed bases—especially in Europe—is limited. Not only do the farmers not want to relinquish their land but the establishment of bases on foreign soil—and the storing of nuclear warheads, in particular—generate severe problems in international relations. Such problems have already been encountered in England and France, for instance.

The different services have different approaches to the mobility problem, chiefly determined by mission and operating environment. All agree, however, that mobility is a means rather than an end. Mobility costs money and has sufficient inherent problems to make it a luxury if unsupported by actual requirements. And the money and problems are in the support equipment. It is here that much can be done to make equipment simpler, more reliable, and less expensive.

AIR FORCE BULLPUP missiles are loaded on transport trailer with ubiquitous MJ-1 loader, originally designed for F-105. Cradle adapter provides positioning.

• **Army approach unique**—The Army's approach to mobility is simple: "If it's not mobile, we can't use it." Only one Army system—the *Nike-Zeus*—is not mobile (and some proponents claim that even this, too, should be.) Even the *Jupiter* was designed to be a mobile system.

The Army likes to point to Germany's experience with the World War II *V-2* in support of its philosophy of mobility. No fixed-base *V-2's* ever survived to fire operationally. In contrast, no *V-2* on a mobile launcher was ever destroyed by aircraft—even in the face of something like 30:1 enemy air superiority.

The Army also contends that mobility will be an even more complex problem in nuclear war. Roads, bridges, railroads, and airfields will be knocked out and only "cross-country" mobility will be able to put missiles into firing positions.

Consequently, Army support equipment is built to meet this mobility requirement. It is designed for aircraft and helicopter transport, and for cross-country travel over rough terrain. Equipment must be rugged and reliable, self-contained, and require a minimum of maintenance.

The *Pershing* system is considered by the Army to be today's ultimate in mobility. Missile carrier, launcher, and support equipment are all contained in four tracked vehicles. These can be transported by transport aircraft or the Chinook helicopter. In a very short time after arrival at a launch site the units can be connected and missiles launched. (Actual deployment time is classified; it can be described only as minimum.)

The tracked vehicles used with the *Pershing* are all the standard M-113 armored carrier. Each is adapted for its primary function: missile carrier, nose

cone carrier, and other support equipment such as fire control and checkout, maintenance, spares, etc. The *Mauler* system also uses the M-113.

• **Universality?**—The Army has two approaches to "universal" support equipment. The M-113, for instance, represents one approach: use the same basic vehicle wherever possible and adopt it for particular functions. Individual weapons systems, however, require their own direct support and test equipment.

Rear-area (second and third echelon) support and maintenance present a different picture. Army Ordnance has already invested a tremendous amount of time and money aiming for automatic universal test equipment for missile systems (see story p. 49).

One area of support equipment for mobile system that gets little attention—at least publicly—is that of site location. In order to hit a long-range target, the exact location of the launch site must be known. This problem exists for all mobile systems, whether air-, sea-, or land-borne.

The Army considers present techniques adequate and foresees no real problems. Available methods are rather crude, however, and could conceivably stand some refinements. Map grids and survey teams seem rather antiquated in the Missile Age.

The future will probably see the use of small inertial guidance systems for each weapon. This is already a necessity for ship-borne and air-launched weapons and the land-based missile operating in strange territory could well use such a system. Primary requirement is, of course, for small, cheap, expendable guidance units.

• **Ground rules for support equipment**—Army has established a set of ground rules—or "military characteristics"—for mobile support equipment. These set basic configurations such as size and weight, reliability, and operating environment capabilities. The most important are these:

–Operation in combat zone environment (which must include any climate from polar to equatorial and any terrain from ocean beach to mountain top.)

–Mobility to fit the mission.

–Transportability by air or land (with available vehicles.)

–Fast deployment (or reaction time).

–Rugged and reliable with minimum maintenance.

• **Mobility no problem for Navy**—An entirely different aspect of mobility arises in the case of the Navy. At first glance, it appears that all Navy weapons systems are the last word in mobility. Each shipboard system is self-contained, autonomous, and free to move anywhere in the world's oceans.

On the other hand, however, few of the many problems affecting mobility on land are involved in the water-borne system. In effect, you have a fixed base that can move. Handling, power, and test equipment is part of the fixed base and does not itself have to be mobile. This eliminates many of the thorny aspects of mobility facing other services.

Navy support people feel that they're well on top of most of their problems. New missile ships have automatic handling equipment built into the ship's structure. Once the weapons are loaded aboard the vessel, it's pretty much a "Coke-machine" operation to assemble, check out, load and fire.

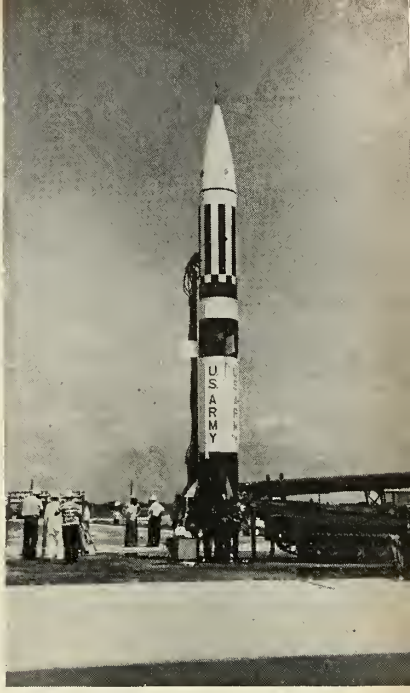
Some portable gear is necessary in the case of airborne missiles carried by carrier-based aircraft. These missiles are relatively small, however, and necessary handling is accomplished with modified bomb dollies and skids. Mechanical handling gear has been designed for carrier installation but, due to lack of money, none has yet been built.

Depot and dock-to-ship transport is, in most cases, handled with the ubiquitous fork-lift, adopted for the various weapons.

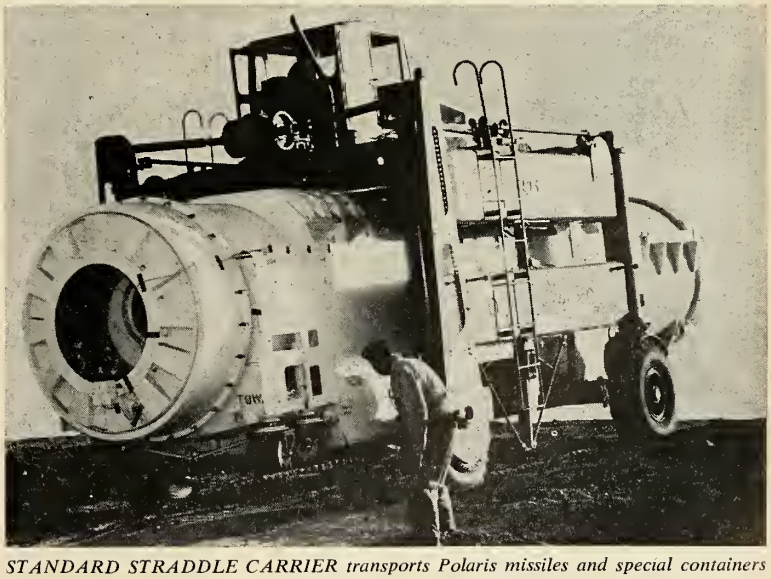
Inter-communications in a ship-borne missile system—for checkout, loading, launching, etc.—is carried by usual shipboard circuits. Such circuits appear capable of meeting requirements and no new systems are contemplated.

Ordinary electronic test equipment carried by ships is sufficient for most maintenance and repair functions. Instruments that require extensive calibration are serviced during periodic yard overhaul periods. Checkout equipment peculiar to the missiles system is installed aboard ship and, in most cases, is operated by the ship's power supply. In spite of the crowded environment and high density of electronic equipment, no serious problems have been encountered with crosstalk or r-f interference.

There remains one major problem in sea-borne missile support, however, and it is giving the Navy considerable concern. This is the requirement for transferring missiles between ships at



ARMY's Pershing has combination of TEL (transporter-erector-launcher), M-113.



STANDARD STRADDLE CARRIER transports Polaris missiles and special containers at Charleston submarine loading base. Carrier is built by Clark Equipment Co.

sea. Navy logistics have long depended on at-sea transfer of supplies. The same requirement holds for missile replenishment.

Conventional methods—using slings supported by a cable running between ships—are much too uncertain and hazardous for transfer of delicate, explosive (and expensive) missiles. New techniques will have to be developed.

Bureau of Ships is working on the problem of installing mechanical handling gear aboard ammunition ships. This is only part of the solution, however. Bridging the overwater gap between ships is the major portion.

Navy spokesmen see no radical departure from present techniques for other aspects of handling and checkout. They foresee little expansion of the "fixed-ammunition" concept—such as *Bullpup* and *Sidewinder*, which require little or no shipboard checkout. The need will continue for test and checkout equipment.

As for mechanical handling equipment, this must be kept as simple and universal as possible. The Navy still has guns. Equipment must be able to handle conventional ammunition as well as missiles. Also, insofar as possible, the same gear must operate both on ship and in the depot.

• **AF has two approaches**—Mobility is looked at by the Air Force as a necessary evil. Fixed bases for strategic missiles are, of course, preferred for many reasons. But when enemy missiles achieve sufficient accuracy fixed bases become untenable.

The Air Force hedges its bets with both fixed and mobile systems. It estimates that the Russians will attain the required ½-mile CEP within five years and base mobility plans on this assumption. Ultimate aim—or "true posture of mobility"—is a manned and maneuverable space weapon.

The Air Force has two mobile strategic missile programs in the works at present: *Minuteman* and *Sky Bolt*. The former—both hard-based and train-carried—is scheduled for operational status in mid 1962. *Sky Bolt* should be operational sometime in 1964.

Both systems pose problems in support equipment. Mobility demands sophistication, ruggedness, and reliability —all of which cost money. Harsh and variable environments pose problems, particularly in the case of airborne equipment.

Major problem for *Sky Bolt* is development of equipment to establish the instantaneous launch-site location. Pinpoint accuracy is not required since the ALBM can use a star-tracker to refresh its guidance memory. But establishing even a close approximation of the instantaneous position of a near-sonic launch platform is a difficult job. Terminal guidance capability is the ultimate goal.

Launch-site location for *Minuteman* is a different situation. Previously established benchmarks will provide the necessary information.

Communications—the key to coordination—is a real problem in any mobile weapon system. *Minuteman* will use airborne command posts with single-sideband radio links. This will get away from the possible loss of ground radio stations and towers through enemy attack. Problems remain, however, even with the use of the more sophisticated radio links. Interference, blackouts, and solar and ionospheric disturbances plague critical command communications.

The more mundane areas of mobile missile support—transport and ground handling—generate their share of problems for the Air Force. Difficulties have been encountered with the *Minuteman* train transporter-erector, for instance (see story p. 29).

The big missiles pretty much require custom-designed equipment. Efforts have been made to standardize some ground-handling components for the smaller missiles.

Probably the best example of universal equipment is the MJ-1 low-silhouette lift truck used in numerous missile applications. This unit—with adapters and cradles—performs a variety of jobs including transporter, lift, maintenance platform, and assembly aid. It comprises a large part of the *Bullpup* GSE (see story p. 42).

Whatever the problems generated by mobility, the Air Force feels they can and must be solved. Mobility will become increasingly important, leading to the ultimate of mobile space-borne weapons systems. ⁂

Free-wheeling Test Device

GYRATIONS OF missile component test boom describe Ferris-wheel pattern at Aeronutronics' Engineering and Research Center, Newport Beach, Calif. The device is used to rotate models in radar studies.

Mobile Minutemen to be 'Randomized'

Air Force plans to have most of its Minuteman trains set up in launch points at any given time; test deployments a big success

those who optimize,
and finalize,
now strategize
that Minuteman should "randomize."

by William E. Howard

DEPLOYMENT OF *MINUTEMAN* ICBMs on the nation's railroads is still more than two years away, yet the Air Force today feels that substantial numbers of these mobile missiles will survive any wartime conditions—and still be able to respond to a Soviet attack.

The solution to the survivability problem does not lie in keeping the missiles constantly on the move, as might be assumed.

Instead, the Air Force plans to have more than 50% of the missiles set up, at all times, at pre-surveyed launch points along railroad sidings. They would be ready to fire on minutes' notice, just like *Minutemen* from hardened silos.

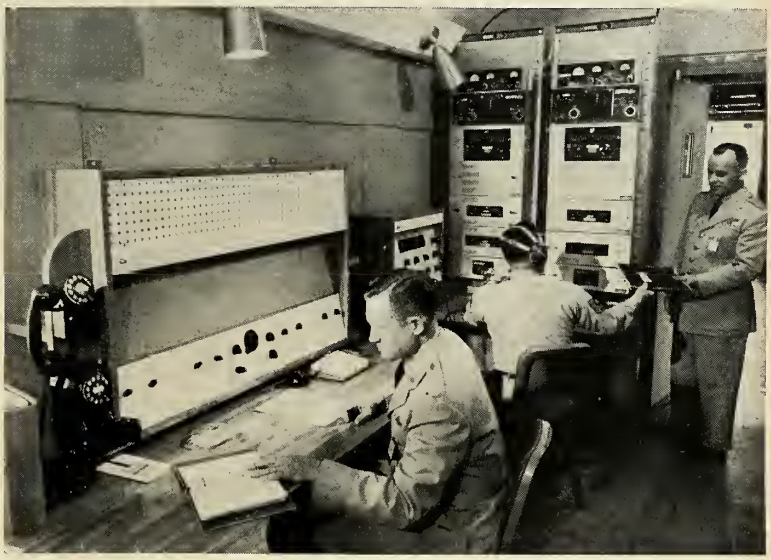
Each train will remain at any one launch site an indefinite period of time. Perhaps only two hours, or maybe 20. The missiles will then be stowed back in their horizontal traveling positions and the train will shuttle off to a new location, which could be 5 miles away or 500. There will be no set pattern.

The Air Force calls this "randomized" deployment, or "programed deception."

Enemy agents might know full well the various areas missile trains are operating in. But, after determining target information of a particular train at a particular site, the agent will have no assurance the train is still there by the time his information reaches Moscow.

"You might say this complicates their intelligence operation just a little," says an Air Force officer drily.

Even assuming the Russians eventually develop a highly effective satellite reconnaissance system, the missile trains not only would be difficult to identify among other trains on the tracks, but their mobility (i.e. more frequent randomization) would make their total destruction by a surprise missile attack extremely difficult, the Air Force believes.



MINUTEMAN MOBILE Command Center, heart of the Minuteman test train "Big Star," including command office and communication station. Boeing installed equipment. Communications systems include powerful "Single Sideband" radio.

Randomized deployment thus is designed to overcome the main critical objection to missile trains; that they are vulnerable because they are exposed, in contrast to a *Polaris* submarine—the nation's first mobile ICBM system—that has the advantage of concealment beneath the sea.

• **100 trains possible**—Much of the Air Force's confidence in a highballing *Minuteman* stems from four deployments of a test train this summer from Hill AFB, near Ogden, Utah. In these 10 to 14-day trials, both communications and operation of the train equipment proved so successful that two additional deployments that had been planned were cancelled by the Strategic Air Command as unnecessary.

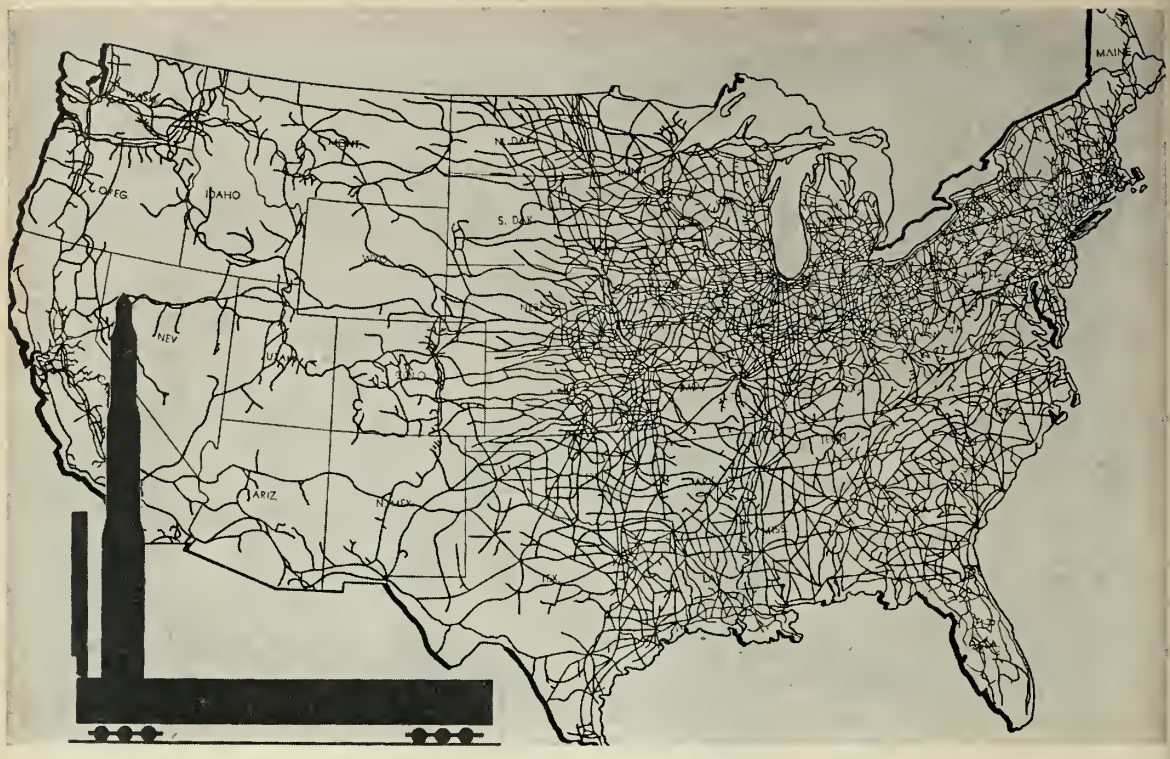
Test data is now being evaluated to determine the composition of trains, number of missiles per train, ancillary equipment etc.

Just how many men will be needed to launch the missiles is still a question. The best estimate is between 25 and 30 for a train of five missiles. More explicit figures are expected to come from some studies currently being run by Boeing Airplane Co., prime for the program.

The maximum number of *Minutemen* expected to be deployed on rails is reported to be about 300. Above this figure, the railroads would become too big a target. Individual trains could carry either three or five missiles, thus requiring from 60 to 100 trains.

Trackage also is a factor. Some studies have shown that a train bearing five missiles should have 900 to 1200 miles of track to operate on for two weeks.

Test trains were made up of about 14 cars—the latter two deployments included the trucks and bed of a pre-



MAP SHOWS all major U.S. rail lines, totaling some 220,000 miles of railroad. About 100,000 miles in Northern half could handle 100 missile trains.

prototype, air-suspended missile car being developed by American Machine & Foundry and ACF Industries. This flat car bore an inert model of a *Minuteman* to simulate the missile's weight.

Boeing furnished a command and control car. It was equipped with single side band and UHF radio for contact with the Train Control Center at Hill AFB and with the SAC Command Post at Offutt AFB, Neb.

Another flat car bore a trailer truck containing an inert third stage *Minuteman* motor made by Hercules Powder Co. to obtain environmental control data.

• **Living cars needed**—Other units, in addition to the diesel locomotive, included four ambulance and two hospital cars which had been converted for use by the 21-man SAC crew and other personnel. There also were two tank cars and a box-car for fuel, water and supplies to make the train self-sustaining for two weeks. In the first deployment, the train carried a pickup truck in the box-car as emergency transport. A jeep later was substituted when the crew found the truck could not be unloaded very easily and it was impossible to drive across tracks in a railroad yard.

The tests revealed that it probably will be necessary to design special living cars for the crewmen. Army ambulance cars will not be available for conversion and the ones used on the tests proved to be rather cramped and to contain waste space (a small kitchen and nurses' station).

One of the hospital cars was used as a ready (recreation) room for off-duty personnel; the other for dining and the kitchen. There was television and radio in the ready room. But, the main diversion at night was outdoor movies shown on a screen rigged on a cattle fence next to a siding.

As much as anything else, the trial deployments were a test of whether missile trains could be handled along with regular traffic on the roads and with union trainmen at the controls.

• **No strike pledge**—Unlike other types of missile deployment, the mobile *Minuteman* will be dependent upon civilians to move the missiles to where they can be launched. The decision to man the trains with regular train crews presumably was prompted by a desire on the part of the Air Force to avoid a battle with unions and to skirt the necessity of training hundreds of airmen in the complexities of train operation.

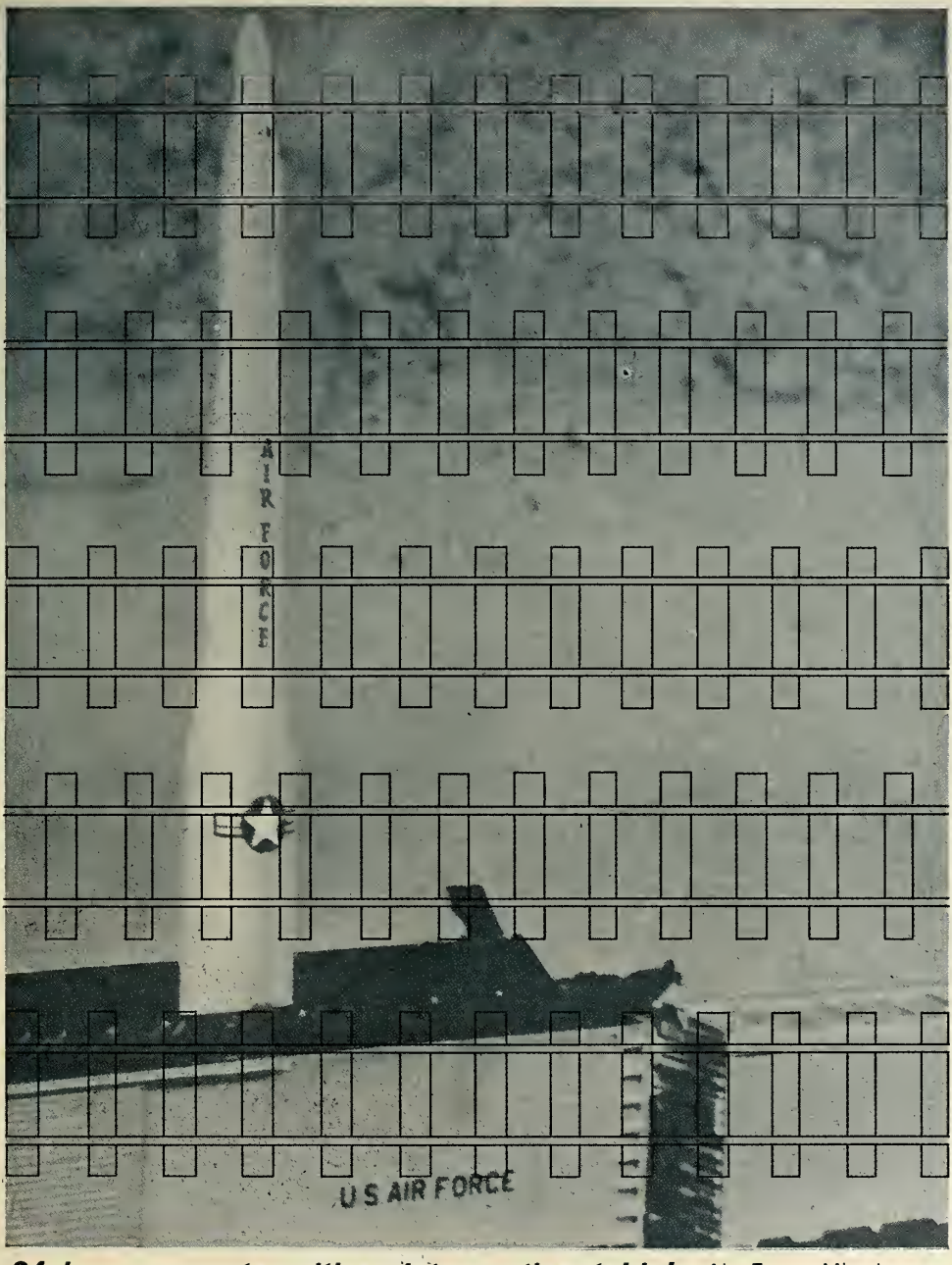
Because of the extra jobs which will be created, the unions have agreed to cooperate fully—within union regulations. To show their support of the program the rail brotherhoods and railroad management through the Association of American Railroads have pledged there will be "no work stoppages" in the maintenance, scheduling, dispatching and operation of missile trains.

Although movement of the test trains went smoothly, there were some eye-openers to the Air Force men aboard. They found, for example, that union rules required a change in operating crews every time they arrived at a division point or switched to another line—even though most division points are less than 150 miles apart.

Operating crews with seniority spurned the bunks in the ambulance cars and slept in their own caboose, which they were allowed to couple on to the missile train under union rules. Presumably they will continue this practice with operational missile trains.

Initial deployments were confined largely to the northwestern states. In the fourth test run, however, the train went as far east as Illinois. Although there are some 220,000 miles of railroad track in the United States, only about 100,000 miles of it is in the northern half of the nation, and within *Minuteman's* striking range of Russia.

However, Canada has another 40,000 miles of railway which conceivably could be made available to the *Minutemen* trains. Thus, there would be sufficient track to deploy 100 trains at 900-1200 miles per train.



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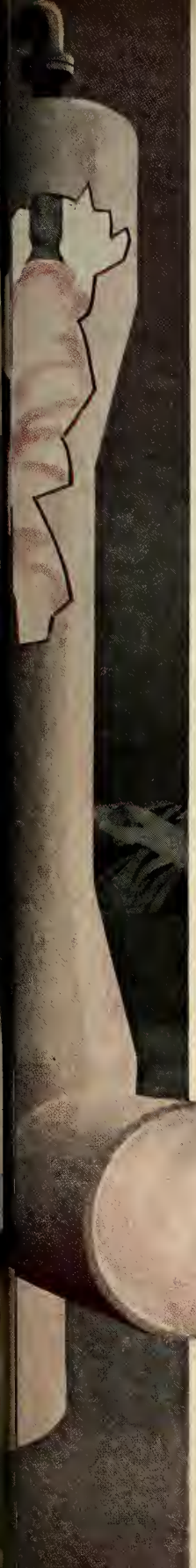

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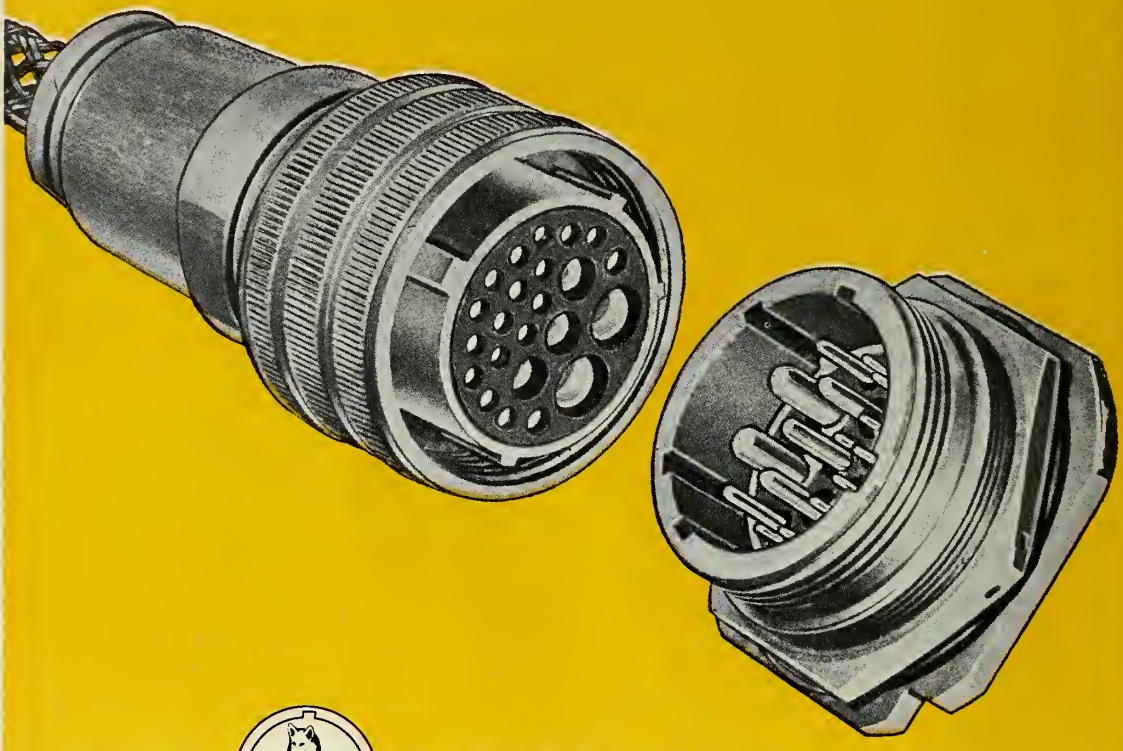

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GSE

SPECIAL ISSUE

Cargo Ships as Minuteman Bases?

Typical fleet of laid-up World War II Liberty ships takes up space at Jones Pt., N.Y.

ONE MEANS of meeting the cost challenge to big missile mobility could be to send *Minuteman* to sea in Liberty ships.

The idea of converting some of the 1500 World War II cargo vessels currently rusting away in various lay-up fleets into floating ICBM pads is before the Air Force for consideration. But, so far it has received little support —mainly on grounds of vulnerability.

Although proponents of the idea concede the slow moving, unarmed merchantmen alone would indeed be easy prey to Russian subs, they contend that it is possible to protect them with warships and in certain waters, such as harbors. Moreover, the proponents say that wide dispersal of these moveable launch platforms would more than offset their vulnerability to surface attack by complicating enormously enemy efforts to destroy them before they could fire their missiles.

The major factor in favor of the proposal is that it would be relatively cheap, according to studies originated by planners at American Machine & Foundry. The solid-fueled *Minuteman* —expected to be operational in mid-1962—is about 60 ft. long and could be padded rather easily in the hull of a ship.

• **Potential**—The WWII moth-balled cargo fleet, consisting of vessels of the EC-2 (Liberty), EC-21 (Victory), and the C-1, C-2, C-3, and C-4 types have a load-carrying capacity ranging from 3500 to 14,000 tons.

Carrying permanent ballast, these ships would be capable of storing and firing from five to nine *Minuteman* ICBMs, and the total cost would be about 1/100 of that of a *Polaris*-laden submarine.

The surface launching fleet could also carry the *Polaris* IRBM, but *Minuteman* has an advantage in greater range.

Though many engineering details would have to be solved before the cargo-ship missile launcher idea becomes a reality, AMF engineers believe that none would be insurmountable.

Some of these problems, and their possible solutions, are:

–Cooling: The average cargo ship has five holds, each of approximately 300,000 cubic ft. storage. All are equipped with double bottoms, which are presently used for fuel storage.

If these bottoms were sealed air tight, they would serve as excellent insulation barriers against heat generated during launch.

Another possibility would be to flood the cargo holds with sea water, using compressed air as is now used in certain launching techniques.

A combination of shielding materials and sea water cooling could also be used to dissipate the heat before it could cause any damage to adjoining steel structures.

–Sonar Detection: Submarine Warfare—During WWII, cargo vessels were considered clay pigeons by the German U-boats. It could be argued that now, with the even more advanced undersea craft of the Russian Navy, the cargo ships would be even more vunerable.

This argument would be valid if only ten missile ships were put to sea for Russian USW to follow and track individually. But if 400 floating *Minuteman* launchers were commissioned, the Russians could not follow them all, nor could they track them all.

It is further argued by AMF engineers that these low speed (12 to 16 knots), unarmed and otherwise unprotected would make ideal retaliatory weapons because they would be constantly moving, and any one vessel in a period of two hours would be outside the destruction periphery of the highest megaton warheads that might be thrown at them.

• **Surface ships as tactical weapons** —The *Minuteman* launching ship would be free to sail at will the Atlantic, Pacific, Indian, and Arctic Oceans, and could even enter the Mediterranean Sea.

This mobility would allow the surface-ship missile launching fleet to lob their 5000 mile ICBMs at any potential target in the world.

Guidance, according to AMF engineers, offers no particular problem, since there are commercial loran available, and a two-dimensional doppler systems is easily adaptable.

The system recently perfected in the *Polaris* launchings could easily be adapted for launching missiles from surface ships.

• **Cost**—At present the U.S. Maritime Administration is turning WWII cargo ships over to private company operators in first class operating condition for approximately $250,000.

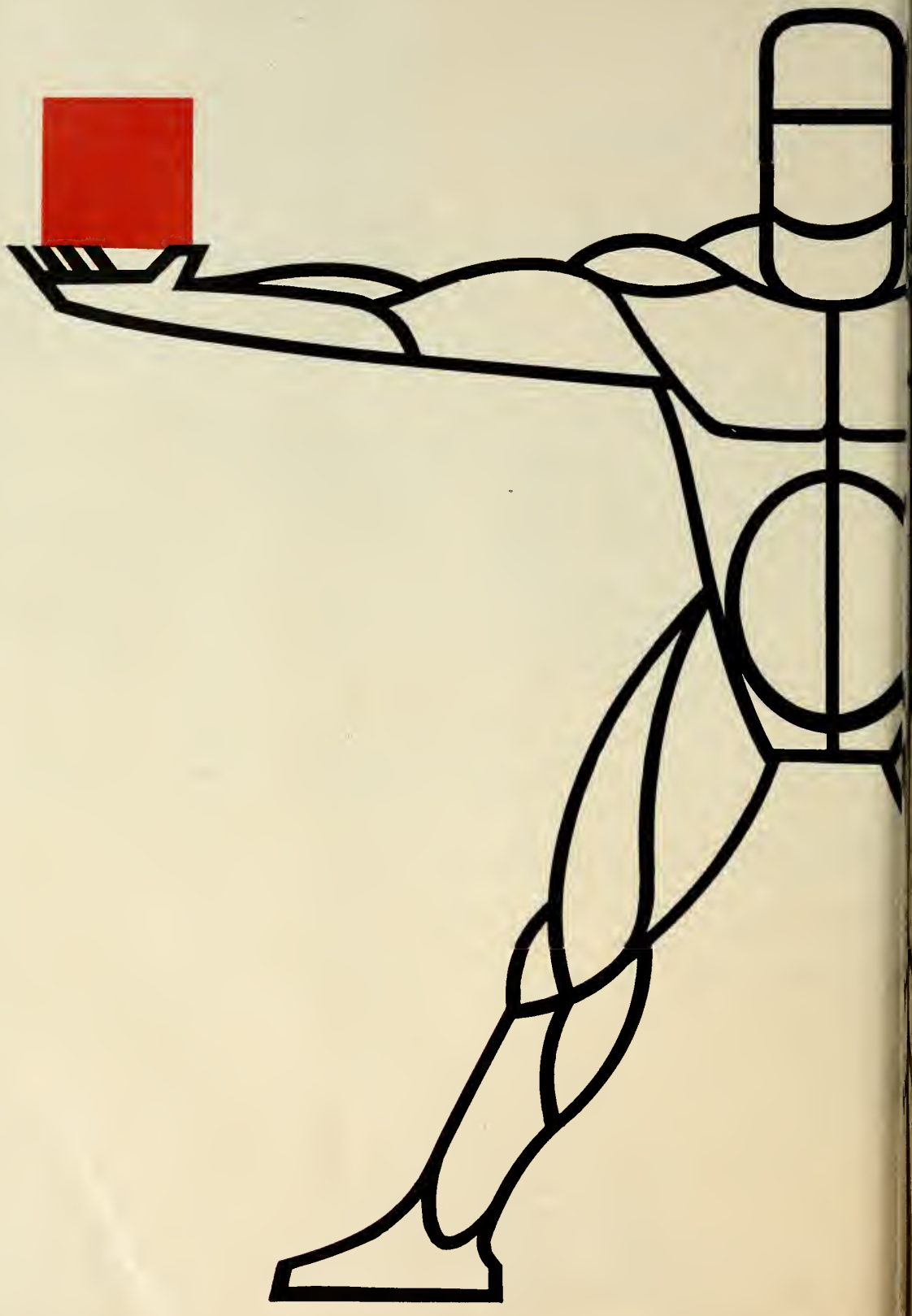
AMF engineers believe the cost of modifying these ships into launching platforms would be comparable to other forms of deployment.

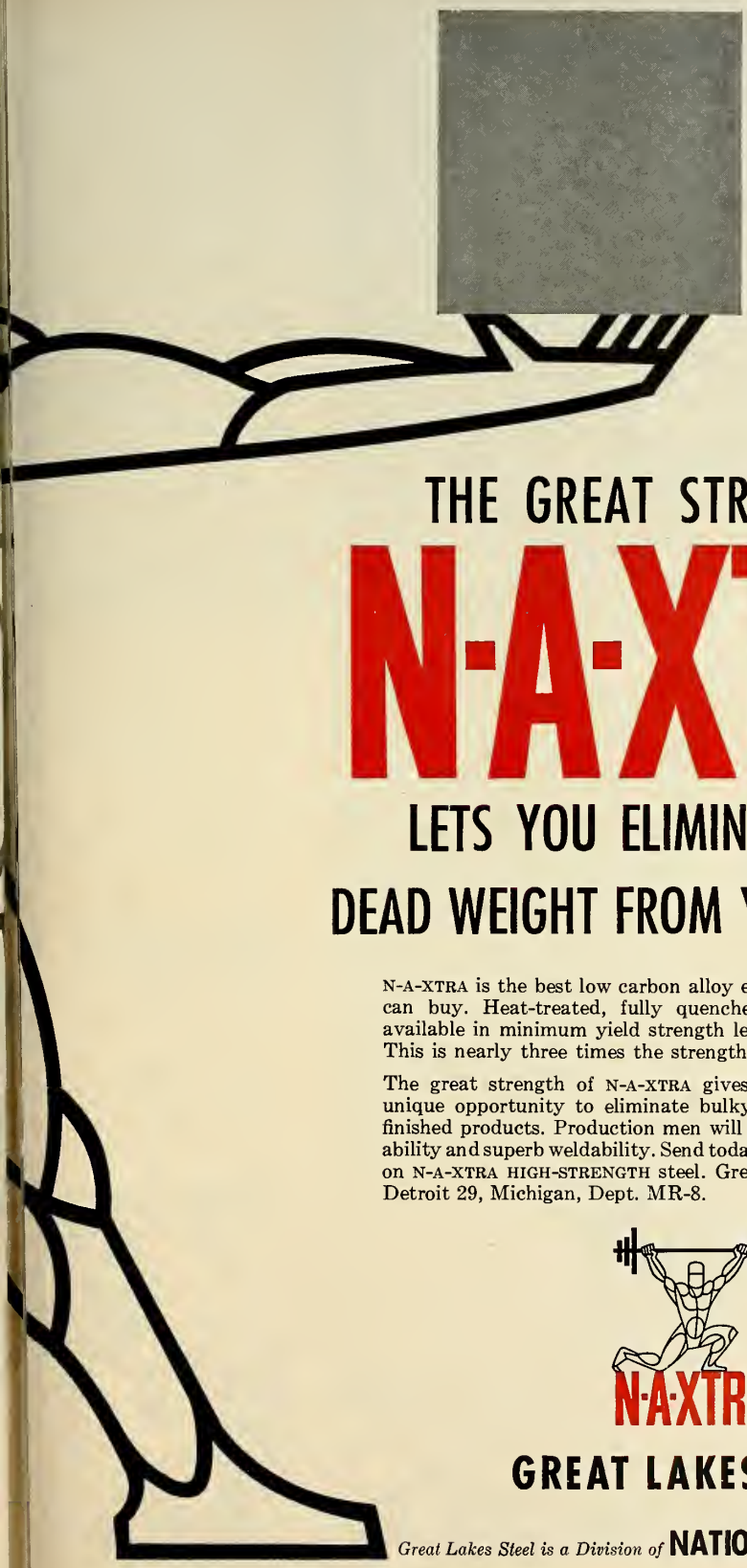
Current estimates of *Minuteman's* cost ranges from $2.4 for a hardened base bird to $4.8 million for each *Minuteman* on a train.

It is conceivable, therefore, that a surface launching ship could be put to sea with nine *Minutemen* for as little as $20 million or as much as $40 million—with most of the money spent for the missiles.

• **Psychological advantages**—Besides the tactical capabilities of the surface-ship missile launchers as part of the U.S. deterrent force, it is suggested that their presence on the open seas and in foreign ports would have tremendous psychological impact.

These vessels, along with the *Polaris* submarines, would give visual evidence of the retaliatory capability of the U.S. armed forces. ⁂





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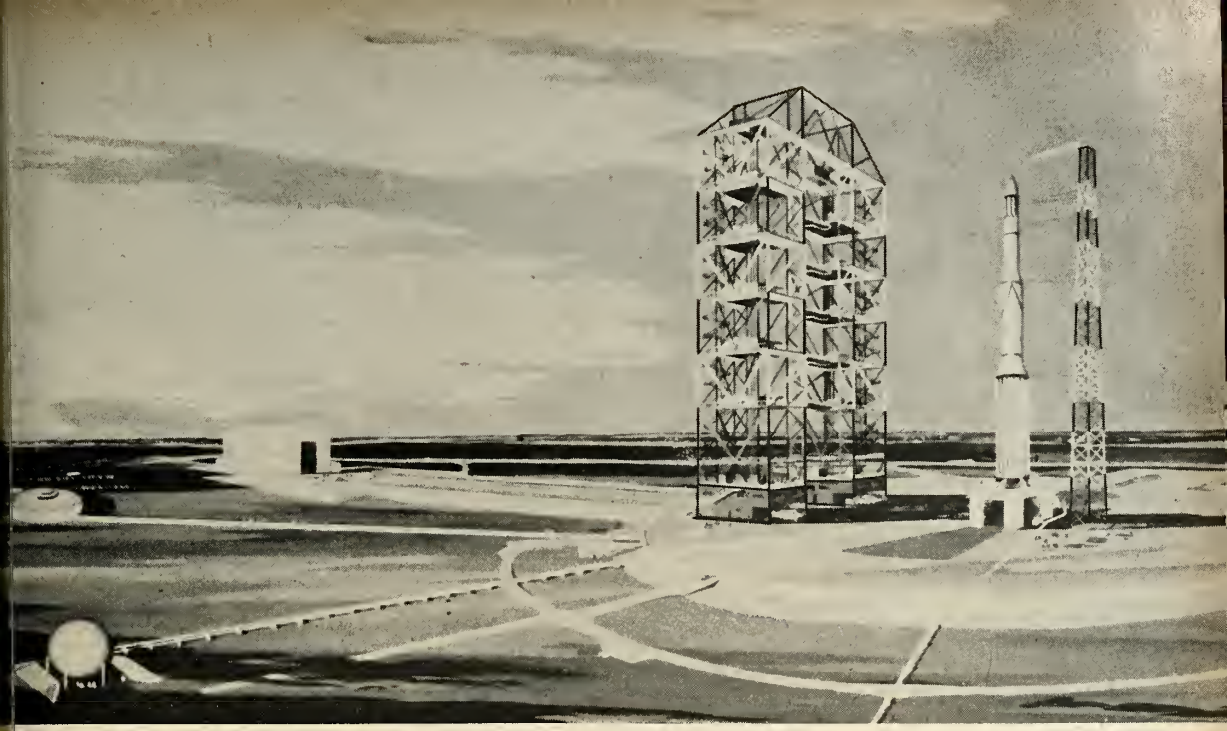


ARTIST'S CONCEPTION of Army Engineers' Saturn service tower, being built for the Cape, which will be 310 ft. tall.

GSE
SPECIAL ISSUE

How Huge Saturn Tower Was Designed

Unprecedented problems were overcome by Kaiser engineers in creating 2800-ton gantry; first step was to divorce major loads

by N. M. Schroeder
Kaiser Steel Corp.
Montebello, Calif.

DESIGN OF THE *Saturn* service structure—310 feet high and weighing 5,600,000 pounds—involved many problems never encountered before in missile gantry construction.

The most critical of these problems centered around putting the gigantic structure on wheels so it could be moved between the launch pad and the safety area. That these puzzles have been solved and construction actually started is a tribute to American engineering ingenuity.

Construction—under a design-build contract with Kaiser Steel Corp.—began last month. Completion is scheduled for early spring, 1961.

Basic performance requirements imposed on the service gantry undercarriage became quite restrictive when the structure's height, its 2800-ton weight, and the elements prevailing at the site were taken into joint consideration. First, it was decided that the structure must withstand winds up to 120 mph while stationary and unguyed. Second, for overall system compatibility, it was necessary that the tower be capable of self-propelled movement at speeds up to 40 fpm against 46-mph winds, with carefully controlled rates of acceleration and deceleration.

• **Divorcing loads**—Investigation of the first basic requirement—that of the stationary tower—revealed that the combined structural dead load and compressive component of the 120-mph wind overturning moment resulted in such a downward force on the leeward columns as to immediately rule out a conventional wheeled undercarriage and support system.

Even had it been feasible from space considerations to concentrate enough rail wheels to support these loads, selection of bearings and other mechanical components with the necessary static capacity and fatigue life was out of the question from an economic point of view.

And it was not practical to design a tie-down system capable of withstanding the enormous uplift forces on the windward columns of the stationary tower and have its points of reaction to the structure coincident with those of the carriages. Under hurricane wind conditions, any great divergence of reaction points for opposing vertical forces on common tower elements would mean severe stress reversals in the base structure of the tower.

Therefore, the first decision was to completely divorce loads inherent to the stationary, or anchored, structure from those of the mobile gantry. This was done by designing into the base of the structure two separate support sys-

tems. One system had to be capable of transmitting the high-magnitude compression and tension forces resulting from hurricane wind conditions; the second system would transmit only those compression loads prevailing under the mobile condition.

This second support system then evolved itself through the design phase of the *Saturn* service structure into four 12-wheel carriages.

It was decided that each of these carriages should consist of three rigid 4-wheel truck assemblies. The 36-in. tread diameter wheels would be mounted on standard railroad gauge and roll on parallel track systems 90 feet apart. Distance between carriage centers in the direction of travel was set at 70 feet.

Since the anticipated load on a single 12-wheel carriage under the previously stated criteria for mobility approaches two million pounds, it was essential that this load be absolutely equalized between the three 4-wheel truck assemblies. If equalization were not positive, an overload on some wheels would occur and most assuredly result in component failures.

In addition to maintaining load equalization among the individual trucks of a carriage, it was further necessary to provide for the extreme differential in carriage loadings resulting from wind forces. Under a 46-mph wind diagonal to the direction of tower travel, it was estimated that the windward carriage would be required to support only one-half that of the leeward carriage.

• **Cylinders picked**—To maintain a level-and-plumb attitude of the structure under such severe loading conditions, it was decided that hydraulic cylinders would be much better than a conventional load equalizing system of multiple pivots.

It was this consideration—plus the realization that these same cylinders could also be used as rams in transferring vertical loads from one support system to the other (from tiedown anchors to carriages and back again)—that finalized the basic design and geometry of the hydraulically equalized carriage and traction assemblies.

An equalizer beam will be fixed to the base structure of the tower at each of the four support points and rigidly held in a horizontal attitude. This beam will contain three 15-in.-dia. hydraulic cylinders mounted on 90-in. centers. A socket is machined into the rod end of each cylinder. When extended downward beneath the equalizer beam, the socket mates with the male half of a ball-joint mounted at the center of each 4-wheel truck.

This arrangement permits removal of individual trucks for inspection, maintenance, etc., by simply retracting the pistons into the equalizer beam. The trucks may then be rolled out and replaced with ease.

The three cylinders of one carriage assembly are hydraulically linked together with a 1½-in.-dia. manifold. This ensures equal pressure to each of the cylinders, providing perfect load equalization between the mating three truck assemblies.

• **Jacking up tower**—To transfer the tower load from anchors to carriages, the structure is literally jacked up by using these same equalizing cylinders as rams. Hydraulic fluid is simultaneously metered to all four carriage manifolds at a pre-determined rate and irrespective of pressure.

This is accomplished through the action of servo valves located one on each center truck assembly. The valves are actuated by small synchronous-motor driven cams which, in effect, reference the elevation of the equalizer beams to that of the traction rails. As soon as all anchorage tiedowns are clear—each carriage support point having been raised precisely the same distance at precisely the same rate—the tower is ready to move.

Traction power for the tower is provided by four 100-horsepower motors Automatic controls are contained within the tower to accurately control speeds, and compensate for various wind speeds or direction. Speed setting range is variable from 1½ feet to 40 feet per minute.

With the *Saturn* service structure now in its erection phase, it is the opinion of many (including the author) who have followed this tower through from concept to reality, that we are rapidly approaching a size limit for the missile erector-service gantry as it is known today.

Soon it will become necessary to sacrifice many of the present-day service tower conveniences to keep overall weight down and permit mobility. It may become necessary with larger space systems of the future to divorce from one another the many functions of today's service gantry, and provide for separate structures: one to erect the missile, another to facilitate service and checkout, another to support the propellant loading systems.

One thing remains certain. Whatever schemes are arrived at and designed into the missile ground support systems of the future, the *Saturn* skyscraper-on-wheels, an engineering feat by today's standards, will be eclipsed again and again.

NASA Building at Cape

About $30 million worth of construction for the National Aeronautics and Space Administration at Cape Canaveral has been funded this year.

To complete the first *Saturn* launch facility by next year, $2.25 million was appropriated for equipment for the staging building, completion of instrumentation sites, pad and blockhouse communication and electrical equipment, measuring and tracking equipment and design and engineering.

Congress also appropriated $21 million to begin work on an entirely new *Saturn* launch complex, to handle the larger four and five-stage *Saturn* vehicles and enable doubling of the launching rate.

The total cost of the second *Saturn* launch complex is to be about $29 million. The remaining funds will be requested in the F.Y. 1962 budget.

The current funds include $1.675 million for blockhouse construction, $8.15 million for the service structure, about as tall as a 30-story building, $7.675 million for pad and area development, $850,000 for the umbilical tower, $900,000 for fuel and oxygen storage facilities, $250,000 for liquid hydrogen facility design and $1.5 million for ground support equipment.

Other construction includes: modification of an existing stand for *Agena-B*, $4 million; liquid hydrogen system for the first *Saturn* complex, $2.5 million; *Saturn* staging building, $1.25 million; and addition to engineering and laboratory building, $300,000. ⌗

U.S. Missile Bases

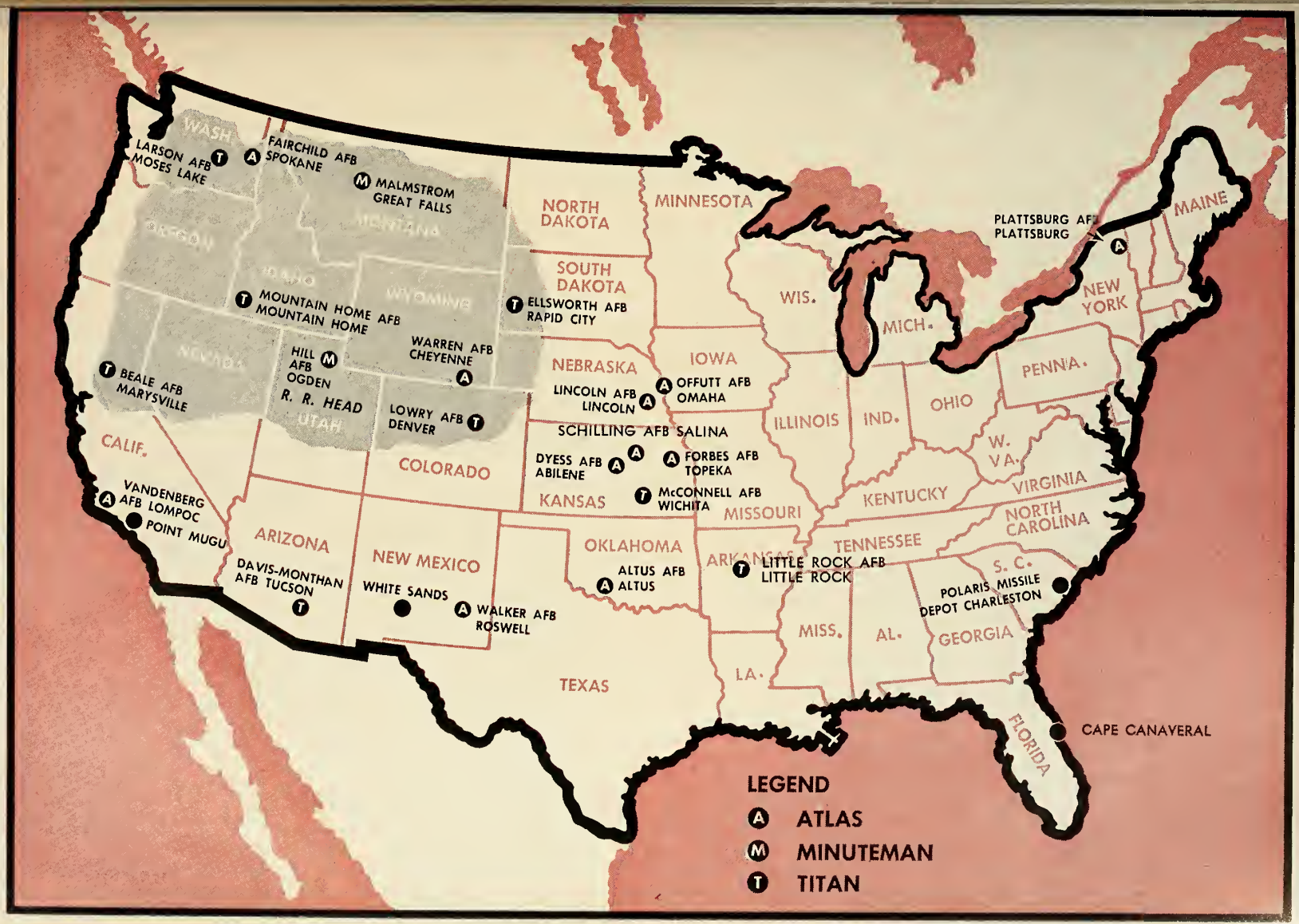
Twenty ICBM bases in the United States have been named to date for a total of 28 squadrons of SAC Atlases, Titans *and* Minutemen. *Charleston, S.C., is the loading depot for the* Polaris *fleet.*

One 2-squadron Titan *base is yet to be named, plus bases for at least five more 50-missile* Minuteman *squadrons. A Pacific Coast* Polaris *depot also may be selected in a year or so.*

Ten of the 11 Atlas *bases shown on the map have one squadron. Warren AFB has three. Six of the* Atlas *squadrons will have 12 launchers dispersed in hard silos. Two squadrons have six missiles in soft pads. The remaining squadrons each have nine missiles, some of them in semi-hard pads.*

Titan *bases at Ellsworth, Mountain Home, Larson and Beale each have one 9-missile squadron in hard pads. The others have two. Three 50-*Minuteman *squadrons are at Malmstrom.*

Shaded area in Northwest is where the first Minuteman *train deployments are to be made, starting in early 1963.*


WASH.
LARSON AFB MOSES LAKE
FAIRCHILD AFB SPOKANE
MALMSTROM GREAT FALLS
OREGON
MONTANA
IDAHO
WYOMING
MOUNTAIN HOME AFB MOUNTAIN HOME
ELLSWORTH AFB RAPID CITY
NEVADA
HILL AFB OGDEN
R. R. HEAD
UTAH
WARREN AFB CHEYENNE
BEALE AFB MARYSVILLE
LOWRY AFB DENVER
CALIF.
COLORADO
NORTH DAKOTA
MINNESOTA
SOUTH DAKOTA
NEBRASKA
IOWA
LINCOLN AFB LINCOLN
OFFUTT AFB OMAHA
SCHILLING AFB SALINA
DYESS AFB ABILENE
FORBES AFB TOPEKA
McCONNELL AFB WICHITA
KANSAS
VANDENBERG AFB LOMPOC
POINT MUGU
ARIZONA
DAVIS-MONTHAN AFB TUCSON
NEW MEXICO
WHITE SANDS
WALKER AFB ROSWELL
OKLAHOMA
ALTUS AFB ALTUS
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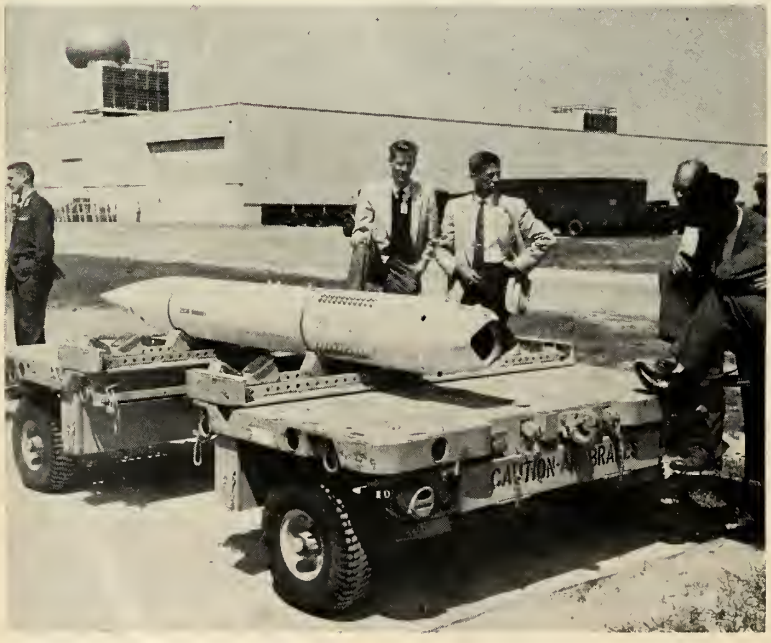
POLARIS MISSILE DEPOT CHARLESTON
CAPE CANAVERAL
W. VA.
VIRGINIA
NORTH CAROLINA
PENNA.
NEW YORK
PLATTSBURG AFB PLATTSBURG
MAINE
LEGEND
ATLAS
MINUTEMAN
TITAN

Standardization Cuts Cost of Bullpup Support

Stress on use of existing GSE will make Air Force version of GAM bird relatively inexpensive and provide easy handling

by Joseph P. Smith, Jr.
Wells Industries Corp.
Washington, D.C.



MHU-12 TRANSPORT TRAILER carries four Bullpups at speeds up to 20 mph. Adjustable chocks and available sideboards make the unit a multipurpose vehicle.

COSTS OF SUPPORT equipment for the Air Force version of the Martin *Bullpup* air-to-surface missile (GAM-63) will run far below the average of other AF missile programs.

The savings are due partly to the simplicity and reliability of the system, but primarily to an intensive effort toward maximum utilization of existing GSE and a minimum of new development.

The need for standardization was the first consideration of Martin engineers when they went to work on design of GSE for the AF *Bullpup*. A study of equipment used by the Navy for the original version of the missile showed that it was unsuitable for the new application. According to a Martin report, AF handling requirements posed entirely different problems.

The primary difference in the logistics problem was due to the handling situation aboard ship. Here, all elements are together in one compact installation. Assembly and maintenance areas with fixed equipment, overhead cranes, and elevators are near the flight deck where the missiles are loaded aboard their aircraft. Transportation is a small problem and low-speed skid dollies are sufficient for the short distances involved.

At Air Force installations, storage, assembly, loading, and maintenance facilities may be widely separated. Mobile hoists are necessary. Transport trailers are required that can handle at least four missiles and can be towed at least 20 miles per hour. Equipment maintenance tools have to be moved about to different areas.

Another major item of consideration was that support equipment be air-transportable and interchangeable with and capable of handling conventional as well as special weapons. In additions, the equipment had to be sufficiently flexible to handle the original *Bullpup* as well as the slightly larger AF version to be supplied later in the program.

The first study by Martin produced a tentative list of equipment to meet the requirements. This list was discussed with the Weapons System Project Officer and specialist personnel of the various laboratories involved at Wright-Patterson AFB, and compared against available equipment.

The survey team then carried the logistic plan and equipment list to AF

depots, the Eglin Air Test Center, Albuquerque Special Weapons Center, and TAC headquarters at Langley Field.

Out of this came recommendations for use of certain existing units and two items under development. The resulting list contained four pieces of government-furnished equipment (GFE) and four to be furnished by Martin.

All items of support equipment were brought together in a duplicate TAC maintenance and assembly building at Martin-Orlando. Here missiles were assembled, transported, and loaded in simulation of actual operating conditions. Equipment performed to expectation and later was accepted by the Air Force.

The final approved list of equipment:

Assembly area

H-90 Tripod Stand (GFE) or Airframe (GFE)

MHU-12/E Munitions Handling Trailer or MK-5 Bomb Trailer

MHU-30/E Guided Missile Maintenance Cradle

HLU-40/E Guided Missile Maintenance Sling

MHU-32/E Guided Missile Maintenance Stand

Storage area

MJ-1 Aerial Store Lift Truck

MHU-30/E Guided Missile Maintenance Stand

ADU-60/E Lift Truck to Missile Adapter (MJ-1 or MHU-31/E Missile Handling Cradle (forklift)

Flight-line area

MJ-1 Aerial Store Lift Truck

ADU-60/E Lift Truck to Missile Adapter (MJ-1 or MHU-31/E Missile Handling Cradle (forklift)

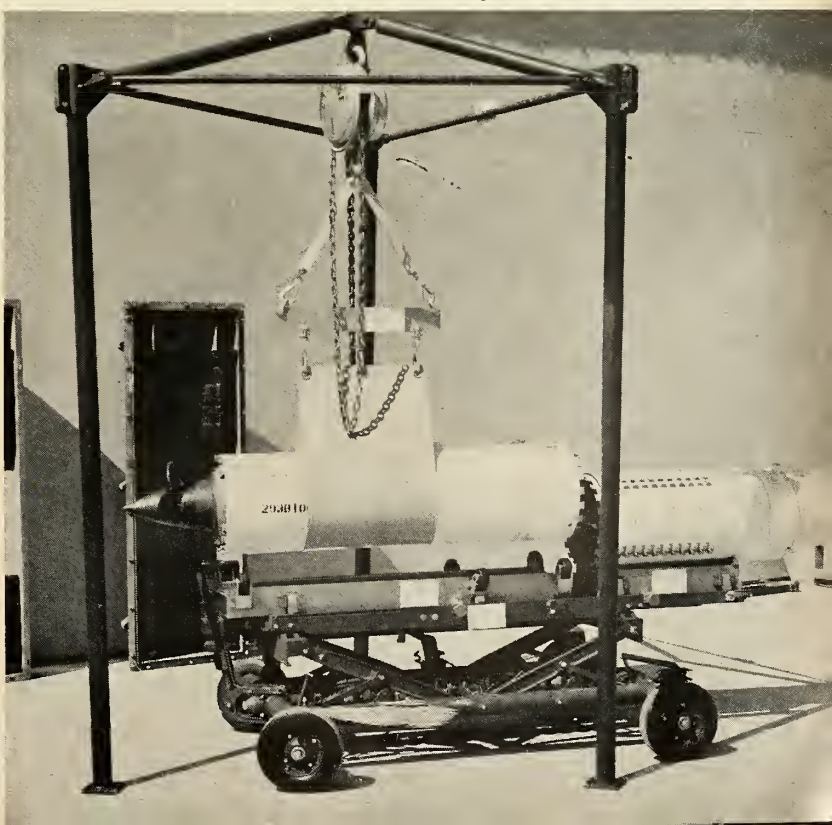
MHU-12/E Munitions Handling Trailer or MK-5 Bomb Trailer

The *Bullpup* missile represents a growing and desirable trend in tactical missile development. It is used by two services with little modification. Its engine is a prepackaged liquid and the assembled unit can be handled like a round of ammunition. The simplicity and low cost of support equpiment fit in well with the overall concept of the missile system.

The *Bullpup* is expected to go into the Air Force missile inventory next year. Only last week, the AF began its flight-testing of two versions of the *Bullpup* at Eglin AFB, Fla. ⁂

HOISTING SLING used with portable A-frame and adjustable missile storage stand provides flexible, mobile handling gear for storage, assembly, maintenance.

BULLPUPS ARE ASSEMBLED on H-12 trailer with aid of tripod stand and hoisting sling. Aft- and center-section cradle adapters provide proper mating alignment.

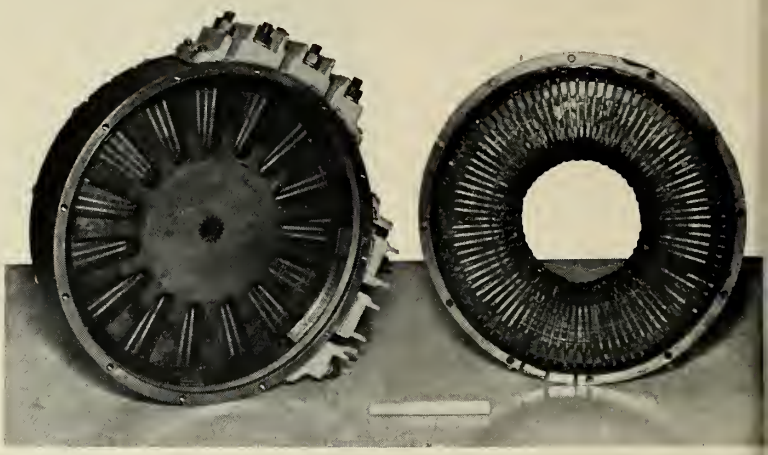


Versatile Gas Turbines: Lightweight Power

Major breakthroughs seen as device makes a bid to become prime mover in Missile/Space GSE Market

W. W. West and C. R. Phaneuf

Both authors are members of the application engineering staff of General Electric Co. at Waynesboro, Va. West is with the Specialty Control Department, Phaneuf with Aviation Electrical Systems Engineering.



SPLIT-STATOR HOMOPOLAR INDUCTOR generator used in VSCF development design has 20 kva output. Stator (at right) is folded around rotor, forming pancake.

THE GAS TURBINE can be expected soon to become an important factor in the ground power market. According to manufacturers' reports, major breakthroughs now imminent will better fit the turbine for many more applications in the missile/space support field.

These improvements, coupled with the new concept of variable-speed constant-frequency (VSCF) electrical power generation, make the prospect attractive for many reasons.

The idea of gas turbines as a prime mover in missile/space ground support systems is not new. They have already been used in a limited number of applications where size, weight, and reliability are of prime importance. But general application of gas turbines for supplying electrical power—although talked about—has yet to become a reality.

The reason behind this is that there are certain inherent problems in the turbines themselves: high-speed operation, specific rate of fuel consumption, etc. However, gas turbine manufacturers have made rapid advances to overcome these apparent drawbacks.

• **Small, light, simple**—One of the basic reasons for considering gas turbines is a matter of logistics. Turbines deliver a lot of horsepower from a small package. In hardened applications, manufacturers report that turbines would require 1/10 the floor area and 1/30 the volume of most of the present prime movers of comparable power. In portable applications, they are almost without peer, since they require less space, and fewer personnel, and can be air-dropped. The gas turbine is 1/10 the weight of most other high-speed prime movers and 1/20 that of low-speed.

But size and weight are just part of the story. Ease of maintenance is another. With a minimum of moving parts—mainly, a rotor—turbines offer a drastic reduction in maintenance costs. One manufacturer points out that conventional systems require a down time of 12 hours per month, plus the overhead of attendant personnel. Turbines are offered with a monthly down time of one hour and are extremely practical for unattended operations.

Turbines offer many other features of interest to support power applications. They use many different fuels efficiently. They are air-cooled and cold-starting; they can run continuously at rated output, and run at low-load with no deterioration. They are less affected by environment and highly shock-resistant to air drop or near-miss (one manufacturer will offer a 25-g rating).

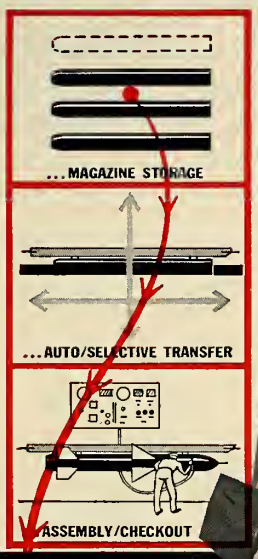
For hardened sites, the turbine requires a minimum of foundation, needs no isolation for vibration, and at the same time offers improved overall thermal efficiency when exhaust heat is utilized for auxiliary services.

As gas turbines near the moment when more general application will no longer be a question but a point in fact, the final step needed to bridge the gap emerges in the form of VSCF.

• **Speed solution**—One of the main limiting characteristics for electrical power generation of the gas turbine is its extremely high speed. A gear box is required to reduce the generator speed. Moreover, the generator size is quite large and heavy.

Not only does VSCF relieve these factors, it achieves such a high degree of versatility that the gas turbine can now become superior in areas never

It has been proven that VICKERS® hydraulics can move missiles from storage to launch . . . faster, smoother, with more precise control . . .



OFFICIAL U.S. NAVY PHOTOGRAPH

Vickers has designed and built over 100,000 hydraulic servo systems for the direction and guidance of ordnance. Applications range from radar controlled anti-aircraft guns to completely automatic missile handling systems.

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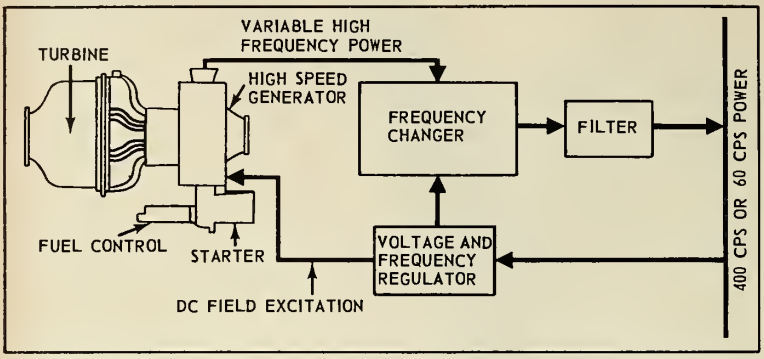
VSCF bridges the gap . . .



BLOCK DIAGRAM of variable-speed constant-frequency electrical power generator.

thought possible. It is at this point that the tremendous potential of the gas turbine in certain ground power applications becomes apparent.

VSCF is an electric generating system which comprises a high-speed, high-frequency generator and a static frequency changer. The generator is integrated with the turbine and supplies variable high-frequency power to a static frequency changer. The output is fed to the constant-frequency bus through a filter. A static regulator maintains voltage and frequency within a wide range of desired limits.

The a-c generator is an advanced design which offers many advantages over conventional machines. To take full advantage of the high-speed turbine operation, a generator capable of being directly connected to the turbine shaft, and operated at high turbine speeds, is required. The inductor type generator provides this capability. Its solid-rotor configuration is simple and reliable. There are no rotating windings to cause unbalance or maintenance problems. The machine contains no other rotating components, such as rectifiers or commutators. It has no brushes or sliding contacts.

The output of the variable-frequency generator is fed into the static frequency changer, composed basically of a power-conversion section and a modulator. The power-conversion elements are silicon-controlled rectifiers, solid-state equivalents of the Thyratron tube. By properly programing the firing of these semiconductors by the modulator, the lower, constant output frequency can be fabricated from the high-frequency input waves.

Output frequency is maintained by the regulator to very precise limits. Accuracies up to 0.001% are obtainable.

Since the system is unaffected by large changes in speed (up to 2:1). transient frequency response approaches steady-state conditions. Individual phase voltage regulation can provide close regulation even under conditions of extreme unbalanced loadings. Provisions for real and reactive load division may be included for parallel operation of several turbine sets.

• **Advantages**—In summary, the improvements for gas turbine operation offered by VSCF are these:

–A small, lightweight generator for direct connection to the turbine shaft. Conventional 60 cps generators at 1200 rpm weigh 10-20 lbs. per kva. Depending on specific application requirements, the overall system can be expected to weigh as little as one-fifth that of other types of ground power, or even less.

–Simpler speed controls are required. In addition, no speed-reducing gear box is needed.

–Improved electrical performance is available from a VSCF-equipped turbine. Frequency transients under load changes do not exist. Close voltage regulation can be provided even under large loading unbalance; damaging output voltage transients are virtually eliminated. With a small (5-15%) increase in system weight, voltage transients for normal load changes can also be a thing of the past.

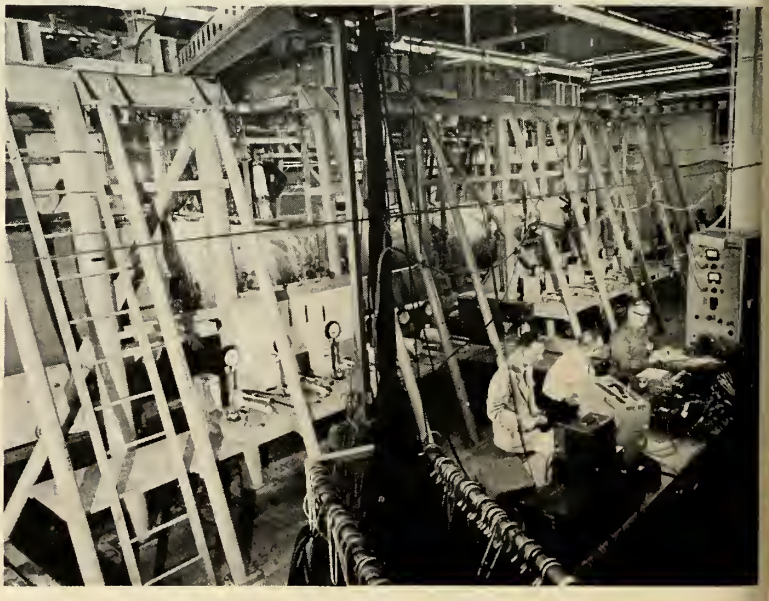
–Versatility of operation is achieved by providing multiple frequency outputs from the same equipment. Either 400 cps, 60 cps, or direct current may be obtained.

–Use of the VSCF system as the turbine starter may eliminate the necessity for auxiliary starting equipment.

–When necessary, the static control equipment can be remotely located from the turbine generator.

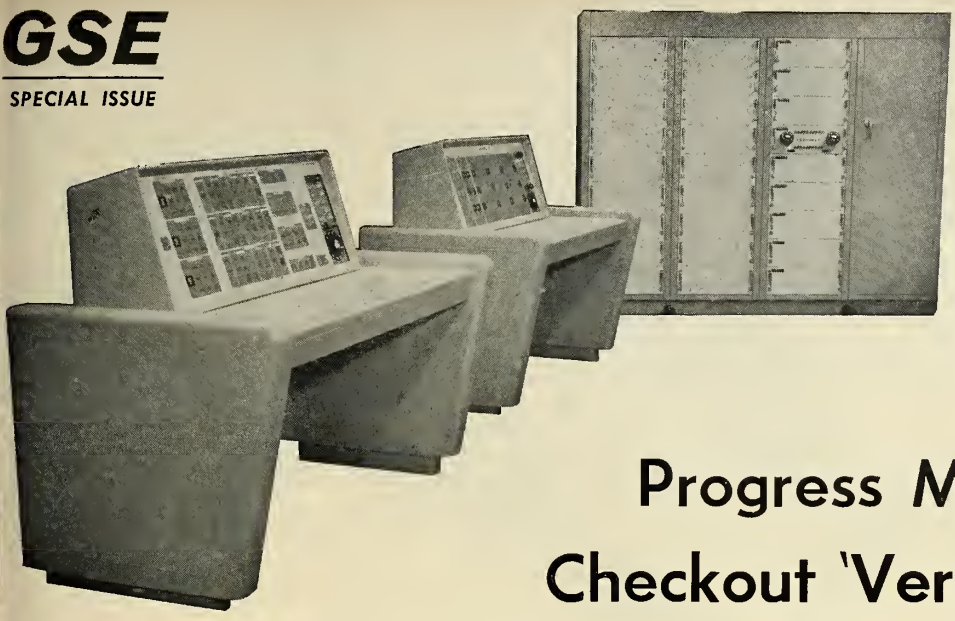
The industry goal of lightweight, compact, portable ground power units is rapidly being achieved. This new concept of static frequency power conversion, with its added features of high performance and extreme reliability is an important step towards this goal.

At present, turbine manufacturers are working to extend the application of such turbine-generator combinations to areas of ground power not formerly feasible. With VSCF, the ground power market will see an ever increasing influx of gas turbines as a prime mover for support electrical systems. ❖



Simulated Flight Test of Minuteman

MINUTEMAN ICBM undergoes dynamic testing at Boeing's Aero-Space Div., Seattle. Tests simulate seven different flight conditions. Program, nearly complete, will determine adequacy of structural design and aid development of flight controls.



TITAN launch, test and checkout equipment is latest approach to short reaction time requirement.

Progress Made In Checkout 'Versatility'

by W. O. Campbell
Martin-Baltimore

WITH SO CLOSE a tie between today's missiles and checkout equipment requirements, a strong tendency has developed—and is steadily growing for checkout and countdown equipment to become increasingly specialized and complex.

The specialization has resulted in equipment which is not too useful for follow-on programs. Warehouses are full of such equipment; surplus sales abound with it.

The complexity has resulted in increasingly high costs; today one finds that as much as 75% of missile program dollars are spent for ground support equipment.

The specialization and complexity tendencies have interacted to produce equipment which usually is neither available on schedule nor reliable after it is available.

These are the prices now being paid. These problems are so severe that it is imperative that solutions be found. The effort to find answers has already caused certain developments.

First, the military has underwritten programs for the sole purpose of developing checkout equipment which meets some of the more common requirements of most missiles, yet is somewhat independent of any particular set of missile requirements, thus being "universal"—or, as the more conservative elements says, "versatile."

This has occurred during the last three years.

At the same time, industry has also produced versatile equipment, so that today there are several such sets now available in varying degrees of versatility.

• **Confusing terms**—Claims as to the true versatility of these sets vary. Some figures run as high as 75 to 90%; others are stated to be 25%. The picture is somewhat beclouded by the fact that there are as many definitions of the term "versatility" as there are GSE engineers, and that no formal evaluation of these sets against the same group of weapon system requirements has ever been made. Further contributing to the problem is the tendency to use the two concepts "versatility" and "follow-on utility" interchangeably.

There is a distinct difference. Versatility refers to the capability in a given set of checkout equipment for easily accommodating the changes that occur in the test requirements for the airborne article. Follow-on-utility refers to the number of racks that can be used without modification on succeeding programs. The more conservative groups usually quote 25% versatility—meaning follow-on utility—a very practical figure such as a weapon system prime contractor might employ.

Certainly this whole development is a step in the right direction, much better than no development at all. The inherent versatility—be it 25% or 75%—allows a continuous program of development, use, redevelopment, use, improvement, use, until gradually the versatility will be adequate, the cost low, and the reliability high. Such a concept of continual improvement of a basic idea is identical to the techniques used by industry to obtain acceptable reliability, cost, and versatility in almost any commercial product one cares to name.

• **Other progress**—Another development is Project SETE at New York University, authorized by DOD some four years ago to collect and disseminate information concerning support equipment of all kinds from the three services. The yearly symposia hosted through this group are well known to all support equipment designers.

A third is MIL Handbook 300 (USAF), a compilation of support equipment in catalog form. First issued in 1959, this Handbook bids fair to become the Sears Roebuck catalog of GSE. It tells many people what is available, thus serving to minimize duplication.

It is interesting to note that some weapon systems contractors, including Martin, have already taken steps to produce a similar Handbook purely for company internal use, to handle the large volume of support equipment information and designs available within the company.

A fourth development is the appearance within the last two years of many support equipment articles in magazines and at conventions. While the subject content of "message" varies, most of them touch sooner or later on the natural causes which have led to this development—namely cost, reliability and versatility.

All of these developments are essentially particular solutions to the general problems previously discussed.

• **How it works with Titan**—A good example of the new look in missile support equipment is in the *Titan* program

THOR
MACE
TITAN
HAWK
ATLAS
SNARK
NIKE B
BOMARC
NIKE ZEUS
SPARROW I
SPARROW II
SPARROW III
NIKE HERCULES
SIDEWINDER
REGULUS II
VANGUARD
REDSTONE
JUPITER C
PERSHING
BULL PUP
MERCURY
TERRIER
POLARIS
TARTAR
CORVUS
FALCON

Designs Assembly Savings Into Critical Miniature/Instrument Ball Bearings!

Helping customers *simplify* instrument assembly is o specialty of the N/D engineering group. Haw? Thraugh *creative* Miniature/Instrument ball bearing opplication ond design. Often, a new ball bearing design will produce assembly sovings in excess of its additianal casts. Integral ball bearings, taa, very aften cut dawn difficult and costly hand assembly of shaft and parts.

A timely example of N/D custamer assembly savings can be seen in Nike Ajax and Hercules missile graund suppart. Here, *special* N/D Instrument ball bearings are naw used in precisian patentiameters. New Departure engineers recommended eliminating two *single raw* instrument bearings, mounted in duplex ond requiring precision spacer and separate guide raller. They replaced this assembly with a *special* N/D *double row* high precision instrument ball bearing with integral outer race guide raller . . . and shaft maunted with a nut. This ane recammendation produced cost savings af over 400%! In turn, the customer was able to reduce the potentiometer selling price to the government. What's mare, the New Departure Instrument Ball Beorings improved patentiameter reliability!

You can laak to minimum assembly costs and unsurpassed *reliability*. Include an N/D Miniature/Instrument Bearing Speciolist in your early design level discussians. For immediate information or assistance, call or write Department L.S., New Departure Division, General Motors Corporation, Bristal, Cannecticut.

NEW DEPARTURE

MINIATURE & INSTRUMENT BALL BEARINGS

proved reliability you can build around

(M/R, September 5, 1960).

This missile is housed in a fixed hard-base installation. It must be capable of being reliably fired upon short notice. Accordingly, the checkout and countdown equipment is designed in a ruggedized rack and chassis manner suitable for permanent installation in the hard base. It is capable of withstanding severe shocks, as is the missile.

Because of the short reaction time requirement, the countdown sequence has been pared to those bare essentials usually referred to as "operations", with almost no testing, as such, in the countdown. The *Titan* requirement for verified reliability has been met by making program and technical provisions for a routine checkout on a scheduled basis, thus again dictating in large measure the test requirements of the checkout and countdown equipment.

This co-relationship between missile requirements and support equipment requirements is just as evident in the highly mobile missiles—*Lacrosse* and *Pershing*, for example. In these, the countdown equipment is transported either on the launcher or on vehicles just as mobile as the launcher, so that all parts of the weapon system are equally mobile. Again, with reaction time of both missiles being rather short, the number of operations in the countdown gear have been cut to the irreducible minimum, several magnitudes less than those encountered in a typical R&D situation.

The reliability of these weapons dictates that the performance reliability of the countdown equipments be very high. It is secured by utilizing certain checkout design criteria developed specifically to meet the performance reliability requirement.

• **Outlook**—Man, being the inquisitive creature that he is, has always enjoyed looking ahead to postulate what will happen in various areas. The test and checkout area is no exception. What will happen?

Certainly the present developments will continue for some years to come, because each of them supplies part of the answer to the total problem. Technical advances such as better comparators, analog-digital convertors, and timer-counters will increase at an accelerated pace, since more and more R&D money will be spent in support equipment developments.

The development of digital versatile checkout sets will continue, because versatility requirements will exist for a long time to come. A curious offshoot of this is that, in the future, certain weapon systems will have design criteria imposed on them to make them easier to test.

The digital computer will also see some use for test and checkout purposes. Mostly this use will center around the indigenous capability—a term meaning that if a digital computer is already on board for other reasons, some of the test and checkout job will be assigned to it.

Another task for large digital computers is the computation of quantities derived from go/no-go checkout results. These derived quantities include such things as statistical measure of weapon performance, flyability index, and weapon system degradation. The go/no-go data will be obtained in much the same manner as it is now, with the results fed over a data link to a digital computer miles away. The computer itself will be specially equipped to handle an equation involving up to 200 simultaneously varying parameters.

Electronic checkout equipment has changed a lot since the beginning of the Missile Age 15 years ago. The equipment in 1945 was a hastily-assembled collection of portable meters and scopes, regardless of the type of missile. Today's checkout and support equipment requirements are much more closely linked to those of the missile; if mobility, basing, reaction, reliability and other requirements of the missile are known, test requirements of checkout and countdown equipment can be readily inferred, if not deduced. ⌗

GSE

SPECIAL ISSUE

Universal Test Systems on the Way

Army Ordnance is reviewing equipment developed by RCA and Nortronics; studies show facilities are practical; first delivery will come 18-24 months after funding

A $6-7 MILLION study program under way since 1955 by Army Ordnance and industry has shown that a universal automatic test facility is both feasible and practical. Prototype hardware for the facility has been built and demonstrated; one equipment contract has been let and others are anticipated "sometime in the future."

The program started with a contract to RCA for research in the field of miniaturization and micro-modules and applicability to field maintenance equipment. Work was later expanded to include multipurpose test equipment. Here began the first look at the feasibility of universal—or, more properly, "multipurpose"—equipment.

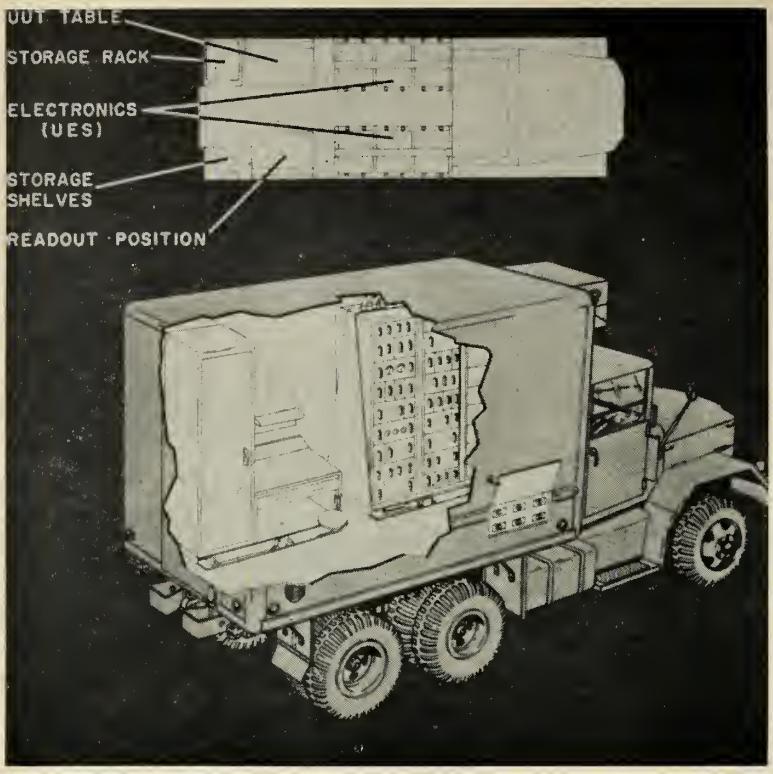
In 1958, Ordnance granted a contract to Nortronics for a feasibility study aimed at a multipurpose checkout system for depot maintenance of the *Nike*. Work was continued for development of a prototype system for evaluation. The Nortronics approach was to incorporate elements of its Datico and other commercial equipment in a system for the automatic checkout of six missile systems.

Concurrently, RCA was continuing work based on its earlier study aimed at developing a similar universal test equipment.

At present, both the RCA and Nortronics systems are being reviewed by Ordnance. Further R&D—scheduled but not entirely funded—will be aimed at producing mobile automatic equipment for field and depot (third-, fourth-, and fifth-echelon) maintenance. After the money becomes available, 18-24 months will be required for first delivery.

Signal Corps has awarded RCA a contract to build a similar system for electronic equipment maintenance for its Tobyhanna, Pa., depot.

• **Characteristics set**—After determining feasibility, the Army Rocket and Guided Missile Agency puts together a specification which sets forth the "military characteristics" of such a system. This MC spells out the necessary requirements, operational and special characteristics and a suggested approach



DIGITAL EVALUATION equipment (electronic unit of shop set) in 2½-ton truck. Complete universal field maintenance system would have 4 vans. (RCA photo)

to the program.

The need for automatic universal test equipment was predicated on several conclusions reached by ARGMA:

–Present concept of providing peculiar test equipment with each missile system is a financial, personnel and logistic burden.

–Over 85% of the basic functions of these peculiar test systems are duplicated in each case.

–Current field maintenance tools and test equipment are designed primarily for lab and production-line use and are not suitable for the field.

–Automatic operation is desirable not only for its speed but because it removes the inherent human factor errors.

The Army also concluded that a universal system could be applied even more efficiently to future missiles. These could be designed with common or assigned power, frequencies, etc., which would fit in with already established characteristics of the test equipment.

Officially termed "guided missile field maintenance shop set," the maintenance facility will consist of electronic, mechanical and emergency repair units. It will be self-sustaining and capable of test and isolation of malfunctions down, where practical, to individual piece parts. Repairs beyond the capability of the electronic and mechanical units would be accomplished by the supplementary emergency repair unit.

• **Operational characteristics**—Design of the shop set will incorporate accepted principles of human engineering for simple operation and minimization of human error. Test equipment will be capable of performing self-test and visually indicating the malfunction down to the smallest component practical. It will automatically provide typewritten information as to location and nature of malfunction and logistic data —nomenclature, part number, etc.—for replacement. It will be able to check out complete missiles, performing both plug-in go/no-go tests as well as component and circuit malfunction isolation.

Mobility requirements are a large factor in the shop set design. All tools and test equipment must be capable of being mounted in standard Ordnance 2½-ton trucks. Equipment must be sufficiently rugged to withstand transport over unimproved roads at 25 mph and over cross-country terrain at 10 mph. It shall be immediately operable after movement without calibration or extensive maintenance. Safeguards will be incorporated to prevent serious malfunctions due to improper hookups, switching arrangements, or power inputs.

Loaded shop set trucks will be transportable by air and have certain amphibious transport capability. Equipment will be air-conditioned to operate in −60 to +125°F ambient temperatures, and be capable of long-term storage with minimum preservation or special packaging.

First priority will be assigned to the development of electronic test equipment. Mechanical, hydraulic, and pneumatic test equipment will get second priority.

The first step in the Army approach to the program is to gather data relating to the maintenance allocation of each system and catalog units expected to need repair. Then technical characteristics of each unit to be tested—power, frequency, terminations, wave shapes, etc.—will be determined.

A further step will be to determine areas of similarity among components common to most missile systems. Applicable existing equipment will be selected and development scheduled for original equipment needed to complete the system.

Accomplishment of the plan requires only time and money. It is generally agreed that the multipurpose equipment would save a great deal of money and greatly ease the logistic burden imposed by present methods of field maintenance. R&D funds are extremely tight, however, and Ordnance is not too optimistic over chances of immediate development funding. ⁂

Mars Travelers Could Ride in Booster Fuel Tank

The first men to land on Mars may make the trip inside a fuel tank.

According to scientists at Lockheed Missile and Space Division, the entire payload, including the earth re-entry vehicle, would be carried within huge chemical booster tanks.

Two of the boosters would be fired into earth orbit, refueled and accelerated to Mars flight velocity—36,000 mph. Then the two rockets would be joined with a half-mile-long steel cable.

Rotation around a common center would provide the crew with essential artificial gravity. The cable would allow a long axis of rotation, sufficient to reduce the effects of coriolis force. If a short axis of rotation were used, the coriolis force would cause a human to reach to the side of an object rather then directly at it.

Lockheed's R. Gillespie says the "cocoon" approach is cheaper and simpler than other Mars flight proposals.

Long-Range Polaris Gets More Funds

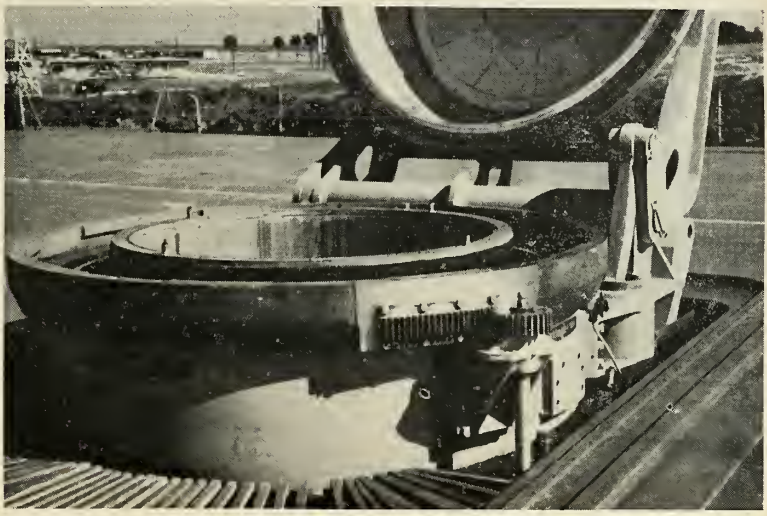
The need for ground support equipment in the *Polaris* R&D program is expected to continue through 1964 with development of the 2500-mile-range *Polaris*.

The Administration has announced that it will release an extra $70 million this year for the long-range program.

Both the 1500-mile and the 2500-mile *Polaris* will be several feet longer than the present 1200-mile version. Launching tubes will be lengthened to accommodate them.

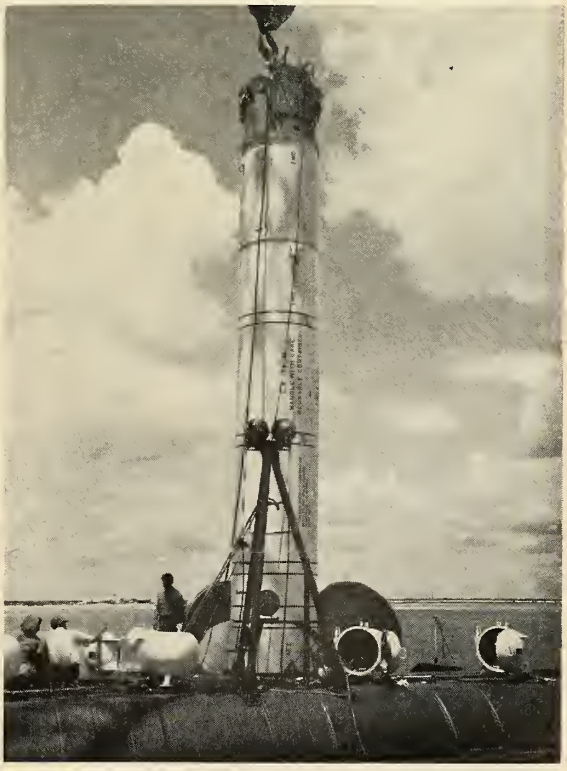
GSE to date has included a vast array of items, from underwater cameras and hydrophones to the very huge ship motion simulator at Cape Canaveral and the underwater launching complex off San Clemente Island, Calif.

Land-based GSE for the operational *Polaris* fleet is centered at the Charleston, S.C., Missile Depot. The Navy is expected to build a similar depot on the West Coast for *Polaris* subs operating with the Pacific Fleet.



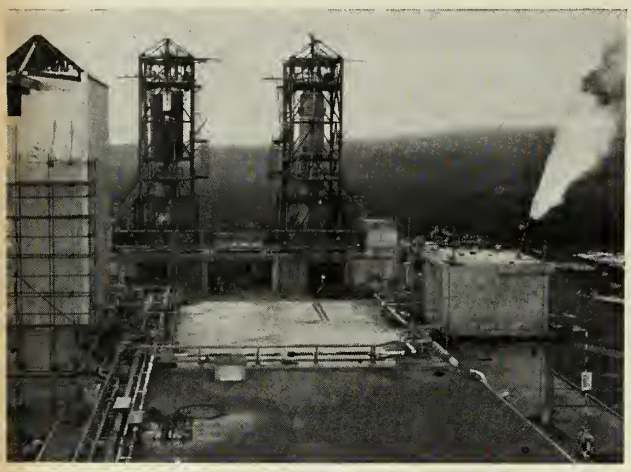
LAUNCHING TUBE for R&D Polaris missiles is one of two on the stern of the Test Ship Observation Island. This one can be tipped at a variety of angles.

RIGHT: *Loading a Polaris missile into the George Washington directly from a missile container. Underwater TV lights and cameras surround the mouth of the missile tube.*



ABOVE: *Visual observation of underwater launchings is further aided by additional lights and cameras rigged to stands on the submarine's deck at Port Canaveral for R&D Firings.*

Britain's Big Rocket Test Center



TEST AREA for engine components at Spadeadam includes two test stands and gas generator test cells.

ROCKET ENGINE Test Stands and Missile Tests Stand. Note the effluent lagoons in the foreground.

by G. V. E. Thompson

Four years of work, employment for 600 persons and at least $56 million will go down the drain unless Great Britain goes ahead with a space program and utilizes its Spadeadam Rocket Establishment.

Built for the assembly, development and test of the now cancelled *Blue Streak* LRBM, all construction work at Spadeadam has stopped. However, engine and vehicle testing is still continuing on a reduced scale until the government makes its long-awaited decision whether to proceed to develop *Blue Streak* as a space carrier vehicle or not.

The Establishment occupies about 10,000 acres set amidst pleasant, unspoiled countryside in an area drenched in history. It is on the Cumberland Fells about 20 miles northeast of Carlisle, and quite near the remains of Hadrian's Wall, Roman roads and forts, and medieval castles used in border disputes between England and Scotland.

The site was chosen as probably the only one of its size still available in England. The only alternatives would have been in the Scottish highlands. Although it is conveniently placed in relation to the Rolls-Royce headquarters in Derby, it has many disadvantages.

• **Bog and fog**—Being on the top of the fells, the weather is frequently wet or misty, and high winds are sometimes experienced. Maps of the area name it as Spadeadam Forest or Spadeadam Waste. The forest disappeared hundreds of years ago and was replaced by a bog. The bog is not dangerous to man but has caused difficulties during construction and increased costs. In building roads at the rocket site, ordinary methods were useless and the old Roman method of "floating" them on piles of brushwood was used.

The Establishment was conceived in 1955 and work began in December 1956. Construction was undertaken by the Ministry of Works to the requirements of the Ministry of Aviation, which specified the number of test stands and other facilities. The main contractors for the work were British Oxygen Engineering Ltd., and Wimpey Ltd. Later they formed a joint company.

Construction was mainly between January 1957 and January 1960, and all services had to be brought to the site. About 2000 workers were employed at the peak period of construction.

The Administration area is located near the entrance to the establishment, and includes offices, a small conference hall, laboratories (for testing effluents, checking instruments, etc.), a machine shop, and assembly shops. Component parts for the RZ1 and RZ2 engines come here from the Rolls-Royce works at Derby, Shrewsbury, Hucknall or Barnoldswick, Lancashire and are checked and assembled.

This LOX/kerosene engine is a development of the Rocketdyne S3, and was first run at the Rocket Propulsion Establishment, Westcott, in 1957. The first firing at Spadeadam took place 18 months ago. The early engines developed 135,000 lb. thrust, but this has been bettered. The dry weight of a single engine is about 1500 lb. and it is 10 ft. 7 in. high.

• **Like Atlas**—The building housing the engine assembly shop also has the missile preparation section, comprising three bays. Only one of these is in use. The *Blue Streak* bodies come from de Havilland Propellers Ltd. plants at Stevenage and Hatfield. Their design employs the same constructional principles as *Atlas*. De Havilland has an agreement with Convair.

The missiles assembled do not contain a warhead. They have a frustroconical guidance section strengthened with external longitudinal ribs of top-hat section, a LOX tank without external reinforcement, a kerosene tank with "top-hat" ribs, and a skirt housing two Rolls-Royce engines.

The skin is made of thin stainless

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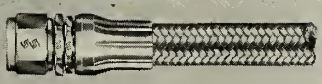

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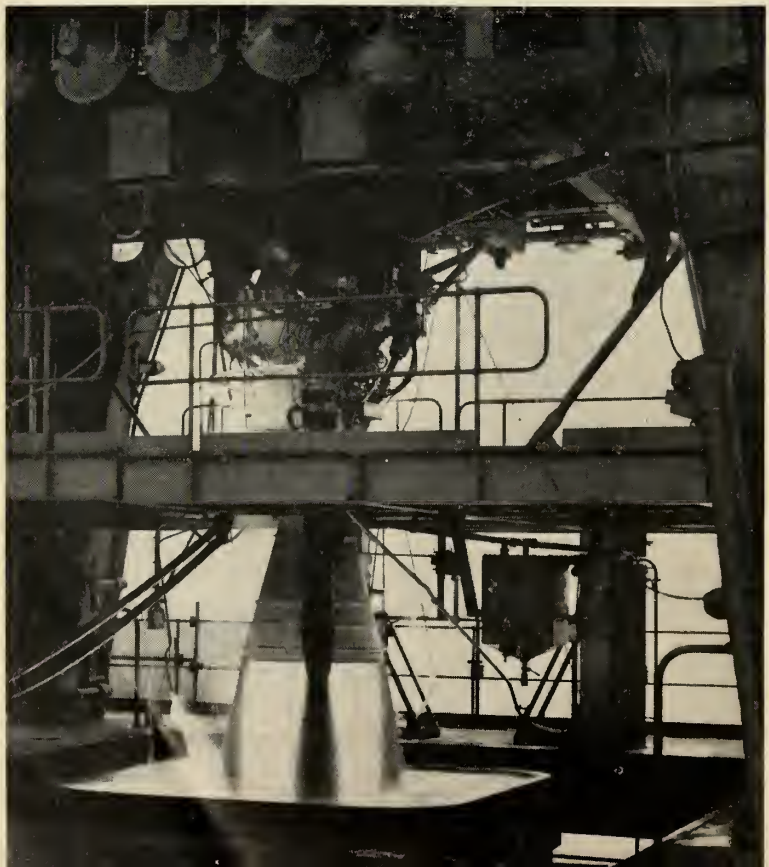
ABOVE: *Close-up of a Rocket Engine Test Stand.*

BELOW: *A rocket firing.*



steel sheet and the tanks are pressurized with nitrogen to prevent bucking. From the time of its manufacture until it is placed in the test stand or on the launch pad, the missile is also held in a frame. By attaching hydraulic jacks to this frame, the missile body can be placed under tension and the pressurization released while work is carried out on the body.

The LOX plant is operated and maintained by British Oxygen Gases Ltd. as agents for the Ministry of Aviation. It contains standard commercial equipment. There are two separate units, each producing 50 tons of liquid oxygen, 80 tons liquid nitrogen and 60 tons gaseous nitrogen per day.

Only one LOX unit is now operating.

LOX produced at the plant is stored in a 500-ton capacity tank and distributed by road tankers. The storage tank is insulated with Brellite powder, and fibreglass. The insulation is 4 ft. thick.

• **Component test area**—Sub-assemblies of component parts of the rocket engine are first calibrated and tested separately in the component test area, which has nine concrete test cells grouped around a central blockhouse.

The cell for testing gas generators has been closed down. The two turbo-pump testing cells are the only active facilities in this area. One cell tests the pumps with kerosene and water, which can be run to waste. The second cell uses kerosene and LOX. These are re-circulated.

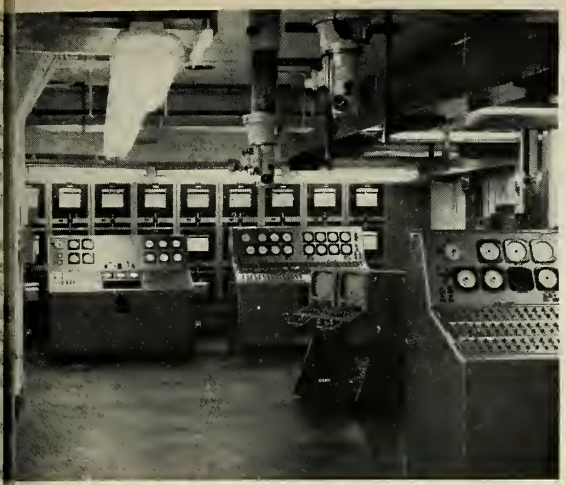
The rig in the cell for testing the gas turbine has not been completed and may never be. The turbine used is a 7500 lb. thrust engine developed by Rolls Royce for aircraft use and is termed superior to the original Rocketdyne equipment. A separate building contains a High Flow Water Test Facility, which is 95% complete.

Designed to be able to handle far larger engines, there is probably nothing as big in Britain. Its pumps can be used either in parallel or in series, giving either 6000 Imperial gal./min. at 300 psi. or 2000 Imp. gal./min. at 930 psi. This facility is intended for the calibration, with water, of flowmeters, injectors, combustion chamber jackets, etc.

The control room for this site has been instrumented by Pye Ltd. and is fitted with Honeywell-Brown chart recorders, closed circuit television, periscopes, etc.

• **Engine test area**—About a mile away is Site A, probably the most conspicuous part of the Establishment. This is a group of four engine test stands erected on a hillside and clearly visible from the Carlisle-Newcastle road.

Three of these (A1-A3) were erected



NGINE TEST Area Control Room equipped with chart-type corders, oscillographs, TV and periscopes.

ROCKET ENGINE Fitting Bay where Rolls Royce LOX/-kerosene engines are assembled for the Blue Streak.

ccording to American practice at the me of designing the plant. These are paced 250 ft. apart and each consists f a massive concrete and steel struc-ure in which the rocket engine can be ounted to fire vertically downwards nto a water-cooled steel flame deflec-or. LOX and kerosene tanks are placed ertically over the engine as in the issile.

The fourth stand has been designed uite differently. Experience showed hat safety precautions on A1-A3 were xcessive. It is more squat, with pro-ellant tanks at ground level on each ide of the stand (permitting direct oading from tankers), much less mas-ive and situated quite near to stand 3. This structure is of prestressed oncrete.

Water from the deflectors passes via oncrete spillways to a treatment plant, here any solids and kerosene are re-oved and the water stored for reuse.

A control blockhouse is 600 ft. way from the A1 test stand. The build-ng is constructed of 2-ft. thick rein-orced concrete and equipped with 130 hart-type recorders, four 24-channel scillographs, closed circuit TV and eriscopes. When completed, there will e eight control consoles.

An underground concrete duct, 7 ft. quare and 1100 ft. long connects he test stands and control room for he routing of 8000 instrumentation and ontrol cables.

As the missile test area is incom-lete, the A1 engine test stand was con-erted some time ago for temporary use s a missile test stand. This has a large ixed tower and is fitted with a missile iring pad, although not an exact replica f the ones to be used at Woomera.

Missiles attached to the carrier rame are brought to the stand by road n a transporter, a pivot attachment bolted on the end of the frame, and this winched up by hand into a vertical position. The *Blue Streak* is then a few yards in front of the firing pad.

A carrier ring is bolted to the top of the missile, and it is then hoisted up free from the frame by this ring, swung into position above the pad and lowered into place.

• **Missile test area**—About 1¾ miles away is Site C, the Missile Test Area. This has two widely separated missile static test stands, C3 and C2, each having a transversing servicing tower, incorporating a gantry for elevating the missile into the vertical firing position. The tower can be withdrawn along a 300-ft. concrete causeway.

Stand C2 is incomplete, but C3 is virtually completed except for electrical work. The launcher is virtually the same as those used for actual launchings in Australia, except that there is no provision for releasing the clamping jaws holding the missile to the pad.

The towers have portal frames open on both sides. There are the usual servicing platforms, each being divided into four quadrants. The quadrants can be operated independently (although usually all are raised at once), but those at different levels are not independent. All the levels in any given quadrant rise together.

Neither stand has been used yet. Equipment for refrigeration, power supplies, instrumentation, air conditioning and control electrics is ready for installation beneath C3 if the word is given to go ahead. The equipment rooms could be ready in a few months.

A central blockhouse is located 1000 ft. from the stands. Except for a Rolls-Royce engine panel, the instrumentation here was designed and installed by de Havilland's. The main system comprises 19 control consoles, 4 checkout consoles, 27 chart controllers with a capacity of 216 channels. Over 3500 cables connect the control center with each test stand.

Bark and Stroud observation periscopes have been installed, and there are also episcopes and closed-circuit TV. Film records of the tests are made by cine-cameras installed around the test stand.

• **Management**—The Ministry of Aviation has vested the management of the Establishment in Rolls-Royce Ltd., which is responsible for overall supervision, the provision of essential services for all users, and maintenance. The site manager is Cmdr. Adams. Total staff employed by Rolls-Royce, de Havilland and British Oxygen at the site is about 600.

The exact cost of the Establishment is not known, but is probably around $56 million. Some newspapers recently carried stories that equipment at Spadeadam had been auctioned. But it turned out that contractors who had finished work at the site had been disposing of surplus equipment.

Two test firings of twin-engine units were made during a press visit this month. In the first, the unit ran for three seconds and was then cut out by automatic equipment because the fuel supply to an igniter failed to register the required pressure.

In the second, the engines ran normally. The unit is fitted with various automatic devices including one which ensures that firing does not take place unless both engines are working satisfactorily.

The complete *Blue Streak* vehicle has been successfully tested and if government approval were given it would be possible to ship several to Australia for actual launching. Conversion for satellite launching could come later.

Big Hydrofoil

200-ton ASW Vessel Due in 18-20 Months

A 200-ton hydrofoil warship will soon be developed by the Navy. The craft will be a follow-on to a 110-ton hydrofoil warship now under preliminary design by Boeing and Martinac Shipbuilding of Tacoma, Wash.

Rear Admiral R. K. James, Chief of the Navy's Bureau of Aeronautics, bills hydrofoil craft as a new species of warship that will at last put the surface vessel back in the competition for antisubmarine warfare work. The breakthrough came with the recent development of hydrofoils that can operate completely submerged rather than skimming across the water surface.

The Boeing-Martinac vessel is being built under a $2-million fixed-price contract awarded last June. The preliminary design stage is expected to be done a year from now and the craft "put together in six to eight months after that."

It will be 115 feet long and have 110 tons displacement. James describes it as traveling 50 to 55 knots and carrying target-seeking torpedoes and sonar gear.

• **Marriage broker**—He called the Navy's interest in hydrofoils an "opportunity" for the "lagging aircraft industry." Adding that for this work a marriage is needed between aircraft builders and ship builders, he said at a luncheon last week that "when tenders for bids went out (for the 110-ton craft), I called for an aircraft company and a shipyard combination to get the contract."

Reasons are that the aircraft industry is experienced in building lightweight structures able to maximize the payload-to-gross-weight ratio; while the shipbuilding industry has a knowledge of the design of displacement vessels.

James emphasized that there are many difficult problems to be solved by designers of the 200-ton craft. These include combining aircraft and marine experience in devising the powerplant; developing unique designs for lightweight structures; contriving an adequate power transmission system, "perhaps through the use of water jets"; and solving the treacherous strength-of-materials problem that arises in supporting a large gross weight on stilts.

He foresees a requirement of 80 to 90 knots for the hydrofoil. This takes the submerged airfoil surfaces into the "supercavitating airfoil design region," where not much experimental or theoretical work has been done.

High praise was given to a control device involving an altimeter that measures the vessel's height above the

water and then appropriately and continuously adjusts the aspect of the submerged wings.

Because of the technical problems involved in designing a hydrofoil craft, James estimates that 500 tons probably marks the upper weight limit for the species. However, the hydro-skimmer or ground-effect machine, "though looked upon with less optimism than the hydrofoil, can theoretically go upward of 2000 tons gross weight."

The Boeing-Martinac hydrofoil is powered by two 3000-horsepower Proteus gas-turbine engines. For slow non-hydrofoil speeds, the drive comes from a 600-horsepower marine diesel.

AF Streamlines

Weapons System Concept Gets New Coordination

The Air Force's systems management concept is being streamlined to allow concept-to-production regulation of a weapons system by a single planning and programing document.

The new regulation, AFR 375-1, provides for "System Staff Offices" (SSO's) at AF headquarters and "Systems Program Offices" (SPO's) to coordinate field activity in weapons development.

The new SPO's most closely related to the superseded Weapons System Project Offices, to be phased out of weapons and support system management organization as soon as projects under their direction are completed.

Development of new weapons will proceed from the SSO's to the SPO's with systems management cutting across many functional groupings in the AF, including: plans, operations, research, development, production, supply and maintenance and personnel. These functional commands will be directed to support "systems management" through the system staff officers at headquarters level and through the system program director at field level.

In an effort to reduce change-of-command red tape, the new regulation encouraged direct communication throughout the AF in support of systems programs: "Direct communication is authorized among commands participating in system programs. Routine direct contacts at working levels among system and functional managers are encouraged."

Normally, ARDC will be assigned overall program managership during the development and production phases. Prime responsibility will usually devolve on the Air Materiel Command after delivery of first production items to the user. AF headquarters will establish initial management responsibility, designating either ARDC or AMC as the program requires.

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NEW TARGET MISSILE—Two missiles in one, this high or low level supersonic target missile for U. S. Army is now in development at Columbus Division. Launched by solid booster, ramjet-powered, it performs from subsonic up through Mach 2, and from ground level to 60,000 feet. NAA Columbus also produces Navy's A3J Vigilante, world's most versatile Mach 2 manned weapon system, and the T2J Buckeye multipurpose jet trainer.

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Technical Countdown

ELECTRONICS

Temp. Range Doubled for Electronic Eyes

Reliability of light-sensing devices for space vehicles operating in high temperatures will be considerably improved by a new photoemissive material developed at Westinghouse. Operational range is reported to be around 120°C—about twice that of present types.

Saturn Radio Emissions Measured

Radio waves from the planet Saturn and from a planetary nebula have been measured by U. of Michigan scientists. Such measurements are expected to shed light on the temperature and density of Saturn's rings and on the distribution of gases in the planet's atmosphere.

High-Speed Light Source Developed

A 0.3-microsecond light source for photographing high-speed phenomena has been developed by Avco RAD. The source can be used with shadowgraph or Schlieren systems to illuminate and "stop" reactions of models, gases, or chemicals in hypervelocity research studies.

Millimeter Power Outputs Increased

A new approach to the generation of "substantial" power outputs in the millimeter region (EHF and above) has proved successful in AF-sponsored research at U. of Illinois. The new technique—using Cerenkov radiation—has produced 300 milliwatts at the tenth harmonic of 2.77 kmc. Researchers feel that outputs as high as 10 watts are within reach with the new method.

Study of Cosmos Continues

A 10-telescope, 250-lb. astronomical payload will be launched from Woomera next year. The U.S.-Britain-Australian joint venture will attempt to observe that part of the cosmos seen from the Southern Hemisphere. British *Skylark* rockets will carry the package vertically to 100 miles. Bids on 4 payloads (due for delivery six months following contract award) were received Sept. 12 by NASA.

Orbital Chaff Chafes Briefly

Proposed use of metallic-fiber orbital path for scatter communications has drawn only flash concern from radio astronomers. The concept was presented by W. E. Morrow, Jr. of MIT's Lincoln Laboratory before the International Scientific Radio Union in London, Sept. 9. Apparently all objections based on possible interference characteristics can be overruled scientifically.

Methods Outlined for Upping Solar Cell Efficiency

Techniques for increasing the efficiency of solar cells are described in a new report to be distributed soon by Bausch & Lomb. This is the first in a series of reports to scientists on new techniques and development of materials, systems, components and other areas associated with optics research.

PROPULSION

Rocket System Study Bids Due Soon

NASA's Langley Research Center is asking bids by Sept. 30 on a study of performance and reliability of sounding rocket systems. Sixteen systems and 20 motors will be covered in the 3½-month study.

MATERIALS

Beryllium Shingles Picked for Mercury

NASA's Space Task Group has switched from ribbed titanium as the outer skin of the *Mercury* capsule. The lower cone will be Inconel and the cylinder will be beryllium shingles.

Titanium Wrapped for High Strength

Titanium pressure vessels are being tape-wrapped by Borg-Warner. The cases reportedly reach tensile strengths of 350,000 to 380,000 psi.

Filament-Winding Advance Announced

Tapco Group has produced filament-wound reinforced pressure vessels with integrally wound closures having a strength-density ratio in excess of 3 million inch-pounds per pound. This corresponds to a unidirectional strength of 340,000 psi in the fiber resin system.

Really Solid Ceramics Developed

Superdense ferroelectric ceramics with 80% of the voids eliminated result from a new technique at Gulton Industries, Inc. One-piece transducer discs up to 20 in. in diameter are possible with the method.

Bomarc Gets New Alloy

Advanced versions of the *Bomarc* will use alloy 2219, a strong, heat-defying aluminum composition. The metal will be used in the missile's combination fuselage-fuel tank.

New Glass Yields Minimum Radiation

Measurement and identification of extremely tiny amounts of radiation will be possible with a new glass developed by Corning Glass Works. With a radioactivity of less than 10 counts per minute per kg, as compared with 175 for current glasses, the new material is slated for use in photomultiplier tubes.

HUMAN FACTORS

Slow Decisions Get Wrong Answers

Human factors research is telling astronauts to trust their first conclusions. In recent testing managed by psychologists and confirmed by the AF Office of Scientific Research, it took subjects working on one problem an average of 376 seconds for correct response, 486 seconds for the wrong answer.

Metal Fibers Urged For Communications

Proponents see orbiting belts as highly reliable means for reflecting transmissions

ORBITAL SCATTER belts will permit very long distance telecommunication transmissions. Their tiny metal fibers (dipoles) will be thousands of feet apart.

Two relatively stationary belts of orbiting metallic fibers have been proposed as a reflector-scattering mechanism for a long-range microwave communications system.

It is believed that the reflective properties of two perpendicular belts of the tiny metal fibers in a 3000-6000-mile orbit would implement extremely reliable long distance worldwide telecommunications.

In addition, its proponents offer other advantages of such a system: "modest" ground antenna tracking requirements and the ability to support a large number of independent circuits.

The concept—originated by W. E. Morrow, Jr. of M.I.T. Lincoln Laboratory and H. Meyer of Thompson Ramo Wooldridge Corp. in 1958—has developed from basic idea to a practical project in just two years. A discussion of the program based on the 2-year study was presented by Morrow on September 9 before the Thirteenth General Assembly of the International Scientific Radio Union in London.

Morrow's paper deals principally with a "hypothetical" system but while the values mentioned are representative the techniques to be employed are firm.

This briefly is a description of the orbital scatter technique:

Almost any good electrical conductor could be used for the metal fiber material. For a long-term system, copper wire would be practical. But, for experimental paths a white tin alloy has been suggested which would gradually turn to a powder and disintegrate with time. Solar radiation pressure would cause the dust to re-enter the earth's atmosphere in a relatively short time.

Each fiber would be a tuned half-wave dipole, over 1 cm. long and having a diameter of 3×10^{-3}cm.

One rocket launched container carrying about 100 kilograms of metal fiber would be needed for each path. After attaining a satisfactory orbit, the container would steadily release its contents.

Dipole distribution according to Morrow could be effected in a period of one or two months if dispensed with a distribution of velocities up to a few meters per second.

• **Broad coverage**—Optimum coverage probably would be achieved, said Morrow, with one equatorial and one polar circular orbital path.

With orbital heights of from 5 to 10 thousand kilometers, single-hop communication could be established between Europe and most of North America and Asia. Coverage areas, however, would be best on north-south circuits.

Most of the globe could be covered with two-hop circuits. The one exception, said Morrow, is the connection of locations near one pole with those near the other. A three-hop connection would be required in this case.

Dipole dispersion is estimated at 40 km. radially in 60 days, 100 km. in a year. Transverse dispersion would be more rapid and would no doubt limit useful life of the path to about 2 years. (With only radial dispersion to contend with, lifetime might exceed ten years.)

Typical ionospheric or tropospheric scatter transmitting and receiving equipment could not be used for orbital scatter. Many of the techniques might be borrowed, however.

The proposed system would operate at a specific frequency between 5 and 10 kmc with a bandwidth adequate for five high quality voice channels.

Transmission power probably would be about 10 kw using 20-meter high gain paraboloidal reflector antennas.

By employing dual or triple-diversity receiving antenna systems and MASER or parametric amplifier front end techniques to reduce noise satisfactorily, highly reliable performance would be attained.

For example, the author estimated that such a system would permit a digital transmission rate of about 10,000 bits/sec. with an error rate of about 10^{-5}.

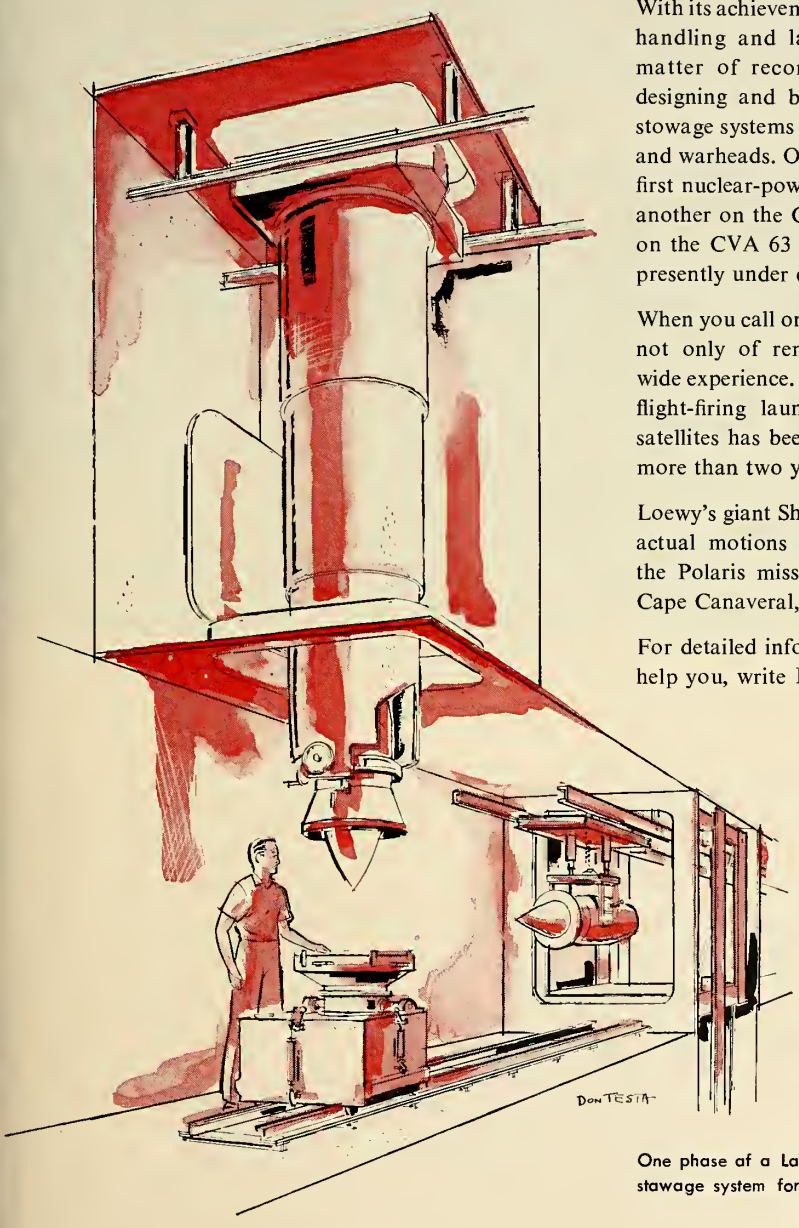
By increasing the mass of orbital scatterers, and using larger ground installations Morrow believes capacities up to 10^6 bits/sec. might be achieved.

There has been "flash concern" from radio astronomers and others, a Lincoln Lab spokesman told M/R, about the use of such a system as Morrow suggests. All of these temporary objections—impact with spacecraft, effects on optical and electronic ground systems—have been investigated and believed eliminated.

The introduction of 100 kg of metal fiber appears extremely insignificant when compared with the several thousands of tons of cosmic dust and other debris accumulated each day from outer space.

It is also significant to note that 9 oz. of the metal fibers offer the same reflective quality as the 100 ft. diameter *Echo* balloon.

For Terrier and Talos missiles and warheads . . . new shipboard handling and stowage systems by Loewy



With its achievements in missile and rocket ground handling and launching equipment already a matter of record, Loewy-Hydropress is now designing and building shipboard handling and stowage systems for the Terrier and Talos missiles and warheads. One system is to be installed on the first nuclear-powered cruiser, U.S.S. *Long Beach;* another on the CG 10 Class cruisers; and a third on the CVA 63 Class aircraft carriers, which are presently under construction.

When you call on Loewy, you are availing yourself not only of remarkable ingenuity, but also of wide experience. The Loewy system for testing and flight-firing launching vehicles of earth-circling satellites has been functioning without failure for more than two years.

Loewy's giant Shaker installation, which simulates actual motions of seagoing ships for test-firing the Polaris missile, is in successful operation at Cape Canaveral, Florida.

For detailed information on how we can possibly help you, write Dept. S-9.

One phase af a Laewy handling, mating and stawage system for warheads on shipbaard.

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Ryan's Explosive Electronics Growth

Company is developing into a prime contender for system contracts with vast expansion in electronics and other areas

PRODUCTION FACILITY of Ryan's Electronics Division at Torrance, Calif., is base for recent boom in Electronics.

SAN DIEGO, CALIF.—Ryan Aeronautical Co. is using a booming growth in its electronics business as the base for development into a prime contender for systems contracts in the missile/space field.

The company's electronic sales in fiscal 1959 totaled $5-million. This year, they will total some $35-million and electronic growth over the next two years is expected to be at a rate of 20% a year.

To complement this explosive electronic expansion, the company's new management team has broadened Ryan's other interests to provide a strong overall systems capability:

–Acquisition of Aerolab Development Co. for missile airframe and design know-how.

–Establishment of Ryan Transdata, Inc., as a subsidiary puts the company in the data handling field.

–Manufacture of high-temperature aircraft, missile and rocket engine components, including rocket chambers for Grand Central Rocket's *Viper* and combustion chambers for Marquardt's ramjet engines, has provided propulsion know-how.

–Large airframe subcontracts have given the firm a background and experienced labor force in modern production-line and metal-working techniques. Emphasis has been placed on advanced materials research and such new manufacturing approaches as explosive forming.

–Continued development of the successful *Firebee* jet-powered target missile system and of vertical takeoff aircraft has given the firm experience in overall systems makeup.

–And last, but far from least, introduction of new blood at top administrative and technical levels has brought together a management team able to cope with the Ryan growth pattern.

For the first time in many years, the majority of Ryan's contracts in 1960 are prime contracts—55% against 45%. Last year, 60% of the firm's business was still in subcontracts.

After a perusal of the company earlier this year, the Philadelphia investment firm of Robinson & Co. reported: "The caliber of Ryan management is evident from its excellent record of sales and earnings, the former having increased from $15-million in 1949 to $85-million in 1959, while earnings have increased eight fold. In net return on invested capital, Ryan ranks among the best in the nation."

• **Electronic pace**—A company official says: "The missile/space business is our business now."

Behind all this is the growth in electronics—from 5% of gross income in 1959 to the point where it today is the company's largest single class of product.

At the beginning of 1958, Ryan still was known in the industry largely for its reputation as a builder of World War II training planes and its competence as a subcontractor on airframes and aircraft engine components. There were only 100 people in the electronics department. Nearly 70% of Ryan's business consisted of airframe and engine subcontracts.

When it came, the move awa

from the dwindling aircraft market was swift. The big electronics push began in 1958, with 1959 as what one division official calls "the real backbreaking year" in electronic growth.

In that year, employment in the electronics division jumped from something like 700 at the beginning of the year to nearly 2000 at year's end.

• **Team members**—Much of the credit for the change in the San Diego firm goes to a new management team put together by promotions from within the company and by recruiting from outside. Under president T. Claude Ryan, its members include:

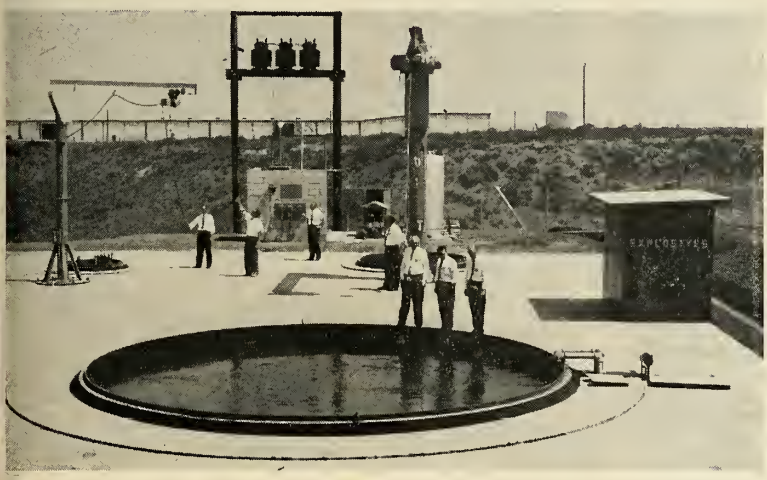
Robert C. Jackson, named executive vice president and vice chairman of the board late last year. Jackson's background is financial. He is vice president and director of Emtor, Inc., an investment holding company which holds the largest block of Ryan stock, more than 300,000 shares. He also is vice president of West Shore Co., another Los Angeles investment holding company, and president of several other financial firms, including South Shore Co., which specializes in real estate mortgage loans.

Edward G. Uhl, who joined Ryan last year as vice president-technical administration. Uhl formerly was vice president-general manager of the Martin Missile Division at Orlando, Fla. With Martin 13 years, working up from research engineer, he was responsible for construction of the missile facility for production of the Army *Pershing* and *Lacrosse* ground-launched missiles, Navy *Bullpup* air-launched missile, and the Missile Master Data processing system.

Lloyd Everingham, who joined Ryan early this year as space laboratory director with responsibility for operating the Aerolab facility. Everingham formerly was vice president in charge of research at Radiation, Inc., in Florida.

Frank W. Fink, vice president-engineering, who joined Ryan in 1955. He formerly was chief engineer of Convair-San Diego, and was in charge of the original *Terrier* and *Atlas* missile programs.

William G. Alexander, president of the recently-announced Transdata subsidiary. Alexander was San Diego general manager of the Stromberg-Carlson division of General Dynamics.



RYAN OFFICIALS inspect new high-energy forming facility at Kearny Mesa.

G. W. Rutherford, vice president and general manager of Ryan Electronics. He has been an officer of the company since 1955, when he was named assistant controller, and has been manager of Ryan Electronics since it was established as a separate division in 1957.

Owen S. Olds, director of engineering and customer relations, Ryan Electronics. In addition to work on other electronic devices for missile programs, Olds has had primary responsibility for technical development of continuous wave Doppler systems at Ryan for 14 years.

John W. Rane, Jr., named director of military relations last year. He joined Ryan after 18 years with Bell Aircraft, where he served as director of engineering and sales, and assistant vice president.

The manner in which the company has been combining old and new in assembling its potent new team can be seen from recent appointments to three top posts at Aerolab. The new chief engineer, Forrest Warren, and financial manager, William Fischer, totaled 16 years with Ryan between them. But the company went outside for the administrative engineer, Frank Bolles of Cornell University Aeronautical Laboratory.

• **Electronics Division**—Production of electronics components, sub-assemblies and C-W (continuous wave) Doppler systems is concentrated in the division's Torrance, Calif., plant not far from Los Angeles. Engineering, research and development, advance design and testing is carried out at the division's Kearny Mesa headquarters.

The two plants contain some 370,000 sq. ft. of working area, including one of the most up-to-date electronic test facilities in the nation.

Ryan got into the electronics business by pioneering C-W Doppler navigational guidance systems on the Air Force's first air-to-air research missile, the Ryan *Firebird*.

The new concepts it found in this field had important applications which Ryan still is developing, although for a long while C-W took a back seat to pulse radar. C-W, however, will do some things pulse radar will not and the latest generation equipment is lighter and more accurate. An important step forward was the development with Varian Associates of the klystron tube.

"We're just now getting into a real delivery position and gearing to even higher production at Torrance," an electronics division official says.

"We sell units, not systems," he says. "We advertise and sell interchangeability. We sell units that make up systems. There's an important little difference there in philosophy."

It's a successful little difference: in one six-week period recently, something like $20-million in new business was logged in by the division.

Torrance is turning out AN/APN-122(V) radar and navigation sets on which orders now are approaching 1000; AN/APN-97 helicopter hovering and ground velocity indicators, primarily for all-weather and ASW work, on which orders exceed 400; AN/APN-130 sets, similar to the APN-97 but with additional navigation and altitude capability and increased accuracy, on which orders top 350; and AN/APN-129(V) lightweight navigation sets for U.S. Army Surveillance aircraft.

• **Aerolab Development Co.**—Aerolab pioneered in the field of low-cost, high-performance sounding rockets utilizing off-the-shelf components to build missiles into multi-stage space probes. It was a prime contractor to the Air Force Special Weapons Center, Kirt-

land Air Force Base, on Project *Jason*. The project was for measurement of radiation effects of the Project *Argus* nuclear explosions in the South Atlantic. The Aerolab *Argo E-5* five-stage sounding rocket was used.

Under an Air Research and Development contract, it put together a four-stage D-4 sounding rocket in Project *Javelin* to measure the Van Allen radiation belt. This program carried telemetry equipment and supporting hardware to heights of 2000 miles.

In the NERV (Nuclear Emulsion Radiation Vehicle) program, General Electric and Aerolab are prime contractors to NASA in studies of the Van Allen belt with a 125-lb. GE instrumentation package boosted by an Aerolab Argo D-8 *Journeyman* rocket.

Adventurer and *Percheron* series rockets under development at Aerolab will carry payloads beyond 4000 miles.

• **Ryan Transdata, Inc.**—Specializing in the design and development of data handling equipment, this new subsidiary initially is undertaking design studies of equipment aimed at office automation—the transfer of data from a central storage center to an executive's desk, where it is displayed on read-out equipment. But applications include supervisory monitoring and command control of space vehicles.

Space Age capabilities in the home plant at San Diego's Lindbergh Field include work with ultra-thin gauge. high strength materials in the firm's Mini-Wate and MicroWate development programs. These were developed to meet the tremendous stress, temperature and weight limitations imposed by hypersonic flight speeds. Ryan recently completed work on a contract from Wright Air Development Division studying application of these materials to a vehicle capable of operating at extremely high altitudes, possibly in something such as a solar sail. The contract included construction of a test structure.

A new high-energy forming facility recently went into production on a 20-acre site on nearby Kearny Mesa. Ryan has been working for two years in the explosive forming field and is recognized as a leader in the technique. One contract calls for turning out large hemispherical bulkhead for *Saturn* fuel tanks as much as 70-in. or more in diameter.

Ryan, with a fresh new management approach, is wrapping all these capabilities into a bid for recognition as one of the missile/space firms capable of handling integrated system contracts. If its accomplishments of the next three years are of the same magnitude as the last three, it should have little difficulty in winning that recognition.

mergers & expansions

RYAN AERONAUTICAL CO. has formed a subsidiary to specialize in design and development of data handling equipment. The new company, Ryan Transdata, Inc., will be headed by William G. Alexander, former general manager of Stromberg-Carlson Div., General Dynamics.

NORTH AMERICAN AVIATION has purchased Temptron, Inc., Reseda, Calif. NAA will operate the thermocouple manufacturing firm as a wholly-owned subsidiary.

FLUOROCARBON CO. has moved its entire Fullerton plant to new and larger quarters in Anaheim, Calif.

TRAK ELECTRONICS CO. has formed a new subsidiary, Trak Microwave Corp., in Tampa, Fla. Operations in the new plant will start Oct. 1.

VARO MFG. CO., Garland, Tex., has purchased all the stock of A. G. Optical Co. of Chicago.

PERKIN ENG. CORP. has changed its name to Perkin Electronics Corp. Dynex Industries, Inc. of Long Island is negotiating for acquisition of Documat, Inc., of Belmont, Mass.

SILVERCROWN, LTD. of London has been licensed to manufacture the complete line of Technic precious metal plating products in England, for sale in England, the Commonwealth except Canada, and throughout Europe.

ZERO MFG. CO. has completed construction of its $500,000 Modular Container facility in Burbank, Calif. The 33,600-sq.-ft. building will contain about $250,000 worth of new manufacturing equipment.

ELECTRADA CORP. has acquired Airite Products, Inc. of Los Angeles. The acquisition brings the number of Electrada divisions to five, including Stillman Rubber Co., Airite Products Inc., Product Packaging Engineering Div., and two electronics divs., Information Systems and Research and Electronic Manufacturing and Engineering.

ANALYSTS, INC., the first commercial chemical laboratory designed especially for the scientific control of engine maintenance, has been established in Oakland, Calif.

PARMATIC INC. has selected a site at the Municipal Airport, Watertown, N.Y., for a new plant and headquarters facility.

Aerospace Delays Laid to Schedule

Slow pace of recruiting is now picking up; official denies that STL men are reluctant to transfer to new firm

by William J. Coughlin

EL SEGUNDO, CALIF.—Delays in the organization of Aerospace Corp. appear to lie with an overambitious schedule laid down by the Air Force rather than any specific problems in attracting employees to the new concern.

Aerospace, formed as a non-profit corporation to supplant Space Technology Laboratories in USAF missile/space programs, has been forced to subcontract Air Force work to STL due to a personnel shortage (M/R, Sept. 12, p. 9).

At the beginning of this month, Aerospace had succeeded in recruiting only 520 of the 1400 employees expected to be on the payroll by then. Of a planned 300-member technical staff, only 76 had signed up.

Although STL sources report that some of that firm's technical staff members have been reluctant to transfer to Aerospace, a spokesman for the new company denies that this has been a major factor delaying organization of the new firm.

"Of course, we wish we were a bit further along than we are," a senior company official told M/R, "but the fact we are not is not due to any difficulties other than those of trying to get an infant born full-size all at once."

• **Pace quickens**—The new Aerospace president, Dr. Ivan Getting, formerly vice president for engineering and research at Raytheon Co., did not report until Aug. 1. Recruiting of senior staff could not really get under way until his arrival—and this slowed the overall organizational effort.

The recruiting pace now is accelerating, a company spokesman reports, but no estimate is available on when the 1400 staff level will be reached. Size of the technical staff doubled in the week preceding Sept. 6—from less than 40 to 76.

An effort was made to select STL technical staff for transfer to Aerospace by IBM machine on the basis of the amount of time put in on projects which were transferred.

"But you cannot attract and motivate a competent technical man by IBM card," an Aerospace official admitted. It also was found that the "man/day" reported by IBM card frequently was not that of one man but portions of the time of two or three men.

In addition, the Air Force did not want to put Aerospace in a position of "raiding" the STL staff by force at the very time STL was setting out on its own in commercial competition. Aerospace, trying to avoid being merely a reincarnated STL, also has made an attempt to recruit outside talent to supplement the transfers from STL.

• **$30 million/year**—Dr. Getting says he expects Aerospace Corp. to be a "going organization" by the end of the calendar year. He estimates the ultimate staff figure may be around 3000 on an annual budget of $30-million; but he emphasizes that these are only estimates.

Aerospace still is operating under a letter contract with the Air Force Ballistic Missile Division, dated July 1. This is to be superseded by a definitized contract. What the dollar volume of this contract will be has not been announced.

"As long as we are talking about a total Air Force spending of about $3-billion annually for Space Age systems —including ballistic missiles—then it is unlikely that our budget would be less than one percent of that, or $30-million a year," Getting says.

Aerospace Corp.'s subcontracts with STL are on an interim basis—"almost a weekly basis"—a company official told M/R. STL has made it plain it is anxious to get rid of them as soon as possible.

Some of Aerospace's support personnel—such as security guards and secretaries—were transferred en bloc from STL when the projects to which they were assigned were transferred. The company has been recruiting its technical staff from STL in two categories, those who were on a "list of invitees" whose jobs were transferred and those who have volunteered.

• **Careful changeover**—At the same time, STL and Aerospace are working closely together in an effort to avoid bidding against each other for the services of the same man.

Senior officials of the new corporation include vice president-administration W. W. Drake, formerly with Raytheon; senior vice president-technical Allan F. Donovan, formerly with STL; vice president-technical Jack Irving, formerly assistant to Donovan at STL; and director of government relations Dan Whitcraft, formerly with General Electric. Beverly Hills attorney Najeeb E. Halaby is serving parttime as corporate secretary.

• **Division of roles**—Aerospace was incorporated in California as a nonprofit corporation on June 3. Its charter provides that its nature is "exclusively scientific to engage in, assist and contribute to the support of scientific activities and projects for, and to perform and engage in research, development and advisory services to or for, the United States Government."

It was announced at the time of Aerospace Corp.'s formation that it might later take on contract work for National Aeronautics and Space Administration and other government agencies, in addition to its duties for BMD.

Aerospace is taking over only a small portion of the work done for BMD by STL. STL contracts for systems engineering and technical direction of the *Atlas, Titan* and *Minuteman* weapon systems are being continued to avoid disruption in the programs. Aerospace is, however, assuming these roles in the *Discoverer, Samos* and *Midas* programs, in addition to branching out into new areas of missile and space technology. (M/R, July 4, p. 10.)

Aerospace has taken over a portion of the facilities at STL's El Segundo Research and Development center and the Air Force has re-affirmed its decision to buy the entire facility from STL.

"Space certainly is going to be a problem and how it will be relieved, we don't know yet," a company spokesman said. An exclusive story in AVIATION DAILY reported recently that the Air Force was looking for a new site for expansion of its ballistic missile management team.

These missile engineers already know the value of missiles and rockets...

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The GEL Telemetry Transmitter Group 19A1 features improved frequency stability (± 0.005% under all environmental conditions); true frequency modulation which can operate with FM-FM or PCM data input in accordance with IRIG specifications in addition to voice modulation where required; and operation under severe environmental conditions.

The Transmitter Group consists of 3 components: Basic 4-Watt Transmitter, Power Supply, and 15-Watt Power Amplifier. Installation in airborne vehicles where space is limited mounts these conduction-cooled units on an aluminum plate which in turn is mounted with good thermal contact to the airframe which acts as a heat sink.

FEATURES

- *Frequency Stability:* ± 0.005% (all environmental conditions)
- *Modulation:* Operates with FM-FM, FM/PDM FM, PCM
- *Max. Deviation:* ± 0.5 mc
- *Distortion:* Total output distortion not to exceed 1.0%
- *Primary Power:* Either 28 VDC or 110 V, 400 cycles
- *Environmental:* Pressurized for operation up to 80,000 ft.

Operating temperature: −54°C to +85°C
Operation through shock of 100g for 11 milliseconds
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500-2000 cps, 15g

MICROWAVE RECEIVERS, 2150 - 2350 mc

GEL Telemetry Receiver Type 20A1 can be used for reception of FM-FM, PDM-FM, and PCM transmissions at ground installations or in airborne applications.

Operation has been simplified as far as possible; number of operating controls is minimum, compatible with optimum performance. The unit is of the double superheterodyne type with both local oscillators crystal-controlled. Design includes FM capture characteristics, high frequency stability, and variable IF bandwidths. Sub-assembly construction is used for simplicity of servicing in the field. AGC extends dynamic range to 100,000 microvolts or 0.1v of RF signal.

This Receiver provides simultaneous AM and FM video, pre-detection 10 mc IF frequency, signal level recorder, and 60 mc IF for operation of a GEL Type 24A1 Frequency Display Unit.

FEATURES

- *Frequency Stability:* ± 0.005% of received frequency using standard MIL CR-33/U crystal without oven
- *Image Rejection:* Greater than 65 db
- *IF Bandwidth:* Plug-in second IF strips with bandwidths of 0.75, 1.5, and 2.0 mc
- *Selectivity:* Response has 60 to 6 db bandwidth of approx. 2.5
- *Interference Immunity:* Highly selective pre-selector for attenuation of interfering signals

FREQUENCY DISPLAY UNIT, SERIES 24

Companion units to GEL Receivers, Types 20A1, 22A1, and 25A1, Series 24 Frequency Display Units feature good resolution, equalization for IF nonlinearity ± 3 db, low spurious radiation, edge-lighted scale, and 60 db image rejection. A signal as low as 8 microvolts at the input of the receiver gives full-scale deflection.

Sweep width, center frequency, and gain controls are located below the 3" Cathode Ray Tube. All normally used CRT Controls are front-of-panel screwdriver adjustments protected by an easily removed cover.

FEATURES

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- High Sensitivity
- 60 db Image Rejection

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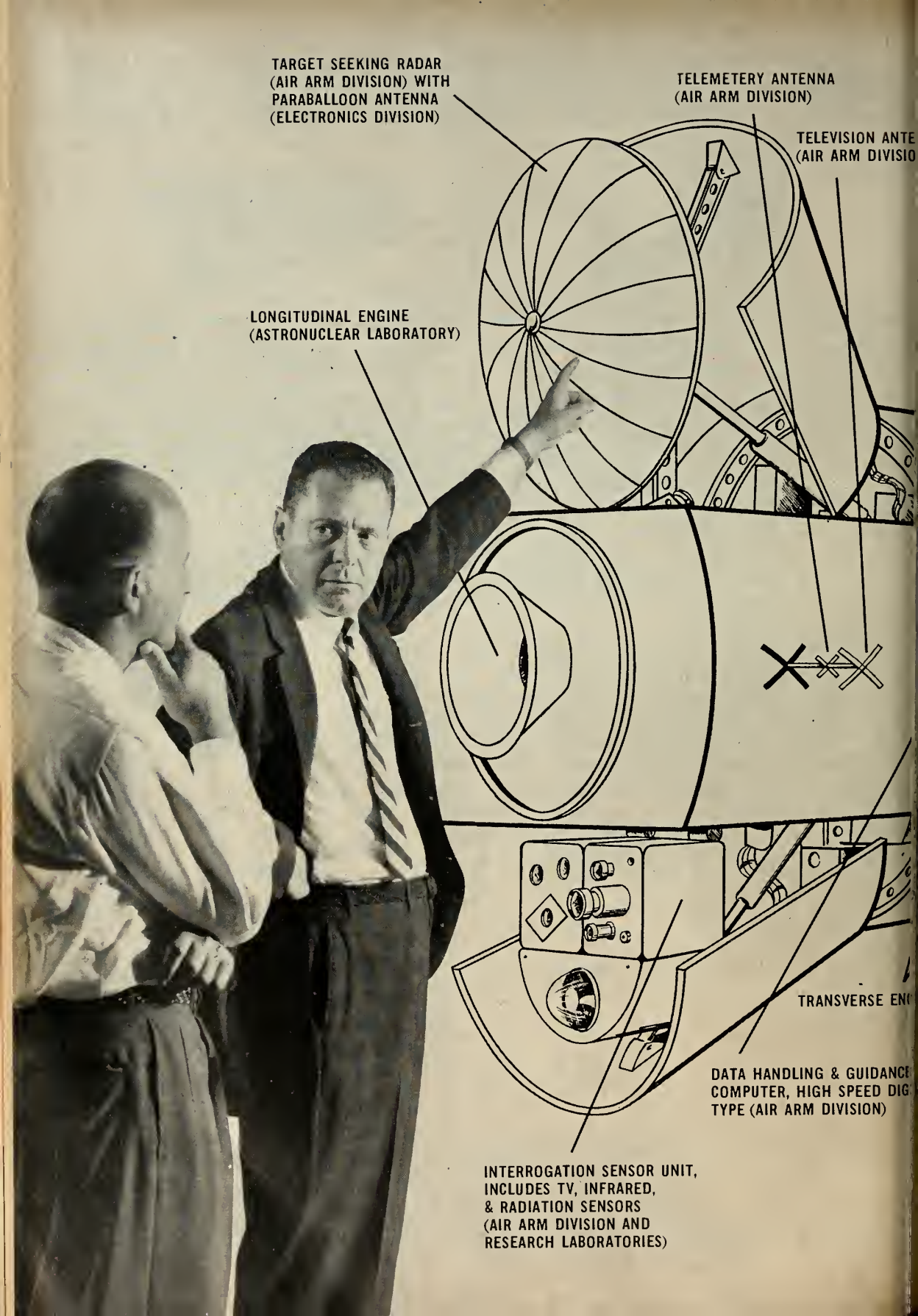
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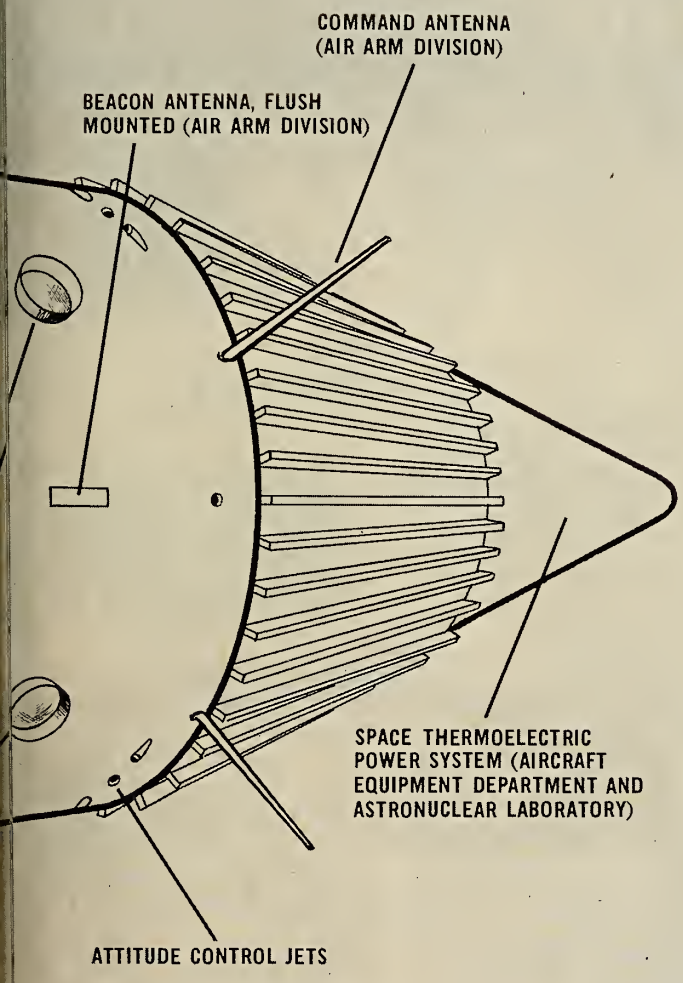

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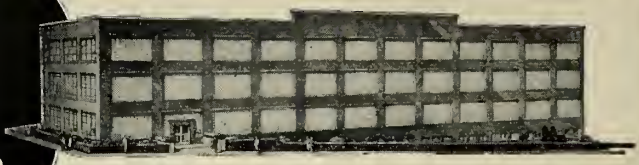

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Double triode and 5 pigtail parts required.

Input, Tube heater voltage and B voltage

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TRANSISTORIZED, Silicon Type
Size 1½" dia. x 3½" H. Wght. 7 ozs.

Frequencies: 360 to 1000 cycles

Accuracies:
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R2007–6 (±.002% at +15° to + 35°C
W2007–6 (±.005% at —65° to + 85°C

Input: 10 to 30 Volts, D. C., at 6 ma.

Output: Multitap, 75 to 100,000 ohms

TYPE 2001-2

Size 3¾" x 4½" x 6" H., Wght. 26 oz.

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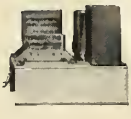
Accuracy: ±.001% at 20° to 30°C
Output: 5V. at 250,000 ohms
Input: Heater voltage, 6.3 - 12 - 28

B voltage, 100 to 300 V., at 5 to 10 ma.



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Accuracy:
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Output, 10 Watts at 115V

Input, 115V. (50 to 400 cy.)

TYPE 2121A

Size
8¾" x 19" panel
Weight, 25 lbs.

Output: 115V
60 cycles, 10 Watt

Accuracy:
±.001% 20° to 30°C

Input,
115V (50 to 400 cy.)

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Size, with cover
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Panel model
10" x 19" x 8¾" H.
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Frequencies: 50 to 1000 cy.

Accuracy:
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Tape Speeds H-1 Parts Development

CANOGA PARK, CALIF.—Tape recordings of full-scale firings of the H-1 engine that forms the *Saturn* cluster are being used for literal "shake downs" of the engine's components.

The unique system was developed by North American Aviation's Rocketdyne Division to reduce time and expense in component development.

To obtain basic data for the system, the component to be tested is drilled and tapped in all three axes (X-Y-Z). Gulton crystal accelerometers are then fitted to the drilled holes. Outputs from the accelerometers supply inputs to a modified Ampex 350 recorder. This setup furnishes complete recordings of the vibration environment to which the part is subject at all phases of the engine's operation.

In another version of the same system, vibration data during actual liftoff of *Jupiter* and *Thor* missiles have been recorded by means of a supplemental telemetry link.

Recordings are made at 60 inches per second. Six channels per component are available, plus one time channel. In some tests, as many as 24 channels have been used.

Taped data is then analyzed to determine the most critical vibration parameter for the component being tested. The original recording is usually transferred from the wide instrumentation tape to standard ¼-in tape.

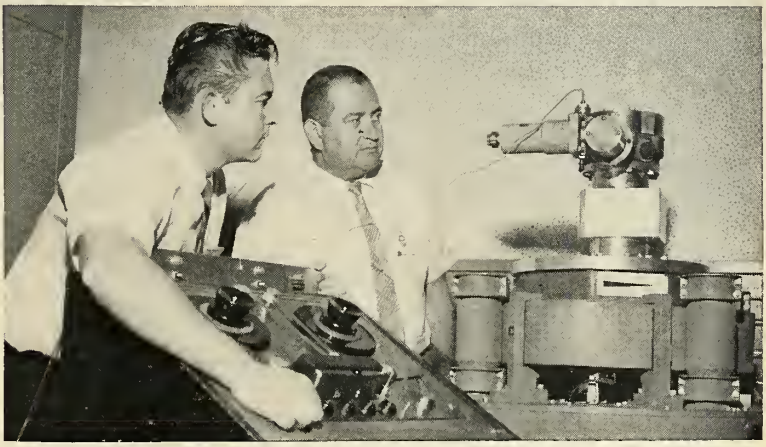
Once the critical vibration regime has been determined, the tape is made into a short loop which repeats the environmental data for a four-second period. For playback, the tape is normally limited to a single; or "worst," channel selected from the original engine recording.

The exact range of interest may vary considerably, depending upon the component and the component's reaction at various frequencies. In general, most of the Rocketdyne tests have fallen within the range of from 20 cps to 2000 cps and with varying intensity.

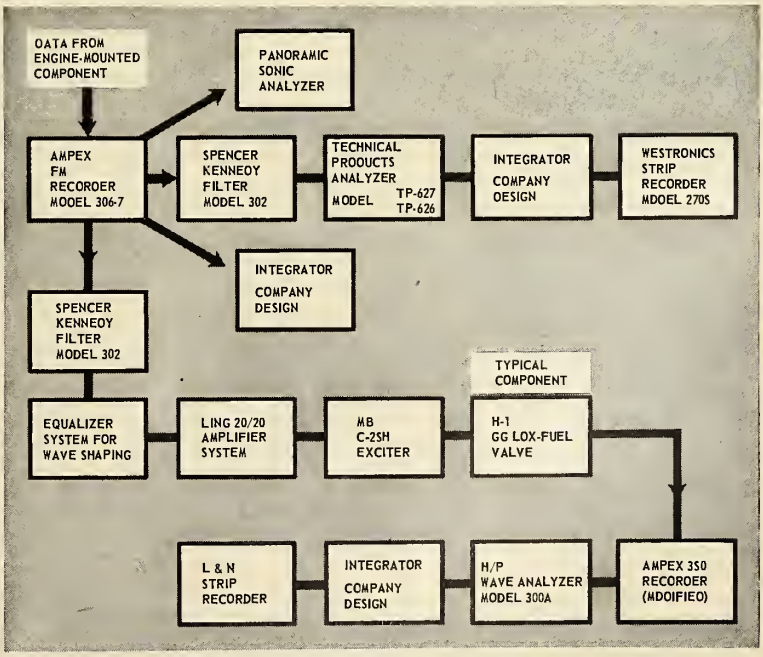
Playback of the tape on an Ampex FM recorder Model 306-7 is fed through a Rocketdyne-designed system to a shaker table. To back up the test, a Westronics strip recorder monitors input frequencies and an Ampex 350 is again used to record data from the component on the shaker table. Further backup is provided by a strip recorder as shown in the accompanying system diagram.

• **Multiple testing**—Where the concept pays off, according to the system's designers, Jud Ferentz, a Rocketdyne senior stress engineer, and Wayne Perkins, instrumentation engineer, is that components may be tested as many times as necessary to develop the required performance and reliability. In addition, vibration factors may be amplified to greatly exceed those encountered in actual engine runs to enable study of hardware moment in axes with larger excursions.

Specific H-1 engine components tested with the tape technique include the main fuel valve, gas generator control valve assembly, main LOX valve and the fuel additive blender unit.



H-1 ENGINE component is checked out by Rocketdyne engineers Wayne Perkins (left) and Jud Ferentz. Tape-fed shaker table duplicates operational environment.



SCHEMA OF ROCKETDYNE'S tape system for testing Saturn H-1 engines.

NTDS Described

Navy's New System Is Big Tactical Advance

THE NAVY IS TAKING some of the wraps off its new tactical data system designed to permit a task force to operate "almost as one ship" to defeat enemy aircraft/missile attacks.

Called NTDS (Naval Tactical Data System), the computer system automates the collection, display, and dissemination of combat information. Computers aboard deployed units of the task force exchange information which, added to memory-held data, provides complete knowledge of an overall tactical situation. Practically zero-time information interchange and evaluation makes it possible for all units to coordinate operations.

The system correlates all data into a clear picture of the tactical situation, processes data required for making decisions, and communicates action decisions to selected weapons systems. By contrast, conventional grease-pencil or voice-telling techniques communicate the tactical picture too late for offensive and defensive action against new high-speed weapon systems.

The Navy describes NTDS as a gigantic step forward in tactical combat direction—comparable to the transition from sail to nuclear propulsion.

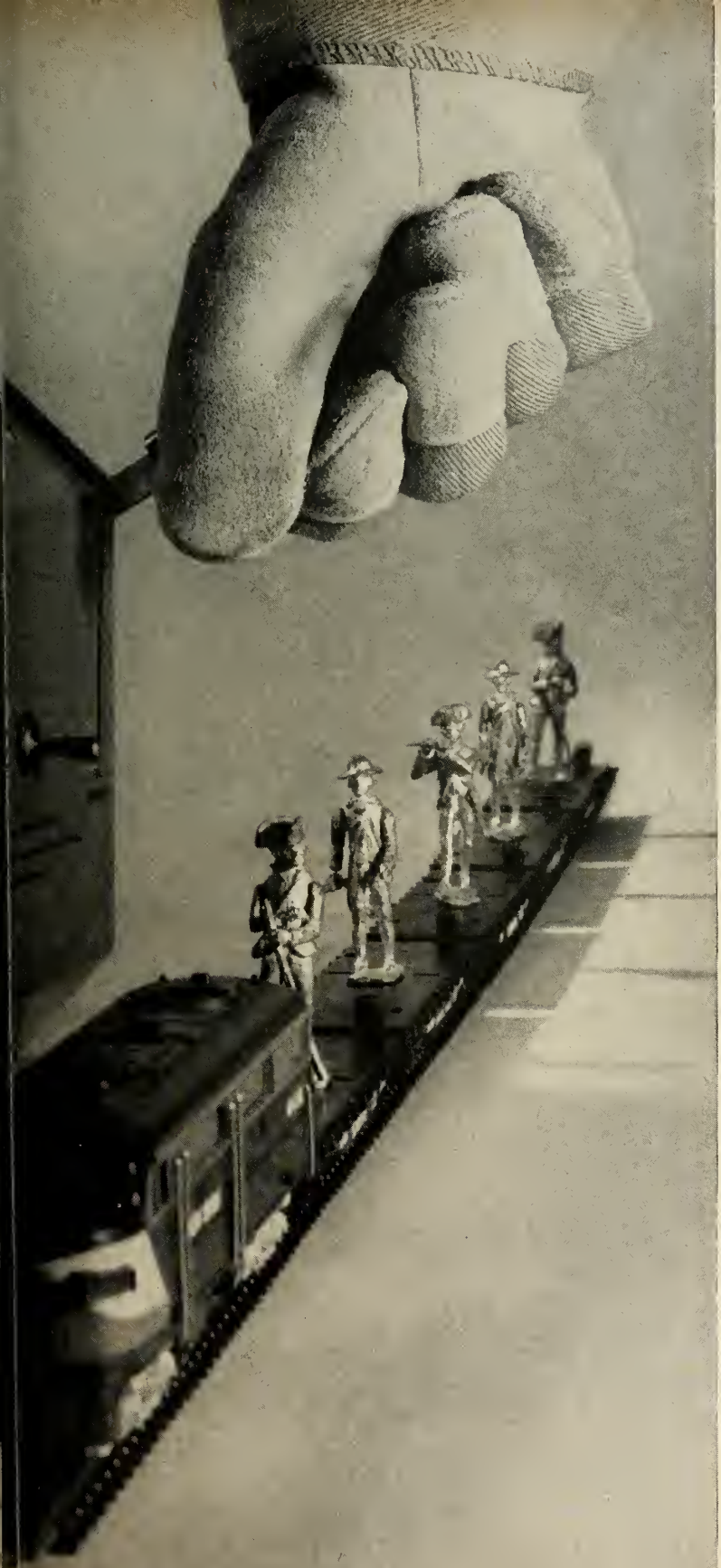
• **Human burden relieved**—NTDS works at fantastic speeds. Action information coming from radars, sonars, radio, IFF, ECM systems, and human sources goes into shipboard data-processing equipment. Here such functions as identity, size, location, detection, tracking, and speed of friendly and enemy vehicles are worked out in transistorized Univac computers that form the "brain" of the system.

The Navy says the NTDS coordination of data will go far to eliminate problems arising from human relay of information. Much of the tiring, repetitive routine will be lifted from operating as well as command echelons, allowing more time for judgment and decision.

Heart of the NTDS is the Univac Advanced Navy Computer (AN/USQ-20). The entire computer measures only 3 x 3 x 6 feet and contains 3776 identically packaged electronic circuit modules.

It is a general-purpose, stored-program machine with a very high-speed, random-access memory containing 1,000,000 bits of information. Thirty bits, comprising a single word, may be extracted from any location in the memory in only 2.5 millionths of a second.

The computer solves a given problem by executing instructions stored in



He's got Minutemen "working on the railroad"

Hard basing is one way to protect America's force of retaliatory ICBM's. The problem was to find an alternate means of accomplishing the same mission. The Air Force solution was a new ICBM mobility concept—railroad car-mounted Minutemen, utilizing the nation's vast track mileage for numerical and geographical dispersion, creating a difficult target for enemy attack.

To put the Minuteman, its support systems and associated equipment on rails was a completely new problem in missile handling. The first requirement assigned by Boeing to American Machine & Foundry Company and ACF Industries, Inc., was a feasibility study of the existing limitations of roadbeds, rails, railroad operations and right-of-way. Unique tactical cars are being designed within these limitations to carry the Minuteman—cars that can handle the missile and its operating equipment, safely isolated from roadbed shock and ready for immediate retaliatory launching.

Single Command Concept

Whether for conceptual problems such as this one, or for challenges in design or manufacturing, AMF has ingenuity you can use. AMF people are organized in a single operational unit offering a wide range of engineering and production capability. Its purpose—to accept assignments at any stage from concept through development, to production, and service training...and to complete them faster in

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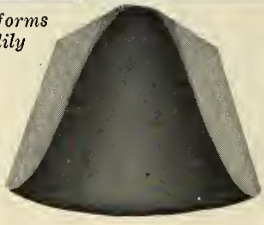

Machines cleanly

J-M THERMOMAT creates components and parts that withstand tremendous heat and pressure . . . offer maximum resistance to flame erosion.

Here's a new development from the Johns-Manville Research Center! A conformable new asbestos molding material which, in final form, meets the extreme demands of rocket and missile applications. Thermomat is a tough, pliable asbestos felt sheet, saturated with phenolic resin.

Thermomat has proved its dependability as a flame shield . . . as a rocket motor liner inside the metal casing of a solid fuel combustion chamber . . . and in nose-cone applications. Project engineers working on a missile project found that when used in a ⅛-inch thickness, Thermomat protected the metal casing of a solid fuel combustion chamber operating at 5000 F for about 90 seconds, in areas where no flame erosion occurred. Asbestos is the "magic mineral" that contributes greatly to Thermomat's exceptional ability to withstand extreme temperatures . . . and resistance to abrasion and erosion during the ablation process.

MOLDERS like to work with Thermomat because it is in sheet form and handles so well. Fibers are free-flowing during molding; joints and seams work readily together, like putty. Thermomat's remarkable draping ability saves many hours of lay-up time. Even in intricate molding, non-fillouts are reduced to a minimum, and parts machine well after molding.

Same material can be molded at low pressures as well as at extremely high pressures. It is supplied in sheets 14" wide...approximately 12' long...and 3/16" thick. Molders are invited to write for samples of this remarkable material. Write to Johns-Manville, Box 14, New York 16, N.Y. In Canada: Port Credit, Ontario.

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its memory. The instruction list consists of 64 operations which the computer is capable of performing.

• **Small but fast**—A list of instructions, called a program, using combinations of the basic 64 computer instructions, controls machine operation. The machine's ability to complete an instruction in only 20 millionths of a second—or 50,000 instructions in a single second—is an indication of its great speed.

New design concepts and the use of transistor-diode circuitry, rather than the conventional vacuum tubes, account for the computer's small physical size. Although it occupies only about nine sq. ft. of floor space, the computer does the work of two Univac 1103 computers, each of which occupies about 1400 sq. ft. of floor space. Power consumption is 2.5 kw.

Overall system responsibility and operational concept and guidance for NTDS rested with the Chief of Naval Operations. The Bureau of Ships, aided by the Navy Electronics Laboratory, has been responsible for system technical-design contract administration and hardware implementation. Hardware was developed and built by various contractors—Remington Rand Univac, Hughes Aircraft Co. and Collins Radio Co.—and the system complex assembled by NEL.

STL Study Aims at Better Batteries for Spaceships

A limited test program being conducted by Space Technology Laboratories under an NASA contract should aid the nation's battery manufacturers to properly direct their development efforts.

STL is seeking to determine the mode of failure of the *Pioneer V* batteries and to determine performance limitations of presently available storage cells for use in space vehicles.

STL, answering an inquiry by M/R, said there are three areas in which extensive effort is required to obtain reliable, long-life, sealed storage batteries in the immediate future.

First, extensive testing must be accomplished to predict performance characteristics.

Second, critical analyses of cell failures are required to explicitly determine failure modes and areas in which R&D are required.

Third, after determining the limits of performance capabilities in the space environment and the modes in which the capabilities are limited, funds must be appropriated to enable battery manufacturers to conduct R&D programs to improve electrochemical and manufacturing processes.

Aerodynamic Re-entry Form Favored by NASA, Soviets

Scientists on both sides of the Iron Curtain declared last week that an aerodynamic shape like *Dyna-Soar* is better than a ballistic shape like the *Mercury* capsule for re-entry from orbit or deep space.

The reports come from Inna Yavorskaya, scientific secretary of the Interplanetary Travel Committtee, Soviet Academy of Science, and from Thomas H. Wong and Robert E. Slye of the Ames Research Center of the National Aeronautics and Space Administration.

Miss Yavorskaya made her statement in an article, "Man Will Fly into Space," submitted to the American press through the Soviet Embassy in Washington.

Recalling that air drag acting on a fast-flying object generates vast amounts of heat, she said:

"This makes it essential to slow down the speed of re-entry by aerodynamic means. The testing of new ballistic missiles in the Pacific last January was of great interest from this point of view. The dummy final stages of the rockets had been protected from heating by a special technique and landed intact in the prearranged area."

Miss Yavorskaya gave no indication of the special technique used for heat protection.

Wong and Slye made their comment in a NASA technical report, "The Effect of Lift on Entry Corridor Depth and Guidance Requirements for the Return Lunar Flight."

• **Rations**—The use of lift in amounts producing relatively small lift-drag ratios increases the usable depth of the entrance corridor, they found.

If maximum decelerations are limited to 10 g, they said, the corridor depth increases from 8 miles for a ballistic vehicle to 44 miles for a vehicle with L/d of 0.47. If 20-g deceleration is allowable, the depth increases from 22 miles for a ballistic vehicle to 104 miles for one with L/d of 0.84.

If higher lift-drag ratios are used, the corridor depth increases—but so does maximum deceleration.

Miss Yavorskaya outlined three major possible methods of solving the re-entry problem. Firing of retro-rockets is very dependable, she said, but the necessity of carrying a big fuel supply into orbit puts the retro-rocket "outside the bounds of feasibility for the time being."

Use of air drag for braking, she declared, does not guarantee an adequate landing accuracy.

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Many of the aero/space age's most precise components are being mass-produced today at Eclipse-Pioneer. An example: inertial guidance systems for second-generation missiles... a true test —and proof—of E-P Knowmanship in action.

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Far more than a prototype, this aero/space-age facility is a going concern, ready to go to work on *your* problems. Benefit from Eclipse-Pioneer's Knowmanship, developed through 40 years' close association with the aero/space industry. Write today—describe your problems—utilize our capabilities.

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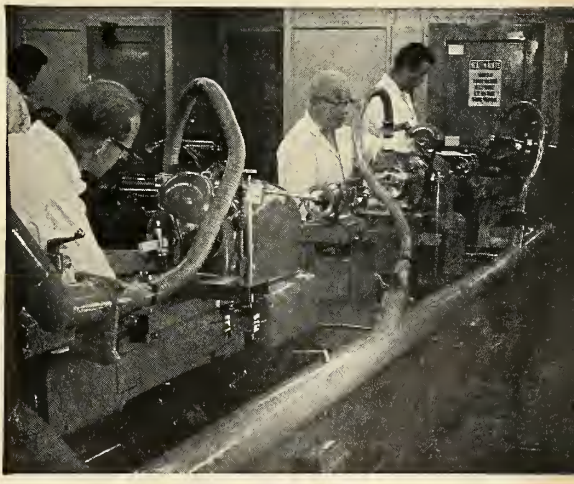

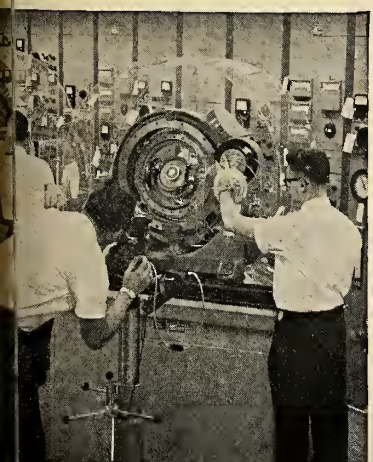

← SUPERFINE TEST AND CALIBRATION. E-P checkout facilities include: Single axis and planetary sidereal test stands accurate to .005° per hour; indexing heads with an accuracy of ± 2 seconds of arc used for calibrating pendulous integrating gyros; turn-tilt stands positionable to ±5 seconds of arc; and ball disc integrator test stands accurate to .0025%. Calibration equipment was bench-mark-positioned by certified geodetic survey.

↑ BERYLLIUM—SPACE-AGE METAL. Here, in a completely enclosed, temperature-controlled room, highly skilled E-P machinists work with beryllium. Parts such as gyro components for missiles are produced to tolerances of ± 10 millionths of an inch. For the exacting demands of this kind of production, entirely new concepts in machining, quality controls and safety engineering were developed by Eclipse-Pioneer.

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By DOD advisory group . . .

Drastic Changes in Parts Specs Urged

Proposed management methods—if adopted—would have top-to-bottom effect on government and industry

by Donald E. Perry

Three years ago, a Pentagon advisory group recommended that some bold steps be taken in the management of electronics parts specifications to insure reliability.

Now something is finally being done about it: another group has made more recommendations.

It appears, however, that the new proposals will have a major impact on both government and industry, from management down. Will have, that is, if they're adopted; many of the suggested procedures are radical departures from established methods.

This month, in any case, a program to implement the new recommendations will be submitted to Dr. Herbert F. York, Director of Defense Research and Engineering, and Perkins McGuire, Assistant Secretary of Defense (Supply and Logistics).

• **Background**—In June, 1957, Task Group 5 of the Advisory Group on Reliability of Electronic Equipment reported that the fast-changing state of the electronics art required:

–More electronic parts and tube specifications.

–Faster coordination of specs.

–More dissemination of technical characteristics data to design and logistics personnel.

–Complete review of parts specifications, to provide both compatibility and reliability.

Thirteen months later, an Ad Hoc Study Group on Parts Specifications Management for Reliability was established under the sponsorship of York's and McGuire's offices.

Under the chairmanship of Paul S. Darnell, of Bell Telephone Laboratories, the study group has now come up with specific recommendations. It has mailed to industry a two-part, 235-page report which details an organization structure and establishes three prototype specifications, together with new procedures for refining the technical documentation of parts characteristics.

• **Indictments**—The report criticizes "unsuitable and inadequate" specification organization and management on the part of DOD and the military services. It makes these points:

–Trouble stems primarily from management and organization—only secondarily from technical inadequacies.

–The services have regarded parts specifications and standardization programs only as "part-time" efforts, and have not given them the attention they deserve in view of their huge potential for saving dollars and improving equipment reliability.

–There is a tendency to make non-technical people responsible for revising and developing specifications—with the result that practically all specs are out of date in terms of industry know-how.

–Some management has been "totally unable" to cope with the simple problem that arises when an individual in one of the services will not agree with certain words in a spec suggested by someone in another service. "Because he will not agree," the study group said, "and because there is no suitable procedure for reconciliation, coordination cannot be completed and the disapproving military service is accused of non-cooperation."

The report emphasized that the need for suitable specifications management is the most serious problem in the military parts picture.

"A major overhaul in the present system of specification preparation and administration and the injection of some radical new concepts in specification structure, objectives and requirements are long overdue," it declared.

• **Recommendations**—The study

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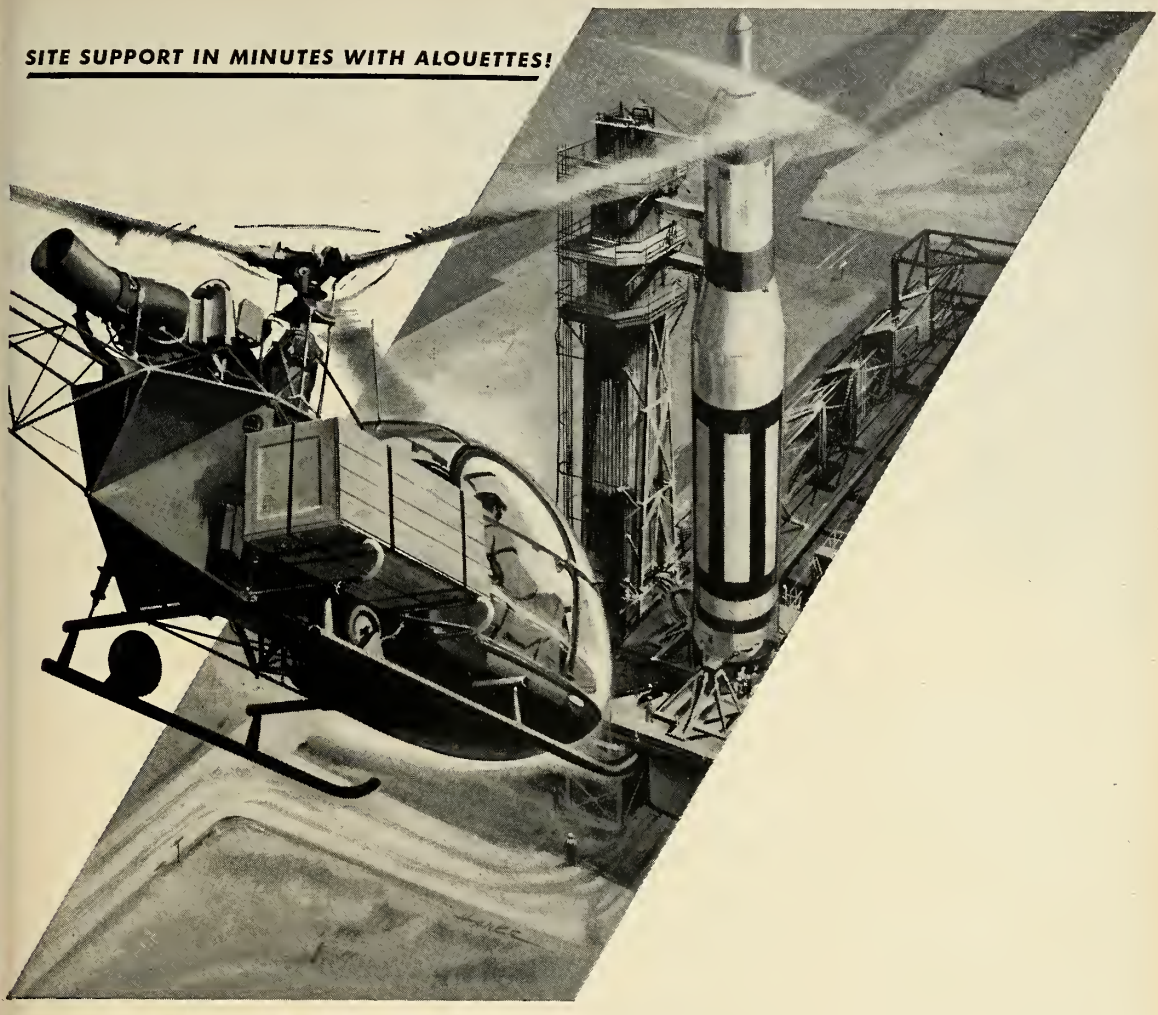

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*Our defense and offense complex must function in a matter of minutes. Reliable missile site support in "minutes" can be maintained by instant-starting, jet-powered Alouette * helicopters, world's only time-proven turbine copter. An Alouette Site Support Program is immediately available to the military—with tested reliability, and low maintenance and operational costs — at ONE-HALF THE COST of comparable programs.*

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group urged that:

1. An Advisory Group on Management of Electronics Parts Specifications be established as an activity of McGuire's office, reporting directly to him. Members would be appointed by McGuire, with the coordination of York's shop. Members would have both management and technical experience in electronic parts, tubes and semiconductors; the electronic-systems design area; and the engineering, procurement and logistics areas of DOD. All programs on electronic-parts specification development and technical documentation, and their management, would be channeled through the Advisory Group.

2. The Armed Services Electro-Standards Agency be organizationally relocated under McGuire's jurisdiction, providing administrative and secretarial support to the Advisory Group.

3. The office responsible for standardization in OSD (S&L) prepare and recommend DOD policy and plans for implementation of development of specs, standards and handbooks.

4. Parts specifications include some new procedures for accumulation of life-test data, over an extended period of time, from tests carried out in acceptance inspections. Failure rates would be computed from these accumulated data, with the specification establishing several graduated failure-rate levels.

5. The present "Qualified Products Lists" be changed to "Approved Sources of Supply for Qualified Electronics Parts List." Besides submitting qualification test data for initial approval, manufacturers also would have to provide evidence that they have adequate production and test facilities and employ sound procedures for process and quality control.

Specifications would also provide for separate identification of items having different established failure-rate levels by using different part numbers. The manufacturer also would be required to assure continued conformity with the specification through routine submission of test data collected during acceptance inspection.

6. All parts specifications require the manufacturers to provide test data on the parts supplied.

7. DOD issue a single new policy manual to standardize design and procurement documentation for military components.

8. Use of contractor's specifications be reduced by upgrading existing military specifications with respect to environmental requirements.

9. Contractors and the military departments insist that all specification test requirements be carried out by the parts manufacturers prior to shipment of the parts.

Welding Method Joins Thin, Thick Metal Parts

A new method of resistance welding which permits joining of ultrathin materials to thick plates has been developed at the Ryan Aeronautical Co.

The company says the method is particularly suited to welding thin sheet metal of a few-thousandths of an inch thick (up to .016 in.) to plates whose thickness ratio exceeds four to one, or any thin metals to thick in parts for Space Age rockets and missiles.

The new system is said to produce a uniformly accurate and securely bonded structure. Conventional resistance welding frequently results in the weld nugget forming within the thick material instead of equally at the interface. This is not true of the Ryan method.

In this type of welding, an electrode is applied under heavy unit pressure at the spot to be welded; a heavy pulse of current is supplied to the electrode and the electrode contact pressure is continued until the weld nugget cools.

Welding apparatus for the new method is relatively simple, consisting of a power supply, timing mechanism and a pressure system.

The power source is connected to opposite ends of the primary winding of a transformer; one function of the timer is to control discharge through the winding. The secondary winding of the transformer is connected to one end of the welding electrode. The other end is either grounded to the welding table or attached to the thicker of the two materials being joined.

When the current is released through the primary winding, it causes a pulse of welding current to flow in the secondary winding. The transformer thus sends a heavy current flow at low voltage through the welding electrode. Ryan says a current of about 40,000 amps. at two volts has been used satisfactorily.

• **Pressurization critical**—Although a wheel-type electrode is said to be ideally suited for use in the process, other types can be used if pressure is accurately controlled. Pressurized to hold the materials together at the point of weld, the wheel rolls along the surface of the thin material to produce a row of space spotwelds.

The timer controls both power and pressure application, with timing varying according to materials used and type of welding performed.

Critical factor is the surface resistance at the interface. Since the surface finish of thin sheet metal is generally smooth, the interface resistance

can be made nearly constant by careful control of electrode pressure.

Greatest heat build-up is at the interface, which provides virtually the entire resistance to the welding current. For this reason, the weld nugget forms equally at the contacting faces of the materials.

Accurate control of pressure after welding is necessary to prevent cracking and expulsion of the foil gages. With a wheel electrode advancing 15 inches per minute, making 10 welds per inch, it was found that electrode pressure was maintained long enough to avoid cavitation.

Experiments indicated that with types of welding requiring longer weld periods, excess heat generated in the weld area resulted in such slow cooling that it was impractical to maintain the required follow-up pressure.

The new method was developed by Ryan welding engineers John R. Fullerton, Laurence E. Leech and Donald L. Heyser. They have applied for patents, assigning the rights to Ryan.

Ion Engines May Utilize Water-Permeable Tungsten

In the production of controlled density tungsten, Firth Sterling Inc. has come up with an interesting by-product—truly porous tungsten.

The company has been working with fully sintered tungsten bodies, varying in density from 50% of theoretical to 95% of theoretical. The techniques involved are being utilized to produce permeable tungsten with theoretical densities from 50% to 75%.

Although parts are being fabricated, physical and mechanical data for all the densities have not yet been determined. At 55% theoretical density, the material shows room-temperature properties including cross break at 4500 psi, tensile strength of 7500 psi (Armour Institute ring tensile method) and thermal shock resistance up to 3200°F with indications that the erosion resistance should be good.

The tungsten is permeable to water at atmospheric pressure.

Such tungsten can be used for rocket nozzle inserts, either impregnated with a plastic which will decompose upon heating to liberate a cooling gas such as hydrogen, or as part of a liquid-cooled assembly where the metal may be used as a throat insert for releasing coolant into gas stream, or as a reservoir for the coolant.

Electronics offers other possibilities. The tungsten may be utilized in emitter tubes and electron tubes.

Plasma and ion propulsion devices may create other applications, such as porous discs in ion engines and circulation-cooled nozzle components.

3M Materials Memo

News of materials for the aerospace industry—selected from the 27,000 products of the 3M Company

Throw The Book At You?

Not this one! But we'll be happy to send you a copy if electrical casting resins are your diet. This particular book is actually a brand new reference manual on 3M's series of "Scotchcast" Electrical Resins. Its proud parent, our ELECTRICAL PRODUCTS DIVISION, would throw up its collective hands in horror at the mere thought of its being even considered a catalog. They've gone all out to insure that this manual will be an equally useful tool for old pro and tyro alike.

You'll find within the 28 pages heavy emphasis on techniques and tips for using casting resins. These cover such aspects as component design, molds and mold releases, resin storage and application, special equipment and all sorts of other "pointers for potters." Then there's the

guide to selecting the proper resins for given electrical applications. Beefing it up still further are tables of physical and electrical property data on the "Scotchcast" family of resins.

This book's a real collector's item. Why not cast off your electrical insulation problems by getting your own copy? Just check the box below.

Caged Radiation

If you've been anxious to put radioactive isotopes to work *for* you, but have been afraid they may end up working *on* you, this will be a welcome bit of news. These hot little personalities have been tamed in a way that makes them even more useful and yet substantially reduces the handling hazards. The isotope is literally caged in tiny ceramic beads, approximately 50 microns in diameter. The union between ceramic and isotope is actually a chemical bond which keeps

miscellaneous solvents, chemicals, and even the human digestive system from leaching out the radioactive material. Our CENTRAL RESEARCH LABORATORIES have refined the process to such an extent that they can now treat almost any of the radioactive isotopes.

The products, known as Radiating Microspheres, lend themselves well to a variety of industrial and medical applications. Being uniform in particle size, and free flowing, they can readily be incorporated in a variety of products. Their use in detectors for film thicknesses and densities or as tank level indicators is a natural, thanks to their chemical resistant overcoats.

Nor do the possibilities end there. Encased in suitable plastics, the Radiating Microspheres can form self-energized luminous instrument dials, signs, etc. Let our Central Research Laboratories tell you how Radiating Microspheres can brighten your future, too—by checking the box below.

Paper Shufflin'

It may seem mundane to talk about paperwork in the highly sophisticated aerospace industry, but correspondence is more than ever becoming the businessman's burden. Indeed, we wonder if a pound of hardware isn't accompanied by a pound of correspondence! There are two bad features about this nightmare of paperwork. One is the time required to handle it and the other is the space required to store it. Our DUPLICATING PRODUCTS DIVISION has come up with two time and space savings ideas to help you solve your paper work problems.

One of these is the fabulous "Filmac" Reader-Printer for reading Microfilm and making instant projection prints. It was described in an earlier issue.

The other is an idea called the Short Note Reply, and sometimes known as the SNR system. It works like this. You get a letter or memo which requires a short reply. Instead of dictating an answer and putting it into the steno pool, you simply write your answer at the bottom of the copy of the letter. A dry copy is then made on a "Thermo-Fax" Copying Machine and returned to the sender. You have the original for your files and he has a copy for his. After you've written your reply, the copying process takes only 4 seconds. For more information on this time saving method of handling correspondence check "Thermo-Fax" Copying Machine on the coupon below.

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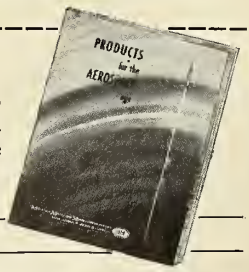

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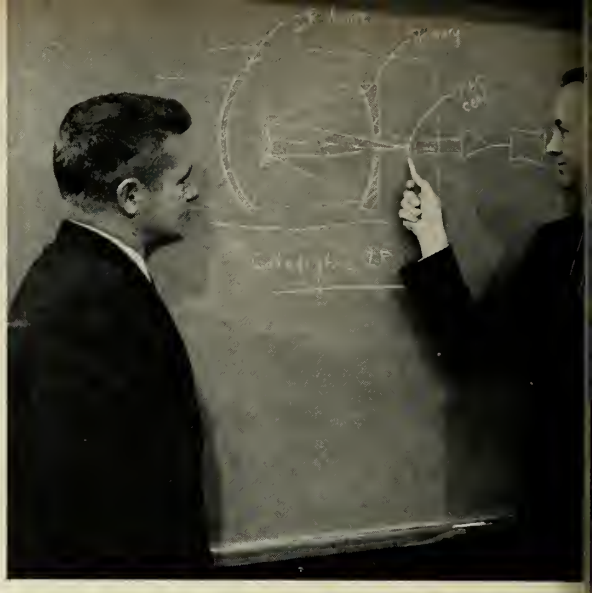
CITY_____ ZONE_____ STATE_____

"This missile age af aurs requires vast scientific and engineering technalagy. MISSILES AND ROCKETS keeps us pasted in this market that expands daily." D. M. Tenenbaum (left), Mgr., Test Divisian, Sacramenta Plants.



"Technical news develapments cancerning the industry are a day-ta-day accurrence. MISSILES AND ROCKETS keeps us right up ta date." Dr. R. H. McFee (right), Dir. af Research, Aerajet-General's Avianics Divisian.

WHY DO SO MANY KEY PEOPLE AT AEROJET-GENERAL READ MISSILES AND ROCKETS?

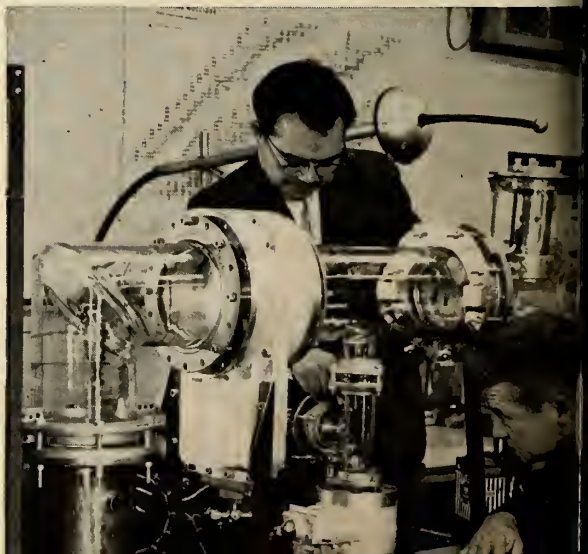
438 PAID SUBSCRIPTIONS! One of the outstanding leaders in the research, design, development, and production of both solid and liquid propellant rocket engines, Aerojet-General ranks 19th among all major defense contractors. Naturally, there are a large number of paid subscribers to MISSILES AND ROCKETS at Aerojet-General—438, to be exact. And since many of the copies have high pass-along readership, there is an even larger number of readers at Aerojet-General.

Some of the many reasons why M/R commands intense readership among key people at Aerojet-General are given in the picture story. They were obtained as a result of a recent visit to the company by M/R Editor Richard Van Osten (insert).

These comments and those of other key readers in other missile/space companies clearly show what M/R has known all along . . . that the missile/space industry is a separate, distinct market with rapidly changing requirements that can best be met by *undiluted, weekly* technical/news coverage. It is this kind of coverage that makes M/R unique . . . explains its deep, penetrating readership and acceptance.

"Tadays missile industry evalved fram the ald cancept af the aircraft-missile business but each is naw a separate and distinct industry. We read MISSILES AND ROCKETS far that very reasan. It deals 100% with Astranautics." M. L. Stary, Directar, Aerajet-General's Systems Divisian.

"In this yaung industry it is absalutely necessary that engineers be filled in an new data as it develaps. MISSILES AND ROCKETS pravides a camplete, clear picture weekly af what's happening in the field af Warld Astranautics." Dr. G. Mae (left), Aerajet-General's Space Technalagy Divisian.



names in the news

Peter Macdonald: Goodyear Aircraft Corp.'s Washington representative for the past five years, named general manager of The Goodyear Tire & Rubber Co.'s Washington office. He succeeds **George M. Riveire,** who has retired.

Dr. E. John Whitmore: Joins Sylvania Electric Products Inc., as manager of development engineering at the Williamsport facilities of the company's Special Tube Operations. Was formerly chief engineer for the Canadian Marconi microwave tube plant.

John E. Peterson: Former associate manager, appointed director of materiel for Space Technology Laboratories, Inc., succeeding **Fran M. Brown,** who has joined the staff of Aerospace Corp.

Thomas T. Witkowski and **John T. Underhill:** Appointed director of Long Range Planning and Operations manager, respectively, for Cubic Corporation. Both were project engineers at Convair prior to joining Cubic in 1956 and 1957.

Dr. George J. Mueller: Named chief of development planning for the Systems Support Dept. of Northrop Corp.'s Nortronics Division. Previous posts: Management consultant on advanced technical programs, American Corporate Services, Inc.; systems technology advisor, Thompson Ramo Wooldridge, Inc.; director of engineering, Packard Bell's Technical Products Division, and technical director, Allen B. Dumont Laboratories.

Edwin A. Speakman: Elected division vice president, Missile Range Programs, for the Government Services Department, RCA Service Co. in charge of RCA's Test Missile Project at Patrick AFB. Prior to joining the firm as manager of planning, Defense Electronic Products, he was vice president of the Fairchild Engine and Airplane Corp. and general manager of Fairchild's Guided Missiles Division.

Dr. Alden Stevenson: Appointed director of research at Pacific Semiconductors, Inc., relieving **Dr. Peterson,** for administrative duties. Dr. Stevenson will also continue as materials research program director.

Col. George Cechmanek (USAF-ret.): Joins Grand Central Rocket Co. as Corporate Counsel. Was most recently assigned to ARDC as chief legal counsel.

James E. Michaels: Appointed supervisor of the Astro Systems Branch, Astro Systems and Research Laboratories at Northrop Corp.'s Norair Division. Previously served with the Space Sciences Laboratory of General Electric's Missile and Space Vehicle Dept. and most recently as project engineer of General Electric-Wright Air Development Division's interplanetary trajectory study.

Rear Adm. H. C. Bruton (USN-ret.): Named vice president-planning for the Military Products Division of Hoffman Electronics Corp.

Michael J. Donnelly and **Dr. R. H. Sanders:** Join Controls for Radiation, Inc., as head of the Reactor Chemistry Dept. and senior biologist in the Radiation Biology Dept., respectively.

Davis Factor, Jr.: Former assistant to the president, promoted to director of advertising at Eldon Industries, Inc.

Rohert Spies: Former engineering specialist for Sundstrand Turbo, joins the technical staff of Electro-Optical Systems, Inc., as a scientist in the Energy Research Division.

Wilbert W. Toole: Named manager of Electronics and Support Systems in the Customer Service Division of McDonnell Aircraft Corp. Was formerly with Avco

Corp.'s Crosley Division, responsible for marketing activities.

J. Norman Rossen: Elected director of the Solid Propellant Division of Atlantic Research Corp., succeeding **Presson S. Shane**, elected vice president. Rossen was formerly head of the Rocket Ballistics Group and assistant director of the solid propellant division.

Boyd W. Granger: Joins International Resistance Co., as marketing research manager, succeeding **Martin Zwerin**, promoted to manager of business planning. Granger was formerly Philco Corp.'s Lansdale Division director of market planning.

Rudolph C. Schmidt: Named sales manager of Universal Transistor Products Corp. Was formerly associated with Fairchild Camera & Instrument Corp.

Virgil W. Wall: Appointed director of engineering for Telecomputing Corp.'s Electronic Systems Division, succeeding **Melvin B. Kline**, named to the new position of assistant to the general manager. Wall was previously manager of Raytheon Co.'s Advanced Development Dept.; chief engineer, G. M. Giannini & Co. and radar supervisor, North American Aviation, Inc.

Dr. Lawrence F. Jones: Joins United Aircraft Corp.'s Norden Division as chief-digital group in the engineering department. Was formerly advisory engineer in charge of the digital computer group for Westinghouse Corp.'s Air Arm Division.

J. Bryan Straley: Elected president of Reeves Instrument Corp., a wholly owned subsidiary of Dynamics Corporation of America. Was formerly executive vice president of the firm.

F. Robert Mayer: Joins Amcel Propulsion Inc., as manager of advertising sales promotion. Was formerly responsible for advertising, public relations and sales administration for the Reaction Motors Division of Thiokol Chemical Corp.

Bert J. Gastineau: Former chief Engineer of Aerojet-General Corp.'s Avionics Division, elected manager, succeeding **Richard W. Powell.** Gastineau, who joined the firm in 1952, has been associated with the infrared sight for the F104, *Sparrow II, Midas* and other classified projects.

G. William Bauer: Joins Stauffer-Temescal Co. as sales engineer responsible for sales, marketing and customer relations.

Mark W. Bullock: Promoted to vice-president in charge of engineering for Continental Electronics Manufacturing Co., a subsidiary of Ling-Temco Electronics, Inc. Was formerly manager of Continental's production division.

Robert Hansen: Appointed sales and marketing manager for the Electron Division of Controls Company of America.

NEW ERA OF WESTERN DEFENSE

Navy launches first Polaris missile from submerged sub

Erupting from Atlantic waters off Cape Canaveral July 20, a slim white Polaris missile fired from the nuclear submarine U.S.S. George Washington launched a new era of defense. Arching skyward on a column of flame, the Polaris made its clear contribution to the security of free nations before it shook off its last drops of brine. To further demonstrate the missile's dependability, the Navy then launched a second Polaris from the nuclear sub. This was the climax of a remarkable 47-month race to develop the Navy's Fleet Ballistic Missile Weapon System. Combined for the first time were a nuclear-powered submarine, hidden in ocean depths and able to cruise anywhere, unseen for months, and a powerful missile, so compact a single sub can carry 16 of them with nuclear warheads. The Polaris gives America a defense that cannot be overwhelmed by surprise attack, a defense that will work for peace by making aggression unthinkable. Lockheed is prime contractor and missile system manager for the Polaris missile. Aerojet-General Corporation is the subcontractor responsible for the missile's rocket motor, General Electric Corporation for its guidance system, and Westinghouse Electric Corporation for the launch system. The U.S.S. George Washington was built by the Electric Boat Company.

LOCKHEED

MISSILES & SPACE DIVISION, SUNNYVALE, CALIFORNIA

contracts

$44,000,000—**Rocketdyne**, Canoga Park, Calif., for development of a 200,200-lb.-thrust hydrogen-fueled rocket engine.
$1,950,000—**Progressive Welder & Machine Co.**, Pontiac, Mich., for engineering, design, fabrication and related services for the manufacture of tooling in connection with various space programs.

NAVY

$8,376,034—**Grumman Aircraft Engineering Corp.**, Bethpage, N.Y., for production of *Eagle* missile airframes, propulsion system launcher and modification of test bed aircraft.
$1,000,000—**Packard Bell Electronics Corp.**, Los Angeles, for production of the AN/ASQ-10 advanced airborne electronics system.
$1,000,000—**Telecomputing Corp.**, Los Angeles, for sonar processing equipment.
$252,000—**Electronic Specialty Co.**, Los Angeles, for timing fuzes for the *Genie*. Subcontract from **Douglas Aircraft**.
$122,588—**The Heil Co.**, Milwaukee, for parts for missile containers (Two contracts).
$80,572—**The Flexible Co.**, Loudonville, Ohio, for frame and lid assembly for missile containers.

MISCELLANEOUS

Instruments for Industry, Inc., Hicksville, N.Y., for developing and manufacturing a missile system gyro test set. Contract from **American Bosch Arma Corp.'s Arma Division.**
$1,165,000—**Specialty Electronics Development Corp.**, Syosset, N.Y., for communication and countermeasure devices and radar test equipment.
$918,000—**William T. Lyons Co., Inc.**, Baltimore, for construction of a complex of buildings, test cells and associated facilities to house a hypersonic propulsion research laboratory. Contract from **Applied Physics Laboratory of The John Hopkins University.**

ARMY

$2,400,000—**Sylvania's Waltham Laboratories**, for development, fabrication and installation of two 60-foot ground antenna systems for *Advent*.
$276,741—**Martin Construction Co.**, Cocoa Beach, Fla., for construction of a *Minuteman* firing tube in two existing concrete silo caissons at Cape Canaveral.
$76,000—**North American Aviation, Inc.**, Columbus, Ohio, for testing a revolutionary concept in antitank missiles.

AIR FORCE

Controls for Radiation, Inc., Cambridge, Mass., for installation, calibration, maintenance and performance of all nuclear radiation protection services at Hanscom Field. Amount not disclosed.
The Rucker Co., Oakland, Calif., for hydraulic and pneumatic power and control equipment for three *Titan* missile launching sites at Larson AFB. Amount not disclosed.
The Garrett Corp.'s AiResearch Manufacturing Division, Phoenix, for applied research on advanced solar space power heat. Amount not disclosed.
$1,000,000—**General Bronze Corp.**, Garden City, N.Y., for acquisition and tracking antenna systems on the *Mistram* project. Subcontract from **General Electric Co.'s Defense Systems Dept.**
$665,600—**North American Aviation, Inc.**, Canoga Park, for installation of facilities for the rocket engine program.
$571,000—**Electronic Specialty Co.**, Los Angeles, for a complete airborne missile tow target for the Century jet fighter series.
$541,498—**The Marquardt Corp.**, Pomona, Calif., for AN/GPS-T4 (v) radar signal simulators.

Martin-Baltimore's Subcontracting

The Martin Co.'s Baltimore divisions spent $23 million in subcontracts during the first half of 1960—more than half of it with small businesses.

Baltimore and Nuclear Divisions let a total of 41,487 subcontracts during this period, to firms in 75% of the States of the Union. Maryland, Martin's home base since 1929, received the most subcontracts—19,757 subcontracts having a value of $6.7 million. New York was second with 5158, totaling $3.1 million. California ranked third with 3913 totaling $2.4 million.

Others: fourth, Pennsylvania, 2813 totaling $2.3 million; fifth, New Jersey, 2606 at $1.7 million; sixth, Ohio, 990 at $1.2 million; seventh, Massachusetts, 1195 at almost $1.

The Baltimore division produces the Air Force *Mace*, the Navy Marlin seaplane and components for *Titan*, *Pershing*, *Lacrosse* and *Bullpup*.

The Nuclear division manufactures atomic powerplants, isotopic power devices and nuclear components. Several types of advanced nuclear reactors and atomic propulsion systems are under development.

The figures do not include Martin's other divisions at Orlando and Cocoa, Fla., and Denver.

reviews

BASICS OF GYROSCOPES (two volumes), Carl Machover, John F. Rider Publisher, Inc. New York. Vol. 1, 112 pp., $3.30; Vol. 2, 120 pp., $3.30.

These books present for the non-specialist a basic explanation of the principles underlying the science of gyroscopics. Mathematics are included only where they are essential to comprehension of gyroscope principles.

The books begin with an explanation of the construction and the physics of gyroscope operative. Then they advance to the Commercial types of gyroscopes and their utility for stabilizing purposes, as used in equipment commonly bound to the earth's surface.

Then the author details the changes in gyroscope construction and design as required for application in space vehicles, missiles, etc. Numerical examples are employed to illustrate the operation of the gyroscope.

VIDEO TAPE RECORDING, Julian L. Bernstein, John F. Rider Publisher, Inc., New York. 272 pp., $8.95.

This book deals predominantly with the recording of television signals and considerable space is devoted to electronic photography.

Techniques and mechanics of recording are reviewed and then the specifics of video recording are explained. The various types of tape transports, video track patterns, and basic block diagrams of a television tape recorder are discussed at length.

From this point, the discussion advances to the latest types of equipment in current usage. The video system is discussed in detail, with explanation of the various recording playback circuits and demodulators given.

FUNDAMENTALS OF TRANSISTOR PHYSICS, Irving Gottlieb, John F. Rider Publisher, Inc., New York. 267 pp., $3.90.

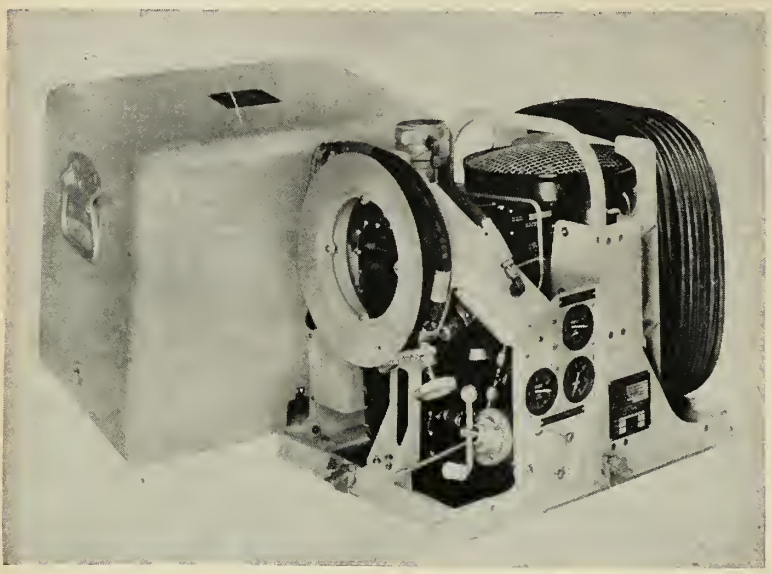
This text provides a thorough analysis of the action of semiconductors from the physics viewpoint. Semiconductor physics is presented in stages, beginning with the theoretical aspects and culminating in the practical transistor and its fundamental circuit. Transistor circuit operations are dealt with only as they amplify the theory.

Of interest to those concerned with recent developments in transistor physics are the four-layer diode, the bilateral transistor, the Zener diode, and the semiconductor variable capacitor. Also covered is the recently developed tunnel diode.

ROCKET SLED DESIGN HANDBOOK, McGraw-Hill Book Company, Inc. New York.

Provided are design philosophy and calculations, pertinent information regarding test tracks and facilities, proven construction practices, a basic glossary of sled terms, abstracts from many pertinent publications (with subject index), and a comprehensive bibliography.

The book represents the latest information and practical experience gained at test tracks throughout the U.S.



High-Pressure Dry Air Source

A portable air compressor assembly, recommended as a source of high-pressure dry air for missile ground support, test and checkout, is now being manufactured by The Cornelius Company, Aero Division.

The compressor and pneumatic system provides dry, compressed air at a regulated delivery pressure from 0 to 3000 psi.

Capacity of the compressor, Model 130R3500, is two cubic feet per minute of free air at 3000 lbs. psi. Operating speed is 4100 rpm.

The compressor is operated with a 200-volt, 400-cycle, 3-phase power source supplied by an auxiliary power unit. Weight of the unit, with carrying case and skid mount, is 93 lbs. Dimensions of the case are 16 x 18 x 21 in. Delivery pressure gauges are calibrated in 10-lb. increments to 600 psi and in 100-lb. increments to 4000 psi.

Circle No. 225 on Subscriber Service Card.

Liquid H_2 Ball Valves

Liquid hydrogen ball valves with low cool-down weight, for use in rocket engine development, have been delivered by Hydromatics, Inc.

Ranging in size from 3/8 to 8 in. diameters, the valves are encased in welded stainless steel vacuum jackets to insulate the valve body from the surrounding air. This minimizes heat transfer from the surrounding air, eliminating liquid hydrogen boil-off. Top loading permits disassembly for maintenance without removing the valve from the line. Zero leakage and self-lapping seat characteristics are built into the valves.

Circle No. 226 on Subscriber Service Card.

Mobile Welding Gun

A manual Aircomatic (gas-shielded metal-arc) welding MIGet gun and controls have been developed by Air Reduction Sales Co. The gun and controls are designed for use in light-to-heavy fabrication where numerous short welds, off the ground welding, or emergency repairs are necessary.

The gun carries its own compact reel of wire, wire feeding drive rolls, and complete-range wire speed control.

Circle No. 227 on Subscriber Service Card.

Folding Column

A power-operated folding column is available from Wayne Iron Works. It rolls in or out to form a rigid column capable of pushing or pulling heavy loads linearly with a steady force.

The column is formed of hinged links of steel or other channel that are wound helically around a power-operated drum. When equipped with a powering device, the drum feeds out or withdraws the column to transmit large forces. As it unrolls, the column is completely rigid in three directions; however, it must roll out over a flat surface to provide rigidity in the fourth.

Circle No. 228 on Subscriber Service Card.

Frequency Converter

A brushless frequency converter for single-phase drive designed to supply three-phase, 400-cycle power from a 60-cycle source is announced by Georator Corp.

Utilizing a low-slip, single-phase motor built into a cast aluminum shell, integral with a "NoBrush" 400-cycle alternator, the low intrinsic regulation characteristic of this unit eliminates the need for an external regulator. Output of the unit is three-phase, four-wire, 120/208 Volt, 2.5 KVA.

Circle No. 229 on Subscriber Service Card.

Sealless Water Pump

An extremely compact, low-cost, sealless water circulator pump combining motor and pump in a single leakproof unit has been announced by Dynapump Division of Fostoria Corp. The "canned" Dynapump Model 400A is equipped with rubber flanges for extremely quiet operation. It can be installed in any position. Measuring 6 in. x 7 in. and weighing 11 lbs., it handles up to 90,000 BTU an hour in systems with a 20° temperature drop.

It circulates up to 12 gpm and produces a 10-ft. head at shutoff. Designed especially for use on closed water systems free of foreign objects and materials, the Model 400A Dynapump has no stuffing box and requires no seal.

Circle No. 230 on Subscriber Service Card.

Antifouling Hoist

The Garrett Corporation's AiResearch Manufacturing Co. is now in production on its universal hoist, which incorporates a unique and highly de-

sirable positive antifouling mechanism.

Advantages offered by the AiResearch hoist include advanced antifouling mechanism, compactness, and light weight. The unit incorporates a 115/200-volt, AC, 3-phase, 400-cycle motor. It contains 15 ft. of ¼-in. cable capable of raising and lowering a 1400-lb. load at a minimum speed of 15 ft. per minute.

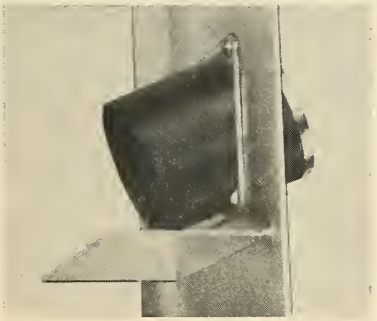
Circle No. 231 on Subscriber Service Card.

Low-Noise Cooling Blower

The Powair Series of Standard 2-in. blowers by Dean and Benson now guarantees 2000 hour life at 22,000 R.P.M.

The motor is a removable unit and is easily slipped out of the blower. All parts are also interchangeable and available as spares.

The 400 cycle motors of the blowers



are constructed of stainless steel and bearings larger in diameter than normally found in motors of this size. New construction versatility also allows endless combinations of flange mountings.

Circle No. 232 on Subscriber Service Card.

Nickel-Plated Couplings

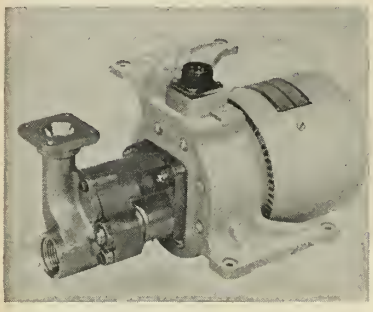
Quick-disconnect couplings, protected by electroless nickel plating are available from Snap-Tite, Inc.

The nickel plating on the coupling is free of voids. The conformity to the surface is so excellent that there is no observable void between the coating and the base material. Under normal conditions, abrasion resistance is very good, and the new plating process produces no effect on the tensile strength or ductility of the steel in the couplings.

Circle No. 233 on Subscriber Service Card.

Ground Radar Motor Pump

Designed and built by Vickers Inc., Division of Sperry Rand Corp., a compact vane motorpump is used to circulate coolant (ethylene glycol and water) through the magnetron tube of a ground radar high-power illuminator antenna. The antennas serve as part of the guidance system for a surface-to-air



missile.

Designed to operate at temperatures as low as –65°F, the motor-pump provides immediate flow to cool the magnetron tube.

The coolant pump, which weighs approximately 6 lbs., operates at a nominal pressure of 300 psi and has a relief valve setting of 350-400 psi. The three-phase, 400-cps, continuous-duty, explosion-proof electric motor operates on 416-volt, AC current.

Circle No. 234 on Subscriber Service Card.

Angular Oscillating Table

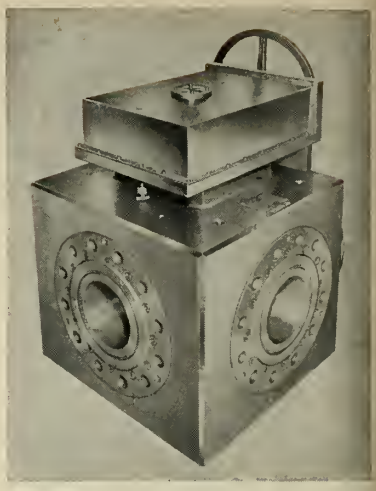
An angular oscillating table is available from Micro Gee Products, Inc., for subjecting gyros, accelerometers and guidance systems to extremely smooth sinusoidal motion for precise frequency response tests. A rate pickoff provides instantaneous rate information for presentation on an oscilloscope or recorder. Input to the table may be from any good audio amplifier, dc power amplifier, or shaker amplifier over the range of 0 to 100 cps. Loads in excess of 100 lbs. may be tested. Output torque exceeds 1 in.-lb. per watt input.

Circle No. 235 on Subscriber Service Card.

Three-Way Ball Valves

A new three-way ball valve to handle liquid oxygen (LOX), rocket fuel, and water at pressures from 0 to 1800 psig in missile test stands is available from The Vickery Co. In laboratory tests this new valve recorded zero leakage on liquid nitrogen (LN_2) at –320°F at pressures from 0 to 1000 psig, and on ambient gaseous nitrogen (GN_2) from 0 to 1800 psig.

These three-way valves may be piped for flow thru either of two inlet ports and one outlet port, or thru one inlet port and either of two outlet ports. Opening and closing is controlled by manual rack and quadrant actuator with visual position indicator.



Circle No. 236 on Subscriber Service Card.

Wide Field Radiometer

Barnes Engineering Company's wide-field Radiometer Model R-4K1 is designed for making radiation measurements of small, remote, fast-moving targets against a variety of day and night backgrounds. The instrument is suited for ground-to-air and air-to-air measurements of the radiation from high-speed missiles and aircraft.

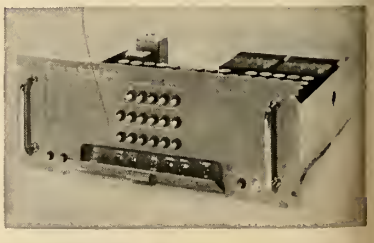
The Radiometer can make either contrast measurements or absolute measurements of target radiation. Selection of the desired mode of measurement is accomplished by installing one of two plug-in chopper packages.

Circle No. 237 on Subscriber Service Card.

Time Code Generator

An all-solid state electronic time code generator is available from the Electronic Engineering Co.

The compact unit supplies either a 17-bit binary coded time signal produced once each second or a slow rate 13-bit binary coded time signal produced each 15 seconds at a 1 pps rate. Both codes indicate hours, minutes and seconds. Seven pulse rates are also available as auxiliary signals. Frequency stability of the ZA-802 is equivalent to one second per month.



Circle No. 238 on Subscriber Service Card.

Circle No. 47 on Subscriber Service Card.

. . . products and processes

Battery Substitutes

Battery replacement units are now available for strip chart recorders, laboratory measuring potentiometers, and other applications which demand a constant dc voltage supply, from Dynage, Inc. The units can be used to replace the 1½ volt dry cell alone, or to replace the dry cell, standard cell and standardizing mechanism in strip chart recorders of all types. Compact packaging allows the unit to be easily installed in existing battery brackets.

Circle No. 239 on Subscriber Service Card.

Universal Power Tester

Transval Electronics Corp. has developed a universal power supply tester that can be used for checkout of airborne or ground support equipment.

The model 9007 Test Console provides AC power for the checkout testing of 60 and 400 cps input power supplies. Its features include controlled high and low line and load transients, controlled rise and fall times, interchangeable loads, pulse generator to simulate sense line transients.

Circle No. 240 on Subscriber Service Card.

Microwave Fault Alarm

The Texas Division of Collins Radio Co. has developed a completely transistorized fault alarm for its microwave systems which is capable of reporting 11 or 17 different fault conditions from each of as many as 30 remote stations.

A transmitter at each remote station continuously scans for faults and simultaneously reports all present to its associated receiver at a supervisory station every four seconds by means of a single AM tone. Because tone spacing is at intervals similar to that in FSK telegraphy, upwards of 30 separate remote stations can report over a single baseband without interfering with other communications.

Circle No. 241 on Subscriber Service Card.

Fast Data Processor

A DP-167 computer of modular construction which adds or subtracts at 167,000 operations per second, multiplies at an average rate of 24,000 operations per second, and divides at an average rate of 16,000 operations per second is being marketed by Westinghouse. It consists of three computer elements—an operand memory, an instruction memory, and an arithmetic and control unit—and a power supply. The operand memory has an access time of 0.8 microsecond and can store 640 words, each consisting of 19 binary

digits and algebraic sign. The instruction memory's access time is 1.5 microseconds, and its capacity is 2048 instruction words of 20 bits each.

Circle No. 242 on Subscriber Service Card.

Parametric Amplifiers

Custom-designed, reactance-diode parametric amplifiers for applications at all microwave frequencies are available from Texas Instruments Inc.

The heart of the parametric amplifier line is the gallium arsenide, variable reactance (varactor) diode which gives greatly enhanced noise performance over a wide range of temperatures down to liquid nitrogen temperature (77°K).

Circle No. 243 on Subscriber Service Card.

Monitors Radar Set Noise

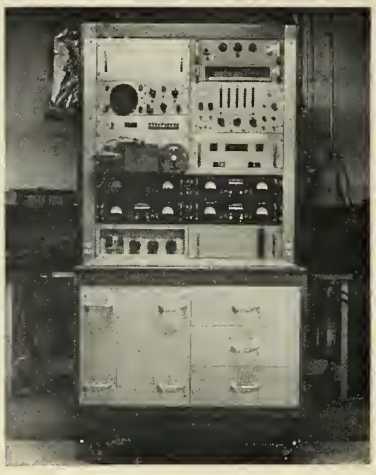
A noise figure meter which directly and continuously monitors the noise figure of operating radar sets is now available from Hewlett-Packard Co.

The noise figure meter, Model 344AR, operates automatically on either a 25 or 30 MC IF Frequency, and is designed for direct application to pulse radars with repetition rates of 90 to 500 pps, or up to 3000 pps with special sampling circuitry. The instrument's fast meter response enables the operator to optimize or adjust the radar system during operation or maintenance. System noise figure is measured on a time-shared basis with the radar scan.

Circle No. 244 on Subscriber Service Card.

System Checkout Tester

ORtronix Inc. has available the ADEPT 400 for automatic dynamic testing of component subassemblies or complete system checkout. Complete flexibility of testing is obtained by control of 295 signal, power and test control lines with punch tape programing. The manufacturer claims greater capability at lower cost than with any automatic Go-No Go checkout system available today.

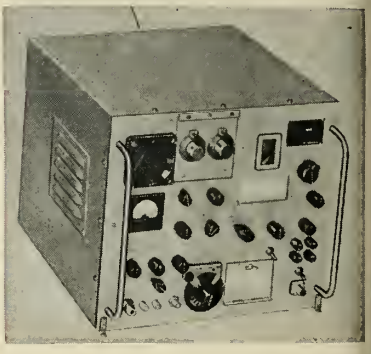


Circle No. 245 on Subscriber Service Card.

Radar Test Sets

Development of two new multipurpose test sets primarily for use with radar systems has been announced by Polarad Electronics Corp.

Operating in a frequency range between 2700 mc and 10,500 mc, each



Test Set is a combination of power meter, frequency meter, spectrum analyzer, signal generator and synchroscope. Model CTS-24 covers the range of 2700 to 3550 mc and Model CTS-810 operates in the 8500 to 10,500 mc range.

Circle No. 246 on Subscriber Service Card.

Curved Primary Battery

A curved powerpack—Model P-3000—is a primary (one-shot) unit designed for wide variations in discharge rates (as high as 100 amps continuously) and the most stringent requirements in voltage regulation called for in any battery to date. The unit is made by Yardney Electric Corp.

Circle No. 247 on Subscriber Service Card.

Insulated Thermostat

Chatham Controls Corp. is manufacturing BW-SS insulated thermostat. This ¼-in.-diameter model is available with Chatham's patented wiping action and contacts that open and close with temperature fluctuations. The unit can be factory calibrated or adjusted externally to obtain the desired actuating temperature by means of an easily accessible adjustment screw. The adjustment screw may be hermetically sealed at the factory or by the customer. Temperature setting is not affected by ambient temperatures.

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new literature

IONIZATION GAGE CONTROLS—A series of ionization gage controls for the accurate and uniform measurement of ultra-high vacuum are described in a data sheet, No. 563, just issued by F. J. Stokes Corp. The sheet gives complete specifications for the four models in the series, available either for rack-mounting or in cabinets.

Circle No. 200 on Subscriber Service Card.

ELECTROLYTIC MACHINING—The complete specifications of their line of electrolytic supply units, ranging from the Model 50 (ampere) to the Model 3000 (ampere) size has been published by the Anocut Engineering Co. Bulletin No. 126 also gives the removal rates and illustrates the placement of power components, fuse cutouts, control chassis and blowers for cooling rectifiers.

Circle No. 201 on Subscriber Service Card.

ORIGINAL TANTALUM CAPACITOR—Information on the subject of wet-type tantalum capacitors is provided in a catalog released by Fansteel Metallurgical Corp. The booklet contains specifications, performance characteristics, ratings, curves, and application data. Bulletin 6.100-5 covers Fansteel's "PP" Type Capacitors ranging from 325 to 1.75 mfd, 6 to 125 maximum working voltages for operation at 85°C at full ratings.

Circle No. 202 on Subscriber Service Card.

INFRARED-DETECTORS — Concise descriptions and detailed specifications of Servotherm(R) thermistor heat detector cells are contained in a technical bulletin available from Servo Corporation of America. TB 1300-6 describes Servotherm infrared detectors for detecting temperature variations in a broad range of laboratory, industrial, or military operations that are too fast, inaccessible, hot, or rigid in specifications for direct contect with the target.

Circle No. 203 on Subscriber Service Card.

SPINNINGS—Bulletins covering case histories of a broad variety of metal spinning jobs, complete with technical data, are available from Spincraft Inc. Unusual spinning jobs in the military, industrial, agricultural, recreational and other fields are covered.

Circle No. 204 on Subscriber Service Card.

ADHESIVES PROPERTIES—Furane Plastics Inc. has published an adhesives properties chart which contains the latest information on epoxy adhesives —their application, cure times and physical properties. The reverse side of his chart contains such information as est methods, application suggestions and availability. A ready reference for adhesive and paste applications, it should help to remove the guesswork from material selection.

Circle No. 205 on Subscriber Service Card.

TITANIUM METALLURGY—Beta-titanium alloy Ti-13V-11Cr-3A1, providing burst strength to density ratios exceeding one million, is discussed in an Engineering Bulletin published by Titanium Metals Corp. of America. The 32-page manual includes data covering the metallurgy, design, welding and forming characteristics of the alloy—considered the most formable, high-strength titanium grade commercially available.

Circle No. 206 on Subscriber Service Card.

CEMENTED CARBIDES—A booklet on Carmet Cemented Carbides designed for wear resistance is available from the Carmet Division of Allegheny Ludlum Steel Corp. The 12-page booklet gives details on design techniques, various sizes, properties, hardness, abrasion resistance and other information to help designers in selection and application of proper Carmet grade and in design of wear parts and die components that will make the best use of Carmet's unique properties.

Circle No. 207 on Subscriber Service Card.

SOLID LUBRICANTS—The theory and practice of lubrication by solids are the primary subjects in a booklet just published by The Alpha-Molykote Corp. Bulletin 124 discusses boundary friction and the role of solid lubricants in reducing friction and wear under heavy loads and at high temperatures.

Circle No. 208 on Subscriber Service Card.

TUNGSTEN PROPERTIES—A tungsten chemicals specifications catalog has been made available by the Chemical and Metallurgical Division of Sylvania Electric Products Inc. It contains a consolidated listing of the five standard high-purity tungsten chemicals produced by the division. They are: sodium tungstate; phosphotungstate acid; tungstic acid; tungstic oxide; ammonium paratungstate. Specifications in the new brochure include available grades. chemical composition, maximum impurity content, physical characteristics, packaging and applications.

Circle No. 209 on Subscriber Service Card.

PHOSPHOR BRONZE—An 18-page technical handbook on phosphor bronze has been re-issued by Riverside-Alloy Metal Division, H. K. Porter Co., Inc. In addition to a detailed explanation of continuous casting, the handbook includes information on phosphor bronze wire, bars, rods, strip, sheets, circles and special shapes. Flexograin, a special fine-grain phosphor bronze, is also discussed in detail.

Circle No. 210 on Subscriber Service Card.

when and where

SEPTEMBER

Engineering Management Conference, sponsored by American Institute of Electrical Engineers and American Society of Mechanical Engineers, Morrison Hotel, Chicago, Sept. 15-16.

Armed Forces Chemical Association, 15th Annual Meeting, Sheraton-Park Hotel, Washington, D.C., Sept. 15-16.

Institute of Radio Engineers, National Symposium on Space Electronics and Telemetry, Shoreham Hotel, Washington, D.C., Sept. 19-22.

Ninth Annual Symposium on Industrial Instrumentation, sponsored by Institute of Electrical Engineers and American Institute of Electrical Engineers, Manger Hotel, Cleveland, Sept. 21-22.

ASME-AIEE Power Conference, Bellevue-Stratford Hotel, Philadelphia, Sept. 21-23.

Air Force Association, National Convention and Aerospace Panorama, San Francisco, Sept. 21-25.

American Ceramic Society, Electronics Division, Hotel Schroeder, Milwaukee, Sept. 22-23.

American Institute of Chemical Engineers, Mayo Hotel, Tulsa, Okla., Sept. 25-28.

American Welding Society Fall Meeting, Penn-Sheraton Hotel, Pittsburgh, Sept. 26-29.

Instrument Society of America, 15th Annual Meeting and Instrumentation-Automation Conference and Exhibit, New York City Coliseum, Sept. 26-30.

American Rocket Society's Space Power System Conference, co-sponsored by NASA, Air Force, AEC, ARPA with cooperation of IRE and AIEE. Miramar Hotel, Santa Monica, Calif., Sept. 27-30.

AFOSR, Conference on Solid State Nuclear Particle Detectors, Asheville, N.C., Sept. 28-30.

OCTOBER

Sixth National Seminar of American Society for Industrial Security, Statler Hilton Hotel, Dallas, Oct. 3-5.

Institute of Radio Engineers, Professional Group on Communications Systems, Sixth National Communications Symposium, Utica, N.Y., Oct 3-5.

IRE Annual Meeting of the Professional Group on Nuclear Science, Solid State Radiation Detectors co-sponsored by PGNS and Oak Ridge National Lab., Gatlinburg, Tenn., Oct. 3-5.

Sixth Conference on Radio Interference Reduction, sponsored by Armour Research Foundation; U.S. Army, U.S. Navy, USAF, IRE Professional Group on Radio Frequency Interference, Chicago, Oct. 4-6.

Briefing Session on Opportunities in Space Age Technology, American Management Assn., Hotel Astor, New York City, Oct. 5-7.

American Ceramic Society, Refractories Division, Bedford Springs Hotel, Bedford, Pa., Oct. 6-8.

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editorial . . .

Where Emphasis on Missiles Belongs

FOR THE PAST several years, the trend in the U.S. military has been toward mobility. Almost every article of armament, from men to missiles, has been equipped with wheels, wings or floating gear.

True, we have the *Thor* and the *Jupiter* in fixed bases abroad, and the *Atlas* and the *Titan* in fixed bases here. The very size of these weapons ruled out the practicality of making them mobile.

But now the Air Force has come up with a challenge to the mobility concept—a plan for hundreds of silo-based *Minutemen*.

The Air Force proposal is based on price—that is, the most bang or the most defense for the least money. AF planners estimate the cost of *Minuteman* in fixed, hardened sites at $2 million each. The cost of *Polaris,* for instance, is about $8 million each. Both figures include the platforms—the hardened silo for the *Minuteman* and the submarine for the *Polaris*. Neither figure includes research and development costs.

In effect, the AF says that if we could have 1000 *Minutemen* in hardened sites it would take the Russians, even with greatly improved accuracy, several thousand missiles of the 10-megaton category to knock out, say, 80% of them.

Even in the event the Soviet forces had this many missiles to expend for this purpose, the argument is made, it would leave them none to deal with our other forces; we would still have 20%, or 200, of our *Minutemen* and enough other forces to conquer Russia.

We find it difficult to regard this proposal with a great deal of enthusiasm. There are several reasons.

What the construction of 1000 hardened missile sites would do to the American landscape is not too pleasant to think about; what several thousand Russian missiles trying to find them would do to that landscape is an even less attractive thought. Plus the fact that it is quite possible that our entire present missile concept might be obsolete by the time we had spent the years and the $2 billion such a project would require.

WITHOUT TRYING to usurp anyone's position as military expert, we would like to suggest that the United States should not spend a pre-emptive amount of money or time on any one weapon system.

If numbers of weapons make us a more difficult foe to disarm, then numbers of weapons in a mixed force make us even more impregnable. We should not spend overwhelmingly on SAC airplanes, on SAC missiles, on Army field forces or on Navy *Polaris* submarine systems.

Forty-five *Polaris* subs (which the Navy wants), each carrying 16 or more missiles, seems to us to be too many. We doubt if they would be effective enough to warrant the cost—at the expense of something else. We also doubt the prudence of buying a thousand *Minutemen,* because the cost would inevitably mean less armament in another area. We would be equally opposed to a thousand missile-carrying B-70's, if they were proposed.

Somewhere there is a balance which will give us the greatest deterrent strength and the greatest ability to absorb the first blow and still go on to win.

This balance should in time become apparent—both to us and to our enemies. It will come through measured judgment and honest decision. But it will not be achieved by putting all, or too many, of our defense eggs in the basket of any one project or any one service.

Clarke Newlon

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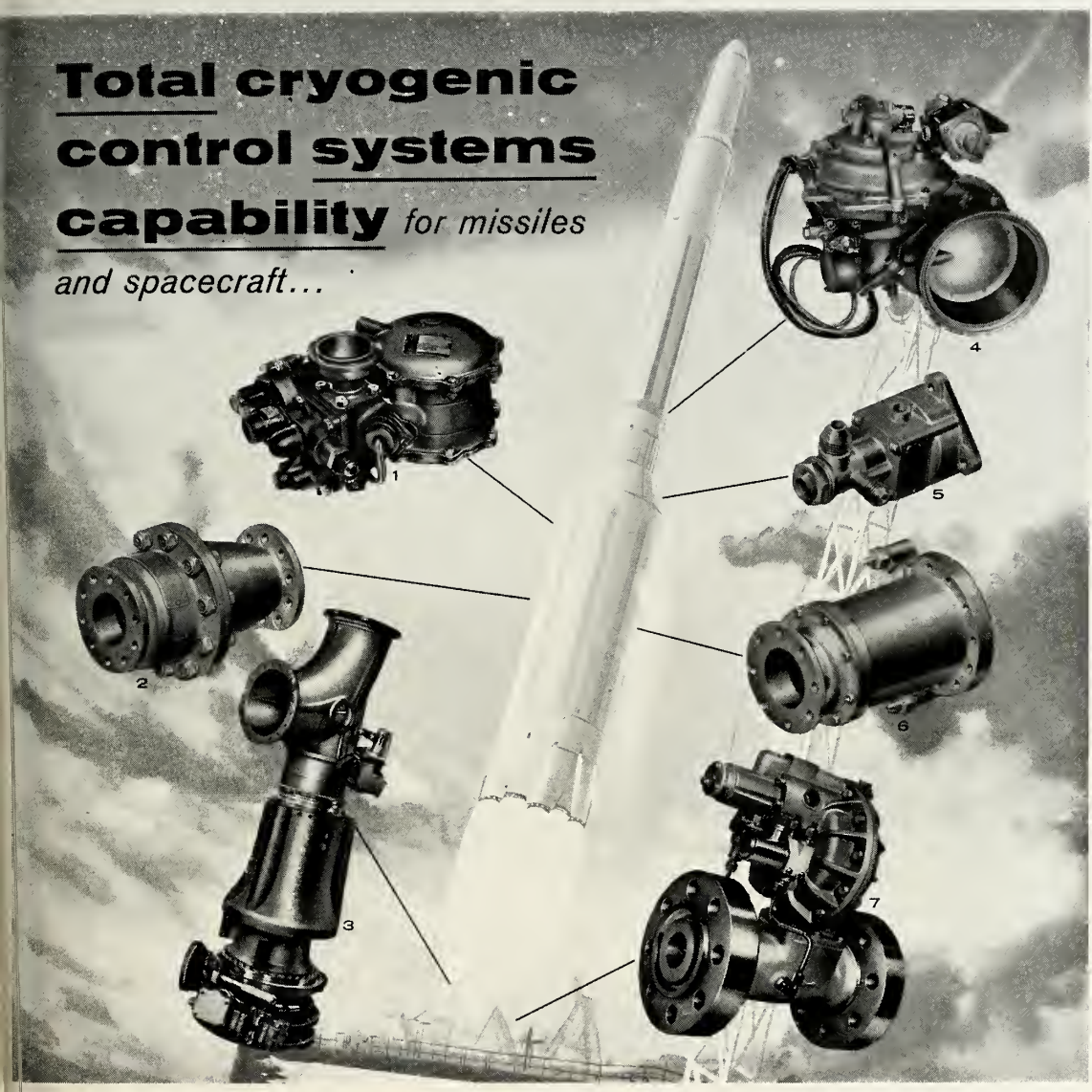

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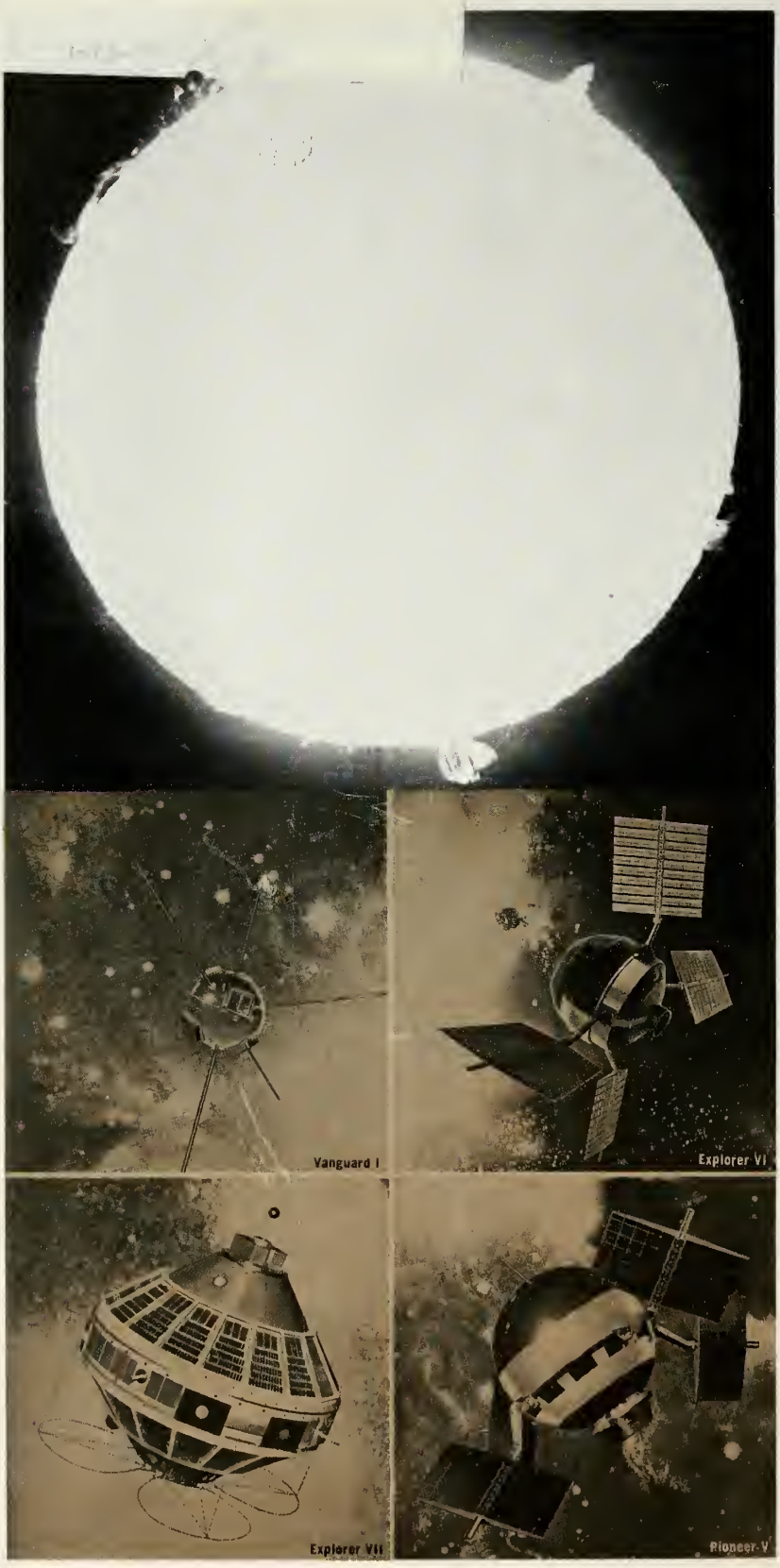

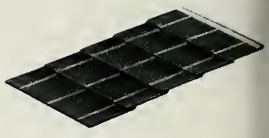

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