DECEMBER 8, 1958

This issue:

AMERICA'S SPACE PROBE PROGRAM FOR '59

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

News and Business Edition

AN AMERICAN AVIATION PUBLICATION

"BERYLLIUM"...IS OUR MIDDLE NAME

Experience is the best teacher and we have our Masters Degree in PRECISION MACHINING and FABRICATION of this atomic age wonder metal, BERYLLIUM.

You can expect the finest end product results when you deal with The American Beryllium Company. The heavy demand for our country's greatly accelerated missile and nuclear development programs brings the "Wonder Metal" — PURE BERYLLIUM — into the limelight.

The incredible close tolerances made necessary by today's requirements by users of Beryllium, made the American Beryllium Company the leader in this field, because for the past two decades ultra-precision has been the experience of their personnel. We pride ourselves on past performances and would like to help you open the doorway to tomorrow. Remember—Beryllium is our middle name.

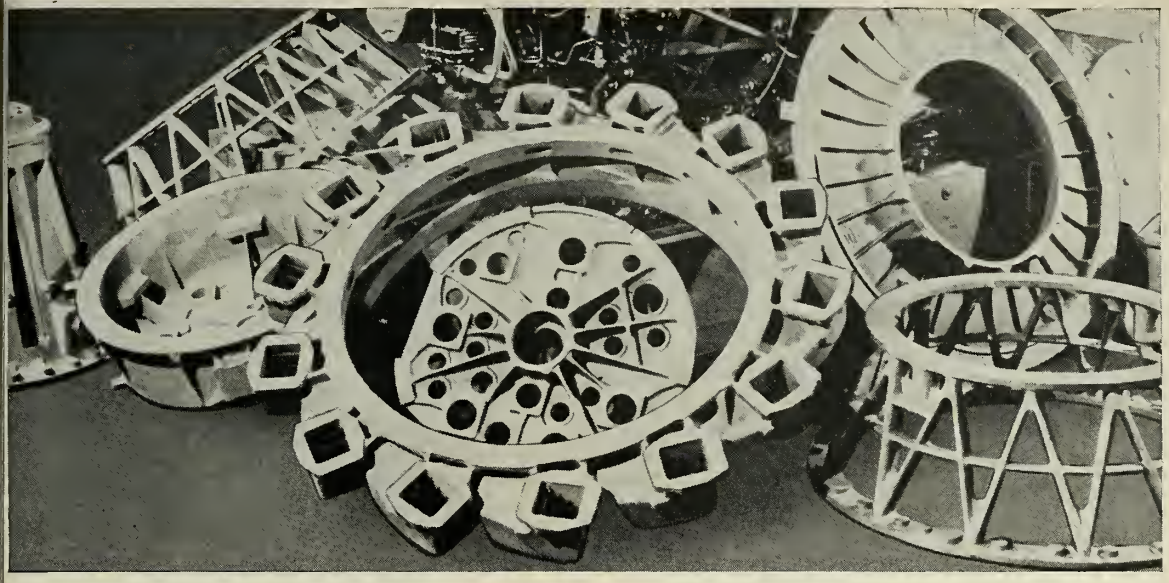
SEND FOR OUR COLORFUL FREE BROCHURE — Complete information in full detail is yours. Wire-write, or phone. If you use Beryllium, you can use our services.

OUR REPRESENTATIVE will gladly call on you at your request. Telephone ELgin 5-5105 for Big News for users of Beryllium.

American Beryllium Company

A DIVISION OF VISIONEERING COMPANY, INC.

SARASOTA BRADENTON AIRPORT, P.O. BOX 3142, SARASOTA, FLORIDA



DOW FOUNDRY EXCELS IN "DIFFICULT" MAGNESIUM CASTINGS

Dow's Bay City foundry mixes skill and magnesium to make sand and permanent mold castings unmatched for quality and intricacy. 35 years' experience with castings of every description plus the most complete magnesium foundry facilities add up to work that will meet your requirements, no matter how complex or exacting they may be.

- magnesium sand and permanent mold castings
- walls as thin as 0.100" ± 0.010"
- cast-in tubeless passages
- constant experimentation and development
- modern precision equipment
- heat treating and machining
- chemical treatment and finishing
- strict quality control

All pattern equipment is carefully checked for occurocy in the foundry pottern shop.

Write today for your copy of the new Dow Magnesium foundry brochure. It presents our services ond shows exomples of difficult castings we have produced. THE DOW CHEMICAL COMPANY, Foundry Soles, 801 Andre St., Boy City, Michigon.

YOU CAN DEPEND ON DOW

VERSATILITY—MISSILE MOTOR CASES

High-strength — lightweight — deep-drown or fobricoted — motor cases os small as Folcan, as large as Nike-Zeus — ore produced with tested efficiency and precision. "Flight-Quolity" prototypes of outstonding uniformity in woll-thickness, raundness, ond quality ore produced by Scaife's Reverse-Draw Pracess on triple-oction hydraulic presses ta 1500 tons ond 188" of stroke by o skilled engineering-metollurgical teom, with proved pressure-vessel "know-how." Scaife high performonce motor cases offer the desired reliability required far your missile programs. For informotion write, or phone EMerson 2-2100.

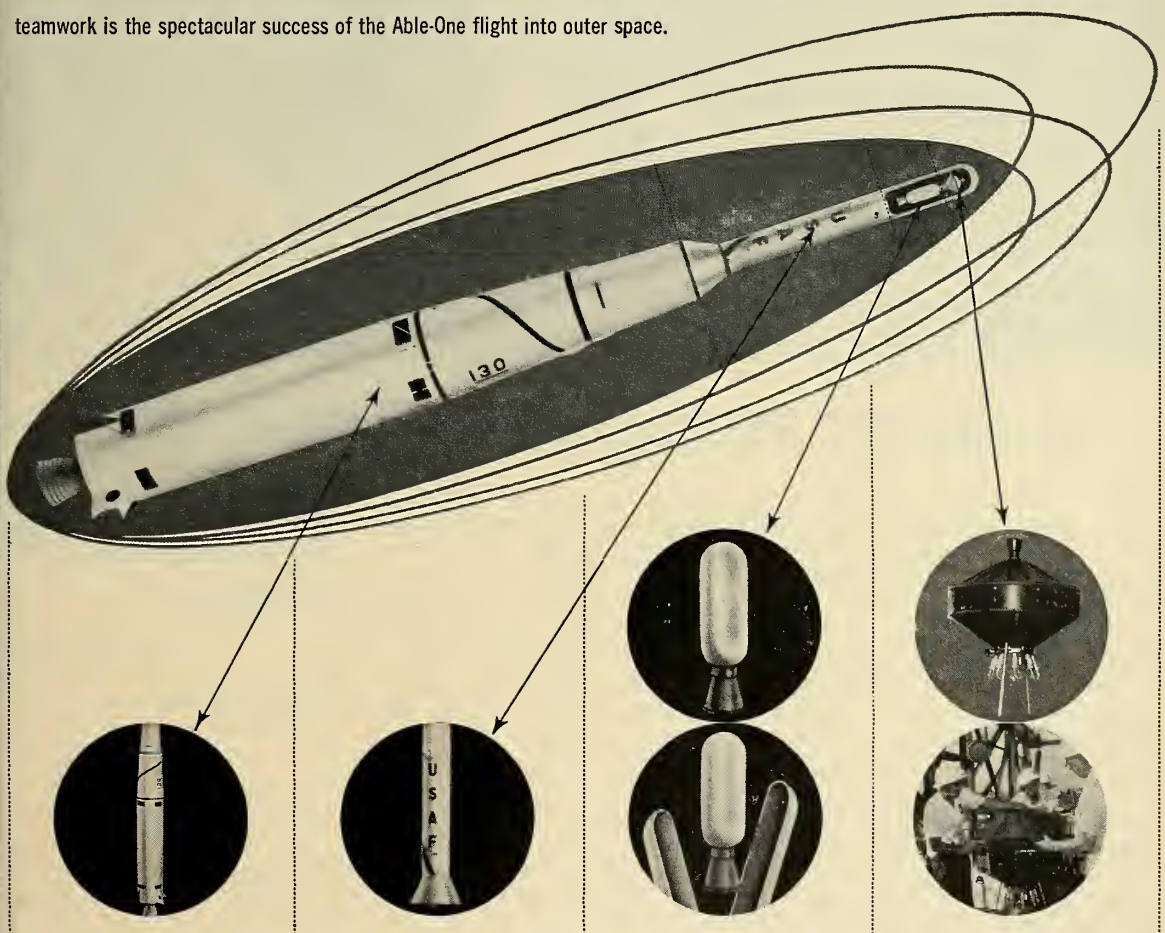
SCAIFE

FOUNDED IN 1802 • OAKMONT (PITTSBURGH), PA. • A DIVISION OF WILSON BROTHERS

PRODUCERS OF THE GREATEST NUMBER OF HIGH PERFORMANCE MISSILE MOTOR CASES IN AMERICA

Able-One... a new apogee in scientific teamwork!

Preparation and execution of an undertaking such as the United States' IGY space probe demanded the participation and exceptional efforts of 52 scientific and industrial firms and the Armed Forces. The Advanced Research Projects Agency and the AFBMD assigned Space Technology Laboratories the responsibility for the project which was carried out under the overall direction of the National Aeronautics and Space Agency. One measure of this teamwork is the spectacular success of the Able-One flight into outer space.



1st stage: Vehicle, Douglas Aircraft **Thor** IRBM; propulsion, Rocketdyne; airframe, control, electrical and instrumentation, Douglas Aircraft; assembly, integration, and checkout, Douglas Aircraft.

2nd stage: Propulsion system and tanks, Aerojet-General; control, electrical, instrumentation, accelerometer shutoff, and spin rocket systems, STL; assembly integration, and checkout, STL.

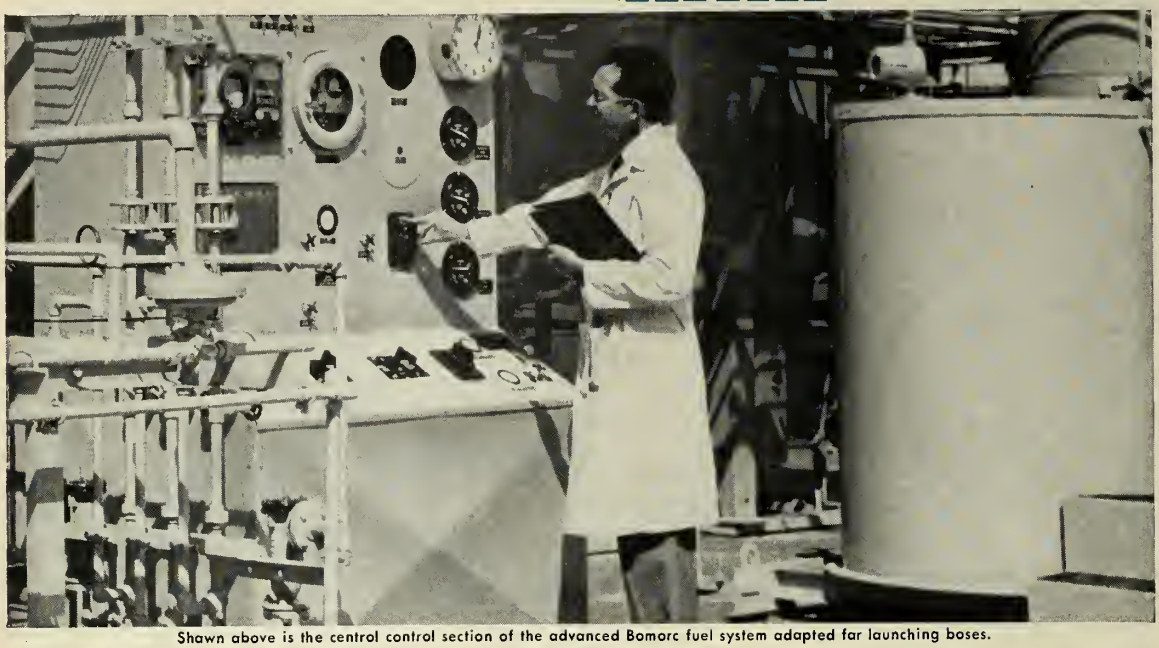
3rd stage: Rocket motor, U. S. Navy Bureau of Ordnance and Allegheny Ballistic Laboratory; structure and electrical, STL; assembly, integration, and checkout, STL; ground testing, USAF's Arnold Engineering Development Center.

Payload: Design and production of **Pioneer**, the payload of the Able-One vehicle, was conducted by STL in addition to its overall technical direction and systems engineering responsibility of the Air Force Ballistic Missile Division project. This highly sophisticated package included a NOTS TV camera and transmitter and Thiokol rocket motor.

Inquiries concerning openings on our staff will be welcomed by

Space Technology Laboratories, Inc.
5730 Arbor Vitae Street, Los Angeles 45, California.

...speaking of *Missile Ground Support* **EQUIPMENT**



Shown above is the central control section of the advanced Bomarc fuel system adapted for launching boses.

WE PROVIDE PROPELLANT HANDLING SYSTEMS

FMC is one of the few companies in this country that is capable of offering coordinated mechanical and chemical experience combined with design, engineering and production facilities devoted exclusively to building advanced missile ground support equipment, under single responsibility.

Under a contract with Boeing, for example, FMC's Ordnance Division conceived, designed, engineered and built this complete support system for the long-range Bomarc interceptor missile.

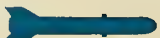
Technical assistance on this important defense project was provided by FMC's Westvaco Chlor-Alkali Division. This chemical group is experienced in producing missile propellants such as *Dimazine* (unsymmetrical dimethylhydrazine) one of the propellants used in the Bomarc.

In the design and production of defense materiel, FMC's background extends over more than 17 years. Also, FMC has long been recognized as a leader in the chemical field. This broad experience, supported by Ordnance Division's completely integrated facilities devoted exclusively to the manufacture of military equipment, can be applied to your missile project – from design concept through development, engineering and production, to on-schedule delivery.

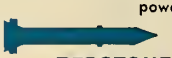
For any size missile ground support project – fixed or mobile, consult with FMC at the concept stage of planning. Contact us today for more information.

HERE IS FMC's PROFILE OF EXPERIENCE:

HAWK
Mobile loader vehicle



THOR
Transporter-erector and power control trailer



REDSTONE
Tracked prime mover

BOMARC
Erector-launcher and power unit

NIKE-HERCULES
Shipping and storage containers

Creative Engineers: Find stimulating challenge at FMC's Ordnance Division.

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION
Ordnance Division
Missile Equipment Section 1-S
1105 COLEMAN AVENUE, SAN JOSE, CALIF.

COVER: *A meteor makes a spectacular path across intergallatic space in this time exposure, representative of the second year in the Space Age. Details of the United States' space program for next year are given in an exclusive article on page 19.*

missiles and rockets Vol. 4, No. 23, Dec. 8, 1958

Published every week by American Aviation Publications, Inc., 1001 Vermont Ave., N.W., Washington 5, D.C. Printed at the Telegraph Press, Harrisburg, Pa. Second class postage paid at Harrisburg, Pa., and at additional mailing offices.

Subscription rates: U.S., Canada and Postal Union Nations—1 year, $8.00; 2 years, $12.00; 3 years, $14.00. Foreign—1 year, $20.00; 2 years, $30.00; 3 years, $40.00. Single copy rate—$.75. Subscriptions are solicited only from persons with identifiable commercial or professional interests in missiles and rockets. All subscription orders and changes of address should be referred to: FRANK R. WILLIAMS, circulation fulfillment manager.

in this issue

DECEMBER 8 HEADLINES

The U.S. Space Program for 1959
Exclusive m/r report outlines *Fledgling* satellite program; MIS, *X-15* tests; future *Vanguard* experiments, interplanetary probes; lunar program; *Baby Sentry* satellites, and military Man-in-Space ..19

Huntsville: From 'Cotton' to 'Space'
President's decision on transfer of Army missile talent to NASA administration is awaited with concern and even anxiety 27

Pacific Missile Range Could Cost Billions 43

ASTRONAUTICS ENGINEERING

***Purr-Kee*, AMF's Versatile Sounding Rocket**
Scientists are making important use of this research tool every day 22

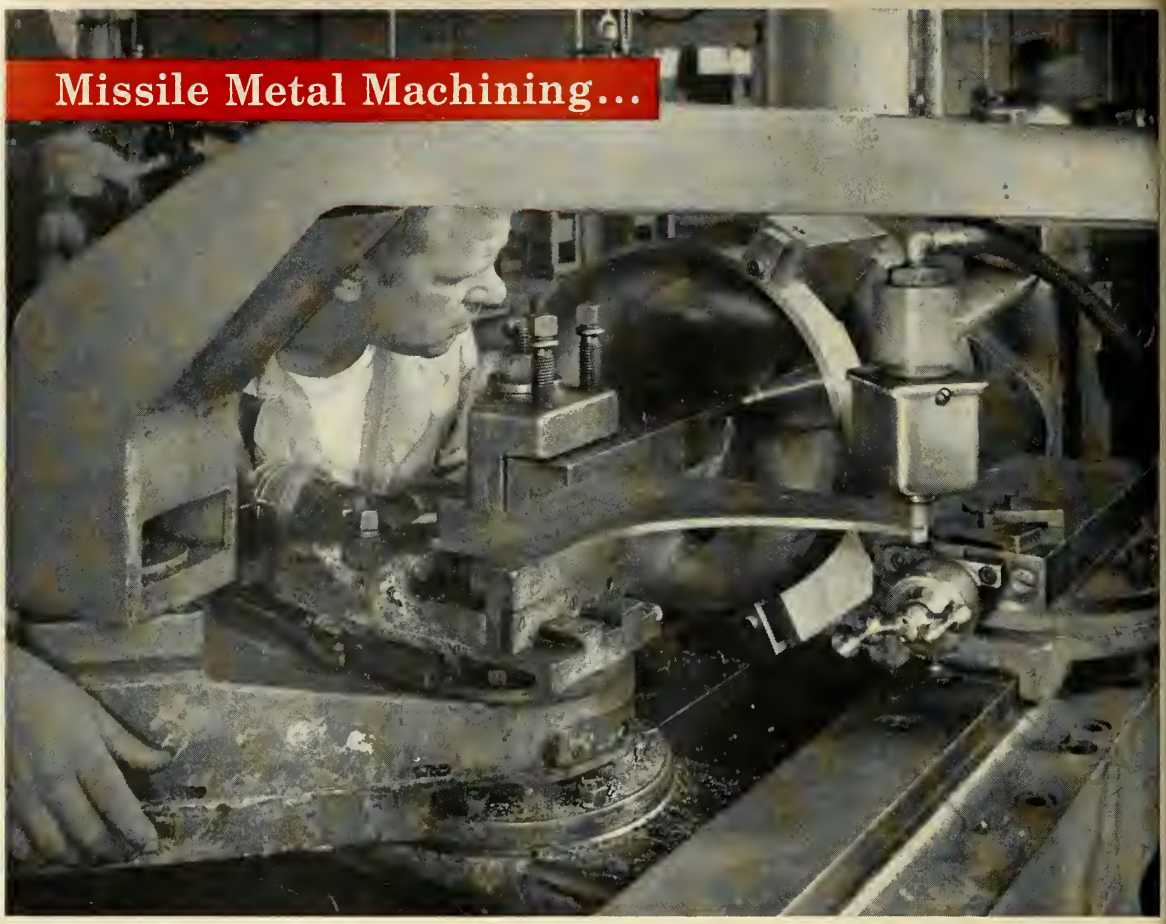
MISSILE ELECTRONICS

Direction Finder May Alter Alinement Concepts
NAA Autonetics' portable device could replace conventional methods of determining azimuth-reference base lines 35

Magnetic Unit Uses Extremely Low Power
National Cash Register glass rod switching and storage element is so fast that top speed is unknown 39

DEPARTMENTS

In My Opinion 9
Washington Countdown 15
Industry Countdown 17
When and Where 49
Propulsion Engineering 49
Contract Awards 50



FROM BLANKS TO BULKHEADS!

The Diversey craftsmen above is machining the inner diameter of a Forward Bulkhead of the Hawk missile to a fine 63 microinch finish. Notice the precision curved template in the center of the picture with the follower at the right end transferring the contour to the interior of the bulkhead. Another good example of the famous air gage tracer lathe technique that has brought the missile hardware field to such an advanced state.

Diversey starts with blank forgings. Using their remarkable ability to integrate hydrospinning and contour turning techniques Diversey craftsmen are able to produce the finest and most precise missile and rocket hardware components.

At Diversey you have the LARGEST FACILITIES exclusively devoted to your missile hardware production. Your work is handled by precise, fast, and progressive technical people. Contact Diversey on your tough jobs.

HYDROSPINNING NOW AVAILABLE

Diversey announces the formation of a new Hydrospinning Division with the acquisition of new Hydrospin equipment up to 42" capacity.

SEND FOR FREE BOOKLET

LEADERS IN CONTOUR MACHINING

Diversey ENGINEERING COMPANY

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

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

In My Opinion . . .

. . . the recent cancellation by the Navy of a follow-up order for *Seamaster* aircraft—and the probable layoff of 6,000 employees at Martin-Baltimore—points to a severe industrial problem that will be repeated many times in the future unless we do something about it now.

The Martin cutback is undoubtedly the first in a series of Department of Defense streamlining attempts for aircraft and missile systems development. There will have to be a choice between the *Jupiter* and the *Thor,* the *Atlas* and the *Titan* and possibly many other extensive and expensive programs. Cancellation of these programs could mean personnel lost at a time when the National Aeronautics and Space Administration is searching desperately for manpower and facilities to get U.S. space programs off the ground.

In an editorial one year ago (m/r Nov. 1957, An Open Letter To President Eisenhower) we recommended that the Administration take immediate steps to plan ahead for the missile teams that will not be needed once our research and development programs mature. We said: ". . . There is a sound solution. If *Thor* proves to be the best weapon of the two IRBMs, do not cancel out the *Jupiter* team and money as a total loss, but shift the team and its hardware to America's inevitable space flight program. Special configurations of the *Jupiter*—or the *Thor*—are capable of putting up satellites of 1000 pounds weight. We could achieve this within months. Either missile represents a valuable piece of hardware for practically any preliminary space flight project. With this approach we can catch up with the Russians two to three years sooner—without slowing our military program—than if we repeat the approach we used in developing the *Vanguard* "me too" satellite.

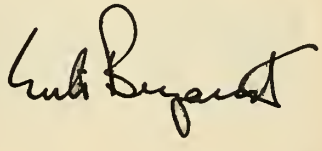
"The same technique can be used with our *Atlas* and *Titan* ICBMs. The missile not selected as a weapon must enter our future arsenal of space vehicles. So must the scientific team behind that missile.

"Employing this approach, we will save the taxpayers millions, possibly billions, of dollars. The decision to pursue this goal and employ this technique must be made now."

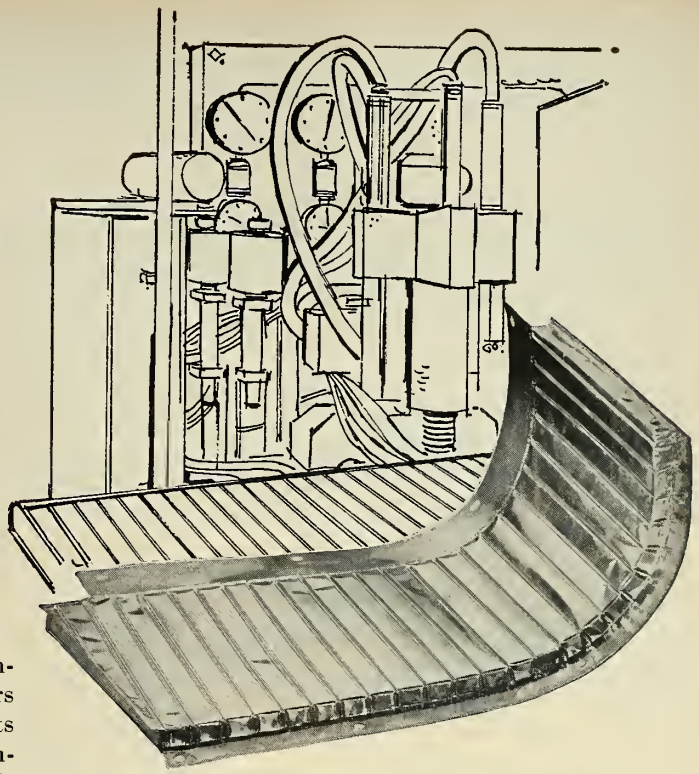
This was one year ago. In the meantime, nothing has been done about this inevitable problem. Convair, Martin, Douglas and Chrysler—and their thousands of subcontractors—must have assurance that their products and personnel be utilized. If one missile is chosen over another as a weapons system, clearly the other effort should not go to waste. Space probes using the non-military rocket are called for in the best interests of peaceful exploration of space.

It appears that here is a chance for the Department of Defense and the NASA to prove that they have "togetherness" and that our invaluable missile manpower and know-how will be used fully in our space program in case of military cutbacks.

Industry itself has put millions of dollars into the training and education of missile personnel. The government is obligated to put a serious effort into preservation of this asset at a time when we're in a struggle for survival. This is an area where DOD and NASA must decide together for the benefit of the country, our missile and space programs—and for the benefit of industry and its valuable missile men. Failure to do so would be catastrophic.



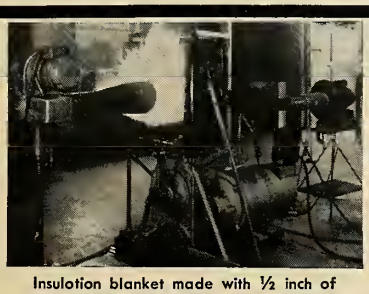
Look to L·O·F GLASS FIBERS for the first truly complete custom-made insulation service



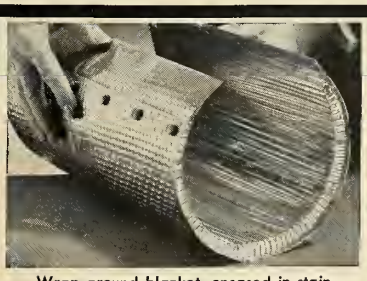
Leaders in the aircraft and rocket industries look to L·O·F Glass Fibers Company for the new developments in both thermal and acoustical insulating components, because this is the *only company in the glass fiber field* that performs all of the following:

starts with the sand . . . turns it into glass . . . draws it into fibers . . . forms them to specification . . . covers them with metal or plastic in custom fabrication.

L·O·F Glass Fibers Company fabricates insulation for thermal applications (up to 3000°F.) and a wide range of acoustical applications, including: de-icer duct insulation, tail-pipe and afterburner insulation, turbine case insulation, engine parts insulation, hot-air duct insulation, cabin-heater duct insulation, cabin insulation, structural insulation and bleed-air duct insulation.



Insulation blanket made with ½ inch of Micro-Quartz felt withstands the searing heat of a 2000°F. flame.



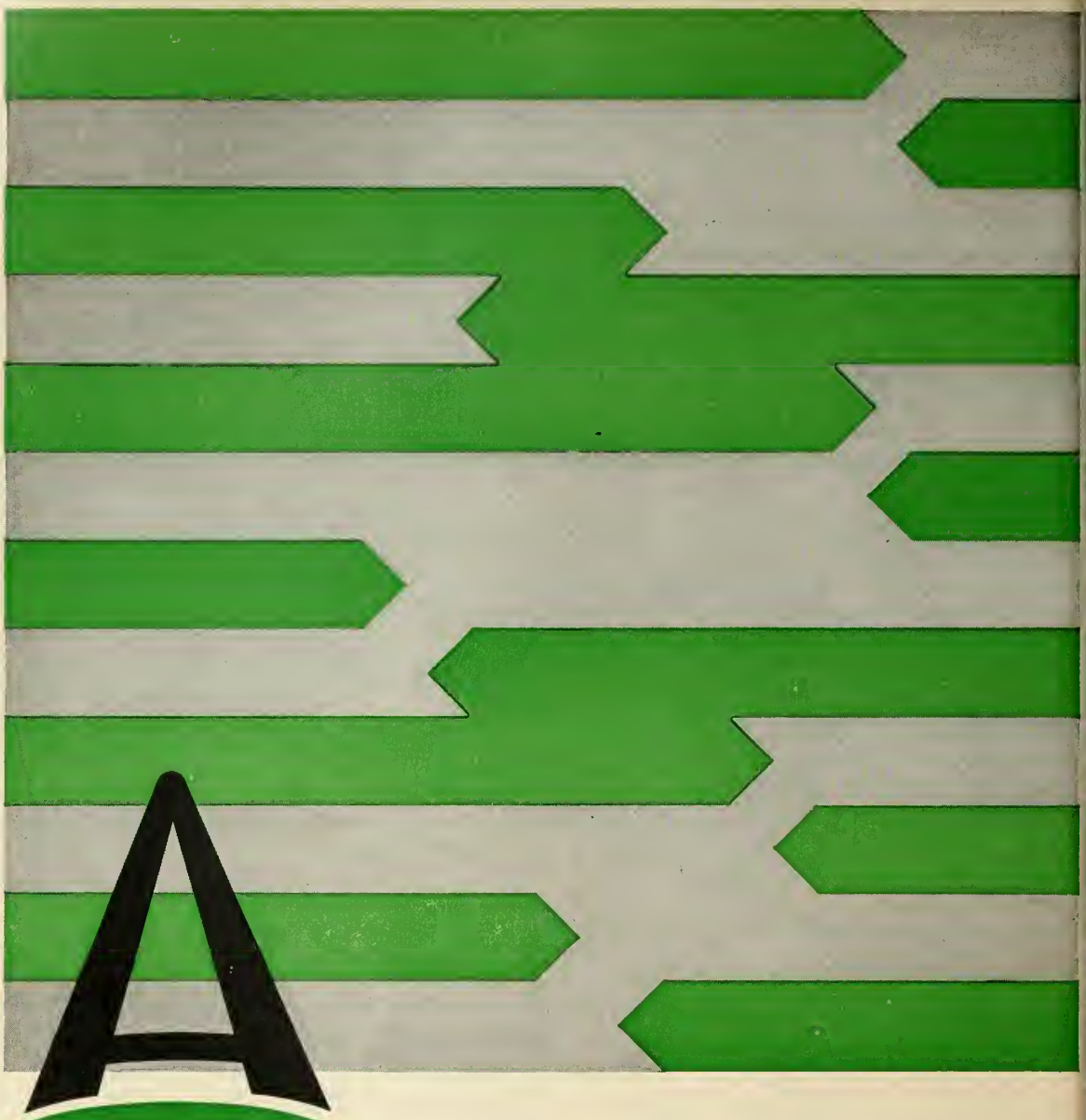
Wrap-around blanket, encased in stainless steel, shields hot-air duct at 600°F. Insulation will not pock, settle or crumble.

New Micro-Fail tape, made from Micro-Quartz felt faced with aluminum, protects parts tao small far molded or shaped insulation.

For:
- **Design or engineering aid**
- **Bulk insulation price lists**
- **Fabricated-parts quotations**
- **Technical information & samples**

L·O·F GLASS FIBERS

WRITE: L·O·F GLASS FIBERS COMPANY, PACIFIC COAST DIVISION BURBANK, CALIFORNIA



ASTRODYNE —aimed for the future in solid rocketry

Astrodyne was founded early this year to bring together in one productive group all the skills, experience, and facilities it takes to design and manufacture America's major solid propellant missile systems.

From Phillips Petroleum Company came men with impressive backgrounds in research, design, and manufacture of superior solid propellants. From North American Aviation came men who know missile systems management, and who have designed and built the largest rocket engines in use today.

Today Astrodyne has the experience to design, develop, and manufacture complete propulsion systems, extruded and cast propellants, solid propellant rocket motors, and boosters, and gas generator charges for auxiliary power units.

Inquiries are welcomed on any phase of the solid propellant field—from preliminary design to quantity production.

ASTRODYNE, INC.
McGREGOR, TEXAS

Ryan Firebee

jet drone missiles

are flying longer, farther, higher, faster on target missions— and more of them "live" to fly another day.

For example, at Vincent Air Force Base recently, the 4750th Drone Squadron launched 44 Firebees *in a row,* which averaged one hour's flight duration each. And 39 of them—many after target "hits"—were recovered successfully for re-use!

Other Firebee firsts: the one that completed 19 missions; the one that flew 1 hour, 42½ minutes; the one that made a flight 152 miles away from ground control and returned to be recovered in a pre-selected area; the drones that regularly fly target missions at Mach .9; and the *production* "birds" that have flown above 50,000 feet.

An elusive, pilotless plane, the Ryan Firebee is the most widely used jet target in training operations... the most realistic stand-in for "enemy" aircraft. That's why the Firebee is used as the target for such weapons as the Air Force Falcon and Genie; Navy Sidewinder, Sparrow, and Terrier; and Army Nike. That's why the Firebee was the exclusive target drone used in the Air Force's recent Project William Tell to evaluate the combat readiness of America's air defense system.

RYAN BUILDS BETTER

AIRCRAFT · POWER PLANTS · ELECTRONICS

Ryan Aeronautical Company, San Diego, Calif.

the missile week

washington countdown

SeaMaster cutback . . .

was only the first of several weapon system reductions, which has the missile industry worried and hopeful that NASA will move in and tighten up the cinches. Industry is thinking of *Atlas* vs. *Titan* and *Jupiter* vs. *Thor*. And if one is chosen over its counterpart as the weapons system (see editorial, p. 9), it would then be logical for the other missile systems to be used in space probes.

Presidential decision . . .

on NASA's request to take over certain service facilities, including ABMA and JPL functions, was expected to have been made as m/r went to press. NASA, unofficially, reportedly also wants in on Aviation School of Medicine, Naval Test Station at China Lake, Calif., and Signal Corps Laboratory at Fort Monmouth, N.J. Huntsville, meanwhile (see p. 27) is anxiously awaiting a decision of the president's Space Council on the ABMA decision.

Provocative book, Spacepower . . .

nine months ago forecast what would happen in the UN regarding control of space. Book accurately predicted that a joint committee of nations (without Russia if it failed to cooperate) would be set up to study plans for a permanent UN Space Agency.

The $40 billion question . . .

facing President Eisenhower and his budget advisors is getting a thorough going over. Details can be polished as late as Christmas, but the bulk of the "best seller" must go to the printer's by mid-December. Big question is how stringently the White House will attempt to impose the overall government budget reduction on the military departments. Defense Appropriations Subcommittee Chairman George Mahon has estimated a minimum budget of $42.5 billion. Being decided are what missile programs will be dropped and just how much emphasis will be placed on the anti-missile missile.

Anti-ballistic missile defense . . .

thinking in the Air Force does not rule out the concept of manned space vehicles as launching platforms for anti-missile missile. This is area defense with a vengeance.

70 Electronic technicians . . .

are required to maintain one ballistic missile squadron *(Thor, Jupiter, Atlas* or *Titan),* just about 10 times the number required to maintain a squadron of F-80s, the first U.S. jet aircraft.

House Armed Services Investigation . . .

Subcommittee headed by F. Edward Hebert (D-La.) latest probe concerns unused facilities of the Armed Services and DOD's standardization program. Not scheduled are weapons system management and the "team concept" of defense buying, although Washington sources say that these items will be taken up later this month.

Another House group . . .

The House Armed Services Subcommittee on Manpower Utilization, is looking into whether or not scientists and engineers are being effectively employed in the U.S. missile program. The subcommittee is chaired by Rep. James O. Davis (D-Ga.)

Successful full-distance launch . . .

of *Atlas,* contrary to publicity, does not put U.S. on par with Russia in ICBM development. Prospects are that Russia made its full distance ICBM tests many months ago. Convair is stepping up *Atlas* tests.

Dedicated Teams . . .

continue to be a big factor in the missile success this nation has enjoyed, Dr. Richard B. Morrison, former test director of the *Thor-Able* recovery program told Detroit audience many on the *Thor-Able* team worked 100-120 hours per week, although their pay checks were only for 40 hours.

First *Titan* firing . . .

is scheduled from Cape Canaveral for mid-December. This initial shot will be for stability, and is destined to travel about 400 miles if successful. As in the first *Atlas* firings, probably only one engine will be used and much of the guidance will be omitted. Second stage probably will not be fired.

COMPUTATION— IN THE DEADLY GAME OF SURVIVAL

BURROUGHS SYSTEMS STUDIES PLAY A VITAL ROLE IN DEFENSE

Problem: How to puncture-proof our air defense against enemy bomber and missile threats. Solution: Systems Studies of all operational problems—studies whose very heartbeat is electronic computation. Burroughs is acknowledged a master in all phases of such computation and its related areas, through its priceless combination of technical competence, outstanding experience and the most advanced research facilities.

Burroughs Corporation

"NEW DIMENSIONS / in computation for military systems"

industry countdown

Accumulated data on beryllium . . .
is available in one volume from the Office of Technical Services, Department of Commerce. Prepared by the Defense Metals Information Center of the Battelle Memorial Institute, the report includes data on sources, extraction, production, fabrication, properties, and applications.

Giant dry hydrogen furnace . . .
for vertically brazing assemblies as big as 10 feet by 6 feet in diameter has been developed by the Stainless Process division of Wall Colmony Corp. Furnace can be used for controlled-atmosphere brazing, heat treating, annealing with pure dry hydrogen, argon, carbon dioxide, nitrogen, or exothermic gases.

Jobs for scientists and engineers . . .
will increase greatly in next ten years, a survey made by Scientific Apparatus Makers Association, shows. Top executives of 500 large firms estimated rises of 25%.

Lockheed MSD has purchased . . .
154 acres of the Holthouse ranch next to its Sunnyvale facility for future expansion. Original size of Sunnyvale was 275 acres but Lockheed also recently added about 16 acres bordering on its east boundary.

Speaking of Lockheed . . .
the company said that missile sales in 1959 will amount to 35% of total volume. Projection is that this will rise to 40% in 1960 and 45% in 1961. The *Polaris* and *Sentry* programs, both among the first six in DOD priority, are the company's top programs.

Contract for the *Titan* . . .
launching system has been awarded to American Machine and Foundry. The $29 million-plus program is for design and development of an underground launching system, the so-called "hard" base for *Titan*. AMF's Greenwich (Conn.) Engineering Division, already at work on the launching system for several months, will handle the program.

New type of glass . . .
which turns temporarily opaque in proportion to the light impinging on it, reportedly has been developed by National Cash Register Co. The special chemical coating opaques the glass by joining molecules together. Company reportedly has no problems, but says clearing still takes too long to be practicable. Uses in space would be many, including shielding from solar rays when a vehicle faces the sun.

A new day has dawned . . .
in rocketry with the announcement by Aerojet that it would merchandise (on an off-the-shelf basis) the British-made Napier *Scorpion* liquid fuel engine. This will be the first time that a fully-developed liquid-propellant rocket will be available from stock. The *Scorpion* is a twin-chambered unit using hydrogen peroxide and jet fuel and has a thermal ignition system.

Navy has approved . . .
the *Gimlet*, a new air-launched, five-inch folding fin rocket, for operation. The solid propellant will be used by attack aircraft. Hunter-Douglas of Riverside, Calif. has a $2 million contract for aluminum rocket motor tubes, but the *Gimlet* is not yet in full production.

Metal forming by explosion . . .
is being developed by Aerojet. In the process, a metal mold is backed in concrete and the blank material to be formed fastened above. Aerojet then pulls a partial vacuum and an explosive change is installed above the blank. The whole unit is submerged in water and then detonated. Process has already proved effective with metals of thickness from 0.012 to 2.0 inches thick.

Looks Like the *Navaho* . . .
is really dead this time. AF spokesmen said that the North American weapon, long-since cancelled, will no longer even be used as a research vehicle for high-speed, high-altitude vehicles. Possibility of getting the same data by "more conventional methods" including wind tunnels was given as the reason.

DIMAZINE® CAPACITY TRIPLED

JUPITER-C, VANGUARD, THOR-ABLE, NIKE-AJAX, BOMARC, RASCAL...

These and other missile programs have generated increased demand for UDMH, the versatile rocket fuel commercially developed by Westvaco under the trademark Dimazine.

Keeping ahead of demand has been an important part of our policy during more than four years as prime producers of this propellant. In recent months, further expansions of Dimazine facilities have more than tripled productive capacity. This additional capacity is available now to supply the fast-moving missile industry with the quantities it needs when it needs them.

We welcome the opportunity to furnish up-to-date information on Dimazine's availability for your program or proposal, and to supply technical and practical information on properties and handling.

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION

Westvaco Chlor-Alkali Division

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

DECEMBER 8, 1958—VOL. 4, NO. 23

missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

Second Year of Space Age:

Nation Scurries to Catch Up

But while there's below-the-surface dissention between agencies, many promising programs are being developed for Man-in-Space: Interplanetary probes to Mars and Venus; Project *Fledgling*; more *Vanguard* experiments; *X-15* tests; lunar exploration; reconnaissance satellites; and use of *Titan* and *Pershing*.

By Erik Bergaust and Norman L. Baker

WASHINGTON—An impressive array of projects has been planned for the second year of the space age, ranging from man's first venture into near space to the projection of small unmanned payloads to the vicinity of Mars and Venus.

Many will probably succeed even though the United States, hurrying frantically to catch up in the race for space, has scheduled a program which is almost certainly suffering from management problems and rivalries in the agencies responsible for carrying that program out.

The major problems, as reported to m/r:

1) NASA, after starting boldly, is now moving over-slowly in its unpopular program to recruit the qualified personnel it must have.

2) The old hauling and pulling of inter-service rivalries continues to plague ARPA.

3) Below the surface dissention has developed between NASA and ARPA, mostly as a result of indecision of roles and missions in border-line areas of authority. ARPA does not want to fund any project that NASA may later take over. NASA wants more information from ARPA.

4) Army is being hamstrung by a growing lack of cooperation between its ABMA and JPL.

5) Several of ABMA's advanced propulsion research projects are being cut, including ion propulsion and high energy fuel, such as chlorine trifluoride and ionized hydrazine.

6) JPL wants to handle all the scientific space work, including the handling of the rocket vehicles, designing and assembling payloads, and operating the tracking facilities. JPL feels it is better qualified in this field than ABMA. Twenty-six million dollars of NASA's budget, planned originally for ABMA, will be awarded to JPL.

Regardless of the reported conflict between the agencies, business within the space industries can expect a sizeable upswing during 1959. In fact, the first impact should be felt within the next 30 days.

• **Project** *Fledgling*—Invitations to bid on NASA's latest satellite program, Project *Fledgling*, will be sent to industry near the end of the month. *Fledgling* will be sent into orbit 5-15,000 miles out for investigating the composition of the sun and the extreme upper atmosphere.

Tentative plans call for 12 satellites to be launched during the program. The *Vanguard* first stage rocket, which many experts consider a highly reliable system, and an advanced *Sergeant* would be used for boosting the *Fledgling* payload into orbit. The advanced *Sergeant* is still in development.

The *Fledgling* program will have various highly-advanced payloads. Some will have instruments to investigate the composition of the sun while others will measure conditions in the vicinity of the earth.

Those for solar investigation will be equipped with spectrographs for more accurate recording of the spectrum. For instance, the calcium line will provide scientists with additional information on the composition of the sun's interior. The satellites, in the sun's light for more than 60 minutes of each orbit, will be equipped with sun-following devices to keep the recording instruments exposed during this phase. A sun-follower device was first used on a *Viking* research rocket flight years ago.

Other *Fledgling* satellites will measure the densities of the ion "clouds" near the earth. The ion "clouds" con-

Variety of Space Probes Planned for 1959

Here are United States space programs for the coming year in capsuled form:

Project *Fledgling:* Tentative plans call for 12 satellites to be launched during the program to investigate the composition of the sun and the extreme upper atmosphere.

MIS Program: First test operations next summer with closer look being taken at Army's original Project *Adam* program.

X-15 **Tests:** First flights with Scott Crossfield at the controls are scheduled for February.

Vanguard **Experiments:** Cloud cover Army Signal Corps satellite; repeat of SLV-3 for investigating variation in light intensities reflected from the earth; satellite for measuring magnetic field flux of the earth; 70-pound payload satellite; "hot" *Vanguard* with liquid ozone added.

Mars-Venus Probes: Three or four attempts planned with first Mars probe in late February, followed by remaining shots in March or April.

Use of *Titan:* ICBM booster under consideration for one Mars project with a "hot" third stage.

Juno **IV:** Under development for interplanetary flights.

Lunar Program: Expansion expected beyond the two Army and three Air Force attempts with NASA reportedly having ordered several *Pioneer* and *Juno* II vehicles.

Explorer: No plans for continuation beyond launch of 100-foot inflatable sphere.

ARPA Man-in-Space: First will be to orbit and recover chimpanzee capsule. Special use of Army *Pershing*.

Baby *Sentries:* Nine test payloads of 200-400 pounds into polar orbits. *Atlas* C or D to orbit about 12 payloads up to 4,000 pounds.

sist of ionized atoms concentrated hundreds of miles from the earth by the magnetic field.

Polarizing telescopes will be utilized in an attempt to track air currents near the surface of the earth. Scientists feel that layers of static and moving air currents can be differentiated with polaroid instruments to aid world-wide weather forecasting. Surface temperatures will be measured with bolometers in the far-infra-red band of the spectrum.

Decision to use the *Sergeant* for the second stage of the *Fledgling* launching vehicle has raised the problem of guidance selection. System to evolve may be similar to the *Polaris* second stage guidance and control system. Final cutoff will be accomplished by ground control.

• **MIS program**—NASA's man-in-space program, initiated last month, will start first testing operations late next summer. The Army's Project *Adam* (m/r, June, p. 40) is reportedly being re-evaluated for man's first ballistic missile ride into space in connection with the manned capsule program. The *Redstone*, unquestionably the most reliable heavy ballistic missile-available, is deemed the only booster safe enough for manned flights for months to come.

Ballistic flights will be made from Cape Canaveral to an altitude of 90 miles and 200 miles down range. Capsule, to be recovered by parachute, will be similar to NASA's preliminary specifications (m/r, Nov. 10, p. 13). Meanwhile, many of the space capsule bidders have teamed up in an effort to obtain a technological advantage in anticipation of the development contract to be awarded shortly after the first of the year. Convair, producers of the *Atlas* booster to be used in launching the later orbiting manned space capsule, is reported a good bet for the system prime contract.

• *X-15* **tests**—The Air Force's man-in-space vehicle, *X-15*, will make the first flight test in February with Scott Crossfield at the controls. Using the eight-barreled rocket engine, installed until the Reaction *Pioneer* engine is delivered, Crossfield will check out flight characteristics. Record flight with 50 k engine and flight to the limit (100 miles altitude and 3000 mph plus) will not be made by an Air Force pilot until summer of 1959.

• **Proposals surveyed**—The Space Science Board of the National Academy of Sciences in cooperation with NASA is surveying hundreds of satellite proposals that have come in since NASA's formation. From these proposals, detailed experiments are being formulated and plans laid for a program that will extend years into the future. However, for the time being, NASA is concerning itself with satellite experiments that will be left uncompleted at the end of the IGY year.

The IGY satellite program fell short of expectations as the result of launching vehicle failures. This forced many experiments of vital importance to be postponed or cancelled. The majority of these experiments have been acquired by NASA and will be the first ones carried out in the near-space satellite launchings.

• *Vanguard* **postponed**—*Vanguard*, originally conceived as the United States' sole satellite launching vehicle during the IGY, after suffering one setback after another since its unfortunate test vehicle attempt a year ago, has been moved into NASA's space plans. Firing schedules will be stretched out with launching dates more relaxed. Under NASA's new schedule, the first of four remaining shots will go in February while the final shot may pass over into 1960.

Experiments planned for the remaining *Vanguard* shots include:

1) Satellite built by the Army Signal Corps containing a photo-electric cell for studying the earth's cloud cover. Weight of payload, 21.5 pounds. This one is slated for the February launch.

2) A repeat of SLV-3, the last unsuccessful firing. This satellite will be equipped with instrumentation for investigating the variation in light intensities reflected from the earth. A photo-sensitive cell will trigger the instruments into operation when the satellite is over the light side of the earth.

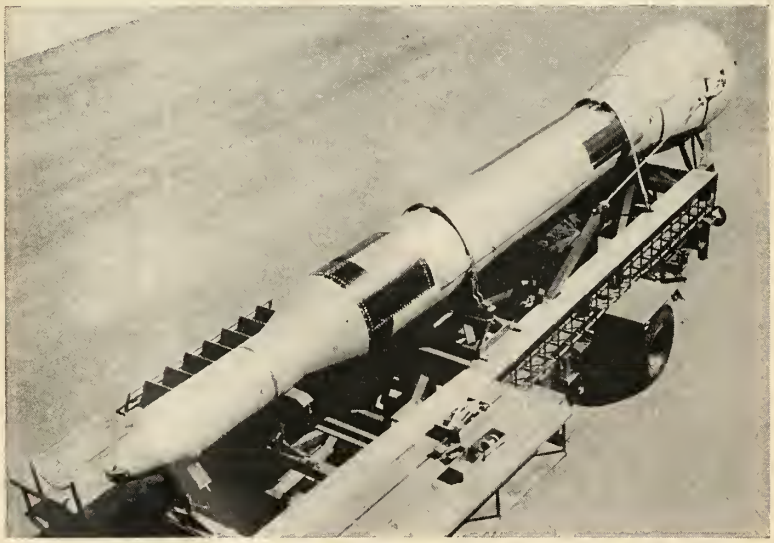
3) Satellite for measuring the magnetic field flux of the earth. The magnetometer payload was originally scheduled for SLV-4.

4) The *Vanguard* program's big effort. Satellite will have a 70-lb. payload. Total weight in orbit, including the empty final stage rocket, will be 115 lbs. Instruments include cosmic ray detectors, magnetometer, hard X-ray and photon counters.

• **"Hot"** *Vanguard*—NASA's *Vanguard* satellite number four will be boosted into orbit with a "hot" first and third stage. First stage will be the standard *Vanguard* first stage with liquid ozone added for increase of thrust. Third stage will be an improved Allegany Ballistics solid propellant. The double-base solid will have a larger nozzle and burn with a higher chamber pressure. Various components of the *Vanguard* have been slated for inclusion in other NASA and ARPA space vehicles.

• **Mars-Venus projects**—Probes to the neighboring planets, Mars and Venus, are receiving high priority with three to four attempts expected if the booster vehicles and payloads can be

Polaris Trailer Transporter



SPECIALLY-DESIGNED trailer-erector transports the *Polaris* from the assembly and checkout area to the firing pad. Hydraulically-operated jacks raise the missile clear of the wheels and establish an accurate level. Erector then takes over, elevating it to a vertical position.

made available in time. Both planets will be in a position favorable for probe intercepts during 1959.

As many as three attempts will be made to place a payload near Mars if the projects are given the go-ahead. First Mars probe would be launched during the last week of February (m/r, Nov. 24, p. 13), followed by the remaining shots in March or April.

The *Titan* ICBM reportedly has been considered for one Mars project, although its acceptance is dependent upon rate of development testing scheduled for the next few weeks. A "hot" third stage developed by JPL or Bell Aircraft will boost the payload to the cut-off velocity of 47,000 ft/sec needed to propel it out to the planet.

The first Venus probe, tentatively scheduled for early summer of 1959, will probably be assembled by JPL. Firing date will not be best for minimum thrust requirements, but due to its inferior orbit (between the earth and sun) required thrust should be about the same for the Mars probes. Most favorable launch date, calculated to reach Venus when it is in superior conjunction (opposite side of the sun and in line with earth and sun), will be in late January, 1960.

Venus payload instruments will include a magnetometer for determining rotation rate of the planet, if any; spectrograph for measuring any distortation of the spectrum lines as the result of the planet's magnetic field; microwave detector for investigation of the heavy cloud layer. A tape recorder will store all data for playback on its return to the vicinity of the earth.

• **Heat transfer problem**—Tracking and payload heat transfer are expected to be the major problems of the Venus attempt. Payload transmitter will operate on 10 watts with a projection range of 50 million miles. Heavy heat build up from the sun's radiation is anticipated during the payload's 150-day trip. Experiments to measure the hydrogen atom cloud densities in space may be included in the Venus payload. Dr. James Van Allen, designer of the *Explorer* radiation instruments, is developing the hydrogen instruments.

• *Juno* IV—An advanced *Juno* II, reported as *Juno* IV, is under development for interplanetary flights (Mars and Venus). Vehicle would use the *Jupiter* as first stage, a "hot" *Vanguard* first stage as the second stage, and a *Vanguard* third stage.

• **Lunar program**—The lunar program is expected to be expanded beyond the two Army attempts scheduled for December and February. The Christmas holiday season may force a postponement of any January firing to February. NASA reportedly has ordered several *Pioneer* and *Juno* II vehicles for the expanded program.

• *Explorer*—Currently there are no plans to continue the Army *Explorer* program, although ABMA may get the go-ahead to launch an inflatable satellite balloon of 100-ft. diameter for density studies.

• **ARPA man-in-space**—ARPA will investigate man-in-space problems by attempting to orbit and recover a chimpanzee capsule. Army *Pershing* solid propellant rocket with unspecified upper staging probably will boost a spherical epoxy plastic capsule, reinforced with piano wire, into low, short-duration orbit.

• **Baby** *Sentries*—Air Force Baby *Sentry* reconnaissance satellite program, (under new name and concept, is scheduled to get under way this month, and will attempt to launch about nine test payloads of 200-400 pounds into polar orbits. In late 1959 or early 1960 the *Atlas* C or D will be used to orbit about 12 payloads up to 4000 lbs. Air Force weather satellite will be a part of this program.

Sentry Revised: Camera to Stay on Ground

By Clarke Newlon

WASHINGTON—As m/r went to press the Department of Defense was readying a news release which would say in effect that ARPA and the Air Force have shelved the *Sentry* WS-117L reconnaissance satellite program indefinitely.

Test firings from Vandenberg AFB will be held as scheduled but the aims and intent of the entire project have been drastically—almost dramatically—switched. The project name *Sentry* will be changed. The originally-intended reconnaissance satellite now becomes a "scientific satellite." The vehicle will be instrumented, it is said, to collect all types of scientific data on cosmic rays, micrometeorites, radiation; to develop stability, to check communications—and for biomedical experiments to build toward placing man in space and getting him safely back down. Above all—at first—it will test the capability of the USAF to put a satellite in orbit.

The first firing is scheduled for the last two weeks in December. Dates have been given—December 15 and December 19. Actually, on this first try, the Air Force will be happy to get it off at any time in the planned 15-day period. It will probably be the second firing from untried Vandenberg pads. The first, a *Thor,* was scheduled to be fired early this month by a SAC crew.

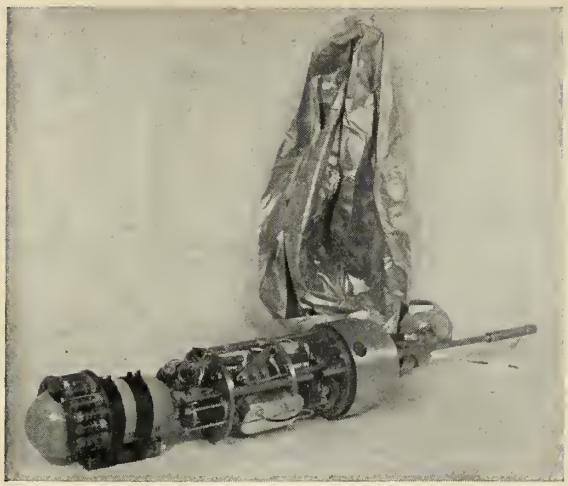
• **Reason for the change**—is largely political. The White House, extremely conscious of world opinion and our various negotiations with Russia, is understandably wary of any move which will give the Soviet government an opportunity to cry "Spy" with justification. Had the U.S. been able to launch a recon satellite under the auspices of the IGY it might have passed as a scientific achievement. To launch one otherwise would be called a purely military maneuver.

The one act which could remove the political heat would be the discovery that the Russians themselves have placed a recon satellite in orbit. The U.S. could then follow suit with the cleanest of hands. But, as many scientists have pointed out, the Russians could place such a vehicle in orbit and it could be years before we discovered that fact, if ever. It could transmit on any one of infinite frequencies, and even if spotted in the heavens (or by our intelligence), its specific identity could hardly be proven.

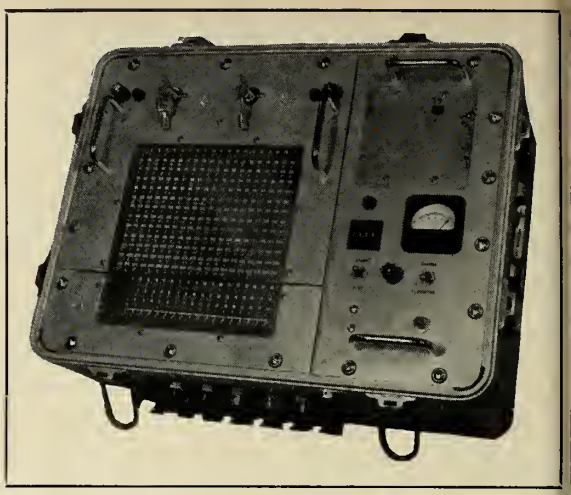
The first phase firings from Vandenberg, including the December shot, will use a *Thor* booster and a second stage, liquid-fueled vehicle developed by Lockheed, the systems manager, for the WS-117L. No "kicker" to put it in orbit is planned. The entire second stage, which will contain the payload, will be placed in orbit, if successful.

The orbiting vehicle will weigh 300-400 pounds, by far the most ambitious U.S. satellite attempt. The payload will contain little more than a battery-operated transmitter to relay the traditional "beeps." The first nine or ten firings will be with the *Thor* booster and then the project will shift into Phase 2 with the *Atlas* boosting and the payload increasing tremendously. All firings are set for Vandenberg with tracking accomplished from the same stations organized by the Atlantic range and Cape Canaveral.

There will be no camera—in the scientific satellite; under planning.



TYPICAL EXAMPLE of *Purr-Kee* **payload. Tank in the foreground and balloon in rear are parts of recovery gear.**



PROGRAMMER BUILT by AMF for *Purr-Kee* **is capable of firing 18 rockets within 65 seconds after receiving start signal.**

Purr—Kee, AMF's Versatile Sounding Rocket

by Peer Fossen

WASHINGTON—Progress with satellite rockets and ballistic missiles tends to make one forget the original member of the family—the research or sounding rocket.

But while the "big brothers" are stealing the show, scientists over the world make use of this important research tool every day. More and better rockets are being developed, and the state of the art is at a very high level.

A recent addition is American Machine and Foundry Company's *Purr-Kee,* an unguided sounding rocket developed and built by the Alexandria Division's Advanced Research Department in collaboration with the contracting agency, the Naval Ordnance Laboratory, White Oak, Md. The contract also included development and production of programmers and lightweight, portable launchers.

Purr-Kee originally was required to place a series of identical pay-loads to a large number of points in space at a given time and then return them by parachute to the ocean surface for recovery. Altitude requirements ranged from 2,000 to 18,000 feet.

• **Overall configuration**—*Purr-Kee* consists basically of two parts, the booster and the dart or forward body. At time of burnout, the booster is separated by drag and the dart continues on a ballistic trajectory. To meet the requirements for varying altitudes, the dart is designed for use with many engines having a wide range of thrusts.

• **The booster**—As mentioned, the original altitude requirements were in the 2,000 to 18,000 feet range. For these heights, AMF engineers powered the dart with either *Deacon, HPAG, Falcon,* or 5-inch *HVAR* engines. The trajectories and altitudes attained with each of these rockets at various launching angles are plotted in Figure 1.

Much higher altitudes are attainable by using other boosters such as multiple *Deacons*—double or triple—or the *DAN,* which is a two-stage *Deacon-Nike* combination. Some of the possible dart-booster combinations are shown in Figure 3.

Only slight modifications are required on the various boosters before they can be used to push the *Purr-Kee* dart to a greater altitude:

1) Addition of fins (if motor is not so equipped).
2) Mounting of launching shoes.
3) Adaption of motor front end to the motor-dart coupling.

Adding to the flexibility in use of boosters is the ability to use a large variety of parachutes which can withstand a long range of velocities and altitudes.

• **The dart**—The *Purr-Kee* dart, which measures six inches in diameter and six feet in length, contains a nose cone, the instrumentation payload, parachutes, and recovery gear.

At a preset time during the ballistic flight, the parachutes are deployed and the dart descends slowly back to earth. The shock encountered at parachute deployment also separates the nose cone to expose the instrumentation section.

The mechanical timer which initiates a squib to release the parachute can also be made to initiate actions in the instrumentation and recovery systems. In past use, this timer has been started by launch accelerations or by an electrical signal firing an explosive motor. The timer can also be lanyard-started if desired.

Purr-Kee's water recovery system consists of a balloon which is inflated after water contact, and a small radio transmitter with antenna to lead the recovery team to the payload. The purpose of the balloon is to add to the buoyancy and visibility of the dart itself.

Careful attention has been given to reduction of the drag of the dart to achieve maximum range. On the other hand, less emphasis was placed on this factor in the booster section where drag forces actually improve the separation action.

The present dart design leaves a cylindrical volume of approximately 143 cubic inches for payload. If recovery gear is stripped, an additional 130 cubic inches could be utilized for instrumentation.

Purr-Kee's ability to accurately place a payload at a given point in space at a given time is due in large

measure to an accurate determination of the drag co-efficient and other aerodynamic characteristics, measured by extensive flight tests during development of the rocket. In addition to the booster flexibility, the weighted nose cone provides for two very important advantages:

1) Means by which overall rocket weight can be adjusted to secure a fine adjustment on range. (A sample curve of this for the HPAG booster is shown in Figure 2.)

2) Excellent stability characteristics to entire rocket before separation—since weight is in an extreme forward position.

• **The launcher**—The lightweight launcher developed for *Purr-Kee* can be quickly and easily erected and operated by a two-man crew. Launching angle is adjusted by a turnbuckle at the rear of the unit. This launcher has performed very satisfactorily under the most difficult field conditions.

• **The programmer**—The programmer was designed and built to fire salvos of *Purr-Kee* rockets and planned for use with a radio controlled relay on an unmanned station. Each pro-

Purr-Kee **ROCKET being readied (on old launcher) for launching at Wallops Island.**

grammer was made as a battery-powered unit capable of firing 18 rockets within 65 seconds after receiving a start signal.

The start signal can be given by a switch or relay. Accurately spaced pulses are produced each quarter second by a switch and are cam assembly driven by a chronometrically governed motor. The pulses are sent to a 260 point patch panel through a set of stepping switches, which advance one position after each pulse. The stepping switches cycle to provide the 260 pulses and reset to start position. The timing cam is set manually to the start position.

Patch cables with spring loaded vibration and pull-proof plugs are used to connect the desired pulses to the output panel. Three leads from each output connector are brought up to the output panel. Two key operated arming switches normally keep power off the patch panel. The timing system is not affected by the safety devices and can be tested without providing output pulses.

The output pulses have a time accuracy of ± 15 milliseconds of the preset time after the first two seconds. The accuracy during the first two seconds is less. Each pulse is 24 volts with a maximum current of 30 amperes.

Programmer Specifications:

Start Signal
momentary switch closure
Timing range

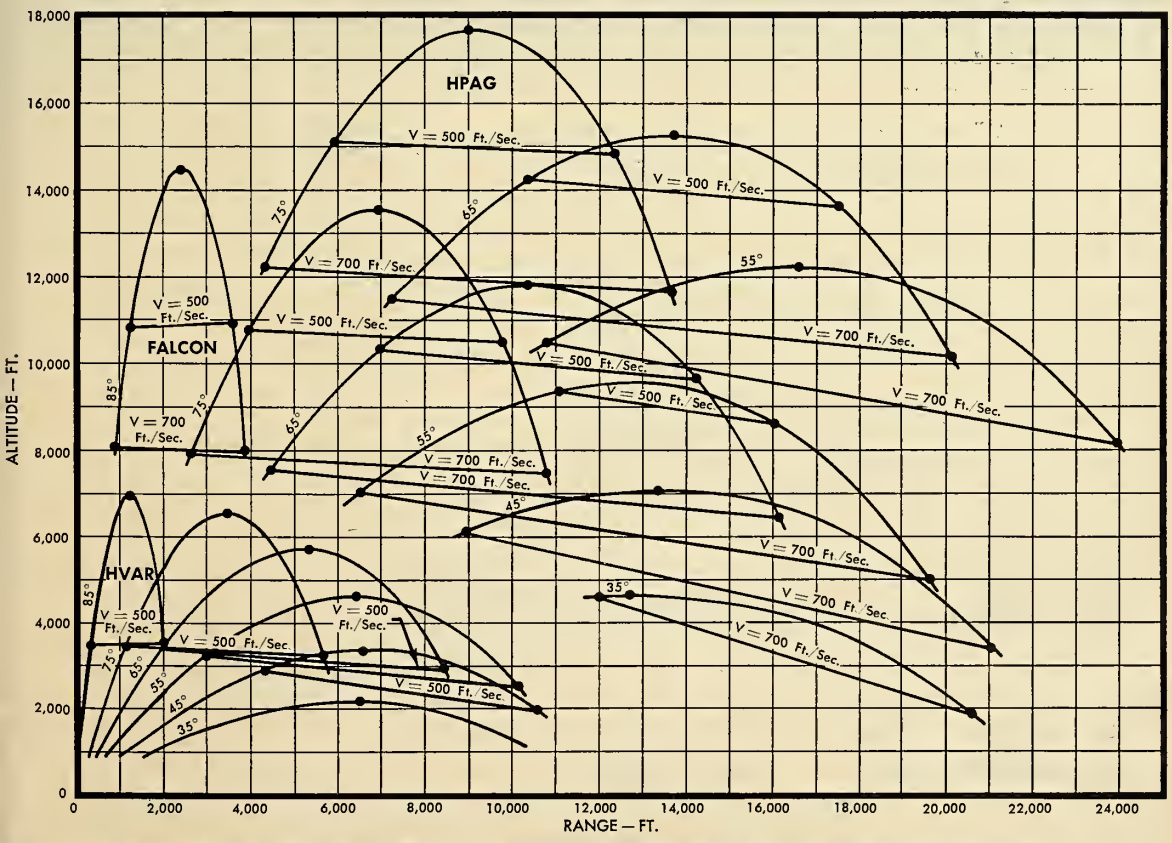
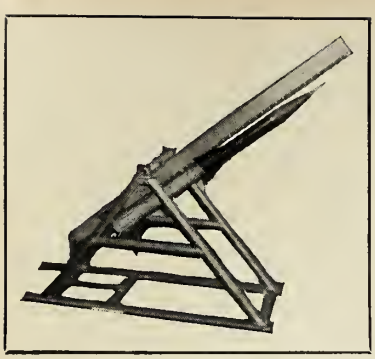


Fig. 1. Trajectories and altitudes attained with *Purr-Kee* dart at various launching angles, using different boosters.



Purr-Kee **in firing position on new lightweight, portable launcher. Launching angle is adjusted by turnbuckle at rear.**

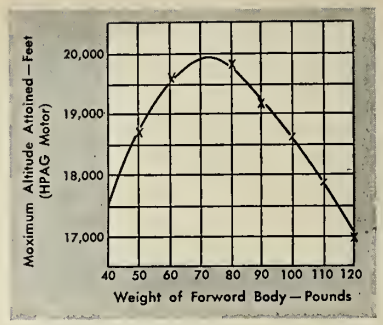
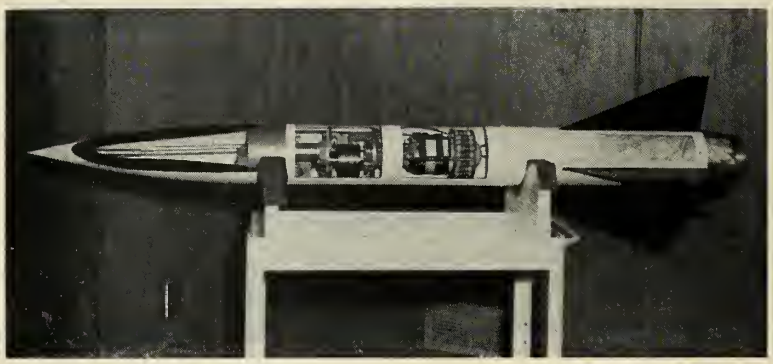


Fig. 2. EXAMPLE OF how weight of nose cone, in addition to booster flexibility, can be changed to secure adjustment.



CUT-AWAY MODEL of *Purr-Kee* dart showing payload and recovery gear.

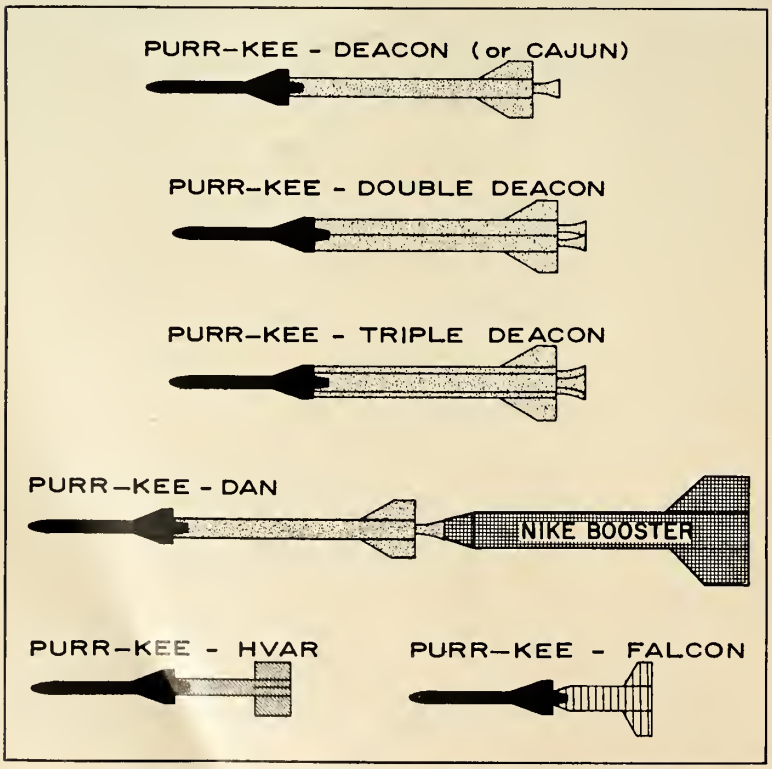


Fig. 3. Examples of possible *Purr-Kee* dart/booster combinations.

64¾ seconds
Resolution
¼ second
Accuracy
± 15 milliseconds after 2 seconds
Pulse length
200 milliseconds
Pulse height
24 volt
Pulse current
30 amp max
Power supply
24 volt 4 A.H. nickel cadmium battery
Dimensions
19¾" x 14¾" x 13"
Weight
40 lbs.
Environmental
waterproof when closed

The housing is a fiberglass transit case with all connections made through waterproof connectors. The transit case becomes a waterproof asesmbly when the top is clamped down.

Industrial Output

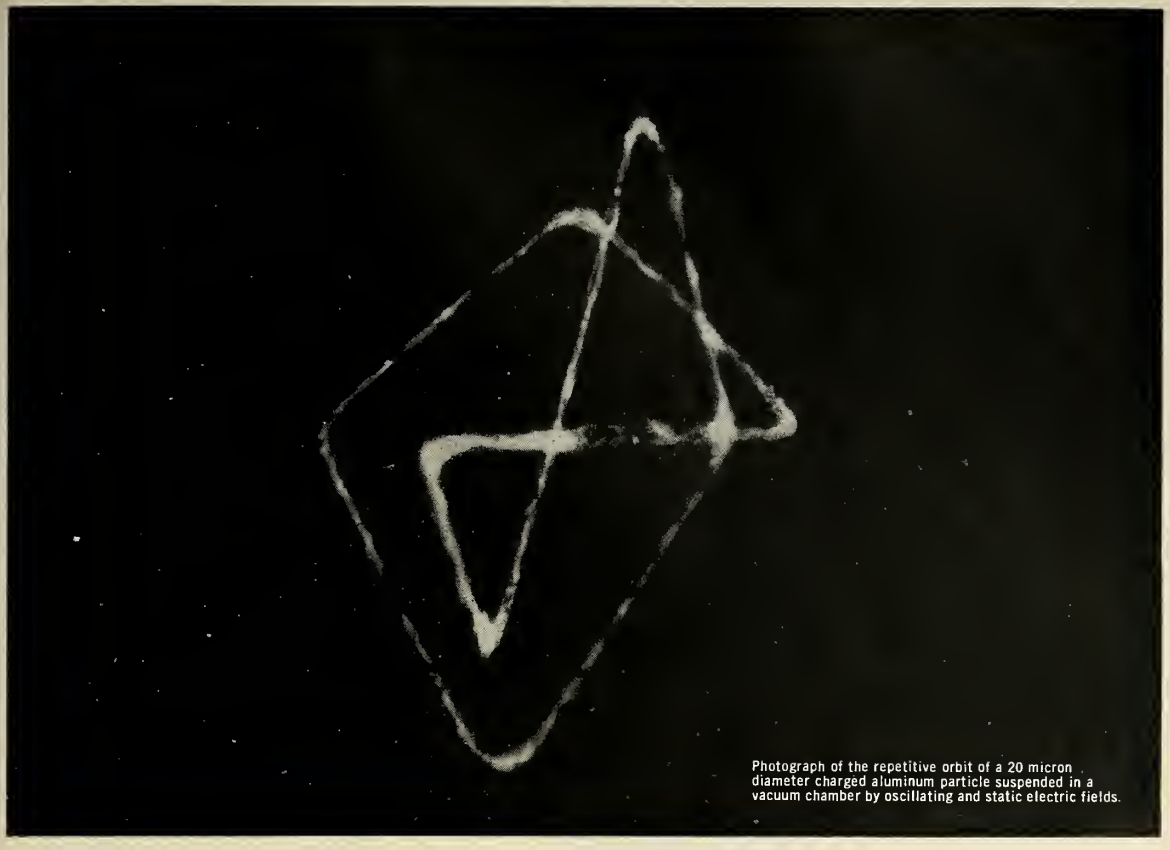
Soviets Claim 10% Rise Over 1957 Period

New data on the productivity of Soviet industry has been published, indicating an increase of 10% over the same nine months of 1957. The Central Statistical Board of the USSR has reported that the state plan for the third quarter of 1958 has been fulfilled by 102%.

According to the figures, the first nine months of this year show an output in the iron-and-steel and nonferrous metals industries 9% higher than last year. The corresponding figures for the chemical and rubber industries show a jump of 12%, and those of the machine-building industry (basis of technical progress in the Soviet economy) indicate a hike of 14%.

In absolute volume, steel smelting increased by 8% and amounted to 40.8 million tons, indicating a total annual output of 55 million tons. The Central Statistical Board's report points out that in this nine month period, pig-iron and steel production in the USSR more than doubled that of 1948.

Labor productivity has also increased, according to the report. The same nine-month period shows that labor productivity has increased 5.6%, and the Board notes that over the last forty years, Soviet industrial workers have increased productivity on an average of 6 to 8% annually, while the U.S. figures show the same parameter as having increased only on an average of 1.5 to 2% annually.



Photograph of the repetitive orbit of a 20 micron diameter charged aluminum particle suspended in a vacuum chamber by oscillating and static electric fields.

ELECTRODYNAMIC ORBITS

By the application of properly chosen alternating and static electric fields, electrically charged particles can be maintained in dynamic equilibrium in a vacuum against interparticle and gravitational forces. This is illustrated in the above photograph of the orbit of a charged dust particle. During the time of exposure the particle traversed the closed orbit several times, yet it retraced its complicated path so accurately that its various passages can barely be distinguished.

The range of particles of different charge-to-mass ratios which can be contained in this manner is determined by the gradients of the static and alternating electric field intensities and by the frequencies of the latter. In the absence of static fields and for a given electric field strength, the minimum frequency required for stable containment of the particles is proportional to the square root of their charge-to-mass ratios. Thus, charged colloidal particles require the use of audio frequencies, atomic ions need HF frequencies, while electrons require the use of VHF and higher frequencies.

Under the confining influence of the external fields, the particles are forced to vibrate with a lower frequency of motion which is determined by the external field intensities, space charge, and the driving frequencies. If the initial thermal energy is removed, a number of particles may be suspended in space in the form of a crystalline array which reflects the symmetry properties of the external electrodes. These "space crystals" can be repeatedly "melted" and re-formed by increasing and decreasing the effective electrical binding force. These techniques offer a new approach in the study of plasma problems and mass spectroscopy in what may be properly termed "Electrohydrodynamics."

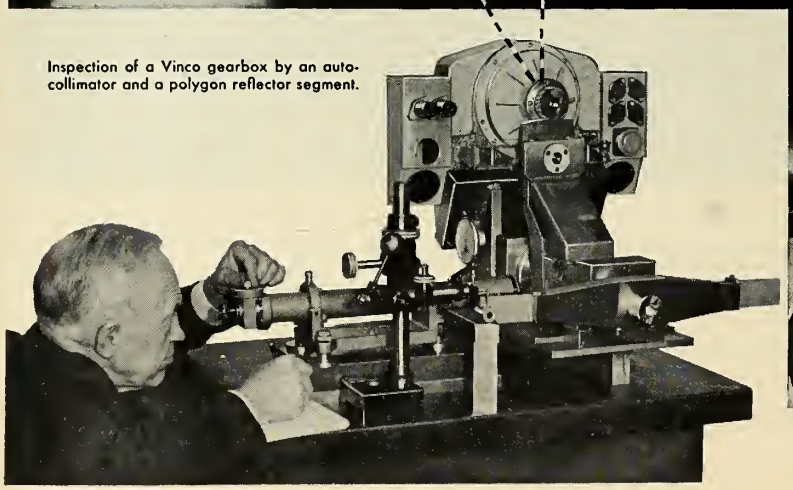
At The Ramo-Wooldridge Corporation, work is in progress in this and other new and interesting fields. Scientists and engineers are invited to explore current openings in Electronic Reconnaissance and Countermeasures; Microwave Techniques; Infrared; Analog and Digital Computers; Air Navigation and Traffic Control; Antisubmarine Warfare; Electronic Language Translation; Radio and Wireline Communication, and Basic Electronic Research.

The Ramo-Wooldridge Corporation

LOS ANGELES 45, CALIFORNIA

MISSILES GEARED TO A STAR BY VINCO

Accuracy of 3.6 seconds of arc.
Gear ratio 2,584,800 : 1.



Inspection of a Vinco gearbox by an autocollimator and a polygon reflector segment.

Test stands for missile guidance systems include a gearbox built by Vinco to isolate the gyro system from the earth's rotation. Driven by an 1800 RPM synchronous motor, with a gear head stepdown to 1RPM, it produces an output motion of one turn in one sidereal day. Output accuracy limit of 3.6 seconds of arc reflects the action of 8 Vinco gears and 9 precision ball bearings. It is equivalent to .00018" error of motion at the pitch line of a 32 diametral pitch, 20° pressure angle, 20.625 pitch diameter output sector.

Such accuracy is a must for checking the error or drift of gyroscopic and inertial guidance equipment. The gears in the sidereal rate test gearbox were ground and inspected on Vinco equipment by Vinco craftsmen. This personnel and equipment are available for producing gears of the same high precision for you.

The Vinco Optical Master Inspection Dividing Head is the most accurate instrument of its kind for checking angular spacing. Accuracy is guaranteed within a total variation of 2 seconds of arc (± 1 second). This instrument is available in both standard and heavy duty models.

VINCO CORP., 9111 Schaefer Hwy., Detroit 28, Mich.

Huntsville: From 'Cotton' to 'Space'

President's decision on transfer of Army missile talent to NASA administration is awaited with concern and even anxiety.

by A Special m/r Correspondent

HUNTSVILLE, ALA.—The President's verdict on Dr. Keith T. Glennan's proposal to transfer 2,100 scientists and engineers from the Army Ballistic Missile Agency to his National Aeronautics and Space Administration is being awaited with concern and even anxiety here in this missile-conscious city.

Ten years ago, Huntsville called itself the cotton capital of Alabama. Today, hugh highway billboards proclaim it the "Space Capital of the Universe." And many of the 65,000 to 70,000 residents know they will be vitally affected by the President's decision, one way or another.

The missile and space industry is a big one in Huntsville, for it directly provides close to 25,000 jobs and an annual payroll approximating $125 million and is the headquarters of the Army Ordnance Missile Command, which spends $2-billion annually.

Keystone of the industry is the sprawling 35,000-acre Redstone Arsenal, which on the day Glennan's proposal was first forecast by m/r, employed 19,972 including 12,283 civil service workers, 3,790 military personnel and 3,899 contractor employees.

In addition, off the Redstone reservation scattered throughout the city are a score or more satellite industries, directly dependent on the missile and space effort of the Army. Add to those the thousands of service firms—motels, airlines, restaurants and the like—whose business caters to the personnel assigned to or visiting at Redstone Arsenal.

It becomes clear why any shift in the missile business is of paramount interest locally.

The Glennan proposal would directly affect only 2,100 persons, but this group is less than half of the ABMA total of 6,758 personnel, of which 5,012 are Civil Service, 358 are military and 1,388 are contractor employees physically located on the arsenal.

• **Big question**—The big question is, if the President approves the Glennan proposal, what will happen to the remaining members of the team? Army scientists including Wernher von Braun, Ernst Stuhlinger and others insist the chiefs of the team (the ABMA group) cannot function without the Indians, and the Indians cannot function without the chiefs.

Hopes are high, of course, that the NASA transfer—which would be administrative only—will not be approved, and the President will, instead, allow a continuation of the present policy of NASA, ARPA and other functions to assign projects to existing commands and installations, rather than changing bosses.

If this is done, high Army officials

THIS FORMER textile mill with some 850,000 square feet of floor space is now the Huntsville Industrial Center. About eight miles from the Redstone Arsenal reservation, it provides accommodations for Warrior Tool and Engineering Co. (Diversey), Spaco Mfg. Co., Chrysler and Brown Engineering Co.

BROWN ENGINEERING Co. employees, J. B. Middleton and Hans Weickardt check analysis of a proposed missile system.

Temco

AIRCRAFT
DALLAS

producing **INTEGRATED AIRCRAFT ANTENNA SYSTEMS**..from concept to roll-out

Designing and producing high performance aircraft antenna systems calls for highly developed skills and advanced techniques. But the key to their successful operation is integration of the antenna into the airframe. At Temco, proven airframe and antenna engineering capabilities unite to produce optimum performance integrated airframe-antenna systems.

Many Temco-developed antenna systems are already operational, principally in reconnaissance and electronic counter-measures applications. These systems include equiangular and Archimedes spirals, slots and radiating cavities for flush installations . . tapered helices, discones, stubs and horns . . operating in up to 5:1 bandwidths. Advanced production techniques at Temco . . etched-circuit methods, high-strength plastic fabrications, precision calibration . . are skills evolved through experience, and implemented in complete, modern facilities.

With its Antenna Research Laboratory and new precision Test Range, Temco is keeping a step ahead of today's high-performance aircraft and missiles. New antenna-airframe designs are under development for operation from 30 MC to beyond 30,000 MC. Integrated antenna systems . . designed and produced by Temco for aero-space craft electronics . . are indicative of Temco's system of weapons management. In subcontracts . . or complete systems, Temco's capabilities are ready to meet your challenge.

Tomorrow's need is today's challenge at..

TEMCO
AIRCRAFT CORPORATION · DALLAS, TEXAS

say, the Army will retain its missile capability and the effectiveness of the successful ABMA development team. If it is not, serious delay to both NASA projects and the Army missile program may be the result. In addition, if physical facilities, such as laboratories and equipment are transferred, it will necessitate an expensive rebuilding program to duplicate them.

• **Far-reaching decision**—There is also local concern over the effect of the NASA proposal on the off-arsenal satellite industries. One likely to be affected is the **Chrysler Corp.** which employs more than 1,000 persons in its Huntsville plant. Activities are confined to "engineering services" rather than production, and the firm is primarily engaged in the *Jupiter* and *Redstone* programs.

There are a number of other satellites which might be affected: **Brown Engineering Co., Diversey Consultants & Designers, Inc., Southern Associated Engineers, Redstone Machine & Tool Co.** and others. All do work for ABMA, but they also do work for other agencies at Redstone, too, and the degree to which they would be affected is uncertain.

The picture is not completely dark for Huntsville. Glennan's proposal would not mean the physical transfer of the ABMA group, although it might mean the ultimate death of the Army's longer range missile program.

But there is considerably more to the picture here than ABMA.

In addition to ABMA, Redstone is also the site of the Army Rocket and Guided Missile Agency, which controls more money actually than does ABMA. It employs 5,262 people, including 2,921 civil service, 2,018 contractor personnel, and 323 military.

ARGMA, of course, has the anti-missile missile *Nike-Zeus* program, as well as R&D cognizance over all the Army's shorter range missiles. In addition, its Field Service Division and Industrial Procurement Division virtually control the Army missile program all over the world, from research and development, contracts to developers and manufacturers production, logistics, storage, and distribution.

• **But future bright**—As each new missile system is added to the Army array, work is increased for ARGMA. Regardless of the route of the long range missiles, such as *Jupiter*, the future remains bright here.

The same is true for the Ordnance Guided missile School, which employs 3,024, including 2,253 military, 508 Civil Service and 263 contractor personnel.

In addition to training servicemen from all of the U.S. services, OGMS is training a growing number of North Atlantic Treaty Organization personnel from France, Denmark, Italy, the Netherlands, West Germany, Turkey, Greece, Norway, Great Britain and Canada.

Redstone Arsenal itself in housekeeping activities for the three agencies, employs 4,426 persons.

So, actually, there are 13,214 jobs at Redstone that are not likely to be affected very much—by the NASA proposal.

And off the arsenal, the satellite engineering and development firms actually are more geared to prototype business than to production in quantity and they might fare not too badly under NASA, especially if the civilian agency's budget is increased, and added to whatever budget remaining in ABMA.

• **Ten years old**—The missile industry has come a long way in Huntsville since it was first born in the waning months of 1949, less than ten years ago.

It was then that Huntsville civic leaders were up in arms over losing the Air Force research and development center to Tullahoma, Tenn. Some obscure colonel named Toftoy (now Maj. Gen. H. N. Toftoy) in Army Ordnance had put a "hold" on the idle Redstone Arsenal properties, and the Air Force, with the urging of Senator McKellar of Tennessee moved on to Tullahoma.

People in Huntsville were not at all pleased over the prospect of "a bunch of foreigners" moving in to develop missiles. What were missiles, and would these Buck Rogers ideas amount to anything? they asked.

The people sing a different tune today, of course, for the missile industry is the backbone of Huntsville's economy.

With a meager beginning in temporary buildings, the arsenal has steadily grown through the years to tremendous proportions, and it is still growing.

Today, excluding capital equipment investment, the replacement value of Army property and buildings is conservatively estimated at $191.5-million.

In fiscal 1958, the Army completed construction projects costing $21.6-million. Another $12-million of construction is in progress, and additional construction involving $20-million is scheduled to be started before January 1.

THIOKOL CHEMICAL CORP. is one of Huntsville's larger missile companies. Here in this static test facility, work is carried out on many systems.

Facilities range from the towering 145-foot tall steel and concrete static test stand which is one of the largest in America to a maze of complex and expensive laboratories which contain electronic brains and other costly equipment necessary for the continuation of a centralized missile development organization. In addition to the vertical test stand, which has been used for the *Jupiter* program, there is a 1-million-lb. thrust capacity horizontal test stand for solid propellant engines, such as the 500,000 lb. *Nike-Zeus* booster.

• **Employment jumps**—Employment, which crept slowly upward after the missile center was established in 1950, was slightly below 9,000 at the end of 1955, just before ABMA was established here. Almost three years later, that figure is more than doubled.

A part of the arsenal's growth is a result of the tremendous expansion of **Thiokol Chemical Corp.**'s Redstone Division, one of two major contractors housed on the arsenal.

A national leader in solid-propellant development, Thiokol today employs

here approximately 1,650 persons, and its Redstone Division sales to all armed forces, to ARPA and NASA this year are reported to be well in excess of $60-million.

Thiokol projects include R&D work on *Pershing, Bomarc* booster, *Hercules* booster and sustainer, *Nike-Zeus* booster, *Minuteman* sustainer, *Falcon, Sergeant, Hawk, Lacrosse, Recruit* and others. The company also developed here the USAF *X-17* rocket motor which has become an "off-the-shelf" item used in numerous projects. Another Redstone Division product were the *Polaris* "test vehicles" which were used in the *Polaris* program until the last two firings.

When Thiokol first opened in 1949, it employed 35 people in three buildings. Today, 35 buildings on 600 acres are jammed with the 1,650 present employes, and an extensive building program is reported in the making.

HEADQUARTERS FOR Rohm & Hass Chemical Co. at Redstone arsenal

• **Satellite industries**—An example of satellite industry growth is **Brown Engineering Co.** which opened here in 1953 with a nucleus of only 10 people in an uptown office building.

Today, there are nearly 600 Brown employes working in one of the most diversified programs in the missile industry, occupying 80,000 sq. feet of floor space with 50,000 more available for expansion.

Brown's activities range from basic R&D in any phase of missile hardware, including an extensive machine shop operation, to the manufacture of printed circuits.

Specific examples of its work include feasibility studies for *Project Orbiter*, frame R&D for *Jupiter* (nose cone designs and aft section designs); guidance and control research, development and frabrication (air bearings, accelerometers, gyros, servo motors, micropositioners); propulsion R&D (turbine exhaust nozzle control mechanisms, gimbaling blow-off nozzle for directional control and thrust termination for solid propellant motors), testing and calibration; ground support equipment R&D and fabrication, including missile trailers, instrumentation trailers, flame deflectors, personnel hoists and the like.

On December 15, 1957, the company had 157 employes. Today there are 544. Net sales in 1956 totalled $770,386, while in the first eight months of 1958 net sales reached $2,409,457.

Brown, along with **Chrysler, Diversey** and **Spaco Manufacturing Co.,** all engaged in missile work, have taken up residence in a former textile mill now called the Huntsville Industrial Center.

The mill closed in 1957, and was purchased by local citizens. Its interconnected 850,000 sq. feet of floor space are being leased to government contractors who wish to avoid the expense of building erection.

The huge reinforced concrete structure has proven ideal for the missile industry, since it is capable of taking great weights on all its floors, and is easily air conditioned.

The only major missile contractor beside **Thiokol** which is located on the Arsenal proper is the **Rohm & Haas Chemical Co.,** which does applied research in both solid and propellant fields, although the emphasis is on solids.

Employing 250 persons, the company's sales this year are reported to total between $2,000,000 and $2,500,000.

General Electric, which operates the computations laboratory has a considerable force here, as does the **Rocketdyne Division of North American Aviation Co.** Both of these number in excess of 100 employes, but accurate figures are not available.

Other contractors are scattered throughout the city. These include **Southern Associate Engineers** and **Consultants and Designers, Inc.,** so far as the larger ones are concerned.

Chrysler has the bulk of its personnel in the Huntsville Industrial Center, but it also has locations in the city and on the Arsenal.

• **Off-shoot gains**—Aside from contractors, the missile business still has considerable influence on the city's economy, particularly in hotels and motels, and the airlines.

Although some 500 motel and hotel rooms have been added within the last two or three years, rooms are still at a premium Monday through Thursday, and even Fridays and Sundays are crowded as contractors' representatives pour into the city to conduct their business at Redstone Arsenal.

Scores of missile firms have resident representatives here, although most of them shy from publicity, and a complete list is almost impossible to obtain.

Many of the firms maintain offices in the motels and hotels.

Another business which has profited tremendously from the missile business is the airline activity here. Capital and Eastern offer 11 daily flights, including two non-stop to Washington and New York. Southern Airways has added two additional flights and on January 1 will add two more for a total of 16 scheduled flights, nearly all of which "load up" coming in to or leaving from Huntsville. The **Chrysler Corp.** maintains its own shuttle service between Detroit and Huntsville, flying a special charter DC3 five days a week. **Martin Company** also uses its company plane.

In addition to all of this, is the growth in community facilities necessary to any rapidly expanding community. More than 2,500 houses will be built in the city this year alone.

Huntsville's population in 1950 was officially 16,472, and counting the immediate area around it, the population was about 30,000.

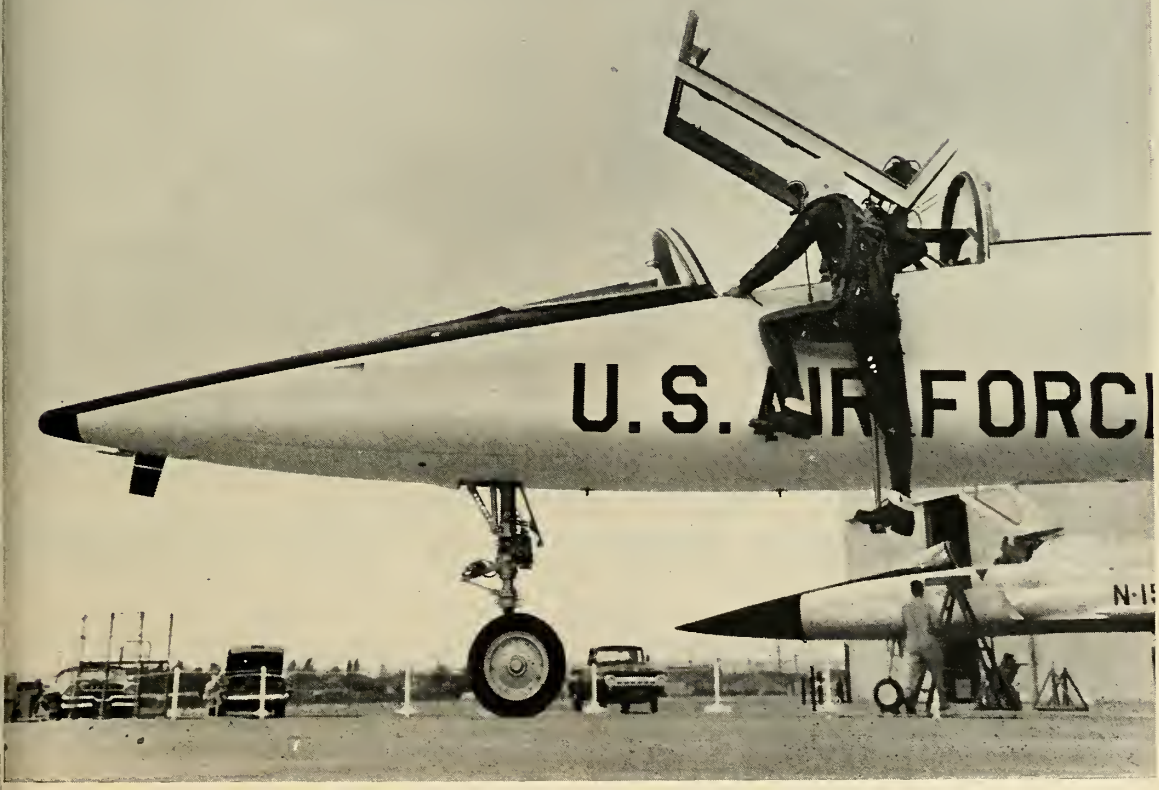
Today, it is in excess of 65,000, and is believed to be about 70,000, but no accurate figures are available.

Schools, churches, stores and other community falicities have grown proportionately, and have kept pace for the most part.

While Huntsville has other industrial activity, there is no question that missiles are the "big factor" in the area's economy.

That's why the NASA action is under such keen scrutiny here.

...NEWS IS HAPPENING AT NORTHROP



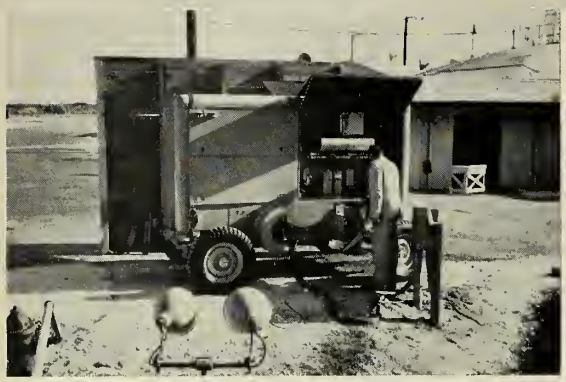
NORTHROP T-38 TO TRAIN THE NEW GENERATION OF SPACE AGE AIRMEN!

Ahead of schedule! Northrop introduces the first lightweight, low-cost trainer with combat performance characteristics, in which U.S. airmen of the space age can safely master the very special art of supersonic flight.

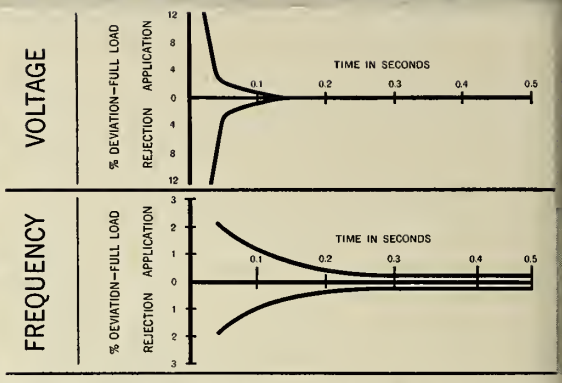
The twin-jet T-38 pioneers a new Northrop family of low-cost, high-performance aircraft. Another member, Northrop's N-156F NATO-SEATO counterair fighter, is now being built at Hawthorne, California. Final mockup of the N-156F is shown in background of above illustration.

Both aircraft are evidence of Northrop Division's skill in creating and producing higher quality products at lower cost. With other current projects, the T-38 and N-156F illustrate a new kind of cost-conscious creativity—are results of Northrop's budget-minded management team, the unique Performance and Cost Evaluation Program called PACE, and of Northrop-developed production techniques.

NORTHROP
HAWTHORNE, CALIFORNIA
A Division of Northrop Aircraft, Inc.



Snork Missile is powered by this Coterpillor Electric Set, photographed at Cope Conoverol, Florido. Full designotion: Coterpillor 60 KW 400-cycle 120-208 Voltoge Low Silhouette Portable Ground Support Unit with Precision Control Regulation.



Almost instontoneous return to normal of the new low silhouette Cot power unit (left) under conditions of full-lood opplicotion ond rejection is shown in the obove grophs. In eoch case test wos mode under o voltoge output of 117.4 volts.

Caterpillar Engines help powe

Rocket boosters blazing a flaming trail, the Northrop Snark SM-62, first U. S. intercontinental guided missile, roars skyward from Cape Canaveral, levels out and hurtles south to the Caribbean.

The precise power used for ground support of the Snark is provided by a Cat Electric Set, designed and engineered for the missile program.

On isolated, down-range islands, the missile is picked up on radar, monitored as it streaks by, and the in-flight data is recorded and transmitted to Cape Canaveral for processing.

The power for these tracking stations—for the delicate, complex equipment and for living facilities for station personnel—is provided by Caterpillar Stationary Electric Sets.

Modern, heavy-duty diesel engines by Caterpillar are playing an important role in the rocket and missile program, and in other important military applications.

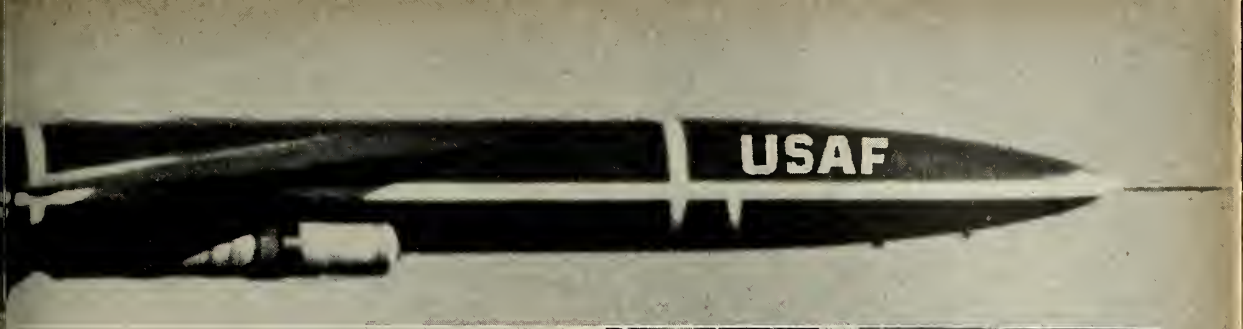
Caterpillar Engines can operate in any climate or altitude. Cat Engines were chosen to supply power for the Antarctic Expedition for the Geophysical Year (Operation Deep Freeze).

Caterpillar Engines can operate on any fuel, from JP-4 through No. 2 furnace oil, without adjustment or dilution. This means Cat Engines can use readily available fuels, eliminating storage or safety problems.

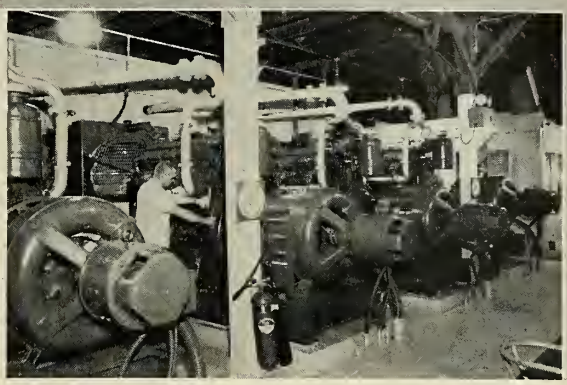
Relatively untrained personnel can operate and maintain these dependable power packages. Only

An electric orgon helps relieve the monotony of life on these vitol but lonely stations. Coterpillor Engines supply the electric power needed to operote effectively in remote places.

Weather informotion needed for missile testing is gothered in this weother stotion on Eleuthero. Precision equipment used here demonds steody, constont diesel-produced electricity.



Central Cantral at Grand Bahamas Auxiliary Air Farce Base is powered by Cat Electric Sets. This is one of 12 such statians that chain sautheastward from the Florida Caast ta Ascensian Island, south of the Equator between Brazil and Africa.



These are Caterpillar Engines supplying electric pawer an Eleuthera Auxiliary Air Force Base, one of the down-range tracking statians. Each af the engines, generating as much as 68,000 KWH each month, has been aperated more than 90,000 hrs.

United States missile program

two minor adjustments are necessary on a Cat Engine: fan belts and valve clearance.

An important factor in military preference for engines by Caterpillar is the world-wide availability of Caterpillar parts and service—832 facilities in the Free World; 398 of them within the Continental United States.

Modern, heavy-duty Caterpillar Engines are a result of more than a quarter century of diesel leadership. Creative engineering plus a quality of workmanship that is the standard of the industry has made Caterpillar power an overwhelming choice where precise, dependable diesel engines are a must.

Engine Division, Caterpillar Tractor Co., Peoria, Ill., U.S.A.

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

ENGINE POWER BY CATERPILLAR

N. W. Ayer & Son, Inc.

"We've had little down time with aur dependable Cat Engines," says Burt Nira, Pan American Airways Base maintenance supervisor, Eleuthera. James McCullaugh, base manager, is at right.

Special Governmental Projects, Dept. MI12, Engine Division
CATERPILLAR TRACTOR CO., Peoria, Ill.

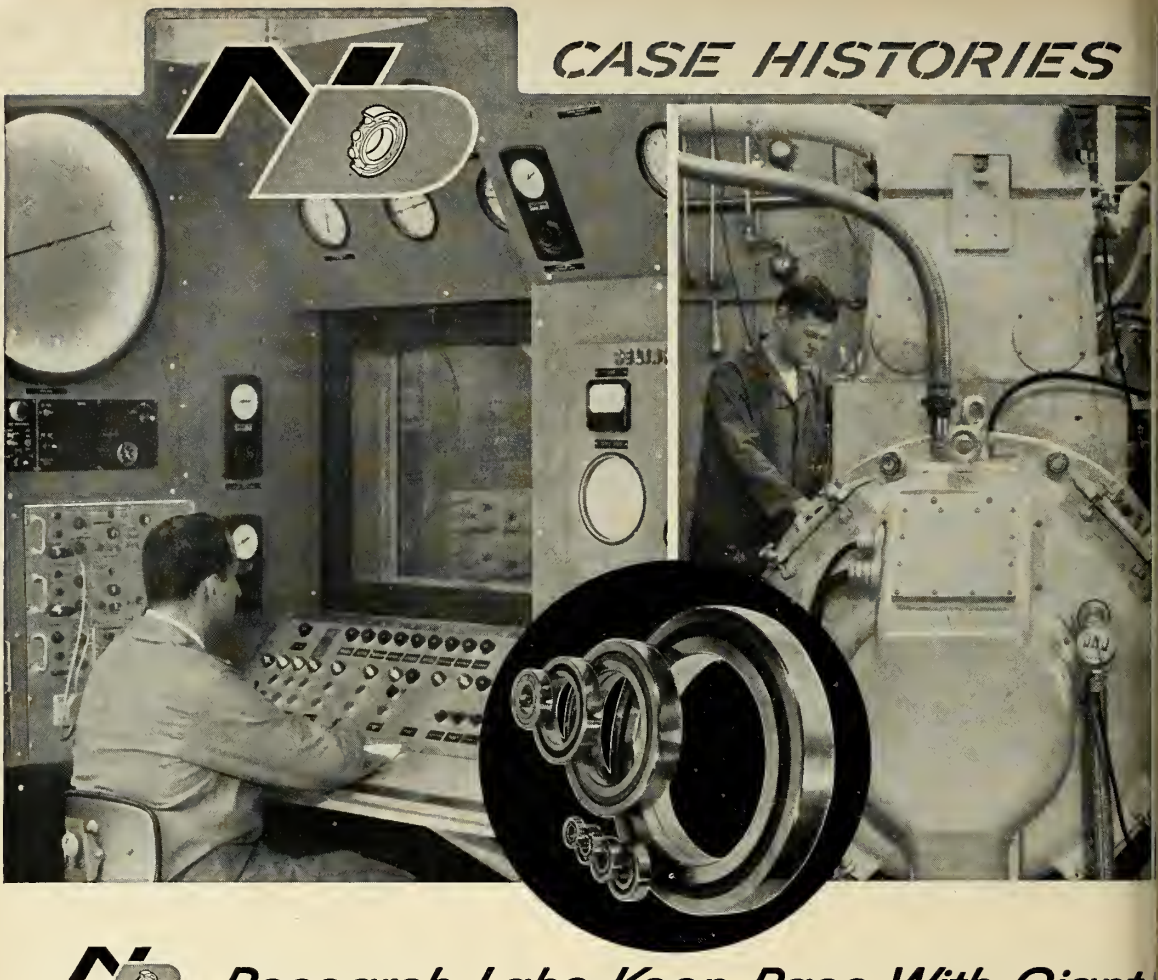
☐ Please send me additianal detailed infarmatian an Ground Suppart Electric Sets.

Name_____

Base (ar Firm)_____

Address_____

City_____ Zane____ State_____



Research Labs Keep Pace With Giant Stride Of America's Air Industry!

CUSTOMER PROBLEM:

Require test rig for measuring full scale aircraft turbine bearings. Test rig must simulate actual operating conditions.

SOLUTION:

N/D engineering, in cooperation with customer under the direction of a defense agency, developed the aircraft turbine bearing testing equipment shown above. The Test Rig Control Console, shown on the left, initiates and controls tests, and completely records *all* operating performance characteristics. The test stand itself, above right, simulates the actual conditions to which the bearings are subjected in flight. It develops radial loads of up to 25,000 lbs. . . . and thrust loads reaching a maximum 75,000 lbs. Bearings up to 110mm bore are tested at speeds as high as 20,000 r.p.m., in temperatures ranging up to 1200° F. Research facilities such as this are your assurance that New Departure stands ready to work closely with you on *your* bearing research problems.

For information on New Departure precision Aircraft and Instrument ball bearings, or research facilities, call the New Departure Sales Engineer in your area or write Dept. K-12.

NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

Direction Finder May Alter Alinement Concepts

NAA Autonetics' portable device could replace conventional methods of determining azimuth-reference base lines

by Fred Hunter

LOS ANGELES—A field-use direction finder which is portable, quick and easy to operate, and at the same time highly accurate may solve a long-time problem of missile launchers, mobile radars and other angle-calibrated equipment.

Designed to replace conventional surveying, celestial and magnetic methods of determining an accurate azimuth-reference base line, ABLE, developed by Autonetics, a division of North American Aviation, Inc. may trigger a major reorientation of alinement concepts.

Celestial alinement equipment requires a fix on a particular star and thus is good only at night in clear weather. Magnetic alinement methods find true north through the long and roundabout process of first locating magnetic north. Then, through consultation of declination tables, a basis for the determination of true directions in azimuth is obtained. Both celestial and magnetic alinement require entire teams of surveyors, who, to attain the necessary skill, must undergo rigorous and expensive training programs. Even with trained teams, these methods take hours for accurate base line determination.

• **By day or night**—ABLE, on the other hand, functions by day or by night, and in all kinds of weather. It requires but a single operator, and in only 10 minutes this operator can be trained to perform the entire alinement procedure. At middle latitudes, determination of an accurate base line is accomplished with ABLE in approximately 15 minutes; at latitudes between 60 and 70 degrees, a slightly longer period is required to obtain equivalent accuracy.

ABLE imposes no tactical restrictions, since it does not necessitate major revamping of missile-firing or equipment-positioning procedures (with the attendant expense and rigorous training program requirements).

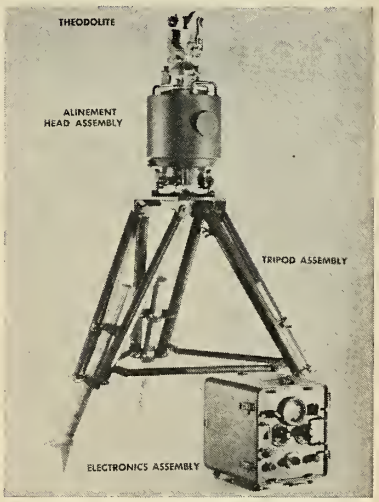
With ABLE, a mobile radar crew need not wait for the passage of inclement weather in order to take a "fix" on Polaris. By the same token, a rocket-launching group, with only a single hour to move into position, erect and aim the launcher, and then move out to escape retaliation, need no longer be dependent on slow surveying methods to determine local directions. These two examples are typical of the numerous applications in which accurate angular reference can be conveniently supplied by ABLE.

• **Three assemblies**—The basic components of ABLE are three assemblies: alinement head, electronics, and tripod. In the portable, general purpose version, the three assemblies make up a single 100-lb. piece of equipment. For practically all positioning, aiming, and surveying applications, this general purpose package—in conjunction with a standard theodolite or transit—is functionally suitable. In many cases, however, such as with missile-launching equipment or radar antenna alinement mechanisms—it may prove more practical for the alinement head and electronics assemblies to be physically integrated into the equipment requiring alinement. In these cases, easy-reading mechanical dials can often replace the theodolite.

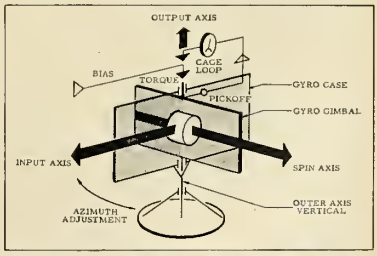
The principles upon which ABLE functions are simple and familiar.

A high-quality, single-axis gyro (located in the alinement head) produces alinement signals. The electronics assembly interprets these signals and, by means of a dial indicator, shows the operator the necessary adjustments for bringing the gyro input axis into alinement with true east-west. The true east-west line thus established by ABLE is then read out with the theodolite and serves as a base line for the accurate determination of any desired direction in azimuth.

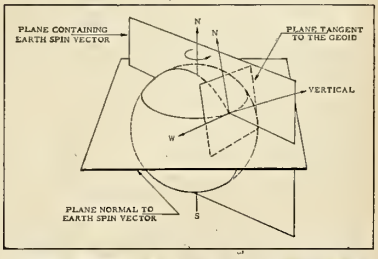
ABLE has much to offer in in-



BASIC ELEMENTS of ABLE: alignment head; electronics; and tripod.



SINGLE AXIS gyro showing input, output and spin axes.



WHEN INPUT axis of gyro is horizontal, axis must be parallel to true E-W line.

creased alinement accuracy and reduced alinement time for the boresighting of radar antennas.

Conventional methods employ either magnetic compasses and declination tables, or optical equipment and an ephemeris. Sometimes one method is used to double check on the other. By either method or by their combination, accuracy cannot be relied upon for precise boresighting.

• **Time consuming**—A magnetic compass is normally used to find magnetic north in daytime alinement. The compass reading, of course, must be corrected by consultation of the declination tables to determine true geographic north. To boresight a radar antenna, a corner reflector is mounted in line with true north, and the antenna is mechanically rotated until the reception of an echo from the reflector tells the operator that the radar beam is centered on true north. All this takes hours.

Sometimes the daytime alinement is either replaced or checked by celestial methods.

If the night is a clear one, the alinement crew sights on Polaris with a telescope. When Polaris has been sighted, the operators must determine the azimuth component of the star's actual location by study of a complicated ephemeris. Accuracy with celestial methods is dubious, not only because of the patent possibilities for human error, but because of the shimmering of the image beneath the telescope cross hairs due to variations in atmospheric density, winds, etc. If the night is completely clouded, the expensive equipment must stand uselessly idle.

In remarkable contrast to these slow, dangerous, and comparatively inaccurate conventional methods, are the simplicity, speed and precision of ABLE, with an alinement time measured in minutes and in an almost unbelieveable accuracy in base line determination.

For automatic alinement of the azimuth axis of the antenna, ABLE can readily be integrated, with minor modification, into the radar system.

Other fields for employing ABLE lie in the alinement requirements of ground controlled intercept (GCI) and missile-positioning and launching operations.

For GCI service, the rapidity with which ABLE can be set up and operated offers an advantage of inestimable importance. Its primary contribution to GCI is found, however, in the highly precise common geographic reference which it provides for the early-warning or acquisition radar and the controlled interceptor aircraft.

The course (vector) provided the interceptor aircrew by the GCI equipment brings the interceptor to a point at which radar contact can be made with the target. To reach this point, the aircrew is supplied ground-controller information concerning the approximate elevation, bearing, speed, and range of the target, as well as of the interceptor. The necessity for extreme accuracy in this information is enhanced by the tremendous speeds and maneuverability of modern aircraft. With the reference furnished by ABLE, the GCI information is accurate and dependable. Because of ABLE's speed of operation, the information can be kept dependable through quick, frequent alinement checks.

In the positioning and aiming of missiles and rockets, ABLE's speed and accuracy could prove invaluable. The ABLE components can be physically integrated into the missile-launching equipment. Total alinement time, depending on latitude, can be as little as 10 minutes. For anti-missile-missiles, the advantages of this capability for almost instantaneous response to early warning of enemy ballistic missile attack is obvious.

• **Meets requirements**—To perform satisfactorily, a ballistic missile must be correctly aimed to within a few tenths of a degree. To hit a target as large as the moon, a rocket must be properly positioned to within a half of a degree. In either case, ABLE's precision is more than sufficient to meet the requirements.

The gyro used in the ABLE system is known as a "single-axis" gyro because its outer case contains only one gimbal. The "spin axis" of this gimbal is defined by the rotor spin bearings; the other axis of the gimbal, termed the "output axis" is defined by the bearings in which the gimbal rotates within the case. The "input axis" is defined as being orthogonal to both the spin axis and the output axis.

In the ABLE configuration shown the gyro behaves as an extremely sensitive rate-gyro. If the case of this gyro, through its connection with the earth, is caused to have an angular rate of rotation about the gyro input axis, the gyro gimbal tends to precess (rotate) about the output axis. The pickoff, sensing a minute displacement of the gimbal with respect to the case, produces an electrical restraint—that is, a torque—about the output axis, which prevents the rotation and at the same time indicates the magnitude of the required restraint.

When the gyro is so positioned with respect to the earth that the component of earth rate lying along the gyro input axis is zero, the gimbal tends to remain stationary with respect to the case and no restraint is required.

In operation, the gyro case position is adjusted in increments about the outer vertical axis until the requisite null condition is achieved. The indicator needle is then centered at zero, and the ABLE operator knows that the input axis is at right angles to the earth rotation vector. If, at the same time, the input axis of the gyro is horizontal, the axis must be parallel to a true east-west line. A true east-west line is defined as the intersection of a plane tangent to geoid with a plane normal to the earth spin vector. If the input axis of the gyro is horizontal, it must lie in a plane tangent to the geoid and, since rotation about the input axis is zero, the axis must also lie in a plane normal to the earth spin vector.

Any gyro is characteristically subject to inherent bias torques acting on the gimbal. These torques are attributable to mechanical stresses in electrical connections, magnetic field effects, etc.

In ABLE, all torques upon the gyro input axis other than those due to earth rotation are measured and cancelled by means of a self-contained bias-compensation circuit. Thus, when the gyro is so positioned that the influence of earth spin upon the gyro is eliminated, the gyro input axis is alined with true east-west and serves as a precise reference for the determination of any desired direction in azimuth.

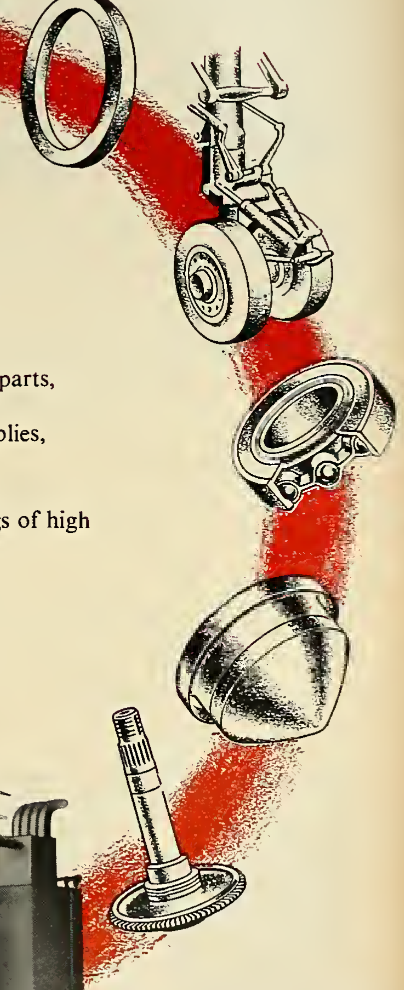
The constant and repeatable precision of the system is maintained through the effective cancellation of internal bias and, also, through the extreme stability of this bias.

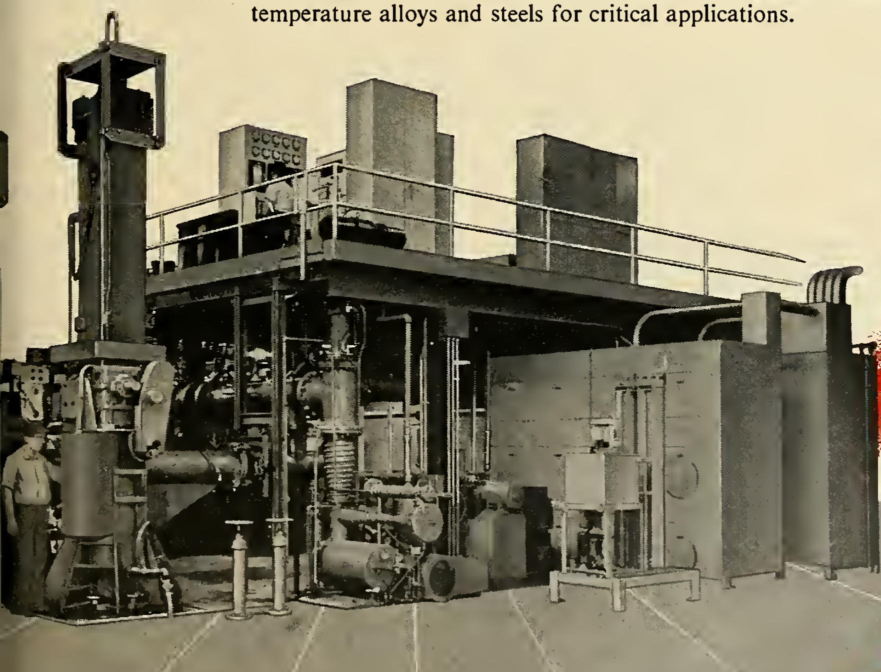
• **Accuracy**—Any electronic equipment is only as useful as it is reliable, and ABLE's remarkable accuracy and high-speed operation is attained by the exclusive use throughout of standardized designs based on actual testing and operating experience. Both purchased parts and components developed at Autonetics have been subjected to extensive test and inspection programs.

The high-precision gyro—which is the heart of the ABLE system—was developed under the cognizance of the Weapons Guidance Laboratory, Wright Air Development Center, Wright-Patterson Air Force Base. These gyros are now in quantity production at Autonetics. The ABLE electronic circuitry has been fully proved under other programs. All circuits are transistorized.

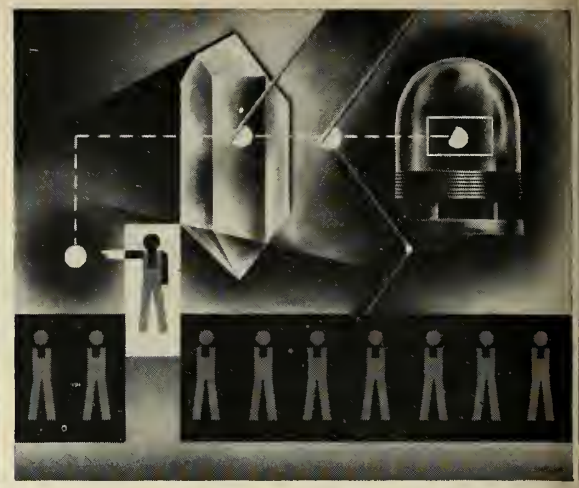
Self-check features in ABLE make possible the ready detection and isolation of malfunctions, and replacement of the gyro-optical subassembly or of any of the plug-in cards can be accomplished in a matter of minutes.

SUPER ALLOY STEEL BY *MIDVAC* ...A NEW STANDARD IN QUALITY





MISSILE COMPONENTS Bulova's infra-red seeker cells are designed to lock any missile on target; Bulova's fuzing systems do the rest. Powder-driven gyros, timers, safety-and-arming systems and other electronic and electro-mechanical devices, designed and made by Bulova, play vital roles in the Sidewinder, Dart, Talos... in all, 18 key missiles.



AUTOMATION Bulova R&D designed mechanized plant and equipment for Signal Corps goal of 10,000 perfect quartz crystals per 8 hour shift —with 1/10th the manpower. From systems analysis through equipment development, Bulova engineers devise industrial and military facilities for automatic production of electronic components and ordnance items.

Bulova precision helps to solve today's most challenging problems

Time, mass, length... the age-old concepts man relies on as he enters the Age of Space.

Time alone is unique. Its accurate measurement demands the highest order of precision in the design and manufacture of electro-mechanical devices.

Bulova, leader in measurement of time, has become master of the very combination of abilities that holds practical solutions to the growing challenges of miniaturization.

Miniaturized systems and components by Bulova are now working for our nation's defense and automated industry. The same vision and experience that developed them are available to assist you... from concept to reliable mass production.

For full information, write *Dept. G.I.S.-1, Bulova Park, Jackson Heights, New York.*

BULOVA watch company

BULOVA RESEARCH AND DEVELOPMENT LABORATORIES, INC.

PRECISION MANUFACTURING Bulova-built servo muscles steer our nation's first ballistic guided missile — the Corporal. When critical tolerances demanded uncompromising accuracy, Bulova solved tooling and assembly problems on a crash basis. Bulova experience and facilities are unexcelled where precision, reliability and capacity are vital.

AIRCRAFT INSTRUMENTS Bulova's new Servo Altimeter combines unsurpassed sensitivity and accuracy with direct-reading tape presentation. Special pressure devices created by Bulova include transducers for air data computers... remote pressure sensors for weather stations and airports... climb and dive indicators... and autopilot altitude controls.

National Cash Register glass rod switching and storage element is so fast that top speed is unknown

Magnetic Unit Uses Extremely Low Power

by Raymond M. Nolan

PHILADELPHIA—National Cash Register's Electronics Division has developed a switching and storage element which works so fast that its top speed is unknown.

The device, a glass rod with a magnetic coating, has had switching speeds of 4 millimicroseconds measured in the laboratory, but production models have not had their speeds timed.

Power required to store a "bit" of information is only 20 thousandths of a watt, and it is possible to link thousands of the rods together.

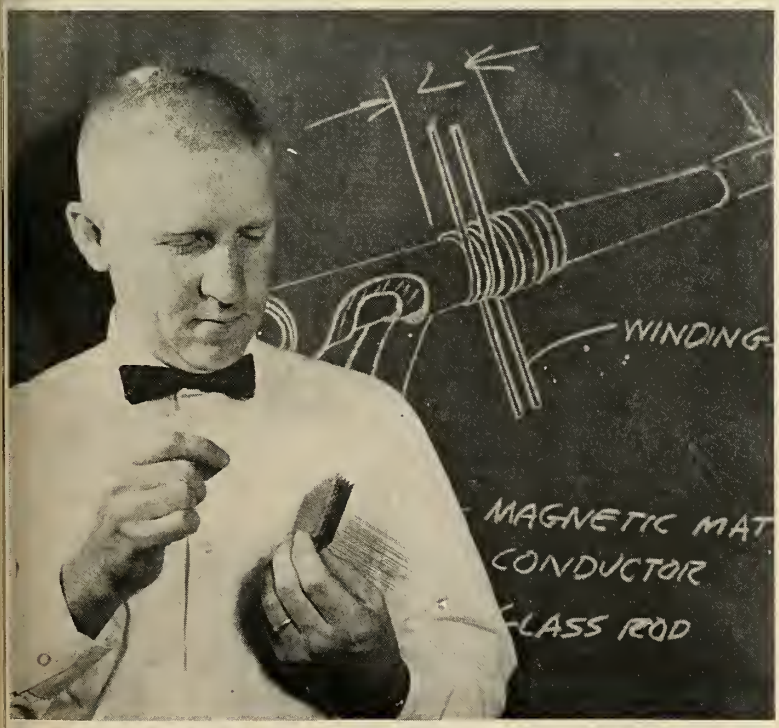
The rod reportedly operates reliably at temperatures 300 degrees F higher than conventional components. In the laboratory, the rod has been operated in the coincident current mode from minus 100 degrees C to plus 200 degrees C. In the word-ordered mode, this temperature range can be extended upward.

Switching has been accomplished continuously at a five megacycle repitition rate without adverse heating effects. The hysterisis loop on the rod's magnetic coating is extremely square, showing a ratio of better than 0.95.

• **Magnetic coating**—The new unit is about 15 thousandths of an inch in diameter. It is given a magnetic coating by an electrochemical process developed by NCR. The length of the rod can be varied, depending on the storage capacity desired. A small winding of wire around the rod stores the information. The compact size of the rod cuts the space required for storing information, with 8000 "bits" being stored in a rod memory system the size of a cigarette package.

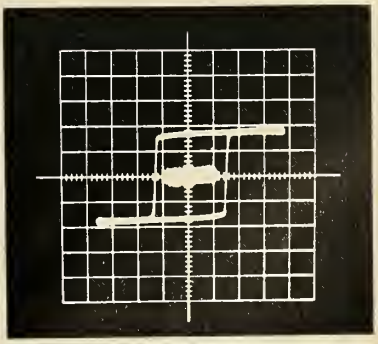
It is possible to wind 10 bit-positions per linear inch along the rod without mutual interference. These windings of very fine wire are placed on the rod in a solenoid-like manner with successive windings superimposed. At the present time, packing density is 1000 bits per cubic inch, although this is not an electrical limit.

• **Memory matrices**—A single magnetic element for a coincident current memory requiring two inputs, an inhibit winding and a sense winding would consist of four separate single-layer concentric solenoids over the rod. Memory matrices each consisting of many solenoids can be stacked and simultaneously threaded with the rod.



DONALD A. MEIER, inventor of the magnetic rod, inserts a tiny element into memory assembly. Blackboard shows construction features.

MAGNETIC ROD memory element. Photo shows relative size.



SQUARE HYSTERISIS loop of magnetic rod. Ratio is better than 0.95.

There is a creative engineering assignment for you with IBM

Assignments now open include...

SYSTEMS ENGINEER to develop complex devices in fields of servo-mechanisms, radar, or computers, and integrate these elements in weapons systems. Must have 3 to 5 years' experience in such activity and two years' experience in over-all systems analysis. Assignment involves design and analysis of closed-loop systems, consisting of inertial and radar equipment, display materials, and digital or analog computers.
Qualifications: B.S. or Advanced Degree in E.E. or A.E.

INERTIAL GUIDANCE ENGINEER to assume broad project leadership in the planning and control of development projects. Must have 3 to 5 years' experience in servo-mechanisms or development of complex devices for military applications, including 2 years as technical leader of inertial guidance system development. Must have experience in astro-compass, with ability to analyze relationship of inertial equipment with bombing and navigation computer.
Qualifications: B.S. or M.S. in E.E. or Physics.

RADAR ENGINEER to analyze ultimate limits of present techniques and develop new concepts of providing topographical sensors for advanced airborne and space systems; to design airborne radar pulse, microwave and deflection circuitry; to analyze doppler radar systems in order to determine theoretical accuracy and performance limitations.
Qualifications: B.S. or Advanced Degree in E.E. and 3 to 5 years' experience in radar system development, including display equipment and circuits, control consoles, and doppler or search radar design.

CONTROL SYSTEM ANALYST to perform physical and mathematical analyses needed to solve complex inertial control problems with real-time digital computers. Applications in area of b navigation systems, missile systems, spe pose computer systems such as DDA.
Qualifications: M.S. or Ph.D. in Physics o fields with strong math minor and up to experience.

COMPUTER ENGINEER to undertake lo sign of airborne digital computer eq transistorizing computer circuitry for weight reduction. Assignment entails: Me tion of computer circuitry and packagir preting problems for solution with the I
Qualifications: B.S. or Advanced De Engineering or Physics and 3 to 5 years ence in design of digital or analog c equipment. Experience desirable in t technology, computer logic, programmin mentation, computer system evaluation, mechanism design.

. . . missile electronics

Sylvania Working at MASER Miniaturization

NEW YORK—Development of the MASER (Acronym for microwave amplification by stimulated emission of radiation) is expected to take a long stride forward because of work now in progress at Sylvania Electric Products.

Dr. Robert M. Bowie, vice president of Sylvania Research Laboratories, a division of the company, recently announced that the Labs are now engaged in a program to "ruggedize, miniaturize and package" the MASER so that it may be used initially in military applications, and ultimately in industry and peacetime research.

Dr. Bowie described the Sylvania program at a conference held at the Research Laboratories at which Sylvania and Arthur D. Little officials dedicated the 100th Collins cyrostat, a device manufactured by Little which liquefies helium gas at a temperature near absolute zero. The liquid helium is used to cool the MASER crystals and their surroundings, which depend for operation on the presence of temperatures close to absolute zero.

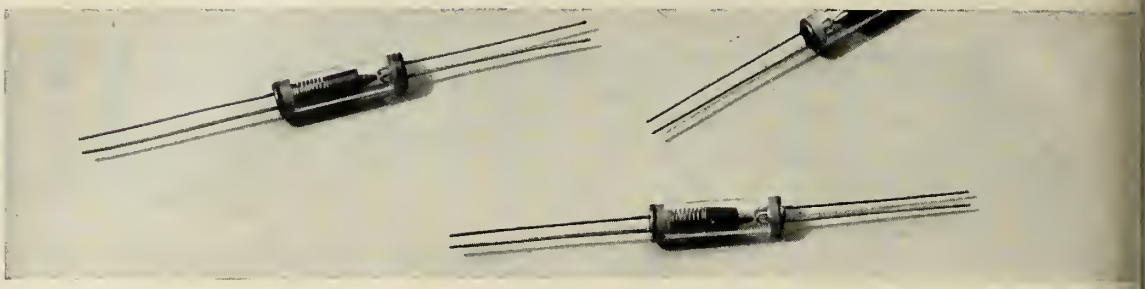
The Sylvania concept of a packaged MASER system would include as integral parts a small, built-in cooling system, and a small permanent magnet instead of the huge electro-magnets now used in laboratory systems.

However, the completion of a prototype packaged MASER system by Sylvania is still about one-and-one-half years away and there are a number of problems still to be solved before a working miniaturized system can be demonstrated, according to Dr. Bowie. He added though, that "we are looking forward to the day when such a system, simplified and easy to operate, will lend new eyes and immeasurably improved defenses to our Armed Forces. It could be put in the field in a radar system, operated by a technician, and accomplish feats of detection not dreamed of with present-day radar."

Dr. Bowie estimates that if a MASER were installed in a conventional radar system, it would increase the range of the system from two and one-half to seven times. Conversely, at closer target ranges, the MASER would produce the same picture as a conventional system, with substantially less transmitter power.

In addition to the packaging program, Sylvania has a four-point MASER program in progress at the Research Laboratories. The program includes the study of existing MASER materials and the search for other materials with improved characteristics.

HUGHES THERMAL RELAYS



FOR RELIABILITY

IN GUIDED MISSILES

Hughes now makes commercially available a completely reliable single action switch. Used in the Falcon, field proven as a reliable missile, this Hughes relay is engineered to meet the most exacting of requirements.

With unusual speed of action, firing signal triggers the release of constrained contact... contact closes upon fixed contact point... switch circuit becomes permanently closed.

In a typical application, 3.0 volts DC applied to a firing circuit of 1.2 ohms fires within 0.3 seconds.

For additional information please write: Hughes Products, Marketing Department, International Airport Station, Los Angeles 45, California.

SPECIFICATIONS

MECHANICAL—Body Size: Maximum diameter 0.252"; length .920". Total weight: Less than 0.1 oz.

ELECTRICAL—**Before Firing:** Insulation resistance is greater than 200 megohms. Minimum breakdown voltage 600 volts.

Firing: 2 volts minimum required. Actual voltage dependent upon closing time desired.

After Firing: Circuit resistance less than 0.3 ohm.

ALTITUDE—Any.

OPERATING TEMPERATURE: −55°C to +125°C.

Creating a new world with ELECTRONICS **HUGHES PRODUCTS**

SEMICONDUCTOR DEVICES • STORAGE AND MICROWAVE TUBES • CRYSTAL FILTERS
OSCILLOSCOPES • RELAYS • SWITCHES • INDUSTRIAL CONTROL SYSTEMS

PMR Could Cost Billions

by Robert Mount
Special m/r correspondent

POINT MUGU, CALIF.—Cost of developing the Pacific Missile Range could run into billions of dollars over the next 15 years, according to Rear Admiral Jack P. Monroe, PMR commander.

"Of course," he said, "we don't know what programs are coming, or even what programs authorities may be thinking about over the next few years which might logically require firings over the Pacific.

"It depends whether all contemplated projects are approved, whether they are assigned to the PMR, and what the pace of the work will be.

"It could cost billions to develop the range over the next 15 years if all contemplated projects should go through and be assigned to the PMR on a normal development period.

"In addition, operation of the range would amount to several hundred millions of dollars a year, subject to the same qualifications I've mentioned."

• **First ship assigned**—The first range ship assigned is the Pvt. Joe E. Mann, now docked at Port Hueneme, near the Naval Missile Center Point Mugu, which is range headquarters.

Also berthed is the converted LST King County, which contains a "piggy-back" mockup of the bow of the nuclear sub, Halibut, plus a complete duplicate of the *Regulus II* missile system aboard the Halibut. The King County will be used for *Regulus II* firings and for training of future missile-submarine crews.

Port Hueneme is also home port for the USS Norton Sound, the Navy's first experimental guided missile ship, which has operated in waters off Point Mugu for nearly 10 years, with occasional long cruises for special projects.

The submarine Grayback, which carries two *Regulus II* or four *Regulus* missiles in her deck hangars, is presently completing her shakedown cruise. But during her first visit to Port Hueneme, she successfully conducted the first sea-launching of a *Regulus II* to an inland point on the Wendover corridor of the PMR. Grayback is expected back at Port Hueneme sometime in January.

In addition to PMR headquarters at Point Mugu, the range includes the Naval Missile Facility at Point Arguello, almost 100 miles to the west of range headquarters, and San Nicolas Island, 62 miles southwest of Point Mugu.

These three sites presumably would be the key instrumentation units for the ultra-sensitive radars which will sweep the range.

• **Established in 1946**—Point Mugu was formally established as a missile center in 1946, and has utilized special facilities on San Nicolas Island in conjunction with early missile development launchings from the main pad at Point Mugu and from vessels in the small Sea Test Range off Ventura County's coast.

At NMF Point Arguello, there are presently no launching sites.

Initial construction of photographic, technical administration and instrumentation facilities at NMF Point Arguello has just begun.

Top military officials have said on numerous occasions that Point Arguello, because of its physical features, is destined to become ultimately this nation's primary satellite launching site.

The Air Force has already achieved operational capability with ballistic missiles at Vandenberg AFB, just across the Santa Ynez River from NMF Point Arguello. Here the *Thor* pads are completed and *Atlas* pads soon will be ready for firings.

Vandenberg AFB is separate from the PMR, but it will undoubtedly be utilized for early PMR work until other facilities for as yet undisclosed projects of ARPA, NASA and private contractors are constructed at the nearby NMF.

The PMR, acting as a service agency for NASA, ARPA, and other government units, will eventually control all of this nation's satellite launchings on polar and equatorial orbits.

Admiral Monroe says, "The Pacific Missile Range is this nation's last opportunity to build a range from the ground up.

"Because of this, we are studying the entire missile and rocket industry, learning what programs are coming, and projecting these programs into future needs.

"We are trying to design the range, as it is developed, so that it will have the capability to match the anticipated needs in the years to come."

Admiral Monroe foresees a time when the instrumentation facilities of the PMR, the Atlantic Missile Range, and the White Sands Missile Range will be tied into a common network, so that each range can assist in such projects as satellite, ballistic missile, and space vehicle tracking with high efficiency and minimal delay in analyzing and interpreting data transmissions.

FIRST *REGULUS*-ARMED LST is the USS King County, an experimental vessel serving the Pacific Missile Test Range. It will test the missile launching system and will train submarine crews.

Bloodhounds ready for launching during acceptance trials at Woomera

For Britain's

Approaching full operational status with the RAF as ma
stay of Britain's air defence.

Adopted by Sweden after exhaustive consideration of surfa
to-air guided missile systems available throughout the wo

Proved in many hundreds of test firings.

Bristol/Ferranti Bloodhound forms the world's most effect
defence system now and for many years to come.

DEFENCE

ity forbids publication of full details, but the o ng facts about Bloodhound can now be given:—

. The Bloodhound is powered by two Bristol ramjets h jet engine with no moving parts. Ramjets ensure and range flexibility, burn kerosene, are simple and handle.

g system. Semi-active: i.e., ground crew directs beam on to approaching target which is reflected to ver in Bloodhound missile.

ensures highest accuracy—regardless of range. sis may be fired singly or in salvoes using only one

ne. Employs unique and advanced monoplane ig wing configuration—two advantages: quicker and more precise response, as well as greater accuracy of interception—superior at high altitudes; this configuration was selected at initial design stage to embody maximum development potential.

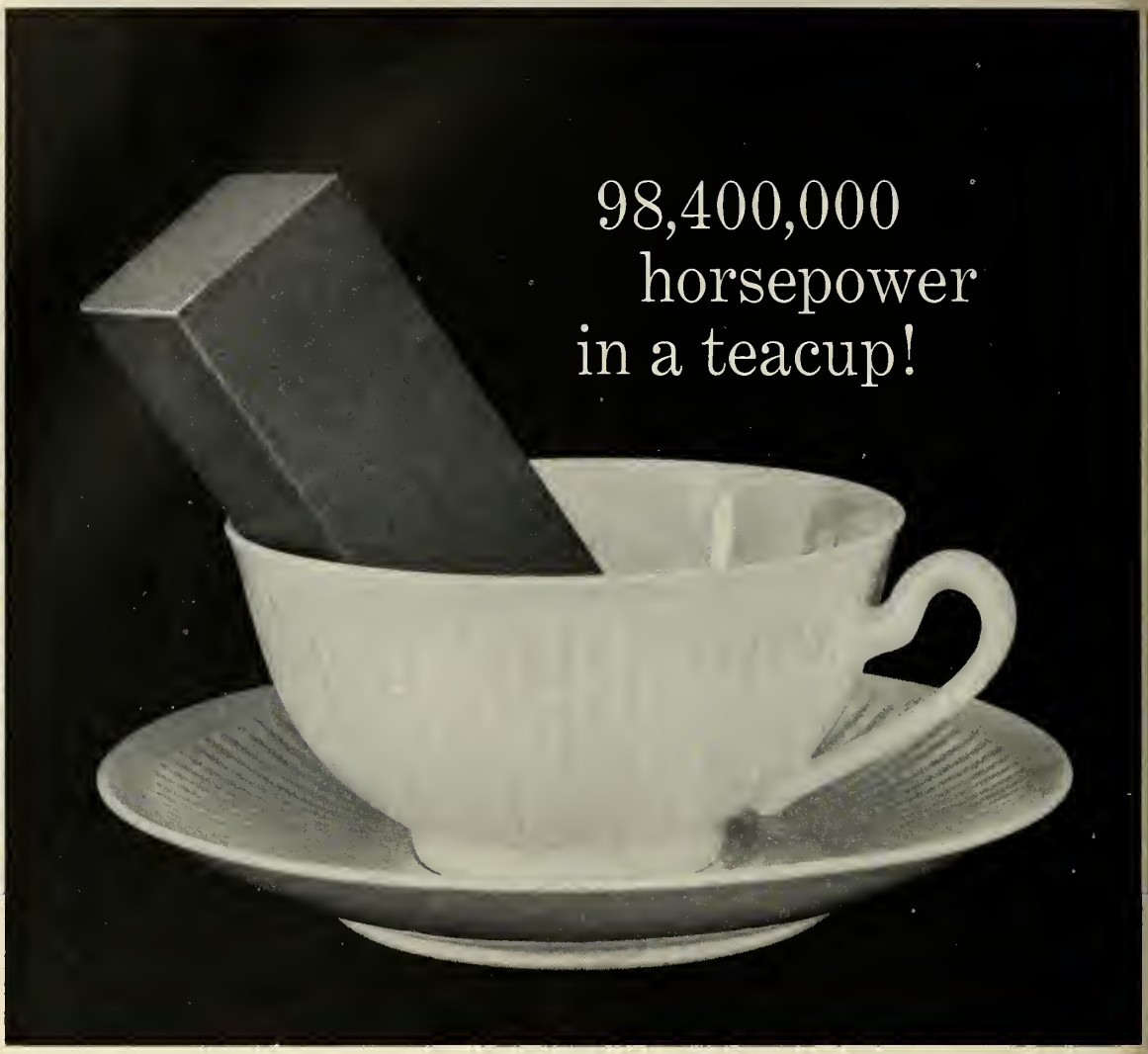
BRISTOL/FERRANTI

Bloodhound

GUIDED WEAPON SYSTEM

BRISTOL AEROPLANE CO (USA) INC
400 PARK AVENUE, NEW YORK 22, NY

design and construction by Bristol. Guidance and control by Ferranti. System sales organisation Bristol Aircraft Limited



Fantastic amounts of chemical energy are developed and packaged in small lightweight containers at the National Northern Division of American Potash & Chemical Corporation. National Northern engineers can develop 98,400,000 HP in packages small enough to fit in a teacup. Businessmen and missilemen have benefitted from our unique ability to apply this highly adaptable form of packaged energy. Power to spin turbines, push pistons, develop heat, and explosively form metals, is available at National Northern. Our technical representatives can assist you in the application of this form of energy to your design and production requirements. *Write or call—*

CURRENT FIELDS OF ACTIVITY:

Rocket motor igniter development; gas generators; surveillance testing of explosives and ammunition; development and production of electric detonators and squibs; explosive metal forming; boron pellets.

NATIONAL NORTHERN DIVISION

TRONA **American Potash & Chemical Corporation**

KING STREET, WEST HANOVER, MASSACHUSETTS

on the west coast—3000 WEST SIXTH STREET, LOS ANGELES 54, CALIFORNIA

SPECIFICATION: Stainless Steel Honeycomb "Sandwich"

FIRST SOURCE: AERONCA

Integrated design and development services.

Special high-speed machinery . . . advanced fabricating techniques.

Large capacity precision brazing furnaces.

Superior honeycomb structures in production quantities.

TODAY...AERONCA IS DESIGNING, DEVELOPING AND PRODUCING A COMPLETE RANGE OF HONEYCOMB STRUCTURES TO MEET SPECIAL REQUIREMENTS

Stainless steel brazed honeycomb "sandwich" structures are solving critical thermal, dimensional and strength-weight ratio problems in the latest air weapons systems.

Aeronca . . . a pioneer in stainless steel honeycomb development . . . *is one of the few companies actually producing these high-temperature structures in quantity.* Flat, wedged, conic, contoured and compound curved sandwich panels are being delivered by Aeronca for application in missiles and supersonic aircraft.

Let Aeronca's *practical experience* and fully integrated facilities help you solve airborne structure or component problems.

Write today for details. Formal letterhead inquiries will receive immediate attention.

BASIC ADVANTAGES OF HONEYCOMB FABRICATIONS

1. Superior strength-weight ratios.
2. Outstanding thermal stability.
3. Excellent resistance to acoustic shock and fatigue.
4. Greater aerodynamic smoothness.
5. Simpler sealing techniques in pressurized areas.
6. Increased usable volume.
7. Fewer detail parts or components.

Expansion of our operations has created openings for additional qualified senior engineers. For information, write to Mr. L. C. Wolfe, Chief Engineer.

AERONCA

aeronca manufacturing corporation
1716 Germantown Road • Middletown, Ohio

when and where

DECEMBER

Plas-Tech Equipment Corp., Symposium on High Speed Testings, Sheraton-Plaza Hotel, Boston, Mass., Dec. 8.

Mid-American Electronics Convention, sponsored by Kansas City Section, Institute of Radio Engineers, Municipal Auditorium Arena, Kansas City, Mo., Dec. 9-11.

American Astronautical Society, Fifth Annual Meeting, Hotel Statler, Washington, D.C. Meeting will be held in conjunction with the 125th Annual Meeting of the American Association for the Advancement of Science, Dec. 27-30.

JANUARY

Reliability and Quality Control in Electronics, Fifth National Symposium, Bellevue-Stratford Hotel, Philadelphia, Pa., Jan. 12-14.

Society of Automotive Engineers, Annual Meeting and Engineering Display, The Sheraton-Cadillac and Hotel Statler, Detroit, Jan. 12-16.

Fifth Annual Radar Symposium (classified), Rockham Bldg., University of Michigan, Ann Arbor, Mich., Jan. 27-29.

Society of Plastics Engineers, 15th Annual Technical Conference, Hotel Commodore, New York, N.Y., Jan. 27-30.

Armour Research Foundation, Fifth Annual Midwest Welding Conference, Illinois Institute of Technology, Chicago, Ill., Jan. 28-29.

Nuclear Fuel Elements, First International Symposium jointly sponsored by Columbia University and Sylvania-Corning Nuclear Corp., Columbia University, New York City, Jan. 28-29.

FEBRUARY

14th Annual Technical and Management Conference, Reinforced Plastics Div., Society of the Plastics Industry, Inc., Edgewater Beach Hotel, Chicago, Ill., Feb. 3-5.

IRE, AIEE 1959 Solid State Circuits Conference, University of Pennsylvania, Philadelphia, Pa., Feb. 12-13.

MARCH

IRE, AIEE and Association for Computing Machinery, 1959 Western Joint Computer Conference, Fairmont Hotel, San Francisco, Calif., March 3-5.

propulsion engineering

by Alfred J. Zaehringer

Atomic ramjet or turbojet might be vastly more economical to run than the boron fuel counterpart. Atomic ramjet fuel (U-235) operating at only 1% energy conversion would deliver about 25,000 Btu per dollar. Boron fuel at 100% energy conversion would give only 3,000 Btu per dollar. Phillips Petroleum propulsion test reactor recently hit a fuel conversion of 18% with uranium fuel elements. In 100% conversion of uranium fission process, heat delivery is 34 billion Btu lb. Big problem with atomic fuels is still radiation. If radiation can be safely handled, the future of any chemical fuel would seem quite dim for economical flight within the atmosphere. Thus, boron fuels, are to be looked on as an interim development that may never be used for commercial operations.

Rocket engine which Aerojet is fabricating for second stage *Vanguard* and *Pioneer* is of unusual construction. A solid metal injector plate is used. Chamber itself is made of stainless steel wrapped with wire. Nozzle is made of brazed aluminum tubing. Propellants are fuming nitric acid and UDMH. Chamber pressure is about 200 psi.

LOX will probably be used in both the 1 meg Air Force and 1.5 meg Army liquid rocket engines. Fluorine and other exotic combinations, probably for the next 2-5 years, will be relegated to use in smaller thrust level second and third stage combinations provided the new liquid storables (nitrogen tetroxide or perchloryl fluoride) and high-energy exotic solids do not take over. Fluorine, however, may appear in the large second generation engines some five years hence.

New lease on life for ozone? A chemical team in Argentina indicates both a reaction and a stabilizing effect when pressurized ozone comes into contact with fluorine. Fluorine does not react directly with the ozone but only with free oxygen or activated O_2 molecules. Effect of chamber walls is important. Liquid ozone-liquid fluorine mixtures might be quite stable and easier to handle than either separately.

New solid programs for ARPA may take the following technical approaches: American Cyanamid could work to improve polyesters, melamines, and other fuel-binders; Dow will investigate magnesium metal powder additives and magnesium metal-organics; Esso on formulation of new fuels from petroleum; and Minnesota Mining & Mfg. on fluorine yielding fuels. US Borax is already working on inorganic (perhaps boron) polymers for fuelbinders.

Solid boron exotics are in the research stage at Callery Chemical Co. The firm, with close ties to Thiokol, will soon set up a pilot plant at Lawrence, Kan., or Muskogee, Okla. to polymerize diborane to yield solid fuels. The company appears less optimistic about boron liquid for rockets than for solid rockets. Decaborane or higher analogs will be alkylated to give stable, high-energy solid fuels.

Aluminum metal in propellants could lead to increased detonation possibilities. Moreover, French researchers report that with a given composition, the detonation velocity increases as the propellant diameter increases. Aluminum powder is currently being tried in both double base and composite solids to increase combustion temperatures. The French findings indicate the criticality that might result in scaling up solids using aluminum additives. Troubles with double base solids already point this way.

Soviet solid propellant work is being done at the Mendeleev Institute in Moscow. Work on nitroglycerine and diglycol dinitrate has been reported.

contract awards

AIR FORCE

By Headquarters, Air Force Office of Scientific Research, Air Research and Development Command, Washington, D.C.:

$41,950—**California Institute of Technology,** Pasadena, Calif. for research on secondary flows in axial compressor stages.

$128,817—The Regents of the **University of California,** Berkeley, for research on internal stresses in ceramic bodies, and for continuation of research on ductile ceramics.

$46,000—The Trustees of **Princeton University,** Princeton, N.J. for research on molecular problems in heat and mass transfer.

$77,870—**The University of Chicago,** for research on nuclear emulsion research with high energy accelerators.

$50,000—The Regents of the **University of Calif.,** Berkeley, for continuation of basic research in microwave electronics.

$49,951—**Westinghouse Electric Corp.,** Baltimore, Md. for research on methods and techniques for space flight.

$45,234—**Atlantic Research Corp.,** Alexandria, Va. for experimental study of turbulent flames in a two-dimensional open burner.

$110,000—Board of Governors, **Wayne State University,** Detroit, Mich. for research on surface phenomena in semiconductors and the growth of semiconductor crystals.

By Headquarters, Air Force Cambridge Research Center, ARDC, Bedford, Mass.:

$31,137—**Control Data Corp.,** Minneapolis, Minn. for magnetic drum information filter system.

$54,789—**Sylvania Electric Products, Inc.,** Bayside, N. Y. for developing a method of analyzing concentrations of impurities in silicon carbide.

$45,057—**Metalab Equipment Co.,** Norbute Corp., Hicksville, N.Y. for radiation laboratory equipage complex to be used in radiation laboratory research.

ARMY

By Cleveland Ordnance District, Cleveland, Ohio:

$55,771—**North Electric Co.,** Galion, Ohio for cost plus a fixed fee contract for *Jupiter* intra-squadron communications systems.

By the Ford Instrument Co.:

$1.5-million—**The Engineering and Optical Division of the Perkin-Elmer Corp.,** Norwalk, Conn. for alignment theodolites to be used in conjunction with the *Jupiter* IRBM program.

By Corps of Engineers, Office of the District Engineer, U.S. Army Engineer District, Tullahoma, Tenn.:

$628,278—**H. E. Collins Contracting Co., Inc.,** Chattanooga, Tenn. for construction in gas dynamics facility, Arnold Engineering Development Center, Tullahoma, Tenn.

By U.S. Army Ordnance District, Los Angeles, Pasadena, Calif.:

$1,345,000—**California Institute of Technology,** Pasadena, for engineering research and development.

NAVY

By U.S. Navy Purchasing Office, Los Angeles, Calif.:

$48,730—**Electro-Mechanical Research, Inc.,** Sarasota, Fla. for telemetry system and components.

$127,598—**Associated Aero Science Laboratories,** Hawthorne, Calif. for personnel and services for performing data reduction analysis service at the U.S. Naval Ordnance Test Station, China Lake, Calif.

$87,510—**Applied Science Corp. of Princeton,** Princeton, N.J. for telemetering equipment ASCOP type M and components.

advertisers' index

Aeronca Mfg. Corp. 47
Agency—Penn & Hamaker, Inc.

American Beryllium Co., Div.-Visioneering Co., Inc. 2
Agency—Gilmore-Rice Adv.

American Potash & Chemical Corp. .. 46
Agency—The McCarty Co.

Astrodyne, Inc. 12
Agency—Batten, Barton, Durstine & Osborn, Inc.

Avco Mfg. Corp., Crosley Div. 51
Agency—Benton & Bowles, Inc.

Bristol Aircraft Limited 44, 45
Agency—Young & Rubicam, Ltd.

Bulova Watch Co., Research & Development Laboratories, Inc. 38
Agency—Duncan-Brooks, Inc.

Burndy Corp. 10
Agency—Ted Gravenson, Inc.

Burroughs Corp. 16
Agency—Campbell-Ewald Co.

Caterpillar Tractor Co. 32, 33
Agency—N. W. Ayer & Son, Inc.

Diversey Engineering Co. 8
Agency—Roark & Colby Adv., Inc.

Dow Chemical Co., The 3
Agency—MacManus, John & Adams, Inc.

Food Machinery & Chemical Corp. .. 6
Agency—The McCarty Co.

Hughes Aircraft Co. 42
Agency—Foote, Cone & Belding

International Business Machines Corp. 40, 41
Agency—Benton & Bowles, Inc.

L.O.F. Glass Fibers Co. 11
Agency—Wade Adv. Agency, Inc.

McCormick Selph Associates 52
Agency—Compton Adv., Inc.

Midvale-Heppenstall Co. 37
Agency—A. E. Aldridge Assoc.

New Departure Div., General Motors Corp. 34
Agency—D. P. Brother & Co.

North American Aviation, Inc., Missile Development Div. 14
Agency—Batten, Barton, Durstine & Osborn, Inc.

Northrop Aircraft, Inc. 31
Agency—Erwin Wasey, Ruthrauff & Ryan, Inc.

Packard Bell Electronics, Technical Products Div. 48
Agency—Robinson, Jensen, Fenwick & Haynes, Inc.

Ramo-Wooldridge Corp. 25
Agency—The McCarty Co.

Ryan Aeronautical Co. 13
Agency—Batten, Barton, Durstine & Osborn, Inc.

Scaife Co. 4
Agency—E. A. Korchnoy, Ltd.

Space Technology Laboratories, Inc. .. 28
Agency—The McCarty Co.

Temco Aircraft Corp. 5
Agency—Rogers & Smith Adv.

Vinco Corp. 26
Agency—Rolfe C. Spinning, Inc.

Westvaco Chlor-Alkali Div., Food Machinery & Chemical Corp. 18
Agency—James J. McMahon, Inc.

Advertising correspondence should be addressed to Advertising Sales Manager, Missiles and Rockets, 17 East 48th Street, New York 17, N.Y.

REGIONAL OFFICES:

New York City: 17 E. 48th St., New York 17. Edward D. Muhlfeld, Advertising Sales Manager; P. B. Kinney and G. T. O'Mara, regional adv. mgrs. Phone: PLaza 3-1100.

West Coast: 8929 Wilshire Blvd., Beverly Hills, Calif. Fred S. Hunter, manager; Walton Brown, regional adv. mgr.; James W. Claar, regional adv. mgr. Phones: OLeander 5-9161 or OLeander 7-1555.

Chicago: 139 N. Clark St., Chicago 2, Ill. George E. Yonan, regional adv. mgr. Phone: CEntral 6-5804.

Cleveland: 244 Hanna Bldg., 1422 Euclid Ave., Cleveland 15, Ohio. Douglas H. Boynton, regional advertising manager. Phone: PRospect 1-2420.

Detroit: 201 Stephenson Bldg., Detroit 2, Mich. Kenneth J. Wells, regional advertising manager. Phone: TRinity 5-2555.

Florida: 208 Almeria Ave., Coral Gables, Fla. Richard D. Hager, advertising sales representative. Phone: Highland 4-8326.

Canada: Allin Associates, 12 Richmond Street East, Toronto 1, Ontario. Phone: EMpire 4-2001. Allin Associates, 1487 Mountain St., Suite 4, Montreal, Que.

Geneva: American Aviation Pubs., 10 Rue Grenus, Geneva, Switzerland. Anthony Vandyk, European Director.

London: The AAP Company, 17 Drayton Road, Boreham Wood, Hertfordshire, England. Phone: Elstree 2688. Cable address: STEVAIR, London.

Paris: Jean-Marie Riche, 11 Rue Condorcet, Paris (9e), France. Phone: TRUdaine, 15-39, Cable address: NEWS AIR PARIS.

AVCOMB®... Crosley's stainless steel honeycomb sandwich

Designed for tomorrow's high-Mach aircraft and missiles, Crosley's *Avcomb* has been tested under the most rigid conditions, has successfully passed all requirements. Crosley is proud that *Avcomb* was the first stainless steel honeycomb to win such approval.

Now ready for mass production, *Avcomb* is the newest of Crosley's advanced manufacturing techniques, which include the latest metal-bonding and chemical milling methods.

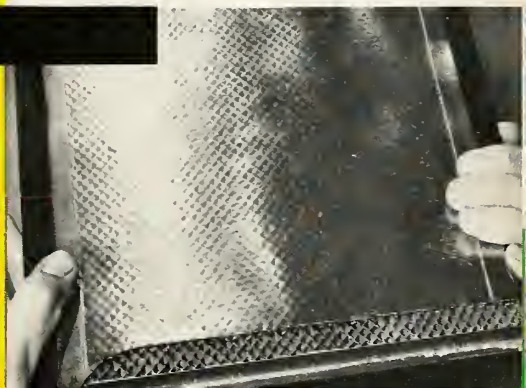
Improved and different production facilities, now being perfected by Crosley, will soon make *Avcomb* available in complex shapes and in very large panels. And costs will be substantially below today's prices.

Together with its associated Avco Divisions, Crosley now offers missile and aircraft manufacturers complete facilities and personnel for:

- *Weapons systems management from initial concept to production.*
- *Research, development, and engineering design of air frames, electronics, control systems, telemetering, automatic test and support equipment, ground handling equipment and logistics.*
- *Production and manufacturing for missile and aircraft systems.*

For further information, write to: Vice President, Defense Products Marketing, Crosley Division, Avco Manufacturing Corporation, Cincinnati 25, Ohio.

Avco // Crosley

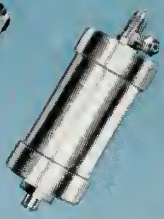


EXPLOSIVE ORDNANCE

LIGHTWEIGHT, MAXIMUM RELIABILITY EXPLOSIVE DEVICES FOR THE MISSILE INDUSTRY

PRESSURE CARTRIDGE

EXPLOSIVE BOLT



GAS GENERATOR

STAGE SEPARATION

Explosive Bolts

Primachord Initiators

RE-ENTRY

Attitude Control Gas Generators

Ejection Cartridges

LAUNCH

Solid Propellant Igniters

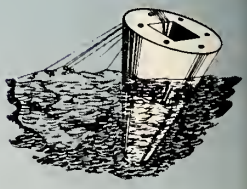
Liquid Propellant Igniters

Systems Pressurization Gas Generators

RECOVERY

Ejection Cartridges

Flotation Cell Inflation Generators



PRE-LAUNCH

Explosive Bolts

Release Cartridges

EXPLOSIVE ORDNANCE

McCormick Selph Associates

HOLLISTER AIRPORT, HOLLISTER, CALIFORNIA