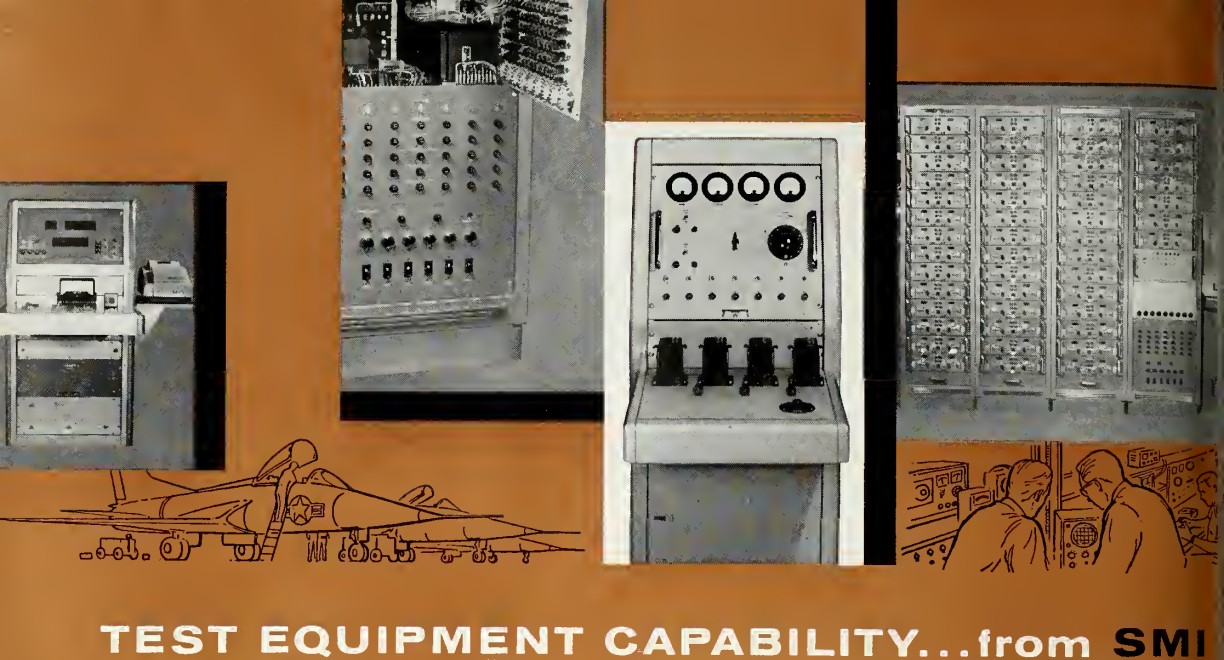
AUGUST 24, 1959

HEAVENLY HOT ROD

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION



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For example, SMI's TS 539 Air Data Computer Test Set is used for checking out elements of the Hughes Aircraft Company MA-1 aircraft and weapon control system. The TS 539 provides both electrical and pneumatic signals to the computer under test, achieving extremely high accuracy by means of electronically controlled force balance sensors. Mach readings are accurate to .7 millimachs and altitude readings within 15 feet at a speed of 1.4 Mach and an altitude of 30,000 feet.

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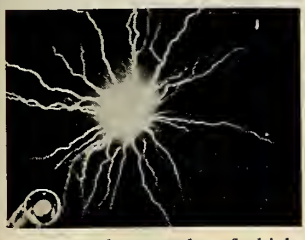
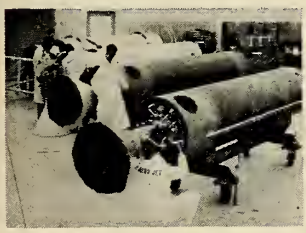
The products of SMI *are available in Canada and throughout the world through Servomechanisms (Canada) Limited, Toronto 15, Onta*

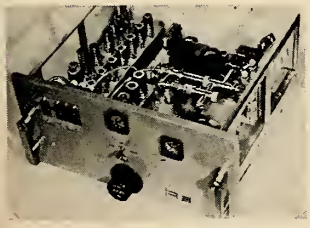
COVER: An ionic-propelled spacecraft proposed by Lockheed scientists would be powered by nuclear reactor separated by mile-long coaxial cable. Unit would weigh about 3½ tons.



SOVIET photograph of high-voltage discharge produced under water at Leningrad Polytechnic Institute. Russians are studying possible use of lightning as weapon. See p. 13.



ASSEMBLY of *Able* rockets at Aerojet-General's Azusa plant. Aerojet designed, developed and is manufacturing the rocket used as second-stage for *Thor-Able, Vanguard*. See p. 22.



PHILCO'S 1435-1535 mc FM receiver. This band is mainly used for aircraft testing. The relatively small telemetry receiver industry is surveyed in story beginning on p. 26.

missiles and rockets ®

MAGAZINE OF WORLD ASTRONAUTICS

AUGUST 24 HEADLINES

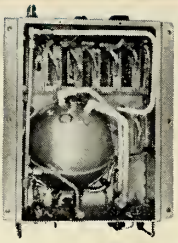
ASTRIONICS

ASTRONAUTICS ENGINEERING U.S. Reg. Pdg.

MISSILE SUPPORT U.S. Reg. Pdg.

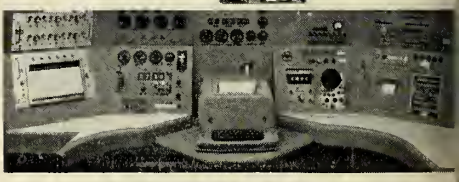
THE MISSILE WEEK U.S. Reg. Pdg.

DEPARTMENTS



Automatic Dewpoint Hygrometer

Rocketsonde Test Vehicle



Sensor and Computer Airborne Control Console

Ozone Sensor

Aircraft Installation for Transonic Sonde Ejection

AN/AMQ-15

. . . concept to reality in one year

Just one year ago, the Air Force Global Weather Reconnaissance Program was only a system concept. Today, the feasibility of this advanced airborne system has been demonstrated at realistic speeds and altitudes.

The Bendix AN/AMQ-15 system includes advanced aircraft sensors for measuring thirteen geophysical parameters along the flight path, and advanced dropsonde and rocketsonde sensors for measuring eight parameters in a vertical profile from sea level to 150,000 feet. Other subsystems are storm radar, cloud top and base radar, air sampling, airborne digital data processing and display, and ground data handling.

For flight demonstrations up to altitudes of 45,000 feet, the Boeing Airplane Company has installed AN/AMQ-15 subsystems in their prototype 707 jet transport. In addition, Bendix has conducted firing of rocket test vehicles at Holloman Air Force Bas

In reporting this achievement of a major syste design and implementation, Bendix is very proud c the contributions of its own divisions, and is mo appreciative of the cooperative teamwork provided b the Air Force, Boeing, and other subcontractors. Th result is a flexible and modular system which can b used in various sized packages for all types of aircra ranging from strategic bombers to interceptors, an for civilian transport aircraft.

The AN/AMQ-15 is typical of the hard-hitting pr grams being carried out by Bendix Systems. Better e gineers and scientists interested in pioneering syste of the future are invited to join this growing tea

Bendix Systems Division
ANN ARBOR, MICHIGAN

Bendix
AVIATION CORPORATION

Washington Countdown

IN THE PENTAGON

Space mice . . .
may go into orbit again next month. ARPA and Air Force scientists probably will try to recover mice from an orbiting *Discoverer* satellite around the middle of September. Or they may put a camera in it.

• • •

Development of *Sentry* . . .
the U.S. reconnaissance satellite, is a lot closer than some have thought. The clue: *Discoverer V* achieved stabilization in a desired position this month while in orbit—the second time this has been achieved in the *Discoverer* series. *Sentry* must be stabilized to operate.

• • •

The real story . . .
of the Red missile-sub threat is this: The Russians have not only beat the United States in development of submarines capable of firing missiles while submerged. They also have built a sizeable fleet of the big Z Class missile-subs that cruise within striking distance of U.S. shores. (M/R Aug. 10) Adm. Arleigh Burke, Chief of Naval Operations, gave out only a watered-down account of the threat at his recent news conference.

• • •

First powered flight . . .
of North America's *X-15* rocket plane is expected by about the end of the month. Glide tests of the early rocket craft are reported to have been perfect.

• • •

Underwater missile bases . . .
an idea often heard discussed, is considered impractical by top Navy research experts. They contend *Polaris* submarines are easier to build and will do a better job. However, the idea continues to intrigue some military officials.

ON CAPITOL HILL

The back door fight . . .
between the House Space Committee and the House Armed Services Committee over jurisdiction is far from over. Rep. Carl Vinson, powerful chairman of the Armed Services Committee, warned the Space Committee privately to keep hands off purely military matters. But the Space Committee apparently feels "purely military" is hard to define.

• • •

The boron fuel inquiry . . .
now planned by the Space Committee is the latest example. The committee plans to investigate the recent cancellation of boron exotic fuel contracts—specifically as it affects NASA. The investigation may come within the next few weeks.

• • •

Despite all the noise . . .
don't expect any action soon on congressional demands for much more subcontracting of the defense program. The water is still much too muddy with proposals. But something may come of it all next year.

• • •

Watch for a move . . .
in Congress next year to throw open to public scrutiny U.S. missile aid to NATO and other U.S. allies. The move can be expected to come in the form of a tough new freedom-of-information provision far tougher than the one now moving through Congress.

AT NASA

Attempt to . . .
recover the *Discoverer* payload with sky hooks by the Air Force last week was to test the feasibility of the operation for NASA's Project *Mercury*. NASA biomedical scientists are worried that the astronaut might be injured as a result of a water impact or water seepage.

• • •

Sputnik's *III*'s life . . .
is much longer than was originally calculated. It was originally expected to die Aug. 15 after 15 months in orbit, but the Smithsonian Astrophysics Laboratory in Cambridge now gives its death date as December 3. The Russian satellite's apogee has shortened over the last 15 months from 1167 miles to 720 miles, its perigee from 135 miles to 128 miles, and its period from 106 minutes to 98.09 minutes.

AROUND TOWN

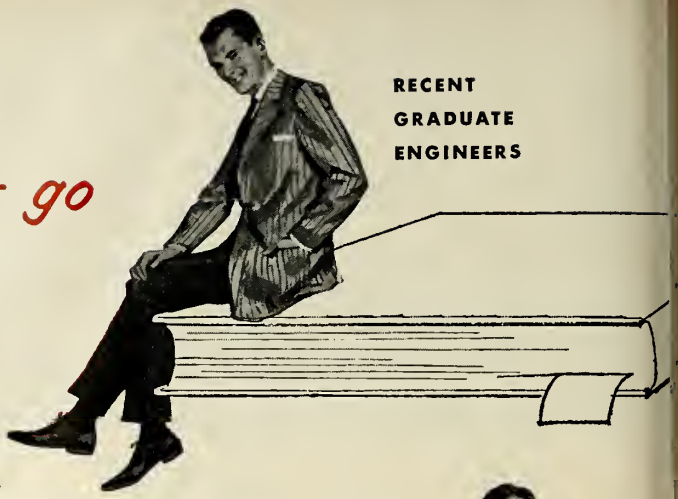
Some of the reports . . .
being passed as "the latest" in the nation's capitol:

. . . A whole series of interservice missile/space fights are brewing—some far bitterer than the fight over *Nike-Hercules* and *Bomarc*.

. . . Civil defense against missile attack may become a major campaign issue next year.

. . . There is pressure for toughening with sizeable deployment of missiles the small nations of Southeast Asia—the underbelly of the Far East.

How far can an engineer go at AC?



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Free education for the space age

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Camparison will prove these are the finest "in house" pragrams available anywhere. And they are educatianal "extras," far AC affers them in additian to their educatianal assistance pragrams far men who wish to study for advanced degrees in nearby universities.

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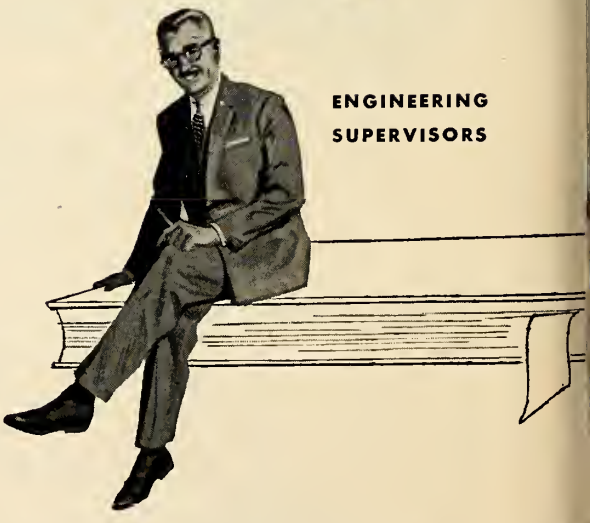
You may be eligible for training . . .

if yau are a graduate engineer in the electranics, electrical ar mechanical fields, or if yau have an advanced degree in mathematics ar physics. Yau'll study while yau work on the renawned AChiever inertial guidance system or a wide variety af ather electramechanical, aptical and infra-red devices.

For mare infarmation, write the Director of Scientific and Prafessianal Emplayment: Mr. Rabert Allen, Oak Creek Plant, Dept. H, Box 746, South Milwaukee, Wisconsin.



ENGINEERING SUPERVISORS

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CHECK YOUR PULSE, SIR?

"SCOTCH" BRAND High Resolution Tapes deliver a sharper pulse—with fewer dropouts!

In instrumentation, as in life, it's often the pulse-count that counts. So what if your recording impulses are as square as a bar-graph? If your tape only records camel-backed humps, where are you? Probably about due for a change—to "SCOTCH" BRAND High Resolution Tapes.

Your equipment is somewhat like the proverbial sweater—no matter how advanced, you can only get out of it what you put in. And that calls for "SCOTCH" BRAND High Resolution Tapes—made to deliver improved resolution as pulse density climbs and effective frequencies soar upward to stratospheric heights.

Like so many other advances in tape technology, this superior resolution is a product of 3M research. For one thing, "SCOTCH" BRAND high potency oxides give coatings a higher magnetic retentivity—about a third more than standard. And since the shorter wave lengths of high frequencies are recorded by the surface of the coating, a coating of these potent oxides can be thinner and yet provide equal flux line strength. Results? A flexible tape for intimate tape-to-head contact, a cleaner, sharper recorded pulse.

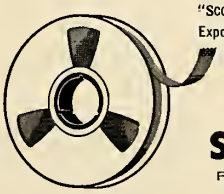
"SCOTCH" BRAND High Resolution Tapes offer these potent coatings on your choice of two tough polyester backings—158 for standard play, 159 for extra-play. And both are designed to line up your square-waves as densely as a close-order drill, so sharp and clean you'll never miss a bit.

In taping high frequencies, the tested uniformity and dropout-free performance of "SCOTCH" BRAND Magnetic Tapes give the added bonus of reliability. The greater the density of information, the more critical the need for defect-free tapes, and here's where experienced "SCOTCH" BRAND Tape technology really tells.

Whatever your application—data acquisition, reduction or control programming—"SCOTCH" BRAND Instrumentation Tapes supply the reliability you need today and continue to anticipate tomorrow's needs with newer, more sensitive tapes.

In addition to "SCOTCH" BRAND High Resolution Tapes 158 and 159, check the others for your application. "SCOTCH" BRAND High Output Tape 128 offers top output in low frequencies, even in ambient temperature extremes. "SCOTCH" BRAND Sandwich Tapes 188 and 189 end rub-off, build-up, reduce head wear to an absolute minimum, show little wear after 50,000 passes. "SCOTCH" BRAND Instrumentation Tapes 108 and 109 remain the leaders for top performance at low cost.

Where there's no margin for error, there's no tape like "SCOTCH" BRAND Magnetic Tape for instrumentation. For details, write Magnetic Products Div., Dept. MBW-89, 3M Company, St. Paul 6, Minn. or mail the inquiry card.



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More than likely this important valve is one of the Crane cryogenic globe valves, specially designed for precision control of liquid propellants at temperatures to minus 297 F.

Here again Crane demonstrates some of the reasons for its leadership in valve manufacture. Whether your need is for special valves for missile fuel handling—or valves for a more "down-to-earth" application in the control of water, steam, air or any fluid—Crane can meet your specifications.

Valve guide for the asking

You will find the Crane handbook "Valves for Guided Missile and Rocket Services" very helpful in specifying for liquid fuels, gases, and other fluids used at launching pads, test stations and operating bases. Request your free copy on your business letterhead from your nearest Crane branch or write to address below.

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Industry Countdown

MANUFACTURING

Faulty release mechanism . . .

is attributed to failure of *Titan* ICBM in its fifth flight test Aug. 14 at Cape Canaveral. The bird was held to stand by special clamps for several seconds after ignition while full power was generated. Clamps released prematurely, before umbilical severance. This caused automatic shutdown of main engine, and the bird settled back on the pad.

• • •

Most successful metal . . .

rocket motor cases manufactured so far are rolled and welded and then hydro-spun. Process is used by **Kaiser Metal Products** on *Polaris* cases; by **Pratt & Whitney** on *Minuteman,* and by **Borg-Warner's Ingersoll-Kalamazoo Division** for special test cases. **General Electric's** rocket engine section is using ausforming—hydrospinning during heat treat cycle.

• • •

Materials most used . . .

in these cases are MBMC-1 and **U.S. Steel's** airhardened X-200. Consistent mimimum yield strengths for the cases in the cases in excess of 225,000 psi are reported in each instance, with some test cases running considerably higher.

• • •

This could mean breakthrough . . .

is near in problem of notch sensitivity—the brittle fracture phenomenon which has seriously limited reliability of high-strength, thin-wall cases at strengths in excess of 200,000 psi.

• • •

Fiber metallurgy . . .

is an **Armour Research** project. Hope is for high strength plus permeability in new materials similar to plastics and ceramics. Rocket nozzles are one possible use; another could be for transpiration cooling of re-entry bodies.

PROPULSION

Aluminized powder injections . . .

to speed burning of *Polaris* first-stage solid engine apparently is creating another chain of problems. With faster burning comes high temperatures, particularly in nozzles. Moly nozzles so far are said to be adding a weight penalty in coping with the higher temperature. Other materials—notably steel—may still be used in *Polaris* nozzles. Despite contrary reports circulating in industry, a top Navy official claims "all problems associated with motors in first models have been solved." However, he declines to pinpoint problem areas.

• • •

Charged liquid colloidal . . .

system for low-thrust (2000-3000 I_{sp}) deep space rockets still looks more attractive than the higher-temperature ion electrical propulsion system. **Aerojet-General** is said to have come up with a colloid source which makes problems of focusing, acceleration and neutralization easier to solve. Company believes flyable colloid system is possible in around five years—perhaps less if there is more rapid advancement in development of nuclear-electric source to free the particles from the colloidal solution.

ELECTRONICS

Promising new process . . .

developed by **Stanford Research Institute's** ceramics technology group may raise temperature limits for transistor and diode operation from 400°F to about 1800°F.

• • •

Air Force $10 million . . .

contract to **Page Communications Engineers Inc., Northrop Corp.** subsidiary, for multichannel troposcatter complex will cover 1700 miles, link the United Kingdom, Spain and Morocco.

• • •

Formation of joint . . .

industry-government group to solve problems plaguing telemetry industry is being studied. Purpose would be to coordinate three unrelated groups involved in telemetry—missile ranges, missile makers and instrumentation manufacturers. Joint group would function as a report center and information exchange.

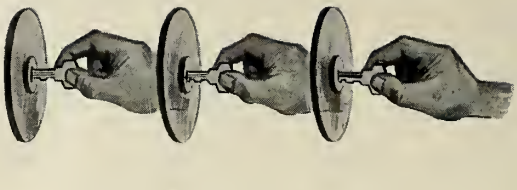
WE HEAR THAT—

Cheaper titanium is coming . . .

Norton Co., Worcester, Mass., has electrolytic process for producing ductile titanium of high purity which may pave the way . . . Copper will be in good supply for 90 days, despite shutdowns. But price of copper is another matter; it's on the way up—fast . . . Plastics information center similar to Battelle Memorial Institute's Defense Metals Information Center, Columbus, will be established at Army's Piccatiney Arsenal . . . **Avco's** Research and Advanced Development Division has delivered an 18,000°F plasma generator to Jet Propulsion Laboratory for NASA re-entry studies.

More about the Missile Week on page 43

3-way locking action



assures

fail-safe missile fueling

FUEL OXIDIZER
Servicing Nozzle
SERIES 13110

G.S.E. personnel deserve it and now can have it!... triple protection in handl oxidizers or exotic fuels... with the new Lear Fuel Oxidizer Servicing Nozz Fail-safe procedure requires 3 separate locking actions before fuel can flow.

Developed originally for safe transfer of nitric acid, the nozzle and adapter make possible a sealed, pressure-proofed closed circuit servicing system to provide "safety-assured" protection. Complies with military test specification

ENGINEERING DATA...

Flow and pressure rating....125 gpm at 60 psig
Operating temperature range....−65 to +140
Maximum operating pressure....240 psig
Military Specifications (Test)
Nozzle... MIL-N-25556 Adapter... MIL-N-25

Complete technical data and costs on requ

RO-25

LEAR

LEAR-ROMEC DIVISION
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Reds May Use Lightning as Weapon

Soviet scientists are deeply involved with study of artificial lightning and may have made machines to create anti-missile 'balls of fire'

by Donald J. Ritchie*

DETROIT—Lightning balls, among ature's rarest phenomena—described "balls o' fire" in the language of ie mountaineer—may one day be put work as a Soviet weapon of war.

Soviet scientists are using huge- ale laboratory equipment to study tificial lightning. Russian engineers e carrying out programs for de- loping very high voltages and cur- nts. And in the area of basic re- arch, such Soviet physicists as I. M. nyanitov are investigating atmospheric ectrical discharges.

A hint of the military applications ntemplated comes from Physicist eorge I. Babat, head of the Soviet stitute of Energetics. Babat proposes generate balls of lightning in the y high above cities by focusing an tense electromagnetic field with the e of two huge parabolic antennas.

Thus a small artificial star or sun ould be formed. It would be fed from ie ground by electromagnetic energy, it its light output would originate in a uclear fusion process occurring within e ball of lightning—or plasma. The asma ball could be easily moved rough the sky by directing the ground ntennas. The effect of directing it at aircraft or missile can be easily agined.

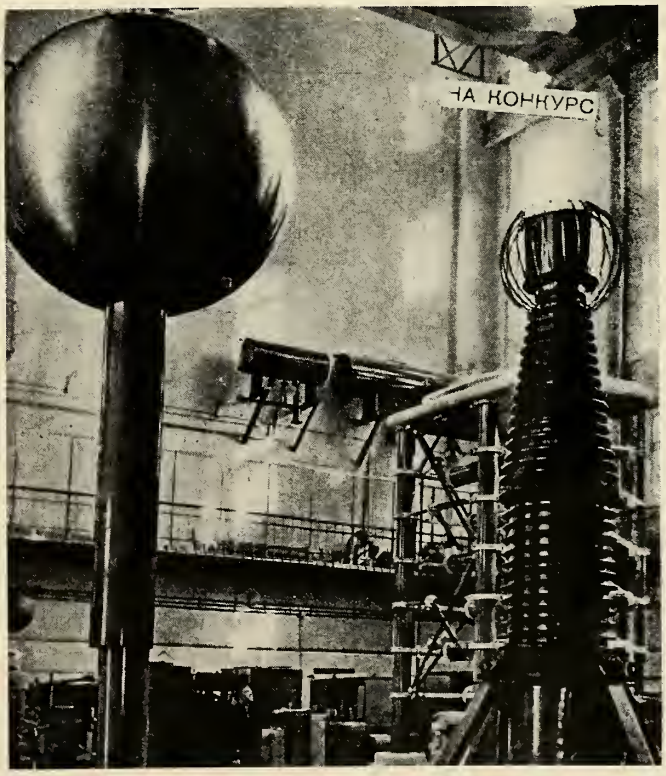
Such a Soviet weapon is not, of urse, just around the corner. The ork in progress almost certainly is ill in the research phase. But Russian ience is rapidly expanding its under- anding of electrical discharge, ball ghtning and lightning under water. he ability of Soviet engineers and ientists to make very practical use techniques and processes at hand as been demonstrated in the past.

• **Observed data**—Although some uthorities stoutly deny the existence ball lightning, others, such as B. F. J. Schonland, have compiled a great deal of data on characteristics. (*The Flight of Thunderbolts,* Schonland, Oxford University Press, 1950). The present author once observed a lightning ball about four inches in diameter during a violent storm at Kenmore, N.Y.

Lightning balls seem to appear near the end of a severe storm—after the air has been highly ionized and is filled with electromagnetic disturbances caused by genuine lightning. Their diameters range from a few inches to —in rare instances—many feet. They move by rolling or sliding along conductors such as telephone wires, fences and other metallic objects. They travel up and down channels such as chimneys and move both with and against air currents.

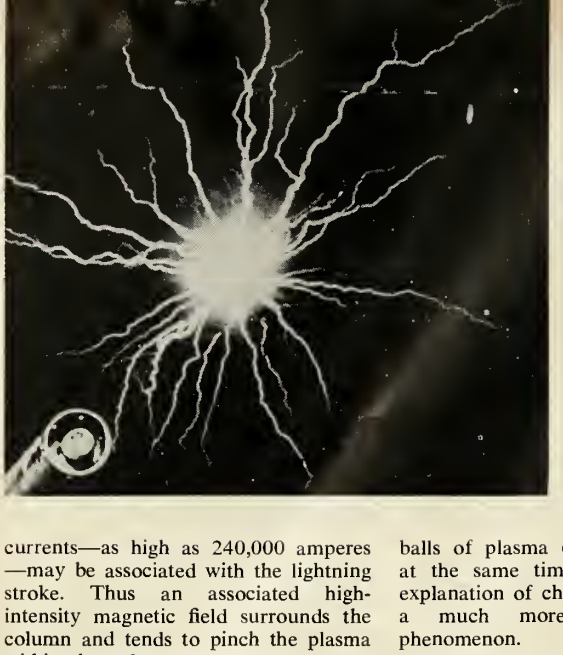
The lifetime of a lightning ball may range from a few seconds to many minutes. Its surface temperature can reach 9000°F. When it decays, a great deal of energy is released.

• **Pinching plasma**—One possible method of natural lightning-ball formation is by the "pinching" of a portion of plasma formed in the core of a column of air through which a lightning stroke has passed. Very great



LIGHTNING RESEARCH in the Soviet Union is carried out through the use of such equipment as this, part of the machinery at a high-voltage lab.

Project mathematician, Research Laboratories Div., Bendix Aviation Corp., and close observer of Soviet military science.



BALL OF FIRE under water. Soviet photograph of high-voltage discharge produced at Leningrad Polytechnic Institute shows that end of "projector" is coaxial cable or waveguide, seemingly coroborating idea that lightning ball is combination of electric and eletromagnetic activity. Engineer Lev Alexandrovich Yutkin has charge of work.

currents—as high as 240,000 amperes —may be associated with the lightning stroke. Thus an associated high-intensity magnetic field surrounds the column and tends to pinch the plasma within the column.

An average lightning flash may discharge about 20 coulombs through a length of two kilometers. With the presence of an oscillating field between the ground and the thundercloud, magnetic lines will become unstable and will tend to pinch off a portion of the plasma. Then this is fed by the oscillating electrical field. Many such balls of plasma could be pinched off at the same time. This may be the explanation of chain or bead lightning, a much more frequent natural phenomenon.

• **Equipment produced**—Photographs in Soviet technical journals show equipment alleged to create balls of lightning. Apparently these are formed by a combination of high-voltage discharge and electromagnetic fields. The same sort of research is in progress in the United States, but with rather low voltage and moderate electromagnetic field strengths.

Soviet Academician Peter L Kapitsa believes that the lightning ba is a mass of highly ionized plasma fe continuously from outside by resonanc absorption of intense radio waves. H indicates that artificial lightning bal can be created by a powerful source c sustained radio waves in the decimet range, focused into a small volume c space.

Lev Alexandrovich Yutkin, an e gineer at the Leningrad Polytechn Institute, has made considerable stuc of high-voltage discharge under wate One published photograph of the ph nomenon shows that the end of th "projector" is a coaxial cable or wav guide. This seems to corroborate th idea that the lightning ball is a con bination of electric and electroma netic activity. A recent Soviet relea stated that Yutkin has produced an put to work a discharge of "far great power than lightning."

An obvious application of ba lightning is in igniting controlled the monuclear fusion reactions—avoidin the messy alternative of setting off fission bomb. Thus far, the instabilit of the electric arc discharges used h slowed progress on both sides of th Iron Curtain. Until a method of ign tion is found, it will not be possib to obtain power or propulsion fro fusion reactions. Perhaps the lightnin ball will provide the solution.

IAF's London Meeting May Draw Record Attendance

LONDON—The annual meeting of the International Astronautical Federation at Church House, Westminster, Aug. 31 to Sept. 5 may turn out to be the largest in the Federation's 10-year history.

President Andrew G. Haley of Washington, D.C., estimates that approximately 600 of the world's leading space scientists will attend. The Federation has 3200 members throughout the world.

This year's congress is being organized by the British Interplanetary Society. By maintaining a stricter standard, the various national screening committees have managed to keep the number of technical papers to be presented down to 80; about half of these are from the United States.

• **Soviets uncommunicative**—This figure includes any that might be given by Russian delegates. Despite all the regulations regarding submission of papers, the titles of those from Russia are never known until just before a Congress. This year, the Russians have been unusually reticent and it is not even known whether they will be attending.

Some delegates from beyond the Iron Curtain will be present. These include several representatives from Poland, and one from the Commission on Astronautics of the Czechoslovak Academy of Sciences.

Several hundred members of the American Rocket Society are expected. Included in the American delegation will be seven U.S. Congressmen, members of the House space committee.

The meeting will cover almost every aspect of space exploration. Subjects include space medicine and biophysics, nuclear and electrical propulsion, satellite design, space communications, planetary landings and base operations, astrophysics, rocket postal service, space guidance and navigation, tracking, orbits and trajectories.

Business meetings of the society will deal with such problems as international cooperation in astronautics, documentation, classification schemes and terminology, the need for a permanent headquarters for the IAF, satellite tracking, and the establis ment of an international Academy Astronautics. British delegates to th Congress include G. V. E. Thompso a contributing editor to MISSILES AN ROCKETS, and A. H. S. Candlin.

• **Commonwealth foregathering**— The Congress is being preceded b the British Commonwealth Spaceflig Symposium, August 27-29. Some 1 papers will be presented including or dealing with Britain's place in inte planetary exploration. Some others i clude altitude sounding by solid roc ets, a review of *Blue Streak*, instr mentation, economics of space flight soft moon landings, satellite trackin and recovery, and navigation.

In conjunction with the Congres a Space Law colloquium is to be hel September 4 in the Great Hall, Li coln's Inn, under the chairmanship President Haley.

The Congress will be opened by th U.K. Minister of Supply, Aubre Jones, and a government reception Lancaster House will be held th evening. Other social events include tea party for participants' wives at th House of Lords, an excursion Windsor Castle, receptions and a co cluding banquet at the Dorchester H tel, Park Lane.

Batteries Retain Their Power Role

Survey shows that electrochemical batteries are desirable auxiliary power sources for many missile and satellite uses—sales expected to grow 10-fold

by Charles D. LaFond

WASHINGTON—Electrochemical batries provide a very practical auxilry power source in both missiles and tellites. Fuel cells, nuclear power acks, thermoelectric generators, and e gas-turbine APU have the potential r greater future use, but today the ttery retains its prominence.

According to a **General Electric** pace Vehicle Division spokesman, batries are quite satisfactory and even sirable in missiles as long as the hyraulic and ac electrical systems reire less than 70% of total power—herwise the APU is required.

Batteries won the battle recently for condary power for the *Atlas* ICBM. et cell batteries are used in the *Atlas* drive a **Bendix** ac inverter. After ending something in the area of $20 illion, **Convair-Astronautics** halted exnditure of further funds for **Sundrand's** development of a monopropellt power system for the *Atlas*.

(Sundstrand had come into the *At*s secondary power picture through purchase of the **American Machine Foundary Co.'s** Pacoima division. ne latter had been working on a biopellant system for the *Atlas*. Sundrand changed to a monopropellant ter it took over.)

Convair currently is buying silverlt batteries from **Yardney Electric,** ne **Eagle-Picher Co.,** the **Cook Co.** in enver, and AMF.

• **Business outlook**—Yardney Elecc has indicated that its annual batry sales are in the range of $6 to 7 illion. Of this, 75 to 80% goes to issile, rocket, torpedo and satellite ograms.

Yardney looks forward to a tenld growth of the missile industry by 70 and it expects its battery sales to rallel this growth. Other battery manfacturers share this confidence, at ast for the present.

Auxiliary power for missiles and satellites presents some unique requirements. Requirements for electrical power exist in communications, guidance and control, telemetering, pump motors, ignition, destructive systems and warheads. The accomplishment of this task calls for power ranging from fractions of watts to kilowatts.

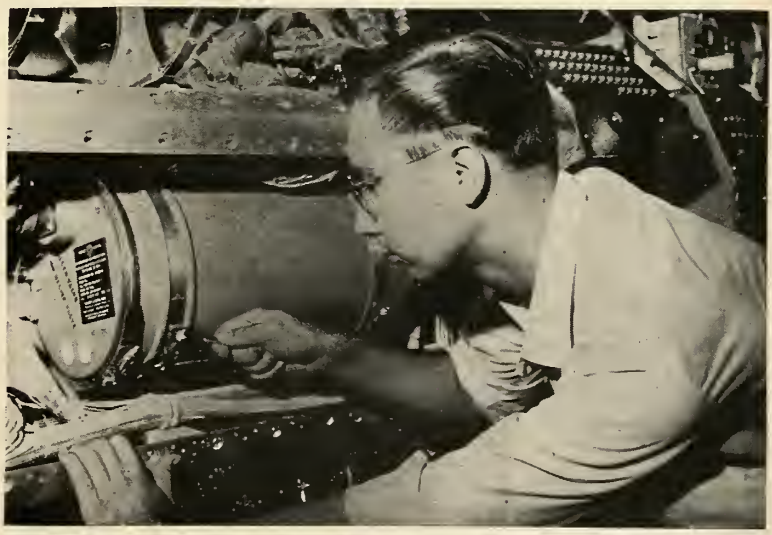
In addition to these requirements, an auxiliary power source must meet most or all of the following requirements: it must be lightweight and require little space; it must have good voltage and high rate discharge characteristics; it must be a maintenance-free system and have the ability to be placed into operation on very short notice; it must withstand varying temperatures, low pressure shock, vibration, acceleration, and in some cases, zero gravity.

Depending on the use, primary and secondary batteries meet these needs. Auxiliary power units (APU's) are excellent in view of the weight-and-volume factor. However, they are very expensive and—most important—not yet wholly reliable. Therefore, they are limited in use.

• **Trends**—In general, mercury cells top the list at the present time for satellite use. **P. R. Mallory and Co.** is the principal manufacturer. The mercury cell has a high watt-hour rating but it also has demonstrated a sensitivity to low temperatures. For this reason, the small-size silver-zinc batteries may find increased use in this field.

The trend appears to run toward the standard storage batteries—lead-acid, nickel-cadmium and silver-zinc.

Because of its relatively heavy weight, the lead-acid battery has found few missile applications compared with either the nickel-cadmium or the silver-zinc battery—the most-used power sources for spacecraft. The nickel-cadmium battery gives excellent performance at sub-zero temperatures and stands up very well under maintenance



ELECTRIC Silvercel battery by Yardney is being installed in an Air Force ICBM, to supply main power during flight. It discharges 300 amps at 26 volts for 10 minutes.

electrochemical advantages . . .

abuses. In weight and output, however, the silver-zinc battery is far superior.

Compared to nickel-cadmium, silver-zinc batteries are only a third as heavy; yet their capacity on an equal-weight basis is four times greater.

Because of their low-weight, small volume, high-capacity and reliable-behavior factors, these batteries are considered superior to all others in missile applications.

For the future, some manufacturers feel there may be a move toward use of primaries instead of rechargeable batteries, because primaries offer indefinite shelf life, require no maintenance, and can be used at a moment's notice.

Secondaries, however, have proved their high reliability and—unlike primaries—can be checked before use.

• **Advantages**—The importance of electrochemical battery sources for missiles and space flight can be shown by some of the principal advantages in missile systems.

• They provide direct conversion of chemical energy into electrical energy.

• They are convenient in scaling power systems either up or down.

• Since they have no moving parts, their maintenance is simple and reliability is high.

• The tapping and transmission of power for varying loads is reliable and easy.

• They provide high energy per unit weight.

• They provide high specific power output, particularly in the range of small-size devices.

Primary batteries find extensive missile application because of the short, one-time use involved (excluding ground checkout procedures). The average battery life in a missile varies from four to seven minutes. This short life span requires batteries capable of high drainage, often referred to as "high rate" cells.

Because of the urgent need to save every single pound of weight in missiles, there has been a renewed surge of interest in the development of new and better battery systems.

Secondary batteries (storage batteries) have limited but very useful applications for spacecraft, particularly for use in satellites in conjunction with solar cells. This provides a means of power storage regeneration when the collector area is fully exposed to sunlight and in turn provides power when the satellite is on the dark side of the earth.

• **Silver-zinc**—The most widely used battery for missile applications is the dry-charged silver-zinc system, which has been adapted to auxiliary power applications, because it most nearly fits all of the missile requirements. Also, it can deliver its power output in a very short time. This battery has the highest capacity of all known practical systems. Primary or one-shot batteries are available in automatically or manually activated models; to supply the requirements of a secondary battery, rechargeable models are also available.

Leading silver-zinc battery manufacturers, in order of importance in the missile industry, are Yardney Electric, Frank R. Cook, Eagle-Picher Co., and the Exide Div. of **Electric Storage Battery Co.** The Yardney Silvercel—a silver-zinc battery—has been applied with a record of success in a great many space vehicles, including:

Titan, Polaris, Falcon, Dart, Pioneer, Snark, Goose, Bomarc, Aerobee, X-7, Jupiter, Vanguard, X-17, the *Atlas* satellite and weather satellite.

A *Viking* rocket, powered by a Silvercel battery, was employed several years ago to photograph the earth from an altitude of some 150 miles.

Finally, almost all U.S. Navy electric torpedoes are now using Yardney Silvercels for propulsion and homing devices.

For the design engineer, faced with the increasingly critical limitations of space and weight, the Silvercel battery has shown several strong attributes—a high-rate, rechargeable source of power in a small lightweight package. It can produce the same amount of electrical energy as other battery types, though only 1/5 their volume and 1/6 their weight.

Where high current drains are essential, it can be discharged at rates as high as 30 times the ampere-hour capacity rating. Its voltage is unusually flat, permitting high operational efficiency and dependability. These batteries are available in two rechargeable and two primary types.

Yardney's newest Silvercel, the PM 200, is capable of an output of 80 watt hrs./lb. The company is currently developing a successor to produce 10 watt-hrs/lb.

Exide Industrial Div. of Electric Storage Battery Co. also produces a whole family of silver-zinc secondary cells. Light weight and small, the units vary from outputs of 7.5 to 200 ampères for one hour at 77°F.

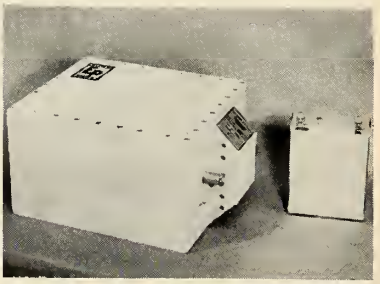
• **Nickel-cadmium** — Nickel-cadmium batteries are most widely known for long life characteristics due to their ability to be trickle charged and overcharged without injury. These qualities make them especially suitable for use as secondary batteries. The low temperature charge and discharge characteristics are quite good and its rugged construction is well suited to resistance of extreme environmental conditions. Although its power output per unit weight and volume is not as high as some other systems, it does provide very dependable long life, secondary battery where weight is not a primary consideration.

Leading manufacturers in the nickel-cad battery field are **Sonotone Corp.**, Eagle-Picher, and **Gulton Industries.** The Yardney Electric Corp. is a newcomer, but, with its new Silcad as a satellite power source, it will be making inroads in this field.

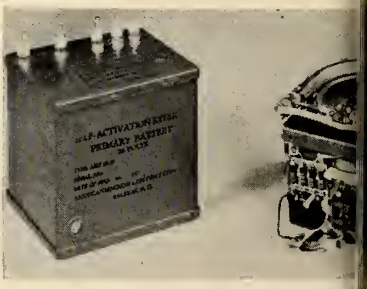
Here the nickel-cadmium system is particularly desirable because high reliability can be achieved by continuous flow of high charging. The units provide good performance over a temperature range of −60° to +160°F and good shelf life in the wet discharged state.

In addition, the nickel-cadmium batteries provide service life from 30 to 2000 charge-discharge cycles.

Another newcomer to this field is **Delco-Remy Div.** of **General Motors Corp.** The company's Electrochemical Research Dept. currently is conducting



MANUALLY activated satellite battery developed by Eagle-Picher Co. has a power-to-weight ratio of 80 watt-hour/lb. including package and hardware.



AMF's Electric Battery Co. has developed this first automatically activated chemically heated Ag-Zn primary battery, less than ½ cu. ft. in total volume.

study program to develop refined sil-r-zinc and nickel-cadmium batteries d new sources of electrical energy.

company spokesman said that new stems under way may provide yields 00% greater than from present bat-ries. The company is known to be orking on a new battery, designated elco-X," but details are still con-lered proprietary and are expected be classified for sometime.

For satellite, telemetering, and re-arch and development applications, anually activated units provide ex-emely high power-to-weight ratios in essentially off-the-shelf item. Each these units is usually modified and ckaged for a particular application.

Eagle-Picher has developed and de-gned manually activated batteries for tellite applications. One such battery, own in photo, has a power-to-weight tio of 80 watt-hours/pound includ-g packaging and other hardware. En-ronmental conditions imposed on any of these types of units include)-g vibration, 60-g shock and 18-g celeration in addition to many other vironment extremes.

• **Solid state**—The Patterson-Moos esearch Division of **Universal Wind-g Co.** has developed a family of solid-ate batteries for subminiaturized sys-ms. Based on the use of a crystalline ectrolyte, conduction is entirely ionic. alled "Dynox," cell configurations are vailable having cell thicknesses of less an 0.005 inch and total power pack zes less than 6 cu. inches. Some units, cording to Patterson-Moos, have op-rational lifetimes in excess of 10 years.

Hermetically sealed, the batteries rovide high shock and vibration re-stance. They can be operated in a mperature range of from —100° to 70°F.

Producing 0.8 volt per cell, single nits can be obtained which will pro-ide up to 950 volts (open circuit) and current of 10^{-3} milliampere for 100 ours at 70°F. Voltage drop is less than 0%.

Dynox batteries have an estimated shelf life of 20 years at from –40° to 70°F (2 years at 130°F).

• **Nuclear**—Another Patterson-Moos Research development is a family of nuclear batteries. Weighing 9 grams, the units measure 9/16" x ½" diameter. They can supply currents rated at from 10 to 200 $\mu\mu$amperes with equilibrium voltages from 5000 to 10000 volts at 70°F.

Construction consists essentially of an emitter electrode coated with a radioactive isotope (β-emitter) and separated from a brass collector case by a solid dielectric.

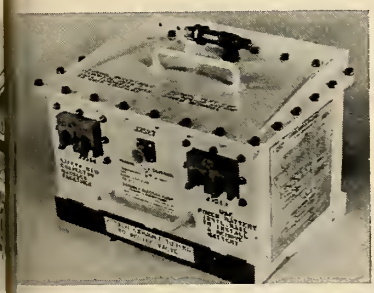
Having a shelf life and use life of 25 years, the units also are independent of adverse physical and chemical conditions, according to Patterson-Moos.

Nuclear power packs—called Raypaks—also are available. Comprised of a PMR nuclear battery, a capacitor, and voltage regulation network, the units are completely encapsulated. These units are provided with voltage ratings of either 375 or 750 volts. They weigh 80 grams and are 1.5" long x 1.25" diameter overall. Particularly designed for trigger power in weapon and ordnance systems, Raypaks can provide a pulse energy source of from 800 to 337,000 ergs.

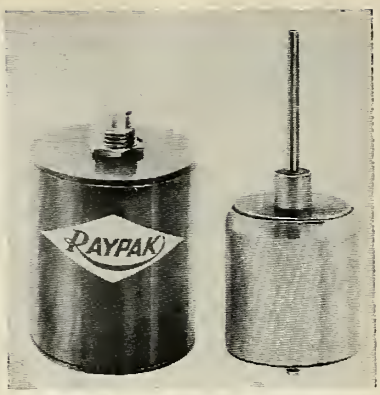
• **Thermal**—Thermal cells are primary cells or batteries incorporating a solid salt electrolyte which is activated by melting the solid electrolyte to make it conductive. This feature provides excellent unactivated shelf life and a means of operation independent of ambient temperature. Although its capacity is not high when compared to other practical systems, it does possess advantages which suit it to specific power requirements. Currently under development by the Eagle-Picher Co., applications and details of these thermal cells are classified.

• **Water activated**—Water activated batteries, also produced by Eagle-Picher, are units which operate when immersed in, or wet by water of 0 to 4% salinity at 28 to 210°F. They are capable of voltages from 1.5 to 1000 volts at currents of from hundreds of amperes to milliampere ratings with discharge life ranging from a few seconds to two days, and with activation time variations from one second to one-half hour. These broad capabilities are covered, in general, by two similar electrochemical systems: silver chloride-magnesium and cuprous chloride-magnesium batteries.

In general, these batteries are designed for air discharge or submerged discharge. The former are manually activated by soaking in water prior to use, while the latter operate submerged in water. Typical applications for the air-discharged are as power supplies for radiosonde balloons. A principal use for water-submerged batteries is in underwater ordnance.



NLY 55 pounds, this Yardney Elec-ic rechargeable Silvercel battery sup-lies energy for guidance electronic gear nd telemetering in missiles.



TWO MEMBERS of the Patterson-Moos family of nuclear power sources. Left, nuclear power pack; right, nuclear battery. Both have 25-year life.

• **Late report**—As M/R went to press, late information was received indicating the reason for Convair's cancellation of the hot-gas APU programs at Sundstrand and Aerojet-General for *Atlas* and *Titan* ICBM's.

A comparative study of hot-gas vs. battery auxiliary power sources for the *Atlas* was performed recently by the Frank R. Cook Co. The report indicated that in all instances of comparison hardware for missile batteries proved to be of less weight than that required for the hot-gas APU's.

After review by the USAF Ballistic Missile Division and Ballistic Missile Office, the APU program cancellation immediately followed.

Frank R. Cook has stated that his company is providing units for "all eight *Atlas* type batteries, four types for *Polaris*, two for *Minuteman*, and others."

New Process for Synthesizing Crystals

SAN FRANCISCO—A new method of synthesizing nearly perfect ferrite monocrystals from a mixture of ferric oxide and other oxides has been revealed by International Telephone and Telegraph Corp.

Developed by ITT Laboratories, crystals can be grown in quantity by a process described as "flameless fusion." This is a thermo-chemical reaction (2000°F) accomplished with high frequency radio energy.

ITT believes process will open new avenues in solid-state electronic research.

Crystals approximately 1.5" x ¾" diameter were displayed for the first time at the 1959 Western Electronics Show and Convention here at the Cow Palace.

Page's DTC Has Wide Potential

Simple device performs well in NATO scatter stations and is expected to find application in telemetry, especially over long distances

by Charles D. LaFond

WASHINGTON—Sometimes a simple, inexpensive gimmick can be as noteworthy as a more impressive breakthrough—that is, if the gimmick has potentially wide application.

Such a device may be **Page Communications Engineers'** new circuit technique called a "decision threshold computer" (DTC) which enables a frequency-shift-keyed receiver system to use information in mark and space channels independently when fading exists between the mark and space frequencies.

Designed, built and tested in Page's Takoma Park, Md. lab and at its Taylors Island Field Station near Cambridge, Md., the diversity technique has produced a significant performance improvement in high frequency and scatter communication circuits.

Currently employed with marked success in NATO's European scatter stations, the technique will be utilized in the many other scatter links around the world. It should also find use in telemetry, principally for long-distance applications.

DTC is designed to make use of the normally deleterious effects of frequency selective fading. It provides up to a 30-fold reduction in telegraph and binary data transmission error rates. This corresponds to a 16-db improvement.

By using the lack of correlation in mark and space signal fading, it effectively provides additional orders of diversity. For a dual-space diversity system, DTC, according to its developers, will produce an overall advantage of quadruple AM diversity, if the correlation between mark and space signal fading is sufficiently low. This is accomplished by separately storing mark and space amplitude formation and deriving from this optimum threshold level.

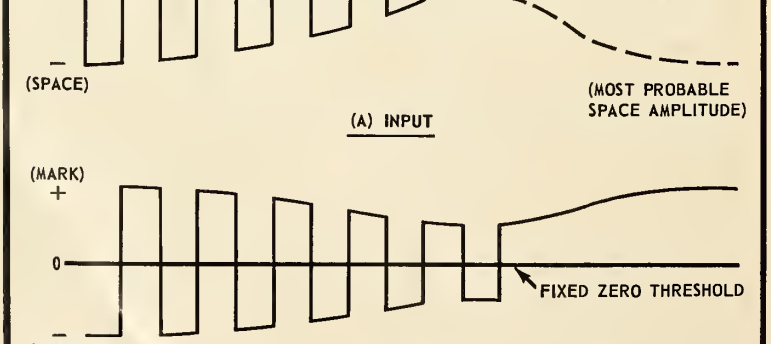
• **AM-FM decisions**—In the modulator of a typical FSK syste mark and space usually are rep sented, respectively, by positive a negative output voltages. The decisi threshold voltage is set at zero.

Unfortunately, FSK signals generally assumed to be balanced, the optimum decision process assur that the signal amplitudes and nc levels are the same for the mark space channels. (This is based on optimum decision criterion presen by Middleton and Van Meter, "Mod Statistical Approach Reception in Cc munications Theory," *IRE Professio Group on Information Theory*, S tember 1954).

Under conditions of selective f ing between mark-space frequenc the FSK decision criterion is no lon optimum. Moreover, with a deep f on either frequency a substantial nu ber of errors could result.

Thus another decision criterion needed, for an AM decision on eit mark or space, as appropriate, wo be optimum. Without this, there is provision for changing both the cision criterion and the threshold, performance would be unsatisfactor

The receiver makes an FSK cision between mark and space wh the amplitudes are equal, but ma an AM decision on the stron channel when the other channel fa completely. A function switch on DTC switches between four mo of operation: Bypass, DTC is connected from the circuit for use w Anti-Multipath Equipment (M/R, Ju 22, 1959) or for testing; Normal, D is connected; Mark, receiver makes AM decision on the mark signal or and Space, receiver makes an AM cision on the space signal only. T latter two positions are used in event of interference on either chan



PAGE decision threshold computer's input and output diagrams.

MOVING AHEAD----

"TO PROVIDE FOR THE COMMON DEFENSE"

Only by conceiving today the weapons which will be needed tomorrow; can the free world continue to preserve the peace—or successfully meet an attack.

TIME IS OF THE ESSENCE!

ANOTHER STEP FORWARD

To cope successfully with this urgent and continuing problem, RCA recently extended to a corporate-wide basis the techniques which had been proven successful within its various departments, by creating an *Advanced Military Systems* organization at Princeton, New Jersey. There, in an atmosphere of intellectual freedom, a group of mature scientists and engineers are engaged in the analysis and study of our national defenses—present and future—and how they can be made most effective to meet any future enemy capability.

These studies are conducted at the frontiers of knowledge and encompass such areas as the physical and engineering sciences, military science, economics, and geophysics. Studies have, as an end result, the creation of military systems which will satisfy projected military requirements.

A SPECIAL KIND OF MAN

Members of the technical staff are at the highest creative and intellectual level. They have a degree of maturity which comes only with many years of experience. They generally have held responsible positions in research, advanced development, or systems planning. Most of them have an extensive background in the broad fields of electronics, vehicle dynamics, physics (astro, nuclear, or plasma), or military science (operations research). All are temperamentally suited for performing highly sophisticated, comprehensive analysis and planning of a detailed nature. They are men who enjoy seeing the fruits of their work turn into realities that have an extensive effect on the defenses of the country.

A SPECIAL KIND OF CLIMATE

Each member of the technical staff operates either independently or in a loosely organized group, and is generally free to select his own area of work. The only condition: results must have a direct application to problems of national defense. He has no responsibility for administrative details, although he must be ready to give guidance to program implementation. He can call in any specialists he may need. He has full access to all available information—military, academic and industrial. Specialized research projects and laboratory work can be carried out at his request by other departments of RCA. In a word, he is provided with every opportunity and facility to use his creative and analytical skills to maximum advantage and at the highest level.

A SPECIAL KIND OF ENVIRONMENT

Princeton offers unique civic, cultural and educational advantages along with the convenience of its proximity to New York City. In this pleasant environment, Advanced Military Systems occupies a new, air-conditioned building on the quiet, spacious grounds of RCA's David Sarnoff Research Center. Working in individual, well-furnished offices, staff members find their total environment highly conducive to creative activity.

INQUIRIES ARE INVITED

If you are interested in learning more about this far-reaching program, write:

Dr. N. I. Korman, Director,
Advanced Military Systems, Dept. AM-1H
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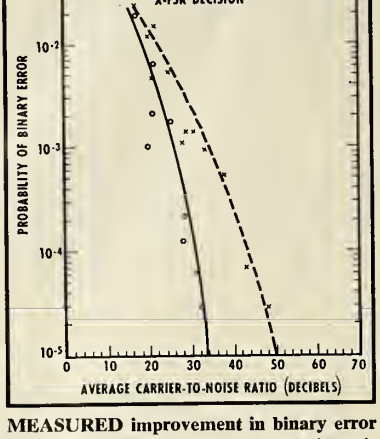
and for testing.

When the DTC is operated in the Mark position, the receiver in effect becomes an AM receiver operating on the frequency of mark signals only. The space signal is ignored by the decision threshold computer, and the resultant intelligence is translated from unipolar to bipolar keying to actuate the remaining circuitry of the combiner. In this way, disruptive interference occurring on the space frequency can be avoided at the expense of a slight degradation of normal performance. For reception in the Space position, the converse of the above is true.

The British "assessor" (described by Allnat, Jones and Law, "Frequency Diversity in the Reception of Selectively Fading Binary Frequency Modulated Signals," *Proceedings IRE,* Aug. 1956) can be used to automatically change the decision threshold, but its frequency response does not extend to dc. Thus, a decision failure may result with some types of traffic.

The Page DTC provides automatic adjustment of the decision threshold. Also, if signal polarity remains constant, the decision threshold is returned to zero for the FSK decision.



MEASURED improvement in binary error rate using Page's new DTC technique is shown by comparison of data with contemporary FSK decision method.

• **Performance**—Extended tests of DTC using the facilities of the ionoscatter test link between Round Hill, Mass., and Streator, Ill., showed that the circuitry remarkably improved the detectability of FSK signals. Mr. Ga Boggs, assistant director of researc at Page, has stated that the use of th device, under some conditions, mig recover traffic on scatter circuits th would otherwise be lost. Page eng neers also felt that an operational a vantage was achieved because le critical receiver balance adjustmen were needed than with convention FSK decision techniques.

The experiments by Page have ind cated that using the DTC circuit tec nique with live FSK signals, in th presence of selective fading mak possible a 5- to 20-fold reduction errors over those resulting with co ventional FSK reception using du space diversity. Similar improveme can be obtained with a 3 to 6-db i crease in transmitter power. Whe operating non-diversity with a sing receiver and under comparable cond tions, the error rate was reduced 10 30 fold, corresponding to an improv ment of 10 to 16 db. An example the results obtained in the latter ca with live signals is shown in the grap to illustrate the effectiveness of th technique.

Tiny Resistor Produced by Sputtering Technique

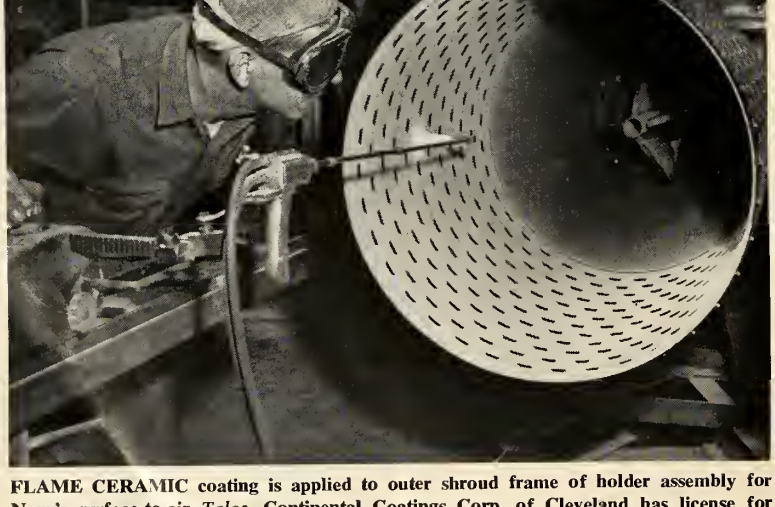
NEW YORK—Microminiaturizatic has moved another step ahead wit **Bell Laboratories'** announcement "sputtered" thin-film resistors. The r sistors, formed from refractory meta such as tantalum and titanium, can b produced on glass or ceramic bases i lines as narrow as one mil. Equivale printed circuits produced by regul methods are more than four times th size of those made by sputtering.

Bell has been researching the spu tering technique for several years. La year it announced the production tantalum capacitors by this method.

Sputtering is an old technique i which ionized gas molecules bombar a cathode, dislodging atoms of met which redeposit on nearby surfaces.

In producing a component by th method, an overall thin film of copp is first sputtered onto the surface the base. Then the desired pattern etched into the copper surface b standard photoetching, leaving the ba substrate exposed. The tantalum—o other refractory metal—is deposite onto the etched copper pattern. Th copper with its overlay of tantalum removed in an etching bath, leavin only the tantalum which was in direc contact with the bare surface. Sinc the masks are extremely thin, fin detail is possible.

Talos Gets Coating



FLAME CERAMIC coating is applied to outer shroud frame of holder assembly for Navy's surface-to-air *Talos*. Continental Coatings Corp. of Cleveland has license for process, developed by Armour Research Foundation. Aluminum oxide coating is applied in powder form to metal combustor. Molten alumina then freezes on metal and adheres by mechanical bond.

Bowmar Leads Precision Gear Field

Firm makes millions in work largely ignored by big missile manufacturers and its head views today's precision miniatures as mere prelude to future

FORT WAYNE, Ind.—Producing iniature gear packages for use in **onvair's** *Atlas* telemetry, **Martin-Or-ndo's** new *Pershing* inertial guidance, nd **North American's** *X-15* spacecraft avigation, the **Bowmar Instrument Co.** rapidly cornering a large portion of ne of the missile industry's youngest nd fastest-growing fields—develop-ient and production of precision, iniature transmissions.

These components have been some-hat ignored in the past by the large anufacturers because of the meager emand for the midget units, and be-ause it was uneconomical to establish ie miniature, high precision tooling equired.

Bowmar is the nation's largest pro-ucer of miniature mechanical com-onents with control of more than alf the market. Although there are andard lines of gearheads and servo-ackages produced in the industry, uch of the work deals with the de-gn and production of custom-devices or air and space navigation and con-ol systems, as well as telemetry, round computers, and atomic engine erve centers.

• **Doubles gross**—In 1956, Bowmar chieved an annual gross of just over 1 million. The annual gross has more an doubled each year since 1956. pproximately 92% of Bowmar's 1958 ales (total over $4 million) were tied military contracts. The remaining % of their business was for com-ercial airliner controls and naviga-on applications. Along with the ever ontinuing need for greater minia-urization for the missile industry, the uture growth area in this field cer-ainly appears to be in this latter evelopmental group.

To build these micro-mechanisms, Bowmar spokesman said that the ompany currently operates on speci-ed tolerances of 0.0002 inch for meas-rements of center shaft diameter, haft center distance, tooth to tooth, tooth width, tooth backlash and out-side diameter.

This kind of precision requires ex-tremely tight controls through the entire manufacturing operation. The gears are manufactured on both Swiss and American type precision gear hob-bing machines. The teeth are cut to the accuracy required in one operation and are finished except for minor burr removal which is performed after-wards. To check the exacting toler-ances, a great many precision equip-ments are required, such as gear roll-ing machines that record total com-posite error of the gears to less than 0.00005 inch.

To increase reliability, the tiny parts are ultrasonically cleaned and assembled in a dust-proof chamber. Bowmar maintains a "clean room" that is pressurized, sound proof, and tem-perature controlled at a positive 72°F and controlled 50% relative humidity.

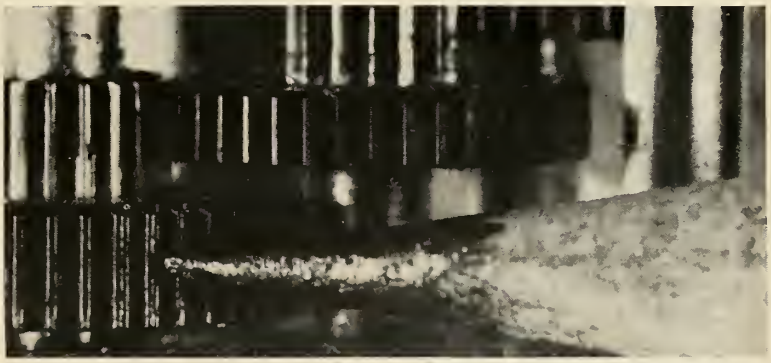
Each month the company assembles an average of 125,000 individual parts, ranging from gears of 0.177" diameter, to pinions of 0.09" diameter and to ball bearing units 0.1" diameter. Fitted together under microscopes, these parts are combined into gearheads, speed re-ducers and servo-packages.

New techniques have permitted the development of ¾-ounce transmissions that can increase torque from a 0.3 inch-ounce input to an output of 540 inch-ounces, using motors of 0.00008 horsepower.

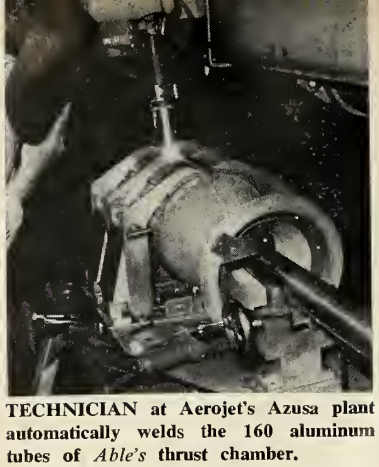
Biggest problem is to keep up with the servo-motor manufacturers, who are currently shrinking motors to these small diameters, and low outputs. Given the job of miniaturizing the size and weight of an inertial-guidance servo-package to meet new specifications for the Army's *Pershing* IRBM, they reduced the unit three times to a final miniaturization of 2½ x 2½ inches and less than 20 ounces in weight.

Grape-sized miniature gearheads are now being produced ranging in speed-reduction ratio up to 3 million to 1 and priced up to $2000 each.

Currently working on a 1" long gearhead that will produce a 6000-to-1 reduction ratio, Bowmar's president Ed White contends that his company and its fellow miniaturists have barely scratched the surface. Before space ve-hicle design can go much further, he believes it will require mechanical pack-ages even more reduced and complex. Compared to future units, Bowmar feels that current devices will seem not only crude but outrageously large.



SCARCELY larger than sharp pencil point, this Bowmar miniature gearhead is used in guided missile control packages and, more commonly, to slow down computer motors.



TECHNICIAN at Aerojet's Azusa plant automatically welds the 160 aluminum tubes of *Able's* thrust chamber.

Success Story: Improvi

History of the progress of the system from four failures in the Vanguard effort to perfect batting average with Thor-Able

by Frank McGuire

AZUSA, CALIF.—From *Vanguard* to *Thor-Able* to *Delta* represents considerable progress since the beginning of the Space Age, and one second stage has prevailed through all three programs. From an unimpressive record of four failures in the *Vanguard* program, the system progressed to a nine-out-of-nine success record in the *Thor-Able* program.

Aerojet-General Corporation, producer of the system, will turn out 15 second-stage systems for the *Delta* program of NASA under a $6 to $8 million contract. The stage is a modification of the *Thor-Able* version, which in turn is a modification of the *Vanguard* version. AGC will be a subcontractor to **Douglas Aircraft Company** on the program.

• **October launching?**—Delivery of the first *Delta* second-stage system to Douglas by AGC was made the first week of this month. The first launching of the complete three-stage vehicle should be sometime in the fall—about October. The third stage is a solid-propellant system produced by **Allegany Ballistic Laboratory.** Gross weight of the *Delta* vehicle is 100,000 pounds.

The only modification of the *Able* system necessary to enable its use in the *Delta* program is the addition of a coast phase altitude control system.

Along with production of the second-stage system, delivery of which will extend over a two-year period, AGC will provide necessary missile support equipment and technical services.

In its *Able* configuration, the system was vital to re-entry tests and deep space probes by the Air Force. The startling thing about this *Able* system is that it moved from idea to initial delivery date in eight weeks.

The entire *Able* system—including test support and propulsion units—was scheduled to be designed, fabricated and tested in 26 weeks. AGC's assignment as of November 27, 1957, was to "produce six rocket propulsion units—to be designated AJ10-40—including systems for attitude control, separation, required airframe structures, and all associated test support equipment." Delivery date was set for May 31, 1958.

The first unit was delivered to **Space Technology Laboratories** on January 17, 1958. It was assembled with other missile systems and shipped to Cape Canaveral for testing.

Initial announcement of the *Delta* contract to Douglas was made April 29, 1959, by NASA, and the first unit was delivered by AGC early in August.

• **Adapted existing engine**—The tight schedule on *Able* forced engineers to adapt an existing rocket engine to the job, and to conduct all component development programs simultaneously. Since basic design requirements were quite similar to those of AGC's second stage *Vanguard* unit, this system was incorporated into *Able*. Two surplus chambers and tank assemblies from *Vanguard* were transferred to *Able*.

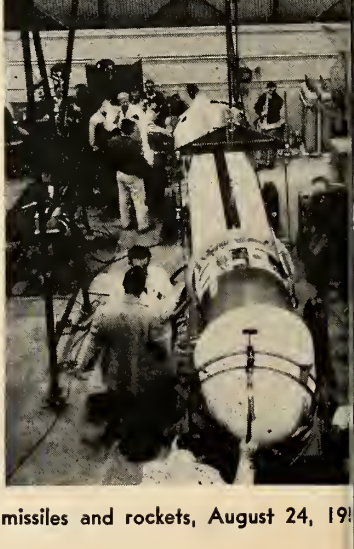
Remaining time was devoted to development and fabrication of 18 functionally distinct items of test support equipment and the modification of the *Vanguard* propulsion system. Excluding the tank and thrust chamber assemblies, Aerojet-General developed nine component systems: gimbal actuation system; helium pressurization system; roll control system; interstage separation system; payload separation system; destruct system; vent and relief system; electrical system; and the aft skirt transition assembly and controls compartment.

As incorporated into the *Able* unit, the propulsion system developed about 7800 pounds thrust. The 66-pound engine is regeneratively-cooled and uses a hypergolic combination of unsymmetrical dimethylhydrazine and white inhibited fuming nitric acid as propellants. The WIFNA oxidizer circulated through the 160 pre-form aluminum tubes comprising the cha ber wall. An impinging injector is us offering early ignition at the l chamber pressure of 206 psi.

Pressurization of propellant tanks accomplished by a helium system wh is beefed up by a solid-grain heat g erator when helium pressure drops 200 psi. The solid-grain generator he and expands the remaining helium.

Tank assembly for the system fabricated by welding two cylindri sections to form each tank. They stainless steel, 0.0050″ thick. Her spheres drawn from tapered blar form the tank ends and the heli sphere.

The gimbal actuation system, wh corrects for pitch and yaw duri flight, is capable of moving the thr



he *Able*

chamber plus or minus 3° and is operated by a hydraulic control system mounted inside the aft skirt adjacent to the thrust chamber. Roll stabilization during powered flight consists of two solenoid shut-off valves responding to control system signals, and two pairs of nozzles mounted on the periphery of the forward skirt. Regulated helium gas from the spherical tank is expelled through selected nozzles, two clockwise and two counter-clockwise, depending on the control desired. Each nozzle of the selected pair produces seven pounds of thrust for a maximum of 20 seconds.

• **Simultaneous venting**—The vent and relief system is designed to simultaneously vent the oxidizer, fuel and helium tanks by means of three vent valves. This is designed to provide a fail-safe means of venting all tanks during a sudden pressure build-up, extended hold during countdown, or valve failure.

Four explosive bolts join the two stages of the *Thor/Able* combination, and separation is achieved when the bolts are exploded by a signal from the thrust chamber pressure-switch which detects rising chamber pressure in the second stage propulsion system, and then effects separation.

Pendulum tests of the payload-separation system were conducted with dummy payload and vehicle structures. The 611-pound payload dummy was joined to a second-stage forward control compartment by two explosive bolts. Both the dummy payload and the control compartment, which had been ballasted to 858 pounds, were suspended to simulate flight position. After actuation of the explosive bolts, separation is achieved through four spring-loaded plungers which push the payload away from the vehicle. A high order of reliability was reported, correlating within 5% the separation velocity measured at 1.6 fps.

The destruct system, composed of a 15' length of primacord strung along the side of the tank assembly, was capable of completely destroying the second stage in one second.

The first test firing of the *Able* propulsion system was a 10-second calibration run, followed by a 60-second checkout firing. Both took place on Christmas Eve, 1957. Thereafter followed compatibility tests to study overall performance and to determine the effect of gimbaling and roll control jets on propulsion-system performance.

• **Test support equipment**—Two sets of TSE units were built, to be used interchangeably at either the launching area or at the hangars. The original schedule called for the entire TSE package to be delivered and checked out before the first *Able* propulsion system arrived at Cape Canaveral. This was done by building, testing and delivering the TSE within 60 days.

Prime support function of the TSE was multi-fold: pre-launch instrumentation; launch control and electrical systems monitoring; functional pressure checkout; missile-control-system checkout; explosive-bolt and squib checkout; hydraulic servicing; supply and maintenance of system equipment; fuel and oxidizer servicing; missile tank decontamination; propellant-tank drying; and missile handling. The vehicle-handling trailer is a three-purpose vehicle acting as road carrier, lifting sling and as a roll-over and handling frame for inspection and test work.

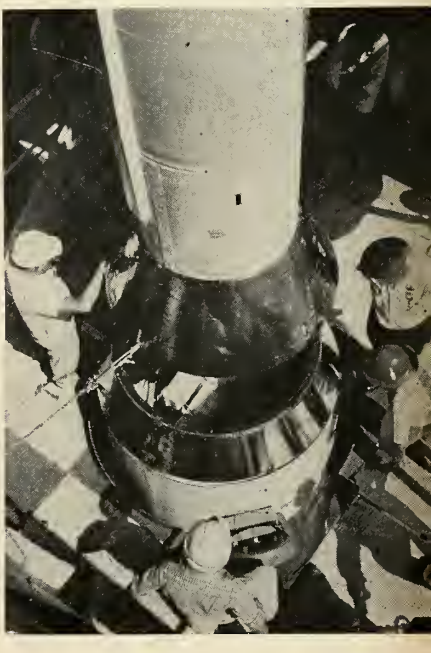
After thorough testing by Space Technology Laboratories upon receipt of the *Able* stage, it was again completely tested at Cape Canaveral.

During countdowns, there reportedly was no major hold during the *Able* phase of the terminal count. Aerojet says that during each flight in which it was called upon to operate, "the second-stage *Able* fired, and flew a predetermined course down range, delivering its instrumented nose cone within the target area. It thus became the first American missile to fly an intercontinental range of better than 5000 miles."

←

AT LEFT, the nose cone and transition skirt (which attaches the *Able* unit on top of the *Thor*) is assembled at Space Technology Lab, Inglewood, Calif.

EARLY STAGES of assembly of *Able* rocket unit at Azusa. Left to right, tank assembly, aligning aft skirt, riveting skirt, assembly of thrust chambers.



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LIQUID-POWERED second-stage *Able* unit is mated atop the *Thor* missile forming the *Thor-Able* test vehicle at Cape Canaveral, Fla.

Spectres Ready for Missile Role

by G. V. E. Thompson
Contributing Editor to M/R

LONDON—The *Spectre* series of kerosene-hydrogen peroxide-propelled rocket engines now in production are intended for both missile and manned interceptor propulsion.

While no information has been released about the use of *Spectre* as a missile propulsion unit, it has a big advantage over liquid engines in that the missile could be held in a state of instant readiness for months without losing oxidant by evaporation.

Manufacturer of the *Spectre* series **—de Havilland Engine Co.**—began work on rocket propulsion in 1946. The first project was the *Sprite*, an ATO unit intended for use with Comet I aircraft.

Sprite was a "cold" unit in which hydrogen peroxide was decomposed with calcium permanganate catalyst (later replaced by solid silver). It functioned successfully but never became operational owing to the use of more powerful jet engines. However, out of it was developed the *Super Sprite*, now in use as an ATO unit for the **Vickers** Valiant bombers.

In *Super Sprite*, kerosene is burned in decomposed peroxide (silver-plated nickel gauze is used as catalyst for the peroxide). Normal maximum thrust is 4200 lb., and duration 40 seconds, but they can be varied within certain limits. The engine weighs 620 lb. dry, 1460 lb. when fueled, and has an overall diameter of 20¼" and a length of 117¼".

The propellant tanks and combustion chamber are made of stainless steel. Only the nozzle is regeneratively cooled. The kerosene tank is wrapped around it to keep the engine as simple as possible. The combustion chamber temperature is kept to 1500°C (instead of a potential 2000°C) by employing excess peroxide. Within the combustion chamber is a large cylindrical flame tube fabricated from Nimonic 75 sheet by argon arc welding.

The combustion products flow down inside this tube. A relatively cool stream of superheated steam and oxygen from decomposed peroxide flows down the annular space between the flame tube and the stressed chamber walls, protecting the latter from the combustion products. The two streams are allowed to mix in the nozzle throat.

• **Advanced series**—The work on *Sprite* and *Super Sprite* has provided a useful basis for the development of the more advanced *Spectre* series of rocket engine. One of *Spectre's* intended uses was as the main power plant of a manned interceptor aircraft. In design the emphasis has been placed on reliability up to accepted aircraft engine standards.

Although the propellants are still kerosene and HTP, *Spectre* is intended for either "hot" or "cold" operation, so HTP has to be used as the regenerative coolant. After experimenting with an indirect system (in which the chamber was cooled by water which then passed to a HTP heat exchanger before recirculation) and then with low-pressure HTP cooling (one pump delivers HTP to the coolant jacket, a second raises the heated peroxide to supply pressure), high-pressure cooling was finally adopted.

An intensive programme of ground and flight test has been carried out, particularly with the **Saunders-R** S-R.53 research aircraft. Thrusts over 7000 lb. were obtained (the engi is designed to yield 8000-10,000 lb Several different units are no available.

Spectre 5 is a variable-thrust un designed to be capable of running any output between its full thrott power and ground idling. All pump valves and controls are in a compa and robust assembly which can rapidly installed, and is much light than the original *Spectre 1*.

A simplified constant-thrust versi *(Spectre 4)* is also in production. Wh used as an ATO unit, it is designed f repeated use and is mounted within releasable nacelle together with ker sene and HTP tanks and parachu gear. The V-bomber force of the RA **(Avro** Vulcans and **Handley Page** Vi tors) is provided with these units.

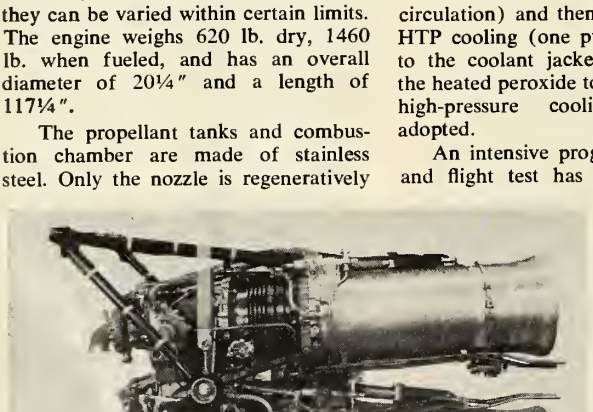
• **Newer addition**—A more rece addition to the series is the *Doub Spectre* (D.Spe.D.1). This consists of fixed-thrust *Spectre 4* mounted abo a variable-thrust *Spectre 5*, with on minor modifications to each. The tw units are essentially independent, a though carried on a common tubul frame and connected by certain pip runs. The combined unit is entirel self-contained.

To operate the engine, the pow rocket must first be started. It is fitte with a spherical starter bowl and ca ries a small pressure bowl of nitroge on the starboard side to initiate th start. Once the lower unit is operatin a small bleed of HTP is fed across t energize the turbine of the pump f the upper unit, which can then b started. The whole procedure takes b a few seconds.

The upper unit is either inactive c operating at full thrust; the output c the lower unit is controllable at an value between idling and its maximu thrust. Once started, either unit ma be shut down independently of th other.

Its principal dimensions are: overa length 58.6"; maximum height 37.5 maximum width 36.6".

All the *Spectre* engines are designe so that it is impossible for kerosene t be injected into the combustion cham ber unless HTP was already flowin through.



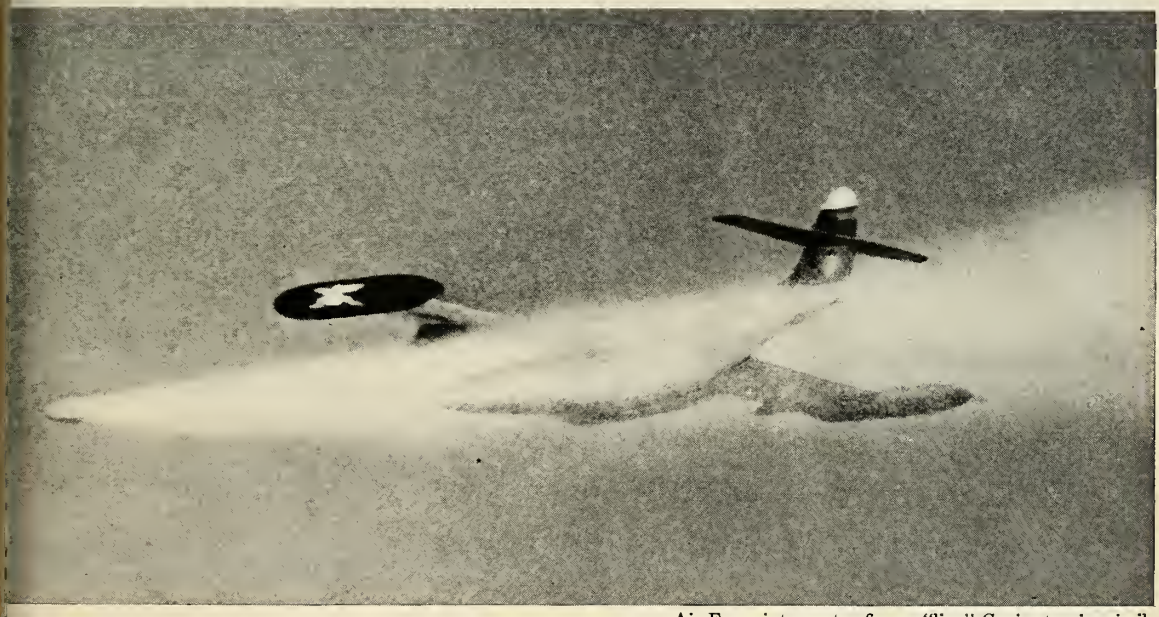
MOUNTING a *Spectre 4* **fixed-thrust engine on frame above** *Spectre 5* **variable-thrust unit produced new** *Double Spectre* **in which the two units are largely independent and can be separately shut down.**

The men:

. . . USAF ordnance technicians assigned to service the Douglas *Genie* air-to-air nuclear-armed missile. They have undergone extensive training in Air Force technical schools and from Douglas field service engineers to become proficient in both rocketry and nuclear ordnance.

The mission:

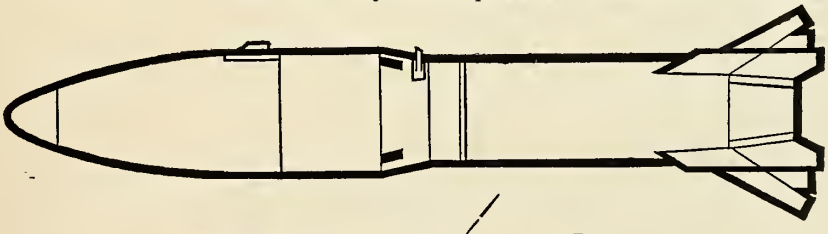
. . . high-level interception of enemy aircraft. Ideal interception would take place far from U.S. boundaries. The atomic warhead of the Douglas *Genie* was detonated under test conditions over friendly troops with no resultant danger.



Air Force interceptor fires a "live" *Genie* atomic missile

The missile:

. . . the Douglas-built *Genie*. This nuclear missile has actually been fired in flight. Retractable fins allow the missile to nest close to the plane's fuselage. Or it can be carried in the bomb bay. Interceptors can be armed with two *Genies*.

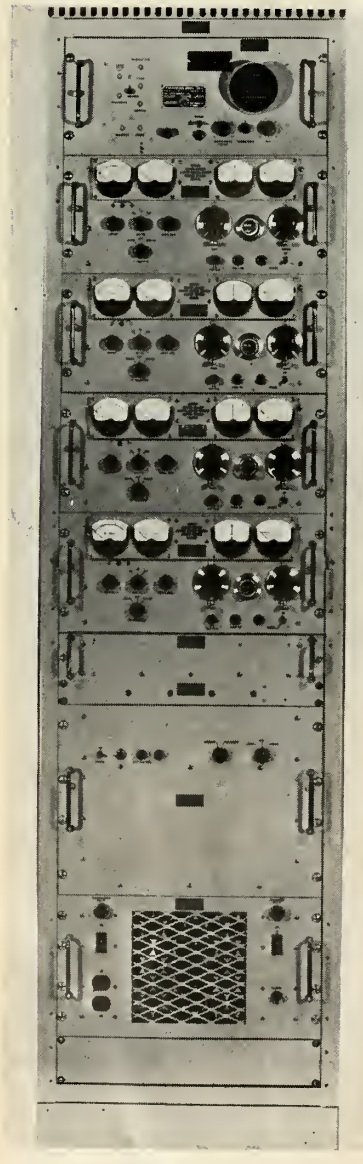


Depend on **DOUGLAS**

The Nation's Partner in Defense

Trouble-free Telemetry Receivers

This small industry—largely in the hands of one company—produces highly reliable and durable units which stay well ahead of their requirements



GROUND receiving station contains four NEMS-Clarke 1400 series receivers.

by Hal Gettings

WASHINGTON—In the hectic flurry of missile research and development at least one vital system part—the telemetering receiver—seems completely competent to handle its important job, today and in the near future.

The specialized radio receivers for missile telemetry have enjoyed a series of steady improvements which keep them ahead of their requirements and promise a continuing capability. They present no real problem in reliability and their operation is generally so dependable that they receive little attention.

The receiver industry is small—and likely to continue so for some time to come. Last year's volume was less than $3 million; 1959 will run under $4 million. And 95% of this business is done by one company—**NEMS-Clarke Division of Vitro Corp.**

There is practically no replacement market for receivers. They have to be repaired and maintained, but they seldom wear out. The first unit developed by NEMS-Clarke, still operating, was built in 1947 for the Bureau of Standards and used for collecting test data on an early parachute-ejection system.

• **Accuracy paramount**—Receivers for missile telemetry must be much more than just good communication equipment. Accuracy of received data is paramount—the receiver must not add any distortion or inaccuracies. Numerous information channels must be crowded in one band and the receiver characteristics must be sharp and clean. Frequency stability must be held within close limits. (Units with variable frequency oscillators provide up to ±0.005%; crystal-controlled units ±0.002%.) Noise figures of less than 8 db, and better, are considered standard. Equipment must be versatile to provide both AM and FM reception —and sometimes CW—and video and audio outputs. Some units feature selectable i-f bandwidths.

This precision and reliability mus be designed in. As a result, equipmen is rather expensive; the best standar units go for around $2500. Many buy ers, though, want a few minor modi fications included—and the price goe up from there. Most in demand woul seem to be a "custom-made standar unit."

• **Limited potential**—There ar probably less than 4000 telemeterin receivers in use today—almost all a missile ranges. The Atlantic Missil Range, for example, has 270 units o one NEMS-Clarke model installed an an unnumbered total of other models

Potential market growth is pretty well limited to two areas: new missil range installations and new telemeterin frequency allocations. It's hard to de fine just exactly how much hardwar will go into these applications, bu estimates are that the business will g along on a slowly increasing level fo the next several years. And, as spac programs grow, the demand for re ceivers will see a commensurate growth

Several major—and many minor— improvements have been made in re ceiver equipment in recent years. Th field has seen no tremendous break throughs, however—possibly becaus none have really been demanded. Mos telemetry people feel that the receive is probably the best and most reliabl part of the telemetry system.

• **Phase-lock progress**—The mos significant advancement has been th development of correlation detection This technique—commonly known a phase-lock demodulation — effectively lowers the receiver sensitivity threshold Gains of from 5 to 15 db have beer realized by the incorporation of phase lock in receiver front ends.

In operation, the phase detector o multiplier compares the instantaneous phase of the FM input signal with that of a locally generated carrier obtained from a voltage controlled oscillator and produces an output voltage proportional to the phase difference. This voltage is fed through an amplifier and

ter network back to the input of the CO which is locked in phase with the coming signal. Since the VCO is following the incoming signal in frequency, the voltage, which causes it to follow in frequency, is proportional to that frequency and thus represents the demodulated output signal.

When the signal input becomes noisy, the ordinary demodulator does not operate properly and the output signal-to-noise ratio deteriorates rapidly. The point at which the demodulator ceases to function correctly is known as the improvement threshold. Phase-lock, by lowering this improvement threshold, increases the sensitivity of the receiver. This is equal, in effect, to increased antenna gain or transmitter power.

No one firm can take full credit for the development of phase-lock. **Radiation, Inc.** several years ago developed an accessory plug-in unit for standard receivers and applied for patents. NEMS-Clarke offers certain models of its 1400 series with phase-lock incorporated.

• **Preamps vs. paramps**—Considerable improvements are expected in low-noise preamplifiers to further increase the sensitivity of receivers. The recently announced "tunnel diode" offers promise in this area.

One industry spokesman feels that efficient advances may be made in tramps to bring them within two db of the parametric amplifier. Problems due to the complexity and stability of the parametric would make the improved preamp more desirable for most applications.

Others feel, however, that the paramp offers a magnitude of improvement not attainable by the other. Especially in the 2200 mc band, the noise temperature seen by an antenna pointed at the sky is low enough to allow the full potential of paramps to be realized.

• **Predetection recording**—One of the most significant advancements in telemetry reception is that of predetection recording. This technique, first used in the reception of radar signals from Venus by **Lincoln Lab's** Millstone antenna, offers great promise in higher reliability of telemetered signals. Receiver input is picked off just ahead of the detection stage, tape recorded, then later demodulated.

The advantage here is in the possibility of applying advanced demodulation techniques to periods in which data are lost due to poor signal-to-noise ratio or interference. Future improvements in this technique are expected to significantly advance long-range telemetry.

Radiation, Inc. has designed and built models of a 2200 mc "state-of-the-art" receiver which provide this feature. Production of commercial models is contemplated.

• **Frequency allocation**—A great hassle has long existed regarding the allocation of frequencies for telemetering use. Today's "standard" band is 215-260 mc and most present receivers are built to cover these frequencies. Predictions are that most of this band will be used at least until 1970. Some equipment is being built to cover the "new" 2200-2300 mc band and it is expected that receiver techniques generally will be advanced as new equipment is developed to fit these higher frequencies. The 1435-1535 mc range is also being used to some extent—primarily for aircraft testing.

NASA has requested assignment of the 135-136 mc band to move the 108 mc Minitrack frequency for future space programs. Although Minitrack is used primarily for tracking, a limited amount of telemetered information is transmitted on this band. A few receivers have been built which cover this band in a spread from 55 to 260 mc.

Generally, the lower frequencies are considered more desirable for their propagation characteristics—and because microwave plumbing in missile transmitters offers problems. Choice is limited, however, by the bands available. Too, missiles are very restricted in the size and type of antennas that can be used—which, of course, has a definite relation to frequency selection.

• **Small business field**—Surprisingly, none of the big radio manufacturers are in the telemetering receiver business to any extent. This is probably because the annual volume is such a small one and that large production runs are not possible. Also, most standard units must often be modified to fit particular applications.

The bulk of the receivers are made by NEMS-Clarke in nearby Silver Spring, Md. This 60-year old firm has been in the field for twelve years. It manufactures a complete line of telemetering receivers and many accessory units such as preamplifiers, multicouplers, and combiner/adders. It heavily emphasizes reliability and goes to great lengths to maintain strict quality control. The company even manufactures almost all its own receiver components—from transformers and i-f coils to plastic panel escutcheons.

NEMS-Clarke produces several series of receivers specifically for FM telemetry. Their 1400 series—with phase-lock in some models—is practically a standard at missile ranges. An estimated 2500-3000 units of their models are currently in use. The company is a leading contender for telemetering receivers for Project *Mecury*.

Tele-Dynamics Inc., formerly **Raymond-Rosen,** was one of the early manufacturers in the field. They built the UKR-2 2000 mc receiver, still being used presently in the *Titan, Polaris* and other missile programs. About 10% of their current business is in receivers; they specialize in miniaturized units for both telemetering and command destruct applications.

Practically all of Tele-Dynamics' business is concerned with telemetering equipment. They claim to be the only company manufacturing a complete system from transducer input to recorder output, including the radio link.

Receivers for all three frequency bands are manufactured by **General Electronics Laboratories,** Cambridge, Mass. They are currently producing one lot of 25 215-265 mc units for the Pacific Missile Range.

TELEMETRY receiving station installed aboard picket ships of the Pacific Missile Range which are deployed to supplement range stations on various Pacific islands.

The Latest Word in Heat Treating

Alco uses a Lindberg furnace with operating temperatures up to 1950° F to treat flight cases for Pershing missiles forged at Latrobe

DUNKIRK, N.Y.—Heat treat of missiles today is a far cry from earlier times, when among other things:

• Armorers quenched the famous swords of Damascus by plunging them into the flesh of the strongest slaves. They believed that the strength of the slaves was transmitted to the steel.

• Metals were immersed in the urine of three-year-old goats that had been fed on ferns for three days.

• The urine of young, healthy, red-headed boys was used.

Little is left to superstition nowadays. Heat-treating facilities are keeping pace with the Missile Age. Metals are quenched after heat treatment in a special oil with temperature specially controlled. The furnaces and tanks all respond to electronic controls, thermocouples and other modern devices.

One of the nation's newest heat-treating facilities, a **Lindberg** electric drop-bottom for missile metals, is installed at the **Alco Products Inc.** plant here. For some six years, Alco has been a key supplier of bodies for the *Honest John*. It has had contracts for making *Nike-Zeus* nozzles and now is producing first-stage flight cases and nozzles for the *Pershing*.

The Lindberg is a versatile furnace. It can perform hardening, stress relieving, normalizing, quenching and tempering, annealing and spheroidizing. Operating temperature ranges from 1400° to 1950°F for 1000 pounds and up to 1650°F for 2000 pounds.

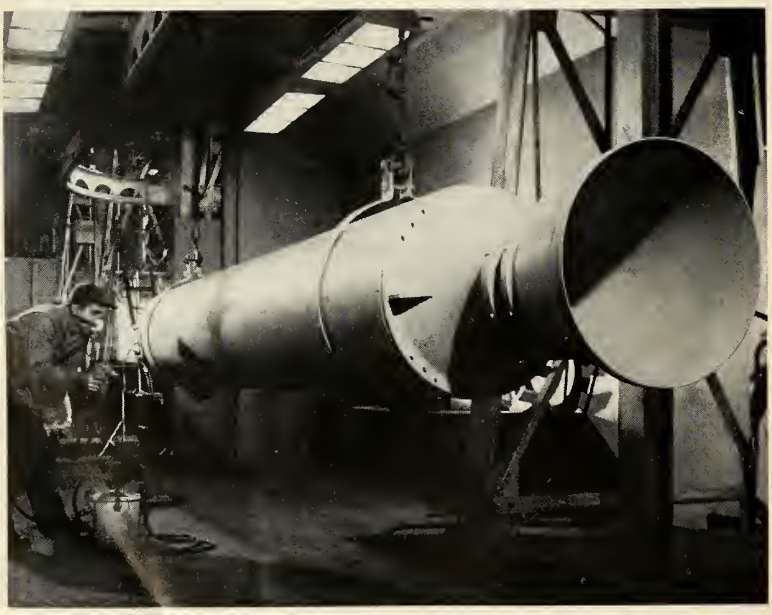
Alco makes motor cases for the *Pershing* on a subcontract from **Thiokol Chemical Corp.,** which has responsibility for the propulsion system. Three precision-made test versions of the motor cases were made first for use in static-fire tests. Later, Thiokol awarded a production order for additional cases, with even more exacting tolerances.

The cases must not be distorted from heat treating in excess of 10 total indicator runout, nor must the 0.105″ skins be decarburized to depth exceeding 0.003″.

The *Pershing* flight case is forge at the Alco plant in Latrobe, Pa. Bot the front and rear heads are hot-presse and contour-machined here. The fro head is hot-formed from ½″ plate an pressed to shape. Then it is roug machined and the center-part forgir is welded in. The head is X-rayed an finish contour-machined to 0.01 thickness.

The rear head is fabricated from seamless forged ring, swaged ar formed to its conical shape and the contour-machined to 0.015″ size. Th shell is formed by rolling and weldir AISI 4130 sheet steel. Then the fro and rear heads are welded to the she to form the case. All welding is dor by automatic Heliarc. Heat treatir brings the yield strength in the 41 case to 180,000 psi.

The **Martin Co.** is prime contracto for the *Pershing*.

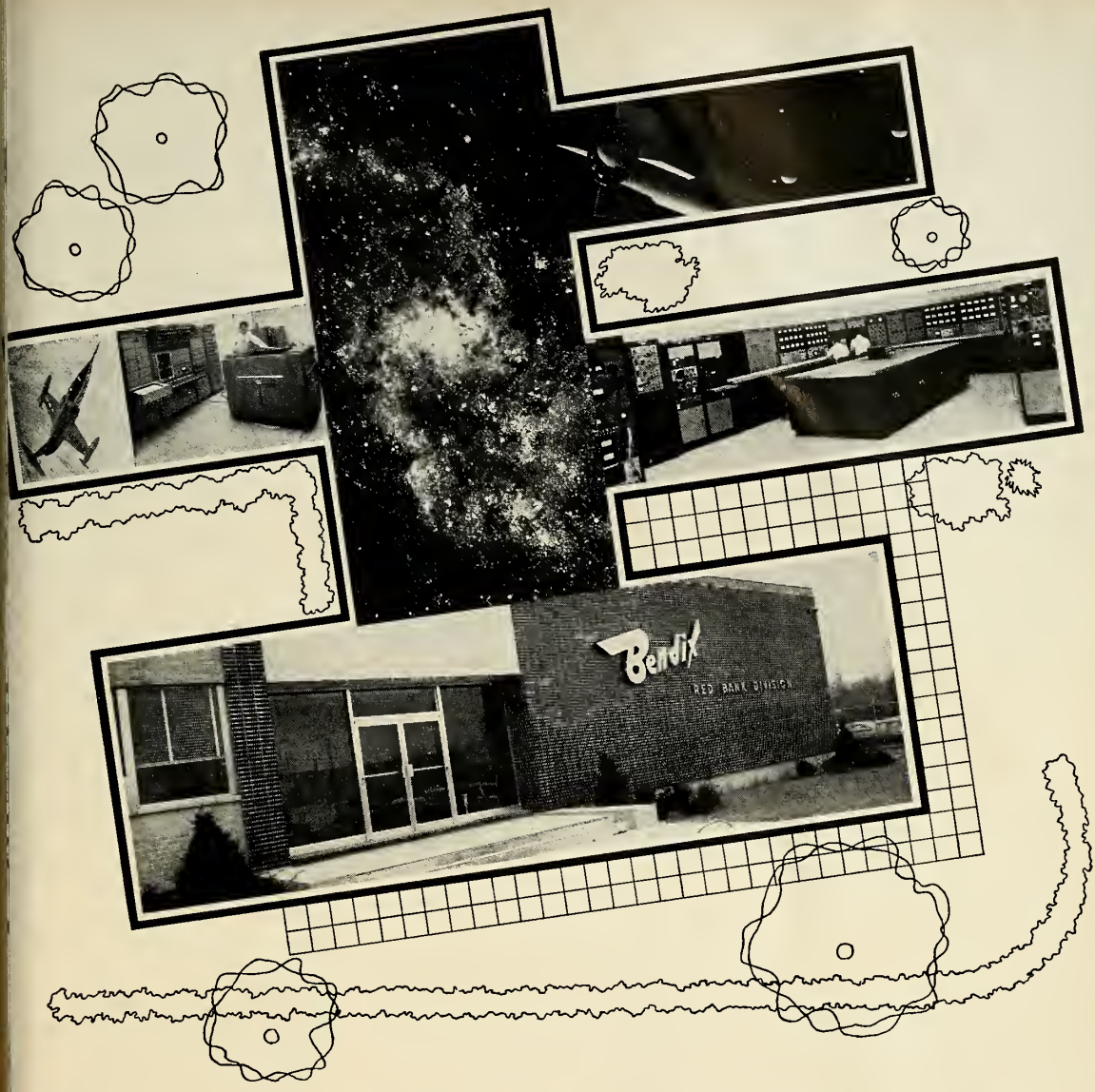


ROCKET BODIES for *Honest John* are heat treated in new facility at Alco Products Inc. plant in Dunkirk, N.Y. Prior to shipment, each body receives careful painting.

Semiconductor Can Serve As A Complete Circuit

SAN FRANCISCO—The newest in growing number of microminiaturize semiconductor devices that can ser as a complete circuit was demonstrate here at WESCON by Bell Telepho Laboratories. The device—a p-n-p semiconductor element—is the bas building block of a silicon steppi transistor. It measures only 0.04″ diameter.

The stepping transistor acts as pulse-controlled on-off switch simil to a gas stepping tube. It can be us as a basic stage in certain digital cor puter logic circuits. It is capable many high-speed functions usually pe formed by complex circuitry. Te models of the device have operated speeds up to one million pps. High speeds are expected with improv design.



THE HOUSE WHERE TOMORROW LIVES . . .

Our newest engineering facility, in Eatontown, New Jersey, is dedicated to creating new ideas and products that will help you meet tomorrow's electronic, missile and aircraft needs today.

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Expansion in Pennsylvania, N.J.

Both states earn upwards of $1 billion a year from missile work; astrionics leads the growth. Second in a series on Middle Atlantic states

by William E. Howard

PHILADELPHIA—Barring a hatch-out of more "bugs," the Air Force in a few weeks will pronounce **Convair's** *Atlas* an operational weapon—the Nation's first ready-to-shoot ICBM. When this missile milestone occurs, it will have particular significance to thousands of scientists and technicians in eastern Pennsylvania and New Jersey. For this hustling industrial area is one of the major subcontracting centers for the big war-bird.

Hundreds of companies in this area are contributing to the development of *Atlas* and dozens of other missile/space systems. Moreover, engineers here hold the prime responsibility for developing BMEWS—ballistic missile early warning system designed to give the country's retaliatory forces 15-minutes advance notice that an enemy ICBM attack is on the way.

Missiles today are an important force throughout the economy of the two states. Defense Department procurement figures and independent estimates place missile-related manufacturing conservatively at more than $1 billion a year in each state. Employment is in the hundreds of thousands. And despite the lack of a major prime missile systems contract, the industry is growing—especially in astrionics.

Much of the activity is concentrated here in the Philadelphia-Camden area. The Big Four of the industry are **General Electric Co., Philco Corp., Burroughs Corp.** and **Radio Corporation of America.** These companies alone employ a total of around 30,000 on missile/space projects and their aggregate contracts run well over $500 million yearly.

GE's Missile and Space Vehicle Department here is developing *Atlas* and Douglas *Thor* nose cones under $168 million worth of contracts. Currently it is working on advanced *Atlas* re-entry vehicle designs in its 120′ shock tunnel which can simulate re-entry environment, including heat transfer, pressures, flow characteristics and other phenomena. Recently the tunnel completed its 1000th firing.

The department also has developed the *Thor-Able* nose cone data capsule recovery system. Its 780 engineers and scientists and nearly 5000 other employees are working on the *Discoverer* satellite series, fuzing and arming *Lacrosse* and *Little John* Army missiles, and pushing R&D on a number of advanced data processing and other projects.

A $700,000 Army contract for *Courier* communication satellite shrouds and code tapes recently went to Philco, which has nearly 5000 employees at its Government Industrial Division here. The company has just received a $13 million follow-on for the Navy *Sidewinder,* which it is co-priming with GE, Utica, N.Y.

Philco in addition has the guidance for Convair's *Redeye*—the Army's new bazooka-type weapon—and the fuzing for *Falcon, Terrier, Tartar, Talos, Little John, Corporal* and *Sergeant.* Philco is now building a new plant for its Transac computer at Willow Grove, Pa.

Just outside Philadelphia in Paoli, Burroughs has a 2000-employee Research Activity which is developing *Atlas* radio inertial guidance computers and electronic devices for a number of other missiles including *Titan* and *Thor.* This facility includes the Ballistic Missile Division of the company—and in the words of Burroughs president John S. Coleman it is the "heart of the participation by Burroughs Corp. in weapon systems programs."

• **Shape of the future**—Across the Delaware River in Camden, RCA—prime contractor for the $1 billion BMEWS (ballistic missile early warning system)—has 15,000 employees at its Defense Electronic Products Division. They are also turning out *Atlas* and *Hawk* checkout gear and working on the Air Force's global communications AIRCOM network, the means whereby SAC will flash the word "Go!" in the event of nuclear attack.

On the plains outside Moorestown, N.J., RCA is constructing the first BMEWS prototype facility. When it's completed, travelers along the New Jersey Turnpike will see something resembling a huge orange sitting on a flat lunchbox.

This full-scale working model of BMEWS installations now under construction in Thule, Greenland, and Clear, Alaska, will be high as a 15-story building—176′. Workmen have completed the three-story base of the facility and will soon finish its top—a gigantic radome 140′ in diameter.

Earlier this month RCA received a multimillion-dollar contract from **Boeing Airplane Co.** for major R&D on sensitive-command and support information networks of *Minuteman's* launch control system.

The whole RCA Defense Electronic Products division is currently doing at least $250 million a year and is growing rapidly.

The missile/space activity of these four major concerns is fostering a profusion of satellite industries. Each company has suppliers, vendors and subcontractors by the thousands. In the past few years many small firms like **Brown Instruments, Suckle Electronics** and **Magnetic Metals,** to name a few in this area, have grown to substantial size.

• **New Jersey electronics**—Missile electronics predominates throughout New Jersey. **Bell Telephone Laboratories** at Whippany is performing for **Western Electric** the R&D on the $450-million *Nike-Zeus* anti-ICBM program. The company's several thousand scientists and researchers also have developed the command guidance system for *Titan* which will be phased out soon by **AC Spark Plug's** all-inertial system.

ITT Laboratories division of **International Telephone and Telegraph**

Corp. has its main installation at Nutley. ITT Labs employs 3500 persons—1100 of them professional engineers and scientists—and they are hard at work on a variety of missile DOVAP (Doppler, velocity, position) guidance systems. Programs include *Lacrosse* and *Talos,* interceptor missile evaluation for *Bomarc* and a number of other contracts running into the millions of dollars.

Only recently ITT Labs received an $800,000 Army award for three *Courier* communication satellite ground stations. In the spring, the parent company established a new unit—ITT Communications Systems Inc.—to handle overall development, design and master planning of AIRCOM. RCA is a principal associate.

One of ITT Labs' subcontractors is **Applied Science Corp.,** Princeton, which is now working for ITT on a $794,000 digital data transmission system to be installed at Eglin AFB, Fla.

The Princeton area holds a small cosmos of missile/space research outfits orbiting around Princeton University's aeronautical laboratory, and the Army Signal Corps' Research and Development Laboratory at Fort Monmouth. This latter unit currently has a $190 million-a-year research program underway and is funding work in some 250 commercial laboratories and 50 educational and non-profit institutions.

Kearfott Co. Inc., a subsidiary of **General Precision Equipment Corp.,** Little Falls, is rapidly growing into one of the state's major missile subcontractors. Recipient of a new $4.5-million assignment from Boeing for production of attitude converter systems and related directional control equipment for *Bomarc,* Kearfott is now in the process of building a million-dollar addition to its main plant. The company employs 5000 now and expects to increase its payroll shortly.

• **Elsewhere about the state—Avion Division** of **ACF Industries,** Paramus, is working on a $435,000 NASA contract for transistorized radar beacons to track the *Mercury* manned space capsule; **Daystrom Inc.,** Murray Hill, a leader in anti-submarine detection devices and producer of missile/space instrumentation, is clipping along at an annual sales rate of $76 million.

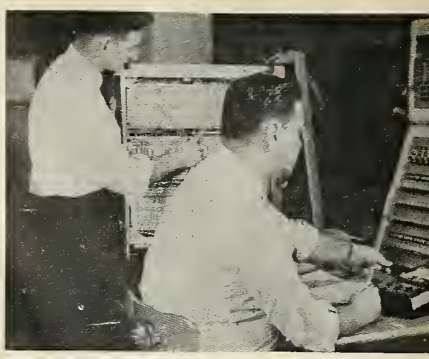
Thiokol Chemical's Reaction Motors Division, Denville, employs in the neighborhood of 1600 persons. Second largest division of the company, Reaction is producing liquid propellants, including storables and advanced packaged fuels. In the engine line, it produces the powerplant for **North American Aviation's** *X-15* rocket plane; *Guardian I* and *Guardian II* rocket engines for the Navy and the engine for the Navy's *Bullpup* and *Covus* air-to-surface missile which homes on radar.

Other New Jersey companies deep in missile work include **Airborne Accessories,** Hillside; **Curtiss-Wright Corp.** at Carlstadt; **Walter Kidde & Co.'s** Aeronautical Division at Belleville; **Gulton Industries** in Metuchen; **Hydromatics Inc.,** Livingston, and **Thomas Edison Industries,** West Orange.

• **Atoms and cryogenics**—Across the state of Pennsylvania there is increasing missile activity—chiefly in the support field. **Westinghouse Corp.,** Pittsburgh, is manufacturing the nuclear powerplants for nine *Polaris* submarines. Each sub costs $100 million.

Westinghouse a few weeks ago established at Pittsburgh an astronuclear lab where scientists will develop nuclear energy for outer space.

U.S. Steel, Bethlehem Steel and **Crucible Steel** are among the state's heavy industries involved in R&D and production of high-strength, high-temperature steels for missiles. Earlier this year Crucible reported a 25% increase in sales of vacuum-melted alloys for jet engine parts, bearings, missile and electronic parts. Sales have jumped for



MORE THAN 200 persons are employed in Burroughs' Ballistic Missile Division at Paoli, Pa., near Philadelphia.

the **Beryllium Corp.,** Reading, as missile makers find more applications for the lightweight metal.

Still another maker of missile steels is **Latrobe Steel Co.,** Latrobe, which this year put into operation a new vacuum arc melting furnace with a 6 million-pound annual capacity output.

In addition to its New Jersey operation, Thiokol's Reaction Motors division has a plant at Bristol, Pa., which is now working on a $3.5-million production contract of *Guardian II* prepackaged rocket engines.

Air Products Inc. at Allentown has grown into a major company apace the missile/space age. It supplies 90% of the liquid oxygen used in the missile program and has a host of industrial customers. It is in the process of building a $6-million facility outside Pittsburgh at Glassmere to produce high purity LOX, liquid nitrogen and liquid argon.

There is missile activity in virtually every corner of the state. The Naval Ordnance Plant at New York is making the launching system and power driver for *ASROC* surface-to-underwater anti-submarine rocket and the assembly and test of *Weapon A.* At McKeesport, the **National Tube Division** of U.S. Steel is fabricating the war head for the Navy's *Bullpup.* John R. Hollingsworth, Phoenixville, is principal subcontractor for generator sets and frequency changers in the *Nike Ajax/Hercules* series. **Hamilton Watch Co.,** Lancaster, is providing safety and arming devices for *Sidewinder* and *Tartar.* **Landsdowne Steel & Iron Co.,** Morton, is making the rocket head for *Zuni.*

There are many more companies producing components and support items and the list is growing. As one industrialist put it recently: "Missiles and spacecraft are the vehicles carrying us into the future. For the company that doesn't climb aboard now—there many not be any room later."

NOSE CONE of *Atlas* built by General Electric's Missile and Space Vehicle Department in Philadelphia is checked by GE technician at Cape Canaveral.

New Regulation May Slow Procurement

DOD officials fear that new 'rider' will further complicate negotiating job

by Betty Oswald

WASHINGTON—"The time is coming when two sets of secretaries will be needed at the Pentagon"—This was the prediction of a long-time Defense Department employee as he left the Puzzle Palace for greener pastures.

The prediction was based on the strong belief that top civilian officials would be forced to spend more and more time on Capitol Hill, leaving less and less time to do the planning and the paper pushing that is required to make a decision and perhaps more important, to make the decision stick.

Now there is new evidence of the need for more top level officials. It is a small rider which the Congress attached to the Military Construction Authorization Act. It provides, simply enough, that beginning with fiscal 1961, Army, Navy and Air Force must request and obtain authorizations for the purchase of missiles, aircraft and warships.

This means that top-level civilians and military officials will be required to justify their procurement programs before four committees of the Congress, the two Armed Services Committees and the two Appropriations Committees, which seemingly will double the time that these men must spend on Capitol Hill.

But time is only one small factor in the new complications added to the already cumbersome process of first preparing, then submitting and finally justifying defense programs.

• **How much detail?**—Perhaps the most difficult question which the rider creates is: "How much detail will the House and Senate Armed Services Committees really want?" Will they want to authorize specific numbers of aircraft and missiles at specific prices or will they know merely that in a period of five years, the plan is to outfit—numbers of squadrons of intercontinental missiles to cost an estimated number of dollars, leaving to the Appropriations Committees the job of approving the specific plans to buy a specific number of missiles in support of that program each fiscal year? Defense Department officials hope that this is all the Armed Services Committees want.

They are afraid, however, that following the pattern of the construction authorization, the House and Senate Armed Services Committees will really want to get down to specifics. In the construction authorization hearings, Pentagon officials are asked to justify the need for everything from machine shops to bachelor officers quarters, including the number of units.

Any such detail when applied to missiles and aircraft, and even more particularly to spares would almost inevitably bog the whole budgeting process down indefinitely. Yet it is hard to expect that Congress will ask for any less detail, since the legislative rider was not passed until after Congressional Committees had repeatedly expressed their dissatisfaction about the way money was appropriated for one program and used for another without consulting the Congress.

• **Wasted time?**—As Defense officials see it, every trip to Capitol Hill takes time needed for other jobs. While it is recognized that the Congress, as it controls the purse strings, must know what goes on, it is equally true that Congress can't do the programming but must leave the job to the military experts and to their civilian masters. Old timers say, however, that Congressional concerns are valid—particularly because decisions to cut down on required programs are based frequently on the hard facts of economic life rather than changes in legitimate military requirements.

As matters now stand, the hope is for a compromise when the Defense Department and the House and Senate Armed Services Committees sit down together early next year to spell out the ground rules needed to implement the rider.

Issues which must be decided include:

(1) The amount of detail the committees will want to provide necessary authorization. Do they want numbers of aircraft and missiles? Is ground support equipment to be included?

(2) Timing of authorization requests so that they won't get in the way of the appropriations bills. It is necessary that authorizations precede appropriations or the appropriation for a given program may become invalid for purely technical reasons.

(3) A definition of what is meant by "procurement" of "operational" missiles, aircraft and warships. Nobody is quite sure whether spares and repair parts are to be included. Also there is some variation in definition by the services as to what constitutes an "operational" weapon.

(4) Test and evaluation of new-weapon systems is now funded out of procurement accounts. DOD officials want to know whether these items will have to be justified or whether test and evaluation ought to be removed from the procurement accounts and handled as research and development. In some cases, this becomes a difficult problem because production for inventory and research and development for product improvement move ahead at the same time.

What does this rider mean to industry? The answer is that it could mean nothing at all. However, what is considered more likely is that contract negotiations will be bogged down on occasion while waiting for both authorizations and appropriations. Programs on which the industry bases its own planning are likely to be changed more often—once as a result of the shift in Defense planning and once as a result of Congressional action.

• **Biggest problem** — However, everyone seemingly agrees that the biggest problem created will be to find the time—time to prepare the justifications needed for authorization—time to appear on Capitol Hill before both sets of committes and finally time to reconcile differences between the Armed Services and Appropriations Committees. End result is that the already drawn-out process of contract negotiation will be delayed still further and the apportionment process by which the Defense Department gets the funds needed to operate will be slowed.

Biggest hope is that when the Congress receives a report from the Pentagon which shows current programs and how the Defense Department is planning to finance them that there will be a change of heart and the rider will be repealed.

NASA to Try Moon Orbit in October

Space agency to use Atlas-Able vehicle which was earlier scheduled for Venus probe

by Paul Means

WASHINGTON—The National Aeronautics and Space Administration will attempt to place a payload in orbit around the moon in early October.

The vehicle to be used, an *Atlas-Able,* was originally scheduled for a Venus probe in early June. The most advantageous date for the moon orbit attempt at Cape Canaveral would be within a few days either way of Oct. 8 —the date when the moon is furthest south.

The *Atlas-Able* vehicle will hurtle its approximately 200 lb. payload into space at just a little less that escape velocity—approximately 24,000 miles per hour. After the payload leaves the atmosphere, the external aerodynamically shaped shroud will be thrown off, exposing the approximately 70 lb. solid retro-rocket developed for the vehicle by the **Atlantic Research Corp.**

At a point around 200,000 miles from earth and 40,000 miles from the moon, the moon's gravitational pull will exceed that of the earth, and the vehicle will approach the moon. Near the point of closest approach, the retro-rocket will be fired, reducing the payload's speed by about 1,500 miles per hour, and placing it into orbit around the moon.

• **Objectives**—The instruments in *Atlas-Able*'s **Space Technology Laboratories'** payload, which is similar to the payload sent aloft by *Thor Able III* in *Explorer VI,* will allow NASA scientists to learn much about the moon's magnetic and gravitational fields.

Other objectives of the experiment are to learn the properties of cislunar space, of the moon's mass, and to gain information about the moon's configuration, surface details and composition, atmospheric composition and density, and radioactivity.

• **Moon's unseen side**—The STL-developed facsimile system, somewhat like a TV camera, which is presently transmitting pictures of the earth from *Explorer VI,* could reveal in some detail for the first time the unseen side of the moon. This unit consists of a tube containing a mirror which receives and focuses light and dark impressions, and an electronic counter which computes and records the impressions before they are converted into radio signals.

A new device to maintain temperature control in the instrumentation compartments—currently being tested in *Explorer VI*—will get a real workout in the *Atlas-Able* moon orbiter. Surface temperatures on the moon range from 212°F on the sun side to –243°F on the dark side. The unit, developed by STL, relies on the absorption and reflection qualities of black and white surfaces, and operates when preset high and low temperature extremes are reached.

Information from the moon-orbiter will be relayed from a tiny electronic brain called "Telebit," also used on the *Explorer VI* experiment. "Telebit" is a digital unit responsible for the gathering and relaying of data concerning scientific data received by the payload's instruments. The instrument not only collects data, but stores and calculates it before transmitting the totalled data earthward via radio signal.

• **Ground stations**—Receiving the data from the moon orbit payload's ultra high frequency payload will be the large Jodrell Bank radio telescope near Manchester, England and the Air Force's 60 ft. diameter dish in Hawaii.

The *Atlas-Able* vehicle consists of an *Atlas* with **Aerojet General's** second stage *Vanguard* engine and **Allegheny Ballistic Laboratories** third-stage *Vanguard* engine on top. It is capable of sending 200 lb. payloads into deep space.

In order to leave its moon orbit and return to an eliptical earth orbit, all that *Atlas-Able's* payload would need is an additional solid rocket capable of increasing its speed by 1500 mph. This would allow it to escape from the moon's gravitational pull, which is about 1/5th that of the earth.

If successful, the *Atlas-Able* will be succeeded by instrumented hard and soft landings on the moon, and eventually, manned flight around and to the earth's satellite.

Other vehicles NASA hopes to utilize to put unmanned orbiters around the moon are *Thor-Delta,* which could orbit 65 lbs.; *Atlas-Hustler,* which could orbit 250 lbs.; and *Vega,* which could orbit 980 lbs.

Rough landings will be attempted by *Thor-Delta,* with a 50 lb. payload, and *Vega,* with a 650 lb. payload. Soft landings will be attempted by *Vega* with 430 lbs., *Centaur* with 730 lbs., *Saturn* with 1700 lbs., and *Nova* with 19,900 lbs.

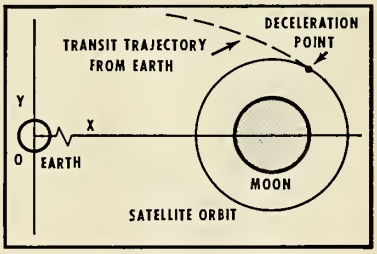
Vehicles expected to orbit the moon and return to earth with their instruments are *Centaur* with 275 lbs., and *Saturn* with 700 lbs. *Saturn* is also expected to soft land 200 lbs. on the moon and return part of the payload to earth.

Manned lunar landings and return with a payload of 2100 lbs. will be attempted by *Nova.*

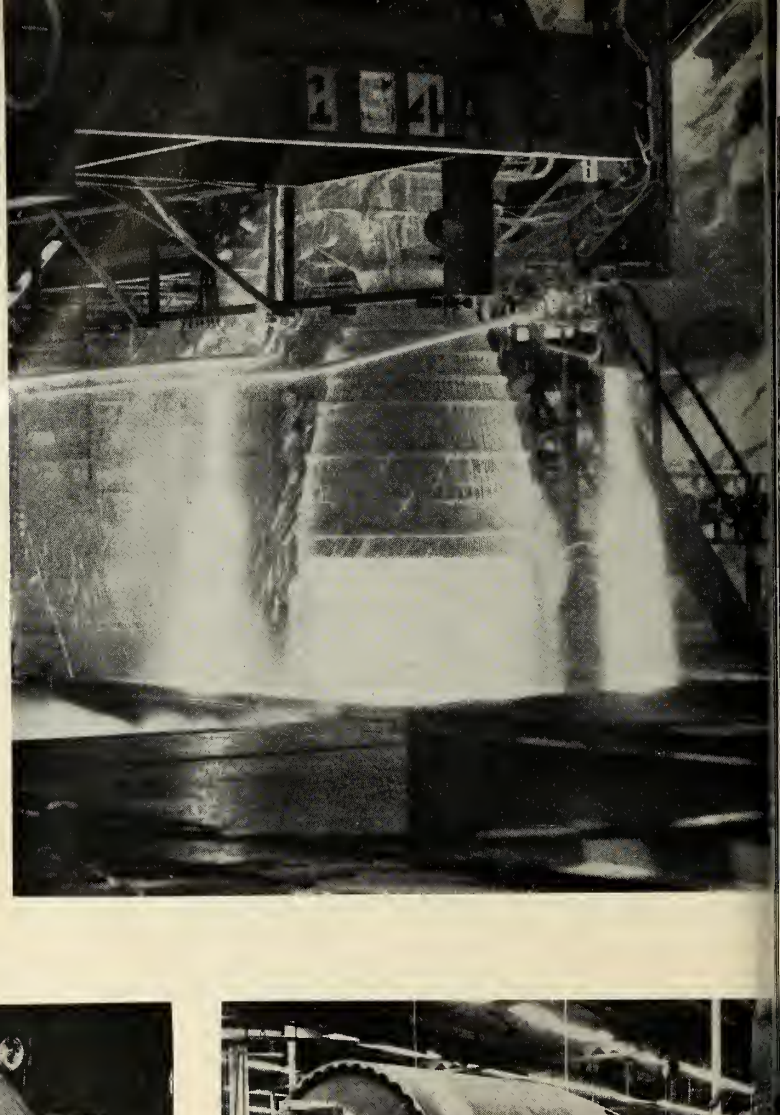
Hardware and Trajectory—

• **Left**
Atlas-Able

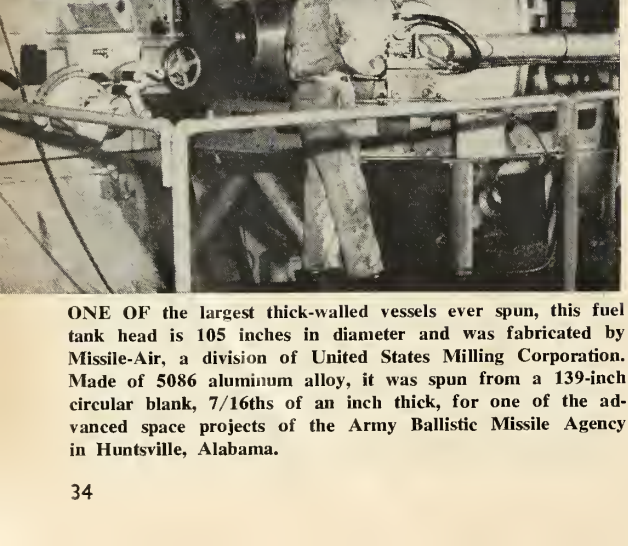
• **Right**
Moon satellite orbit



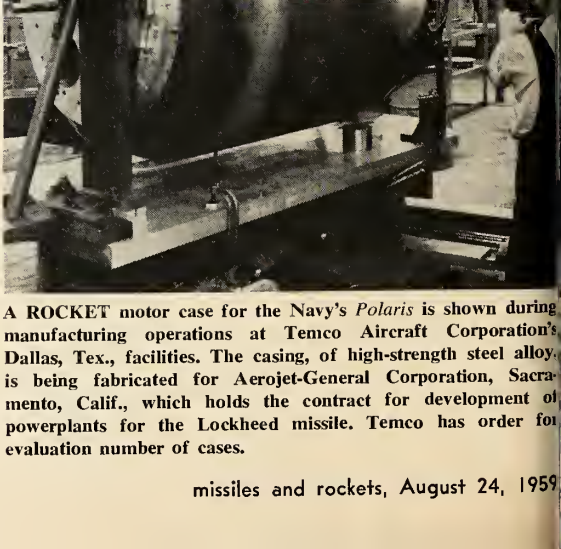
PICTURES IN THE NEWS



ICE-COATED *Thor* **rocket engine leaps to life immediately after 72 hours exposure to freezing temperatures in an environmental chamber. The Rocketdyne 150,000-pound thrust ballistic missile engine was exposed to five days of 160 degree heat and 95% relative humidity.**

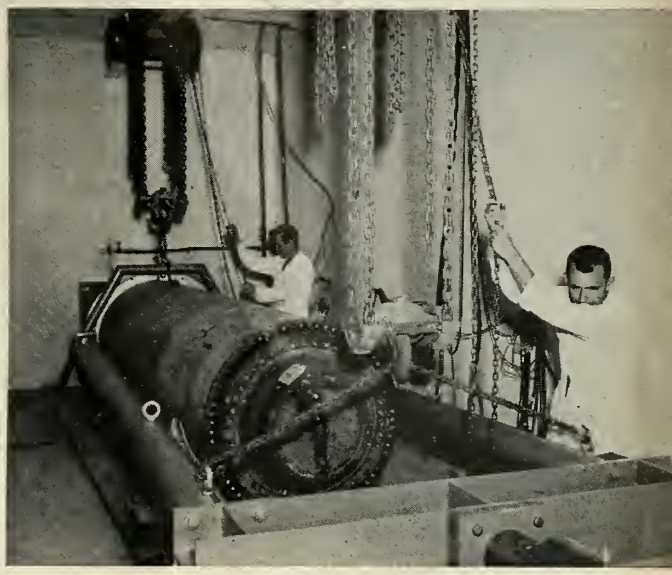


ONE OF the largest thick-walled vessels ever spun, this fuel tank head is 105 inches in diameter and was fabricated by Missile-Air, a division of United States Milling Corporation. Made of 5086 aluminum alloy, it was spun from a 139-inch circular blank, 7/16ths of an inch thick, for one of the advanced space projects of the Army Ballistic Missile Agency in Huntsville, Alabama.



A ROCKET motor case for the Navy's *Polaris* is shown during manufacturing operations at Temco Aircraft Corporation's Dallas, Tex., facilities. The casing, of high-strength steel alloy, is being fabricated for Aerojet-General Corporation, Sacramento, Calif., which holds the contract for development of powerplants for the Lockheed missile. Temco has order for evaluation number of cases.

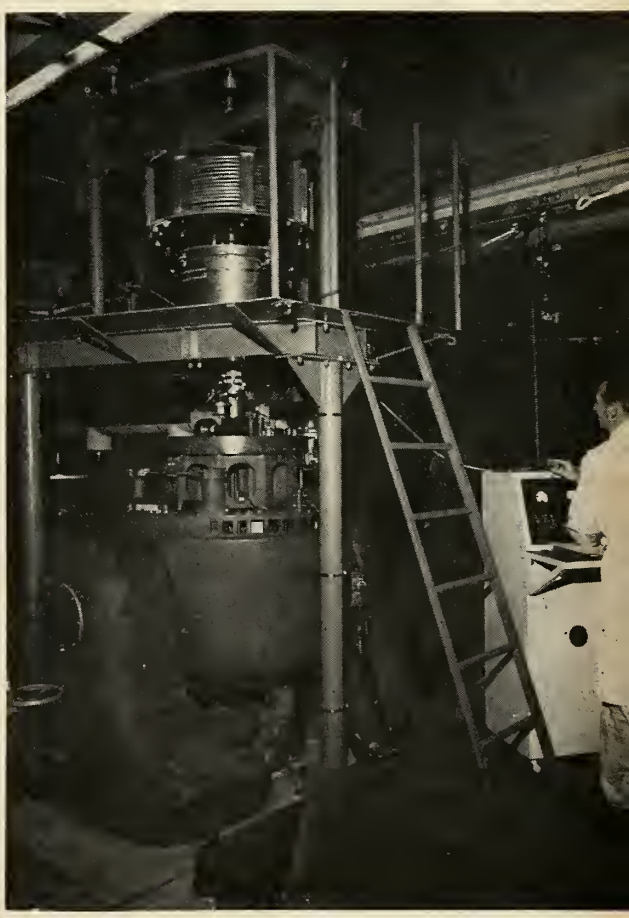
COMPLETE *Atlas* is loaded aboard Air Force plane. The Convair ICBM is expected to be operational soon.



SUSTAINER motor for *Nike-Zeus* is located in thrust cradle at Grand Central Rocket Company.

AT RIGHT, AiResearch engineering lab has built a rig to test missile solenoid valves, in the combined environment of vibration, acceleration, altitude and cold, while flowing helium at a pressure of 4500 psi. The basic test rig is a centrifuge built atop a C100, MB Shaker.

ABOARD the USS Norton Sound, a high-performance *Tartar* surface-to-air guided missile leaps from its launcher and streaks toward its target off the Pacific Coast. The supersonic Convair *Tartar* is about 15 feet long and slightly more than a foot in diameter. This photo was made from a stationary high-speed sequence camera mounted on the Norton Sound's after-deck.



USS Boston is armed with *Terrier* missiles. Total of 27 ships will have them.

Navy Wants Huge Fleet of Missile Subs, Ships

But tight money picture may force it to choose between limited-war carriers and proposed missile-space plans. Second in series on DOD planning.

by James Baar

WASHINGTON—The time: The late 1960's. The place: The oceans of the world. Beneath the surface some 50 *Polaris* submarines wait on station. On the surface cruise a score or more of *Polaris*-packing warships.

Meantime, Navy task forces built around attack and ASW carriers stand ready around the earth.

Ships and planes bristle with whole arsenals of new and improved missiles. Navigational, communications and reconnaissance satellites flash far overhead.

These are the strategic pictures framed in the minds of top Navy officials as they struggle with their new budgets and plan against the dangers of the coming decade.

Their approach is a two-fold one designed to meet what they see as the double threat of total and limited war. Their prime problem is lack of money. They need billions more each year to do what they feel they ought to do.

The **Lockheed** *Polaris* is the Navy's top claimant for scarce dollars. But the Navy also needs money for such missile/space projects as:

- A wide variety of satellites—both permanent and temporary.
- New and improved ASW weapons for both detection and kill.
- Development of families of cheap missiles designed to carry conventional warheads.
- *Polaris* **beef-up?**—The cost of the *Polaris* program already has passed the $2 billion mark. However, this is nothing compared to what the Navy would need to employ fully the missile's potential capabilities.

As of today, the Navy has received authorizations and money for a fleet of nine *Polaris* submarines and some long lead-time items for three more.

Navy officials talk in terms of building a fleet of about 50. Moreover, the Navy would like to deploy the *Polaris* on cruisers and possibly carriers and battleships.

Polaris tubes would be installed in the decks of cruisers and now mothballed battleships. They would be attached as pods to the sides of carriers.

Cost of nuclear-powered submarines for *Polaris* is running about $100 million each. Cost of installing *Polaris* on cruisers and carriers is considered relatively small as long as facilities for only half of a 16-missile round are involved. But the cost of converting cruisers and battleships into huge Polaris launching platforms would be much greater. The total cost for subs and surface ships alone could range from $6 to $10 billion.

However, the Navy contends that the security the nation would get from a mighty fleet of *Polaris* submarines and warships is well worth the price.

Each *Polaris* submarine carries 16 missiles. Cruisers and carriers could be quickly converted to carry eight apiece and new cruisers can be designed to carry a full round of 16. A fully converted cruiser or battleship could carry 100.

A fleet of some 50 *Polaris* submarines and a score of warships could rain more than 1000 megatons on Russia.

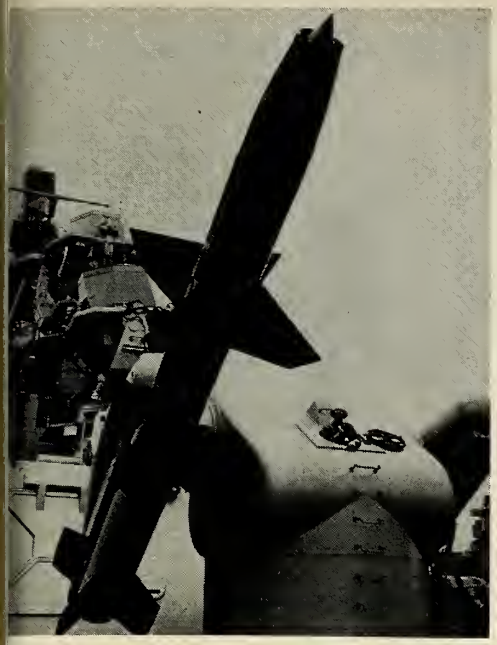
Such a devastating launching would be impossible to prevent. The fleet would be scattered throughout the Atlantic and the Pacific, the Indian and the Arctic Oceans. It would be on the move continually. It would be impossible to cripple it by surprise.

No place in the Soviet land mass would be safe from a retaliatory attack by the 1500-mile range missiles except for the small area around Alma Ata in the deep interior of Kazakh. And Navy plans to extend the range of *Polaris* would leave no part of Russia a sanctuary.

The first *Polarises* scheduled to become operational late next year probably will have a range of about 800 to 1000 miles. However, the Navy expects to extend the range rapidly to 1500 and later to about 2200.

The Administration-enforced ceiling on military spending has left little room for a rapid early build-up of a large *Polaris* fleet. And there is no indication of much change in the Administration's attitude.

The Navy this year sought authorization for three more *Polaris* submarines. It got the long lead time items, instead. It probably will seek a new block of nine *Polaris* submarines next year. At best, it probably will get three past the Bureau of the Budget. It has sought authority to install *Polaris* launching facilities aboard some cruis-



FIRING of mock-up *Polaris* missile from an observation ship. Navy wants many *Polaris* ships.

FIRST ship to be equipped with *Talos* was USS Galveston. Present shipbuilding program calls for seven cruisers armed with *Talos*.

ers. But the Joint Chiefs of Staff has tentatively shelved the plan.

•Space entries—The Navy's move into the national space program is increasingly determined.

Transit—the navigational satellite—is being developed by the Navy for ARPA. The Navy is fighting hard to keep it when it becomes operational. The Navy also feels it has a strong need for communications, weather and reconnaissance satellites.

In this line, the Navy is devoting its considerable in-house abilities to the development of equipment for operations in space rather than to development of equipment for getting into space.

Moreover, the Navy can be expected to play an increasingly greater role in missile and satellite tracking. It has developed part of ARPA's satellite detection fence. And earlier this month it disclosed Project *Tepee*—a high-frequency radar system capable of detecting at intercontinental ranges an ICBM launching seconds after the missile leaves the pad.

Finally, the Navy is taking the approach of closely watching all space developments for possible application to Navy missions. Some ideas already under more or less active consideration are development of:

• An anti-satellite missile for use against enemy reconnaissance satellites.

• A reconnaissance satellite that could be launched in the air from a carrier-based plane.

• An anti-missile system for protection of ships.

• An anti-submarine satellite—possibly for early warning of missile launchings from submarines.

In the missile field, the Navy is expected to move ahead as rapidly as possible with the development of such new missiles as **Temco's** *Corvus* and **Bendix'** *Eagle*.

Corvus is an air-to-ground missile that homes on radar. It is designed to attack heavily-defended ground installations and ships. Its engine is powered by a packaged liquid propellant.

Eagle is a nuclear-tipped air-to-air missile. It is designed to fly at high speed after being launched from relatively low speed aircraft.

Both of these are long-range programs. And the missiles are considered high priced.

In contrast, the Navy is extremely interested in the development of a school of "poor man's" missiles carrying conventional warheads.

Navy officials consider that they already have a "poor man's" air-to-air missile in the **GE/Philco** *Sidewinder*. They also feel they have a "poor man's" air-to-surface missile in the **Martin** *Bullpup*.

However, they are still looking for a "poor man's" surface-to-air missile. And at the same time they would like continued improvements in both *Sidewinder* and *Bullpup*.

One *Bullpup* improvement already planned is the increasing of its warhead from a 250 to a 1000-pound bomb. There also are plans to develop a small nuclear warhead for it.

A possible candidate for a "poor man's" surface-to-air missile is the **Convair** *Redeye* now under development for the Army. Navy experts are considering the possibility of adapting *Redeye* for use on landing craft.

But how fast any of these programs will be able to move—or whether in the end some will survive at all—is again dependent on how much of the thinly spread Navy budget can be devoted to them.

One of the Navy's toughest financial problems is the maintenance of its carrier strength in the face of increasing opposition from many quarters.

The Navy feels that it must have 14 attack carriers to maintain U.S. overseas commitments. This fleet at present is comprised of four 76,000-ton Forrestal Class carriers, three of the 62,000-ton Midway Class and the rest of the World War II Essex Class.

By the mid-60's the Essex and Midway Class carriers will be worn out. That will leave the four Forrestal Class carriers, two more that are under construction and the nuclear-powered Enterprise—a total of seven.

Congress appropriated a small payment this year for another Enterprise Class carrier after a bitter struggle. It is open to question whether the money ever will be forthcoming for completing its construction along with the construction of six more to replace the other aged carriers. More than $3 billion would be needed.

soviet affairs . . .

By DR. ALBERT PARRY

Launcher-trains for missiles . . .

Some time ago, American experts on Russia's vassal states in Eastern Europe suggested that Soviet IRBM bases, when established in Poland, Hungary, Bulgaria and other "people's democracies," may take the form not only of "hard" launching pads of permanent type, but also of a "soft," more flexible and less vulnerable kind—moved about on flat railroad-cars specially designed for the purpose. Although suitable for solid-fuel rather than liquid-fuel missiles, such launchers on wheels could in time (it was felt) be developed for liquid Soviet IRBM's, too. Whether or not such Red launcher-trains are already a fact, the Soviet government may indeed consider them a necessity.

Political vulnerability of IRBM bases . . .

in vassal territory is what the Soviet government wants to reduce. Despite all the shrill words Khrushchev utters on the subject of "love" allegedly felt by the East Europeans for his Russia, in reality there is ever a danger of sabotage, particularly if war does break out, sabotage by Poles, Hungarians and other captive nationals against the Soviet Russian masters and their armaments on vassal soil, including Red missile-launching sites.

Putting IRBM's on railroad wheels may give the Red missiles a mobility that would reduce their vulnerability, a safeguard not alone against Western weapons, but also against those native guerrillas.

Similar U.S. plans . . .

for missile launcher-trains have recently been made public for our solid-fuel *Polaris* and *Minuteman*. For the *Polaris* the recommendation of railroad wheels was included in the report of the President's Committee to Study the U.S. Military Assistance Program headed by William H. Draper, Jr. Plans of trains for the *Minuteman* have been presented by the **Bethlehem Steel Company** and the Los Angeles missiles engineering firm of **Paul Hardeman, Inc.**

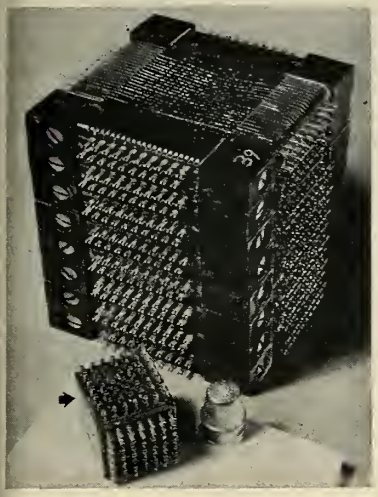
The main thought here is to reduce vulnerability of our missile sites as threatened not by sabotage at home (which we have lesser cause to fear than the Soviets have in Eastern Europe) but by the foreign foe's action. The consideration of expense is also important. Launcher-trains would cost less than permanent missile sites.

Expense as Soviet consideration . . .

Yet the point of expense may be applicable to the Soviet ledger, too. On his recent visit to this country, Soviet First Deputy Premier Frol R. Kozlov said to Vice Admiral Hyman G. Rickover that the Red government was cutting down on its atomic research and production because this nuclear program's cost had turned out to be unexpectedly high. Kozlov blamed Soviet scientists for leading their Communist government into too much expense. If Kozlov wasn't lying to Rickover (which is of course quite possible), the Kremlin's worry about the expense is valid not only for Soviet atomics but also for Soviet rockets and missiles (these have nuclear warheads, after all!). Reducing the cost of the nuclear and rocket-and-missile effort may well now be a goal for the Russians.

Where best to establish Soviet missiles? . . .

It may be worthwhile to hear from Khrushchev himself on the subject of best terrain for the establishment of his medium and short-range missile bases. In a speech to Albanians, on the occasion of his visit to their country early in June, Nikita said that Albania and Bulgaria had "exceptionally favorable conditions to put up rocket bases." He elaborated: "Mountains are high there, gorges are deep; that's the place to put our rockets."



Memory Stack's Size Reduced 50 Times

A new miniaturized memory stack for coincident current systems, whose physical volume is 1/50th of the conventional stack, has been developed by the Applied Logics Division, **General Ceramics Corp.**, Keasbey, N.J.

Improved design and assembly techniques, making possible the wiring of ferrite memory cores at a density rate of about 3.5 million per cubic foot, have produced prototype stacks consisting of 2048 cores in a unit measuring only 1 x 1.4 x 1.4 inches. This compares with a conventional stack measuring 3½ x 3½ x 4 inches. In each case the device consists of eight 16 x 16 arrays. Production models will be available in September.

The stack is said to increase reliability by sharply reducing the number of solder connections—in the case of the 16 x 16 x 8 unit from 1056 to 96. It also shortens lead lengths.

The stack, which is said to have as low a noise ratio as conventional stacks, is made up of .050-inch memory cores, the smallest in current usage. The original ferrite memory core and the .050 size were developed by General Ceramics.

Applied Logics Div., General Ceramics Corp., Keasbey, N.J.

Tiny Solid-state Decade Counter Module Produced

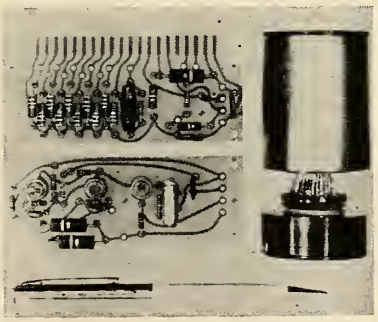
A miniature Decade Counter Module featuring a minimum of component parts has been announced by **Burroughs Corp.** Electronic Tube Division of Plainfield, N.J.

Called the DC-110, the new unit combines solid-state devices and the Miniature Shielded Beam Switching Tube in a circuit which is capable of resolving pulses at 250 KC rates. Electrical outputs are provided to operate remote Nixie Indicator Tubes, printers, and to perform other circuit functions.

The unique combination of transistors and the Beam Switching Tubes in the DC-110 makes possible a number of advantages never before available. Examples are: total power consumption of only two watts; elimination of as many as 90 components from the counting circuit; and increased reliability due to component reduction and use of the ultra reliable Beam Switching Tubes.

The DC-110 is designed as a plug-in module for use in computers, electronic counters, machine control, automation and test equipment. The units are directly cascadable and can be driven by a twelve-volt signal. The electronic and visual outputs which are provided suggest their use as preset or variable scale counters and as active elements in electronic systems, particularly where useful work must be performed.

Burroughs Corp. Electronic Tube Division. Plainfield, N.J.



Infrared-Transmitting Materials Improved

Reduction in cost of optically polished domes and windows for infrared-guided devices and enhanced transparency as far as 8 microns wavelength, even despite the blinding effect of re-entry heating, can be expected from a newly developed optical material, **Eastman Kodak Company** has announced.

Domes, prisms, and flats of the new material are already being molded, ground, polished, and sealed to metal by the company under the designation "Kodak Irtran Optics, Type AB-1". Interference Filters to pass specified infrared bands can also be produced on the new material.

In structurally adequate thicknesses, the Type AB-1 "Irtran" material is described as transmitting more than 90% of impinging energy from 3 to 6 microns. The company's tests indicate that the high transparency is retained at 800°C and even beyond. This eliminates the "hot window" effect, where image-forming radiation is drowned out by the emissivity of the optical parts themselves. Other effects of severe heating, as well as those of thermal shock, weathering, humidity, and abrasion, are said to be overcome in the "Irtran" material.

Refractive index of the substance at 6.7 microns is low—1.301. Reflection losses at "Irtran" surfaces are therefore so small as to obviate need for coating, the company feels. Microwave characteristics are close to those of natural mica for insertion losses and reflection in the 9 and 10 kilomegacycle range.

Special Products Sales
Apparatus & Optical Division
Eastman Kodak Co.
Rochester 4, N.Y.

High-Power Silicon Transistors Produced

New high-power silicon transistors, which, when operated as a switch, are capable of controlling over 5 kw of power, have been demonstrated by the **Westinghouse Corp.**, Pittsburgh, Pa.

According to D. W. Gunther, manager of the Westinghouse semiconductor department, "These are the highest power transistors, in either germanium or silicon, that have yet been developed. Although these first devices are still in the prototype stage, we expect commercial quantities to be available soon."

These transistors are suited for high-power switching and linear power applications since they have the following characteristics: collector-to-emitter voltage ratings from 30 to 200 volts; maximum operating junction temperature of 150°C; and saturation resistance less than 0.1 ohm. With a minimum current gain of 10 to 15 amperes collector current, these devices

have a maximum collector current rating of 30 amperes.

Because of the higher temperature capabilities of silicon, one of these transistors can be used in applications that previously required a number of germanium units in parallel. The low thermal drop from junction to case, coupled with this higher temperature capability enables these power transistors to dissipate up to 250 watts internally.

The predecessor to these high-power silicon units, a five-ampere silicon transistor, is ideally suited as a driver for this new 30-ampere device.

These new units use ultrapure silicon produced by the Siemens-Westinghouse process. They are of n-p-n configuration and use a new case that is specifically designed to take advantage of the high current and high voltage capabilities of the new device. The case is of double-ended construction and is hermetically sealed.

Mr. Gunther added that these devices can also be applied in high-power d-c to d-c and a-c to d-c converters;

d-c to a-c inverters; high-power d-c regulators for current and voltage regulation; and in high-power linear amplifiers.

Westinghouse Electric Corp.
Box 2278
Pittsburgh 30, Pa.

Converter Allows Input of Tape to Plotters

A new converter which makes possible the direct use of digital magnetic tape as input to automatic graph plotters and similar voltage devices is being manufactured by **Benson-Lehner Corp.** of Los Angeles. It eliminates the necessity for transferring data from magnetic tape to punched cards, and more than doubles plotting speeds even for existing plotters.

The unit has solid-state switching circuitry and can be adapted to magnetic tape from any digital computer. Selection of data by patchboard makes special programming unnecessary.

Unusual features of the Benson-Lehner Converter include a point density selector, automatic file and record run-up, parity check, off-scale error count or stop-plot, and provision for omitting records which contain specified characters.

Benson-Lehner Corp.
11930 West Olympic Boulevard, Los Angeles 64, Calif.

Digital Indicator Has Servo Null-Balance

A new servo null-balance digital indicator, Type 6R, has been added to the line of continuous reading indicating instruments of the Cox Instruments division of the **George L. Nankervis Co.**

The type 6R digital indicator features high-accuracy multichannel readout for measurement of flow, pressure, speed or frequency with pulse producing transducers.

This instrument qualifies for precision laboratory, production and process applications with an accuracy of plus or minus 0.25%. Linearity is plus or minus 0.25% at any point over a 10 to 1 range. With four digit readout, the Type 6R has a resolution of up to one part in 9000.

Ten scale ranges, with various cross range speeds, are available. This instrument presents an analog numerical readout which continuously follows both increasing and decreasing transducer output. An analog output voltage is also provided for use with oscillographs and recorders for measuring transients and high-speed fluctuations.

The unit contains a completely electronic frequency converter, which supplies the servo null-balance system with a dc voltage proportional to the transducer output frequency. A built-in, tuning fork controlled frequency standard supplies calibration frequencies with check points at 60, 120, 600, and 1200 cps.

The digital indicator can be supplied for one, two or three channel operation with manual and/or automatic channel switching. Span and zero adjustments for each channel and a specific gravity adjustment common to all channels are located on the front panel of the instrument. A variable damping control stabilizes the readout by smoothing transducer fluctuations

and transcients. A small meter on the front panel shows rapid changes in the measured variable which are not indicated by the damped digital readout.

The unit is available with scale ranges up to 9000. Transducer signals with a minimum output of 10 millivolts and a frequency range of 5 to 40,000 cycles can be read with this instrument. Type 6R has a 500 ohm input impedance and power requirements of 115 volts, 60cps and 80 watts. It is housed in a standard 19" rack mount, 7" high and 12" deep.

Cox Instruments Div., George L. Nankervis Co.
15300 Fullerton Avenue
Detroit 27, Mich.

west coast industry . . .

By FRED S. HUNTER

The time cycle in the fundamental sciences keeps moving faster. Here you have the reason for the **Boeing Airplane Co.'s** increasing interest in scientific research and its construction of a new $2.25 million building for the Boeing Scientific Research Laboratories. "If you aren't in the cycle, you don't know what's going on until it is too late," says Guilford Hollingsworth, BSRL director. "You have to be a member of the scientific research to keep pace."

Boeing is erecting the new laboratory . . .

building on a separate piece of property at Seattle. This is to avoid any possible conflict with security on the various classified projects on which Boeing engineering may be engaged. Boeing already has several foreign scientists at work in its scientific research laboratories and expects to add more. The laboratories engage solely in basic research in the physical sciences for the benefit of the company. There are no plans to do any contract research. The BSRL has 50 scientists on the staff now; they will number 100 when the new building is completed.

Fringe benefits are increasing . . .

faster in the industry than base pay. J. D. Hodgson, director of industrial relations at **Lockheed's** California division, reports that fringe-benefit costs have risen 161% on an hourly basis since 1946 against an average hourly base-rate increase of 80% during the same period.

Increase in production rate of the *Atlas* . . .

is indicated by the $85 million included in the 1960 appropriations bill as a first installment of the move to add eight new squadrons to the nine currently programmed. Each squadron is armed with 10 missiles. Employment also is going up at **Convair-Astronautics.** Net increase in the work force since Jan. 1 is 2318. The total payroll is expected to reach 14,260 by year-end.

Lockheed's California division has been . . .

working with **Hughes Aircraft** on a joint study of a space vehicle designed to carry personnel "commuting" between the earth and a space station for observation purposes or to assist in the actual construction of such a station. Hughes, it might be added, was recently reported to be seeking to acquire a gyro outfit, looking toward diversification into the stable platform field by the time its extensive aircraft weapon systems business (fire controls and guided rockets) reaches the end of the line.

Air Material Area base at San Bernardino . . .

is giving up most of its other logistic support responsibilities to concentrate on the ballistic missile group. It has relinquished control of the **Douglas** B-66 twinjet bomber, the **Ryan** Q-2 *Firebee* and the **Radioplane** *Q-4* drone to Mobile AMA, such aircraft as the **North American** B-45 jet bomber, **Douglas** C-47, C-54 and C-118 transports to Warner Robins and the **Hiller** H-23 helicopter and the **Ryan** L-17 observation plane to Middletown.

This is our last column from . . .

the Pacific Coast. We move East reluctantly. California provides a pleasant way of life. This is one of the big reasons defense companies on the West Coast are strong companies. People like to live here. Political pressures may bring about geographical replacements of contracts. If they do, the Nation's defense will be the loser.

propulsion engineering

By M/R STAFF

Dramatic changes in molecular sieves . . .
announced by the **Linde Company** give these sophisticated adsorbing powders a new and vital role in missile chemistry. Modifications developed by the Linde Division of **Union Carbide Corporation** change the molecular sieves from powders that extract undesirable impurities from chemical systems into powders that store desirable ingredients, unreacted, right in the system until reaction is deliberately promoted by heat or addition of another chemical.

'Chemical-loaded' molecular sieves . . .
as Linde calls them, may ease handling and storing of difficult fuels and ignitors. Company scientists also cautiously predict that the combustion characteristics of certain fuels may improve when they are loaded onto molecular sieves. Anti-oxidants and anti-ozonants for rubber and plastic gaskets, tubes, etc., already have been successfully loaded on molecular sieves, and many compounds that may be useful in high-temperature lubricants have been adsorbed.

Resembling white powders . . .
the sieves are synthetic metal-alumino silicate three-dimensional crystals containing water of hydration. Heat will drive out the water without collapsing the crystal lattice. The particle diameter ranges from one to three microns. They are inert to most chemicals except strong acids. Linde first made molecular sieves available in 1954. The new chemical-loaded sieves were announced last year, but Linde has just published detailed properties and suggested uses. The original sieves were removal agents used primarily for drying gases—including hydrogen and hydrocarbons—drying liquids including alcohols, other hydrocarbons and fluorocarbons, and for separating gases.

Sieves work this way:
Each particle of sieve powder is a crystal containing billions of cavities connected by channels of constant diameter. The uniform channel size and strong surface force isolate compounds contained in the crystal "cages." Compounds remain confined until released by heat or displaced by another adsorbable material. This is what led to their new use as carriers for chemicals. The sieve can "carry" a chemical into a mixture and keep it there, unreacted but ready for action. When it is time for the chemical to play its part, it is released by heat or displacement with water or another chemical.

Four major uses are:
(1) Isolate adsorbed chemicals within a solid, liquid, or gaseous system until release from the molecular sieve is desired.
(2) Establish an atmosphere in a confined space by slow displacement of the adsorbed chemical over an extended time.
(3) Reduce odor, noxious or dangerous properties, or volatility of many chemicals.
(4) Store chemicals for prolonged periods.

Some types of chemicals . . .
which have been successfully loaded on sieves include alcohols, peroxides, hydrocarbons, halogens, acid gases, organo-metallics, amines, ethers, aldehydes, ketones, esters, anhydrides, organic acids, and water.

Other types of chemicals . . .
cannot be loaded on molecular sieves: Compounds whose molecules have a critical diameter larger than 10 angstroms (e.g., cross-linked polymers, proteins, certain polycyclics); thermally unstable, low volatility compounds insoluble in nonpolar solvents; inorganic salts; metals.

Recovery Failure Mars *Discoverer V* Success

WASHINGTON—*Discoverer V* soared into orbit Aug. 13 handling ARPA and the Air Force a new success and a mysterious failure.

The **Lockheed** satellite was launched from Vandenberg AFB Calif., by a modified **Douglas** *Thor*. The entire 1700-pound second stage—called *Agena*—went into a 450-136 mile orbit.

The *Discoverer* achieved stabilization in a desired attitude and maintained its position in orbit. This is the second time in the launching series that a *Discoverer* has achieved stabilization—a key step toward development of a reconnaissance satellite.

The *Discoverer* also ejected its biomedical capsule as scheduled over the Hawaiian Islands area on Aug. 14. But Air Force and Naval units failed to recover it.

The failure was officially said to have been caused by loss of communication with the capsule. Recovery teams received no signals.

However, the loss of the signals was understood to have been caused by a malfunction in the capsule apparently resulting in a bad re-entry.

'Munitions Lobby' Probe Nears Temporary Halt

WASHINGTON—The House Armed Services Subcommittee investigation of the so-called "munitions lobby" is moving toward a temporary halt in its public hearings.

The subcommittee probably will adjourn its public interrogation of top industry and military officials until the winter—possibly December. (M/R Aug. 17)

Subcommittee staff members will use the interim period for following up on a number of matters that have come up during the current series of hearings.

The subcommittee in recent days has spent much of its time questioning military legal officers on what kind of legislation might be written to check possible pressuring of the Pentagon by retired military officers employed by defense contractors. The legal officers testified generally that they would put their reliance on the basic character of military officers. They shied away from proposals for tough new laws.

The subcommittee also heard a number of influence charges from Columnist Drew Pearson including an allegation that Dr. Richard Porter of **General Electric Co.** got the Pentagon to switch the *Vanguard* engine contract from **Reaction Motors** to GE. Pearson said the switch enabled Russia to beat the United States in launching the first satellite.

However, Pearson conceded under questioning that he had no "proof of influence peddling."

Porter denied Pearson's charge and called for an opportunity to rebut it before the subcommittee.

Steel Shipments Drop

In the first half of 1959, reports American Iron & Steel Institute, ordnance and other military groups (excluding aircraft) took 97,534 tons of steel, compared to 128,001 tons in the first half of 1958. Aircraft took 43,540 tons, compared to 30,021 tons.

Ordnance's share of all steel shipments was 0.2%, a significant drop from its share of 0.45% in the first half of last year. Aircraft's share of the market changed little: From 0.09% last year to 0.1% this year.

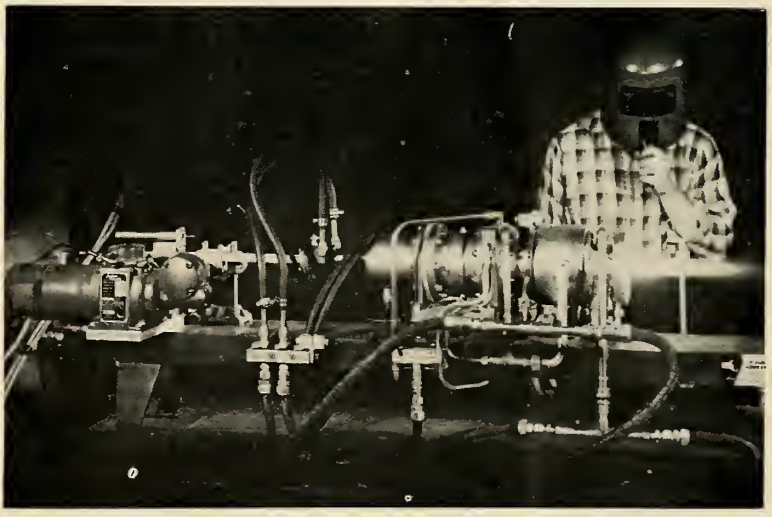
Steel setasides for defense needs are being drafted by the Pentagon. Chances are they will never be used, because stocks of special missile needs are reportedly in good enough shape for a 60-day strike, and the odds are for a settlement before then.

Beryllium extrusions by **Norair Division, Northrop Corp.,** are being developed to individual specifications, as a result of a 1958 survey of the aircraft-missile industry to learn just what engineers wanted from the glamour metal. Three of four builders of missiles and space vehicles will be using beryllium for primary flight structures within five years.

Martin's *TM-76B Mace* ground-to-ground tactical missile has been fired successfully from a simulated shelter, apparently a prototype of hardened base configuration in which the missile will be installed in Europe. The firing was from the AF Missile Development Center, Holloman AFB, N.M., to Wendover AFB, Utah.

Boeing Airplane Co. is consolidating its Systems Management Office, Seattle and Pilotless Aircraft Divisions into a single unit to be called the Aero Space Division . . . New entrant in germanium alloy junction and silicon transistor production is **U.S. Transistor Corp.,** Syosset, L.I., which also has taken over the sales organization of **Super Electronic Corp . . . Avien Inc.** is in the process of acquiring **Luther Mfg. Co.,** North Hollywood, Calif.

AVCO'S PLASMA ARC



FIRST production model of 18,000°F plasma generator turned out by Avco's Research and Advanced Development Division of Wilmington, Mass., was recently purchased by Jet Propulsion Laboratory. The arc was perfected by Avco as part of a materials testing program for re-entry vehicles for the Air Force *Titan* and *Minuteman* ICBM programs. It is the result of a two-year development program.


STEINHOFF

Appointment of **Dr. Ernst A. Steinhoff,** well-known, German - trained missile engineer, as director of its newly formed Missile Department, was announced by the Crosley Division of Avco Corp. Dr. Steinhoff was technical director for flight mechanics, ballistics, guidance and control, and electronics at the German Rocket Research Center at Peenemunde under **Dr. Wernher von Braun.**

Since coming to this country in 1945, Dr. Steinhoff has been chief scientist of the Ordnance Department for the Army at Fort Bliss, technical director at Holloman AFB and has served on the technical management council of the Air Research and Devclopment Command. He served on the Teller Committee in November of 1957 and in March of 1958 received the Exceptional Civilian Service Award of the U.S. Air Force.

Prior to his Crosley appointment, Steinhoff was deputy technical director in charge of Defense Products for the Aerophysics Development Corp., a subsidiary of Curtiss-Wright.

The board of directors of Litton Industries has elected **Charles R. Abrams, Jr., Dr. George Kozmetsky,** and **Harry J. Gray** vice presidents and **William L. Reynolds** secretary of the corporation.

Abrams, who has been treasurer of the company since August, 1955, a post he will continue to hold, joined Litton in February, 1954 as controller. Dr. Kozmetsky, assistant general manager of the Electronic Equipments Division, came to Litton in May, 1954, as director of the company's digital computer and controls development work.

Gray joined the company in November 1954 and has held various management positions in components since. Reynolds, who came to Litton as general attorney on June 1, had previously been general counsel of the Electronic Industries Association.


BAKER

Stanley E. Baker, Rocketdyne, N.A.A., is newly elected national president of the Society of Photographic Instrumentation Engineers. Baker is supervisor of the Photographic Instrumentation department for Rocketdyne and a charter member of the society which elected him to its highest office.

"Rapid diversification" of its billion-dollar-a-year business, according to Lockheed Aircraft Corp. has resulted in the formation of separate aircraft and missile-electronics combinations. each headed by a group vice president.

William R. Mogg has been appointed general manager of Crucible Steel Co.'s Spring Division succeeding **T. T. Crowley,** who has been named vice president and general manager of Crucible Steel of Canada, Ltd. Mogg joined Crucible last year as sales manager for the Spring Division after leaving Cleveland Graphite Bronze Co., where he was sales manager of Special Products.

Max F. Balcom, director-consultant of Sylvania Electric Products Inc., was recently reappointed chairman of the Electronic Industries Association Legislative Policy Committee. Members of the committee, in addition to Balcom, are: **Ben Adler,** Adler Electronics, Inc.; **E. C. Anderson,** Radio Corp. of America; **William F. Ballhaus,** Nortronics, Div. of Northrop Corp.; **Roland M. Bixler,** J-B-T Instruments, Inc.; **Sidney R. Curtis,** Stromberg-Carlson; **L. Berkley Davis,** General Electric Co.; **Philip Dechert,** Philco Corporation; **J. B. Elliott,** Tele-Dynamics Inc.; **Robert W. Galvin,** Motorola Inc.; **H. Leslie Hoffman,** Hoffman Electronics Corp.; **W. F. Joyce,** Texas Instruments Inc.; **Robert C. Sprague,** Sprague Electric Co.; **D. R. Hull** (Ex-officio), President EIA.


BROWN

Herschel J. Brown, assistant general manager since 1956, succeeds Root as vice president and general manager of the Missiles and Space Division. **W. A. Pulber,** assistant general manager, moves into Kotchian's former job as vice president and general manager of the Georgia Division.

Roy B. Williams has been named West Coast Plant Manager for American Machine Division, United States Chemical Milling Corp. as a part of an overall expansion program. The Division produces precision parts for the missiles and aircraft industry. Williams was formerly assistant to the vice president of manufacturing, American Bosch Arma Corp. American Machine Division and head of Operations Support in Arma's integration facilities on the *Atlas* missile program at Convair's Astronautics Division.

Aerojet-General Corp.'s Liquid Rocket Plant at Sacramento has named **Rudi Beichel** project engineer for the *Saturn* space vehicle's second-stage rocket engine.

He will head up the redesigning and modification work necessary for adaptation of the liquid-fueled *Titan* first-stage engines to second-stage use on the *Saturn.* Primary purpose of *Saturn* is to place large weights into orbit.

Beichel has been head of the Special Projects Department, Liquid Rocket Plant and formerly worked with von Braun at the German Rocket Research Center in Peenemunde. Von Braun heads the overall *Saturn* program.


FLYNT

Jerome D. Flynt has been named executive assistant to **Elmer P. Warnken,** president of CTL Inc. Flynt, who has been head of CTL's Technical Services Department, will continue this responsibility until a successor is named. He started at CTL in 1949 while a university student.

L. Eugene Root, vice president and general manager of the Missiles and Space Division since 1956, will become group vice president-missiles and electronics, covering the Missile Division and Lockheed's new Electronics and Avionics Division in Newport Beach and Los Angeles.

A. Carl Kotchian, vice president and general manager of the Georgia Division in Marietta, will be group vice president-aircraft responsible for Georgia, California Division, Burbank; Lockheed Aircraft Service, Ontario, Calif.; Lockheed Aircraft International, Los Angeles; and Lockheed Air Terminal, Burbank.

Neil M. Blair has been elected vice president and assistant to the president of Intelex Systems, Inc., subsidiary of International Telephone and Telegraph Corp. Blair, who will supervise the accelerating expansion of the firm into the commercial and industrial automation and control fields, was formerly vice president of Panellit, Inc., and vice president and general manager of Panellit Service Corp.

Maj. Gen. Thomas C. Musgrave, Jr. takes on the job of handling Air Force legislative liaison on Sept. 10, succeeding **Maj. Gen. William P. Fisher,** who will get a new assignment. Musgrave is now chief of manpower requirements and liaison in the office of the assistant secretary of Defense for manpower, personnel and reserve.

James G. Miles has been elected to vice president for Marketing. Since joining the company in 1957 he has been director of Service Engineering. Miles previously was with Remington Rand Univac as director of Special Sales, Bendix Aviation Corp. and Sylvania Electric Products, Inc. in engineering operations.

missiles and rockets

2nd ANNUAL MISSILE SUPPORT ISSUE

SEPTEMBER 21, 1959

From the magazine which is first and best in Missile Support—the most accurate picture available of the tremendous Missile Support field, which takes a big slice of every missile dollar. Penetrating articles and reports by recognized experts and experienced M/R staff members help you reach the heart of this multi-billion dollar market . . . through the pages of the technical/news weekly of the missile/space industry. Contact your *missiles and rockets* representative today, and find out how you can put your sales message before the men who make the important decisions concerning Support System equipment and capability.

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NRL Reports Gains in Thermonuclear Control

by Jay Holmes

WASHINGTON—Controlled thermonuclear power—an ultimate source of propulsion for big interplanetary space ships—moved a giant step closer to reality last week.

Dr. Alan C. Kolb of the Naval Research Laboratory reported achievement of deuterium pressures consistent with temperatures on the order of 20,000,000°K for periods of 5 to 12 micro-seconds. These results, with high gas densities—upwards of 10^{16} particles/$_{cc}$ are about 10 times as long a duration as ever previously attained.

Kolb made his report at the Fourth International Conference on Ionization Phenomena in Gases, at Uppsal, Sweden. NRL officials here estimated that—as a result of the stepped-up progress—usable thermonuclear power might be produced within 20 years. Dr. C. V. Strain, superintendent of the Laboratory's radiation division, was even more optimistic. He remarked that research in this field is progressing at an ever-increasing rate.

"There is good prospect that on a laboratory scale a controlled thermonuclear reaction has already been achieved," an NRL statement declared. "The results satisfy all the experimental tests which have been applied. However, further tests will be necessary to establish beyond all doubt that a thermonuclear reaction has, indeed, been observed."

Kolb used relatively simple equipment. His experiments cost about $2 million, shared equally by the NRL and the Atomic Energy Commission, over about three years. His device consisted of a cylindrical magnet 12″ long, with a 6″ outside diameter and a 1½″ inside diameter. The deuterium gas is in a tube inside the center of the magnet.

The openings at either end of the magnet are less than ¼″ in diameter, creating a magnet mirror effect, with a field of 125,000 gauss compressed shock preheated gas. A 20-KV, 4-million-ampere pulse in the tube lasts from 5 to 12 microseconds. The current is supplied from a 285,000-joule condensor bank.

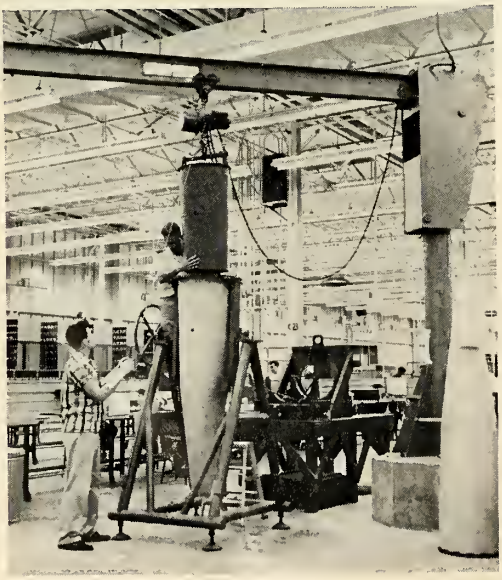
NRL's Dr. W. R. Faust said the next experiment should confirm the thermonuclear reaction. This would involve scaling up the present apparatus. The condensor bank would go to 20 million joules. The coil would be 15 cm in diameter and three meters long. He estimated that this would produce temperatures in the neighborhood of 50,000,000°K—possibly enough for a self-sustaining deuterium-deuterium reaction. It would cost another $2 million and take about a year to set up and perform.

The prime interest in controlled thermonuclear power is, of course, its potential for ground-based power, consuming the deuterium of the sea in tiny quantities. But the great efficiency of thermonuclear power also gives it great promise for space propulsion. Specific impulse would be measured not in hundreds but thousands and perhaps millions of seconds.

Many machines have been built in several parts of the world in efforts to tame the thermonuclear reaction—the nuclear fusion process in the Hydrogen bomb. (For a report on Soviet work in this field, see page 13.)

The difficulty in every case has been the instability of the high-current, high-voltage discharge used to generate the multimillion-degree temperatures needed to ignite the hydrogen fire. Kolb's results indicate this difficulty has been overcome.

ASSEMBLING LACROSSE



A CANISTER is installed in the nose section of a *Lacrosse* missile, in production at Martin-Orlando. *Lacrosse* equipment was delivered recently to Army at Ft. Sill, Okla.

Further *Explorer VI* Data Is Disclosed

SAN FRANCISCO—New details on *Explorer VI* were revealed at the WESCON meeting here by Dr. George E. Mueller of **Space Technology Laboratories.**

The satellite has counted one dust particle for every one hundred million cubic feet of space. This is equal to the space occupied by the Empire State building. Dust distribution is apparently uniform to an altitude of 22,000 miles.

The satellite has not found particles of sufficient size or momentum to harm space equipment. There is a larger concentration, however, of low-energy particles—mostly electrons—than had been anticipated.

These particles are on the order of 200,000 electron volts and up, and cover the entire Van Allen belt area. Two hundred thousand electron volts is the lowest energy being measured by the satellite.

There is no data to discourage man in space and Dr. Mueller estimated that a vehicle with reasonable shielding could get safely through the belt while traveling at escape velocity.

Explorer VI has a perigee of 134 nautical miles and an apogee of 22,900 miles. Scientists hope to get a crude facsimile picture of the earth at 10-20,000 miles altitude.

Monitoring instruments indicate that the solar cells are not putting out their anticipated power, Dr. Mueller said. The cells are covered by a glass protection with the exception of one uncovered test cell.

Dr. Mueller said the Van Allen radiation belt appears to be a fine, layered structure instead of one uniform area. The radiation level at 22,000 miles is low and probably would not endanger a manned space station at that altitude.

contracts

NAVY

$9,373,728—**Texas Instruments, Inc.**, for an advancement airborne surface search radar system.

$5,900,000—**Hoffman Laboratories, Div. of Hoffman Electronics Corp.**, Los Angeles, for production of a passive countermeasures system for underwater and surface craft.

$1,389,345—**Paul Smith Construction Co.**, Orlando, for construction of *Nike-Zeus* facilities.

AIR FORCE

$1,500,000—**Consolidated Systems Corp.**, subsidiary of Consolidated Electrodynamics Corp., Monrovia, Calif., for production of ground support equipment for the *Atlas* missile program. (Subcontract from Convair Div. of General Dynamics Corp.)

$1,000,000—**Perkin-Elmer Corp.**, Norwalk, Conn., for alignment theodolites to be used in conjunction with the *Atlas* ICBM. (Subcontract from Arma Div. of American Bosch Arma Corp.)

$780,000—**McDonnell Aircraft Corp.**, St. Louis, for production of *GAM-72* missile and launch gear.

$118,000—**Aeronautical & Instrument Div., Robertshaw-Fulton Controls Co.**, Anaheim, Calif., for special cable assemblies for checkout and launching of the *Atlas* missile.

$90,000—**Raytheon Inc.**, Waltham, Mass., for the study of methods for converting microwave energy into heat.

$73,041—**Graflex, Inc.**, Rochester, N.Y., for camera sets and ground support equipment.

ARMY

$5,317,195—**George A. Fuller Co.**, Atlanta, for construction of *Minuteman* facilities at Patrick AFB.

$4,852,228—**Rheem Manufacturing Co.**, Downey, Calif., for an AN/USD-2 surveillance system.

$4,821,715—**Western Electric Co., Inc.**, N.Y., for engineering services and technical reports in conjuction with UNICOM.

$3,909,999—**Kaiser Steel Corp.**, Los Angeles, for construction of service tower at Patrick AFB.

$3,023,204—**Chris Berg, Inc.**, Seattle, for tracking and data acquisition station.

$2,768,964—**Five Boro Construction Corp.**, N.Y., for construction of *Nike-Hercules* facilities at Robins AFB. Macon, Ga., and Turner AFB, Albany, Ga.

$1,191,070—**Otto J. Eickhof & Sons, Inc.**, Crookston, Minn., for construction of electrical distribution power plant and radar tower for Finley AFB.

$865,700—**Edward R. Marden Corp.**, Brookline, Mass., for construction of *GAM-77/72* facilities at Griffiss AFB.

$806,852—**Diversified Builders, Inc.**, Cocoa, Fla., for construction of blockhouse for space systems launch facility.

$601,407—**R. E. Daily & Co.**, Detroit, for construction of radar tower, Selfridge AFB.

$426,539—**Parsons Construction Co.**, Omaha, Neb., for construction of nose cone facilities at Offutt AFB.

$279,505—**Raytheon Co.**, Newton, Mass., for electron tubes.

$104,000—**C. H. Leavell & Co.**, El Paso, Tex., for construction of *Nike-Zeus* facilities, Walker AFB.

$99,977—**American Machine & Foundry Co.**, Alexandria, Va., for research in the transmitting of beams of ions, neutral atoms and electrons over long distances through space.

$97,320—**University of Wisconsin**, for studies of the three-dimensional structure of the planetary boundary layer.

$92,600—**Sylvania Electric Products, Inc.**, Mountain View, Calif., for electron tubes.

$92,315—**American Machine & Foundry Co.**, Alexandria, Va., for technical and scientific assistance for range instrumentation facilities.

$69,695—**Sylvania Electric Products, Inc.**, Williamsport, Pa., for electron tubes.

$57,112—**Armour Research Foundation of Illinois**, for studies of micro-meteorological surveillance observing system.

BIDS

Rome Air Materiel Area, Att: ROPNA, Griffiss Air Force Base, N.Y.—Transmitter T-282 GR, 1 ea. Modulator Power Supply MD-141 ()/GR, 5 ea. required cable assemblies 5820 NSL, in acc./w Specs. MIL-T-4755A (USAF) dated 12 Mar. '59 and Amendment NR.1 thereto dated 26 June '59. Major spare components equipment and depot spares in acc./w MCP-71-673, Ground handling and special tools equipment and test equipment in acc./w MCP-71-650 and amendments thereto, 300 each. Two each first article will be tested in acc./w MIL-T-9107 and 1 each will be tested by Air Force. A 30-day continuous performance reliability test will be run. Models of similar equipment will be supplied for guidance purposes only. Closing date for receipt of bid requests is 14 Aug. '59.—IFB 30-635-60-47B—Bid opening 21 Sept. '59.

National Aeronautics and Space Administration, Lewis Research Center, 21000 Brookpark Rd., Cleveland 35, Ohio—Power supply, shall be rated at 0 40000 Volts D.C. at 0.1 amperes, continuous duty, current output continuously variable from Zero to 4000 volts in steps on exceeding one-half of one percent full voltage, 1 each. Power supply, high voltage D.C. 0-50 KV variable in steps of not more than one-half of one percent, 2 each.—IFB C-601—Bid opening 8-21-59.

Power supply, D.C., 20/40 volts, 7500/3750 amps, complete with saturable reactor, stepdown transformer—rectifier and balance coil assembly, temperature controller, input-output voltmeters and ammeters—1 each—IFB C-491—Bid opening 8-21-59.

Services, labor and materials for installation and connection of electrical equipment for NASA reactor facility in accordance with our specifications—Job—IFB C-534 PB—Bid opening 8-25-59.

U.S. Army Engineer District, Jacksonville, 575 Riverside Ave, Jacksonville, Fla.—Construction of space systems launch complex 36, AFMTC, Patrick AFB, Fla.—Job—IFB ENG-08-123-60-9 B—Bid opening 9 Sept. '59.

review

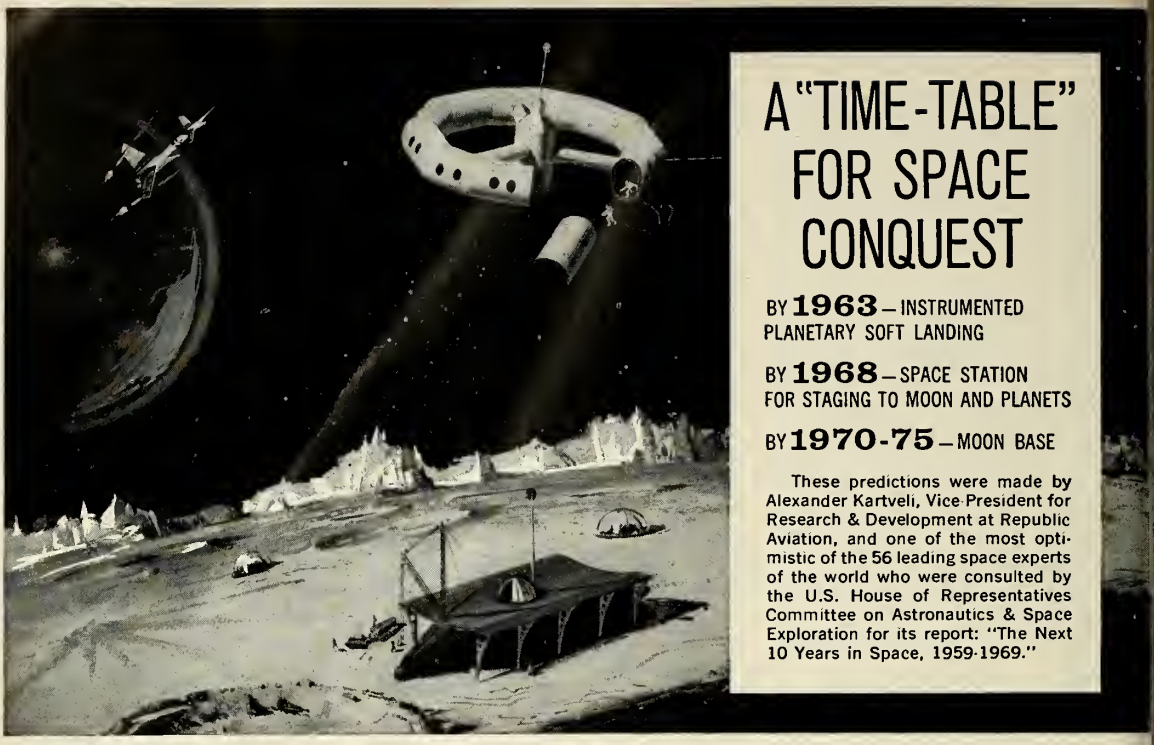
AIR RESEARCH AND DEVELOPMENT COMMAND TECHNICAL SYMPOSIUM, JULY, 1958, WADC, U.S. Air Force, Dec. 1958, Order No. PB151627 from OTS, U.S. Dept. of Commerce, Washington 25, D.C., 502 pps. $7.

This report contains technical papers and discussions of an ARDC symposium on materials for space vehicles and propulsion systems, held last July in Dallas.

Material covered includes papers on such structural materials as aluminum, magnesium, beryllium, steels, super alloys, adhesives, graphites, plastics, and surface treatments.

Special purpose materials such as elastomers, lubricants, glasses, shielding, and textiles are also in the report.

Material on electronic materials include papers on synthesis and application, energy transforming materials, insulation and dielectric materials, magnetic materials, and transistors.



A "TIME-TABLE" FOR SPACE CONQUEST

BY **1963** – INSTRUMENTED PLANETARY SOFT LANDING

BY **1968** – SPACE STATION FOR STAGING TO MOON AND PLANETS

BY **1970-75** – MOON BASE

These predictions were made by Alexander Kartveli, Vice-President for Research & Development at Republic Aviation, and one of the most optimistic of the 56 leading space experts of the world who were consulted by the U.S. House of Representatives Committee on Astronautics & Space Exploration for its report: "The Next 10 Years in Space, 1959-1969."

JOIN REPUBLIC IN AN **INTEGRATED ATTACK** ON PROBLEM AREAS OF **SPACE EXPLORATION**

It's the fervent conviction of engineers and scientists at Republic Aviation that the courageous "Space Time-Table" above is entirely feasible – given a tradition-free, integrated approach to the problems. Such an approach is evident at Republic Aviation. Here, groups of specialists from many disciplines are working in close collaboration to solve problems across the entire spectrum of space technologies, which limit today's interplanetary and upper atmosphere flight capabilities.

Expanded by $35,000,000 last year, Republic's integrated Research and Development program has already produced signal advances in space guidance concepts; in new propulsion systems (plasma, nuclear); in radiation physics; in new materials and processing techniques; in unique hypersonic configurations; and in prototype development of hardware (as an example: hydraulic systems that operate reliably up to 1000°F).

Professional men—who can meet new challenges with enthusiasm and dedication – are urged to look into openings with our R&D groups, working in an atmosphere of exhilarating intellectual adventure.

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Radome & Antenna Design
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Receiver & Transmitter Design
Airborne Navigational Systems
Jamming & Anti-Jamming
Miniaturization — Transistorization
Ranging Systems
Propagation Studies
Ground Support Equipment

Thermo. Aerodynamics
Theoretical Gasdynamics
Hyper-Velocity Studies
Astronautics Precision Trajectories
Airplane/Missile Performance
Air Load and Aeroelasticity
Stability and Controls
Flutter & Vibration
Vehicle Dynamics & System Designs
High Altitude Atmosphere Physics
Re-entry Heat Transfer
Hydromagnetics
Ground Support Equipment

Plasma Propulsion
Plasma Physics
Gaseous Electronics
Hypersonics and Shock Phenomena
Hydromagnetics
Physical Chemistry
Combustion and Detonation
Instrumentation
High Power Pulse Electronics

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Nuclear Power & Propulsion Applications
Nuclear Radiation Laboratories

Send resume in complete confidence to: Mr. George R. Hickman, Engineering Employment Manager, Dept. 4H-5

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reviews

ADVANCES IN ASTRONAUTICAL SCIENCES, VOLUME 4. Proceedings of the 5th annual meeting of the American Astronautical Society, distributed by Plenum Press Inc., N.Y. 460 pps. $8.

This American Astronautical Society publication is a record of special lectures and technical papers presented at the AAS meetings held last December in Washington.

The volume includes material grouped under the headings of upper atmosphere research and re-entry mechanics, space vehicle design, guidance and instrumentation, satellite mechanics and space exploration, rockets and satellites, and man's environment in space.

ELECTRONIC DESIGNERS SHOCK AND VIBRATION GUIDE FOR AIRBORNE APPLICATION, published by WADC. Available to Dept. of Defense contractors. Order through Armed Services Technical Information Agency, Number AD-204095. 250 pps.

Written by technicians and scientists from the WADC Electronic Components Laboratory working with RCA electronic engineers, this electronic designers reference manual is devoted exclusively to shock and vibration environments.

The manual includes theory philosophy, vibration studies, electronic component parts and their characteristics, rack and chassis design, damping equipment for simulating and measuring shock and vibration, laboratory test procedures, vibration and shock protective devices; and equipment mounting and installation techniques.

DESCRIPTION OF AFMDC PROTOTYPE CAMERA STATION FOR SATELLITE SURVEILLANCE; Walter E. Woehl and Richard M. Waetjen. Order No. 140 199 from Library of Congress, Photo duplication Service, Publications Board Project, Washington 25, D.C. 47p. Microfilm, $3.30, photocopy, $7.80.

The basic requirements and a description of the philosophy adopted in the determination of accurate orbital data of satellites with the help of ballistic cameras are given.

Coded automatic-shutter operation and correlation to true standard time are described, and the photometric performance of the cameras using different optics is computed.

Data processing and evaluation, and improvements in the basic system are outlined. Sample photos of recordings are included along with a summary of those satellite position determinations which were performed.

when and where

AUGUST

AFOSR/Propulsion Research Division, Directorate of Aeronautical Sciences Office of Naval Research, Office of Ordnance Research and National Aeronautics and Space Administration, Symposium on "The Dynamics of Ionized Cases," Northwestern University, Evanston, Ill., Aug. 24-25.

American Rocket Society, Gas Dynamics Symposium, Northwestern University, Evanston, Ill., Aug. 24-26.

Institute of the Aeronautical Sciences' National Specialists Meeting, A Symposium on Anti-Submarine Warfare, (classified), San Diego, Aug. 24-26.

USAF's Ballistic Missile Division; Space Technology Laboratories, Inc., Fourth Symposium on Ballistic Missile and Space Technology, Los Angeles, Aug. 24-27.

International Commonwealth Spaceflight Symposium, Church House, Westminster, London, Aug. 27-29.

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

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

CLASSIFIED

Advertiser's Index

Integrity Cannot Be Legislated

For days now we have watched a succession of witnesses appear before the Subcommittee for Special Investigations of the House Armed Services Committee to testify on the influence of retired military officers in the matters of defense contracts. Some have been from the Pentagon, but most have been from industry, either the retired officers themselves or their employers.

It would show less than a conscientious regard for us to say the testimony has not indicated that many of these retired officers have been greatly beneficial to the companies which employ them. But we believe that the great bulk of that benefit has been derived from utilizing the same qualities of leadership, wisdom and experience which made these men good generals and good admirals—and not because they could negotiate the sale of otherwise unsaleable products or programs.

We know several companies with tremendous defense contract backlogs which hire almost no generals or admirals in what could be called a "contact" capacity, and one woefully weak in government contracts which employed a half a dozen.

The services which a retired officer can contribute honestly and ethically to a company handling defense contracts are many. It costs, for example, literally hundreds of thousands of dollars and many man hours of skilled scientific labor for a major prime to make a proposal for a major weapon system.

If the retired officer knows which concepts are obsolescent, which have been proven impracticable or simply lead up a blind alley, and if he can prevent his company from heading into that field in its proposal—then he not only has saved his company money but has prevented wasted effort on the part of engineers and scientists whose time and effort the country can ill afford to waste.

It is probable that some new laws will come out of the Hébert hearings to guide the relations of retired officers with both industry and the government. But we suspect they will be inconclusive of any hard result in solving the true problem involved here—the real or fancied unethical practices of the nation's big defense industries.

For this is the heart of the question, and it evolves from the President's casual reference to the existence in this country of a "munitions lobby"; it asks whether or not pressure is brought upon the military by industry to continue weapon systems after they have become obsolescent, pressure to produce competing weapons—and other practices which deviate from reasonable honesty.

The solution for that, we feel, can come from one source and one source only—the Pentagon. Firm and clear-cut decisions must be made there between weapons, weapon systems and which service is going to use them.

There used to be a day when each Service had a job to do and the authority to get it done. Budgets were presented to Congress on this basis and there was a mutual confidence and respect. Somewhere in the dawning of this confusing Space Age the simple system of deciding what is best and sticking to that decision seems to have been lost. So has the time-honored precept of coupling responsibility with authority. On top of the military services, the nation's Defense Establishment has layered board upon board, committee upon committee, agency upon agency—not to make decisions but to delay or avoid them.

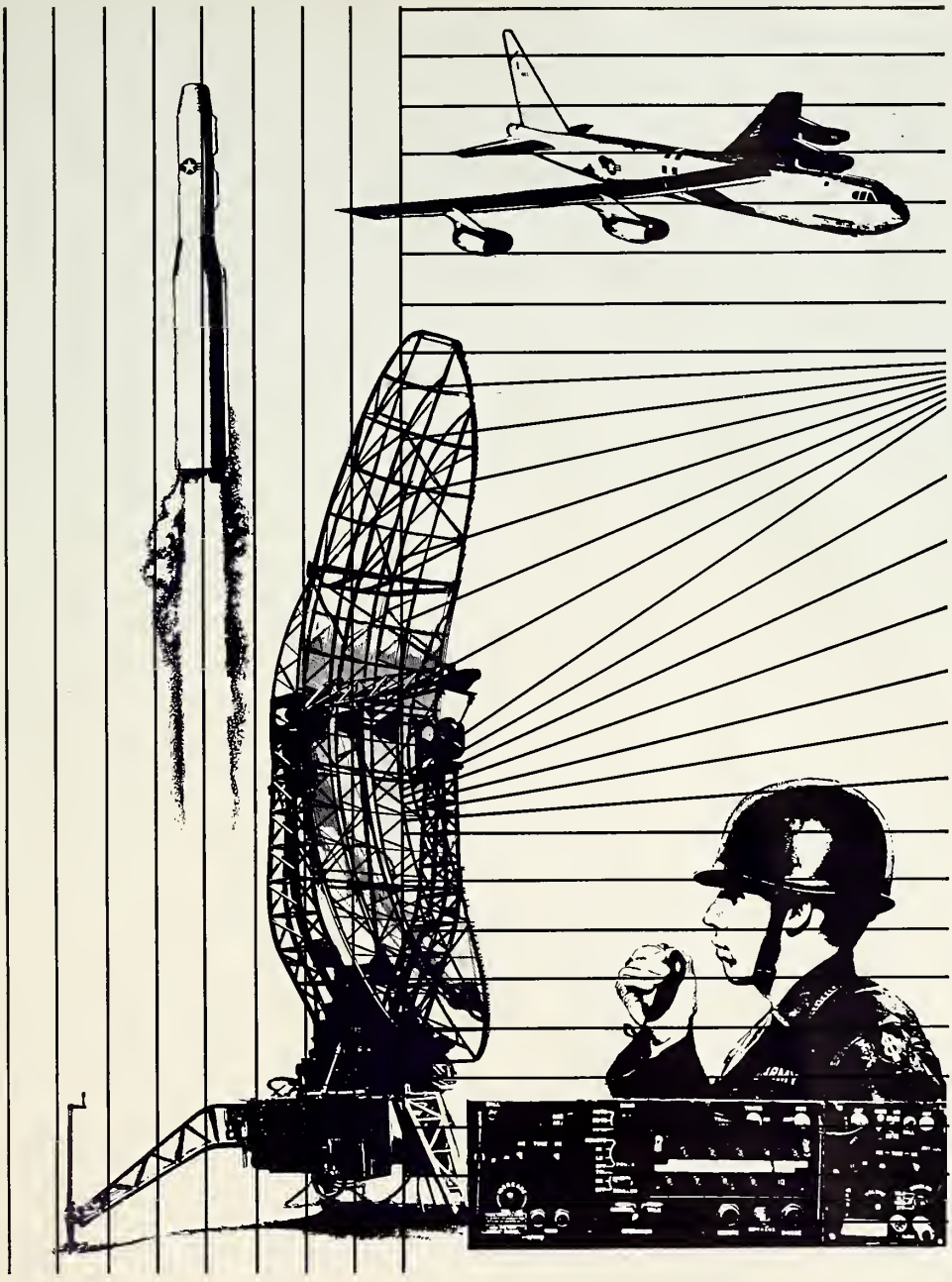
This is the area, we think, where Congressman Hébert and his committee must look for a solution. Inertia itself tempts industry to go overly far in trying to force action.

The testimony before the Hébert Committee, some of it inept and some of it strongly perceptive, has not shown any wrong-doing on the part of retired military officers working with the defense industry—and we doubt that it shall.

It would be a great tragedy if it did, for, as the Martin Company's Chairman of the Board, George M. Bunker, said in his prepared statement before the committee:

"In the final analysis, it is really a matter of integrity that we are talking about and I have every reason to believe that the integrity of retired military personnel is of the highest caliber. In any event, integrity cannot be instilled by legislation. However, I would suggest that if there are any real doubts about the integrity of our military personnel, these doubts should be exhaustively explored and at all costs eradicated, for the damage in disservice that a military officer lacking the requisite integrity could do to his country is far greater in his military capacity than it could ever be as an employee of industry."

CLARKE NEWLON



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