MARCH 23, 1959

ROCKETDYNE'S HOFFMAN

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION

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missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

MARCH 23 HEADLINES

ASTRONAUTICS ENGINEERING

MISSILE ELECTRONICS

DEPARTMENTS

COVER: The power behind Rocketdyne's phenomenal growth is Sam Hoffman (p. 26).

NEW fabrication techniques for tungsten use in missiles have been developed (p. 22).

VARIAN Associates has developed this 12-foot, 900-pound klystron tube for missile tracking.

FIRST *Talos* to be fired at sea leaves the deck of the guided missile cruiser USS Galveston.

PLASMA jet test facility is in prototype operation at ARGMA, giving new capabilities for AOMC (p. 39).

DOW | MAGNESIUM

a comparison:

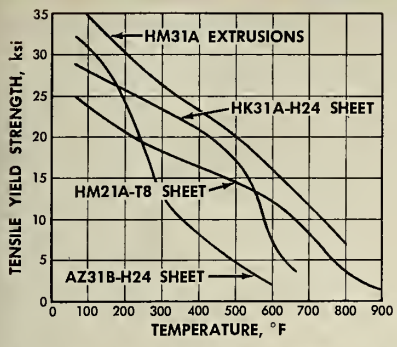
4 MAGNESIUM ALLOYS for elevated temperature service

A wide variety of elevated temperature alloys extends the use of lightweight magnesium into the critical 300°-800°F. temperature range.

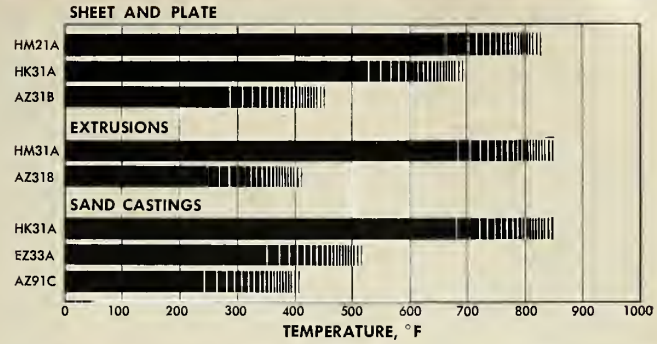
Name your weapon—Jupiter C, Polaris, Talos, Discoverer, Falcon or Bomarc. All make extensive use of elevated temperature magnesium alloys. Improved resistance to creep, increased stiffness and strength and exceptional shop characteristics are the long suit of these materials. At elevated temperatures they maintain a high ratio of fatigue strength to static strength. (About the same ratio as standard magnesium alloys at room temperature.)

SHEET AND PLATE

Alloys HK31A and HM21A have been widely used for many different parts in missiles, rockets and aircraft. Some of the most common applications include body skins, engine air inlets and ducts, nose cowlings and cones, external and internal skins on control surfaces. HK31A extends the usefulness of light-



New alloys have extended magnesium's useful service temperature range.



A comparison of short-time tensile yield strength exhibited by a standard magnesium alloy and the commonly used elevated temperature alloys.

weight magnesium to a temperature of 500°F. and above. HM21A withstands temperatures up to 700°F. and higher for short time periods. And it exhibits better creep resistance above 350°F. and better static properties above 550°F., than does HK31A.

FORGINGS

At operating temperatures up to 800°F., HM21A offers excellent mechanical properties, optimum creep resistance. HK31A has better room and elevated temperature properties up to 400°F. Both have good forgeability.

CASTINGS

Engine air inlets and ducts and housings for electronic guidance systems are examples of the many applications of cast magnesium alloys HK31A and EZ33A. EZ33A has good general properties in the 350°-500°F. range. HK31A is recommended up to 700°F. and above. Components of military systems weighing as much as 105 lbs. have been cast in one piece with HK31A. A new elevated temperature alloy for die casting is now in development and will soon be available.

EXTRUSIONS

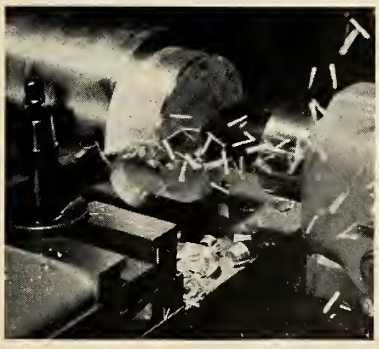
Alloy HM31A has put the many benefits of elevated temperature magnesium into extrusion form. This alloy is used as ribs and horizontals in missile bodies, instrumentation booms and external tunnel fairings for wiring and plumbing, etc. HM31A maintains high elastic modulus, excellent creep resistance and strength at elevated temperatures. Elevated temperature exposure at 600°F. for 1,000 hours causes no change in room temperature properties and only a slight drop in creep strength.

ELEVATED TEMPERATURE MAGNESIUM EXCELS IN PRODUCTION

The elevated temperature alloys possess the best welding characteristics of all magnesium alloys. Arc welded joints can be easily made and welding compatibility of magnesium alloys is excellent. For example, HK31A sheet can be welded to HM31A extrusions.

Weld efficiencies at room temperature range from 70% to 80%. At temperatures above 400°F., HK31A has a weld efficiency of 100%. The same goes for HM21A above 500°F. In general, preheating and stress relieving are unnecessary with these alloys. They can be readily spot welded and are not subject to cracking.

Machining operations can be carried out at extremely high speeds, with heavier depths of cut and higher rates of feed than are possible with other metals. All chemical treatments used to finish standard magnesium alloys are applicable to the elevated temperature alloys, with the exception of Dow 7, which does not coat satisfactorily on magnesium-thorium alloys. For extended service above 400°F., the anodic treatments are preferred.



Elevated temperature alloys possess the same excellent shop characteristics—such as machining, forming and welding—as the standard magnesium alloys.

MAGNESIUM ALLOYS FOR ELEVATED TEMPERATURE APPLICATIONS

SHEET	HK31A HM21A
PLATE	HK31A HM21A
FORGINGS	HK31A HM21A
CASTINGS	HK31A EZ33A
EXTRUSIONS	HM31A

WRITE TODAY for this new 27-page illustrated brochure on magnesium alloys in aircraft and missiles.
THE DOW CHEMICAL COMPANY, Midland, Michigan, Magnesium Sales Dept., 1301CL3-23.

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Circle No. 2 on Subscriber Service Card.

Stratoflex assemblies help fuel THE MIGHTY ATLAS

Every time a Convair Atlas intercontinental ballistic missile lifts from its Cape Canaveral launching pad, fantastic demands are made of the fueling system and powerplant.

A touch of the blast-off button triggers hundreds of simultaneous chain reactions in the giant ICBM's fuel system. Under tremendous pressure, liquid oxygen is delicately and precisely force-mixed with a kerosene-like fuel and flashes through the lines as vapor to feed the fires burning in the combustion chamber. This blend, mix, fire sequence must commence in a split second and continue at tremendous speed if the launch is to be successful. Fuel line plumbing on the Atlas must be absolutely leakproof, immune to strong vibrations, and able to withstand continuous temperature variations.

Despite the infinite possibilities for human mistake and material malfunction, the Air Force, aided by Convair technicians, has successfully launched the Atlas ICBM time after time at Cape Canaveral. (In the spectacular December 18, 1958 firing, the 85-foot Atlas was placed in orbit around the earth.) Stratoflex is proud that its specially-designed Teflon* hose and metal tubing assemblies are vital parts of the Atlas fuel line system.

* A DuPont trademark

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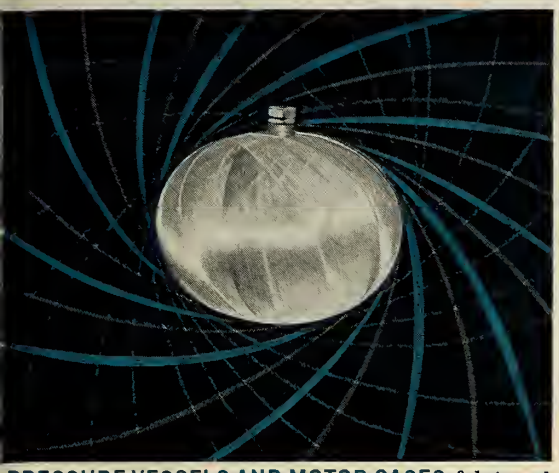
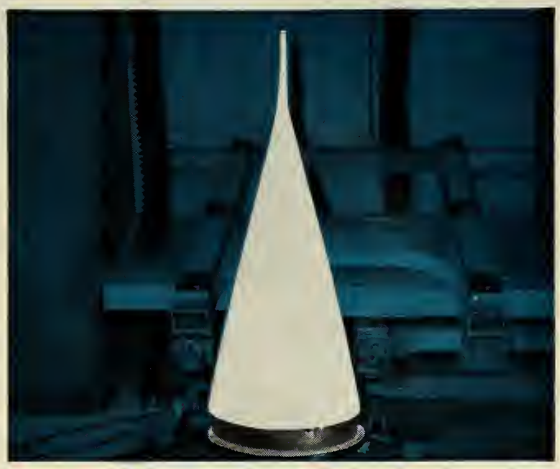
SF1-9

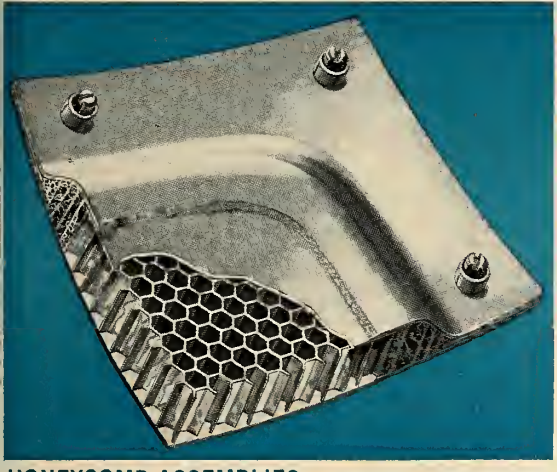
Brunswick technology leads the way in three critical space-age components



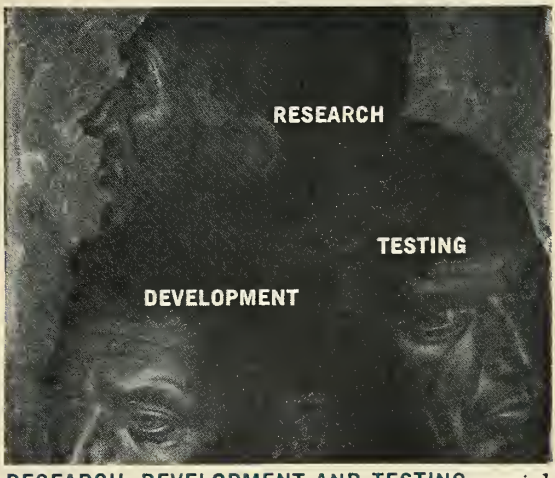
PRESSURE VESSELS AND MOTOR CASES, fabricated by Brunswick's exclusive Strickland "B" Process, now have the highest strength-to-weight ratio ever obtained in filament-wound components. Brunswick is *now* producing these virtually leak-proof pressure vessels. Brunswick also fabricates motor cases capable of withstanding extremely high pressures and temperatures.



RADOMES AND NOSE CONES, created by Brunswick's outstanding research and development efforts and filament winding process, are being used on supersonic aircraft such as the advanced Convair F-106 and McDonnell F4H, as well as on missiles such as the Boeing Bomarc, Lockheed Q5 and similar missiles. And, of course, Brunswick capabilities include complete electronic design and test facilities.



HONEYCOMB ASSEMBLIES, now developed by Brunswick can support two million times their own weight. Brunswick research has created honeycomb assemblies of paper, fiber glass, aluminum and stainless steel as well as conventional forms. Using the most advanced adhesive systems, these assemblies can be formed in compound curvatures with extremely close tolerances.



RESEARCH, DEVELOPMENT AND TESTING—carried on by Brunswick teams have contributed heavily to space-age technology . . . most notably in solving problems of increasingly high operating temperatures (600°—4,000°F.) for critical components and new heights in strength-to-weight ratios. For full information on how this leadership can help you, write or call Brunswick today!

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DEFENSE PRODUCTS DIVISION • 1700 MESSLER STREET • MUSKEGON, MICHIGAN

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Six Lines for the *V-2*

Dr. Walter Dornberger, dean of the famous German "paperclip" scientists who have contributed so much to this country's missile and satellite programs, tells this story (paraphrased) of building the *V-2*, the world's first operational ballistic missile:

"The specifications consisted of six lines. Those lines directed me to build a missile which would do so-and-so. They didn't tell me how to build—just what to build."

In last week's issue of M/R, Managing Editor Don Perry reported that there is grave danger that our military "spec" writers may be endangering the nation's defense system by over-particularizing their orders to industry, particularly in the field of transistors. The report Perry wrote was discussed with M/R's electronics staff and checked in detail with the magazine's editorial board.

It said that in some cases the military contract writers were pushing the state of the art too far by demanding—in weapon systems—complete transistorization of electronic equipment before these relatively new items of electronic hardware have been proven; that the non-solid state devices—transducers and diodes—still require more research in one most important field before they can be cleared for complete operational work. That field is the determination of nuclear radiation effects upon them.

In other words, can our missiles and satellites as they are presently equipped pass through primary and secondary radiation and perform effectively?

The truth is that we do not know. We are not completely sure of it whether they are equipped with transistors or with vacuum tubes, which have been around a great deal longer. In some areas the transistor has been pretty thoroughly tested; in other fields the vacuum tube has been. But there are other fields in which neither is certain.

We have no quarrel with either transistors or tubes. Both are products of the large missile electronics fields which this magazine serves. But we do feel we are doing the nation a service by pointing out industry's viewpoint that neither the transistor nor the vacuum tube is the answer to all evils nor the perfect tool for every job.

Nor do we feel that it is the job, normally, for the gentlemen sitting in the Pentagon, who frequently are a little further away from realism than industry's workmen, to specify in arbitrary detail the minute hardware components comprising space systems. We feel sure there are times when a combination of transistors and tubes, say, might produce a better instrument and that no one is better qualified to say this than the man responsible for building that instrument.

There are evidences that the military's insistence on use of the newer and perhaps more glamorous transistor, with its undeniable advantages of smaller size and less weight, has delayed certain of our military programs. There is evidence in others that revised specifications now call for using whichever device can do the job better, the transistor or the tube.

Again, it is not our purpose to decry either of the two systems, to say that either is better. But we do think it is our job to point out the situation and to point out further that in these days of racing against time for both space supremacy and defense capability, this is no time to be playing tic-tac-toe with destiny.

Every missile and space project this country has achieved has been the product of U.S. industry. No military service really builds an engine or a nose cone or a guidance system. The service job is to foresee the need, come up with the requirement, levy on industry and supervise. In some cases the Army has assembled. But largely it has and always will be industry which produces the detailed hardware.

In doing this industry must have latitude to use the device which will best perform the mission, not suffer under specifications which are both arbitrary and so finely detailed that they can and probably do affect the final performance of the product. The specifications given Dr. Dornberger may have been a little too general. (In those days there wasn't any state of the art; there wasn't any art.) But somewhere between his six lines and the detail of today must lie a reasonable and happy medium.

Clarke Newlon

New recording versatility with 3 interchangeable magazines

With a new high-actinic light source and Slot-Exit Magazine, the 5-119 now becomes one of the most truly universal tools of data processing available. Addition of the direct-print process and new magazine to the 5-119 now brings you three uniquely different recording processes, enabling engineers to select the process best suited to specific test requirements.

PROCESS 1 DIRECT-PRINT... Clearly resolves writing speeds to 100,000 ips. High-actinic light source 5-119 P4-36V (or -50V) and new 5-051 Slot-Exit Magazine produce records on standard direct-print papers without chemical processing of any kind. Records emerge from the magazine slot continuously, and latensification takes place in ordinary room fluorescent light.

PROCESS 2 RAPID-ACCESS... Provides the shortest access time of any known process, and yields records of higher trace contrast and greater permanency than afforded by direct-print materials. Process employs the 5-036B DATARITE Magazine which automatically develops and dries oscillogram as quickly as data are recorded. Provides ready-to-read test results almost simultaneously with the occurrence of events under study.

PROCESS 3 CONVENTIONAL... Used where the finest available recording trace and contrast with highest writing speed are paramount requirements. Records are contained by the 5-006A Standard Magazine which uses conventional 12-inch films or papers. Records are processed following the record run.

The 5-119 provides 36 or 50 independent data input channels... Wide record-speed and frequency-ranges... Flash-Timing System to synchronize timing lines of 2 to 100 remote oscillographs. For complete details call your nearest CEC sales and service office, or write for Bulletin CEC 1536-X5.

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These new accessories exemplify the advanced production models available to meet today's aircraft/missile performance demands. Undivided responsibility for component design and production enables coordination in the development of each new system or accessory. True systems engineering assures matched component performance and maximum reliability.

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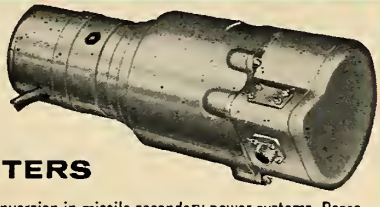
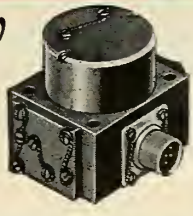
new INVERTERS



For d-c to a-c inversion in missile secondary power systems, Pesco Inverters provide maximum reliability, miniaturized package design and simplified, rugged construction. The Pesco electric motor, speed control and alternator are built integrally on the same shaft. Models are adaptable to applications within the 26 to 56 volt d-c input range. Output may be either single or three-phase, 400-cycle a-c up to 12 kva. Inverter maintains output voltage to ± 1.0% with ± 2.5% output frequency variation.

new SERVO VALVES



High-fidelity Pesco Servo Valves are electro-hydraulic transducer type, feature unique flow-sensing principle. Meet toughest missile requirements with excellent system stability, insensitivity to operating variables and dirt, minimum null shift, fast response, faithful reproduction of smaller input signals, minimum threshold and dead zone. Miniaturized and designed for consistent, high-quality mass production.

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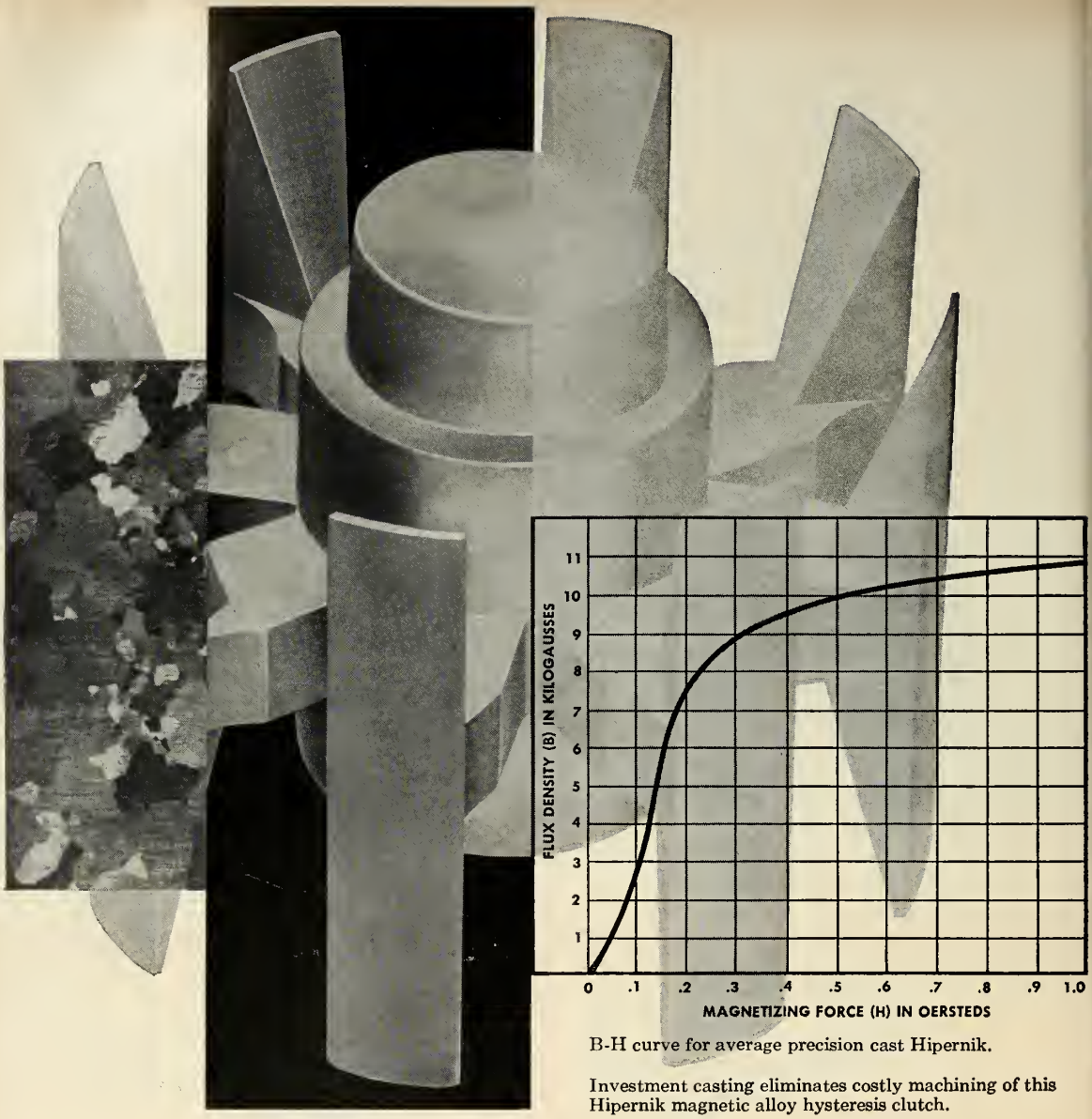

B-H curve for average precision cast Hipernik.

Investment casting eliminates costly machining of this Hipernik magnetic alloy hysteresis clutch.

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The field of electronics has created special metal problems. The Westinghouse Metals Plant has accepted and solved some of these problems.

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washington countdown

Three more ICBM bases . . .

have been announced by the Air Force. They are near Ellsworth AFB, S.D. and Mountain Home AFB, Idaho, for *Titan* and Schilling AFB near Salina, Kan. for *Atlas*. This brings to 10 the number of ICBM launch sites announced thus far.

Some 60 possible promotions . . .

retirements and reassignments of Air Force general officers are being considered by Defense Secretary McElroy, many of which must go to Congress and the White House for final approval. It may be some time before the list is finally decided upon but one promotion and reassignment may be pulled out and ahead of the rest. That would be the third star for present Maj. Gen. Bernard Schriever and his assignment to be commander of Air Research and Development. His present job is CG of the AF Ballistic Missile Division.

The mystery firing . . .

at Cape Canaveral a few days ago was another tryout of McDonald's two-stage, solid fuel air-launched ballistic missile, code named the *Draca*. McDonald is one of several companies in the ALBM competition.

Mail by missile . . .

is under consideration by the Post Office Department as an experiment sometime this year. A PO spokesman said in answer to questions that the project still is in the "think stage" but that the department is "most anxious to keep abreast of the times" in mail delivery. He said the test vehicles probably would be obsolete *Snark* or *Regulus* missiles.

Reconnaissance satellite program . . .

expected to change hands. Chances are good that NASA will take control of *Discover* and the follow-on but probably not WS-117L, *Sentry*. Transfer won't be made by ARPA until next fall. Idea is that State Department would like to convince Russia that satellite is for peaceful purposes only. Meteorological satellite will be transferred by ARPA July 1. It is a 250-pound vehicle carrying an RCA television said to be so sensitive that it shows 500 lines to a millimeter.

Man of the hour . . .

In Washington last week was Dr. John P. Hagen, director of the Vanguard project. He received the Navy's Distinguished Civilian Service Award, and was guest of honor at a reception and dinner marking the first anniversary of the launching of the *Vanguard I* satellite.

Carrying a source of energy . . . space . . .

into space is a major problem, Hagen said. One solution is seen in the solar cell still supplying power for transmissions from *Vanguard I*. H. Leslie Hoffman, president of Hoffman Electronics Corp., said the cells, originally conceived by Bell Telephone Laboratories, and developed by Hoffman, had been increased in efficiency by about 400%. He predicted a broad use of the cells as a power source in space vehicles.

Compulsory competitive bidding . . .

for defense contractors got further support with the introduction of a bill by Sen. John J. Williams (R-Del.). Williams said the bill was prompted by reports from the General Accounting Office. It provides contracts must be awarded to lowest bidder except when unfeasible from a national security standpoint.

Major weapons system managers . . .

can expect summons from House Armed Services subcommittee. Chairman F. Edward Hebert (D-La.) said last week a comprehensive procurement investigation "is long overdue." He said some critics of weapons system procedure call it a "blank check." The "administered price" will come in for a lot of attention in the new investigation, he said. At least four manufacturers have been advised by the committee exactly what kind of information the subcommittee wants regarding financial arrangements, performance rates, facilities, termination costs and cost allowance. Hearings are scheduled to begin after the Easter recess ends April 6.

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Space Technology Laboratories is responsible for the over-all systems engineering, technical direction, and related research for the U.S. Air Force Ballistic Missile Programs. To carry out the fundamental investigations of those physical phenomena related to very advanced and long-range problems of space technology, STL established the Physical Research Laboratory.

This laboratory is making significant contributions in experimental and theoretical research in the fields of controlled fusion and associated plasma physics, magnetoaerodynamics and low temperature solid state physics.

Dr. Milton U. Clauser, Vice President of the Company and Director of STL's Physical Research Laboratory, draws upon a rich background of industrial, as well as academic, experience and achievement in charting the areas of research that will be important to the space technology of the future.

The professional staff of the Physical Research Laboratory, the majority of whom hold the Doctorate, are supported by unusual shop facilities and a complete staff of technicians. Also available is an outstanding digital computing center within the STL complex. Scientists and engineers with competence and imagination in fields related to advanced cryogenics, fusion physics and magnetohydrodynamic investigation, are invited to inquire about Staff positions.

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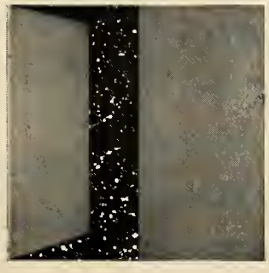

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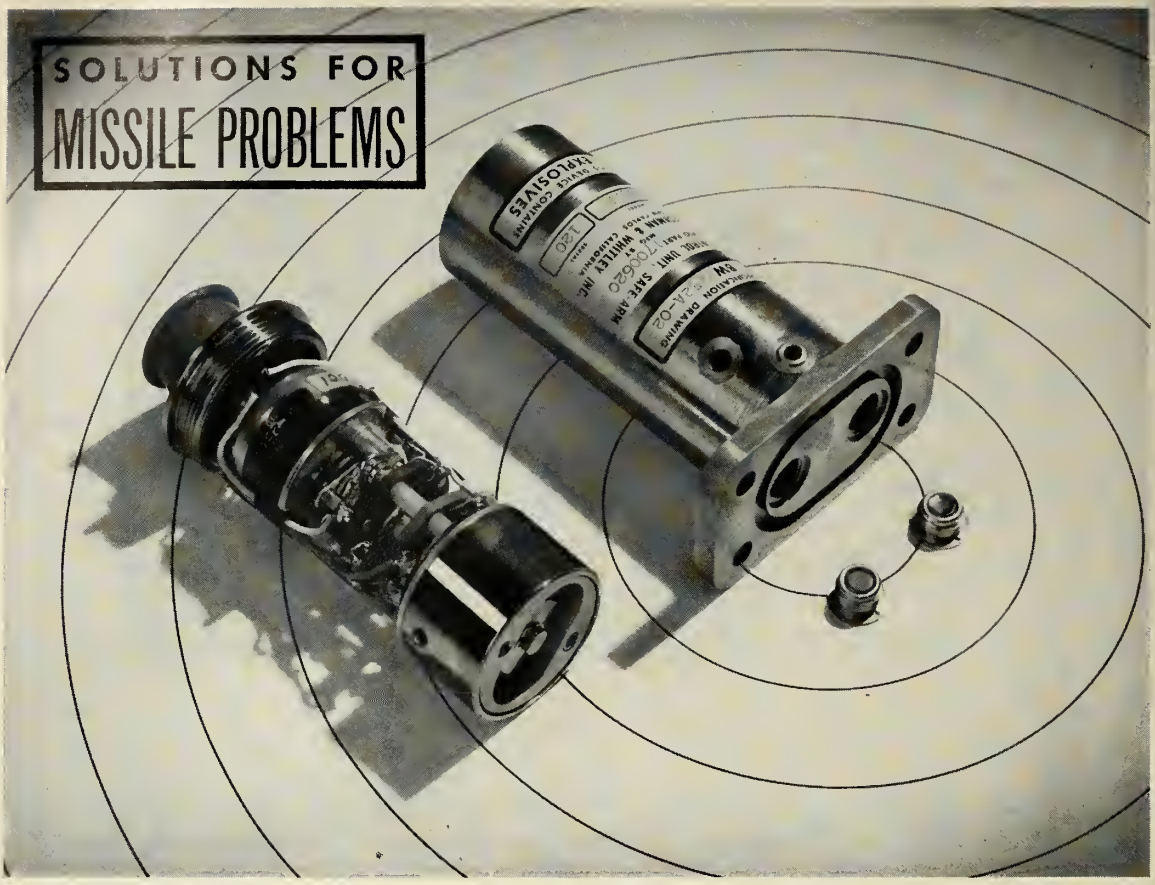

safe/arm initiators

Ten years of pioneering in the missile component field has made possible this new line of Beckman & Whitley solenoid-operated safe/arm explosive initiators. Unit on the left has cover removed to show internal arrangement.

Weighing only 1.85 lb loaded, this model is 5 in. by 3 in. by 1¾ in. It was designed to military requirements. It can be armed or disarmed by remote electrical signal and includes both visual and electrical telemetering facilities for indication of armed or disarmed condition. On reception of a command firing signal, the unit will initiate associated primacord, low-energy detonating cord, (LEDC) or bulk charges.

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industry countdown

NASA will control . . .

design and development of all space-missile propulsion projects after June 30. On that date, the space agency will take over control of *Centaur*, second-stage liquid nitrogen-propelled rocket being worked on by Convair and Pratt & Whitney.

Centaur's second-stage . . .

incidentally, consists of two 15,000-pound-thrust rocket engines using liquid hydrogen. It may also have a third stage same as *Vega* with 600-pound thrust under development at JPL. The combination reportedly is 50% more powerful than *Vega*.

Work with new HILAC . . .

atom-smasher at University of California's Lawrence Radiation Laboratory points toward revising the belief that cosmic radiation will damage humans in proportion to the weight of each type of atomic nuclei. An AEC-sponsored program indicates that damage increases with nucleus weight only up to a certain point, then levels off.

Fluorine-based liquid fuels . . .

will out-perform proposed boron-based solids in payload-orbiting ability even if the latter come into being soon, according to a Rand Corp. research engineer. The expert, Martin Goldsmith, says in a report that this is true even though the boron-based fuels may give higher specific impulse than present LOX hydrocarbon combinations. He added that solids will always require heavier vehicles than liquids for a given job of orbiting.

Frame contract bids . . .

for Project *Scout* should be opened on Monday, March 23. Between 20 and 25 bids are expected.

Titanium prices will drop . . .

to about $1.50 per pound ultimately, in the opinion of metals experts. The say a large commercial market for the metal has yet to be tapped.

Tensile strength of 750,000 psi . . .

in some steel alloys is "within reach," according to metals people. The ultra-high-strength steels have far surpassed their former characteristics and are now considered "new" metals.

***Snark* production is programmed . . .**

through calendar 1960, despite misleading statements to the contrary, Production models, painted grey, continue to roll out of Northrop's facility at Hawthorne, Calif. Checkout before delivery to SAC is being done at the Norair Division.

About $1,770,000 will be spent . . .

on initial construction of limited *Minuteman* test facilities at Edwards AFB, Calif., the Air Force says. The construction, now underway, will include buildings for instrumentation and control, assembly and shop-work. Additional component testing will be done at Holloman AFB and the complete system eventually will be flight tested at Patrick AFB.

Secode Corp. of San Francisco . . .

a developer of electronic communications equipment, has acquired a "substantial" interest in C. A. Rypinski Co., Southern California producer of regulated power supplies for missiles.

***Polaris* exhaust nozzle liners . . .**

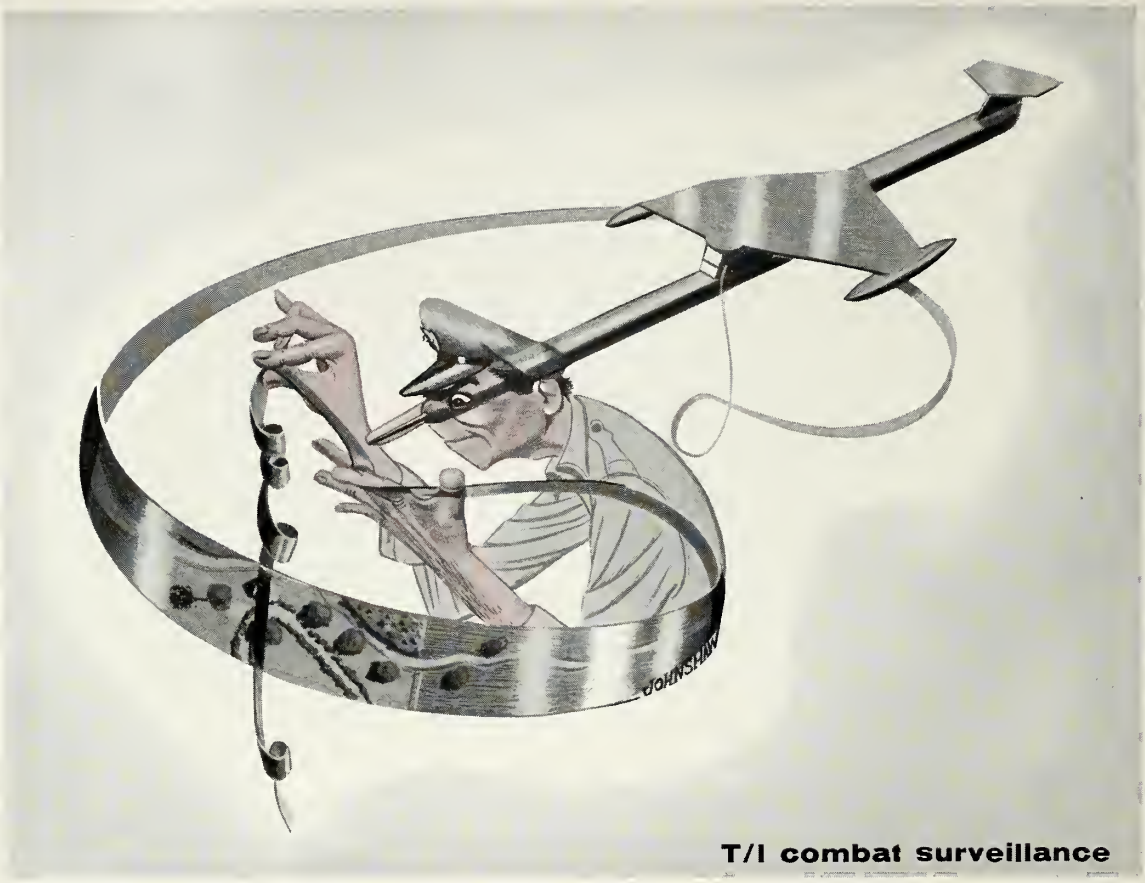
have been contoured by forming molybdenum forgings into the desired shape by hydrospinning at 1000° F. The advanced process was carried out at the Wright Aeronautical Div. of Curtiss-Wright and described recently in C-W's annual report. The report also noted that the division was involved with development of inert components of propulsion for *Minuteman* and *Pershing* as well as *Polaris*.

A weapons system management . . .

proposal for an Air Force ASM is being prepared by Northrop-Norair. Team members include Nortronics, ITT, AVCO and Aerojet-General.

One of the most modern . . .

printed circuit manufacturing facilities opens on April 15 when the U.S. Engineering Co., a division of Litton Industries, moves into a new plant at Van Nuys, Calif. It will be the "only fully integrated printed circuit operation in the country," according to Jack Gentry, USECO's general manager. The plant should be in full production by the end of April.



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MARCH 23, 1959—VOL. 5, NO. 12

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Some Views of DOD Research Chief York

Pentagon's first R&E director gives priority to weapons system on basis of importance of its mission and encourages industry to do more research on its own. He will add new offices to bolster the development present set-up.

by Paul Means

WASHINGTON—Dr. Herbert F. York, first man ever given the power to direct the Department of Defense's entire research and engineering program, has told M/R he intends to:

• Assess the importance of a new weapon in relation to its' mission and not its components and environment.

• Engage industry to do more research . . . with less of it becoming systems work.

What goes on behind door 3E-1006, Pentagon has becn a question of great curiosity and concern to Congress, the military, industry, the press and the entire nation ever since Dr. York was assigned this room in December as the first Director of Research and Engineering.

Recruiting with a big R is one of the major activities conducted behind the door. An interview which took months to schedule will be interrupted constantly while the new Director talks long-distance to a scientist or engineer he feels is needed to carry out the task of the new office.

The recruiting will continue until Dr. York's team has a few more than 100 members whose duty it will be to direct the expenditure of $5 billion that will be spent on the thousands of DOD R&E projects in fiscal '60.

• **Problem of priorities**—One of the big problems that has plagued centralized Defense planning is: Where should the money go? Which new service project or weapons system is the most important?

Dr. York hopes to resolve this problem by evaluating the new weapon in relation to its mission instead of its environment or components.

He uses the early warning, navigational, and communications satellite projects as examples of what he means. The importance of these projects should be evaluated primarily in relation to the entire air defense, navigation and communication systems, and not solely in relation to the space program or in relation to their boosters.

"How does the communications satellite fit into the entire communications Program?" This is the question Dr. York's office will ask in evaluating the need for such a satellite, and in deciding how fast its R&E should progress. The questions of where it fits in the space program and where it fits in the booster development program are secondary to the importance of its mission.

Dr. York intends to apply the same analysis to missiles, aircraft, ship propulsion, nuclear and conventional weaponry, propulsion, ground support, ground transportation, better bullets, materiel, food, blood preservation, and all of the major Defense R&E projects.

• **New offices**—To implement the evaluation of R&E projects in relation to their mission, Dr. York intends to augment the present offices dealing with the specific technical fields of aeronautics, electronics, atomic weapons, fuels, and guided missiles, with offices which will deal with overall military missions, such as air defense, tactical weapons, strategic weapons, communications, etc.

Dr. York considers these new "mission" offices important enough to be headed by Assistant Directors.

Under such a system, Dr. York should be able to assess with greater reliability which new project is most important, needs the most money, and should progress at the faster rate.

• **Industry research**—Another problem which Dr. York hopes to correct is the time and expense wasted on R&E for weapons systems which it is found later do not work or are not needed.

Dr. York said that he was going to see that industry does "more exploratory work, and that less of that kind of work becomes systems work."

He hopes to cut the tremendous cost of industry weapons development by supervising industry R&E, and cancelling projects when it is determined that it will not result in a workable or needed component or weapons.

"We have to explore as many areas as possible, but it is difficult to limit exploratory efforts," Dr. York said. "When a contractor carries on extensive exploratory work on one project, he tends to think that his way is the only way to solve the problem."

Much of this evaluation is already done by the Systems Evaluation Group, whose scope of activities Dr. York intends to expand.

• **Selective approach**—Direct supervision by his office will be limited to the major projects. Dr. York points out that there are thousands of R&E programs and his small office could not hope to direct the spending of $5 billion in detail. He said his office will pick those projects which he feels are important, and will keep track of the others.

Dr. York feels that his relationship to the Advance Research Projects Agency, which has the job of tying the military space program together, is identical with his relationship to the service R&E offices, and that ARPA projects will warrant the same type of direction from his office.

Besides evaluating R&E projects as to their relative importance in relation to the mission they perform, Dr. York feels his department must fight for those programs which are not as glamorous as others.

"Most of what we are doing is not shooting things up into the air. An important part of our job is to see that programs not as glamorous receive sufficient planning. We must make sure that no important projects are left out —or that none are left out because they are only half-important to two services," Dr. York said.

• **No conflicts**—Dr. York sees no conflict in goals, confusion, or duplication in the present science and military space programs. There are different programs he said, because different organizations have different missions in space.

(Continued on page 36)

Fansteel research opens new applications for missile electronics, propulsion and structures

RECTANGULAR PIECES are "boats" for containing small parts in furnaces, and round cups could be gyroscope rotors.

'Breakthrough' in Tungsten Fabrication

by Donald E. Perry

CHICAGO—Tungsten—twice heavier than iron but with the highest melting point of the refractory metals family—should assume important applications in missile and space vehicles if research in pure tungsten fabrication by the Fansteel Metallurgical Corp. is an indication.

Until last summer, tungsten was being fabricated in relatively simple shapes. Today, Fansteel has reversed the fabrication picture. Here's what the company is doing:

• A deep drawing process has been developed. To the company's knowledge it is entirely new within the last six months. It gives about a 20% increase in density over tungsten alloys now being used.

• Parts, while small to be sure, have been fabricated from tungsten sheet by spinning the almost unworkable metal.

• **Self-financed**—Fansteel's research to explore use of tungsten for rocket nozzles, electronic components and reentry nose cones is self-financed. Most of today's government-sponsored research for rocket applications is going into molybdenum, with half the weight of tungsten and a melting point of 4752°F, compared with tungsten's higher 6152°F.

But Fansteel feels that expanding present limits of tungsten fabrication will make possible an endless stream of component parts for the missile industry.

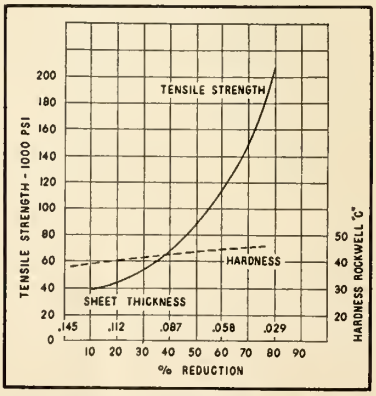
For example, deep-drawn tungsten boats will make it possible to fire electronic tube components to higher temperatures so that better tubes can be mauufactured. And, there is the possibility of designing continuous metal evaporating equipment which in turn would reduce processing costs.

Most important, design engineers can consider deep drawing of tungsten sheet metal parts for vector control of rockets. Since the rocket nozzle is one of the most severely stressed parts, Fansteel believes there are tungsten requirements.

As rocket performance requirements increase, flame temperatures will become higher than molybdenum can withstand. Tantalum is being tried, but Fansteel thinks maximum performance will not be possible until tungsten is used.

While Fansteel is generally regarded as the leader in the tungsten field, it—like many other companies—is in deep with other refractories: tantalum, moly, and columbium.

• **Binding challenge**—One possible use of tungsten in rocket nozzles would be to bind it to stainless steel in the throat section and allow the tungsten to take the punishment. However, this would add weight and pose a tremendous—but not impossible—binding problem. Use of nickel with tungsten probably would be a logical step.



TUNGSTEN STRENGTH increases with work. Curves show effect of roll-reduction.

Fansteel points out that deep drawing and machining can extend the use of pure tungsten for gyroscope motors. With about a 20% increase in density over tungsten alloys now being used, a drawn rotor may make it possible to decrease the size of gyro controls and yet retain their operational integrity. Tungsten has the lowest coefficient of thermal expansion of any of the metals presently used in rotor construction, Fansteel says.

• **Brazing**—Using gold, which has the same density as tungsten—19.3 grams per cubic centimeter (lead is 11.3)—as the brazing agent, Fansteel has come up with a miniature-sized container made from two drawn tungsten cups which can hold radioactive materials.

R. W. Yancey, consulting metallurgist in the metals and fabrication division, cites an interesting possibility for this process. He envisions two drawn tungsten cups brazed together at angles with gold that would be about the size of a potato. By drilling a hole in the bottom of one of the cups prior to assembly, it could be used as a radioisotope container.

In the *SNAP III* (secondary nuclear auxiliary power) project, decay of a Polonium 210 isotope created heat energy which was captured by thermocouples and produced five watts of power. Yancey believes tungsten could well serve as the casing for such power packages.

APPROXIMATE LIMITS of tungsten fabricability as of six months ago. All of this forming, of course, is done hot.

PARTS FABRICATED from tungsten sheet by spinning, an art dating back to Middle Ages but new to refractory metal.

• **Background**—Within recent years there has been a tremendous increase in interest and use of pure tungsten products or alloys containing a high percentage of tungsten.

While powder metallurgy has resulted in many high density products, the mechanical properties of these alloys have depended on the nature of the cementing agent, the weakest link. Melting point, density, high-temperature strength, modulus of elasticity of the alloys and other properties have been inferior to those of pure tungsten. Another drawback has been the difficulty of working the powder metallurgy product except by machining.

Another important reason why pure tungsten has not been used more extensively is the ratio of cost to economical performance. This has left little incentive to develop new manufacturing techniques in wrought tungsten, Fansteel feels.

However, the emphasis has changed rapidly in recent months. Today the military is emphasizing performance rather than cost. Factors influencing this emphasis are greater reliability and longer life in electronic components; processing materials at higher temperatures; and manufacturing of sturdier components and assemblies which can operate at high temperatures.

• **The tungsten problem**—Fabrication is exceptionally hard because it must be heated to temperatures at which stainless steel and some of the super-alloys would melt. Its working has to be done at a high temperature and must be done quickly.

After preliminary working, continued working is less severe. But here another problem enters the picture: As tungsten cools to a temperature approaching 800°F, it rapidly loses much of its ductility and rapidly gains in strength. Working tools have to be fabricated from an alloy that has good high-temperature strength, plus an ability to withstand considerable wear.

Forgings are made in a series of steps, taking advantage of more ductility as the metal is worked further.

Another new Fansteel development is seamless tungsten tubing produced by hot extrusion. A tube was reduced by 70% of its original area, showing the extent that hot tungsten would flow under proper conditions. The extruded tube possibly could be used for drawing thinner-walled tubing, or it could be hot upset to make a special shape.

Materials for space vehicles—not only in power plants but in skin surfaces as well—pose uncertainty and difficulty. The requirements are basic: they must be easily formed into large sheets, welded, cast, or wrought to the desired contour.

Tungsten by its very nature is tryingly difficult, but Fansteel believes its research into new fabrication processes is crossing a metals frontier.

Plenty of Work for Small Firms, MIT Forum Is Told

NEW YORK—Convair's chief engineer predicts that a few companies with "demonstrated capabilities" will be given the responsibility for developing major systems in America's space program.

However, Mortimer Rosenbaum, head of the Convair technical staff that developed the *Atlas,* said here recently that other companies would have plenty of opportunity for subcontract roles.

Rosenbaum was a principal speaker at a forum on "Conquest of Outer Space" held at the annual technical dinner meeting of the MIT Club of New York.

The 300 attending also heard:

1. A top test pilot declare that qualified pilots lack enthusiasm for the Project *Mercury* man-in-space plan because it is so automatic that the pilot has no control over his destiny.

2. An industrialist call for more research in metal strengths.

• **Sharing in** *Atlas*—Rosenbaum said subcontractors handled 50% of the job General Dynamics' Convair Astronautics Division did on the *Atlas* major system. Of this subcontracting, 36% was done by small businesses.

There is room for small companies to do specialized work, too, Rosenbaum continued. As an example, he cited McDonnell Aircraft's victory on the Project *Mercury* capsule contract, bidding against G-D and other large companies.

• **Pilots balk**—Ralph Cokely, engineering test pilot for Boeing Airplane Co., told the forum he had yet to find a qualified test pilot who wants to test the Project *Mercury* capsule.

"A man should be given alternate means of manned control," Cokely declared.

The test pilot said there had been a trend in recent years toward building of aircraft with red and amber lights rather than gauges to indicate actual conditions.

"It is better to have a temperature gauge that predicts the problem before it arises than a flashing light, that tells you when it's too late," he asserted.

• **Metals work urged**—Everett T. Welmers, assistant to the president of Bell Aircraft Corp., told the audience that space technology requires considerable basic research in the reaction of metals to temperatures measured in the thousands of degrees.

"We have made considerable progress recently in chemistry, particularly in plastics," he remarked, "but we haven't gone so far in the field of metals. With many metals, we still are using techniques thousands of years old."

World Must Solve Brand New Problem of Moon Rights

Authorities seeking answers find few precedents to work with and most consider U.N. control the most feasible.

by Donald Cox*

BALTIMORE—Now that the Soviets have sent their *Mechta*—dream rocket—within 4600 miles of the moon on its way to solar orbit, we are suddenly aware of the problem of the ownership of our lunar orb.

Who owns the moon anyway? God? . . . Gamal Abdel Nasser? . . . The Soviet Union? . . . The United States? . . . All mankind? . . . This question was academic before October 4, 1957, and was semi-dormant before January's *Lunik*, but now it is a pressing matter which in the very near future may be causing our State Department, Department of Defense and United Nations legal representatives loss of sleep.

For at the moment that the U.S. or the U.S.S.R. splashes the instrumented nose cone of a rocket on the dusty surface of our moon, the controversy over ownership will flare up into major proportions. For this reason, it is important that the various alternatives on ownership and control of the moon be examined now, calmly, so that we will be prepared for a better understanding of the problem when it becomes a stark reality . . . which it should someday this year!

• **Staking claim**—This problem will be complicated further in a few years when the first man lands alive on the moon or circumnavigates it in a close-in orbit. Will the nation who sends the first man safely to the vicinity of the moon gain sovereign rights over its territory? Will the old rules of exploration which were applicable in the great days of the discovery of the New World still apply to the moon?

The precedents of international law would tend to lead one to believe that planting an unmanned radar beacon in some lunar crater or mountain top might be a sufficient basis for a national claim to sovereignty by the nation which put it there. Fortunately, however, international law is a living organism and is subject to change, having passed through many stages of growth in the past.

Now, in its greatest moment of ascendancy, international law will probably have to look elsewhere than to the past to learn who should own and control celestial bodies like the moon. Since the moon undoubtedly will be the first focal point of man's space exploration, it will serve as a "live" guinea pig in the struggle for ownership and control of other bodies—the planets and their moons.

• **Four leading theories**—It is fairly obvious that we will not turn our backs on the ticklish subject of lunar ownership or conquest whether it be under a military or scientific banner, or both. If we did put our heads in the sand like the proverbial ostrich we would be burying our chances to participate in the last great adventure of mankind—the exploration of space.

But in facing up to our destiny and continuing our national plans to land on the moon, we will run the risk of meeting some "other national" lunar explorers head-on in some well-known lunagraphic terrain feature. Before that moment arrives, we might well spend some time examining four theories of possible lunar ownership and control and their consequences.

1. **National lunar subdivision concept**—As various nations send their human "space" representatives to the moon, some theorists believe, less friction will evolve up there and back here on earth if the moon is sliced up like a giant pie, subdivided into massive triangular real estate holdings and doled out to the interested nations by some previously-agreed-upon international lunar real estate corporation This "lunar suburb" theory holds that a subordinate body of the United Nations could be set up to divide the moon in advance, with the size of the slices being determined by population and relative power here on earth.

Each earth nation could indicate those areas or pie-slice parcels that it desired to explore and colonize. The large, underdeveloped nations of Africa and Asia—not yet technologically ready to participate in a mass colonization attempt—would have their plots held in escrow by the U.N. body.

This theory has many loopholes, including a considerable doubt that the nations of the earth would agree to such a plan. It is further complicated by the fact that mapmakers here on earth along with lunar real estate salesmen and legal experts might have trouble deciding which wall of which crater belongs to one nation rather than to another.

This concept probably is the least workable of the four.

2. **First come-first served**—Some experts feel that the first nation to reach the moon and establish a claim with an unmanned rocket or a manned lunar base could theoretically claim the whole of the moon as its own "seventh continent" of the earth. Although the Soviets did not say so at the time, the official photos of the *Lunik* sphere showed it liberally adorned with the hammer and sickle and "USSR" painted all over its surface.

This can only be interpreted one way: had *Mechta* impacted on the moon's surface while it was still called *Lunik*, the Soviets might have claimed the entire moon. Only when it was obvious that *Lunik* would miss the moon by several thousand miles did the Soviet propagandists slyly change the name of their instrumented payload to "Dream."

Even though *Mechta* missed its target, it emphasizes the coming problem of recognition or non-recognition

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* *Donald Cox, a frequent contributor to m/r, is the co-author of the book, Spacepower.*

for the nation that first "plants its flag" on the moon. Whether recognition is granted by individual nations, like the Soviet satellites, or an international body, like the UN, is a minor point, if such an event occurs in the very near future.

What is more important is the ability of the nation that first lands an object on the moon to deny landing rights to other nations. Unless the first nation establishes many manned lunar military bases, it probably will find that it is almost impossible to prevent others from landing at will.

Because no one nation is so far ahead in the missile art, it appears unlikely that such unilateral denials will ever occur. This leads some theorists to propound the theory that the moon should be considered as *res nullius* ("Free for occupation"), like the undiscovered parts of the Antarctic continent. In this way, different governments could stake out non-conflicting, peaceful claims to various parts of the moon wherever they happened to land, provided someone else hadn't gotten there first.

Long before it was applied in Antarctica, this "first come-first served" approach was the unwritten—but thoroughly understood—basis for the exploration and conquest of the New World in the 16th and 17th Centuries.

In evaluating this theory, as it is working out in the Antarctic, it must be noted that none of the claims staked out there by the various earth nations before, during or after the IGY have been recognized by any international body.

3. **Lunar national corridors**—As manned spaceships travel over the moon's crust from close-in orbits, it is possible that their navigators will lay claim to wide corridors on the moon for their home countries. They could back these claims by presenting photographs before some international "space real estate" body on earth.

If such a system comes to pass, in advance of actual landing claims, disputes might arise over conflicting claims where space-photo mapping corridors overlap later moon tractor-explored corridors.

The Antarctic overland corridor surveyed by Sir Edmund Hillary and Dr. Vivian Fuchs on their dashes to the South Pole in 1957-58 theoretically could be claimed by both New Zealand and Britain.

But what about the supply aircraft which flew over the same territory? Couldn't they claim it? Weren't some of the planes used to supply the Hillary-Fuchs Snocat team flying the American flag? Therefore a conflicting claim in theory already exists in the Antarctic. If such methods were applied to the moon, similar problems would arise.

At this writing, none of these Antarctic corridors have been recognized as sovereign to one nation. Similar moon claims may well be ignored in the same way.

4. **A United Nations concept**—The most feasible theory for future ownership of the moon is one that envisions putting our satellite under the control and jurisdiction of the United Nations. This presupposes that no staked land outposts or national corridors could be claimed by any earth nation. Rather, all of the lunar surface and its natural resources would be owned by the United Nations and leased by that body to groups of nations for peaceful exploration. The Trusteeship Council of the U.N. is the logical agency to undertake such a task, having had considerable experience with similar problems on earth.

Cooperation among the various nations during the IGY (1957-58) in the Antarctic offers some hope that similar cooperation could be undertaken on the moon. To make it work, the U.N. will have to have enough power to enforce and carry out such a mandate.

This means that the nations must give up more sovereign rights to that body than they have in the past. It applies mainly to the major world powers in the Security Council—and Red China—since the smaller powers have already given up much of their rights.

A new IGY applied to the moon, termed a "Lunar Graphical Period" (LGP) would be in order to set the framework for such an enterprise. Calling it a "period" instead of a "year" would eliminate the time-factor stigma, which has already caused a let-down among IGY scientists. It is fairly obvious that the moon is not going to be colonized in a year or eighteen months, anymore than launching small artificial earth satellites was restricted to the IGY.

• **Which concept?** Of the four concepts examined, each has its virtues and liabilities. Granting ownership of the moon to the U.N. is the most logical for the long run, but man doesn't always act by reason alone, and the result may well be a combination of the "corridor concept" and the "first-come" concept.

A titanic battle in space may be waged between the major earth powers for control of the dark side of the moon, which hasn't been discussed here. The outcome of such a battle could dictate ownership and control not only of the light side of the moon . . . but of the earth as well.

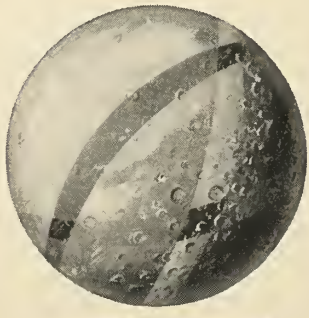
Time is short, and decisions on the ownership of our only natural satellite must be made before it is too late.

WHO OWNS THE MOON?

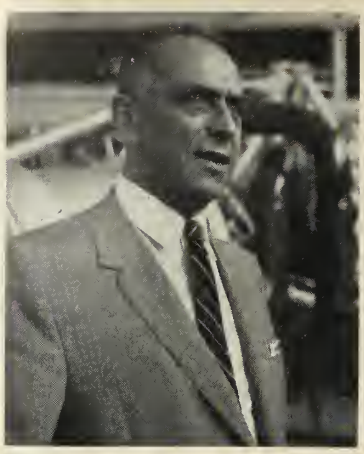
LOGICAL BUT difficult is to set up U.N. control of entire moon.

ONE SUGGESTION is division among the Earth nations.

SOME EXPERTS look for "first come-first served" area division.



OR THERE could develop a national corridor concept.



HOFFMAN

. . . the power behind Rocketdyne

by Erica M. Karr

WASHINGTON—Unless the Russians get there first, a Rocketdyne engine probably will put the first man on the moon—an event that could occur within six years.

In Washington this week, Rocketdyne's mild-mannered Sam Hoffman, the power behind the powerhouse of the U.S. missile effort, told the story of his company's historic record in creating the boosters for *Atlas, Thor, Jupiter* and *Redstone*.

He downplayed his own role in the company's growth from a small section in North American Aviation Co. to one of the top rocket engine producers in the country. But Sam Hoffman unquestionably had more to do with it than anyone else.

As manager of the Rocketdyne engine empire, Hoffman rules plants in Canoga Park, Calif., and Neosho, Mo., and extensive field test laboratories in California's San Susana Mountains.

• **Aircraft background**—Hoffman, 56, former university professor, joined North American as chief of the Aerophysics Department's Propulsion Section in 1949. Looking back, he says "I have spent almost my entire life in aircraft companies of one kind or another."

He has been design engineer for Fairchild Aircraft Co., Lycoming Manufacturing Co. and the Allison Division of General Motors Co. At Lycoming he was chief engineer from 1936 to 1945. Christmas, 1943, he was involved in an accident that led him out of the aviation field. He was one of two survivors of a DC-3 crack-up which killed 25 people.

"I was in and out of hospitals for six months and had plenty of time to think. The crash, I knew, would slow me up for a while. The life of a college professor looked good."

But it wasn't until two years later that he was offered a professorship of aeronautical engineering at his alma mater, Pennsylvania State University. He stayed there until North American beckoned in 1949.

• **Work on** *Navaho*—An old-time North American employee recalls that the company was "forced into the engine business—we had the prime contract for the *Navaho* and couldn't find a subcontractor who would tackle the engine for it. So we decided to build it ourselves." The only large liquid propellant engines were those that powered the *V-2*. A small team set to work disassembling the *V-2* and rebuilding it to fit the *Navaho*.

When Hoffman came to North American, its Aerophysics Department was made up of four sections: frame, guidance, nuclear and propulsion. His job as head of the propulsion department was to design and develop the rocket engine for the *Navaho* booster.

North American was charged by the Air Force with developing an air-breathing, cruise-type missile, brought up to speed and altitude by a liquid propellant rocket engine, more powerful than anything before conceived.

Work on the *Navaho* resulted in a number of steps toward achievement of the large rocket engine such as use of lightweight tubular-wall thrust chambers instead of bulky double-wall chambers. Significant advances in use of JP fuel were accomplished. Most important was the background of experience which was accumulated during the early days of development on high-thrust rocket engines.

• **In other missiles**—The engine was later repackaged and sold to Redstone Arsenal to fire the *Redstone* missile. "This is the same basic engine," Hoffman says, "which put up our first satellite." Newer and larger versions went into the *Thor, Jupiter* and *Atlas*.

The basic *Navaho* engine became the building block for a two-chambered engine in the second phase, and finally the three-engine cluster in the final phase. Its first firing in January, 1956, resulted in the highest thrust ever achieved in a ballistic missile engine. The three-barrel cluster concept of the *Navaho* had approached flight status when the Air Force program was cancelled in 1957.

The experience was accompanied by exploration in fluid dynamics, thermodynamics, chemistry and metallurgy unlike any encountered previously in the field of rocketry. An outgrowth was the development of high-performance turbopumps for forcing propellants from tanks into rocket engine chambers at high pressures. The high flow attained is sufficient to empty an average-sized swimming pool in a few minutes.

Propellant research resulted in development by Rocketdyne scientists of Hydyne, the fuel used in the Army's 1958 *Jupiter C* satellite launching. A blend of chemicals based on a derivative of hydrazine, it matched the physical properties and combustion characteristics of the alcohol fuel used in the Rocketdyne-developed *Redstone* engine which powered the first stage of the *Explorer* satellite. It gave additional thrust, with a substantial increase in vertical range.

• **New horizons**—In 1956 Rocketdyne began studies on ion propulsion. This Air Force-sponsored program will ultimately send vehicles through space by a light-giving current of charged particles a million times greater in number and weighing 350,000 times as much as the stream of electrons in a television picture tube.

In 1957 research toward a nuclear rocket engine was started at Rocketdyne under Air Force sponsorship although North American had been conducting studies in nuclear energy as early as 1946.

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Metals Congress Discusses Problem Solutions

Great strides reported in such fields as increasing metal strength and test methods.

LOS ANGELES—The 11th Western Metal Congress met here recently to explore a wide range of strength and fabrication problems relating to missile and rocket development. Industry representatives told how some of these problems are being solved.

Lewis E. Zwissler of Aerojet-General said that, "One of the major sources of failure in solid rocket motor cases has been the result of defeats associated with welding in the fabrication process." Zwissler, head of Aerojet's applied studies department in solid rocket research and development, said that is why so much development work is aimed at fabricating motor cases with minimum welding.

Zwissler also commented on the problem of obtaining steel strong enough for ultra-high strength pressure vessels. "Present mill practices are not adequate to give sufficient control of chemistry and cleanliness," he said. This, combined with welding drawbacks, results in lower-than-desirable motorcase quality.

• **Porosity cured**—Virtual elimination of porosity and cracking in X-200 high-silicon, high-carbon steels for skins of pressure vessels was claimed by United States Steel Corp. Porosity was eliminated, spokesmen said, by employment of a new "two-pass" technique, welding from one side on an inert gas backup. The first weld laid down filler wire of the same material as the steel involved. The second weld fused in and compacted the adjoining material. Both welds were performed with a heliarc tungsten torch.

Hughes Aircraft Co. announced development of an automatic welding process for hemispherical sections of a pressure vessel proof-stressed at a pressure creating internal wall and weld stresses approaching 87% of the metal's ultimate tensile strength. Direct current equipment and the non-consumable tungsten electrod inert gas process were used. The rejection rate due to welding alone is held below 1% in high-rate production, Hughes said.

But burst tests indicate that while many alloys can be welded and heat treated to ultra-high strength levels, many lack sufficient ductility in the weld zone area to permit practical use.

• **Testing alloys**—Solar Aircraft Co. reported testing alloys capable of heat treatment to ultimate tensile strengths in the 220,000 to 300,000 psi range. Solar said it was recognized that standard tensile and bond tests were inadequate for evaluating the potential performance of welds in pressure vessels where imposed stresses are multi-axial.

After welding parameters had been established by conventional methods and dozens of small pressure vessels were broken in tests, the conclusion was reached that each alloy has a maximum usable strength level beyond which reliability is lost.

General Electric cited its experience in fabricating vessels and tubing for nuclear applications as an example of stainless steel welding. The company uses tungsten-arc cutting of austenitic stainless steel wrought materials to prepare the 300 Series of stainless for welding. The firm notes that excellent quality cuts can be made in austenitic stainless steel, cast iron, copper and aluminum pipe by using heliarc cutting and "mechanical draftsman" units together.

• **Yield strengths**—Great emphasis was placed on increasing yield strengths of aircraft/missile metals through heat treatment and other methods and producing lighter gauges, wider widths and better flatness in structural metals.

As an example of the results of better use of existing continuous rolling facilities, Republic Steel Corp. cited Type 301 stainless steel, an austenitic grade with good work-hardening characteristics. It has been rolled on a 27-inch Sandzimer mill to .006 inch gage strip with as-rolled yield strength of over 250,000 psi. After aging, Republic says, the yield strength increased to more than 300,000 psi, with gage variation held within .0005 inch.

Douglas Aircraft engineers said 4340 ultra-high-strength aircraft steel has been heat treated to attain an ultimate tensile strength of 260,000 to 280,000 psi. Proper cleaning and plating, followed by baking and painting, will avoid hydrogen and corrosion embrittlement, they said. (Hydrogen penetration or corrosion can occur in aqueous or acid cleaning, electrolytic plating and exposure to natural atmosphere.)

Acid cleaning, which produces severely embrittling conditions, was rejected in favor of controlled plating. Adequate control involves only mild embrittlement, which can be relieved by baking. Instrumentation to achieve carbon control in heat treating processes has been considerably advanced Lindberg Engineering Co. said ". . . more R&D time is being given to problems of carbon potential control than to any other furnace problem."

• **Test methods**—New methods for non-destructive tests of materials were revealed at the Congress. Instrumentation used included radiation, ultrasonic, magnetic, various electrical devices, and eddy current testing.

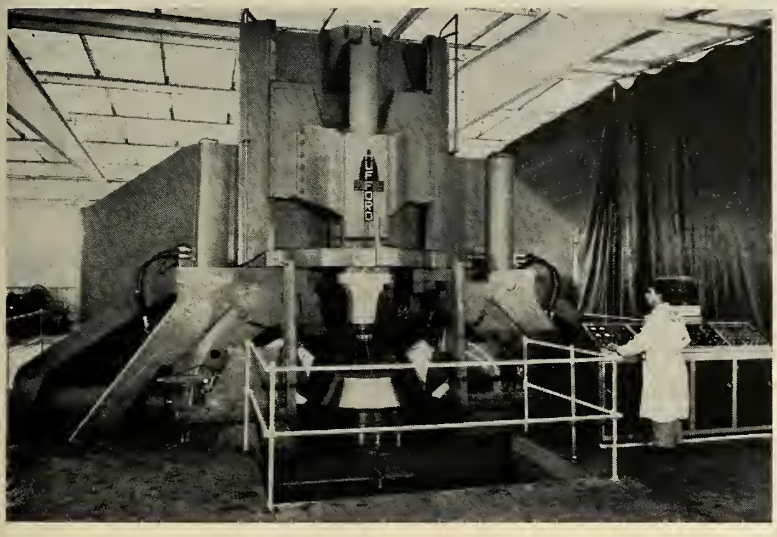
Eddy currents, induced by a radio frequency field, explore the part for flaws, chemical properties and internal metallurgical dislocations. They do no damage to the part. A graph shows findings of the test.

Another recently developed method uses pulse beats in the form of echo patterns to determine metal flaws. The metal is subjected to 1000 beats per second during the test, known as "pulse echo ultrasonic flaw detection."

Both thick and thin walled casings can be inspected. Corrosion and erosion are detectable, as well as delamination in multi-layered structures.

B. F. Brown, head of physical metallurgy at the National Research Laboratory, disclosed that removal of embrittlement-causing hydrogen from steel in the molten state is practical with vacuum degassing. Brown said the process may be favored over zone refining of large solid forgings.

Spin Forge Forms Steel One Inch Thick



A new space age machine tool that reportedly can form a one-inch-thick piece of stainless steel or other hard metal into an aircraft or missile part has been produced by the **Siegler Corporation.**

In forming the metal part, the manufacturer says, the machine increases the strength of the material used up to 100% and the machine cuts the production cycle by more than 50% over the metal now used for making such items as rocket engine cases.

Known as the "Spin Forge," the tool is claimed to be capable of applying a total work force in excess of one million pounds to form parts up to 60 inches in diameter and 10 feet in height. The machine tool is 25 feet wide, 24 feet high, including its base, and weighs more than 450,000 pounds.

In operation the Spin Forge utilizes a combination of rolling and shearing principles to produce mechanically spun "surface-of-revolution" sections such as conical, tubular or parabolic configurations with varied wall thicknesses.

In forming a component, the metal to be formed is placed on the Spin Forge's mandrel, a form that is shaped as the desired part, and held tightly in place by a vertical tailstock or hydraulic ram that can exert 200,000 pounds of force. The mandrel is then rotated at speeds up to 400 rpm, and two massive working rollers, set across from each other at either side of the mandrel, come in to force the metal over and around the form.

Quality of finished product and shorter, lower-cost production cycles, plus elimination of a portion of the weldments normally required in the fabrication of such parts as pressure vessels or rocket engine cases, may be realized with the new tool.

• **Grain refined**—Quality of the finished engine component is achieved during the Spin Forge's roll forming through orientation and refinement of the grain of the metal. In effect, the grain is caused to flow, with the flow line and characteristics changed in such an extent that there is superior alignment. Metallurgically, the grain condition of forging is obtained with close tolerances that eliminate the need for finish machining.

A part made from 4130 steel, with the metal in fully spheroidized annealed condition, had prior to being roll-formed a tensile strength of 80,000 psi with a hardness of 90 to 96 Rockwell B. After being formed on the Spin Forge the material in the part had 160,000 psi tensile strength, grain elongation of 4-6%, and 35 to 37 Rockwell C hardness. The surface finish of a roll-formed tubular part will be approximately six micro-inches inside and 40 to 60 micro-inches outside.

A key factor from the standpoint of both cost and finished part quality is the elimination of the longitudinal weldments and the decrease in the number of transverse welds generally associated with components made by the wrap and weld method. By eliminating major weldments in the tubular sections the Spin Forge eliminates possible points of failure.

Circle No. 225 on Subscriber Service Card.

Binary Counter Gives 100 Channel Analysis

A new transistorized 10-state indicating reversible binary counter has been announced by **Navigation Computer Corp.** The unit features both serial and parallel read-in and read-out.

Eighteen-volt dc levels are available from either side of the counter stages; and they may be directly loaded by other transistor stages. Internal amplifiers may be added to operate relays, low impedance busses, etc.

The Model 111B reversible binary counter has completely automatic internal switching. Pulses may be fed into the forward and reverse inputs, and the sum of the two inputs is made

NOTE: *For additional information about any product mentioned in this section of Missiles and Rockets use the attached prepaid reply cards. Circle numbers shown on the reply card that correspond with numbers appearing beneath items described. If no circle number accompanies the article or advertisement, give page number (and advertiser's name) on line provided at bottom of card.*

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The Editor

visible with neon indicators.

The units operate up to 200 KC with a single 20V supply voltage. Both push-button and electrical presetting are available and any number of units may be cascaded.

Circle No. 226 on Subscriber Service Card.

Sensor Helps Eliminate Missile Countdown Errors

A new type of frequency sensor, employing magnetic and static elements throughout, and operating on the "go, no-go" principle, has been introduced by **Magnetic Circuit Elements, Inc.**

The device, one of a family of magnetic "instrument sensors," is said to offer several important benefits over conventional dial indicators, among which are greater accuracy, reliability, reading ease and installation flexibility. Read-out is achieved by means of green and red lamps, denoting "within tolerance" or "out of tolerance" respectively.

The elimination of all movable and corrosible parts has resulted in an insensitivity to extremes of temperature and vibration, as well as to large over- and under-tolerance conditions. Tolerance limits are "built into" the sensor, enabling it to achieve accuracy of ¼% or better.

The sensor is said to make the missile countdown engineer's job much easier, since chances for reading error are, for all practical purposes, eliminated. Not only do red and green lights supplant the needle dial, but several sensors may be connected to a logic circuit in such a way that a single read-out will indicate the "no-go" condition if any one of the readings is out of tolerance.

The sensor may be mounted remotely from the read-out lamp—in wing, tail or other areas where space is not so critical as in the control area. Remote installation also minimizes danger of damage to the circuit being measured, by allowing the sensor to be mounted, for example, right next to the frequency generator.

The new unit is said to relieve the busy operator of a considerable amount of high-pressure, high-speed decision-making which, up to now, has been increasingly troublesome.

The C-400FS1 frequency sensor operates at 115 volts. Nominal frequency and tolerance limits are made to customer specifications. The 2-watt output drives 24-volt lamps or relay drives. If desired, it will work in connection with an annunciator system. Temperature limits are −65° to +185°F; vibration specifications are 20 g's; 2- to 2,000 cps.

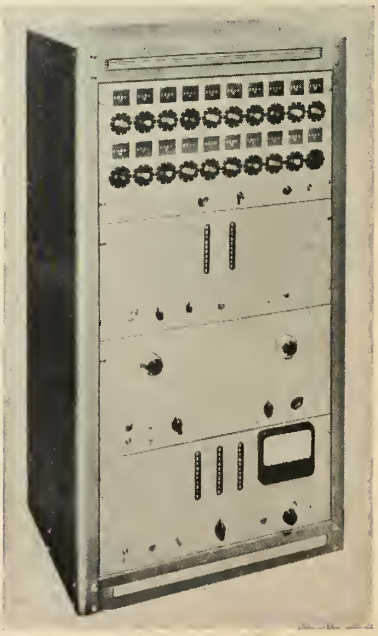
Circle No. 227 on Subscriber Service Card.

Pulse Height Analyzer Has 20-Channel Storage

A new 100-channel pulse height analyzer with 20-channel storage is announced by **The Victoreen Instrument Co.**

Designed by **Tullamore Electronics Corp.,** recently acquired subsidiary of Victoreen, the PHA-120 analyzer is the latest Tullamore instrument designed specifically for moderate and low counting rate spectroscopy work.

Because a full 100-channel analysis is made and read in five steps of 20 channels, the manufacturer claims the unit is inexpensive in addition to being precise and reliable. Other features include analog-to-digital conversion for pulse sorting which provides uniform channel widths and makes individual



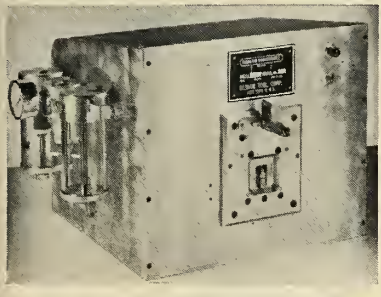
channel width adjustments unnecessary, exact alignment of end channels of 20 channel groups, no data distortion for counting rates up to 6000 cpm per channel, and "zero level" adjustment to allow a particular peak to be centered in a particular 20 channel group.

The PHA-120 analyzer comprises five basic assemblies: preamplifier, amplifier, amplitude digitizer, storage unit and decade scaler.

Circle No. 228 on Subscriber Service Card.

New Unit Straightens, Cuts, and Preforms Leads

The Electro-Machinery Division of **Design Tool Corp.**, has introduced a new radialead straightener, model AL3NS, an all-purpose machine for automatically straightening, cutting and performing the leads of transistors.



The unit straightens and aligns transistor leads, or straightens, aligns and cuts transistor leads to specific lengths, or cuts and notches to stand above the board for heat dissipation.

From a specific job, a rapid change of head will adapt the machine to serve a new job function. It will automatically straighten and align leads to the proper center distance so that the components will always exactly match the holes in the printed board.

Circle No. 229 on Subscriber Service Card.

Small Synchro-Timing Motors Are Produced

The A. W. Haydon Co. has announced the introduction of a new line of extremely thin synchronous timing motors for 25, 50 or 60 cycle operation in five standard voltage ratings.

Main features of these motors are: thin design with available torque equivalent to much thicker motors, and completely electrical operation.

Only 7/8" thick, these motors were designed to occupy considerable less space than other available motors. Mounting dimensions conform to The A. W. Haydon Co.'s standardized di-

mensions for timing motors, and those of the industry in general.

The design of these motors has eliminated the need for mechanical devices to control the direction of rotation of the motor.

The 22100 series motors meet all significant requirement of specification MIL-E-5272A, and are designed for applications where high performance, reliability and immunity to rugged environments are required. Also available is a non-military version (42100 series) for high volume industrial and commercial applications.

Over 125 standard output speeds from 300 rpm down to one revolution in six hours can be supplied with either standard or heavy duty gear trains. With a nominal 30 oz-in running torque at 1 rpm, these motors can be used in a wide variety of applications.

Circle No. 230 on Subscriber Service Card.

Low Noise Amplifier Has 11 Fixed Gain Steps

A chopper-stabilized, low noise and drift amplifier, designated Model 512-A, and featuring eleven fixed gain steps with continuous variable gain between each gain setting, has been produced by the **Allegheny Instrument Co., Inc.**

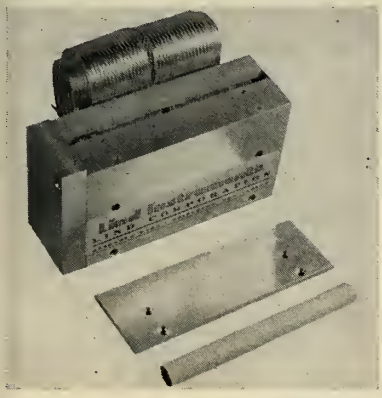
The Model 512-A is used for the amplification of signals from wire strain gage transducers, thermocouples or other low-level, low and medium output impedance signal sources. It can be used to drive pen-motors, light beam galvanometers, and cathode ray oscillographs, as well as modulators used in magnetic tape recording.

With a simple circuit change, this amplifier may be made operational or can be provided with a floating input. It is well suited for operations such as voltage summing, integration differentiation, etc.

Circle No. 231 on Subscriber Service Card.

Commutator Features Long Life, Reliability

A thermocouple and strain gauge millivolt telemetering commutator produced by **The Linde Corp.** is said to have 300 times the life and reliability of circular sampling switches.



The two pole, 60 contacts per pole switch takes only 11¼ cu. in., and weighs 12 oz. It samples 3 millivolt signals with ½% accuracy, and has contact resistance of less than 5 ohms. Redesign reduces wear by a factor of 300:1.

There are paired contacts and wipers for each channel, giving 1/60th the wear per contact, 1/5th the diameter for travel-produce, and 1/300th the wear and movement.

The commutator has a low mass system and self-cleaning, time-shared collector ring. The unit also has long motor brush life because negligible torque requirements mean low current drain by low-speed motors.

The unit will operate on 2/3rds watt power, and will operate from 36 to 2500 cps @ 25g's applied vibration, and withstanding 150 g's shock for 11 millisec.

Spiral helix provides a new approach to low-level switching. The unit is precision-machined to tolerances of ±.0001 inch. Phases to ±5%, and has a life at 10 rps in excess of 1000 hours.

Circle No. 232 on Subscriber Service Card.

Billet Heater Features Improved Control System

A new induction billet heater which provides an improved control system for accurately heating aluminum billets to precise temperature for extrusion is offered by the High Frequency Heating Division of the **Lindberg Engineering Co.**

The "metered BTU's" system measures watt-hour input to the billet with an integrating watt-hour meter and de-

. . . new missile products

termines, with a totalizing timer, the amount of energy absorbed by the billet. A means of compensating for the starting temperature of the billet is provided.

Thus, with a billet of known weight and known initial temperature, a predetermined amount of energy can be selected to heat the billet to the desired extrusion temperature. No prod type thermocouple (with its inherent inaccuracy and maintenance) is required.

With low-voltage power sources, stepless power control can be obtained by the use of saturable core reactors. This eliminates high contractor maintenance cost as well as providing control of the billet heating rate.

Circle No. 233 on Subscriber Service Card.

. . . York Interview

(Continued from page 21)

"Space is a place, not a program," he said.

His understanding of the nation's space set-up is that the National Aeronautics and Space Administration has the primary role in the field. It is charged, according to Dr. York, with not only the scientific applications in space but also the overall development of the means for exploring space.

"It has the overall exploratory responsibility, and we exploit their results. There is no reason to combine these. We do not need a new booster for every communications experiment we run," he said.

Dr. York pointed out that the military has been given certain space work, but only "by exception." DOD's function, Dr. York said, is to apply the NASA projects to military needs—"We can do what amounts to putting a requirement on them."

Does this affect lead times on military space systems? Dr. York's answer was, "In principle, no." In practice, "there are a lot of people on both sides of the fence. I myself feel neutral. I mean to (a) cooperate, and (b) make the best use of the system."

Nor does Dr. York see any great problem in defining each service's role in space. The criteria is whether the space application will benefit the service's needs, and Dr. York foresees navigational satellites for Navy, communications satellites for Army, early warning satellites for the Air Force, etc.

"Anyone should be able to use space if it benefits his mission," he declares.

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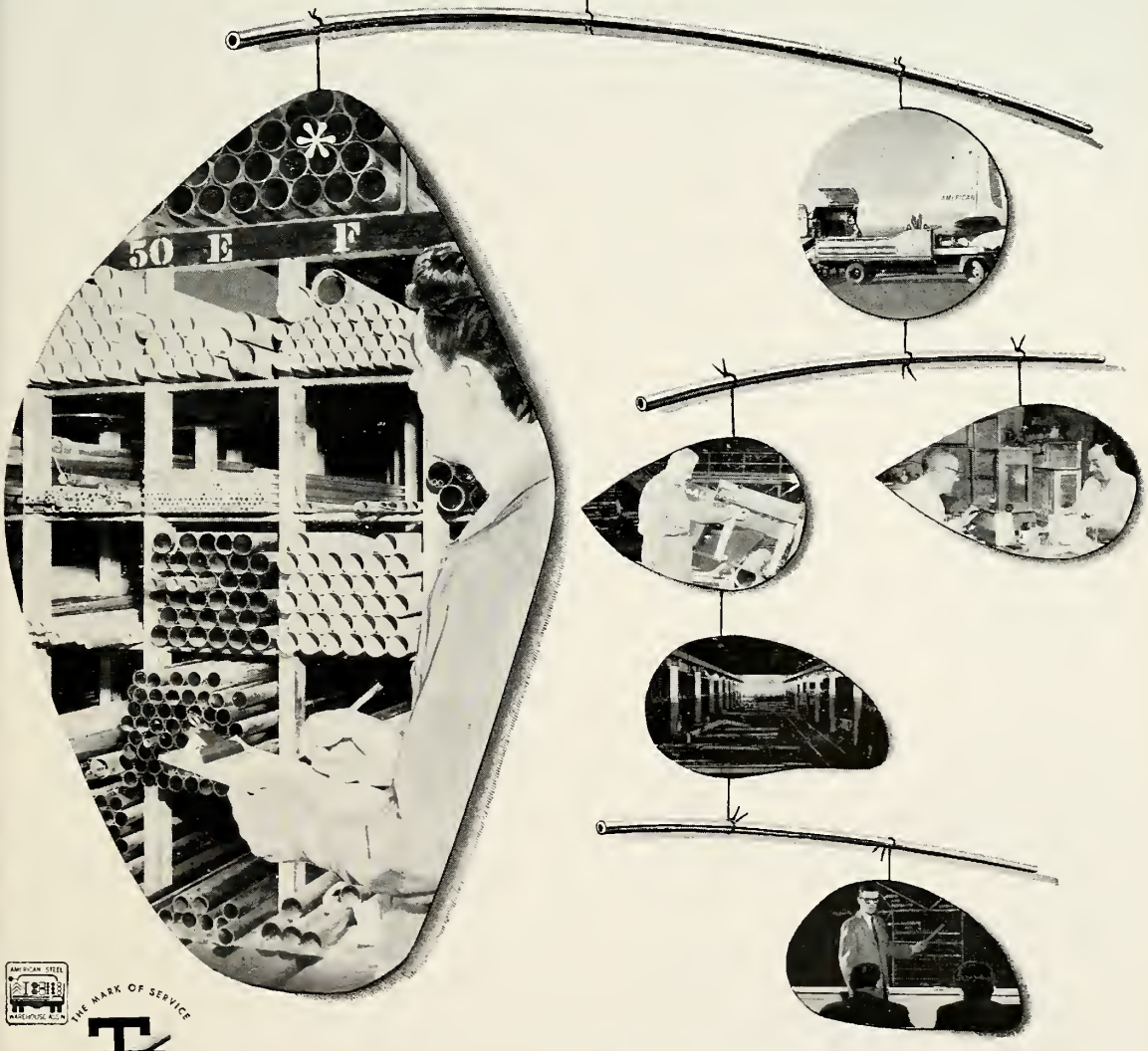

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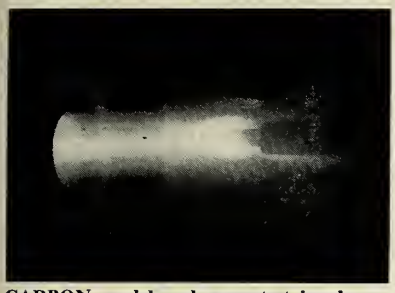


CARBON model undergoes test in plasma jet high temperature arc.

ARGMA's Plasma Jet Test Facility in Operation

Prototype model for aerodynamic heating tests reaches 50,000° Fusing argon gas with 13,000 fps flow rate

HUNTSVILLE—A new plasma-jet test facility is now in prototype operation at the Army Rocket and Guided Missile Agency here. Construction of the final version of this hyperthermal unit already has begun.

Temperatures up to a maximum of 50,000°F have been achieved with the prototype, and the final test facility, scheduled to be in operation sometime this spring, is designed for even greater capability.

The man behind this research program is Dr. Thomas A. Barr, Jr., a physicist and chief of the Magnetohydrodynamics Unit in the Agency's Ordnance Missile Laboratories Division. Dr. Barr, formerly a professor at the University of Georgia, initiated the program two years ago.

Using electric current to heat a gas, the test facility produces temperatures much higher than can be achieved through any chemical combustion process. At these temperatures, gases decompose, rather than combust. That is, following molecular breakdown, the atoms are dissociated into ions and electrons. Gases in this extreme state are referred to as plasmas.

• **Plasma-jet process**—The process for achieving such tremendous temperatures is simple in concept. The test facility consists essentially of three sections: the arc chamber, the test section, and a low-pressure chamber.

In the arc chamber are a water-cooled carbon electrode and a carbon nozzle, or ring. The electrode fits into, but does not touch, the nozzle. An external dc generator, connected between the electrode and the nozzle, provides the necessary energy to develop an electric arc in the gap between the two assemblies.

Pressurized gas introduced into the arc chamber moves through the electric arc stream and into the low-pressure area in the downstream chamber where a vacuum pump is employed. As the gas passes through the electric arc it undergoes tremendous heating, to a degree depending on the amount of electric power sent through the arc.

In the prototype, argon gas has been used principally since it is inert and has good electrical properties for conducting high currents. The gas flows through the arc in a supersonic jet, with a maximum flow rate of 13,000 feet per second. Thus the term plasma-jet test facility has developed. Characteristics of the new jet flow are regulated by adjusting the arc column, or electrode, in its position in the nozzle.

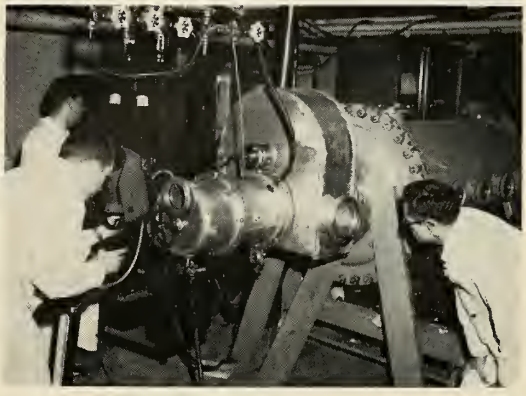
• **Material testing**—The high temperatures achieved by plasma-jet facilities are invaluable in testing materials which must withstand the extreme heat developed in missile flight—largely resulting from aerodynamic heating as a missile passes through the atmosphere.

The method also is useful for testing the high-temperature properties of various gases which may be used or encountered in missile development and flight, or in simulating stellar atmospheres.

Testing conducted in the prototype has been confined largely to that related to developing the final facility, rather than any testing related to a specific missile project.

• **New facility**—Like its prototype, the final test facility now being built will be unique in both design and functions. Electric power will be provided by six generators of the type used for main propulsion in World War II destroyer escort vessels. These generators will be capable of producing up to 8 million watts of electric power as opposed to the 75,000-watt capability of the single generator now in use in the prototype.

This increase in power will make it possible to heat a much larger body of gas. A number of operations, such as the controlling of arc power and regulation of the arc column, will be ac-



IN CARBON hemisphere test, 22 kw was delivered to the arc with an ambient pressure of 0.5 cm Hg. Heat transfer to a cooled (300°K) probe was 1.0 kw/cm².

complished automatically.

Thus, the new facility will be used for aerodynamic testing as well as high-temperature testing and properly can be termed a hyperthermal wind tunnel. When completed, it will serve the testing needs of all elements of the Army Ordnance Missile Command.

• **Preliminary research**—When Dr. Barr initiated the program in 1956, he reviewed literature in the high-temperature field to determine the best method for developing the required test facility. He selected the electric arc method as the easiest for producing sustained high temperatures. He put his first arc into operation in June, 1957, and the prototype facility now in use was completed six months ago.

He has been aided in his research by three highly experienced assistants: Walter LaVaughn Hales, Thomas G. Roberts and Charles M. Cason III.

In addition to the hyperthermal wind tunnel, Dr. Barr is developing a second facility designed to produce transient high temperatures up into the millions of degrees in low-density gases.

Narmco Project

Radar Reflector Said To Sharply Cut Weight, Cost

La Mesa, Calif.—The unique design principle of Narmco Manufacturing Company's recently announced radar reflector reportedly cuts weight and costs to a fraction of that of any other current construction method for large-scale paraboloidal-reflector antennas.

Dubbed TETRAC (TEnsion TRuss Antenna Concept), the design is adaptable to antennas of from something less than 100′ to over 400′ in diameter.

The TETRAC antenna consists of nine components, basically identical in design, but size-scaled in relation to antenna dimensions. Backing for the antenna "dish" is a series of five concentric, sectional-honeycomb, sandwich compression rings, supported and stabilized by pre-stressed radial inter-ring tension rods fitted like bicycle spokes.

The other four components are honeycomb sandwich sections which form the paraboloidal reflector surface. Total number of panels varies with antenna size as does the individual panel size, but design is identical for each of the four types.

The sandwich construction panels offer high rigidity with low weight. This appears to offer a considerable advantage for solid face surfaces used with high microwave frequencies. Acceleration and deceleration inertia loads are relatively low due to inherent light weight of the honeycomb structure—an aid in maintaining close contour tolerances of reflector surface.

It is claimed that an antenna of approximately 120′ diameter would be capable of holding a surface accuracy of ±0.125 in. in a 45-mph wind. Larger antennas of about 450′ diameter can be designed to hold surface accuracy of ±0.50 in. in a 35-mph wind.

The pre-stressed construction feature also permits relatively high resonance (from 15 cps up), due to low deflection under loading conditions. As a result, forces applied to mechanical and functional components are also low. Combined with the light overall weight, the two features make it possible to simplify the antenna pedestal and other related system components —both in function and cost.

Modular construction of panels and ring sections permits an installation or move of the antenna to a remote site with a minimum of difficulty. Ring sections could be jack-assembled on the ground and easily erected into position

in the field. Same technique might be applied to surface panels. Optical instrumentation could be used for precise alignment of components prior to erection. Rings are fitted with standoff pads for fine alignment of reflector-surface panels.

Cost-wise, the Narmco approach will vary considerably in relation to antenna size and surfacing materials used. However, it is claimed that system savings of several hundred thousand dollars can be achieved in antennas of around 100' in diameter. The company also states that overall systems savings would be much greater in very large diameter installations.

Some work has been done on the prototype of such an antenna to be used in target tracking as part of the *Nike-Zeus* system. An additional contract is expected shortly. The company hopes also to apply the TETRAC principle to radio astronomy fields, satellite tracking, and concentration of solar energy.

Sylvania Offers Measuring Unit for Solid State Devices

WALTHAM, MASS.—Faster and more accurate orientation of silicon and germanium crystals for transistors, diodes and other semiconductor devices may be possible with a new measuring instrument developed by Sylvania Electric Products, Inc.

The company says the new instrument is superior to conventional and more complicated reflection, microscopic and X-ray methods.

Transistors have as their center a tiny die of silicon or germanium with "zones" or layers of differing electrical properties. These zones are formed by allowing or diffusing minute quantities of special metals, such as indium or antimony, into the crystal structure.

Accuracy in the formation of these zones depends on precise alignment of the die surfaces with the molecular structure of the germanium and silicon.

The Sylvania measuring device uses a converging beam of light projected upon microscope etch pits on the surface of the material. The beam is reflected from the facets of the etch pits and split into a number of component rays equal to the number of planes comprising a single pit.

The planes behave like tiny mirrors which reflect these component rays to a screen in the form of a light pattern which can be interpreted by the operator immediately as to orientation.

Proposed price for the new orientation instrument complete with accessories and power supplies is $1500 per unit.

New Amplifiers Extend Missile Tracking Range

WASHINGTON—The recent use of newly-developed low-noise parametric amplifiers is largely responsible for new records in space communications. Highly successful tests of these amplifiers were conducted independently by two distant missile-tracking stations during the space probe flight of *Pioneer IV*.

General Electric engineers, at the company's test tracking station in Schenectady, N.Y., received signals from the probe at distances of more than 410,000 miles (m/r, March 16). Allan D. French, a consulting engineer from G.E.'s Heavy Military Electronics Department, was in charge of the tracking project.

The G.E. parametric amplifier was connected between the receiving system and a horizontally-polarized 18-ft. paraboloidal-reflector antenna having a 32-db gain. Operated in the L-band (1000 mc) region, it is a straight-through

amplifier with a pump frequency in the X-band. It uses a specially-designed parametric diode having a 1-db noise figure. The amplifier was developed by the G.E. General Engineering Laboratory.

A similar device in a system using a 14-ft. dish antenna enabled Army Ballistic Missile Agency crews at Redstone Arsenal to conduct experimental long-range tracking of *Pioneer IV*. Here, too, a parametic amplifier, developed by International Telephone and Telegraph Laboratories at Nutley, N.J., added more than 150,000 miles to the tracking-equipment range. The 13-lb space probe was tracked for a total of 37 hours to a distance of 215,000 miles before the test was discontinued.

Fred Kupersmith, test supervisor, stated that the received signal intensity, at the end of the test period, was weaker than –158 dbm. The strongest signal received was –143 dbm.

The ITT device functions much as other amplifiers, but it employs a small diffused silicon diode to produce a 90% reduction in interference resulting from static electricity and heat forces.

It was established at both stations that by employing either of the two tracking systems, without the support of its respective parametric amplifier, the faint signals would have been lost at around 50,000 miles and certainly long before the *Pioneer IV* batteries expired.

Rheem Co. and Baldwin Group Forming R&D Firm

SAN FRANCISCO, CALIF.—The Rheem Manufacturing Co. and a scientific and engineering group headed by Dr. E. M. Baldwin have announced plans to form a company for research, development and production in the field of semiconductors including silicon diodes, transistors and other devices.

Rheem will hold a majority interest in the proposed company, which will be operated as a subsidiary.

Plans call for a new plant at a site to be selected in the peninsular area south of San Francisco.

Heat Exchangers Are Used for *Atlas* and *Thor* Tests

LOS ANGELES—In-flight conversion of liquid oxygen to its gaseous state and controlled expansion of gaseous helium and nitrogen reportedly has been accomplished by a series of new heat exchangers manufactured by Waste King Corp.'s Technical Products Division here.

The heat exchangers are required to permit pressurization of liquid fuel tanks and structure during missile flights. Prototypes of the new heat exchanger are presently used on the *Atlas* and *Thor*.

The heat exchangers are made entirely of stainless steel in order to withstand the high-temperature rocket exhaust gases which are the heat source for the units.

The stainless steel design is a cylindrical shell which functions as an exhaust duct and through which a coiled tubing is passed.

The hot exhaust gases pass over the oils and convert the liquids flowing through the coils to a gas by the time they emerge at the other end of the exchanger.

Each unit is strength-tested with hydrostatic pressures up to 7500 psi

for the tubing elements and 25 psi with nitrogen for the shell structure.

The heat exchanger's operational life expectancy is rated at more than 2000 seconds.

The four basic types of missile heat exchangers produced by Waste King are: for liquid oxygen only (with twin tubing coil structure); liquid oxygen and liquid nitrogen; large size liquid helium only, (with triple tubing coil structure), for booster engines; and small-size liquid helium only, used on the sustainer engine.

Avco Pyrometer Measures High Surface Temperature

WILMINGTON, MASS.—An optical recording pyrometer capable of measuring material surface temperatures between 1400°C and 3000°C with millisecond response time has been announced by Avco.

Developed by their Research and Advance Development Division here, it is called the Auto-Optic Recording Pyrometer.

Employing a high-vacuum phototube, the device focuses monochromatic light, having a wavelength of 0.65

micron, on an opaque plate. A small aperture in the plate admits the radiant energy to the phototube. After amplification of the phototube output, the final output level can be observed directly in microamperes on a built-in meter at the rear of the pyrometer.

Measuring surface changes over a 3/8-in. diameter area, sample brightness temperatures with ±20°C can be obtained.

A remote recorder can be connected to the output of the pyrometer to provide a continuous record of temperature versus time. Using a recorder, the pyrometer may be operated unattended.

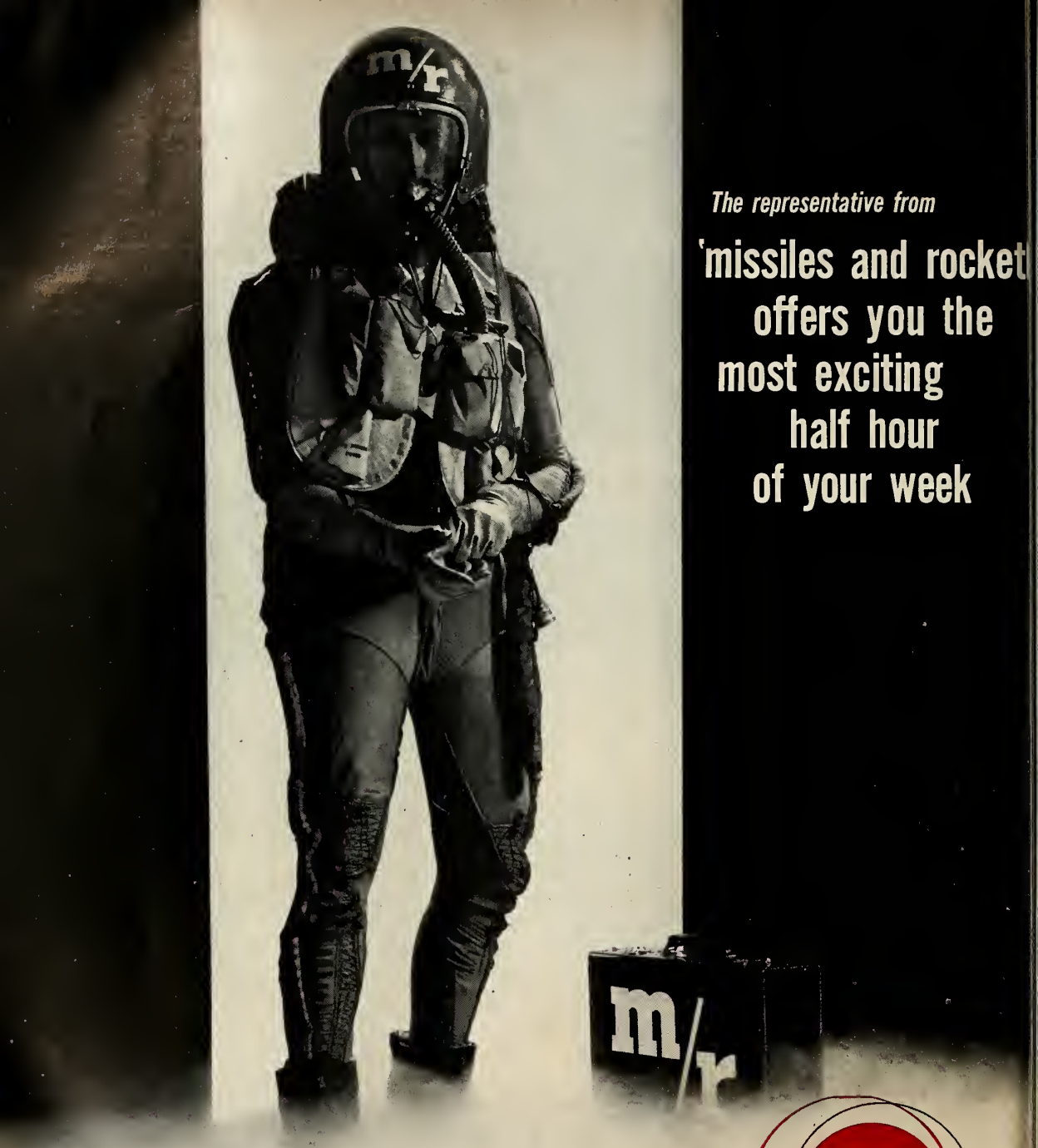
FIRETRAC System Proves Accurate Miss-measurer

FREDERICK, MD.—A highly reliable missile-tracking system for measuring "near-misses," developed here by Aerojet-General's Atlantic Division for the Navy Bureau of Aeronautics, has successfully completed recent operational evaluation tests at Point Mugu, Calif.

A *Sparrow III* air-to-air guided missile was used during the test firings at a target drone.

Designated FIRETRAC, the tracking system is essentially comprised of a four-channel receiver and standard-type telemetry transmitter, carried in a target drone, and a receiver and recorder installed in a ground station.

Four dipole antennas on the drone receive pulses from the approaching missile and the signal is automatically transmitted through a telemetering antenna to the ground recording station.



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The system utilizes phase comparison and operates in the VHF telemetry frequency band.

The system is highly sensitive within a "near-zone" of from four to five missile lengths. Within this zone, relative trajectory, velocity, and miss-distance of a missile with respect to a target drone can be computed within 5%. Until the drone is hit, any number of near-misses can be recorded intelligently as long as a finite time lag exists between missile approaches.

The ground station tape recordings provide a permanent history of all firings.

Data obtained from the FIRE-TRAC system could contribute to the development of better missile systems and more accurate guidance fusing subsystems.

Pioneer IV Had Ceramic Tube for High Frequency

OWENSBORO, KY.—Part of the credit for the successful tracking of *Pioneer IV* beyond 400,000 miles belongs to a small ceramic transmitting tube produced by the General Electric plant here.

The tube—a receiving type 7077, a half-inch long and a half-inch in diameter—allowed the probe to transmit with an output of 200 milliwatts at 960.05 megacycles. The higher frequency, as compared with the previously-used transistor transmitting frequencies of 108 megacycles, permits more accurate tracking.

The higher frequency signals are less subject to bending and reflection by the ionized layers of the upper atmosphere and also require less cumbersome tracking antenna.

Commerce Dept. Says *Sputnik IV* May Be Up

The Soviets may have orbited *Sputnik IV*.

This and other information about the Russian IGY program from Soviet and other foreign publications is contained in a Department of Commerce bulletin prepared by the Office of Technical Services.

The bulletin quotes an article appearing in *La Libre Belgique*, a Brussels newspaper, on Jan. 31, reporting that the Bochum Public Observatory in West Germany picked up radio signals on 20.5 megacycles at 7:46 on Jan. 31.

These signals, which differ from those of *Sputnik III*, were heard three times in the space of 104 minutes and always began several minutes after the signals from *Sputnik III* were heard.

propulsion engineering

NATO will look at propellant chemistry during a June meeting in Paris. The discussion shouldn't embarrass U.S. representatives since it is not classified. However, during NATO classified meetings on strategy or advances in weapons, our people are often lost. A major gripe: meetings are run as if each delegate had read all the papers in advance and was prepared to ask questions. NATO headquarters marks the papers "NATO Classified" before sending them to member countries. In the U.S., that means "Secret." Many times, U.S. representatives do not see the reports until they are presented, which gives little opportunity for discussion.

Navy lost its only source of one type of high-temperature gyroscope floating oil used in missiles in the Lehigh Chemical plant, Chestertown, Md., fire . . . Trouble in the USS Seawolf was not in the reactor. Shutdown was caused by leaks in the external sodium loop, not in the reactor which operated over two years without maintenance.

Titanium may be in for a comeback after more than a year of near obscurity. NASA reveals that titanium will play a leading part in McDonnell's manned space capsules. Tonnage-wise, this will not be significant. However, it can be regarded as "proof of the titanium pudding" for potential users. JPL used titanium instead of stainless steel in the final stages of the *Explorers* and *Pioneer III*, cutting weight by two pounds to permit additional instrumentation. In *Mercury*, titanium will be used as a covering and in critical spots. Major structural materials will be nickel-steel alloys. Ceramic-metal combinations probably will not be used in the capsules at all. Beryllium will be used for the re-entry heat shield.

Beryllium will be available from British sources before the year is over. Imperial Smelting is putting up a thermal reduction plant at Avonmouth. It will produce nuclear-grade beryllium for canning fuels used in high-temperature reactors. Although the company will not reveal the plant's capacity, officials say another plant will be built if British demand for beryllium reaches the almost undreamed figure of 100 tons/yr by 1965.

Red fuming nitric acid apparently has met defeat in its war of destruction. The conqueror: Compound 18007. Not too much has been said, but Precision Rubber Products, Dayton, reveals that the new material can handle all missile applications involving RFN.

More research is coming on special materials for missile and atomic energy uses. Calumet & Hecla's Wolvering Tube Division is tripling its facilities at Allen Park, Mich., to intensify studies on titanium, molybdenum, zirconium, niobium, vanadium, tantalum, and tungsten. Some of the fabrication techniques will include hot and cold extrusion, high-velocity forming and spin forming.

Retiring Atomic Energy Commissioner Willard F. Libby tells friends he hopes AEC will act on one bit of parting advice: Go more into basic high-temperature materials research needed to backup critical programs particularly in reactor projects.

Nitrogen tetroxide is now available from Hercules Powder's California plant, completed in December. N_2O_4 is being shipped in one-ton cylinders and tank cars.

The rubber vs. plastic propellant feud continues in full swing, with no hope for an early government specification which would say in effect "This is our choice." The first two stages of NASA's project *Scout* underline this. The Aerojet *Senior* is urethane; the improved Thiokol *Sergeant* is polysulfide rubber; and the scaled-up *Vanguard* third stage by ABL may feature an entirely new type of fiberglass case.

State Department no longer controls export licenses for silicon transistors. Department of Commerce has taken over licensing because of its increasing industrial use. Until recently, silicon transistors were primarily military items. They still require individual export licenses—under Bureau of Foreign Commerce's positive list, Schedule B, No. 70848—for shipment to anyplace except Canada.

missile people

The Defense Department has named **George P. Sutton** to be chief scientist of the Advanced Research Projects Agency, succeeding **Dr. Herbert York,** who has moved up to become the Pentagon's director of research and engineering.

Sutton is a professor of aeronautical engineering at the Massachusetts Institute of Technology. Earlier, he was an engineer with the Rocketdyne Div. of North American Aviation and the Aerojet Engineering Corp. At 38, he has had 16 years' experience in rocket-missile work. He was a founder and first president of the Southern California Section of the American Rocket Society.

Sutton

Dr. Hector R. Skifter has been named Assistant Director of Defense Research and Engineering, under York. He will be responsible for technical evaluation and integration of weapon systems and planning and supervision of the development of new systems. He is on leave of absence as president of Airborne Instrument Lab., Div. of Cutler-Hammer.

Lockheed's former chief scientist, **Dr. Louis N. Ridenour,** has been named to head its new Electronics and Avionics Division. The new division, according to the company, was set up "to further diversify operations and expand participation in the military and industrial electronics markets," and will launch Lockheed into quantity production and marketing of electromechanical products.

Ridenour

Ridenour was chief scientist of the U.S. Air Force in 1950 and 1951, assistant director of the Radiation Laboratory at Massachusetts Institute of Technology during World War II, and served as chairman of the U.S. Air Force Scientific Advisory Board committee that led to establishment of the Air Research and Development Command. He joined Lockheed in 1955.

Dr. D. B. Duncan, manager of advanced engineering for the Autonetics Division of North American Aviation, will serve as a member of NASA's Advisory Committee on control, guidance and navigation.

west coast industry

By Fred S. Hunter

Among the larger West Coast companies, look for Marquardt Aircraft Corp., the ramjet producer, to be the next to change its name, removing the word "aircraft" and reducing it to Marquardt Corp. This is scheduled to take place in May. There will be others following the trend started by Whitley Collins when he decided to change Northrop Aircraft, Inc., to Northrop Corp.

We have heard that Lockheed Aircraft Corp., has discussed changing its name to more properly reflect its diversified activities, but so far as we know there has been no decision. However, the Lockheed Missile Systems Division recently changed over to Lockheed Missiles and Space Division, so you can see that they are name-conscious at Lockheed.

We rather doubt that any change is imminent at the Douglas Aircraft Co. Donald W. Douglas takes a great deal of pride in the airplanes his company has turned out over the last 35 years, and we don't think he will be in any hurry to disassociate the family name from the product it has been producing so successfully, no matter how the company may diversify.

It is also safe to predict that North American Aviation will stick to its present name. There are many companies in various fields using the "North American" name (North American Van Lines, North American Life Insurance Co., etc.), and a few years ago NAA went into court to protect its exclusive right to the name in the aviation field, winning a restraining action against a non-scheduled air carrier which had called itself North American Airlines. From a legal standpoint, it is much simpler for NAA to stay as it is.

If the directors of North American Aviation decide at the close of the year that the company's Fiscal 1959 earnings justify sweetening the regular 40¢ quarterly dividend with a year-end extra—and the way things look now, we would say this is very likely to happen—it will be paid in cash—not in stock. While NAA's dividend policy has been reasonably liberal, it has never embraced the payment of extras in stock.

Two stockholders took to the floor at the recent annual meeting to urge NAA to declare stock dividends because of the tax advantage. President J. L. Atwood replied that the directors would give consideration to such an action, but he indicated that if NAA could afford a higher dividend, the board undoubtedly would vote to make the distribution in cash. "A stock dividend is just something you already own," observed Board Chairman J. H. Kindleberger.

Marquardt Aircraft Corp. recently announced that two of its vice presidents, W. H. Schwebel and Don L. Walter, had been elected directors of the company. Generally overlooked was the fact that they have replaced two directors who had represented Olin Mathieson interests on the Marquardt Board—William C. Foster and Harry A. Sosnoski, both vice presidents of the Olin Mathieson Chemical Corp.—thus formally ending the former close affiliation between the companies.

Olin Mathieson, at one time, was Marquardt's biggest stockholder, with its holdings amounting to 25%. This distinction now belongs to the Nelson Rockefeller interests, with holdings amounting to 20%, which, it might be added, Rockefeller is retaining.

Lockheed Missiles and Space Division has developed its own airborne magnetic tape recorder to answer its need for a lightweight, versatile communication unit for scientific space missions. It says its Palo Alto research laboratory developed the recorder in one-fourth the time and one-fifth the cost asked by an outside manufacturer for the same job.

The 1959 Western Space Age Conference and Exhibit was better managed, more orderly and, we believe, more profitable to the participants than the first show held last year.

40 Nations To Be at World Flight Congress

LAS VEGAS—The United States will be staging a virtually one-nation missile and space show at the first World Congress of Flight. Russia isn't coming.

No invitation to participate was extended to the Soviet Union because reciprocal State Department travel restrictions post Nevada "off limits" to citizens of that country.

Hence, Russian scientists will miss a scheduled first public unveiling of the *Mercury* manned space capsule, showing its retro-rocket installation and pilot control monitor.

Conversely the Soviets will miss an excellent opportunity to show off some of their own space hardware to the free world. More than 40 of 77 invited nations, including Czechoslovakia which is not barred from Nevada, have signified they will send delegations to the Congress here April 12-19.

Lack of Russian representation may cloud somewhat the high aims of the conference, but not its effectiveness as a massive clearinghouse for exchange of technological information. The project is dedicated to the "belief that greater world knowledge of aircraft, missiles and spacecraft—in realistic perspective—will help bring the world closer to permanent peace."

A spokesman for the sponsoring Air Force Association said Las Vegas was picked before invitations went out in January. Proximity to the desert over which air shows will be staged, availability of nearby Nellis AFB, hotel and meeting accommodations determined the choice. "We wanted to invite the Russians, but found we couldn't because of the ground rules," AFA told m/r.

In scope, the exposition is the most ambitious undertaking of the AFA since it inaugurated Jet Age Conferences in Washington a few years ago. Executives of 1000 or more American companies, hundreds of scientists, engineers and technicians representing all components of the missile-space and aircraft industries are expected to attend.

At least 150 companies have taken exhibition space. In the international array of aircraft and space hardware will be a "walk-in" display of the 85-ft. *Atlas* ICBM. There will also be a military firepower demonstration.

Six of 11 symposiums to be conducted in the new Las Vegas auditorium, a saucer-shaped 7500-seat structure just off the gambling "Strip," will be devoted to space, missiles and R&D. They include:

—Aircraft and Space Communications sponsored by the Electronics Industries Associations. Papers will be presented by D. M. Cutler of ITT Laboratories, satellite communications; M. Berkowitz of GE, space cabin communication system design; and Stanley Plass of Packard-Bell Electronics Corp., pre-flight radiation test equipment.

—International Air Force Research sponsored by the Air Research & Development Command. Presenting papers on basic research required by military aeronautics and astronautics will be Brig. Gen. B. G. Holzman, AF office of scientific research; Col. Nathan L. Krisberg, commander of ARDC European office; Dr. B. K. Lundberg, director, aeronautical Institute of Sweden; Dr. Samuel S. Steinberg, rector, Institute Technologico de Aeronautics Sao Jose Dos Compos, Sao Paulo, Brazil; and Prof. Itiro Tani, Institute of Science & Technology, University of Tokyo.

—Missile Management, including presentations and panel discussions on weapons management, industrial problems of limited production, industry's future in space age R&D and the Prime-Sub contractor relationship.

—Advanced Air Traffic Control and Navigational Aids Concepts, including presentations on possible use of space platforms and satellite for traffic control; advanced navigational aids, such as Doppler systems, inertial guidance and hyperbolic systems, and their aircraft applications.

—Space Age, including progress reports on space exploration, presentations and discussions on the impact of science and technology on military posture and economic activity and a panel presentation on the interaction between scientific progress and man's philosophical problems and outlook.

As m/r went to press, the full program had not been completed. However, the AFA said other speakers definitely would include ARPA Director Roy Johnson, Dr. W. Randolph Lovelace, chairman of NASA's Man-In-Space Committee; Dr. Abe Silverstein, NASA director of space flight and development; Col. Carlo R. Tosti, special assistant to commander, ARDC; and Dr. Edward Teller of the University of California Radiation Laboratory.

contract awards

Boeing Airplane Co. reportedly has a government contract to study the question of placing an observatory on the moon.

George H. Stoner, general manager of Boeing's *Dyna-Soar* program, recently described the observatory as an example of the type of program Boeing is working on. Speaking in Seattle, Stoner did not identify the government agency for which the company is undertaking the studies, but he said it is many years away.

Martin has a team analyzing moon base requirements. One segment of their study was finished in August, 1957.

Other awards:

ARMY

$12,419,415—**Blount Bros. Construction Co.,** Montgomery, Ala., for construction of *Titan* and *Atlas* launch facilities and utilities at Warren AFB.

$1,455,197—**Aerojet-General Corp.,** for R&D.

$1,142,476—**Douglas Aircraft Co., Inc.,** for *Nike* repair parts and launching area items.

$714,070—**R. E. Clarson, Inc.,** St. Petersburg, Fla., for construction of Azusa facilities at Patrick AFB.

$660,230—**Warner Construction Co.,** San Angelo, Tex., for special weapons assembly facility at White Sands.

$660,000—**Telecomputing Corp.,** for overhaul of *Nike-Ajax* rate gyros and amount gyros.

$620,472—**Rocketdyne Div., North American Aviation,** for classified contracts.

$500,000—**General Electric Co., Missile and Space Vehicle Dept.,** for R&D of warhead arming and fusing system for *Little John.*

$477,883—**Chavis Construction Co., Inc.,** Pensacola, Fla., for construction of missile facilities at Eglin AFB.

$351,287—**Gilfillan Bros., Inc.,** for *Corporal* repair parts.

$296,901—**Electro-Optical Systems, Inc.,** for R&D.

$166,049—**Western Electric Co., Inc.,** for *Nike* spare parts and components.

$165,823—**Fred A. Arnold,** Los Angeles, for R.I.M. Building at Vandenberg AFB.

$143,650—**The Firestone Tire & Rubber Co.,** for *Corporal* repair parts and ground equipment.

$141,335—**Western Electric Co., Inc.,** for engineering services and training aids for improved *Nike-Hercules* system.

AIR FORCE

$18,681,124—**Sperry Gyroscope,** for radar sets, spares, data, installation and report.

$3,313,488—**Raytheon Mfg. Co.,** for electron tubes (four contracts).

$1,283,095—**Convair Div., General Dynamics,** for increase in funds (two contracts).

$725,000—**Republic Aviation Corp.,** for research.

NAVY

$3,329,797—**Packard Bell Electronics Corp.,** for integrated electronic central equipment.

book reviews

THE SCIENTIFIC REVOLUTION, edited by Gerald W. Elbers and Paul Duncan, Public Affairs Press, Washington, D.C., 275 pp., $6.00.

This book puts in print the periodic cry for drastic changes in our scientific age. In this case, the clarion call comes from 34 of the leading participants in the 1958 Yale conference on "America's Human Resources to Meet the Scientific Challenge." Each of them has contributed a chapter to the book.

While it probes varying aspects of the problem deeply, it offers few promising solutions. Agreed: we need better teachers, better courses, a better educational system that would cull the brightest students into separate classes, better understanding between scientists and the public, better use of research and development funds and more of them, and better pay for government scientists.

While varying solutions are offered, consensus seems to be that before any effective answers are possible, there must be a dramatic change in attitude on the part of the American people.

Anthropologist Margaret Mead calls for a new kind of education beginning in the nursery "which will make children not into a mass of non-scientists and a few scientists, but into citizens of a civilization in which everyone has a stake in understanding the meaning of science."

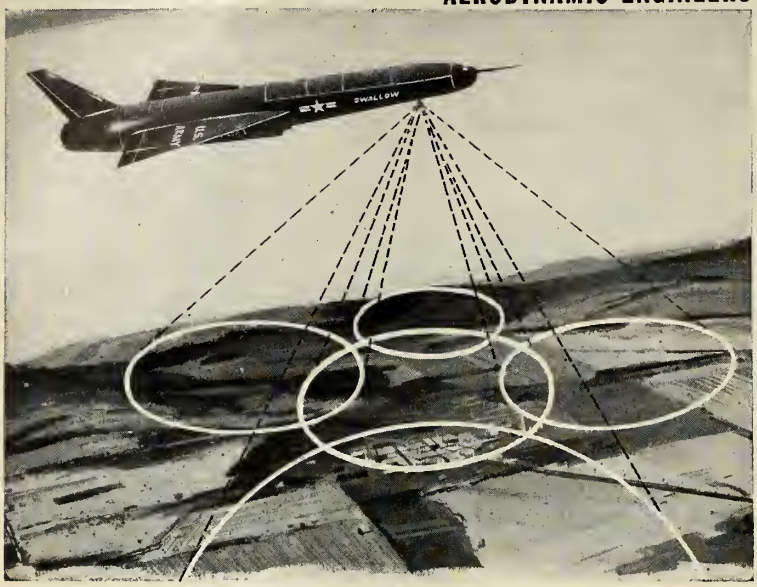
She gives examples of the mistrust some young minds entertain about the field by quoting compositions submitted by high school girls on the subject, "My Neighbor Who is a Scientist." A typical excerpt: "I wouldn't want a scientist living next door to me because anything might happen."

Another one, which has been echoed from other quarters and which scientists might well consider: "He should know how to get along with people that aren't as smart as he is."

PROGRESS IN METAL PHYSICS, edited by Prof. Bruce Chalmers of Harvard University, Pergamon Press, 408 pp, $16.

A seventh annual review of published material in the field, with selected chapters dealing with equilibrium, diffusion and imperfections in semiconductors, physical metallurgy of titanium alloys, thermodynamics and kinetics of martensitic transformations and the storage of energy in cold-worked metal.

AERODYNAMIC ENGINEERS



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when and where

MARCH

American Rocket Society, 1959 Sectional Meeting, Daytona Plaza Hotel, Daytona Beach, Fla., March 23-25.

Institute of Radio Engineers, National Convention, Coliseum and Waldorf-Astoria Hotel, New York, March 23-26.

Society of the Plastics Industry, 16th Annual Conference, Pacific Coast Section, Hotel del Coronado, San Diego, March 25-27.

American Society of Mechanical Engineers, Instruments and Regulators Division Conference, Cleveland, March 29-Apr. 2.

Society of Automotive Engineers, National Aeronautic Meeting, Hotel Commodore, New York, March 31-Apr. 3.

APRIL

Conference on Electrically Exploded Wires, sponsored by the Thermal Radiation Laboratory of the Geophysics Research Directorate of the Air Force Cambridge Research Center, Somerset Hotel, Boston, Apr. 2-3.

American Society for Quality Control, Portland Chapter, Oregon Museum of Science and Industry, Portland, Apr. 3-4.

1959 Nuclear Congress, Municipal Auditorium, Cleveland. For information: Engineers Joint Council, 29 West 39th St., New York, Apr. 5-10.

American Welding Society, 1959 Welding Show and 40th Annual Convention, International Amphitheatre and Hotel Sherman, Chicago, Apr. 7-10.

Air Force Association, World Congress of Flight, Las Vegas, Nev., Apr. 12-19.

Aeronautical Training Society, 17th Annual Meeting, Las Vegas, Apr. 16-17.

American Society of Tool Engineers, Annual Meeting, Schroeder Hotel, Milwaukee, Apr. 18-22.

American Rocket Society, Man-in-Space

(Continued next page)

. . . when and where

(Continued from page 52)

Conference, Hotel Chamberlain, Hampton, Va., Apr. 20-22.

Institute of Radio Engineers, Spring Technical Conference on Electronic Data Processing, Cincinnati Section, Engineering Society Bldg., Cincinnati, Apr. 21-22.

Institute of Environmental Engineers, 1959 Annual Meeting, La Salle Hotel, Chicago, Apr. 22-24.

American Rocket Society, Controllable Satellite Conference, Massachusetts Institute of Technology, Cambridge, Apr. 30-May 1.

MAY

Institute of Radio Engineers, 11th National Aeronautical Electronics Conference, Dayton, Ohio, May 4-6.

Instrument Society of America, 5th National Instrumentation Flight Test Symposium, Seattle, May 4-7.

International Scientific Radio Union, Spring Meeting, Willard Hotel, Washington, D.C., May 5-7.

1959 Electronic Components Conference, Benjamin Franklin Hotel, Philadelphia, May 6-8.

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NEW PRODUCT BRIEFS

WER AMPLIFIER. Designed to ex- d the effective range of standard emetering transmitters in the 215-260 gacycle band, the Model A-25 RF ver amplifier features miniature con- action, stablized circuitry, and im- ved thermal characteristics. A full watt output is claimed with a 2 t input drive; input and output nomi- 50 ohms. Circuitry and sectionalized chanical construction permits full ver operation without the usual re- rement for blowers or other forced cooling. Only 42 cubic inches and pounds, the supply requirements are volts plate, 225 volts screen and ier 6.3 or 12.6 ac/dc filament. The 5 is primarily designed for FM or systems, however, it is adaptable AM with slightly reduced power put. All tuning controls and monitor- test points are located on the front el so that alignment can be ac- plished without removing the cover. A-25 is designed for operation er the usual environmental condi- s specified for missile telemetry.

le No. 240 on Subscriber Service Card.

WER SUPPLIES. A series of high age power supplies providing un- al compactness at higher currents less ripple have been developed produced by the Condenser Prod- With a simplified circuit design, del PS15-5M60S requires input volt- of 118 VAC-60 cycles, with out- of 15 KVDC at 5.0 MA. Ripple is than 1% at full rated output. Only /16 x 3-¾ x 9 inches in height, the is hermetically sealed in an oil- d housing and is operable in tem- atures up to 85°C. Either silicon or nium rectifiers may be used in as- bly. Circuit configuration ranges n half wave to full wave doubler full wave tripler. This power sup- because of its small size, is par- larly useful in such applications as orne radar, electrostatic precipita- , infrared, irradiation and x-ray chines.

e No. 241 on Subscriber Service Card.

NTACT INSERT. A push-in con- insert designed for high-speed termination of high reliability are ng introduced by the Pyle-National With the inserts, contacts are ped automatically or semi-auto- ically to wires outside of the con- nector, with ample space for working and inspecting the secureness of the crimp. A cross-hold in each contact permits ready inspection of the termination joint to determine the depth of the wire engagement. A hand tool developed especially by Pyle-National for use with the new inserts is available for inserting the contacts into the premounted resilient insulation within the connector barrel shell. Retention ability of the resilient insulation exceeds the requirements of MIL-C-5015C, even after many reassemblies. Failures due to heating or faulty wire termination are said to have been eliminated by the crimped joint which actually is stronger than the wire itself. Push-in application of the contacts reduces the possibility of circuitry errors because contact positions are plainly identified. Should a placement error occur, it is corrected by removing the contact and relocating it in its proper position. Identified as Pyle Mod. 2 insert, the new two-piece units can be furnished with up to 100 poles for wire sizes 16, 12, or 10, with no sacrifice of environmental resistance. They can be used interchangeably with the Pyle Mod. 1 three-piece inserts within standard Pyle-Star-Line connector barrels.

Circle No. 242 on Subscriber Service Card.

MAGNETRON. A new fixed-frequency K-band magnetron, ruggedized for missile applications, has been announced by Sylvania Electric Products Inc. The new tube, type M4154, delivers a minimum peak power output of 20 kilowatts. The tube is given a 30 g vibration test at 20 to 2000 cps, and shock tests which simulate missile conditions. The tube's adaptability to missile applications is said to have been achieved in part by cathode ruggedization, and special high pressure windows.

Circle No. 243 on Subscriber Service Card.

SEQUENCE INDICATOR. The Opad Electric Co.'s model VA7 phase sequence indicator provides a means of rapidly determining the order in which the voltage peaks occur in a three-phase power source. This panel mounting instrument has been designed for 'built-in' applications and can be used for integration in test stands, panel boards and special equipment whose satisfactory operation is dependent upon proper phase sequence.

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MARCH 23, 1959

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• • Advertisements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224
225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

• • New Missile Products

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MISSILE LITERATURE

CERAMICS. The Electro Motive Mfg. Co., Inc. has published a new six-page folder, describing the tough qualities of El-Menco Ceramic Disc Capacitors. The folder includes complete specifications dete, charts, and graphs on the performance capabilities of the following capacitors: TS-Temperature Stable—designed for applications where a minimum capacitance change with temperature is required; SS-Semi-Stable—general purpose with stability; GP—general purpose units by bypassing, coupling or filtering applications often referred to as the "space-saving" capacitors since they provide very high capacity in relation to size; TC—Temperature Compensating—for resonant circuit applications where stability of capacitance characteristics is essential.

Circle No. 200 on Subscriber Service Card.

COAXIAL CABLES. Full information on its line of miniature coaxial cables—both military and commercial specifications—is supplied in a 4-page catalog issued by The Rex Corp. It contains temperature-rating data for each type jacket Rex supplies, minimum tensile strength and minimum 0/0 elongation standards—to which Rex coaxial cable conductors conform, and a table covering Rex standards for miniature coaxial cables insulated with a uniform wall of extruded polytetrafluorethylene (Teflon) and shielded with a minimum of 40 microinches of silver plating on copper. Information on electrical characteristics also is included. Rex manufactures and stocks as standard items miniature coaxial cables with all types of plastic insulation which meets or exceeds all relevant military specifications and comparable commercial specifications.

Circle No. 201 on Subscriber Service Card.

GAS SERVO SYSTEM. Publication GEA-6846, 4 pages by General Electric Co., discusses the design of the system and its application to flight control surface actuation, rocket thrust vector control, or nuclear control rod actuation. Its light weight, reliability, high-temperature capability, flexible performance capabilities and energy sources are also described and illustrated.

Circle No. 202 on Subscriber Service Card.

CAPACITORS. A technical publication on what to expect from tentalum capacitors of the wet electrolytic type has just been released by Fansteel Metallurgical Corp. The 16-page booklet discusses their capabilities and limitations under verious electrical and electronic service conditions and shows representetive applications. In addition, the two-color publication includes tables, charts and curves.

Circle No. 203 on Subscriber Service Card.

LIQUIFIED GAS. A new six-page folder, describing a complete line of small containers for the transport and storage of liquefied gases, is available from Linde Co. Its folder includes descriptions, design features and performance data for containers ranging in capacity from 1 to 100 liters. I[illegible] includes the new 25-liter aluminum c[illegible] tainer, which has a special insulation [illegible] minimize evaporation losses.

Circle No. 204 on Subscriber Service Ca[illegible]

PHOTO REPRODUCTION. A new fo[illegible] page illustrated folder describing [illegible] features and accessories of Keuffel [illegible] Esser Co.'s micro-master 105 mm ph[illegible] reproduction system for engineer[illegible] drawings is available for distributi[illegible] The folder describes how the mic[illegible] master system reproduces almost [illegible] size drawing, restores smudged or w[illegible] originals to almost perfect legibil[illegible] guarantees distortion-free accuracy, a[illegible] by producing permanent negatives [illegible] archival quality allows economical est[illegible] lishment of a disaster storage file. [illegible] addition to a brief technical descr[illegible] tion of the micro-master camera co[illegible] ponents, the folder explains the mic[illegible] master concept as a totally integrat[illegible] system for photographing, film proce[illegible] ing and final reproduction or project[illegible] printing.

Circle No. 205 on Subscriber Service Ca[illegible]

RACKS. Stone & Smith, sheet me[illegible] fabricators for the aircraft and miss[illegible] industry, has issued a brochure descr[illegible] ing the company's new line of [illegible] modular electronic racks and cabine[illegible] Seven sizes of vertical racks in heig[illegible] from 26½" plus 3" pedestal [illegible] 82⅞" plus 3" pedestal in choice [illegible] depths from 22" thru 30". The catal[illegible] illustrates means of combining parts [illegible] form any given console, lists part nu[illegible] bers and gives working dimensions.

Circle No. 206 on Subscriber Service Ca[illegible]

TECHNICAL DATA. McCormack Sel[illegible] Associates hes published and is now r[illegible] leasing their New Technical Data bo[illegible] The book will contain product specific[illegible] tions, performance data, description a[illegible] illustrations on ell Mc/S/A explosi[illegible] ordnance products—explosive bolts, g[illegible] generators, pressure cartridges, ignite[illegible] squibs, initiators, destructors and oth[illegible] explosive systems and devices.

Circle No. 207 on Subscriber Service Car[illegible]

MICRO PROBES. A literature list [illegible] micro probe research is available grat[illegible] from the Instruments Div., Philips Ele[illegible] tronics, Inc. The tabulation of publishe[illegible] papers includes 73 articles which a[illegible] pear in domestic and foreign public[illegible] tions.

Circle No. 208 on Subscriber Service Car[illegible]

COMPUTER TEXT. A new textbook [illegible] the basic principles, language an[illegible] characteristics of electronic compute[illegible] has been issued by the Radio Corp. [illegible] America. The 114-page book, entitle[illegible] "The Languege and Symbology of Dig[illegible] tal Computer Systems," explains mar[illegible] of the basic characteristics of con[illegible] puters. It discusses Boolean algebra i[illegible] practical terms, and contains a cro[illegible] reference of logic diagrams and sym[illegible] bols used by various computer manu[illegible] facturers and a dictionary of comput[illegible] terminology.

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NEW ENGINEERING IMPROVEMENTS THROUGHOUT

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- Greater accuracies — Static: 0.1%; Dynamic: 0.2%.
- 0.05% internal calibration.
- High precision internal Zener diode reference.
- New improved vacuum hold-down system.
- Vernier control between ranges.
- Input function modules in rack mountable case can be removed from plotter for remote operation.
- Calibrated scales on both axes.
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- Vacuum release on front panel.
- Visible ink supply.

One basic plotter with input modules available for general purpose, computer, low level differential, time base, curve following and other specialized functions.

	Model 41D Computer Module	Model 42D General Purpose Module	Model 43D Low Level Differential Module	Model 45D Curve Follower Module	Model 46D Time Base Module
Input	Single Ended	Single Ended	Differential	Single Ended	Single-Ended
Ranges	0.1, 1.0, 10v/in, calibrated vernier	16 steps, 1m v./in to 100 v./in, plus vernier	16 steps, 1m v/in to 100 v/in, plus vernier		0.1, 0.2, 0.3, 0.6, 1.0, 2.0 in/sec
Accuracy: Static Dynamic	±0.1% F/s ±0.2% F/s	±0.1% F/s ±0.2% F/s	±0.15% F/s ±0.2% F/s	±0.25% F/s	(time) ±1.0% F/s
Linearity				±0.1% F/s	(sweep) ±0.5% F/s
Input Resistance	2 megs, all ranges	1 meg to 3 megs Oepending on range	1 meg to 3 megs Oepending on range		
Zero Adjust	Full scale X and Y plus 9" offset	Full scale X and Y plus 9" offset	Full scale X and Y plus 9" offset		
Reference	Internal Zener diode and external ±100v computer	Internal Zener diode	Internal Zener diode		Internal Zener diode
Calibration	Internal 0.1, 1.0, 10v Accurate to ±0.05%				
Common Mode Rejection			0C, 120 db AC, 100 db at 60 cps		
Max. Common Mode Voltage			50 v dc or peak ac		
Principle of Operation				60 cps magnetic induction	Electronic integration
Zero Drift				None	

Dimensions All Modules: 8½" W x 3½" H x 7¾" D

Model 400 Plotter

Recording Size: 10" x 15"
Slewing Speed: X, 40"/sec; Y, 30"/sec
Inputs: X and Y inputs, and computer reference
Power: 115 ±10 v, 60 cps
Dimensions: 19" W x 19½" H x 11¾" D
Ambient Temperature Range: 0-55°C
Controls: Power off, standby, operate, pen; vacuum release; curve follower, amplifier; local, remote.

3540 Aero Court
San Diego 11, California

Electro Instruments, Inc.