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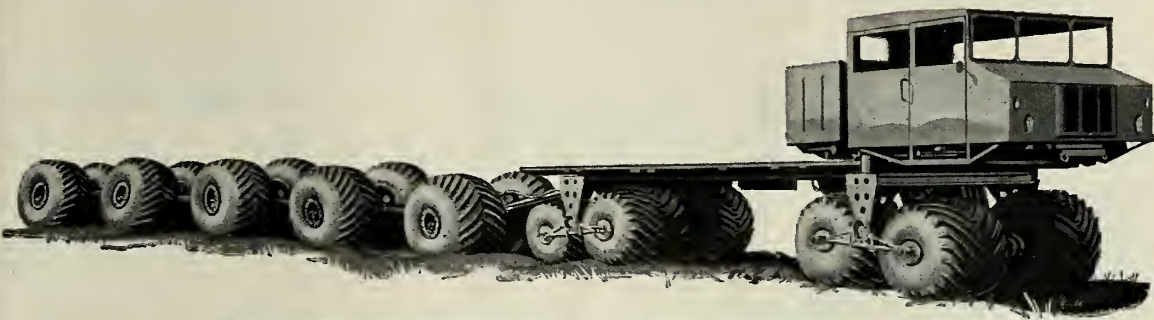
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Whither Vanguard

Naval Research Laboratory's future in space research will be decided before the end of the next five *Vanguard* satellite orbiting attempts. Political or public opinion pressure against continuation of the ill-fated program beyond the end of the International Geophysical Year will undoubtedly sway the decision.

Vanguard has been something of a political football since the Navy underbid the other services on the project away back in 1953. At the moment it seems to be something of a political liability, too, with neither ARPA nor NASA, both new and vulnerable agencies, exactly fighting to get it.

Vanguard, despite the fact that its record in launching satellites is meager, actually has a valiant scientific accomplishment record, as pointed out elsewhere in this issue. President Eisenhower, on advice of his scientific advisors reportedly is receptive to transferring *Vanguard* to NASA, with ARPA happily concurring and NASA regarding such a move with mixed emotions.

The question is—in the eyes of ARPA and NASA officials—whether *Vanguard* should continue to be looked upon as strictly a non-military program and logically should fall under NASA's Congressionally-dictated role of "peaceful scientific space exploration," or whether it should be continued for military purposes only in field assigned by the President such as space communications, navigation, weather, etc.

Some \$50 million of ARPA funds are slated to be spent annually for the next three years in continuing and expanding the Hagen space team. However, any continuation would not be the original *Vanguard* program per se, but would see drastic modifications both in management and actual hardware, with only proven capabilities of the original program being utilized for future space vehicles. This is good.

It seems to us that the NRL team—a *military* institution with the task of perfecting *military* research for the benefit of tomorrow's advanced U.S. Navy—should continue to work for ARPA. If this were the case, the NRL will continue to function as one, undiluted unit designed to work for progress in military space flight. This is the kind of progress this country needs. From the military advances will come the engineering breakthroughs which in turn will advance our "civil" astronautics goals.

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"THE COVER"

Now that both the Air Force and Army have received the nod to obtain engines of a million pounds or more of thrust (see p. 13), the spacemen envisioned on the cover by a Japanese-born artist are not nearly so fanciful a prospect. With engines such as the million-pounder authorized for the Air Force, and the 1.5 million pounder for the Army, payloads necessary to put a space station into orbit come close to possibility.

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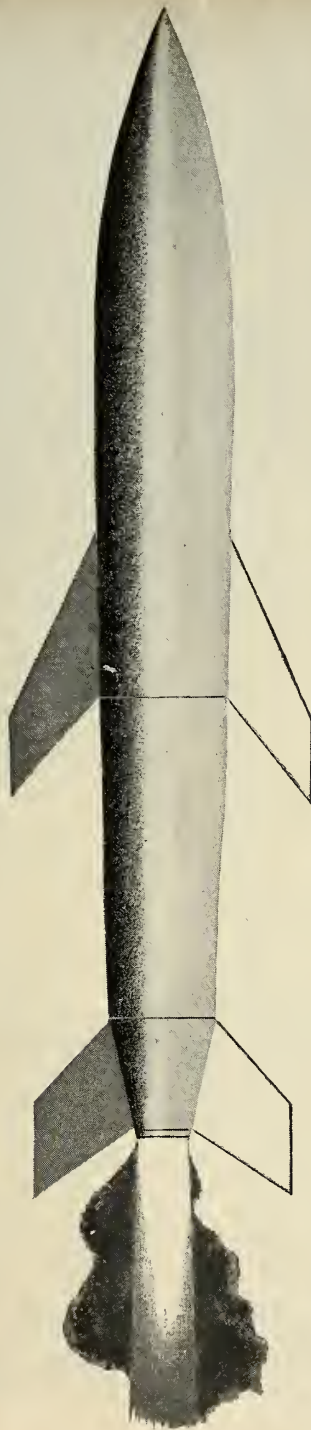


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industry countdown

Contractors have been warned about releasing information pertaining to "contracts, operations or facilities," even though it may be asked on certain government questionnaires. Recent advice from DOD says: "Questionnaires submitted by or under sponsorship of the Executive branch should be complied with when there is evidence that the request has been approved by the Budget Bureau."

Dissension over Nixon's tax program as outlined at Harvard has been in evidence in Washington, even among staunch Republicans. They oppose his ideas of cutting taxes for upper income brackets with the idea of thus stimulating investment. "Cut consumer taxes so people can buy what we are already making," they say. Nixon's probable position in the 1960 race has made his proposals more significant.

The "Buy American" policy for the U.S. Forces abroad has not deterred Nord-Aviation, a French firm, from producing and selling over 15,000 missiles. The sales have been made to Canada, Sweden, Germany, Italy, Israel, and even some to the U.S. Largest item is the SS 10 antitank missile and its successors, the 11 and 12.

A new research organization, Analytic Services Inc., has been formed as a non-profit organization. The firm has taken over the former quarters of AMF's defense products group in Alexandria, Va. The group was formed to perform contract research on problems related to national security.

Reorganizations and mergers show increasing corporate interest in missile business. The Weatherhead Co. has formed a new Aviation and Missile Group comprised of three plants in various sections of the country. Firewel Co., Inc. has organized its new Space Technology Department to supplement its Aeronautical Equipment Department. Electrosnap Corp.'s new Astromatic Division will develop and produce electro-mechanical subsystems and components. CBS-Hytron has consolidated its mechanical

and electronic equipment design, development and production facilities at Newburyport, Mass.

An Employee Pension plan has been approved by Temco Aircraft Corp. The plan is the last phase necessary to include all of the firm's employees in a retirement system, and affects about 4500 personnel not previously covered. It becomes effective October 1. A professional placement office has been opened by RCA for scientists and engineers of senior level in the New York City area.

Air Force Requirements from industry have been broken down into approximate areas of expenditures. The \$10 billion annual figure has been subdivided into \$4 billion for hardware to support the operating AF and \$6 for new weapons and equipment. About 4,000 prime contractors are involved, over 600 of which are in New York state.

A personnel shift at Food Machinery and Chemical Co. has resulted in a new boss for Grand Central Rocket Co. Charles E. Bartley, formerly president of GCR, has been named coordinator of FMC's rocket propellant activities. He is succeeded at GCR by Dr. Cleo Brunetti, who has been elected a vice president. GCR is a subsidiary of Petro-Tex Chemical Corp., which is jointly owned by FMC and Tennessee Gas Transmission Co. In announcing the switch, FMC cites its "growing interest and activities" in the rocket propellant field.

Marquardt Aircraft Co. will change the name of Associated Missile Products Co., which it recently acquired from AMF. The firm will henceforth be known as the Pomona Division of Marquardt.

Aerojet's underwater activities have led to increasing speculation on the state of rocket-propelled-torpedo art. The Aerojet-Azusa plant considers its recent \$19.3 million contract for an antisubmarine torpedo to be "one of the most important projects ever to hit the plant."



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washington countdown

The "E" ring of the Pentagon—that's where the big brass sits—is busier than a county courthouse in a Georgia Primary. Reason: Reorganization is picking up speed—and nobody knows which assistant service secretaries will be eliminated.

The worry goes down the line, too, to R&D organizations of all three services. Their problem: Who will be the new Director, Research and Engineering. The appointment is due within about two weeks.

You can stop using the term NACA (for National Advisory Committee for Aeronautics), and start using NASA (for National Aeronautics and Space Agency) about Oct. 1. That's the date when NASA Administrator T. Keith Glennan is expected to announce his organization is ready to absorb NACA.

Excess funds for *Polaris*, voted by Congress, will be kept on tap, though it's not certain the money will be spent this year. How fast the money will be spent depends on research and development progress.

Army and Air Force have been ordered to stop low-rating each other's anti-aircraft missiles—AF's *Bomarc* and Army's *Nike-Hercules*. Cease fire orders came from Secretary McElroy, who added that both missiles will stay in the arsenal.

The right missile has been picked for display at Air Force Association's convention at Dallas this week (see also p. 14). The *Atlas*, to be on display outside the convention hall, last week completed its third successful test over a 3,000 mile range. The first full-range test (about 6,000 miles) may be made in the next few weeks.

A weather observation satellite has been developed by Army signal research and development laboratory, says October ARMY INFORMATION DIGEST. But Signal Corps adds, privately, that there is no scheduled launching program.

ARPA isn't just a space agency. Look at

two other research areas ARPA's working on: anti-submarine warfare, and night fighting for ground troops. Agency chiefs hasten to add that they're studying proposals and are open for suggestions, pending arrival of technically competent people.

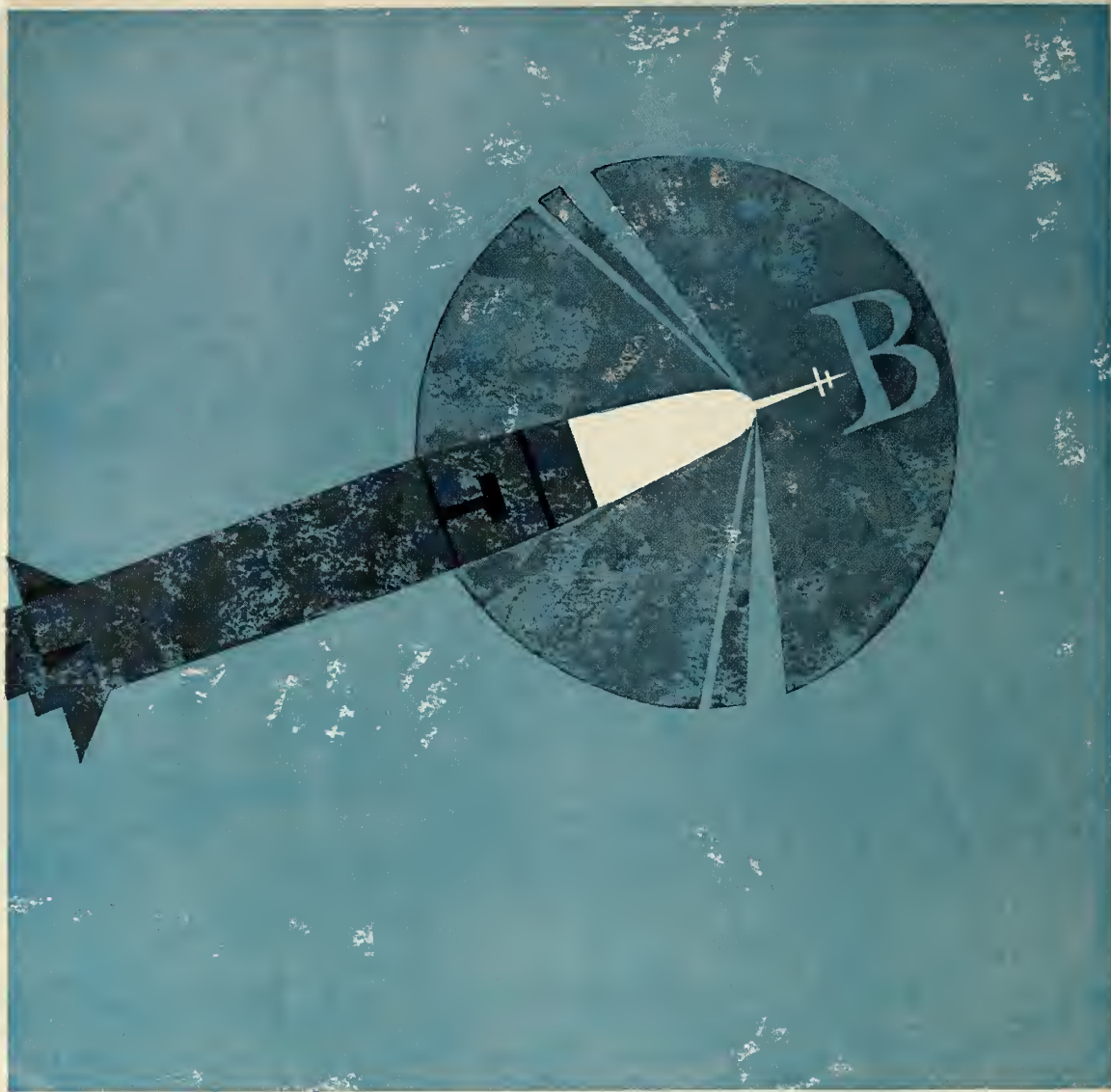
That night-fighting scheme, by the way, will be worth watching. It is said to entail a lot more than equipping troops with proper glasses.

Contrary to strong Washington rumors, USAF is interested in sponsoring activities of junior rocketeer groups. A regulation to this effect is currently being drafted in Pentagon. The program is primarily concerned with safety factors, and one requirement for USAF cooperation is that interested groups must be properly organized. Main problem seems to circle around getting personnel and space to handle the young rocketeers.

The British are talking about launching large satellites. Ministry of Supply is continuing its check into whether such rockets as *Blue Streak* and *Black Knight* may be used for launching such vehicles. There are some problem areas—money being one. Some experts are already complaining that modification of these rockets for satellite launchings would be an expensive diversion of the nation's military effort.

No cancellation is in sight for *Atlas* or *Titan*, despite the emphasis on which system will be slated for specific tasks. Says AF Maj. Gen. Charles McCorkle, assistant chief of staff for guided missiles: "Liquids still look good for space exploration—liquid ballistic missiles will not be phased out completely."

AMF isn't pulling out of the electronics business—despite the Washington rumors to that effect. The rumors are based on the fact that last year, AMF discontinued operations of its Boston facilities, now has sold its Westcoast firm, AMPCO (see p. 9). But with its Greenwich Engineering Lab, and facilities in Chicago and Alexandria, Va., AMF is still in.



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Million-Pound Thrust Engines Will Be Jupiter Clusters

DOD Authorizes N.A. Rocketdyne Power Plant; Clusters Will Be Interim Answer, Pending Single-Chamber Unit

By Donald E. Perry

WASHINGTON—The Army Ordnance Missile Command at Huntsville and Rocketdyne Division of North American Aviation have been authorized by the Defense Department to cluster modified *Jupiter* engines to provide a 1.5 million-pound thrust vehicle within one year. This confirms a story appearing in *m/r* (September 8, p. 13).

The action came after reportedly "high level" decisions between Advanced Research Projects Agency and the soon-to-be National Aeronautics and Space Administration. According to an ARPA spokesman it was mutually decided that ARPA will have cognizance over the Army's engineering program to cluster the *Jupiters*, while NASA will administer Air Force and Rocketdyne efforts in development of a one million pound thrust single chamber engine. However, a query to NASA Administrator T. Keith Glennan by *m/r* brought the comment that no "final decisions had been made in the area of high-thrust engines."

The single-chamber development, for which Rocketdyne has a \$2 million Air Force contract, is considered to be some four to five years away from flight test. ARPA wants the interim *Jupiter* development within one year for the initial purpose of placing a 24-hour satellite in orbit some 22,300 miles above the earth's equator. The satellite would be used for communications relay in the high frequency spectrum.

• **Possibilities**—However, a communications relay satellite for the clustered *Jupiters* is but one possible application. It could also be used for interplanetary probes and a manned satellite. ARPA declined comment on these possible uses, saying only that "there are no specific programs for utilizing the clustered *Jupiter* boosters," and the program is geared strictly for "satellite maneuverability and recoverability." One prototype vehicle is planned for the initial program.

The clustered *Jupiter* program is expected to cost nearly \$20 million. Initial contract to Rocketdyne is also \$2 million—in the same bracket as the single chamber development.

Defense Department has said that a single-chamber engine in the one million pound thrust bracket could orbit a 20,000 lb. satellite or provide an interplanetary probe weight of 5,000

lb. Such an engine would be about 17 feet high and would have a diameter of about eight feet for the exit area.

ARPA said it decided on the *Jupiter* plan because of the proven "extreme reliability" of the Rocketdyne engine (unofficially estimated at 80 percent) and clustering is the only method feasible to give "early availability" of large boosters necessary for space exploration objectives.

• **Clusters**—"Seven or eight" *Jupiters* will be clustered, according to ARPA, which foresees no "major" engineering problems. The Army's Ballistic Missile Agency at Huntsville will work with Rocketdyne in engineering the clusters and fabricating a new frame. A static engine test stand at Redstone Arsenal, capable of handling twin 500-

000 pound thrust engines, will be modified slightly for the program. Army reportedly as of September 12 had ordered nine additional Rocketdyne engines, although some may be slated for *Explorer* programs in probing the radiation belt.

The Rocketdyne engine used in *Jupiter* is rated at approximately 150,000 lb. of thrust. Use of hydene as a fuel, based on experience with the *Redstone* rocket, probably would up performance by 15 percent, giving a thrust of possibly 175,000 lb. Eight engines then would provide thrust in the neighborhood of 1,400,000 lb.

ARPA acknowledged that the cluster arrangement would involve firing of all rockets simultaneously with gimbaling of four engines on "corners" of the cluster. If eight engines are used, it probably will involve fabrication of a stubby frame some 18 to 20 ft. in diameter and about 90' in length around the four center rockets.

The remaining rockets would be attached to outer frame and would be jettisonable.

Navy to Spend \$1.1 Billion For Missile Ships

Almost two-thirds of the Navy's \$1.8 billion shipbuilding and conversion program released last week will go for missile ships including frigates, cruisers, destroyers and submarines.

Of the total estimated fiscal 1959 program, \$1.1 billion will be spent on the missile ships. The only combatant ships in the program which will not employ missiles will be four attack submarines, utilizing the latest in torpedoes and other underwater weapons.

No individual cost figures are available, since the contracts will be let on a competitive basis. However, past cost figures and testimony before Congressional appropriations committees make possible close estimates.

The largest item in the program is for nine guided missile frigates which will employ the *Terrier*. At an average cost of \$48.7 million each, the frigates will come to some \$438.3 million. Two will be built at Naval Shipyards at Puget Sound and San Francisco, with the other seven going to qualified yards on a basis of competitive bidding.

Five guided missile destroyers are in the program at some \$36 million each. They will be numbers DDG15 through DDG19, names to be assigned. These vessels will employ the forthcoming *Tartar*.

Three nuclear-powered guided missile submarines are in the program at an estimated cost of \$56 million each. These subs carry the *Regulus* II. This includes two boats from the 1958 pro-

gram, the SSGN 595, not yet definitely assigned, and the SSGN 596, plus one boat under the 1959 program—the SSGN 607.

• **Sub details**—In addition to the three Fleet Ballistic Missile submarines authorized under the fiscal 1958 program, two were assigned in July: the SSGN 601, which will be built at Newport News Shipbuilding and Drydock and the SSBN 602, which will be built at the Naval Shipyard, Portsmouth. Each will cost an estimated \$90 million.

Included in the overall figure are the conversions of the cruisers Columbus and Chicago to *Talos* ships. Conversions will cost an estimated \$90 million each.

These contracts will be in addition to current construction as reported in *m/r* 14 July 1958, p. 11.

Vanguard Try Fails

The navy's latest attempt to launch its *Vanguard* Satellite—this time with an Army "weather eye" in its nose—failed Tuesday, after a countdown of more than six hours. Official reason for the failure was given as a malfunction, which triggered an automatic shutoff. Details of other *Vanguard* attempts and their results are printed on p. 22 of this issue.



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Dr. Turkevich



Capt. R. M. White

AFA Meet Stresses Space Age

List of speakers points up vastly increased interest in space problems as Air Force Association opens annual session and exhibit show at Dallas

by Peer Fossen

The Air Force Association's annual National Convention and Airpower Panorama will be held in Dallas, Texas, September 25 through 28. The convention, which will emphasize missiles and space age subjects, is the twelfth such meeting held by AFA since its formation in 1946. It is estimated that about 3,000 AFA members, Air Force personnel, industry leaders, government officials, and others interested in airpower will attend the meeting.

The highlight of the program is a Space symposium on September 26. Sponsored by AFA's Space Education Foundation, the symposium will be held under the theme "The Space Age in Perspective." The symposium's morning session features three speeches and a forum on the hypersonic X-15 research aircraft. After introductory remarks by AFA President Peter J. Schenk, Dr. John Turkevich, Professor of Chemistry, Princeton University, will speak on "The Challenge of Soviet Science." Following Dr. Turkevich, General Thomas S. Power, Commander, Strategic Air Command, will discuss "Strategic Aspects of Space Operations."

The X-15 Forum, panel under chairmanship of Brig. Gen. Marcus F. Cooper, Commander Air Force Flight Test Center, ARDC, Edwards AFB,

will have the following members: Scott Crossfield, Test Pilot, North American Aviation; Captain Robert M. White, Test Pilot Air Force Flight Test Center, ARDC, Edwards AFB; and Walter Williams, Chief, High Speed Research Flight Station, NASA, Edwards AFB. The last item on the agenda for the morning session is a speech by Dr. Hugh L. Dryden, Deputy Administrator, NASA, in which he will outline NASA's role.

At the Space Age Luncheon that day, General Thomas D. White, Chief of Staff, USAF, will give a major speech.

The afternoon session of the Symposium will hear a speech by Dr. Gerard P. Kuiper, Director, Yerkes Observatory, University of Chicago, on the subject: "Exploration of the Moon."

• **Space Forum Planned**—Following immediately after Dr. Kuiper's speech there will be a Man in Space Forum under the chairmanship of Major Gen. Don Flickinger, Director of Life Sciences, ARDC, Andrews AFB. The four panel members will discuss topics of vital interest in the research being carried on to place man in space. Lt. Col. Rufus R. Hessberg, Chief, Aeromedical Field Laboratory, AFMDC, Holloman AFB, will discuss "Acceleration and Weightlessness in Space Flight." The problem of "Arti-

ficial Atmosphere in a Sealed Cabin" will be handled by Dr. Paul Webb, Chief, Environment Section, Aeromedical Laboratory, WADC, Wright-Patterson AFB, and Capt. Clyde H. Kratochvil, Chief, Dept. of Physiology, Bio-Physics, School of Aviation Medicine, Randolph AFB has as his topic "Medical Instrumentation in Space Flight." The last panel member, Col. John E. Pickering, Chief, Dept. of Radiobiology, School of Aviation Medicine, Randolph AFB will conclude the session with a speech on "The Significance of Cosmic Radiation to Manned Space Flight."

Alex Dreier, NBC commentator from Chicago, will function as moderator for the Space symposium. The Airpower Panorama will be held in the new Memorial Auditorium in downtown Dallas, where more than 100 displays from leading manufacturers will occupy 75,000 sq. ft. On opening day, the *Atlas* ICBM will be unveiled publicly in front of the Auditorium. This is the first public showing of the *Atlas*.

Participating in this event will be leaders from government, industry and defense, including Secretary of the Air Force, James H. Douglas, Generals Thomas D. White and Curtis E. Le May, respectively Chief and Vice Chief of the U.S. Air Force; other Air Force leaders, aircraft company presidents, congressmen, and Texas civic officials.

Space Scientists Use Sun For Moon Power Station

WASHINGTON, D.C.—Elements of an electric power station designed for use on the moon were demonstrated here last week by the Westinghouse Electric Corporation.

A working model of the moon power station was operated to show how the revolutionary generating unit would be powered by light from the sun. A modified vacuum tube, containing the same elements that would be used in a full scale station on the moon, absorbed a beam of light from a nearby sun lamp generating enough power to drive a small motor.

Guiding the space technology work within Westinghouse is the newly formed Astronautics Institute, headed by Dr. Peter Castruccio of the company's air-arm division in Baltimore.

Scientists at the applied research laboratory of the electronic tube division were responsible for the successful work in the theory, design and construction of the operating model of the moon station.

Dr. Castruccio, an authority in space guidance and communications problems, explained the construction and operation of the moon power station.

He pointed out that the sun, at zenith, pours upon the lunar surface something like 6,000 kw of power per acre, and that the proposed lunar power station would use this light or radiant energy to generate electrical power. The equivalent figure for the Earth varies with the atmosphere. On a clear day on a high mountain the sun would emit power on the order of 4,800 kw per acre.

• Station components—Basic components of the actual power station consist only of wire mesh and a chemically coated plastic. Giant sheets of a thin plastic material will be stretched and supported over several acres of the moon's surface. Coated on these sheets would be an extremely thin layer (about one micron thick) of a photosensitive material.

A thin wire mesh would then be placed parallel to, but slightly separated, from the plastic sheet and insulated from it. The photoelectric generator would then be ready to produce electric power.

As the sun's rays strike the plastic sheet, the coated surface would emit electrons. These electrons would strike the wire mesh, generating a voltage. Upon closing the circuit between the wire grid and the coated surface

through a suitable load, current would flow.

This type of electric power plant is the lightest known to man. The total weight of required material would amount to about three pounds per kilowatt.

"In practice," said Dr. Castruccio, "since the voltage generated by each cell is only a few volts, several cells need to be connected in series. This can be done quite easily by separating the sheets into several sections by insulating strips, and connecting the sections in series. Doing this, practically any voltage, including 110 volts dc, can be obtained."

• Advantages—One of the chief advantages of this device is its exceedingly long life. Even relatively large meteorites impinging upon it would

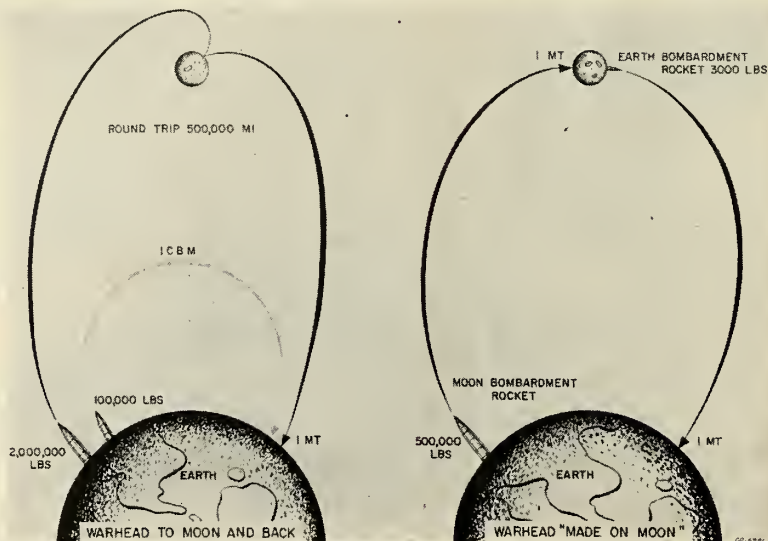
destroy only a portion of the photo-converting surface without disabling the generator.

There would be a small reduction in power output directly proportional to the area destroyed. To prevent meteorites from accidentally severing the power cables, these would be flat rather than cylindrical. A meteorite would merely punch a hole in the flat conductor without severing it.

As to solar conversion efficiencies, Dr. Castruccio pointed out that insight gained into the photoelectric phenomenon now shows promise of generators having up to 25% efficiency.

Once the power station is constructed, it would operate for 14 days at a time, since there are 14 days of sunshine followed by 14 nights at any one spot. Westinghouse scientists envision construction and interconnection of a number of these power stations all around the surface of the moon. With this type of lunar electrical network, continuous power would be assured to any point on the moon.

Dr. Castruccio said some of the



STRATEGIC ADVANTAGES of a self-supporting lunar base, according to Westinghouse's Dr. Peter Castruccio, include these: to bombard the Earth with a one-megaton nuclear warhead, from the Moon, would require a take-off weight of about 3,000 lbs.; the same warhead launched from Earth to bomb the Moon would require a take-off weight of the order of 500,000 lbs. A military base on the Moon is thus in the enviable position of a fortress located on a high mountain, which can easily rain projectiles into the valley, but which is almost invulnerable to a valley-bound adversary.

It would, however, not be practical

to construct a base on the Moon with the intent of supplying it entirely from Earth. A nuclear warhead lifted from Earth, landing on the Moon, stored there and subsequently relaunched towards Earth would require—with advanced propellants—an initial take-off weight of the order of two million pounds. By contrast, an ICBM to accomplish essentially the same purpose requires a take-off weight of only 100,000 pounds. A similar balance applies to using the Moon as an interplanetary stopping point, since the characteristic velocity of an interplanetary mission is increased in this case by more than twice the lunar escape velocity.

materials needed to construct the lunar power station may be found on the moon itself, though no way is presently available for on-the-moon conversion of such raw materials into usable products. He added, however, that Westinghouse is investigating ways of determining the presence and properties of the moon's materials through the use of unmanned lunar probes or satellites.

At the recent WESCON show, the Laboratories Div. of Hoffman Electronics Corp. disclosed the feasibility of solar energy converters capable of delivering up to 2,000 watts as power supply stations and satellites.

Hoffman has two proposed configurations, based on utilizing silicon solar cells, for such a converter. One is a balloon, which would inflate after the vehicle reaches outer space. The other involves a planar arrangement which could be unfolded from the launching vehicle after it is placed in orbit.

Point Arguello Range Construction Pushed

Navy bureaus and offices in southern California received orders from the Secretary of the Navy last week to push construction of the new Pacific Missile Range, at Point Arguello, Calif.

The orders read that "establishment, operation and support" must be assigned high priority.

Two contracts for work on the new facility were let recently: Alco Construction Co. of Beverly Hills was awarded the construction of a range operations building, transmitter and receiver; Alpan Construction Co. of Long Beach received a contract for construction of an administration facility.

Plan Separate Company for Space Tech Labs

In order to allow the parent company to compete for production contracts for Air Force missiles, Ramo-Wooldridge Corp. will establish its Space Technology Laboratories as a separate division, it was disclosed last week.

The disclosure came in a proxy statement, issued by Thompson Products Inc., as a preliminary to a special stockholders' meeting called for Sept. 30 at Cleveland to approve the proposed merger of Thompson and Ramo-Wooldridge.

Reason for the separation of STL from its parent company lies in government rulings that because of the nature

of the work of the laboratory division (as technical director for the Air Force intercontinental and intermediate-range dridge itself may not compete for probabilistic missile program), Ramo-Wooldridge contracts on the Atlas, Titan and Thor missiles.

Ramo-Wooldridge would retain ownership of all the stock of the new company formed out of STL—this ownership to pass to the new Thompson-Ramo Wooldridge if the stockholders approve the merger.

The STL division has accounted for 60% of the aggregate consolidated net sales of Ramo-Wooldridge since 1954, the proxy statement said.

Satellite Data Published By Science Academy

The sixth in a series of IGY satellite reports has been published by the IGY World Data Center A, National Academy of Sciences. The publication, entitled "Reports and Analyses of Satellite Observations," contains Moonwatch catalogues of May through June, 1958.

Also included in the paper are preliminary data on the mass-area ratios of satellites 1958 Beta 1 (carrier rocket) and 1958 Beta 2 (satellite proper of *Vanguard I*), the descent of 1957 Beta 1 (*Sputnik II*) and positions of Satellite 1957 Beta 1 during the first 100 revolutions.

Material in the booklet consists of special reports 15 and 16 of the Smithsonian Astrophysical Observatory and excerpts from special report 14.

First Atlas Crews Start Training Program

Student missilemen who will operate the first operational *Atlas* ICBM Squadron entered their first day of training at Vandenberg Air Force Base, Calif., last week.

The initial class of ICBM training students at the base will last for 22 weeks. The members of the 576th Strategic Missile Squadron, assigned to the base, will receive instructions in the guidance and computer system and will become a part of the *Atlas* guidance team.

Classroom instructions for the first group of men are provided by contractors from General Electric and Burroughs Corporation under the supervision of the 394th Missile Training Squadron, commanded by Colonel A. W. Stephens.

Last month the first class in Thor (IRBM) integrated weapons systems training started with 57 students. IRBM training is conducted by the 392nd Missile Training Squadron, commanded by Col. Robert W. Christy.

Naval Powder Factory Becomes Propellant Unit

The Navy has announced that the name of its Indian Head, Md., powder factory has been changed to the U.S. Naval Propellant Plant. Rear Admiral Paul D. Stroop, Chief of the Bureau of Ordnance, explained that the new name more accurately reflects the modern tasks being performed there.

The plant's present functions are primarily in manufacture of large propellant grains used in such missiles as *Terrier*, *Talos*, *Sidewinder*, *Weapon Able*, *Mighty Mouse* and other rocket motors. It is also engaged in research and development work in connection with missile programs.

The Indian Head facility has recently received an authorized personnel increase of over 100 people, about 25 of whom will be in the process engineering phase.

Douglas Team Enters Minuteman Competition

Douglas Aircraft, Hughes Aircraft, and Food Machinery and Chemical Corp. have teamed up to enter the *Minuteman* ICBM competition. The solid propellant missile is an Air Force project expected to produce an "instant and massive retaliation" capability for this country to replace both *Atlas* and *Titan*.

Douglas will be manager of the team, with Hughes responsible for electronics and FMC for ground handling equipment. A "Minuteman Assembly and Test Policy Board," headed by Donald W. Douglas Jr., has been established to provide major policy direction.

This board will meet at least twice a month to review the program, and also has as members A. E. Raymond, v. p.—Engineering at Douglas; L. A. Hyland, v. p.—General Manager at Hughes; J. M. Hait, Executive v. p., Director of Engineering for FMC; E. P. Wheaton, Douglas Director of Missiles and Space Systems Engineering, and Kenneth B. Bingham, General Manager of Douglas Aircraft's new *Minuteman* Division.

NATO Experts Here To Discuss Missiles

A group of some 40 NATO military and technical experts have started a three-week series of talks in the U.S. in connection with development of coordinated missile production within the NATO countries. The missile experts represent West Germany, Great Britain, France, Italy and the Netherlands.

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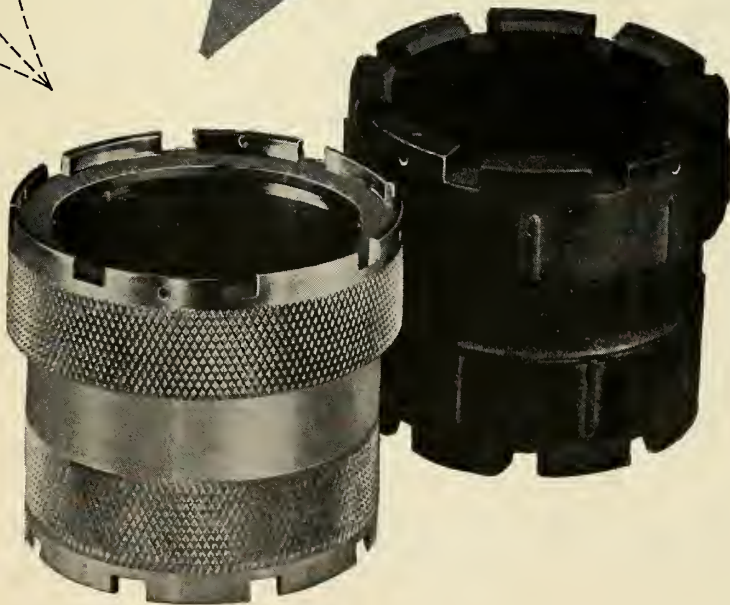
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Third Inflatable Satellite Hits 160,000—Fails

WALLOPS ISLAND, VA.—National Advisory Committee for Aeronautics has released further details on its inflatable aluminum-foil type satellite program, following the third flight test

at the Pilotless Aircraft Research Station here.

The test—second for the 12-foot diameter sphere which will be scheduled in the Explorer program—failed

to inflate. Tracking radars lost the rocket after it had travelled about 160,000 feet. It was not equipped with telemetering instrumentation, and NACA was unable to determine if the sphere had been ejected.

The 12-foot sphere also was flight-tested April 25 and inflated at an altitude of 50 miles. It was tracked visually for some 300,000 yards. A 30-inch sphere, slated as a sub-satellite for the *Vanguard* program, was fired May 21.

Technicians had hoped that the last attempt would allow them to determine atmospheric density at an altitude of 80 miles. The 40-pound research model was four feet long and 7.5 inches in diameter. The sphere weighed nine pounds.

• **How it's done**—The model, in addition to the folded sphere, included a timing mechanism, a 1500 psi air bottle and bellows to eject and inflate the sphere and a simple explosive mechanism to separate the model from the rocket motor. A solid-fuel first stage *Nike* rocket motor and a solid-fuel second-stage *Cajun* rocket, were used as boosters. Launching weight of the 26-foot rocket was 1350 pounds.

The rocket was fired about 30 minutes after sunset at an elevation angle of 80 degrees. First stage burned for about three seconds and the model coasted for about 20 seconds to an altitude of 40,000 feet. The second stage clearly fired for three seconds. The burned out second stage remained attached to the payload, as planned, and the combination coasted upward leaving the Earth's shadow and entering into sunlight.

If the sphere had been ejected, it would have been as visible as a Zero magnitude star about 150 seconds from launch, and would have remained in view for about four minutes.

NACA personnel pointed out that expansion plans for Wallops Island include the capability to launch satellites under 100 pounds in weight. Visiting newsmen were given details of a multi-million dollar expansion program for the facility as reported in *m/r* (Sept. 1, p. 13).

Wallops Island, according to AC now devotes 90% of its effort to flight research in the hypersonic range.

AF Moves Bomarc Testing From Canaveral

• **Cape Canaveral**—The transfer of AF *Bomarc* intercept missile testing facilities from Cape Canaveral to the Air Proving Ground Center missile site on Santa Rosa Island, near Fort Walton, Fla., is underway and scheduled for completion late next year.

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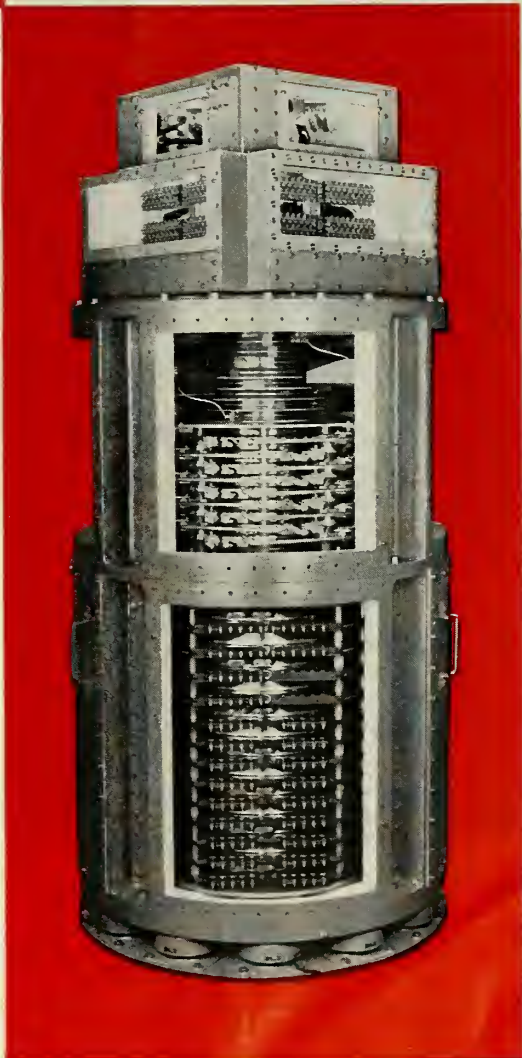
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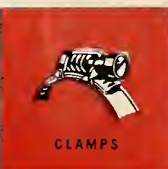
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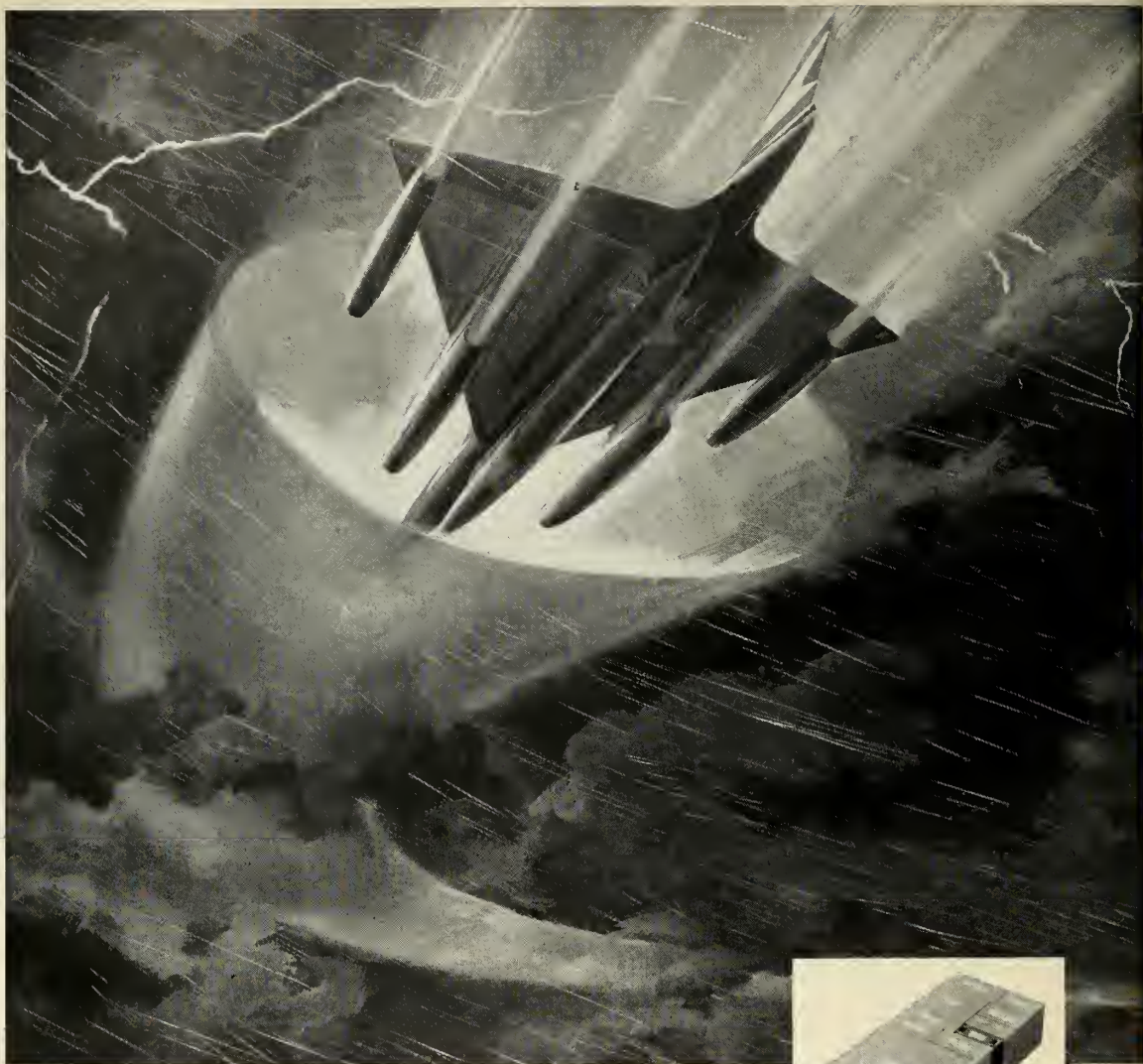
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ment of the high-performance aircraft of today and tomorrow. Its operating ambient temperature range is -60 to +125 degrees C. at altitudes up to 70,000 feet. Widespread use of semiconductors in the ILS receivers and TACAN circuitry means high reliability, small size and low power consumption.

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Wide Industrial Base Supports Atlas Program

The size of the industrial pyramid supplying the missile prime contractor was dramatically illustrated in a report released by Convair Astronautics Division of General Dynamics Corporation.

A total of 1,209 companies were listed as primary suppliers who contributed directly to the Atlas ICBM. Covering 32 states, these firms provided raw materials, parts, equipment or special services for the Air Force missile during 1957.

The report, first of its kind ever made public, excluded equipment furnished by the government and indirect suppliers of the Convair-built missile which is programmed to go into the Air Force inventory as the Western World's first truly intercontinental missile.

"If an overall total could be compiled," Convair Vice President J. R. Dempsey said, "we would expect it to show that more than 5,000 firms are participating in development of the Atlas weapon system as primary or secondary suppliers."

Approximately \$90 million was paid out to companies in 344 cities and towns. Eighty-six percent of the Atlas suppliers were small business firms (less than 500 employees) and they received 65% of the 1957 disbursements.

Over half of the primary suppliers—661—are in California. Other states which led the Convair list included: New York: 124; New Jersey: 74; Massachusetts: 57; Illinois: 57; Pennsylvania: 48; Connecticut: 44; Ohio: 40; Indiana: 16; Michigan: 15; Missouri: 10.

Systems Concept Boosted by Navy Evaluations Head

Dallas—The "weapon system" concept got a boost when Vice Admiral John H. Sides told the 60th annual convention of the National Association of Life Underwriters that "the best guided missile in the world would be useless unless every part of the system is in place and functioning."

As director of the Weapon System Evaluation Group, Department of Defense, Admiral Sides is concerned with weapon systems of all U.S. Military Services.

"In this day of high speeds, short times and long distances, we are forced more than ever to recognize the absolute necessity for putting all the pieces together into a well-knit organization which can insure that we achieve the full potentialities of our weapons system," Sides said.

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Here is the Vanguard Record

Satellite Record Isn't Good, But Program Has Produced Much Useful Information

by Norman L. Baker
and
Donald E. Perry

WASHINGTON—The current rumblings regarding the uncertain future of the Navy's *Vanguard* program is apparently not denting the optimism of Dr. Hagen's team in the continuance of their planned objectives.

Certainly many of the NRL people are deeply concerned—knowing that a poorly informed public could seriously endanger any future plans for the future use of the team.

Many top officials predict that ARPA will cancel any further launching attempts if the September 16th shot is a failure, and the Hagen team would be overlooked for future space programs. What would happen to the remaining hardware if this decision is made has not been determined.

While *Vanguard* (at press time) has failed to place into an orbit a full-size satellite, it has piled up an impressive array of technological accomplishments—accomplishments that

are being utilized in present and future military weapons and space vehicles.

The Air Force's *Thor-Able* lunar rocket depends heavily on rocket engine and guidance technology gained in the development of the *Vanguard* rocket. There are also unconfirmed reports that the Army may use some *Vanguard* components in their lunar shots.

The 200 people comprising the *Vanguard* team have a tough schedule ahead if they are to complete the series of launchings planned before the end of the year. Yet, they are confident the schedule will be met and at least one full-size satellite will be put into orbit.

Five shots (including SLV-3) remain to be launched in the current program. SLV-3 carrying instrumentation for studying the earth's albedo is an experiment of the Army Signal Corps. With a rotation of one revolu-

tion per second, the instruments will measure variations in light intensity reflected from the earth.

A photosensitive cell would trigger the instruments into operation when the satellite is over the light side of the earth and shut them down when in the shadow. Play-back in one minute-bursts from a storage tape will take place during the time it is on the dark side of the earth. In addition to the albedo instruments there will be micro-meteorite impact detectors and temperature gauges.

Experiments in the later satellites, continuing through SLV-7, will follow the NAS-16Y policy of giving each experiment a maximum of two chances. After first success the next experiment is flown.

SLV-4 will attempt to place a 13-inch magnetometer satellite and a

(continued on page 25 and 26)

Vehicle Development Test

Test Vehicle Number and Date of Test	Purpose of Test	Composition of Test Vehicles and Flight Performance				Results of Test
		First Stage	Second Stage	Third Stage	Test Satellite	
1. TV No. 0 8 Dec 56	Set up the Vanguard launch facility and to test out the facility itself before field tests of the Vanguard vehicle components. To be tested out and made workable before the vehicle test program could proceed.	Viking No. 13—fitted with Vanguard telemetering and instrumentation. Launched & flown successfully. Reached an altitude of 126 miles and range (distance from launch site) of about 183 miles.	None.	None.	None.	Completely Successful. Instruments in vehicle transmitted all desired flight information to the stations on the ground at Cape and down range. Vanguard tracking radars ground stations and data reduction facilities and methods proved out.
2. TV No. 1 1 May 57	Flight test the newly developed Vanguard third stage (solid propellant rocket by Grand Central Rocket Co.) This was a test of spin up, ignition of third stage at altitude, separation of the two stages, guidance of the whole vehicle and third stage propulsion.	Viking No. 14—Launched and flown successfully. Vanguard control systems worked well. Nose cone contained instrumentation in addition to the third stage.	None.	Vanguard. Spin up, separation and propulsion completely successful. Reached an altitude of 120 miles and range of 450 miles after successfully separating in flight from the first stage.	None.	Completely successful. All test objectives were met.
3. TV No. 2 23 Oct 57	First flight test of the Vanguard first stage and of the three-stage rocket configuration. Major objectives were to: test the newly developed (General Electric) first stage engine and propulsion system; vehicle structure and guidance and control under powered flight.	Vanguard. Launched and flown successfully. Guidance and control worked well. The entire vehicle reached an altitude of 109 miles and a range of 330 miles.	Dummy Vanguard. Was built to look like the real Vanguard to test the vehicle structure. The second and third stages were not loaded with live propellants.	Dummy Vanguard. Same as second stage.	None.	Completely successful. First stage propulsion performed above minimal specifications. The overall vehicle structure proved sound and capable. Guidance and control worked well.

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The all-new 5-702 DataTape Recorder is enclosed in a rugged, lightweight case of cast magnesium alloy that is precision machined to assure accurate alignment of internal components. Infinitely superior to sheet-metal cases that bend and yield to stress.

FLEXIBILITY IN USE
The highly flexible 5-702 provides 7- or 14-track operation with exclusive front-panel switch selection of all six tape speeds from $1\frac{7}{8}$ to 60 ips, using $10\frac{1}{2}$ " standard NARTB reels or special CEC high-performance reels of $\frac{1}{2}$ " or 1" tape.

A single cast aluminum alloy case houses seven miniaturized record amplifiers. The system converts readily to 14-track operation by simply adding a second 7-amplifier case and changing tape width.

DOWNSTREAM MONITORING

Use of all-metal-surface playback heads permits simultaneous downstream monitoring of all tape tracks—continuously and virtually coincident with the recording of test data. These reproduce headstacs also allow the 5-702 to be used as a laboratory playback machine.

The new airborne system provides FM, PDM or Analog recording through its interchangeable plug-in amplifiers, and is completely compatible with CEC's 5-752 Recorder/Reproducer.

For complete details, contact your nearest CEC sales and service office or write for Bulletin CEC 1607-X5.



TYPE 11-114 AIRBORNE REMOTE CONTROL INSTRUMENT-PANEL UNIT
Allows remote operation of the 5-702; indicates per cent of tape remaining on supply reel. Requires standard $3\frac{1}{8}$ " aircraft-panel opening for mounting.

DataTape Division

Consolidated ElectroDynamics



300 N. Sierra Madre Villa, Pasadena, Calif.

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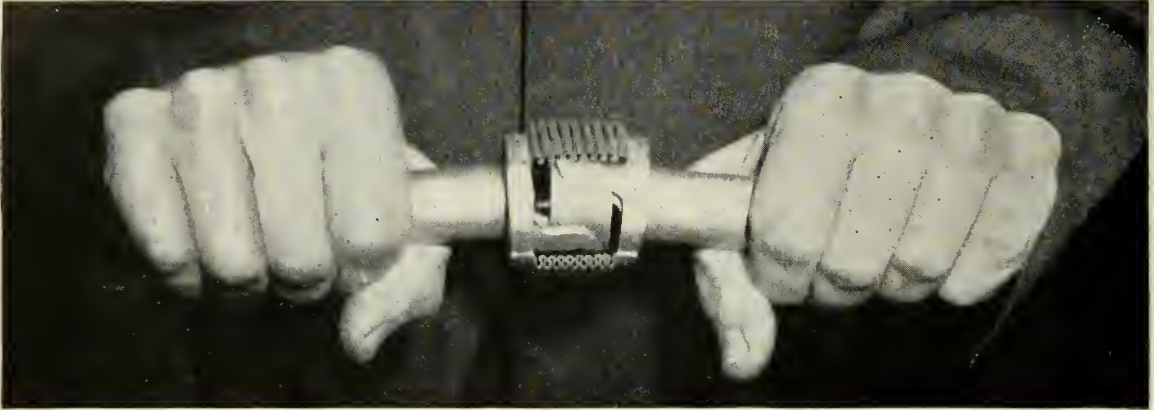
DUCTING AND COMPONENTS ENGINEERING BRIEFS



One of a series of reports to help you
make more effective use of Flexon products.

THE FLEXON GIMBAL JOINT

A new approach to absorption of ducting motion in any plane



Flexon Gimbal Joint cutaway to show how it permits motion in any plane yet is self restrained.

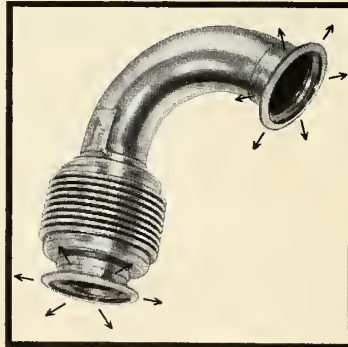
To answer a critical motion absorption problem in the most advanced jet aircraft and missiles, Flexonics engineers reached back over 500 years. They took the gimbal principle—the same one used in the compasses of Columbus, Magellan, da Gama, et al—and applied it to a flexible connector. The result is the Flexon Gimbal Joint.

Here is a joint designed especially for the supersonic space age. Its design recognizes the problems of thermal expansion, installation misalignment, air frame deflection and high end loads which are so critical in modern jet aircraft and in missiles and rockets.

The simple, efficient design provides a combination of advantages available in no other type of flexible connector:

1. Completely self-restrained.
2. Low loads for deflection.
3. Reduced pressure drop (liners incorporated).
4. Reduced system weight—heavy anchors are eliminated—simple line supports are the only requirement.
5. Minimum envelope.
6. Maximum fatigue life verified by comprehensive laboratory tests.

Significant, too, is the fact that the Flexon Gimbal Joint will take motion in any plane. Joints taking motion up to 7° have been manufactured and are in service. The units are made in high strength corrosion resistant alloys to meet specific requirements. Sizes range from 1" through 4".



The Flexon Gimbal Joint can be used to join a variety of tubing shapes to make a wide range of connector types.

Engineering Assistance on Ducting Problems

The Flexon Gimbal Joint is only one of many Flexonics developments for the advancement of the science of aircraft and missile plumbing. Other products include metal, synthetic and plastic hose, flexible ducts, liquid oxygen lines, pinned elbows, high pressure ducting and thin wall tubing.

Out of this background has come unmatched experience proved in many of the nation's most advanced aircraft, rocket and missile programs. This experience is available to help you in the solution of your most advanced design problems. Put it to work!

For factual data right at your finger tips, write for information on securing your copy of the Flexonics Engineering Manual.

For help on specific problems send an outline of your requirements. Flexonics Application Engineers will be pleased to make recommendations.

AERONAUTICAL DIVISION
A-38

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... here is the Vanguard record

Test Vehicle Number and Date of Test	Purpose of Test	Composition of Test Vehicles and Flight Performance				Results of Test
		First Stage	Second Stage	Third Stage	Test Satellite	
Test Vehicle No. 2 Back-up Not Flown	Since the test of TV-2 was so successful there was no need for the contingent repeat test for which this was available.					
4. TV No. 3 6 Dec 57	First flight test of the complete, three-stage launching vehicle rocket system. Prime objective was to test the new second stage which had never before been flown.	A malfunction occurred and fire broke out in the first stage which quickly consumed the vehicle on the launch stand.	Due to mishap in first stage, second and third stages had no chance to perform.	Same as second stage.	6" test sphere. A small test satellite was placed in the nose cone so that if the over-all test vehicles performed beyond expectation during the test program the test sphere might go into orbit.	Not successful. Test objectives were not met. Launch stand was damaged. Since the project had been authorized only one launch stand at Canaveral, all testing using the stand was delayed.
5 TV No. 3 Back-up 5 Feb 58	Test Vehicle No. 3 Back-up was constructed for the purpose of repeating the tests scheduled for TV-3 in case all test objectives were not met with TV-3. Prime objectives: to flight test the second stage and the overall guidance and control system.	In flight for 60 seconds. At that time, a component malfunction in the controls system resulted in a "hard over" engine which broke the vehicle in two and terminated the flight.	No chance to perform because of control component malfunction.	Same as second stage.	6" test sphere. Instrumentation consisted of two temperature sensitive Minitrack oscillators—one of which operated on solar power.	Partially successful. First flight of the full Vanguard guidance and control system. Operated well during powered flight. Second stage was not ignited.
6. TV No. 4 17 Mar 58	Further flight test of complete Vanguard three stage vehicle system. All modifications dictated by results of previous test.	Launched and flown successfully. All components worked well. The first stage propelled the vehicle higher and further than the minimum required.	Lifted to an orbital altitude of 400 + miles, spun up the third stage at the proper time and then fell back to earth as planned about 1500 miles from launch site.	Propelled test satellite into orbit 2466 miles from the earth's surface at apogee and 400 miles at perigee. Calculated to stay in orbit for 200 years.	6" test satellite. Separated from the third stage after burnout as planned. Solar cells are still working and will continue to transmit signals for an indefinite period.	Completely successful. All components, propulsion, guidance and control, ground stations, telemetering, Minitrack network, tracking radars, etc., performed assigned missions in a satisfactory manner.
TV No. 4 Back-up	This vehicle was available in case test objectives of the TV-4 flight were not completely met. Converted to a true satellite launcher.					
7. TV No. 5 28 Apr 58	Last test of all components prior to start of IGY Satellite Launching Program.	Launched and flown successfully. Burning time, velocity, cut-off separation, guidance and control all excellent.	Ignition and separation from first stage good. Propelled vehicle up to an orbital altitude of 340 miles (spec call for 300 miles). However, two minor components (electrical relays) malfunctioned and failed to signal the third stage to fire.	Did not receive signal from second stage "brain." Therefore, did not fire and impacted at a point 1500 miles from the launch site.	20" test satellite. This was the first flight of a fully instrumented IGY type satellite.	Successful. The design of the 20" fully instrumented satellite proved out under flight conditions. Propulsion of the first stage was excellent for the fourth time in five tries. Second stage propulsion was above par.

All Subsequent Vehicles Are True IGY Satellite Launching Attempts

Satellite Launching (SLV) Vehicle number & Status	Flight Objective	Flight Performance of Vehicle Components				Results of Flight
		First Stage	Second Stage	Third Stage	Scientific Satellite	
1 SLV No. 1 Launched 27 May 58	To place in orbit around the earth a Vanguard-IGY 20" diameter, 21½ lb, spherical satellite plus the 50 lb third stage rocket casing. Solar Lyman-Alpha Radiation and Space Environmental measurements.	Launched and flown very successfully. Lifted vehicle to required altitude, obtained the right velocity and separated successfully from the second stage.	Lifted vehicle to an altitude of 368 miles. Engine did not cut off properly at the end of flight causing the vehicle to fly with its nose at an upward angle instead of parallel to the earth.	Satellite reached a peak altitude of 2200 miles and traveled some 7500 miles from the launch site and landed near the East Coast of South Africa.	All instrumentation worked perfectly and scientific data was obtained.	Partially successful. Over-all, the satellite flew for 20 minutes.
2. SLV No. 2 Launched 26 June 58	To place 20" satellite in orbit. Instrumentation was to measure X-radiation in space emanating from the sun.	Launched and flown very successfully for the sixth time in seven tries (including test flights).	The motor cut off prematurely due to low chamber pressure and terminated the flight.	Second stage malfunction prevented firing of third stage.	All instrumentation was working perfectly when the flight terminated.	Not successful. The very limited number of vehicles in the over-all program makes evaluation of flight results and testing before each flight of extreme importance.



. . . Vanguard

30-inch expandable ball on satellite in orbit.

SLV-5 will be a 20-inch satellite loaded with radiation balance equipment. This experiment would supplement the current *Explorer* experiments. Instrumentation will be by the University of Wisconsin. SLV-5 will be a repeat of SLV-4 if first magnetometer try is unsuccessful. SLV-6 will carry the remaining 16Y experiment depending on the successes or failures of the earlier flights.

SLV-7, the TV-4 back up vehicle, will use the Allegany Ballistics third stage rocket now in use on the *Thor-Able* lunar probe. The satellite will contain 50 pounds of instruments with a total weight in orbit of 100 pounds. Instrumentation for this one is yet to be determined.

An alternate third stage of even higher performance than the current Allegany Rocket may be available in time for this flight. Development on the rocket has been underway since the beginning of the program and has now reached the testing stage. Allegany has been with the *Vanguard* program as a back-up. Seven of the engines have now been shifted to the lunar program.

After the satellite launchings have been completed, the NRL team will, if NASA or ARPA gives the go-ahead, initiate a lunar research vehicle program. Again, components of the *Vanguard* rocket would be utilized. It has been reported that the *Vanguard* lunar project would develop satellite systems with payload up to 50 pounds.

Plans reportedly called for deliveries of first launching rockets within four months after the official go-ahead. The Allegany Ballistic third stage and a more powerful first stage would be used for these shots. It is not known whether the first stage would be an entirely new system or would use exciting hardware, although the description tallies closely with Air Force *Thor-Able* lunar vehicle.

The original *Vanguard* program will be completed during the current fiscal year. The total budget estimate for the project to finance all costs from start to finish is \$111 million. Of this, \$97 million is allocated to the Naval Research Laboratory. The remaining \$14 million goes to other departments as follows: National Science Foundation, \$5 million; Air Force, \$8 million, and Army, \$1 million. Vehicle development, testing, production, launching and flight operations and support, vehicle telemetering, assistance to Army and Air Force projects which use *Vanguard* vehicles have cost \$73-million.

THOMPSON PRODUCTS NEEDED A HEATER FAST . . .

Here's how General Electric solved customer's heating problem—in 3½ days!

Recently, Thompson Products, Inc., ran into a problem: components were not available which would function at the extremely low temperature ambients required for a control being manufactured for a new USAF fighter. A holdup here could halt the entire aircraft program.

A General Electric sales engineer was called in. To General Electric's Specialty Heating Products plant at Coxsackie, N. Y. went a call. Asked the customer: "How soon can you design, develop and deliver a prototype heater for our airborne system component?" The General Electric answer "78 hours—3½ working days—after we receive your specs."

Project preparations started immediately. When the rough equipment sketches arrived, the team

went into action. At 11:00 A.M. Thursday—3½ days later—the heating unit passed final inspection; was on its way. Final result: the aircraft program never slowed down.

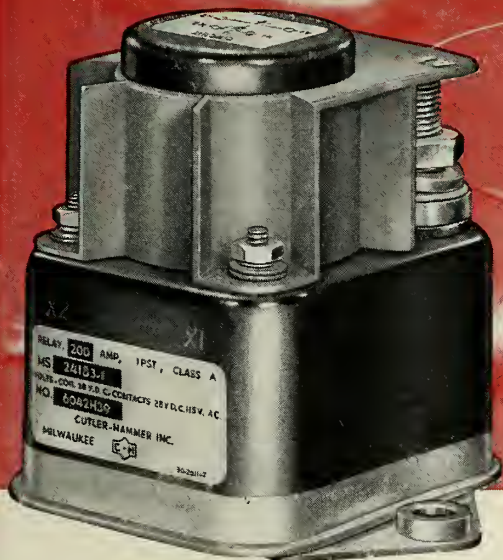
THIS IS ONE EXAMPLE of how quickly General Electric can solve straight forward thermal conditioning problems. When you have a heating problem, call in your nearest General Electric sales engineer.

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Typical Cutler-Hammer Hermetically Sealed Relay with protective terminal cover available on all relays in the line

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The broad line of Cutler-Hammer Hermetically Sealed Power Relays is the only family of such advanced aircraft relays to be proved by years of actual service. This line has been in mass production for more than three years. Thousands have been shipped and installed . . . and their performance has been outstanding.

Cutler-Hammer Hermetically Sealed Power Relays were designed to meet the MS drawings and Mil-R-6106. Testing done beyond the requirements of Mil-R-6106 for a number of air frame builders has resulted in the selection of these relays for many "special use" applications. The auxiliary contact arrangements possible with these relays often permit the elimination of another relay in circuit planning.

Whether you are building air frames, missiles, tanks or space ships, you will find the best relay for your purpose in the large family of Cutler-Hammer Hermetically Sealed Relays. Be sure you have the latest data on this constantly growing line. Write *now* on your company letter-head for Pub. EE 140-T-224. Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

AN and MS Toggle Switches

Cutler-Hammer also manufactures the most complete and fully proven line of type AN and MS toggle switches. There is no substitute for experience. Specify Cutler-Hammer and be sure.



50 amp. single pole, single throw Class A power relay.



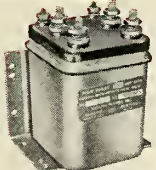
200 amp. single pole, single throw Class B power relay with N.O. and N.C. auxiliary contacts.



25 amp. three pole, single throw Class B power relay with N.O. and N.C. auxiliary contacts.



100 amp. three pole, single throw Class B power relay.



50/25 amp. single pole, double throw Class B power relay.



25 amp. three pole, double throw reversing duty Class B power relay.

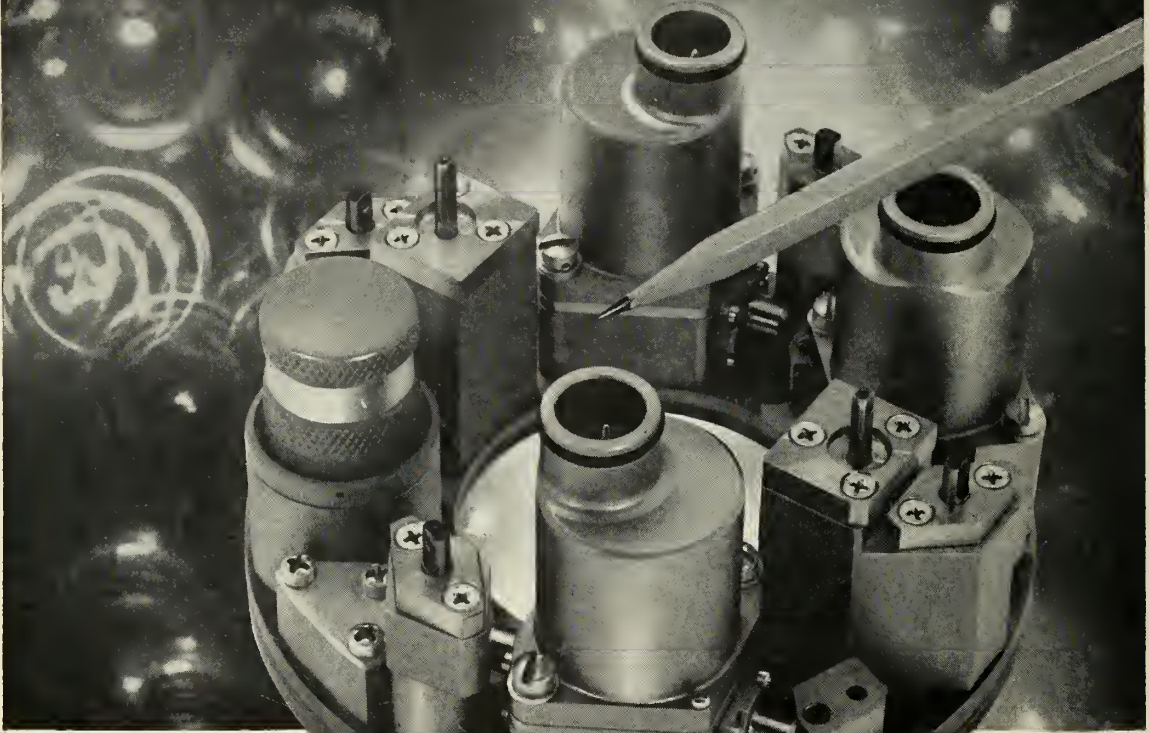
Cutler-Hammer Power Relays—Finest in Flight

Cutler-Hammer Hermetically Sealed Relays are designed to meet Spec. Mil-R-6106B. Operate at 80,000 feet. Class A can operate in ambient temperatures to 71°C; Class B in ambient temperatures to 120°. Class B are available with or without auxiliary contacts.

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NEW AiResearch steering control system



Combines Acceleration Switching Valves And Hydraulic "Printed Circuit"

More reliable and responsive... this lightweight electro-hydraulic steering control system converts low-level electronic signals from the main guidance system into hydraulic energy which actuates the mechanisms steering the missile.

Packaged as an integrated unit, the three servo valves and six control actuators are mounted on a common manifold and powered by fluid or hot gases. The simplified "printed circuit" system of integral passageways within the manifold eliminates all external plumbing

and leakage.

The acceleration switching servo valves provide positive control of spool velocity, thereby achieving greater resolution, reliability and response even at extreme temperatures.

Easily installed and removed as a complete, interchangeable unit, acceptance testing of this compact system can be accomplished prior to missile installation. Suggested applications are: missile surface controls, jetavator controls, and vector and nozzle steering controls. Your inquiries are invited.

Specifications

Actuator load (range)	90 to 150 in. lbs.
Electrical input (nominal)	... 28 volts DC—10 Milliamperes
Pressure range	... 500 to 3000 psi
Rated flow	... 1/2 to 2 gpm
Mounting	... Manifold
External leakage	... None
Proof Pressure	... 4500 psi
Burst Pressure	... 7500 psi
Temperature operating range	
Fluid	... -65°F to 450°F
Ambient	... -65°F to 750°F
System filtration	... 10 microns

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Cavitation Detector Aids Ground Testing

Failure in fuel regulation system may be cut by new electronic instrument

by Richard Van Osten

The AiResearch Manufacturing Division of the Garrett Corp. has developed a cavitation detector for incorporation in a missile ground-test system, or a flight test vehicle.

One of the problems encountered in liquid-propellant rocket engine systems is an instability of power output due to inconsistent fuel-oxidizer mixtures. A good portion of the mixture ratio deviation may be traced to cavitation in the fuel and/or the oxidizer system.

Cavitation is a well-known phenomenon that occurs with rapid evaporation of a liquid in local areas where static pressure is less than vapor pressure. Areas subject to this condition are usually those with steep pressure gradients such as valves, fittings or other points where abrupt changes of cross-sectional area or flow direction occur. The problem has been somewhat complicated by a lack of instrumentation required to determine the existence, location and magnitude of cavitation in a fluid flow.

• **Components**—Three basic elements make up the instrument: a sensing grid; an electronic control circuit; and an indicating and/or recording unit.

The sensing unit is an insulating support structure containing a series of metallic sensing grids in the liquid stream. The grids are designed as high-speed, low pressure drop hydrofoils. The hydrofoil shape was chosen to minimize any possibility of incipient cavitation being created by the grids themselves.

When tied into the electronic control circuit, the sensing grids are capable of detecting the passage of any single bubble or group of bubbles without regard to the diameter or complexity of the bubble pattern. In laboratory tests, bubbles no larger than 0.050-in. have been detected with ease in a 6-in. diameter line. Foreign matter, such as sand particles, may also be detected easily.

The relationship of the hydrodynamic center of pressure to the CG of the sensing grids results in an extremely high "flutter speed." This also mini-

mizes any possibility of fluid flow exciting unstable grid vibration and furnishes an inherent damping characteristic within the unit.

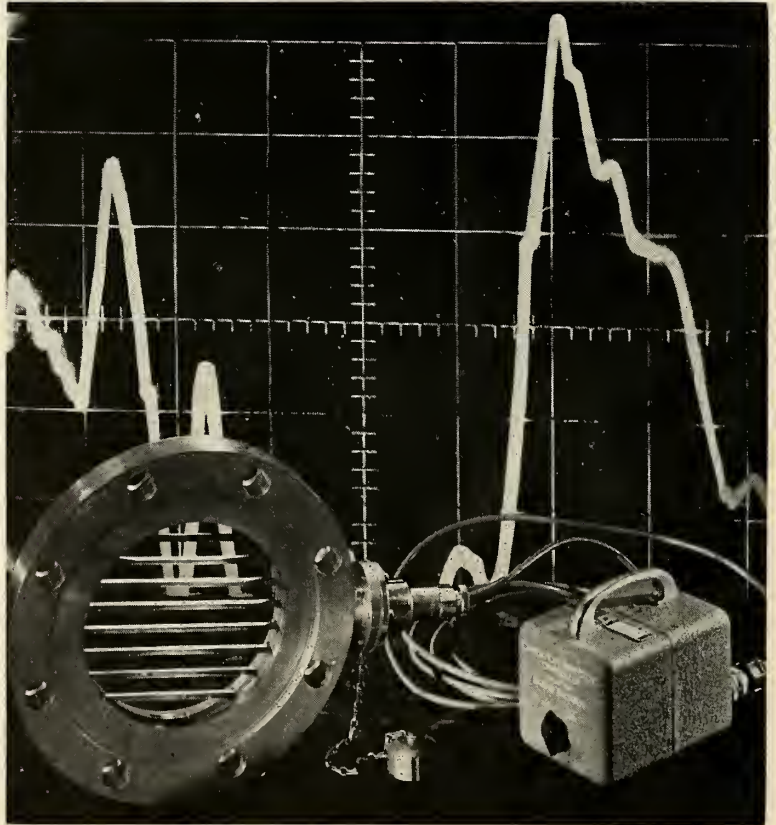
The electronic control unit is designed with transistorized circuits, as well as a self-contained power source and miniature components. Output from the control unit may be furnished as an input to a conventional cathode ray oscilloscope and/or a conventional type electronic recorder. Flow characteristics may be indicated directly on the scope or on a recorder tape. There are additional circuits under development, which will apply the output to the control circuit of a servo loop of regulating equipment.

Indicating and recording units for

use with the system are normally commercially available and require only nominal modification to be used with the detector.

The device is capable of reading out turbulence in flow as well as cavitation. Its output may also be converted to telemetry signals for airborne use or to a firing circuit, such as for rocket booster ejection.

Because there may be some applications in which the sensing grid is either impractical or even impossible to install, a ring-type sensor has been developed. In this case, the ring is flush with the inside wall of the flow tube, but the balance of the equipment is essentially identical to that used with the grid sensor.



EFFECTS OF CAVITATION shown on chart produced by detector.

Insure added safety and efficiency with new R/M TEFLON* spiral cover for hose and cable

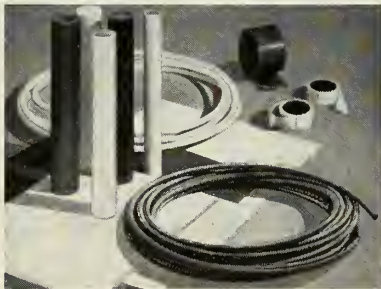
Raybestos-Manhattan has developed a "Teflon" spiral cover for hose and cable similar in principle to the cover on your telephone handset wire. It is nonwicking and has ex-



ceptional resistance to abrasion and very high temperatures. It is especially desirable where hose or cable passes through a firewall. Overlapping construction permits lengthening the spiral without uncovering the hose or cable. Diameters are easily altered by twisting.

Aircraft, missiles and rocket applications of "Teflon" are numerous. The early advent of others is indicated by modern research and development, especially in the production of "Teflon" custom-machined parts, which in certain situations are superior to those of any other material. R/M has complete facilities for machining "Teflon" parts to your specifications, with very close tolerances and rigid quality controls.

For more information, literature, and sales and engineering assistance, contact your nearest R/M district office listed below or write direct to Plastic Products Division, Manheim.



Other R/M "Teflon" products for the aviation, missiles and rockets industries: stainless steel wire braid covered thin-wall "Teflon" hose, rods, sheets, tubes and tape; rods, tubes and sheets in certified and stress-relieved grades (X-ray films for sheets and rods are also available); and centerless ground rods held to very close tolerances.

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Missile Guidelines

Manufacturers Get Tips On Government Requirements

The Office of the Director of Guided Missiles for the Defense Department has set down a list of guidelines for manufacturers seeking missile work. In determining whether missile contracts would be either attractive or unattractive, the Office suggests these "special factors" should be taken into consideration:

"Missiles utilize almost every science and technology to the maximum of our knowledge and skill.

"Missiles demand high, uniform and repetitive quality.

"The environment criteria is much more severe than for conventional weapons.

"Missile tolerances are generally an order of magnitude 10 or more times more exacting than the weapons they replace.

"The materials used, the tolerances and the quality establish peculiar manufacturing needs.

"The complexity of both the missile and its operating system is generally of the highest order.

"We strive for infallibility-assurance of reliability.

"We have found it justified to pay for premium quality and workmanship when it assures high operability and reliability of the missile and its system.

"There is a high single shot-cost—and high single shot loss in case of flight failure.

"Because of the very rapid advance in the technical state of the art, we have a high obsolescence rate-technical growth frequently exceeding prediction.

"We must build shelf life, operability and preventative maintenance into the weapon to minimize demands on military manpower."

These guidelines were spelled out by Robert J. Gutheim, head of the division of planning in an address before the New York State Defense Procurement Conference at Utica, N.Y.

He said the complexity of missiles and missile systems "result in the prime contractor having relatively few of the array of skills and manufacturing capabilities needed for the complete job."

The prime has the ability to manage and the responsibility of breaking down the overall job into segments "that can be delegated and subcontracted to other organizations for design or manufacture." In turn, the prime contractor then "knits the output of all the supporting organizations into the product we need."



"FORCES OF NATURE," another in a collection of paintings by Simpson-Middleman, two talented artists who find in the natural sciences the subject matter for their contemporary expressions. Courtesy John Heller Gallery, Inc.

Conquest of space

Boeing has geared its facilities, research and manpower resources to meet the complex technological requirements of the space age. The Systems Management Office, for example, has responsibility for the over-all management as well as the technical research and development activities in advanced flight technology, electro-magnetics and support systems leading to operational space weapon systems.

The Boeing Scientific Research Laboratories have been established to develop new, fundamental knowledge at the frontiers of science. They provide the environment of scientific freedom necessary to the attainment of this objective. Areas of investigation include, but are not limited to, hypersonics, energy

conversion, solid state physics, magneto-hydrodynamics, nuclear and plasma physics, advanced propulsion systems, and the effects of high temperatures on structures and materials.

Boeing engineers and scientists are currently at work on an Air Force assignment for Phase I development of Dyna-Soar, a manned space vehicle which will orbit at speeds approaching 18,000 miles an hour and be capable of re-entry and normal landing.

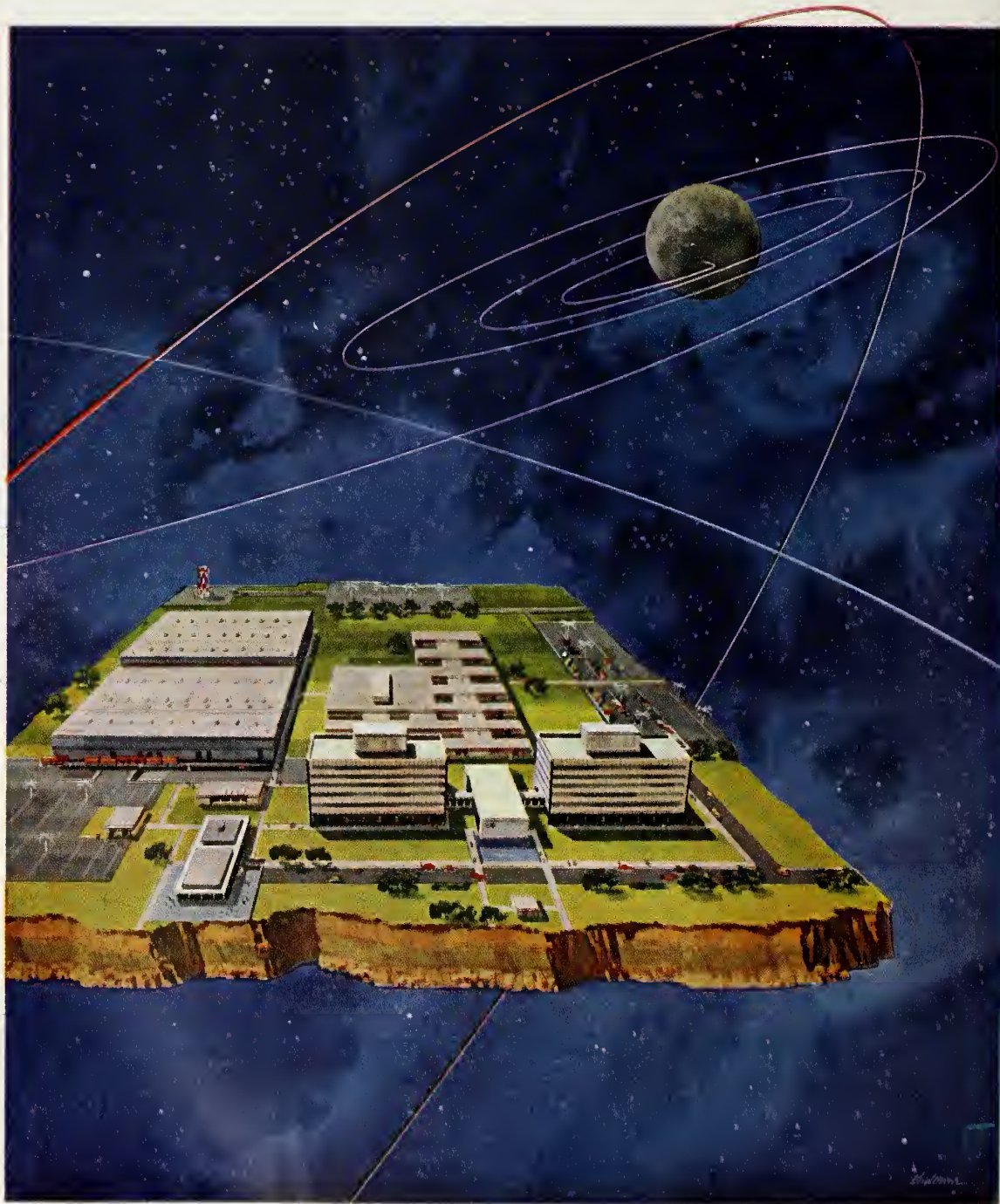
Dyna-Soar and other advanced projects at Boeing offer exceptional space-age opportunities to engineers and scientists of all categories. Drop a note now to Mr. Stanley M. Little, Department R-80, Boeing Airplane Company, Seattle 24, Washington.

BOEING

CONVAIR-Astronautics... springboard into space

CONVAIR-Astronautics—producer of the Atlas ICBM—has in its new facility a center for the conquest of space and for the continuance of our freedom. Our future is guarded by the superior talent and experience teamed to create—at CONVAIR-Astronautics—America's advanced *springboard into space!*

CONVAIR A DIVISION OF GENERAL DYNAMICS CORPORATION



Ozone Taking Back Seat In Use As U.S. Rocket Fuel?

Indications Are That Ozone Will Not Be Ready For At Least Five Years

by Alfred J. Zaehring

CHICAGO, ILL.—Talks with Armour Research Foundation and other sources definitely leave the impression that the U.S. has taken a back seat in the utilization of ozone for rocket propulsion.

Armour's pioneering work with high concentration liquid ozone dates back at least ten years, but is still at an early level—not much beyond the laboratory level—and probably it will be at least five years before liquid ozone can be successfully applied in a small rocket engine. In contrast, liquid fluorine is being tested in medium thrust rocket engines by at least three agencies.

Liquid fluorine is stable. Despite encouraging experiments at Armour and elsewhere, 100% liquid ozone still has not been stabilized enough for reliable rocket runs. Meanwhile, liquid fluorine is becoming a standard production item in the chemical industry, leaving ozone in the microlab level. Ozone stabilization, though, looks feasible, and it is here that additives may provide the breakthrough. Sulfur compounds

have been mentioned as stabilizers.

An ozone research committee has been formed, and will possibly advise ARPA and NASA what has to be done and how much it will cost to successfully stabilize ozone and start rocket engine tests. That point, however, has not been reached.

Meanwhile, the U.S. ozone program is left hanging. Only a few thousand dollars are now going into ozone propulsion research. It is barely enough to keep the few ozone research groups intact.

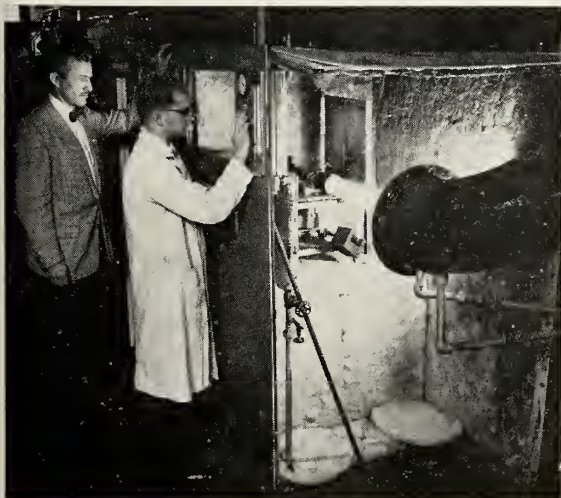
• **Soviets years ahead**—Clark E. Thorp, manager of ARF's Chemical & Chemical Engineering Department, points out that the Soviets are investing heavily in ozone propulsion. A great deal of Red ozone literature has been openly published, and it is suspected that much more lies in the realm of classification. Some estimates of USSR ozone effort place the figure in millions of rubles.

There is evidence that the Russians have successfully stabilized ozone for

employment in new liquid missiles and manned rocket aircraft. Whether the Reds are using 100% liquid ozone, or whether they are merely using it in concentrations of 30-40% with liquid oxygen, is a matter of conjecture. Either way, it places the Red ozone efforts some 10 years ahead of the U.S. More significantly, it means that the ultra-energy Red missiles can be loaded at launching pad from portable LOX-LOZ generators.

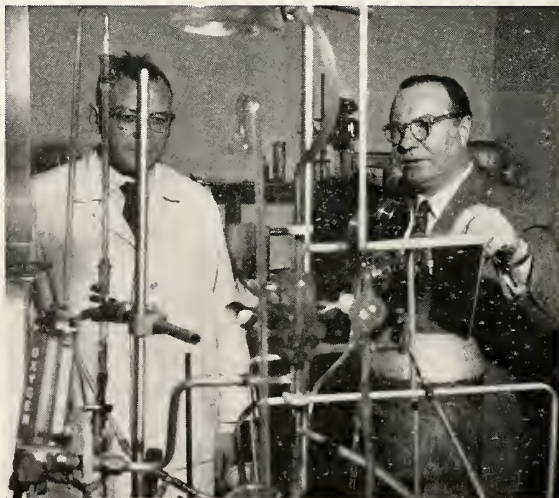
• **Fluorine disadvantages**—When the U.S. finishes applying fluorine to its rockets, it will be faced with a huge logistical problem—manufacturing fluorine in the U.S. and shipping it overseas to missile bases. Ozone can be manufactured from gaseous oxygen, which is available the world over.

An even more serious consequence is the toxic exhaust of fluorine. Chemical "fallout" from the firing of a fluorine ICBM or IRBM can cause serious health hazards in the form of HF to humans, animals, and even plants. By contrast, combustion of



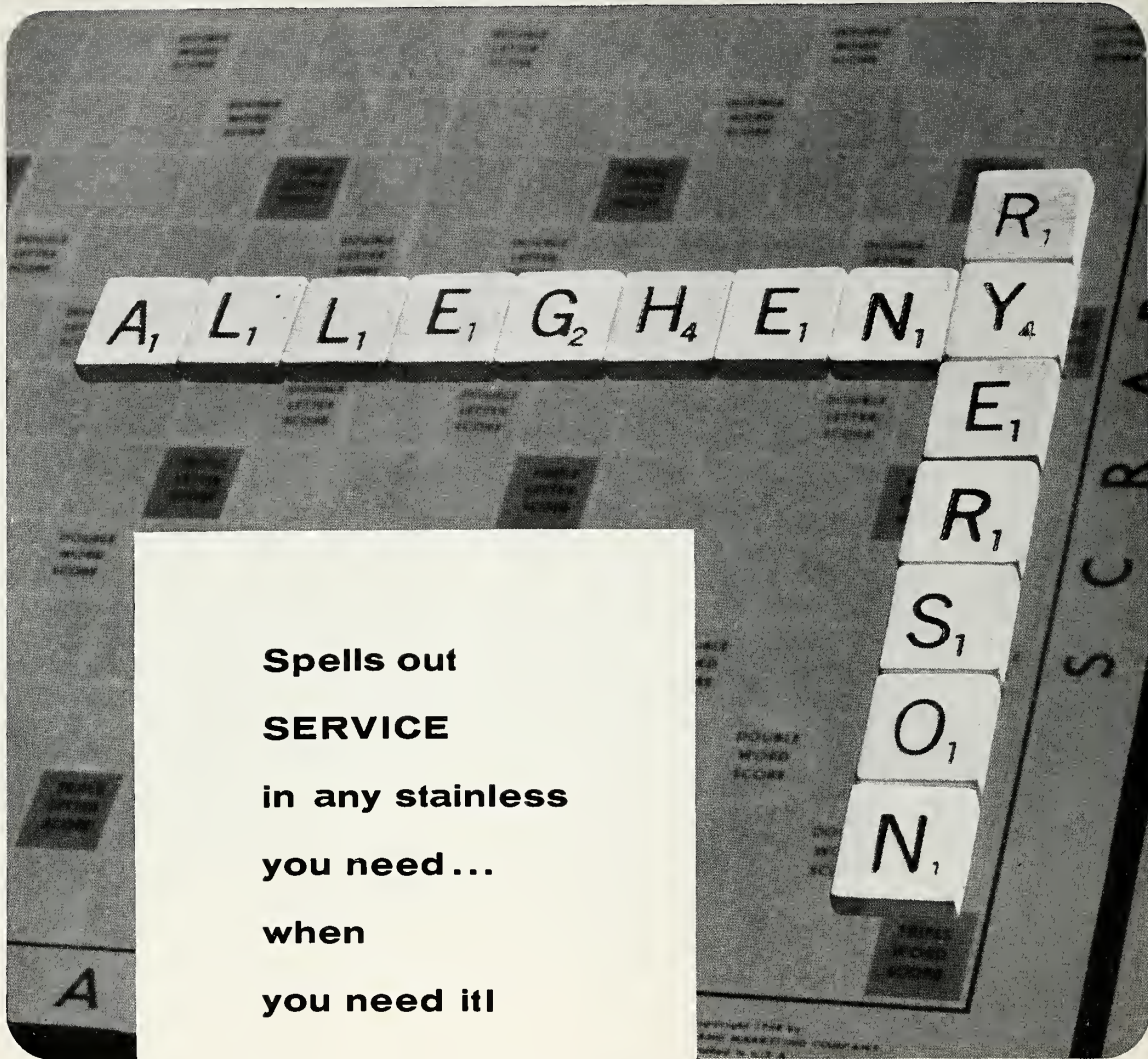
Armour

HOT AND BRIGHT, liquid ozone burns in combustion test at Armour Foundation Laboratories.



Armour

LABORATORY HANDLING of new fuel is a touchy, difficult problem that must be carefully monitored.



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SERVICE
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You can win only when you buy Allegheny Stainless from Ryerson. Two top names are teamed to give you quality stainless, the fastest way possible!

Allegheny Ludlum is the leading producer of stainless steels in all forms. Ryerson is recognized as the top steel service center. It's a team to bring you the best quality stainless, quick, when you need it.

Ryerson now stocks 2,351 shapes, sizes, finishes and alloys of Allegheny Stainless. It's the most complete line of stainless anywhere! And Ryerson takes the inventory cost from you, gives you as quick service as your own stockroom.

Whether your order is for Allegheny Stainless sheet, plates, bars, or whatever, Ryerson has it in stock. Trained salesmen and technicians to help in selecting or in fabricating are at your beck and call.

For top quality Allegheny Stainless from warehouse stocks, call Ryerson. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*

WSW-7128

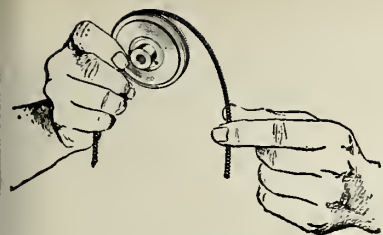
ALLEGHENY LUDLUM

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EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT





**A new key
to Accuracy...**

**IN JET ENGINE,
MISSILE AND AIRCRAFT
CONTROL LINKAGES**

The unusual cable shown above is Teleflex—the unique “flexible rack” that is helping to solve mechanical motion problems in the control of jet engines, missiles and aircraft.

HI-TEMP mechanical feedback control linkages operating at temperatures exceeding 1200°F.

HI-EFFICIENCY control systems comparable to tension cable systems... but at 1/9th the space, up to 60% less weight. Operating on every major aircraft in the country.

- No external moving parts...
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- Notural thermal loop—no special provisions necessary to compensate for temperature changes...
- The ultimate in minimum lost motion...

Teleflex tubular conduit, routed along contours and around obstructions, guides the cable to remote locations, duplicating the motion at both ends of a system.

DESIGN ENGINEERS—
For complete engineering data—send to Teleflex Incorporated, Church Rd., N. Wales, Pa., for your copy of Catalog 400.



TELEFLEX

MECHANICAL CONTROLS



LINKAGES

MECHANISMS

Circle No. 31 on Subscriber Service Card.
missiles and rockets, September 22, 1958

... ozone

LOZ with the hydrocarbons produces ordinary water.

Although Thorp, a top ozone expert, admits some of these facts, he is confident that ozone will follow the same growth and safety patterns shown by other high energy compounds that have become common items of chemical production.

• **Solid ozone?**—Ozone may take an entirely new approach for competing with fluorine. Armour recently proposed to AFOSR that work start on an old principle of stabilizing explosives—that of “dead pressing”.

Deadpressing is a term used in the explosives field to indicate a change that takes place when a compound is highly compressed. Some explosives will not detonate after such compression, but will merely burn.

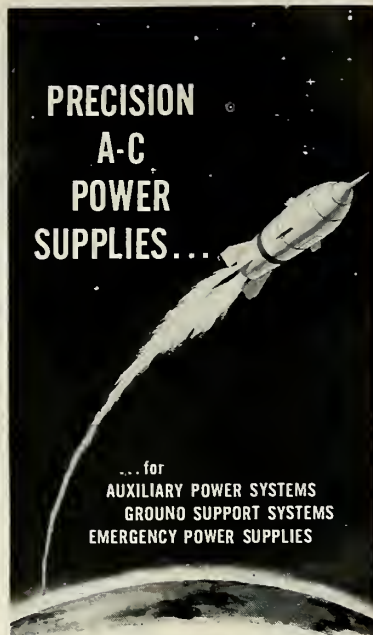
Though details were not given by Armour, here is how ozone might be used in a solid propellant: after compression, the solid ozone might be mixed with a fuel-binder to form a cold solid substance. The binder, acting in tension, would keep the ozone compressed. To use this “cryogenic solid,” the mass would have to be kept refrigerated—say at about -195°C. Though this is cold, it is much “warmer” than the few degrees K temperatures needed to stabilize free radicals.

• **Ozonide oxidizer**—Another ozone area that Armour doesn't wish to comment on are the ozonides. There have been numerous references in literature (including Armour's) to the organic ozonides. Surprisingly enough, such ozonides are remarkably stable.

This is probably the area where ozone can be used—as replacement of the age-old standard inorganic oxidizers (nitrates, perchlorates) with a molecule that combines both oxidizer (ozone) and fuel (a metal or organic radical). Ozonides might make possible an over 325 sec homogeneous solid propellant.

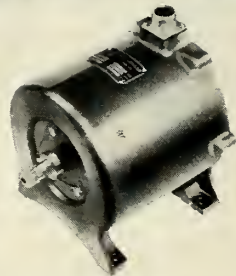
There is every indication that the Soviets have scooped us here, too. Much European and Russian work has been openly reported on metal and organic ozonides. The Reds may have been the first to realize that, to improve the performance of solid propellants, you have to not only work on the fuel, but on the oxidizer.

Meanwhile, Armour has quietly set up a static test facility some 50 miles west of Chicago. Fluorine has been fired here, but whether ozone (solid or liquid) will get into a rocket engine is now nebulous.



**PRECISION
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POWER
SUPPLIES...**

... for
**AUXILIARY POWER SYSTEMS
GROUND SUPPORT SYSTEMS
EMERGENCY POWER SUPPLIES**



**PERMANENT
MAGNET ALTERNATORS
AND INVERTERS**

**Extreme Reliability • High Efficiency
Static Voltage Regulation • High Speed**

The superior advantages of Pesco produced permanent magnet alternators and inverters are responsible for their use in many of the major missiles and supersonic aircraft. By utilizing a radial air gap permanent magnet rotating field, all brushes and slip rings are eliminated, thus reducing radio interference and explosion danger. Present models range in size from 25 VA to 12 KVA output at speeds of 3000 to 48,000 R.P.M. Pesco's creative research, engineering and production group offer a completely integrated facility for your power supply needs. Please write for full technical data to



WESTERN BRANCH

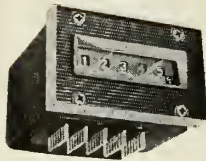
PESCO PRODUCTS DIVISION



Borg-Warner Corporation
3310 Vanowen Street
Burbank, California

Circle No. 32 on Subscriber Service Card.

COMPARE FEATURES

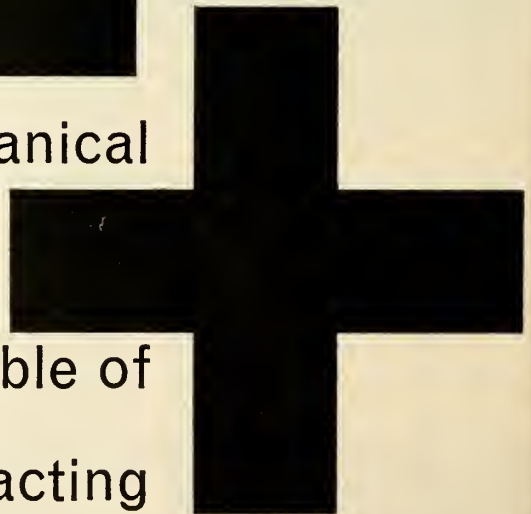


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Neuron High-Speed Electromechanical Counter, now manufactured by the Data Instruments Division of Telecomputing Corporation, is the same highly reliable Neuron counter which has enjoyed wide acceptance in a great variety of totalizing applications. ■ Prompt Delivery—assured by Telecomputing's resources and facilities. ■ High Speed—counting rate to 40 per second. ■ Precision—cannot double index. Full count registered on leading edge of input pulse. ■ Add and Subtract—accepts random add and subtract pulses. ■ Instant Reset—mechanical or electrical. ■ Environmental Capabilities—balanced moving elements provide exceptional resistance to vibration and shock. ■ Switch and visual readout. ■ Designed for panel mounting. ■ Specify Neuron for the solution of tabulating problems that ordinary counters cannot solve. For complete information, write, wire, phone, DATA INSTRUMENTS DIV. ■ TELECOMPUTING CORP., 12838 Saticoy St., N. Hollywood, Cal.



the only electromechanical
totalizer with
switch-readout capable of
adding and subtracting



world astronautics



by Frederick C. Durant III

The capabilities of man's physical senses in space, as compared to terrestrial functioning, will not be determined finally until man is in satellite flight. According to space medical authorities, X-15 flights and manned ballistic flights of a few minutes duration will not provide sufficient data to predict man's physical capabilities in weightless condition for hours or days.

J. C. Guignard, M.B., ChB., writing in the July issue of The British Interplanetary Society's *SPACEFLIGHT*, reviews some of the physiological problems man would face in the manual assembly of prefabricated space stations. This thoughtful piece is recommended to those who would have man locating, moving, and fastening innumerable pieces of "tinkertoy" in orbit.

Man will, eventually, assemble space stations, but at first he will handle only the smallest number of simple components. An interesting appendix to this article illustrates with diagrams the problems of discrimination and depth perception of objects in space under conditions of objects (a.) in planetary shadow, (b.) of high albedo in full sunlight and (c.) against a planetary segment. It is suggested that a system using consecutively placed contoured lights might be used to aid in determining attitude, size, distance and displacement of bodies in space.

According to Krafft Ehrlicke, the problem of timing is acute in the launching and programming of thrust in earth-lunar trajectories. It is greater in launchings from higher latitudes.

Furthermore, the farther a launching site is away from the equator the longer the interval is between possible launchings to the Moon. The reason for this is that the Moon lies in an orbit whose plane passes close to the equator. Launching from the higher latitudes causes the vehicle to approach the lunar orbital path at higher angles. Such flight paths result in greater critical timing and vehicle velocity.

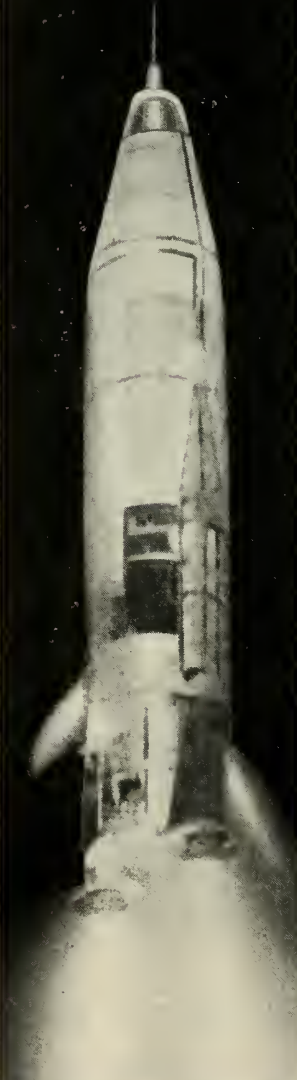
The above conditions are bad enough for a one-way mission to the Moon. On circumlunar shots, however, northerly launching points become even more undesirable. The U.S.S.R., for example, cannot fire a circumlunar vehicle from within their borders unless (a.) the vehicle remains at a great distance from the Moon (scientifically undesirable) or, (b.) considerably more energy is stored in the vehicle for powered maneuvers. Thus the U.S. currently has a major advantage over the U.S.S.R. by having a lunar launching site appreciably nearer the equator.

A rocket launching system which utilizes atmospheric oxygen from take-off to 100,000 feet has a potential design weight advantage. Numerous concepts have been put forward including aircraft as launchers and clustered turbojet engines. Another favorite is the "ram rocket" power plant in which a rocket motor is operated over-rich and the rocket jet exhausts into a ramjet after-burner where combustion is continued. Experiment, Inc. and Aerojet-General have been studying ram rockets for several years.

Anhydrous (water-free) hydrazine in immense quantities is an apparent requirement for large space-age rocket launching vehicles. Dilute water-hydrazine mixtures are cheap; the problem—and cost—is in the removal of the water. The use of chemical agents (such as alkaline earth metal hydroxides) for dehydration give low yields while the application of these metals in elementary form (such as sodium amide) is hazardous because of the possible formation of explosive compounds. Mere evaporation leads to azeotropic distillation of low concentration, with water and hydrazine both boiling off at the same rate.

H. Bock of University of Munich published a method whereby appreciable quantities of concentrated hydrazine have been obtained in his German laboratory. The final stage of the process is rectification at 720 Torr in a Dewar-like vessel under an atmosphere of nitrogen.

FOR THE AIR FORCE'S ATLAS
**TITANIUM FOR
WEIGHT
REDUCTION**



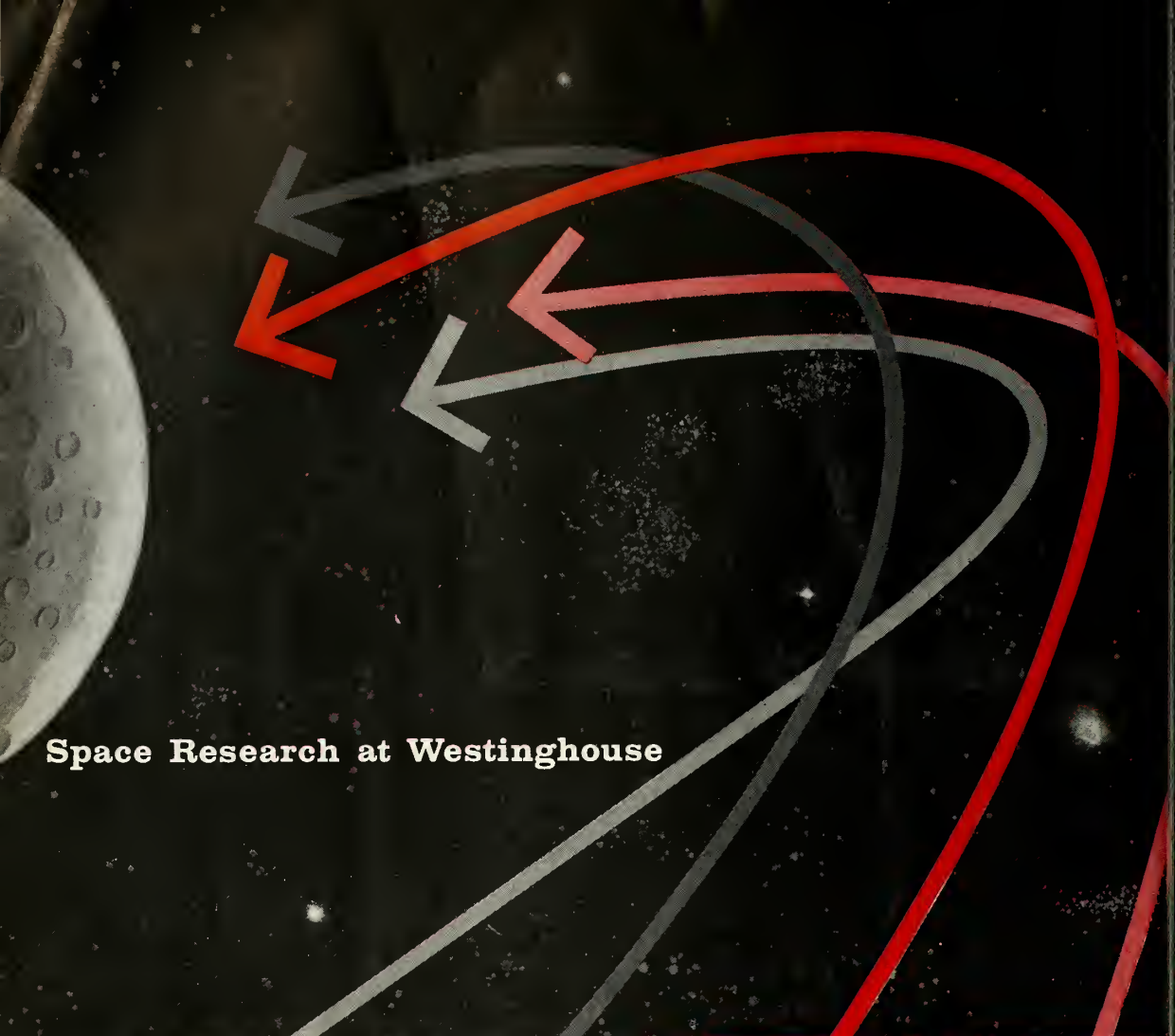
(Official U.S. Air Force Photograph)

Our metallurgists and engineers will be glad to work with your personnel in developing the most advantageous use of Republic Stainless Steels, Alloy Steels, and Titanium. There's no obligation. Write Republic Steel, Dept. MR-6078, 1441 Republic Building, Cleveland 1, Ohio

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Space Research at Westinghouse

Navigation

Communications

Detection
& Tracking

Missile Control

to make the moon the free world's high ground

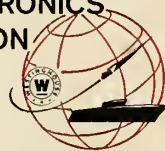
The skills and talents of the Westinghouse Electronics Division have been directed to research and development in these critical fields to help find the answers to man's next major space accomplishment . . . reaching the moon . . . and beyond.

These activities are typical of the Westinghouse projects for present and future military applications. They are facets of the Electronics Division's abilities and capabilities to design, develop and produce systems and sub-systems for the conquest of space.

Westinghouse Electronics Division, P.O. Box 746, Baltimore 3, Md.

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RADAR
COMMUNICATIONS
MISSILE CONTROL
DATA PROCESSING
AND DISPLAY

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Photosynthesis Seen Answer to Space Life

GROTON, CONN.—Photosynthesis, which replenishes life-sustaining oxygen in an endless cycle on earth, may enable man to travel in outer space for unlimited periods of time, it was reported here to the first international symposium on submarine and space medicine.

The feasibility of growing algae in nuclear submarines and space ships was outlined by T. A. Gaucher of General Dynamics Corporation's Electric Boat Division. GD's research was conducted in cooperation with Dean Burk and George Hobby of the National Institutes of Health.

Gaucher declared that a new strain of algae has been developed which increases 1,000 times a day compared to only 8 times a day in previously employed algae.

The new method, using very dense plant cultures of fast acting algae irradiated with extremely intense light, has reduced the volume of algae required to one-twentieth of the most

recently published estimates.

The noxious carbon dioxide respired by men is removed from the closed atmosphere of sealed containers in the same manner that green plants do on earth. In addition, the report stated that the algae also produce large quantities of food material rich in protein and vitamins.

A small source of light energy to serve as an artificial sun many times the intensity of the brightest sunlight was developed for the method by the General Electric Company.

Cultures of the new algae strain, discovered by C. Sorokin at the University of Texas a few years ago, are pumped very rapidly past the light, which is not much bigger than a pencil. This provides rapid stirring to use the well established advantage of intermittent illumination. The alternate periods of high intensity light flashes are followed by dark rest periods for recovery.

Philco Forms Group for Advanced Weapon Systems

Philco Corporation's Government and Industrial Division has announced the formation of an advanced weapon systems (AWS) group. The objective of the group will be to study and formulate new and advanced weapons systems to meet future military requirements.

The group will be headed by Hayden N. Ringer who has been with Philco since 1945. Up to now, Ringer has been in charge of the Government and Industrial Division's missile fuze research, development and production engineering for the *Terrier*, *Talos*, *Tartar*, *Sergeant*, *Corporal*, *Little John*, and *Falcon* missiles.

Biggest Environmental Unit Built for Testing

Tenney Engineering Co. of Union, New Jersey recently completed construction of what it says is the world's largest environmental chamber, for McDonnell Aircraft.

The unit is 18 feet square and 42 feet deep, weighs 125 tons and has a temperature range of minus 100 degrees to plus 1200 degrees F through altitudes to 150,000 feet.

Effective workspace in the chamber is 14 feet square by 35 feet deep. Within the area, McDonnell can simulate ram airflows up to 100 lbs/min.

at 75,000 feet at various temperatures. It is also possible to dissipate a live heat load equivalent to 30 hp at altitude conditions while maintaining a temperature of minus 80 degrees fahrenheit.

The unit is equipped with four viewing windows and additional guarded openings for electrical and hydraulic pressure lines. Walls are two feet thick and the interior is stainless steel, treated to withstand the high operating temperatures.

U.S.-British Firms Join to Produce Control System

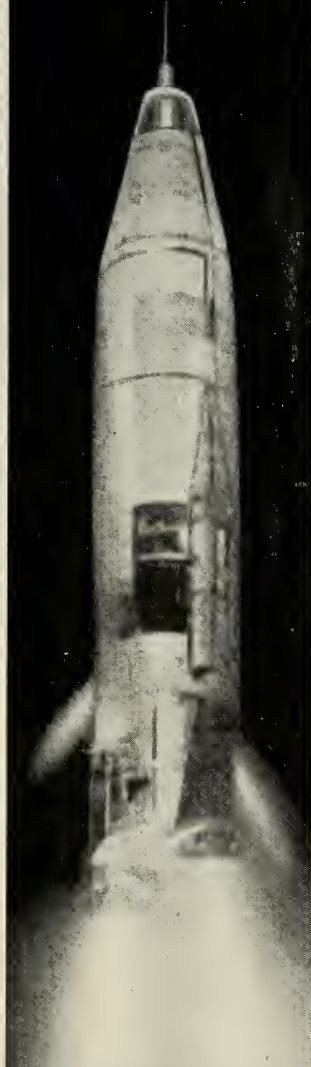
Consolidated Electrodynamics Corp. of Pasadena, and The Elliott-Automation Ltd., of London, England, last week announced an exclusive licensing agreement, under which the British firm will manufacture and market analytical and control instruments of CEC design.

Under the agreement, the English firm will market the licensed instruments in all countries of the British Commonwealth, except Canada. It may also act as supplier to a CEC subsidiary in Germany.

The instruments included in the agreement are analytical and process-control MAS spectrometers, chromatographers, moisture monitors, refractometers, and oxygen analyzers.

(m/e News continues on p. 41)

FOR THE AIR FORCE'S ATLAS
**STAINLESS STEEL
FOR HEAT
RESISTANCE**



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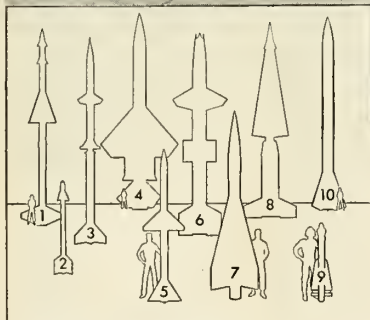
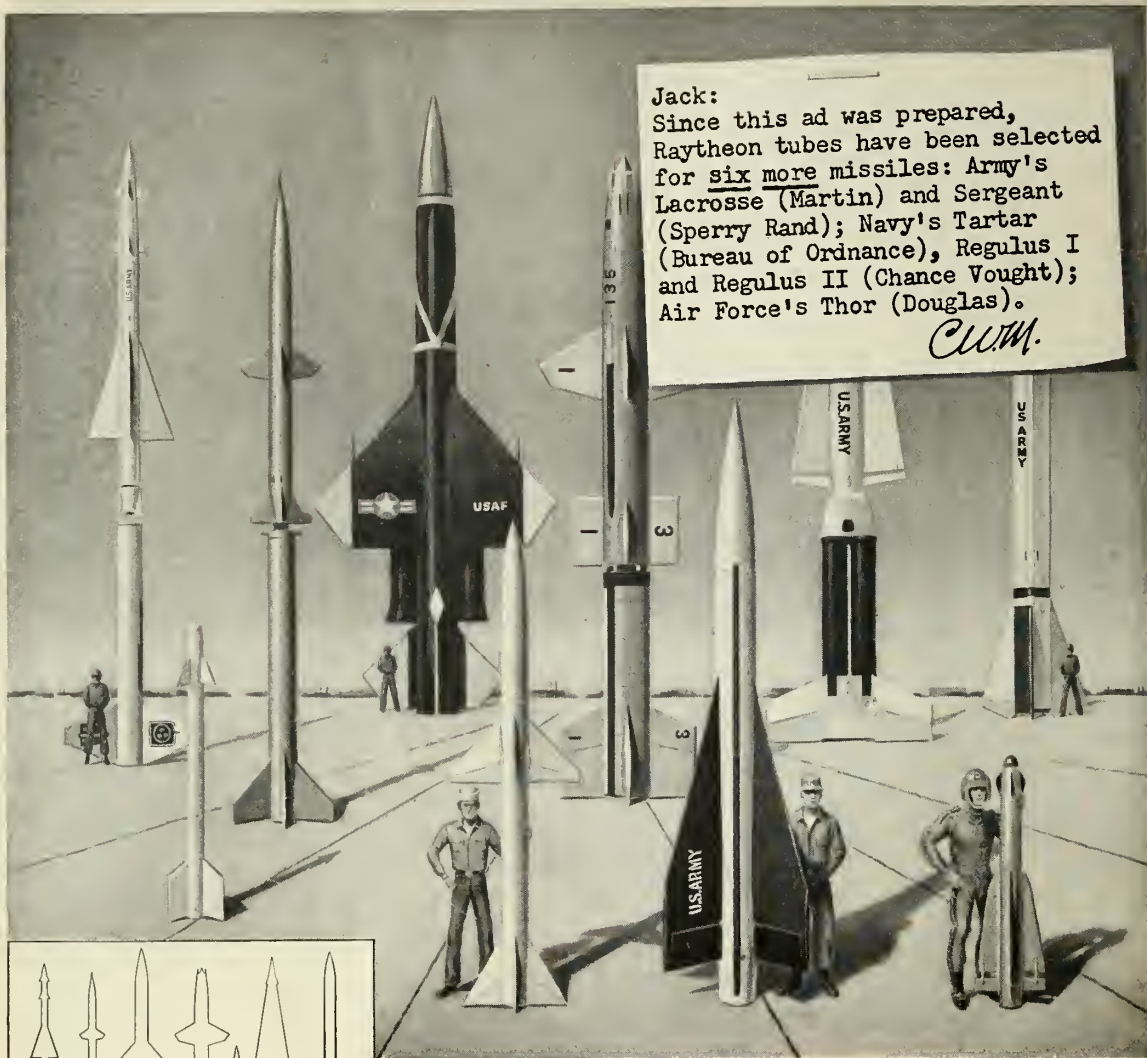
REPUBLIC STEEL

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World's Largest Producer of Missile Metals — Titanium, Stainless Steel, and Alloy Steel

Jack:
 Since this ad was prepared,
 Raytheon tubes have been selected
 for six more missiles: Army's
 Lacrosse (Martin) and Sergeant
 (Sperry Rand); Navy's Tartar
 (Bureau of Ordnance), Regulus I
 and Regulus II (Chance Vought);
 Air Force's Thor (Douglas).

C.W.M.



1. Nike Ajax. Army. Ground-to-air. Prime contractor: Western Electric.
2. Sidewinder. Navy. Air-to-air. Prime contractors: Philco; General Electric.
3. Terrier. Navy. Surface-to-air. Prime contractor: Convair.
4. Bomarc. Air Force. Ground-to-air. Prime contractor: Boeing.
5. Sparrow III. Navy. Air-to-air. Prime contractor: Raytheon.
6. Talos. Navy. Surface-to-air. Prime contractor: Bendix.
7. Hawk. Army and Marine Corps. Ground-to-air. Prime contractor: Raytheon.
8. Nike Hercules. Army. Ground-to-air. Prime contractor: Western Electric.
9. Falcon. Air Force. Air-to-air. Prime contractor: Hughes Aircraft.
10. Corporal. Army. Ground-to-ground. Prime contractors: Firestone; Gilfillan.

10 MAJOR U. S. MISSILES RELY ON RAYTHEON TUBES

Crushing acceleration and searing heat must be endured by the electronic tubes in guided missiles. Even under these grueling conditions, tiny Raytheon tubes produce guidance impulses with steadfast *reliability*. This reliability is achieved through capable engineering and painstaking manufacturing and testing techniques.

The choice of Raytheon Reliable sub-miniature tubes for use in these 10 missiles is another example of how the 31,000 men and women of Raytheon are contributing to the nation's security.



Excellence In Electronics

RAYTHEON MANUFACTURING COMPANY, Waltham, Mass.



astrionics

by Raymond M. Nolan

An indication that the computer industry is really coming of age is the offer by Remington Rand to sell a number of traded-in Univacs. The computers, among the earliest ones built, carry a price tag in the vicinity of one-half the original \$1 million cost.

The Nortronics division of Northrop has come up with what it claims is the first spherical-type airflow direction and pitot pressure sensor. Called the "Q" ball, it measures angle of attack, sideslip angle and dynamic pressure. One use could be for achievement of optimum reentry angle for *Dyna-Soar* type vehicles.

Sperry Gyroscope recently ran through first tests of its inflatable radome, developed to house the MPS-21 Tactical Early Warning Radar. The complete system, developed for battlefield portability, can be assembled and operating in something like two hours. The miniaturized radar set has superimposed paraboloidal-shaped dishes on the antenna, combining search and height-finding functions by measuring return echoes picked up by the vertical and slant-beam reflectors in relationship to the angle between the two and the time between echo "hits" on them.

A unique approach to accelerometer development was described recently by the research department of a major manufacturer. The method, which evidently never got beyond the laboratory stage, measured deflections of small "pellets" of liquid impinging on a target. Accelerations caused the pellets to deviate from the "bullseye" and the amount of deviation was convertible to a measurement of force and direction. Some thought was also given to an analogous system using electrons in place of the fluid, but discarded because the parameters to be measured were so small in relation to normal power supply perturbations.

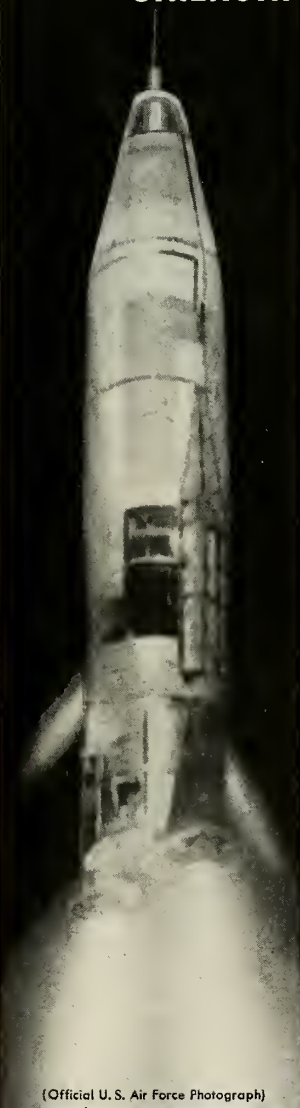
It's sometimes hard to tell who will turn up in the missile business these days. Paramount Pictures recently announced the election of three new vice-presidents in the Autometric Corporation, a subsidiary of Paramount. Autometric is an R&D firm working in the fields of electronics, data reduction, and reconnaissance analysis. One of the vice presidents is Dr. Ulrich K. Heidelauf, formerly a special consultant to WADO on intelligence and reconnaissance systems.

Interstate Electronics Company continues to expand with the addition of 15,000 sq. ft. to its Anaheim facility. Only in business 31 months, the firm experienced much of its expansion right in the middle of the DOD stretchout, because of its heavy involvement in the *Polaris* program. One neat device developed by Interstate was a super-efficient filter used by Aberdeen Proving Ground to track *Explorer* satellites. The filter reportedly allowed tracking through a full quarter-orbit using a conventional precision receiver.

Electronic Industries Association's latest Specification for Military Components is SMC-2 for insulated, high-temperature electrical wire. The specs, which are formulated by EIA's Engineering Department Committees, are approved by EIA industry members. For further information, write to EIA Engineering Office, 11 West 42nd St., New York 36.

FOR THE AIR FORCE'S ATLAS

ALLOY STEELS FOR HIGH STRENGTH



(Official U.S. Air Force Photograph)

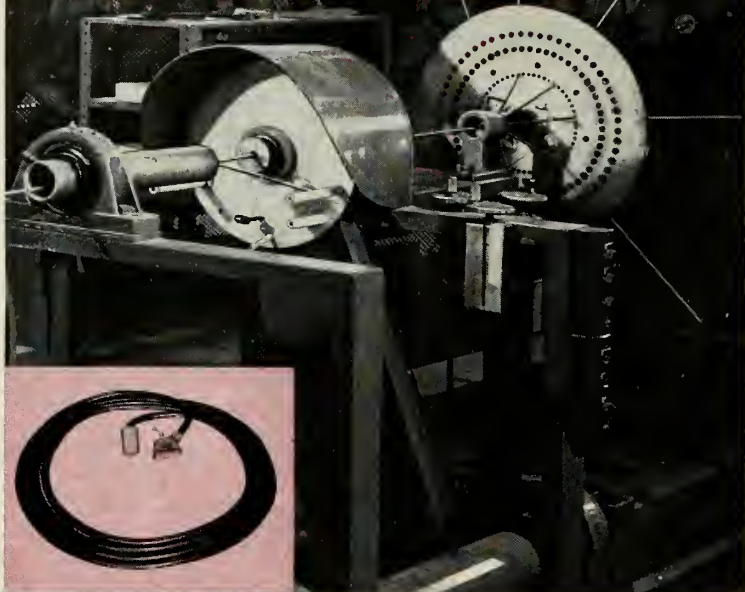
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Robertshaw delivers More Reliable Electronic Cable Fast and for Less Cost



R-F Designed Planetary Cabler



As the count-downs become more complex, the need for more reliable electronic cable systems become compelling. Robertshaw's unique approach to the fabrication of custom electronic cable assures missile manufacturers of precision cable delivered on time, more economically.



Connector Wiring

At Robertshaw's integrated cable facility, leading cable designers and engineers have developed revolutionary new equipment and methods capable of fulfilling every conceivable cable requirement.

This is Cable Systematics. Designed to answer *your* cable problem. We invite you to inspect our facilities.

Write for Technical Bulletin, RF-5810

AERONAUTICAL AND INSTRUMENT DIVISION

Robertshaw-Fulton CONTROLS COMPANY

SANTA ANA FREEWAY AT EUCLID AVENUE • ANAHEIM, CALIFORNIA



... m/e news

GE Reorganizes MOSD Facilities

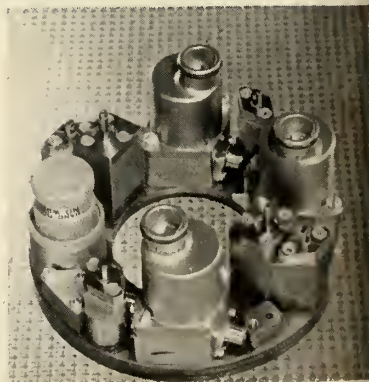
Reorganization within the Defense Electronics Division of General Electric is expected to relieve the Missile Ordnance Systems Department of responsibility for operations of the Ordnance Section, and to make MOSD talents and facilities available on advanced types of missiles and new projects.

MOSD has been redesignated the Missile and Space Vehicle Department. The former Ordnance section of MOSD has been established as a separate operating division of the Defense Electronics Division and renamed the Ordnance Department.

The Missile and Space Vehicle Department employs about 5,000 people, many of them engineers and scientists. It has applied research and development facilities at Philadelphia, and a missile production section in Burlington, Vermont. Field personnel are located at primary missile and space vehicle locations in the U.S. and overseas.

The Ordnance Department employs about 2,500 in development and manufacturing facilities at Pittsfield, Mass. This department is currently working on development of fire control and inertial guidance systems for the *Polaris*; development of shipboard handling and launching system for the *Talos*; and development and production of the *Mark 73* fire control system and the *Mark 43* torpedo for the Navy.

"Black Box" Hydraulic Servo Eases Repair



LOS ANGELES—Simplicity has been a prime factor in the design of an electrohydraulic steering control system developed for missiles by the Garrett Corporation's AiResearch Manufacturing Division.

The system controls the positioning of steering surfaces, jet-avayors, jet engine exhaust areas, nozzle and vector

missiles and rockets, September 22, 1958

steering controls. It converts low-level electronic signals from a missile's main guidance system into hydraulic forces which actuate directional control mechanisms.

A design feature is the use of "hydraulic printed circuits," analogous to electrical printed circuits. It combines manifolds and mounting structures in a series of integral passageways, eliminating all external plumbing and leakage.

The system's control elements are relatively insensitive to missile maneuvering accelerations and can stand at least 100 g force with no change in performance.

Modular design of the AiResearch unit helps reduce missile trouble, shooting to a simple process of tracing a difficulty to a major package. Quick replacement of the modular unit becomes the only delay at missile level, with detailed trouble-shooting accomplished almost entirely at specialized test locations.

Once the package is bench checked and calibrated as a complete unit, it can be installed in the missile without danger of making incorrect or leaky connections, or changing critical adjustments.

Missile Companies Discuss Merger

Preliminary discussions are underway between General Transistor Corporation, New York, and Barnes Engineering Company, Stamford, Conn., for a possible combination of the activities of the two companies. If the merger is agreed upon, it would be effected through the exchange of one share of General Transistor stock for each 3/4 Barnes stock.

Barnes Engineering Co. played an important role in the Army's recently completed *Operation Gaslight*, which involved the successful re-entry of a *Jupiter* nose cone. Barnes supplied scientists and other personnel for the experiments, and also developed special radiometers and a meteor-spectral camera.

Mack Truck Electronics Division Acquired by E.A.C.

The Electronics Division of Mack Trucks in Plainfield, New Jersey, which was discontinued on August 30th, 1958 has been acquired by the Electronic Assistance Corp. of Red Bank. Included in the acquisition are the manufacturing rights, tools, drawings, etc.

Robert Edwards, former general manager of Mack Electronics, becomes President of E.A.C. In addition most of the key personnel from the former

Major Southern California
missile operation has
immediate openings
for qualified graduate
engineers with experience in

Instrumentation Systems

with general knowledge of missile systems, including propulsion, guidance, structures and electrical systems.

Guidance Systems

Experienced in research and testing of practical hardware, and with mathematical background for systems analysis.

Flight Test

Background should qualify for planning and formulating entire flight test programs.

Aerodynamics

Must be able to analyze missile configuration to determine aerodynamic performance and stability and control characteristics.

Well paid jobs
for qualified people

Relocating expenses paid.

For information on these and other engineering positions, write:

Mr. H. B. Richards, Dept. 451

Missile Division

North American Aviation, Inc.

12214 Lakewood Blvd., Downey, California

electronics division have moved to the new company.

E.A.C. will continue to produce all the electronics equipment formerly manufactured by Mack. This includes radar and communications equipment for military use. Present contracts include the completion of Mack's obligations to the government and subcontracts from Lockheed Aircraft and the Signal Corps.

ITT to Show Weapons System at Dallas

International Telephone and Telegraph Corporation will make a presentation of a complete weapon system with its complex communication network at the Air Force Association's Air Power Panorama at the Dallas, Texas, Memorial Auditorium, September 25-28.

The sixty-foot exhibit will show a weapons system from the early research stages until it emerges as a

fully operating unit. The exhibit will also illustrate ITT's role in the field of missile electronics and communications. By means of a stylized missile, illuminated and synchronized with a descriptive sound system, spectators will be able to observe where components or assemblies are used in a typical weapon.

ITT has been in the foreground of the missile business since 1945. Among its missile projects have been the development of airborne guidance equipment for the *Talos* and *Terrier* missiles; a new control system design for *Rascal*; the computing ground, air and tracking system for *Lacrosse*; the ground communications network feeding information to the *Atlas* ICBM.

Douglas Organizes Reliability Subdivision

Organization of a new sub-division to lend emphasis to the importance of reliability in its products was announced at the El Segundo Division of Douglas Aircraft Company.

In announcing the new sub-division, H. G. Hynd, Division Vice President-General Manager, disclosed the realignment of several other departments as well as the creation of a new department. W. L. (Lew) Whittier, former Chief Service Engineer, has been named Product Reliability Manager.

Hynd said that under the new sub-division will be the present departments of Quality Control and Materials-Process Engineering. Newly organized will be the Manufacturing Reliability Assurance department which will work hand in hand with a new manufacturing reliability engineering group.

Conservation functions, formerly a part of Safety and Conservation, will also fall under the new setup, with safety being integrated into Industrial Relations.

"We feel that today's high performance aircraft and missiles require higher degrees of product quality and reliability than ever before in aviation history," Hynd said, "and we intend to meet these needs squarely."

Whittier, who also has been temporary Location Manager at the Douglas Palmdale Assembly and Flight Test facility, will be succeeded in that capacity by Harold W. Swartz, former Assistant Manager. Hal Bayer, Assistant Chief Service Engineer, will replace Whittier as Chief of the Service Engineering Department.

Providing the "Knockout Punch"
in Anti-Missile MISSILES

Missile Quality
FORGINGS
LABORATORY CONTROLLED

brochure gladly sent
THE BILLINGS & SPENCER CO.
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New Automaton Beats Man's Speed 1,000 Times

An automatic information retrieval that is said to search out written information 1,000 times faster than a man could do it has been placed in operation at General Electric's Aircraft Gas Turbine Division in Cincinnati, Ohio.

The new system, believed to be the first of its kind, is based on the use of descriptive key words and on document file numbers. All technical documents in the AGT Library are carefully identified in terms of these key words. Each document may have a dozen or more words to describe it, and all documents pertaining to the same subject will be listed by number with these terms. In addition, a concise, descriptive abstract is prepared for each document in the system.

All this information is transferred to a series of magnetic tapes for use in the electronic computing equipment, located in the same building with the Library. At present there are more than 30,000 document abstracts recorded on just three tapes; there are over 7,000 key words describing these documents; and there are more than one-quarter million document file numbers coordinated with the words in the system.

The retrieval system, using IBM computing equipment, can search through the entire list of numbers in less than three minutes. And in less than 15 minutes, the time depending on the number of documents it found during the search, the system will deliver printed abstracts of those documents. Each abstract carries the requestor's name and address, the document's title, author, and file number, and the security classification of the material.

• **Too much data?** Before the system was put into use, an average literature search by trained personnel required as many as 14 hours.

Reid Barton and Lee Caplan, designers of the computer program, explain that in its present form the system can accommodate 1,000,000 abstracts, 56 million file numbers, and can perform up to 99 simultaneous literature searches. Barton adds: "New computing equipment is available which could increase the speed of our present system by 1,000%, while the document storage capacity would be around 10,000,000."

The need for additional speed and storage capacity may not be far in the future. Reliable estimates show that well over 2 million technical documents were published in the world

last year. And statistics indicate that the rate of output will double every 10 years.

Speculating on the future, Mr. Dennis, manager of the AGT library says: "Our system performs even better than we had hoped. But it is only the first step in automatic literature searching. I visualize that within the next 10 to 20 years the nation's entire industrial community will be tied together through a network of sophisticated automatic retrieval systems. Published data from other industries, government agencies, and educational

institutions will be made available to the inquiring engineer merely by feeding questions into electronic searching system at his place of work.

These questions will be channeled to all the technical data centers in the network. At each center an automatic retrieval system, probably based on ours, will search through all the documents available. They will then transmit the material back through a filtering center, which will eliminate all duplicated documents, and forward the information to the waiting engineer."



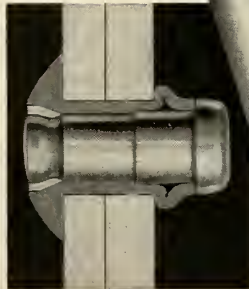
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Constant Current Generator Has Wide Range

A new Model CC2000 Constant Current Generator is a transistorized, regulated, AC-operated design providing adjustable constant current over a wide range of output load variation.

This supply is intended for all types of constant current applications including transistor testing, transistor biasing, solenoid operation, instrument calibration, electro-plating, chemical testing, and other medium or high current applications.

Electronic Research Associates, Inc., asserts the Model CC2000 accomplishes current regulation by means of a transistorized series regulator whose resistivity is varied in proportion to the change of current in the output load.

The regulator includes a current reference source utilizing a silicon zener diode network and differential DC amplifiers are utilized in order to obtain optimum thermal stability.

A second source of voltage is connected in series with the constant current generator and this adjustable source provides a centering voltage setting for the unit.

Input power for both the voltage

source as well as the current source is regulated by means of magnetic elements which compensate for slow variations in the input line voltage. In addition to absorbing the slow input variations, the magnetic regulator reduces the build up of voltage across the transistor regulator and hence promotes conservative operation.

The Model CC2000 provides an output current which is adjustable over the range 25 ma-2 amperes. Operating voltage point is adjustable over the range 0-180 VDC. Current ripple is less than 0.05% RMS. The unit is designed for bench or 19" relay rack mounting with a 10" panel height, and includes both voltage and current metering. Operation is for an input of 105-125 VAC, 60 cps.

Circle No. 299 on Subscriber Service Card.

Relay Test Sockets For Component Connection

The **Barnes Development Co.** Test Socket provides a method of connection to a wide variety of components with hermetic, seal headers of the hook, pin, or flattened terminal types

used on relays and other components.

The socket is said to be durable to withstand production test usage, with mica filled epoxy or teflon dielectric, beryllium and copper contacts and mutually insulated dual contacts on each connection. This dual contact is claimed to have advantages in contact resistance evaluation of relays in that a current and measuring terminal is provided. There are advantages also in dry circuit testing where the dual contacts paralleled provide an extremely reliable, low-resistance contact to the relay.

Circle No. 298 on Subscriber Service Card.

Time Delay Relay Offers Instantaneous Recycling

A time delay relay, factory preset to give delay times from 50 milliseconds to 50 seconds, is said to offer instantaneous recycling. It is developed by **Masters Specialties Co.**

The unit has a transistor control circuit, with a relay contact as the only moving part. Weighing four ounces, this time delay relay is accurate from 18 to 32 VDC, and -55°C to +71°C.

The hermetically sealed unit uses printed circuit construction. It will



VERSATILE MULTI-RANGE METER TESTER

Model M-2

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Precise, self-contained unit for laboratory and production use. For DC instrument calibration from 25 ua full scale to 10 ma full scale, and 0-100 VDC; sensitivity and resistance measurement; DC current-voltage source; limit or bridge measurements from 0-5000 ohms. Regulated power supply. Stepless vacuum tube voltage control. Accuracy exceeds 3/4% (current), 1/2 ohm or 3/2% (resistance). For 115V, 60 cycle AC. Complete - needs no accessories. Bulletin on request. Marion Electrical Instrument Co., Manchester, N. H., U. S. A.

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U. S. Patent 2,740,093



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FREE 180 PAGE WELDING DATA BOOK

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INCLUDES:

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Also: money-saving suggestions on Overlays, Paste Alloys, Cutting, Pre-heating, Shims, Flux, Metalworking and an illustrated chapter on Controlling Heat Input...how to avoid warping, embrittlement and distortion.



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METALS FOR MISSILES...

Armco PH Stainless Steels— PH 15-7 Mo 17-7 PH 17-4 PH

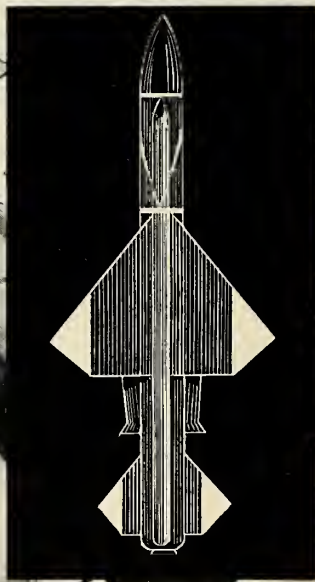
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These special Armco Stainless Steels, developed specifically for aircraft and missiles, are used for missile airframes, tanks, power plants and accessories because they:

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Missile and aircraft parts, demonstrating the weight-saving possibilities and producibility of Armco's PH Stainless Steels, will be on display. Armco engineers will be on hand to give you complete information on the properties and fabrication of these special stainless steels.

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Access doors and other thin section missile parts often require pressure tightness and maximum physical properties. Accuracy is critical. Many missile manufacturers are investigating the unique foundry methods of Morris Bean & Company, Yellow Springs 11, Ohio.



Circle No. 41 on Subscriber Service Cord.
missiles and rockets, September 22, 1958

... new products

withstand exceptional shock and vibration. The relay can be delayed pull-in, or delayed drop-out. Contact rating is 5 amp. resistive.

Circle No. 297 on Subscriber Service Cord.

Long-Life Hose Made By Zero-Motion Braiding

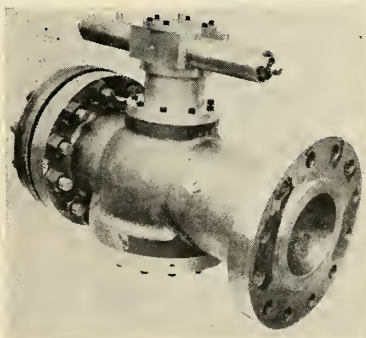
A new wire braiding technique, which greatly increases hose life and decreases elongation and contraction under pressure to less than 1/2 of 1%, has been developed and put in production by **Titeflex, Inc.**, Springfield, Mass., a subsidiary of Atlas Corp.

A sudden application of pressure on a flexible hose creates axial and diametric forces within the hose. Since the innercore is elastic (400% elongation), all the forces are transmitted directly to the braid. The axial force will tend to elongate the braid; the lateral forces, meanwhile, tend to cause a diametrical expansion and thereby cause a contraction in length.

It was established that if the individual braid wires are applied at a certain angle, the tangent of which is equivalent to the ratio of the axial force to radial force, there will be no relative motion among the wires. This braid process angle is equated, the angle having a tangent equal to the pitch of the helix of the braid length, divided by the braid circumference.

Circle No. 296 on Subscriber Service Cord.

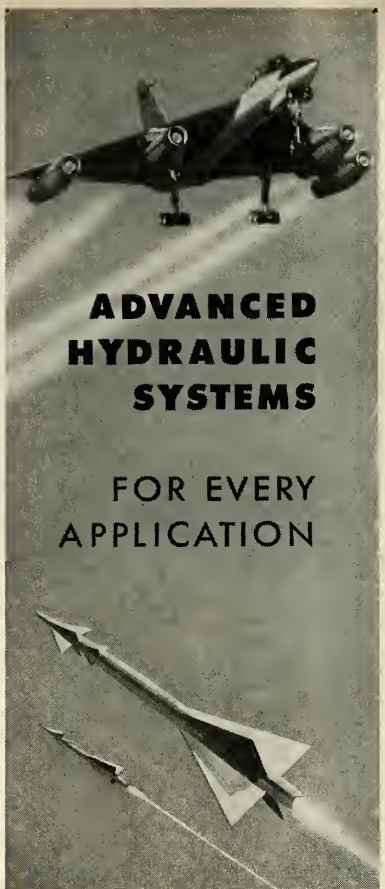
Pressure Ball Valve Largest Size Made



Hydromatics, Inc. has produced and delivered an initial quantity of 8" ball-type control valves, intended for high pressure systems up to 2,000 psi and temperatures up to 225° F.

These valves mark the first time that a fast-acting, ball-type unit has been successfully designed and built for large size lines.

Controlled by pressure operated actuator, these valves are notable for



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ENGINEERING OPPORTUNITIES AVAILABLE
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MISSILE ENGINEERING

The "collapsing of time" concept has taken on added significance as a result of the current international situation. In Tucson, Arizona, Hughes has established the Tucson Engineering Laboratory for the purpose of shortening the elapsed time between missile development and its effective tactical use. This activity, established over 2 years ago, has proven that the quasi-simultaneous development and production of missiles can become a feasible reality.

The Tucson Engineering Laboratory is now expanding its scope of operations. Mechanical Engineers, Electrical Engineers, or Physicists who like to work on urgent problems and who have the ability and enthusiasm to constantly improve the product and its reliability, will find this an ideal environment. Specific areas of interest include: missile system analysis, infrared and radar guidance systems, electromechanical and hydraulic control systems, missile and test equipment and electronic circuit design.

An added advantage: Tucson's dry healthful climate. Investigate by sending resume to Mr. W. A. Barnes at:

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TUCSON ENGINEERING
LABORATORIES

Hughes Aircraft Company

Tucson, Arizona

Circle No. 43 on Subscriber Service Card.

... new products

their response characteristics . . . capable of two full travel cycles per second, or ten cycles per second through any 10% portion of a full stroke.

The overall valve envelope is considerably smaller than any unit previously available for full flow operation at pressures up to 2,000 psi.

Smooth, fast acting response is assured by bearing-mounted shafts. The valves may be used with a wide range of liquid or gaseous media, providing bubble-tight flow control.

Circle No. 295 on Subscriber Service Card.

"Viton" Wiring Fastener Designed for Missile Use

"Viton" synthetic rubber. Du Pont's new fluorine-based elastomer, has been adapted to a recently developed wiring fastener.

The fastener consists of a U-shaped nylon cradle and a flexible clip of "Viton" which cinches across the open end of the cradle and locks under inverted lips, holding a bundle of wires securely in place. Not only does this fastener provide a neater and more secure wire bundle than tape, string, or wire wrapping, says Du Pont, but it can be installed in about half the time.

The fastener was designed originally with a clip of neoprene synthetic rubber. But with temperatures as high as 300 degrees F., accompanied by the presence of lubricants, aromatic fuels, hydraulic fluids, and other strong oxidizing agents, "Viton" is required for the clip material. "Vitone" has the further advantage of being even more resistant than neoprene to ozone, sunlight, and weather.

Circle No. 294 on Subscriber Service Card.

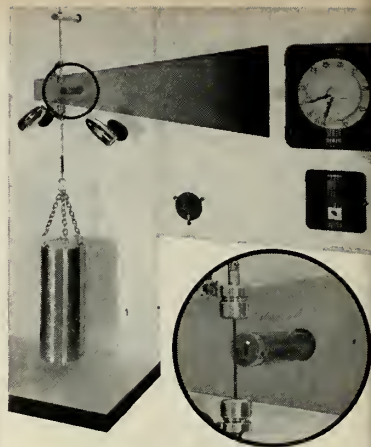
Miniature Switch For Timing-Control

A high-speed miniature stepping switch is now available from **IMTRA Corporation**. The "Miniature Uniselector" is designed, according to the manufacturer, for use in automatic switching and timing-control circuits.

The Uniselector will operate at speeds up to 80 steps per second on impulse drive (80% make, 20% break) from a power supply of 24, 50 or 110 volts d.c.

Up to twelve banks can be fitted, each having 30 individual contacts mounted in a complete circle. When seven or less banks are required, a sequence switch can be fitted. This takes the form of an auxiliary bank of contacts and wiper assembly. The sequence switch wiper steps once for each complete revolution of the main wiper assembly. All wipers can be either bridging or non-bridging.

Circle No. 293 on Subscriber Service Card.



KENTANIUM*

"flexes its muscles" for inter-planetary flight

All of the development work in projected inter-planetary flight, and actual super-sonic flight, point up the importance of thermal shock resistance in the materials used.

On the test stand shown, Kentanium is demonstrating its claim to this all-important property. A Kentanium rod .156" in diameter, loaded to 8000 pounds per square inch, is heated to 2000°F., then cooled to 300°F., on a one-minute cycle. After 1000 continuous cycles, the specimen is still unbroken.

One of the many places where this thermal shock resistance of Kentanium may make a vital contribution is in impellers for gas turbines. Here any fuel failure immediately subjects the part to terrifically severe thermal shock, as the temperature falls. During experimental operation of one such unit, there were several emergency shut-downs due to fuel failure. No damage to the Kentanium impeller was incurred.

Many of the finest ideas of both science and industry have been "grounded" for want of materials with the necessary service properties. Many are getting off the ground now, as designers and engineers discover the unusual combination of characteristics available in the Kennametal* family of metals. If you have any applications where thermal shock resistance, resistance to corrosion, abrasion and erosion, or unusual strength and stiffness are important, ask for Booklet B-111A. Write KENNAMETAL INC., Dept. MR, Latrobe, Pa.

*Kentanium and Kennametal are the trademarks of a series of hard carbide alloys of tungsten, tungsten-titanium and tantalum.

3059

INDUSTRY AND
KENNAMETAL
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Circle No. 44 on Subscriber Service Card.

space age

by Norman L. Baker



Engine future brightens—Now it's a 1.5-million lb. thrust rocket engine program that has received the DOD nod. An initial \$2-million Army contract to Rocketdyne for an engine system to place "very large payloads into orbit" could well be the first major step toward putting a manned satellite into orbit. Clustered engines should be able to orbit a 30,000-lb. manned satellite or a 7-8000-lb. interplanetary vehicle.

Navaho refuses to die—For a missile system that was considered too uneconomical after absorbing an aggregate DOD funding of \$690-million, the WS-104 *Navaho* continues to prove its worthiness in repeated tests at Cape Canaveral. Both *Navaho* and its booster demonstrate unlimited possibilities for future weapon systems and space vehicles. The *Hound Dog* air-to-surface missile is a direct descendant of the bird—*Dyna-Soar* may be another.

World peace through space travel—The abolishment of national claims to the moon and the planets of the solar system is expected to be a major issue on the provisional agenda of the United Nation's assembly. Secretary General Dag Hammarskjold, voicing the proposals of the United States and Russia, has called for international agreement which would rule that outer space should be a community affair with individual power claims to celestial bodies illegal.

Balloon satellites near launch—The density measurement expandable balloon satellites for the *Explorer* and *Vanguard* programs are undergoing operational tests at NACA's Wallops Island facility (see page 18). Twelve-ft. spheres (for a forthcoming *Explorer* shot) and 30-inch models (sub-satellite for SLV-4 *Vanguard* shot) have been sent aloft in high altitude flights and inflated successfully.

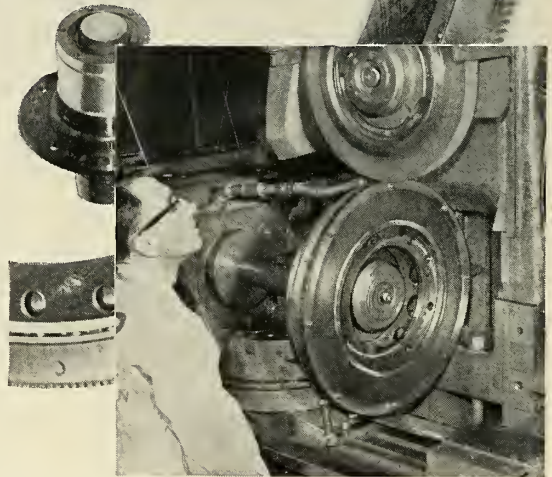
Black Knight to be assigned space role—The British IRBM, *Black Knight*, successfully tested two weeks ago (see m/r, Sept. 15, p. 7) and reported to technically advanced over the *Thor* and *Jupiter* will be adapted for satellite and lunar probe shots. The 2-2500-mile solid propellant missile, with the addition of two stages, is scheduled to start launching larger and more complicated satellites than the United States has launched to date.

Fixing coordinates in space—Space Navigation will be major topic at October 27-28 meeting of the 5th annual East Coast Conference on Aeronautical and Navigational Electronics sponsored by the IRE in Baltimore.

A new heat-converting material, said to be capable of converting heat directly into electricity, has been disclosed by Westinghouse Electric Corp. The material is a ceramic, which, according to company sources, can convert heat emanating from any source directly into electrical current, simply by passing the heat through the material. Use could be for power for satellites, radios, scanners.

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Circle No. 46 on Subscriber Service Card.

letters

CED Query

To the Editor:

I was much interested to read in the September 1st issue of your excellent magazine that the Committee of Economic Development has published a pamphlet entitled, "The Problem of National Security—Some Economic and Administrative Aspects."

I wonder if you would be good enough to let me know where I might obtain a copy of this pamphlet.

C. C. Keefer

Director, Canadair Ltd.

P. O. Box 6087

Montreal, Canada

CED's address is 775 Fifth Avenue, New York, N.Y.—Ed.

Rights of Press

To the Editor:

I have several questions that I must, in all conscience, ask after reading the editorial opinion in the September 1 issue of m/r.

Is not the press, "public and business," a tremendous industry? Is not the press an industry of free enterprise—competing in kind with all members of the industry? Then, disregarding the trite old journalistic concepts of freedom of the press, why should the press have license to sell at \$8.00 or so per year, our priceless scientific and technical information to those who would overpower our Nation?

The "duty" to keep the general public informed on matters in which m/r has special competence is nice reading, but why not print the facts? If m/r and similar "trade journals" did not publish, in great and often erroneous detail, items regarding our missileery and related scientific failures and achievements, these journals would not sell many copies and after all, the sale of the published material is the important thing, not the actual contents, right?

Incidentally, calling yourselves the nation's press, the "public" press is the subterfuge of the century. Is not the press private enterprise, trying to make a profit?

R. L. Reichard

Box 1279

Alamogordo, New Mexico

m/r is a profit-making institution and hopes to continue as such. The right to exist and compete among the free press is guaranteed by the Constitution, whose authors fervently felt that the public's right to know both pleasant and unpleasant news was one of the major rights of free men.—Ed.

missiles and rockets, September 22, 1958



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Whenever, wherever trouble flares...

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STRAC, the new Strategic Army Corps . . . our tough, "trouble-shooting" fighting force . . . stands ready, night and day, to speed into combat by land, sea, and air.

In today's brand of warfare, STRAC must be equipped with vehicles that can move men, guns and equipment anywhere. Helping to meet rigid military requirements like these has been a major project of Timken-Detroit® engineering for nearly 50 years.

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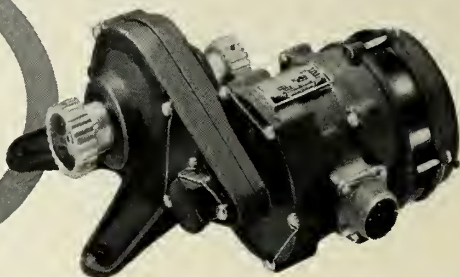
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AXLES FOR TRUCKS, BUSES AND TRAILERS

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Emergency flap drive on Boeing 707 Stratoliner is provided by Airborne Model R1624-1 special-design rotary actuators. Units are permanently coupled to flap linkage, provide electro mechanical drive in event of hydraulic failure. Output shafts are driven whenever hydraulic system operates, but because of special inertial clutch, rotors do not turn unless energized.

**AIRBORNE
LARGE SPECIAL
ACTUATOR SOLVES
EMERGENCY FLAP DRIVE
REQUIREMENTS ON
BOEING 707**



Specifications: Motor: 200/115 v a-c, 400 cycles, 3-phase, reversible. Speed at rated torque (450 in-lb): 85 rpm \pm 10 rpm. Duty cycle 3 min. on, 27 min. off. Operating range: 102-124 v (line to neutral); 380-420 cps; -65 to +160°F; 0-50,000 ft. Weight 12 lbs.

PROBLEM

Rotor to be disconnected from output gear stages except when motor is energized in either direction.

Starting torque to be 800 in-lb minimum, with pullout torque of 900 in-lb (\pm 100 in-lb) at 50% motor slip (\pm 10%) under all voltage, frequency and environmental conditions.

In event of a jam in actuator transmission or rotor, unit to be fail-safe by permitting rotation of output shaft by torque of 1000-1300 in-lb. Once started, rotation to be maintained by torque not exceeding 100 in-lb.

SOLUTION

Inertial clutch—consisting of small weights in a cage—incorporated between motor and gear train. Makes positive contact with intermediate drive gear only when rotor shaft turns.

Special lightweight motor developed by Airborne to meet these exacting requirements. Rated 9 hp at 10,300 rpm, drawing 2.5 amp maximum.

Special ball-detent, torque-limiting clutch incorporated on output shaft.

Contact us for recommendations on your special actuator requirements . . . or for information on Airborne's standard line of modular design actuators.

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missile business

by Fred S. Hunter

New plant construction in Los Angeles by companies identified with the missile or electronic industries has not come to a complete halt. Witness the Ramo-Wooldridge Corp's plans to establish a new research and development complex on a 90-acre site in the Chatsworth area. But factory acreage within the boundaries of Los Angeles County is getting scarce. In order to make use of the Chatsworth location, Ramo-Wooldridge faces the necessity of obtaining a zoning clearance, and this is for a facility entailing no factory chimneys.

Choice factory sites, where no restrictions are imposed—except smog control—and where trackage is available, are being priced as high as \$45,000 and \$50,000 an acre. This is too high for most companies, and more and more companies are moving out to adjoining counties to meet their expansion needs.

The population of Orange County, adjoining on the south, is up over 150% since 1950, making it the fastest growing area in southern California. Here, in Fullerton, Hughes Aircraft Co. has located its ground radar equipment division and has a new 300,000-square foot plant under construction. The plant site is 42 acres. In the acquisition of so much acreage, Hughes is, of course, allowing for future plant expansion.

But the big reason for a 42-acre site for a plant occupying about 7½ acres is the employe parking problem. The first question the personnel manager of a company will ask about a proposed new factory site is: "How much space for parking?" Workers in southern California think nothing of driving 15 or 20 miles to and from a job, but if convenient parking isn't available practically at the factory door, they're off to another company.

Aeronutronics Systems, Inc., the Ford Motor Co.'s missile and space subsidiary, is another new Orange County resident. It is building its new facility in the Newport Beach area, where living conditions should appeal to engineers and scientists and where space for parking is available.

Other examples of southern California companies displacing the orange groves and bean fields in Orange County include: Hallamore Electronics, B-J Electronics, Interstate Electronics, Foster Manufacturing, Narmco, Cherry Rivet, Nutt-Shel, Cooper Precision and Northrop's Anaheim Div.

Charles B. Thornton, president of Litton Industries, predicts that electronic firms will eventually replace the aircraft industry as the Los Angeles metropolitan area' No. 1 employer. Thornton points out that the square footage of electronics plant facilities has increased from 10 million in 1955 to 26 million this year. A share of this increase took place in Orange County, whose northern sections are counted as being part of the Los Angeles metropolitan area.

At the opening of its giant factory in San Jose, International Business Machines disclosed it has orders for 1000 RAMAC data-processing machines. At rentals ranging between \$3,100 and \$4,500 per month, this means a gross rental of about \$4 million a month for IBM.

Company Notes: Datafax Instruments—a new program of Convair Division of General Dynamics Corp.—has been organized to design, develop and produce specialized electrical instruments and instrument systems at La Jolla, Calif. . . . AMF has completed studies of transporting, handling and launching *Atlas* . . . **Air Reduction Sales Co.** is building a new plant at Denver.

contract awards

LAST MINUTE ITEMS

A. C. Spark Plug Division of General Motors Corp. gave Electro Instruments, Inc., San Diego, \$1.4 million for digital test equipment to be used in the *Thor* ICBM program.

AF awarded Aerojet-General Corp. \$1,106,470 for large solid rocket production and solid propellant production facilities.

Olympic Radio and Television Division, Siegler Corp., was awarded \$350,000 for research and development to design the AN/TPQ-11, a ground-based radar operating in a 35,000 megacycle range.

International Business Machines Corp. received a contract totaling \$2,631,122 for automatic data processing equipment.

Republic Aviation Corp. was awarded \$1,318,825 for short range surveillance drone engines.

ARMY

By Signal Supply Agency:

Radiation, Inc., Melbourne, Fla. received \$119,680 for multi-helical antenna system radiation.

By Quartermaster Research and Engineering Command:

Magnesium Products of Milwaukee, Wis., received \$130,276 for seventeen shelters, frame type, warhead and thrust unit, mating *Jupiter* system.

Radio Corp. of America, Cherry Hill, Camden, N.J., received \$103,188 for services of qualified technicians in connection with courses of instruction for training groups of military and other personnel, and providing specialized technical assistance to the U.S. Army Ordnance Guided Missile School.

The Deutch Co., Los Angeles, Calif., received \$39,723 for miniature electrical connectors.

AIR FORCE

By Cdr. HQ AMC, Wright-Patterson AFB:

National Northern Corp., West Hanover, Mass., received \$36,272 for producing forgings through the use of explosives.

By HQ, Mobile Air Materiel Area:

AiRepair, Inc., North Hollywood, Calif., received \$277,271 for oxygen regulators.

D. K. Mfg. Co., Chicago, Ill., received \$38,415 for cylinder, oxygen low pressure type.

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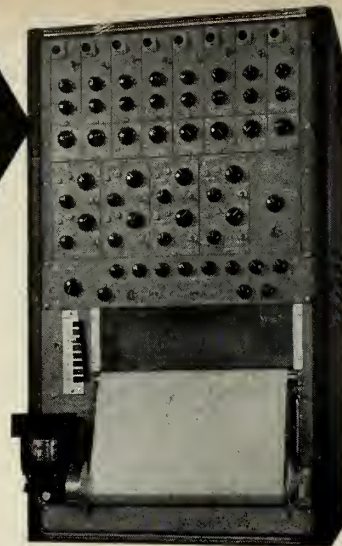
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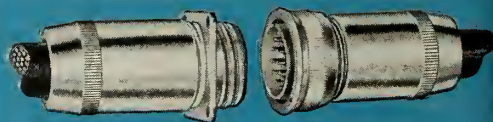
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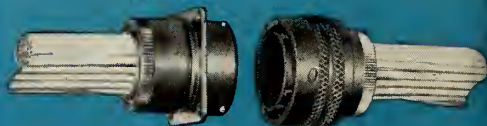
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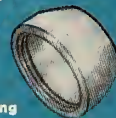


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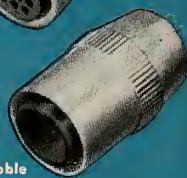
"E" Open Wire

"A" General



"P" Potting

"W" Cable



"W" Cable

when and where

OCTOBER

National Symposium, sponsored by Institute of Radio Engineers and George Washington University, Extended Range and Space Transmission, Lisner Auditorium, Washington, D.C., Oct. 6-7.

Third Symposium on Hypervelocity, Host: Armour Research Foundation, Sherman Hotel, Chicago, Ill., Oct. 7-9.

Armour Research Foundation and Illinois Institute of Technology, Annual Noise Abatement Symposium, Hotel Sherman, Chicago, Ill., Oct. 9-10.

Fuels-AIME Conference, American Society of Mechanical Engineers, Old Point Comfort, Va., Oct. 9-10.

14th Annual National Electronics Conference, Hotel Sherman, Chicago, Ill., Oct. 13-15.

ASME, Lubrication-ASLE Conference, Statler Hotel, Los Angeles, Calif., Oct. 14-16.

Association of the United States Army, 1958 annual meeting, Sheraton-Park Hotel, Washington, D.C., Oct. 20-22.

Fourth Annual Symposium on Aviation Medicine, Miramar Hotel, Santa Monica, Calif., Oct. 22-24.

SAMA Laboratory Apparatus and Optical Sections' Midyear Meeting, Westchester Country Club, Rye, N.Y., Oct. 26-28.

Institute of Radio Engineers East Coast Conference, Aeronautical and Navigational Electronics, Lord Baltimore Hotel, Baltimore, Md., Oct. 27-28.

1958 National Metal Exposition and Congress, American Society for Metals, Public Auditorium, Cleveland, Ohio, Oct. 27-31.

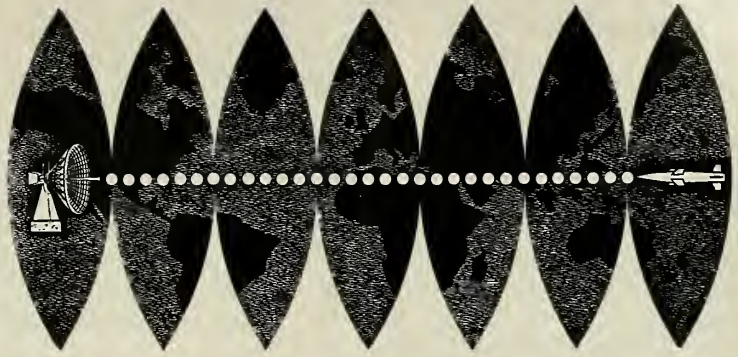
IRE, 1958 Electronic Devices Meeting, Shoreham Hotel, Washington, D.C., Oct. 30-31.

NOVEMBER

Fifth Annual Meeting, Institute of Radio Engineers Professional Group on Nuclear Science, Villa Hotel, San Mateo, Calif., Nov. 6-7.

Conference on Scientific Information, AFOSR/Directorate of Research Communication, NAS, NSF and the American Documentation Institute, Mayflower Hotel, Washington, D.C., Nov. 16-21.

American Rocket Society, 13th Annual Meeting and Astronautical Exposition, Hotel Statler, New York, N.Y., Nov. 17-21.



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book reviews

Three reports of human engineering research for the Armed Forces, including an extensive bibliography of the literature in the field, have been released for the use of industry and psychology researchers through the Office of Technical Services, U.S. Department of Commerce. The volumes are:

HUMAN ENGINEERING BIBLIOGRAPHY, 1955-1956. E. V. Saul, Tufts University for Office of Naval Research. Oct. 1957. (Order PB 131507 for OTS, U.S. Department of Commerce, Washington 25, D.C., \$4.75.)

One of a planned series of bibliographies of literature concerning human engineering. Parts are devoted to a topical outline of literature, dummy of subject matter files, alphabetical index to the literature, abbreviations of military and government organizations, and a collection of more than 1,000 citations and abstracts. An author index is included.

HUMAN FACTORS CONSIDERATIONS IN THE DESIGN PROPOSALS FOR A BALLISTIC MISSILE UNIT PROFICIENCY SYSTEM. F. F. Kopstein and R. L. Morgan, Wright Air Development Center, U.S. Air Force. Dec. 1957. 17 pages. (Order PB 131696 from OTS, U.S. Department of Commerce, Washington 25, D.C., 50 cents.)

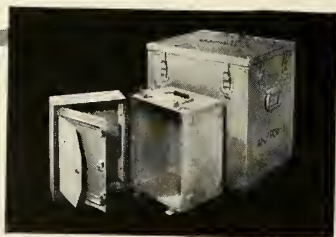
Provides an outline of steps in the design of a "Unit Proficiency System" for a ballistic missile program. The system is described as the means by which proficiency training and proficiency measurement are obtained in ballistic missile systems.

PSYCHOLOGICAL STRESS AS A THEORETICAL CONCEPT. W. D. Chiles, Wright Air Development Center, U.S. Air Force. July 1957. 20 pages. (Order PB 131616 from OTS, U.S. Department of Commerce, Washington 25, D.C. 75 cents.)

Some typical treatments of psychological stress are examined. The approach of construing stress in analogy to physical and physiological concepts is rejected. According to the author, such approaches have not led to quantifiable insights into the action of stress with respect to human behavior. A systematic approach is suggested, along with the frame work for the quantification of psychological stress as a theoretical concept. Some implications of this approach with respect to performance variables are discussed.

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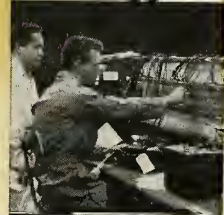
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soviet affairs

by Dr. Albert Parry

In their proud descriptions of the rocket experiment of August 27 which sent two dogs up to 279 miles above the earth and brought them back alive, the Soviets revealed an interesting point: They *do* drug their dogs for some of those rocket trips.

The August 27 rocket shoot was with undrugged dogs, Moscow says, and thus extremely valuable because it showed animals enduring "cosmic trips" in their normal state. But some Soviet rocket-flying dogs are drugged, in Moscow mentions casually.

Only a short time ago Soviet propagandists loudly claimed that all their dogs were rocketed undrugged; but that American experiments with monkeys and mice being sent up in rockets or balloons were of no worth because Americans "always" drugged their animals. Yet now the Soviets reveal that they, too, drug their cosmos-riding dogs.

In commenting on the Red dog-flights, Professor Vladimir N. Chernigovsky, director of the Institute of Physiology of the Soviet Academy of Sciences, declares that the importance of their experiments is "inestimable" because they "give us grounds to believe that man will penetrate into outer space in the near future." He elaborates: "What we now know of the changes in the basic physiological functions of the test animal allows us, with certain amendments, to picture the physiological changes that will take place in humans under similar conditions."

Dr. Chernigovsky admits that the problem of sending man into outer space is far more complicated than the task of testing dogs on such journeys. Yet, he says, there are certain advantages, too.

One such advantage is that "men will not be passive passengers in their pressurized cabin" as dogs are. "Evidently there will be no need for a number of complex automatic instruments because the men in the ship will be able to meet their needs by operating the instruments themselves."

Not just astrophysicists and engineers, but medical men and psychologists are now working in the Soviet Union on the problems of the future space-flyers. In SOVETSKAYA AVIATSIYA, Professor K. Platonov, a

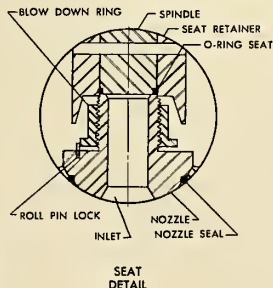
doctor of medicine, includes among the problems to be solved "the influence of such various factors of the cosmic flight on the spaceman's psyche as accelerations, weightlessness, isolation, and the like."

Oral communication by radio between the space-ship's crew and the Earth (says Dr. Platonov), should be preserved by all means as a tremendous positive effect upon the crew's morale. Weightlessness, psychologically and physically hard on the crew, can be combatted by such mechanical devices as special magnetized shoes, also by creating an artificial weight via the ship's orbiting around its own axis. The crew's feeling of monotony and isolation can be minimized by "alternating, inside the space ship, colors and sounds," also by lighting the cabin so as to create an imitation of day following night.

Sputnik Monument To Be Erected in Moscow

A Soviet team of two architects and one sculptor have been announced in Moscow as the winners of the first prize in the contest for the best project of a monument to be erected in the Lenin Hills near the University of Moscow, in honor of *Sputnik I*. Nearly 1,000 entries from 114 Soviet cities and many foreign countries had been submitted in the competition.

The monument, to be built of aluminum and to be covered with semi-transparent smoky glass, will consist of a 50-meter-high obelisk representing *Sputnik I* at the moment of its break-through into outer space.



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VALVE. A newly-designed splitter check valve, adaptable to handling the flow of all types of gases and liquids in missile ground support or initial equipment, has been produced by the Garrett Corp.'s AirResearch Initial Division. Though the use of stainless steel materials, it can be made applicable to operational temperatures ranging from cryogenic levels to 1,000°F.

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ISOLATION SYSTEM. Protects delicate electronic equipment, such as missile controls, subjected to large and rapid "g" load changes. The isolation system accomplishes this by maintaining its desired low natural frequency while limiting relative displacement at various load conditions. The system, developed by Walter Kidde & Co., Inc., consists of three independent sets of servo-controlled gas springs, each set absorbing a component of the vibrational and acceleration along one of three mutual particular axes.

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WEIGHT LOCATING DEVICE. A new device, versatile enough to find the center and center of gravity location of a wide range of rocket engine sizes, has been developed by the Hunter Division of Thiokol Chemical Corp. The device is simple to operate, and the same device can also be used for weight locating of devices other than rocket engines.

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GATE VALVE. Valves for handling liquid oxygen and other cryogenics are now available from Koehler Aircraft Products Co. The valves can be used as pre-valves or fill valves under operating conditions involving line pressures up to 60 psi, and ambient temperatures ranging from -320 deg. F to +250 deg. F. The valves can be actuated manually, electrically or by pneumatic pressures.

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WAVEGUIDE WATERLOAD. A broad band power absorbing waveguide waterload-BL-570, developed by Bomac Laboratories, is said to be capable of absorbing up to 400 watts of C.W. power over the frequency range of 4.95 Kmc, and the VSWR is under 1.20 over this range. This represents a reflected power of under 1%.

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OSCILLATOR-MIXER. A new reference oscillator-mixer, model GRO-2, is said to combine four functions: generates reference frequency for addition to an FM/FM telemetering multiplex; mixes the reference frequency and the multiplex; de-emphasizes the multiplex spectrum for recording; matches reference and signal amplitudes. The unit is designed for use in tape speed compensation systems, and was developed by Data-Control Systems, Inc.

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CERAMIC TOOLING. Low-cost ceramic tooling suitable for operation up to 3,000 deg. F is now being produced by a casting technique using Sur-Braze Grade S-2 ceramic, a high-temperature material developed by Duramic Products, Inc.

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CAPACITOR MOTOR. Western Gear Corp., Electro Products division, is offering a 115V, 400 cycle, single phase capacitor start and run motor with a planetary gear reduction at each end. Dimensions are 5" long, 2 1/2" in diameter.

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● **Missile Literature**

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● **New Missile Products**

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MISSILE LITERATURE

NUCLEAR FUEL ELEMENTS. A new bibliography on nuclear fuel elements, believed to be the first such reference listing of available data on solid fuel elements, has been made available by Sylvania-Corning Nuclear Corp. The edition is titled "Bibliography on Solid Fuel Elements." The 64-page volume contains 306 references on problems concerning solid fuel elements, such as fabrication and properties. The references are arranged alphabetically, and include short abstracts of each item. **Circle No. 200 on Subscriber Service Card.**

FLUID POWER. Engineering data for designers who use fluid power motors, pumps, valves and cylinders, has been published in a 4-page bulletin by Commercial Shearing & Stamping Co. Bulletin 100-P3 is entitled "Designers' Check List of Commercial Fluid Power Components." The bulletin pictures each type of component, describes features, and includes tables of design and application data. **Circle No. 201 on Subscriber Service Card.**

PRESSURE TESTING. A new illustrated 16-page catalog and manual describing equipment and methods for sealing openings for pressure testing has recently been published by Mechanical Products Corp. The "Quick-Seal" line of test plugs and filling connectors is described by the new #658 manual, which illustrates the application of "Quick-Seal" units to many different types of openings. **Circle No. 202 on Subscriber Service Card.**

FLAME-PLATING. This is a special process by Linde Co., division of Union Carbide Corp., by which a hard, thin coating of tungsten carbide, aluminum oxide and other materials is applied to a metal surface. Flame-Plated coatings have an outstanding resistance to wear, abrasion and fretting corrosion, even at extreme temperatures. Additional information on the Flame-Plating process and numerous successful applications is available in a new brochure. **Circle No. 203 on Subscriber Service Card.**

COMPUTER CONTROL. A new brochure is available on digital computer control and data logging from the Thompson-Ramo-Woodriddle Products Co. Included in the reference bulletin is a description of the RW-300 Digital Control Computer as well as comprehensive discussions of process control, data logging, pilot plant, and test facility applications for computer control systems. **Circle No. 204 on Subscriber Service Card.**

TOROIDAL CORES. A 12-page handbook for designers on the use of Genalex toroidal cores is available from

Wallace E. Connolly & Co. The handbook covers permeability, temperature coefficient of inductance, dc bility, core size and finish. Comp graphs and technical data on the characteristics of Genalex cores presented. The handbook charts physical and electrical properties of Genalex cores. **Circle No. 205 on Subscriber Service Card.**

ELECTRONIC TRACKING EQUIPMENT. The Electronic Tracking is considered the most accurate cine-theodolite system in use today. The system is fully described in an illustrated 12-page brochure offered by J. W. Fecker, Inc., a subsidiary of American Optical Co. Photographic diagrams and tables in the brochure fully describe the components of the EOTS system, as well as the characteristics of the theodolites themselves. **Circle No. 206 on Subscriber Service Card.**

SWITCHES. Micro Switch, a division of Minneapolis-Honeywell Regulator Co. has just published an enlarged 32-page edition of its Basic Switch Catalog. Significant innovations in basic switches for industrial and commercial applications have been added to make the catalog useful to the user of basic switches. New mounting brackets, auxiliary actuators for Micro Switch basic switches have also been added. **Circle No. 207 on Subscriber Service Card.**

LAMINATES. A 21-page technical manual containing test values, curves, plus specification data on laminated reliability epoxy glass copper clad unclad laminates for printed and other circuitry has been issued by the Union Carbide Corp. Such factors as requisite bond strengths, flexural strengths, dielectric breakdown and constants are also included. **Circle No. 208 on Subscriber Service Card.**

POWDER. A new 4-page folder, introducing the New Oxweld ACL powder Lance," describes a revolutionary new tool capable of slicing through concrete or metal of any thickness. Accurate control of intense heat is the key to operation of the new lance developed by Linde Co., Division of Union Carbide Corp. No known materials, not even new, super heat-resistant materials developed for high speed jet travel—can withstand the piercing action of the new ACL-3 Powder Lance. The booklet outlines the principle, and scope of the powder-lance process. It also describes cost-saving applications in steel mills, foundries, on construction and demolition jobs. **Circle No. 212 on Subscriber Service Card.**



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• **Missile Literature**

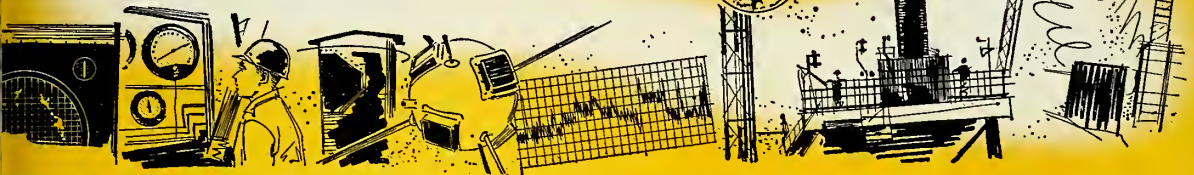
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Which of these nine missile hydraulic power problems face you today?



PROBLEM **weight and space** Eastern hydraulic power units are made of *miniature* high-speed gear pumps, close-coupled directly to performance-tested electric motors. Even when components are added such as reservoir, expansion-relief valve, expansion bellows, adjustable pressure-regulating valve, check valves — total weight is under 5 pounds, size only 7½" x 2½" x 7½" (Eastern unit illustrated used as example).

PROBLEM **high temperatures** Most Eastern units normally operate at temperature range of -67°F. to +220°F. Higher temperature limits are no problem.

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PROBLEM **high-speed power take-off** Eastern gear pumps with speeds of 24,000 RPM permit direct drive by main power source.

PROBLEM **complicated, heavy plumbing** Running lines from power unit to remote areas can be eliminated by using individual self-contained hydraulic power units at each point. You gain maximum flexibility, simplicity, reliability, while removing more weight in plumbing than you add in power packs.

PROBLEM **compromised accessory performance** When all accessories adapt the 3000 PSI main system pressure by means of power-wasting, heat-producing, pressure-reducing valves, performance suffers. Eastern units offer individually selected hydraulic fluids and pressures to give optimum performance to each accessory in the system. Eastern units have capacity to 1.5 GPM at pressures to 3000 PSI.

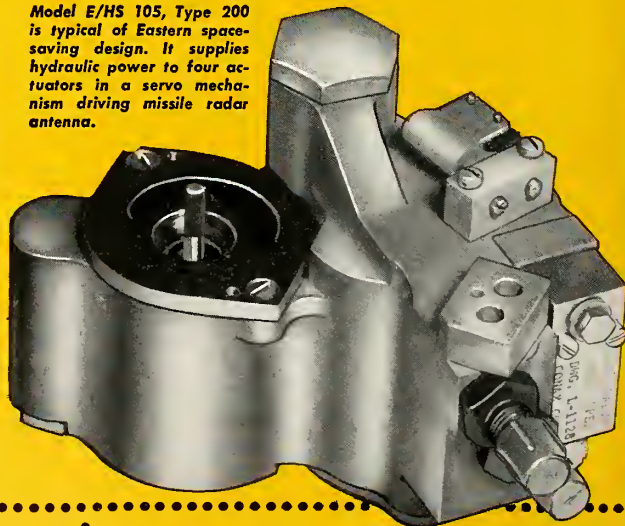
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PROBLEM **fluid contamination** System cleanliness is insured by a sealed system and continuous filtering of pump discharge.

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PROBLEM **divided responsibility** Eastern welcomes the opportunity to develop components or complete missile subsystems in hydraulic power, electronic cooling and refrigeration, and pressurization. Design and manufacturing responsibility from one experienced source is your assurance of dependable performance. Write, phone, wire for complete information.

Model E/HS 105, Type 200 is typical of Eastern space-saving design. It supplies hydraulic power to four actuators in a servo mechanism driving missile radar antenna.



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