CONRAD LAU

Conrad Albert Lau, aeronautical engineer, inventor, executive, known to his friends and business associates as "Connie", was born on February 8, 1921 in Port of Spain, Trinidad, British West Indies to Mr. and Mrs. Egbert Lau. He was one of a family of four, all boys. His brothers were Neil, Roy and John. He and his wife Nancy Page Lau had three children, Conrad, Jr., Sally and Michael.

Conrad attended school in Trinidad through his sophomore year at Queen's Royal College. He entered Massachusetts Institute of Technology in his junior year. He received his B.S. Degree in 1942 and his Masters Degree in Aeronautical Engineering in 1943. While at MIT he was on the Dean's List for high scholastic achievement, and he was elected to membership in TAU BETA PHI, National Honorary Engineering Fraternity. Also, at MIT, in recognition of his Christian leadership, he was elected Secretary of the Technical Christian Association, a student organization of all Christian denominations dedicated to practicing and encouraging the Christian life.

Conrad joined Chance Vought Aircraft, Division of United Aircraft Corporation, upon graduation from MIT in 1943. He devoted his entire professional career to the Company that had become Ling-Temco-Vought, Inc. at the time of his untimely death, April 18, 1964. Through his initiative, superb intelligence, and human warmth, he had advanced rapidly from the position of Junior Aerodynamics Engineer to Director of the U. S. Navy VAL Light Attack Aircraft program for LTV.

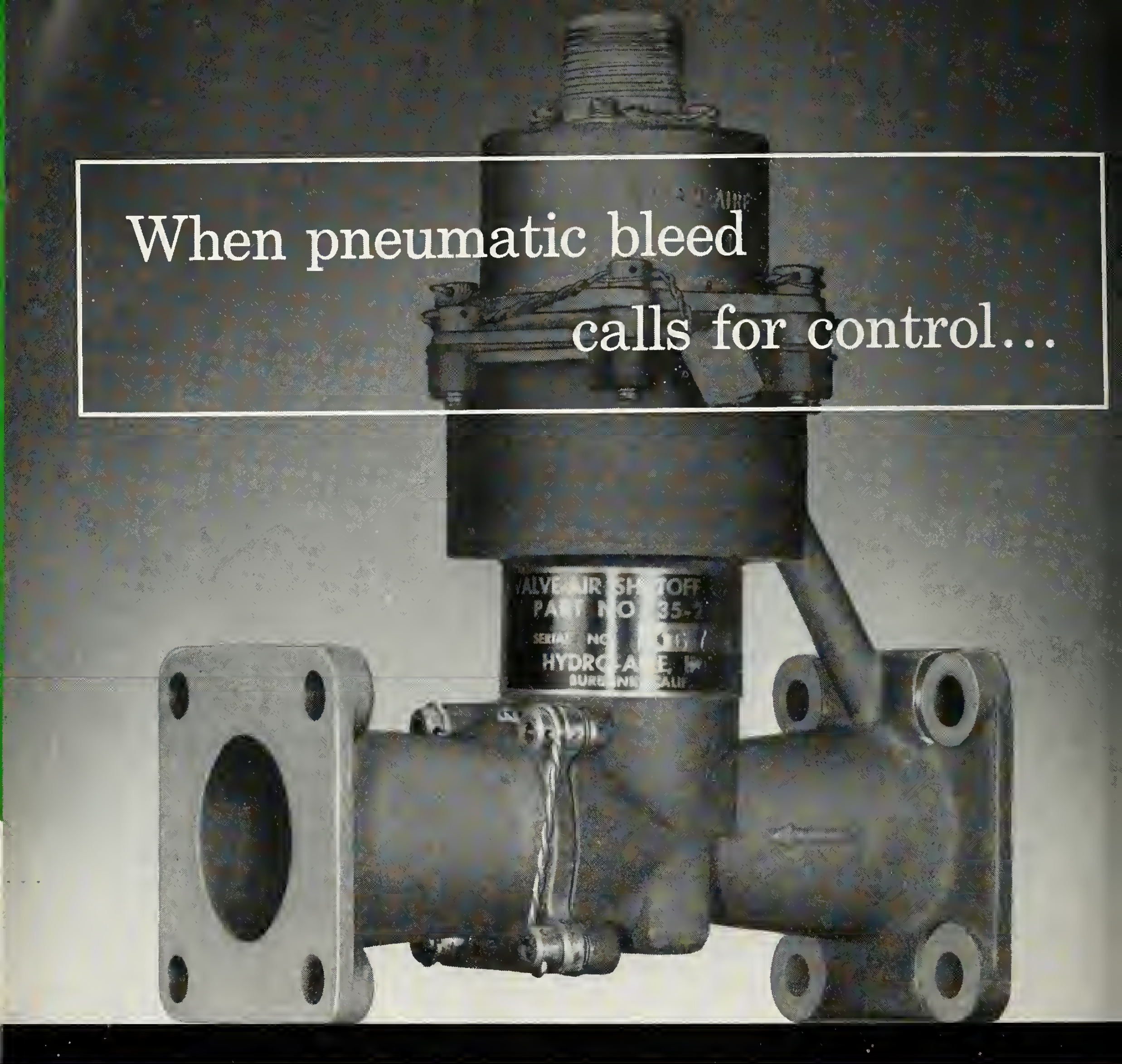
SEPTEMBER 29, 1958

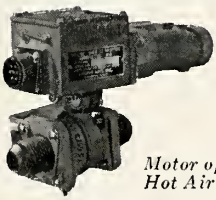
missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

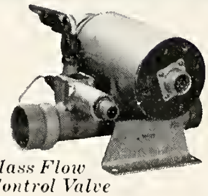
News and Business Edition

AN AMERICAN AVIATION PUBLICATION





Motor operated Hot Air Butterfly Valves



Mass Flow Control Valve

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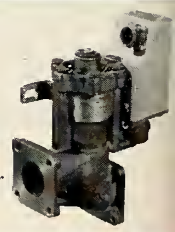

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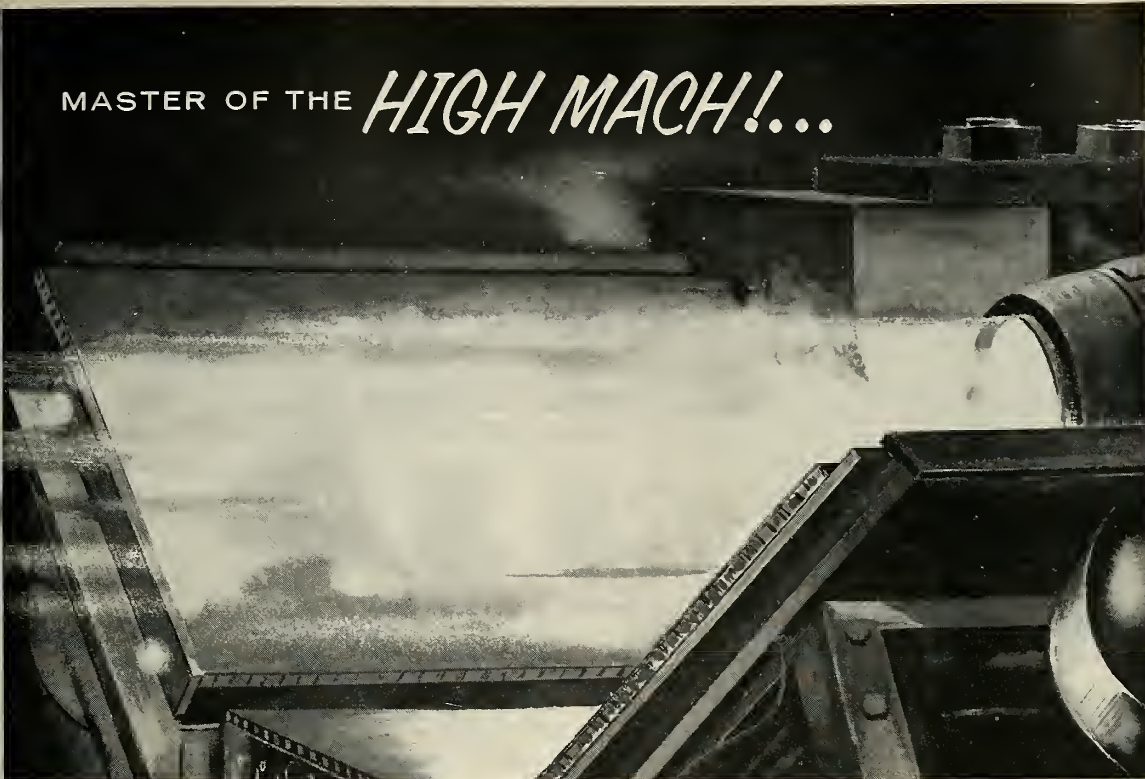

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SEPTEMBER 29, 1958
VOL. 4, NO. 13

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

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First Year Of The Space Age

During the latter part of September and the first days of October, 1957, a busy Russian rocket-science team—and it must have been a good and an experienced one—was working hard to get a sophisticated missile off the ground. The team must have been told about the great propaganda value of the experiment. Among others, rocket and space industry leaders from all over the world were meeting in Washington and Barcelona in those days. Thus, the world's press already was somewhat geared to space flight.

On October 4 the giant CH-10 converted Red ICBM satellite carrier roared aloft and successfully put into orbit the first man-made moon. One of man's biggest—if not the biggest—rocket industry breakthroughs was a fact.

The Red propaganda machine had won a major victory. Americans had been painfully scooped—in the eyes of the rest of the world—and in their own eyes.

To men of the American missile industry it is indeed clear that the first *Sputnik* meant considerably more than a Red propaganda stunt. Yet, to most people it meant that Russia was stronger than America, scientifically as well as militarily.

The true and significant meaning of *Sputnik* I, however, lies in the fact that the world is being rushed into the space age under the leadership of someone other than the United States—the country which customarily set the pace for man's advancement in important technological and industrial areas—in a democratic way. Nobody questions our superiority in industries such as transportation—rail, air or automotive, or in construction, or chemistry, or medicine and others. But in astronautics we are only second best.

In Russia, every child is being taught about the greatness of Professor Tsiolkovski, the "father" of space flight, according to the Russians. How many text books in this country mention Dr. Robert H. Goddard, the father of modern rocketry? Could it be we are still not accepting the fact that we are entering the space age?

It is easy to blame our derelictions on our political leaders and defense planners. But could it be that the man in the street—in his reluctance to recognize what others are achieving—should blame himself for not having employed enough foresight? If so, it is about time—now that the space age is one year old—that he make an honest attempt to revise his opinion about where mankind is headed, and how important it is that this country accept its missile industry's drive to get there first—and best.

contents

"THE COVER"
The big stainless steel tanks of Air Force's Atlas ICBM are framed by a tooling ring at the San Diego plant of Convair's Astronautics Division. Big missile last week ran into trouble in its first full-scale test *(see p. 29)*.

washington countdown

First firing of the *Titan* . . .
will not be until October, probably during the second week. The missile in the gantry now is for testing ground service equipment, and is not a launchable bird.

Many detailed changes . . .
on the first-stage *Thor* are being made to ready the missile for the next lunar probe. The changes haven't been easy or simple. AF is seeking perfection, and if the shot goes on Oct. 11-14, it probably will succeed. Trouble last time was in propulsion.

The AF WS-117L . . .
is on schedule, but the international political implications pose almost as great a problem as the creation of this Lockheed recon-satellite vehicle. To avoid Russian protests, a launching under an extended IGY program would be simplest.

***Minute Man*'s progress . . .**
has been almost astonishing, but disregard any reports it will overtake and supplant *Atlas* and *Titan*. Differences in payload (*Minute Man* is smaller) gives entirely different target potentials.

First supersonic target . . .
for any U.S. missile was the real test of the *Bomarc* shot at Cape Canaveral last week. The target was, of course, one of the *Navaho* boosters left over when that program was abandoned.

The fact that military reorganization
. . . did not really touch the most important area is a widespread feeling in the Pentagon. Centralization of research and development is considered paramount and most important—including authority to control contracts.

R&D director . . .
for the Department of Defense is still an unfilled job. Secretary McElroy recently said the post would be filled soon. A major problem is finding a man with the required background in military research and engineering, yet with the objectivity which frequently is impaired in acquiring this background. Any man smart enough to handle this tough job, someone remarked, should be too smart to take it.

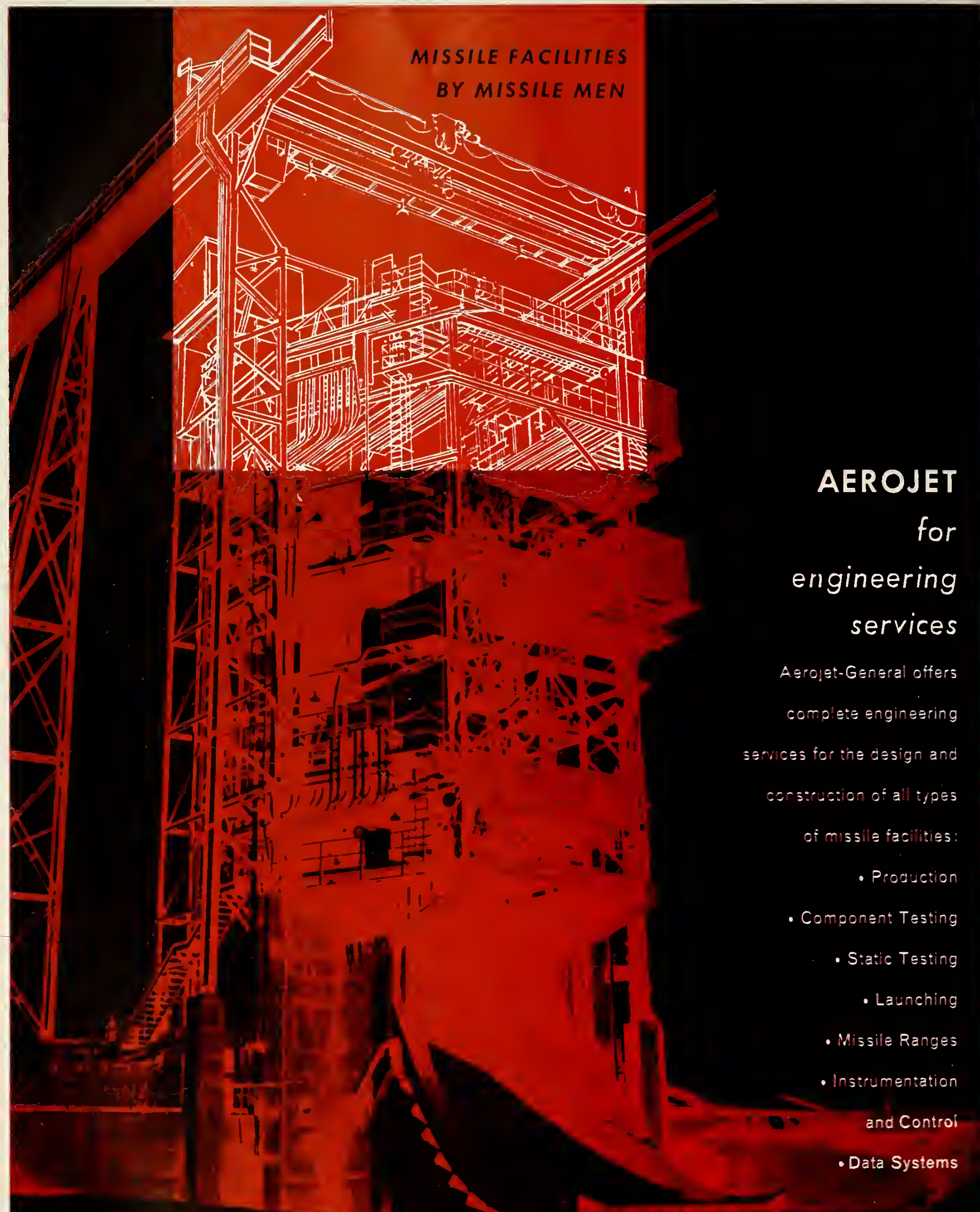
NASA's real test . . .
will come in the 1960 budget allocation, depending upon how Congress looks on the organization. The overall space program will receive a thorough investigation, which means the organizations concerned. Real support hinges on one thing: will this nation, through Congress, support an expensive space program divorced from the military appropriation with its inherent fear/defense motivation?

The nuclear-powered bomber . . .
is a subject of controversy within the AF. Big problem is utilization. One group says the bomber would have to fly too low and too slow. The other school of thought says it doesn't care how low or slow, so long as an air-to-ground IRBM can be hung on a plane which is able to remain on airborne patrol indefinitely.

Money is no major problem . . .
in the overall missile development program, that is, on genuine missiles. Service chiefs admit financial difficulties in some satellite areas and other of the more exotic space projects. Should breakthroughs occur in these areas, reprogramming within the service concerned or the DOD emergency fund can provide ample funds for most work during any given fiscal year.

Heat problems and vibration . . .
which have been major causes of trouble in earlier missile tests, are rapidly being minimized as research and development broadens. As missilemen point out, something is learned from every firing, regardless of the outcome.

There have been no official reports . . .
of a successful recovery of a *Thor* or *Thor-Able* nose cone. Sources close to the projects state that at least two instrument packages have been recovered intact. Data obtained indicated that the cones—from their apogee of about 500 miles through the re-entry phase—performed perfectly.



THOR test facilities engineered by Aerojet for the Douglas Aircraft Company, Sacramento

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industry countdown

Project *Saturn* . . .
the Rocketdyne effort to cluster a group of its X-1 engines for 1½ million lbs. thrust, is on a "crash" basis. However, although the X-1 is the latest simple, reliable and fully tested Rocketdyne model of a 165,000-lb.-thrust liquid engine, and incorporates design features gained through the *Jupiter/Thor* programs, don't expect success for many, many months. Too complex a problem.

***Jupiter* re-entry data . . .**
gained from the nose cone developed by Cincinnati Testing Labs' impressed ARDC officials at their first briefing on the subject —by CTL (not Army) two and a half months after the fact. Air Force is now believed to be considering combining the CTL ablation approach with its own beryllium/heat sink approach to the *Minuteman* ICBM. The *Jupiter* cone burned off less than ½″ of the plastic laminate outer covering out of a total of 3″.

First *Hound-Dog* . . .
flight control system has been completed and delivered by Autonetics division of NAA to the firm's missile division. North American says the all-transistorized unit uses the "latest" type of etched-circuit electronic designs.

Weapons system reliability . . .
and quality control are scheduled for two of the 12 day-long production forums at the National Aeronautical Meeting, SAE, which runs to October 4 in Los Angeles (see also p. 12). Other subjects to be covered by the meet include high temperature materials, test equipment, production rates, procurement, costs, sandwich construction, ground support equipment for missiles and "exotic materials and processes."

The fate of Fairchild's . . .
J83 turbojet engine hangs on the Air Force's decision regarding the decoy *Goose* missile. The *Goose* is powered by the J83 and successful tests at Cape Canaveral indicate that AF will decide to turn out substantial numbers of the bird, thus bringing the J83 into production.

Large solid-propellant . . .
rocket motors were the subject of discussion when Thiokol v.p. J. S. Jorczak was asked about the recent firing of his company's 450,000-lb.-thrust motor at Redstone Arsenal. Replied Jorczak: "You mean our small one?" Meanwhile, some indication was seen at Redstone that a solid motor utilizing boron fuels would soon be fired. Thrust exceeds a half million pounds.

A rocket nozzle . . .
has been produced by The Norton Co. which is capable of withstanding 3,200° F. The hardware is part of an RMI drone project.

Drastic departure . . .
from conventional rocket engine design appears to have occurred in the *Polaris* program. The casing, although meeting all strength requirements, gives the deceptive appearance of being "flimsy." The first stage casing is 110″ long by 54″ and the second stage measures 54″ in diameter and 47″ in length.

Army has cancelled *Dart* . . .
the offspring of the French SS 10, and has terminated research and development on the bird. Aero Physics Development Corp. of Santa Monica had the R&D contract and production was by Utica-Bend Corp. Value of the production contract was placed at $16.5 million. Cancellation was attributed to duplication of the *Dart's* job by other missiles.

Armed Services procurement . . .
Regulation 35 has been revised to establish fee limitations on cost-plus-fixed-fee subcontracts. The new ruling provides that all such contracts limit the payment of fees to 10% of the estimated cost, exclusive of additional fee in the case of any subcontract for experimental, developmental or research work. In all other types of subcontract, payment would be limited to 7% of the estimated cost.

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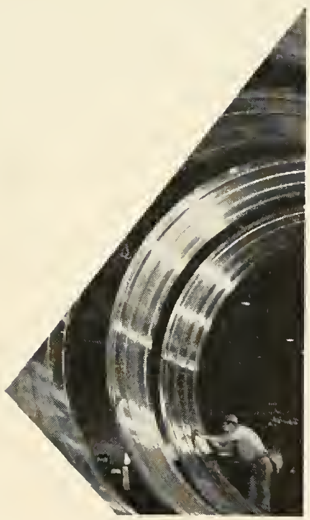

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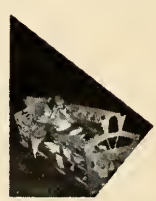

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Plasma Jet Thrust Up; A Space Milestone

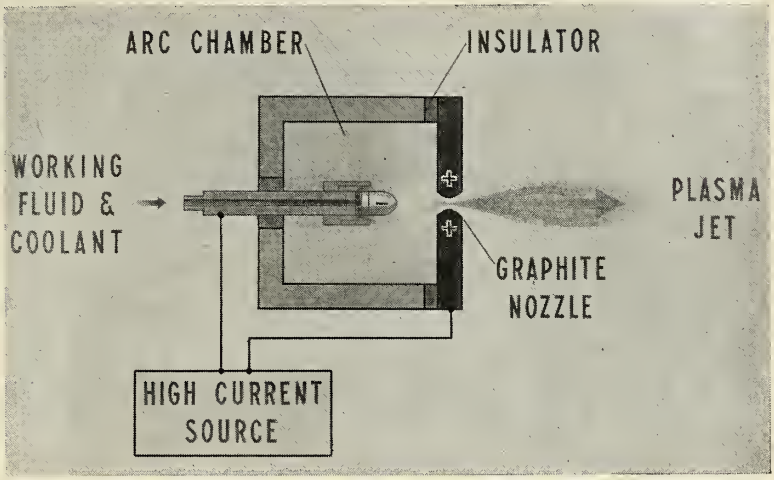
Laboratory Success Shows Higher-Power Engines Await Controlled Fusion

by Raymond M. Nolan

Plasma jets are now being operated in the laboratory at thrusts of up to two pounds.

This is the report from Plasmadyne Corporation of Santa Ana, Calif. A spokesman for Plasmadyne said that thrusts of this magnitude could be used for attitude control of satellites or space vehicles with not much more provision for power than is now planned for TV scanning satellites.

This marks the first step into the new electric forms of propulsion that many feel are necessary before space can be explored.



IDEALIZED plasma jet is illustrated in NACA sketch.

Plasma jets have been studied for many years, both in this country and in Germany—and presumably in the USSR. They are intriguing to scientists because of the relatively high temperatures they entail and the high (600-and-up seconds) specific impulses they give for propulsion. The main drawback has been the enormous amount of power required, because the most practical way of operating a plasma jet has always been in an electric arc.

To generate a plasma (defined as a state of matter consisting of highly excited free electrons and positive ions), an electrical potential is first set up across a gap bounded by an anode and a cathode. The cathode releases an electron stream which ionizes some of the atoms and molecules in the gap. In this way, additional electrons are freed, and collisions with atoms become more frequent.

Thus, the total kinetic energy of the particles in the gap continues to increase, with a corresponding increase in temperature. Finally, two sub-atomic streams are flowing—electrons to the anode, positive ions to the cathode. This is the plasma state. Light quanta are given off when electrons and ions recombine to form neutral atoms. If the kinetic energy imparted to the electrons is sufficiently high, the particles will begin knocking positive ions off the anode where they proceed to the cathode. The stream of hot eroded ions constitutes the arc.

Propulsion units of future

Plasma jets have two principal uses in the missile field today—they are seen as propulsion units of the future, and they are valuable tools for investigation of aerodynamic heating in re-entry problems, where the temperatures involved give a good picture of what happens to materials when vehicles come back into the atmosphere. However, their greatest potential lies in the propulsion area.

It is already a well-known fact that we are pushing the state of the art in chemical propulsion. The weight of the fuel which must be carried for long voyages just about rules out chemicals for propulsion to any of the other planets—or even to the moon if we intend to land and then return.

Several ways are under investigation for propellants of the future—nuclear engines, plasma jets, ion engines, and the presently far-off photon propulsion. All of these are theoretically feasible, but the over-riding consideration for all but the nuclear is electrical power. In the case of the nuclear engine, it is the weight of the engine, fuel, shielding and conversion device.

Electrical power is, and will continue to be, the most serious drawback to space travel. We have not as yet developed any way to tap the almost limitless electrical energy which is present in outer space, so most programs today are concerned with means of developing the power within the vehicle.

Power from fusion

Power for the two-pound thrust engine developed by Plasmadyne is not too much of a problem, because it is planned for use as a control device and for relatively short-term periods. However, power for larger engines or for longer times will be difficult to come by. About the only method now considered possible is that of controlled thermonuclear fusion, but here again the problems are many.

Fusion needs fantastically high temperatures to maintain a sustained flow, but to date, we, the English, and the Russians have only been able to create temperatures of a fraction of those needed—and these for extremely short periods. When someone does solve the power problem, we will have taken a giant step forward.

Scientists on AEC's Sherwood program (code word for the controlled thermonuclear program) are working with a goal of 100 million degrees, the temperature believed necessary for a self-sustaining thermonuclear reaction. This takes the form of a magnetic pinch effect where the electrically charged particles are controlled by magnetic lines of force, supplied by coils or by currents passing through the plasma itself.

The magnetism must be strong enough to contain the plasma and has to be self-variable so that it can adjust to changing temperatures. The pinch effect is obtained by using the phenomenon of attraction of parallel currents. Discharges of heavy parallel currents pinch the atoms of the plasma together and suspend them in a thin line away from the container.

When a pinch is sustained for significant periods of time, researchers believe that they will have the temperature necessary for a plasma jet which will have an energy output far greater than the power necessary to produce the pinch.

Ten lb. thrust equals 25,000 mph

However, the two-pound thrust en-

(Continued on page 30)

Chemists Look To Missile Money

Meeting Stresses Need For New Fuels, Better Solids

m/r report

CHICAGO, ILL.—Over 14,000 chemists and chemical engineers convened here at the 134th national meeting of the American Chemical Society held this month. Dr. Howard L. Pilat of the Celanese Corporation of America sparked the confab in his address: "New Impulse to Profits: An Appraisal of Chemical Opportunities in Rocket and Missile Developments".

"The chemical industry should look to the missile spending area for R&D funds," pointed out Dr. Pilat. However, the chemical industry will find no welcoming committee inviting them into missiles; fierce competition will be offered by diverse industries such as aircraft, automotive, metals, and even foods. The trend to solid rockets should be a good opportunity for chemicals to enter the missile field.

• **Chemical needs**—(1). Non-toxic, storable, non-corrosive oxidizers with performance comparable to LOX.

(2). New liquid fuels giving higher performance, and better handling than experimental fuels.

(3). Better solids.

Another area for chemicals is the growing field of synthetic lubricants, hydraulic fluids, and coolants for jet aircraft, missiles and spacecraft. J. S. McClure of the Oronite Chemical Co., San Francisco, Calif. told of developments toward such high temperature fluids.

In order to eliminate operational difficulties, particularly at high temperatures, near pharmaceutical manufacturing conditions prevail for the new synthetic lubes. Both the X-10 and the *Navajo* test missiles used a silicate ester high temperature hydraulic fluid. The X-15, also, will use synthetic lubes that will prove feasibilities for the forthcoming *Dyna-Soar*.

At present, sales of lubes are made to primes and subs. However, when aircraft (such as B-58) and missiles become operational, lube sales will be made directly with the service involved. Products are now in the nature of a low-volume, specialty item. High temperature hydraulic fluids now offered are:

Company	Products
Bray Chemical Co.	Silicate ester fluid
General Electric Co.	Versilube F-50
R. M. Hollingshead	Silicate ester fluid
Monsanto Chemical Co.	OS-45-1
Oronite Chemical Co.	8515 & 8200 fluids

Petroleum-based hydraulics are limited to temps of 250-275 F. Research on synthetics is aimed at service at temps of 700-1,000 F.

Esters of dibasic acids and polyglycols do not meet temp requirements. Silicones have poor steel-steel lubricity. Organic silicate esters have poor hydrolytic stability. Stable alkoxy disiloxanes, however, have appeared. The long evaluation period for systems, however, will require chemical manufacturers to get in with their new lubes soon or find conventional materials being used.

• **Requirements**—What will the lube requirements for missiles be? It may follow the jet engine pattern outlined by C. T. Stone of Esso Standard Oil Co. One jet engine lube (LIL-L-7808) will be a market of over one million gallons a year for a product that originally cost near $10 gallon.

By 1960 synthetic lubes will soar to four million gallons per year. Consumption of oil in jets is small, so that the figures may be applied to a large number of one-shot missiles. Meanwhile evaluation costs and time requirements for testing are going up. Manufacturing the new fluids after successful testing can also be quite a problem.

Thermal degradation of new plastics material was also reported. The Pyrotechnics Lab of Picatinny Arsenal reported on its work on styrenated polyesters for high-temperature ordnance applications.

Union Carbide reported on an epoxy resin combination that is stable to exposures of 250 C for at least 100 hours. Dicyclopentadiene dioxide forms the basis of these high-temp epoxies.

NBS outlined its work with an amidine fluorocarbon copolymer that has good elastic properties and promises greater thermal stability above 500 C than the more common polytetrafluoroethylene polymer. A complixating factor is the 20-30% volatalization which occurs initially but which may be overcome by removal of impurities.

According to J. W. Cole of the University of Virginia, no ideal antioxidant has yet appeared to protect lubes against high temperature degradation. His statements are also somewhat applicable to plastics.

Automotive Engineers To Get Missile Briefing

Add one more old-line professional society to the list of those emphasizing missiles and space when the Society of Automotive Engineers opens it Annual Aeronautic Meeting in Los Angeles, Sept. 29-Oct. 4.

Although the total number of "production forums" is down from the 1957 meeting, two classified sessions involving missiles are slated, as are two open meetings for a total of four sessions and 12 papers directly involving missiles. There will also be one panel forum on "Ground Support Equipment for Missiles."

• **Classified sessions**—In the first of two classified missile sessions (Confidential), missile auxiliary power systems will be discussed by P. I. Wood and B. M. Wilner, Aerojet-General, "Performance Capabilities of Turbine Driven APS"; Bernard Clifton, Bendix Aviation, "A General Survey of Missile Electronic Power Supply"; and D. A. Rains, Ramo-Wooldridge, "Secondary Power for Space Flight".

The second classified session will cover missile engineering with papers by C. S. Ames, "Highlights of the Atlas ICBM Development and Flight Test Program"; R. S. Gardner, Wyle Labs. and Elmer R. Easton, Wyle Associates, "A New Concept of Missile Reliability Assurance Through 100% Testing of Airborne Propulsion Components"; and W. A. Knittle, Rocketdyne, "Liquid Propellant Vernier Engines (Design and Application)".

• **Open sessions**—Open sessions include missile guidance and control with papers by C. R. Faulders, North American Aviation, "Low Thrust Rocket Steering Program for Minimum Time Transfer Between Planetary Orbits"; A. D. Wheelson, Ramo-Wooldridge, "Midcourse and Terminal Guidance"; and E. R. Buxton, Autonetics, "Automatic Landing Flare System for Aircraft, Missiles and Space Vehicles".

Papers on missile handling and storage will take up another open session with F. P. Price, Convair-Pomona, "Terrier Field Service Problems"; H. J. Ide, Douglas-Santa Monica, "*Nike* Hydro-Mechanical Maintenance Problems"; and R. W. Manley, Hughes, "Maintainability of the *Falcon* Missile System".

Other subjects of general interest to the missile field will be "High Temperature Materials", "Shock and Vibration" and "Aerodynamic Labs and Test Facilities".

In addition to the technical sessions, an engineering display will be held at the Ambassador with 120 booth spaces reserved by about 90 firms, it has been reported.

Defective Valve Stymied *Vanguard* Attempt

by Norman L. Baker

Preliminary investigations indicate hat a defective valve stopped the flow of one of the propellants a fraction of a second from maximum thrust build-up. Shutoff was activated by a fail-safe device as a result of engine starvation.

Disaster in the form of total rocket destruction was averted by the launch stand's new hold-down devices. Four arms similar to the two hold-down arms employed in the *Atlas* launch system, were installed on the pad shortly before this last test. The arms are designed to hold the *Vanguard* secure until almost total thrust is developed (27,000-lb) in winds up to 30 mph. Wind velocity during the countdown varied from 10 to 20 mph. If the vehicle had cleared the arresting arms before the thrust decay it would have toppled to its destruction.

NRL informed m/r before the unsuccessful try that the *Vanguard* crew had checked, rechecked, modified, recycled and de-bugged the vehicle until they felt no further improvement was possible. Confidence was supreme hours before the attempt—odds were considered one in four for success. After the try, a spokesman in dejection summed it up with, "They did the best they could."

Another attempt is not expected for several days. The rocket will have to be cleaned throughout and a complete checkout made on instrumentation and wiring. NRL is optimistic that the rocket can be made ready for its next try this week.

• **Satellite details** — The SLV-3 Weather Eye satellite will measure the global distribution and movement of cloud cover over the daylight portion of the orbit and relate it to the over-all meteorology of the earth. Incorporated in the satellite package are two photocells, sensitive to red and near-infrared for scanning the surface of the earth and the cloud systems. Since the tops of clouds and the earth's terrain have different reflectability levels, light striking the photocells will cause changes in electrical impulses in direct proportion to the light intensities. Clouds reflect 30 to 80% of the light striking them, while land masses reflect 15 to 20%. The near-infrared sensitive qualities of the photocells will provide the best possible contrast in detecting land, cloud and water masses.

Signals from the photocells will be recorded on a 75-foot loop of erasable tape. The signals from the tape will be interrogated by a command receiver in the satellite during each orbit. The information collected will be relayed in one-minute transmissions to the Minitrack stations on the 108.03 megacycles frequency and re-recorded.

During the first 24 hours of operation, the satellite will not be interrogated in order that a scale of reference may be established at the equilibrium temperature. In addition this will allow time for correlation of orbit, time, position and cloud cover information. As the satellite progresses from light into darkness it will be turned off by a solar-cell activated switch reducing the drain on the power of the mercury batteries. The same switch will activate the instruments when the satellite again enters the sunlight.

Instrumentation and batteries account for approximately one-half of the 21.5-lb payload. Instrumentation was developed by the Army Signal Research and Development Laboratory.

Scientists believe that the satellite will be able to recognize hurricanes and typhoons and the severe storms which breed cyclones and tornadoes. Ultimately it may be possible to produce facsimile weather maps.

This experiment will make possible a measurement of the total earth cloud cover, and will allow meteorologists for the first time to develop a good theory on the flow of heat through our atmosphere, and thereby improve long range weather predictions. It may even be possible to reproduce an image with enough identification to distinguish types of clouds, lakes, mountain ranges and other features.

X minus O, and Holding

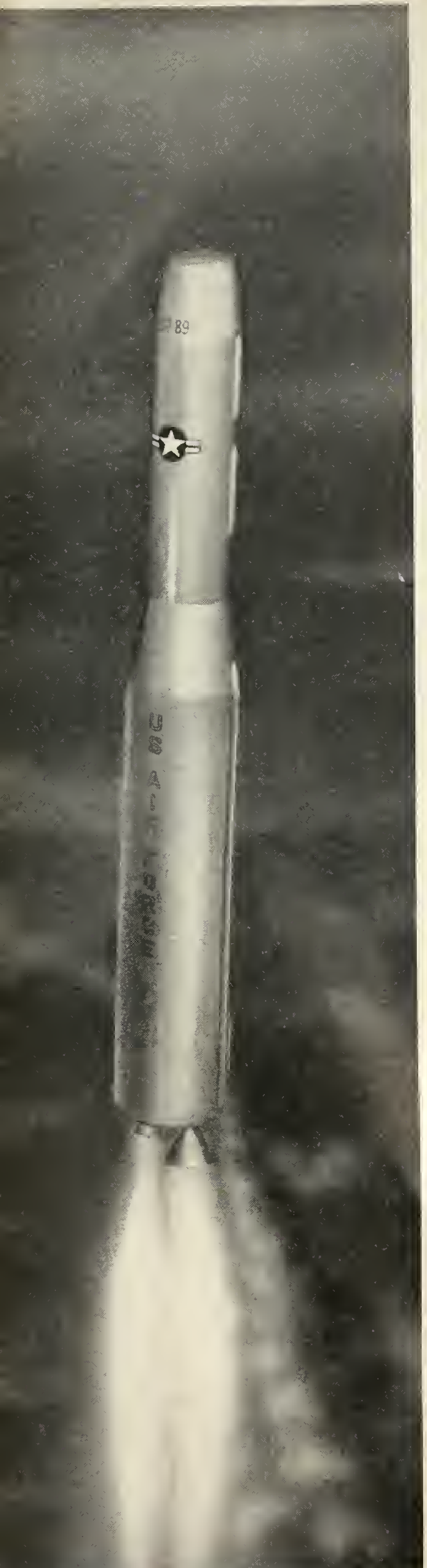
CAPE CANAVERAL—Once again the hard luck *Vanguard* program has suffered a severe prestige setback. SLV-3, loaded with an Army Signal Corps "Weather Eye" satellite package refused to leave its pad during a precedent-breaking countdown on its first try last week.

Countdown began 6 hours before scheduled lift-off time. All proceeded well until the last sixty minutes. A series of minor holds stretched the launch time from 9:30 A.M. to 11:17 A.M. Major difficulties were experienced in the range instrumentation checkout. After a hold at X minus 36 seconds, the count proceeded smoothly to the "X minus O, rocket 1391 at zero."

The first stage engine responded instantly to the ignition signal. Smoke and steam poured from the deflector plate as thrust build-up began. Approximately five seconds later a burst of off-color, unwanted flame appeared in the vicinity of the engine—then the announcement, "X minus zero and holding." Moments later the countdown was moved back to X minus 35 minutes to reload. Within minutes SLV-3 was pronounced scrubbed and the gantry slowly moved back into position. Official announcement for the failure—malfunction triggered an automatic cutoff.

MEMBERS OF THE *VANGUARD* TEAM meet with Dr. John P. Hagen, director of Project *Vanguard*. Left to right: Dr. J. W. Siry, head of Theory and Analysis Branch; Mr. D. G. Mazur, manager of the *Vanguard* Operations Group, PAFB, Florida: Mr. J. M. Bridger, head of the Vehicle Branch; Cdr. W. E. Berg, Navy Program Officer; Dr. Hagen; Mr. J. P. Walsh, Deputy Project Director; Mr. M. W. Rosen, Technical Director; Mr. J. T. Mengel, head of Tracking and Guidance Branch and Dr. H. E. Newell, Jr., Science Program Coordinator.

Titan: "Most Advanced" Missile



Titan, the Air Force's back-up ICBM, incorporates within its design the most advanced rocket technology available in the free world. Its two-stage configuration is the near-optimum in the critical mass-ratio parameter. This makes it possible to send a warhead equal to the destructive potential of the missile's forerunner *Atlas* the same distance, yet with a drastic reduction in total take-off thrust.

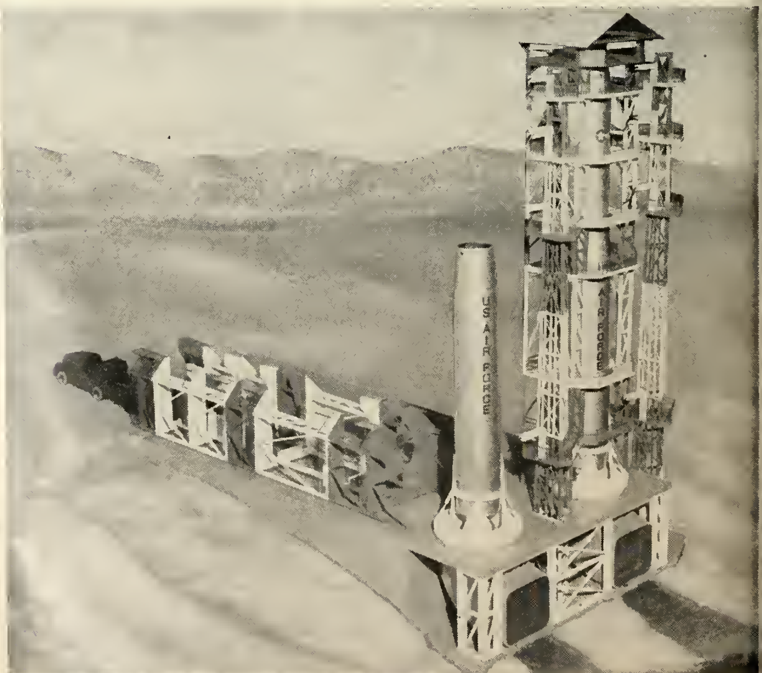
Overall weight of the *Titan* is approximately 10 tons less than its sister weapon, *Atlas*. Take-off thrust is 300 to 330,000 pounds, compared with 360 to 390,000 pounds for the *Atlas*. While *Atlas* employs three engines for generating the necessary power, *Titan* will be pushed with two engines. The *Titan* engines are very similar to those used by the *Jupiter, Thor* and *Atlas* (boosters).

• **Test and development**—The clustered first-stage engines, developed and manufactured by the Aerojet-General Corp., have received extensive captive testing, singly and paired, at Martin-Denver's test facilities in Colorado. Engines are gimballed three to five degrees for obtaining major attitude control. Four vernier engines mounted on the second stage, at the junction of the first and second stage, provide precise attitude and thrust control. Burning time of the first stage is estimated to be between 140 to 160 seconds.

A bell-nozzled rocket engine developing a thrust of 60,000 pounds propels the second stage after separation from the first stage. The four vernier engines continue to thrust throughout the second stage portion of the flight and for several seconds after the sustainer's burnout. Burning time of the final stage is approximately three minutes.

First stage has an overall length (measured to the exit area of the rocket nozzles) of about 53.5 feet, and a diameter of about 10.5 feet. Second stage has an overall length of 37 feet, 8 inches (frame length of 32 feet, 9 inches); and a diameter of 8 feet, 3 inches.

The first complete *Titan* missile has been delivered to the Cape Canaveral test range for evaluation. The two stages have received extensive captive tests at the prime contractor's test facilities at Martin-Orlando before delivery to the AFMTC. This first missile will not be flight-tested, but will serve only as a static-test vehicle. The first two launch pads have recently been completed and are expected to go into service with flight missiles within the next few weeks.



MODEL of *Titan* ICBM assembly-erector-gantry crane for the test at Cape Canaveral. LEFT, *Titan* in simulation of firing.

• **System evaluation**—The *Titan* guidance system, developed by Arma, is probably one of the best inertial guidance systems in existence, although it will not fly with the first, or even the tenth, test version of *Titan*. Reason: early versions of the missile were programmed to use the more positively-controlled radio inertial guidance developed by Bell Telephone Labs for *Titan* and *Thor*.

Later versions still will not have equipment available because of the Air Force decision not long ago to use Arma guidance in the production *Atlas* missiles. The BTL radio inertial guidance, incidentally, is very similar to the type which General Electric built for the *Atlas*, and which is now being phased out so that the *Atlas* missiles will be all inertial.

The Arma system, which will appear in production versions of both liquid-fueled ICBM's, consists of a control central, a guidance computer, a stabilized platform with two two-degree of freedom gyros, and three vibrating wire accelerometers.

Overall weight of the system is about 500 lbs., and it is built with techniques far in advance of most other systems, even though one Arma official describes it as the "Model T" of Arma's guidance concept.

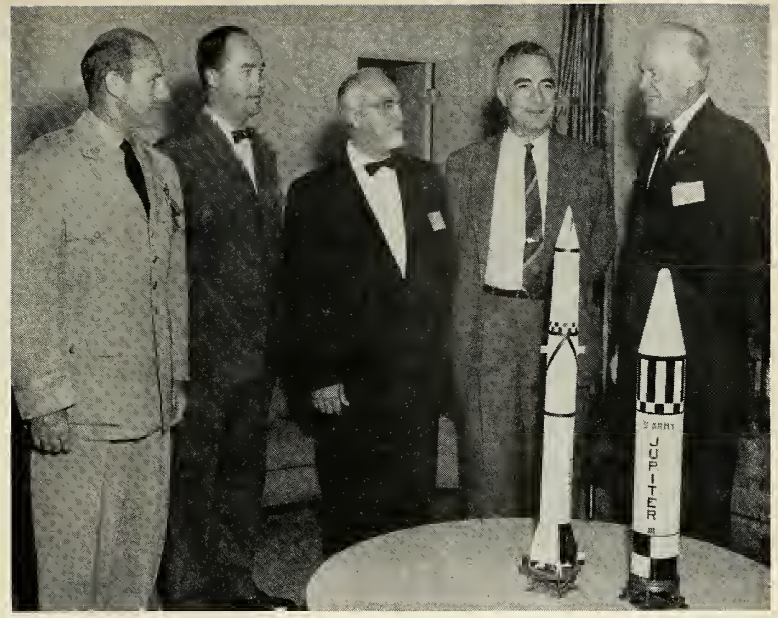
Arma has already standardized the 6 by 9-inch circuit cards, so that less than ten types are used in the three-deck, 180 lb. guidance computer. Miniaturization efforts are already being applied to reduce the computer to 60 and then 20 lbs. respectively.

The 20 lb. version will feature ceramic discs with sub-miniature components stacked on a 9-inch diameter card, and surrounded on its periphery by a magnetorestrictive delay line. With every pound saved in the instrument section translated into more payload or less fuel, Arma engineers feel that miniaturization is their most important product.

• **Launching**—One major difference between the *Atlas* and the *Titan* will be in the launching method.

The firm of Daniel, Mann, Johnson and Mendenhall, Los Angeles constructors and engineers, are reportedly working on plans for "hard" launching sites, a formidable problem with liquid-fueled missiles.

The toughest part of the "hard" complex will be the storage and rapid pumping facilities for liquid oxygen, although there are some reports that a missile on "ready" will be fueled and have its LOX continuously recirculated.



ROCKET SOCIETY chiefs confer with speakers. (Left to right) Gen. H. Boushey, Jim Harford, G. Edward Pendray, George Valley, Harlan Hatcher (president, U. of Mich.)

ARS Reports R&D Up, Hardware Trimmed

DETROIT—Some 1,000 members of the American Rocket Society met here Sept. 15-18 to discuss missile production problems, auxiliary powerplants, and the impact of space flight on the nation's industries.

Biggest news to hit the meeting was North American Aviation's announcement of a cluster rocket engine to deliver 1.5 million lbs. of thrust (m/r Sept. 22, p. 13). This is an apparent back-up for the one megapound single chamber engine that Rocketdyne is to design for USAF.

According to Lt. Gen. Arthur G. Trudeau, Army's chief of Research & Development, the 1.5 megapound engine will be employed under ARPA or NASA-designated programs for space and satellite use only. Trudeau thought that such an approach would do much to reduce the usual long years from "womb to boom" in most missile programs.

Most engineers, including Rocketdyne's, differ considerably as to possible production times of either engine, ranging from one to three for the cluster and three to five for the single chamber. Beyond these engines, Rocketdyne sees large manned satellites (figures) which would require 6-15 megapounds of lunching thrust.

• **Reliability-production problems**—Most unclassified papers were concerned with production problems in the complex art of missile manufacture.

The liquid propellant *Redstone* missile, with an engine (the A-7) in the 75,000 lb. thrust class, has attained an overall engine reliability of about 96%.

This may not be high enough for anti-missile use. Even the solid propellant *Nike-Zeus*, though its powerplant will have almost 100% reliability, will have inherent detection and guidance problems. For this reason, Dr. George E. Valley, chief USAF Scientist, does not hold out much hope for "antis".

Other factors may also obsolete missiles. Detroit, for example, was startled to hear that the *Dart* anti-tank missiles would no longer be produced at the Curtiss-Wright subsidiary plant at Utica, Mich. The Army cancelled the $16.5 million contract, presumably because the European allies were able to produce cheaper, more reliable, and more versatile AT rockets.

• **Space-flight forum**—Brig. General Homer Boushey, first director of Advanced Technology for USAF, said that there would be a gradual shift from military aircraft and missiles to military use of space weapons. The trend would be from the aeronautical industry to the astronautical industry.

K. J. Bossart of Convair-Astronautics' Technical Division emphasized that for a long time to come most efforts would be for R&D rather than manufacturing. Reliability and long-life will be major goals. According to Dr. Valley, booster rockets for space operations would seem to require standardization.

missile business

Labor costs—in the form of wages, anyway—will go up this year. That's obvious from the demands of labor unions already on record. And it won't be easy for management to counter these demands—the labor leaders are perfectly well aware of the improving economic picture, better sales and improving profits.

The jump could run as high as 10 cents an hour for manufacturers in the missile field, following hard on what the steel industry has already okayed. And from those agreements you can read the place where the changes will be: improving established benefits—bigger premium pay for week-end work, vacation provisions.

And white-collar wages will have to go up, if the men in the shop get theirs. Best guesses are that white-collar (and blue-collar unorganized workers) should average about a 4% hike.

Productivity may be a bright spot in this picture. Official measurements are necessarily inaccurate, but indicate a rise for production workers of about 4% in 1958, and further rises due in the spring.

More business for small business is expected to result from those changes in government procurement laws recently signed by the President. Gist of the changes is that "open market" purchases, until now limited to between $500 and $1,000, are raised to $2,500 for all agencies. Expectation is that this will permit more small orders that can readily be filled by small business firms.

How much missile business means to many types of business activity is indicated by only a partial list of developments last week. Among new plants, for instance, there were these: Linde Co. (Division of Union Carbide) broke ground for a multi-million LOX and nitgrogen plant at Pittsburg, Calif.; Bendix Industrial Controls Section (of Bendix Aviation) will increase its floor space at Detroit by 60%; H. B. Fuller Co. plans a 14,300 sq. ft. addition to its adhesive plant in Fairfax, Kansas; Magnetic Amplifiers, Inc., has opened a new plant in New York, upping its manufacturing space by 50%.

Good news for stockholders came out of financial reports last week. The Siegler Corp., Los Angeles (which recently merged Unitronics Corp. into its corporate structure) reported record sales of $72.9 million for the 1958 fiscal year, a net of $1.2 million. Telecomputing Corp., Los Angeles, showed increased sales of $21 million and net income of $542,460 for the first nine months of 1958. Clary Dynamics Division (of Clary Corp., San Gabriel, Calif.) listed more than $500,000 in new order for its valves, gyros and missile components, in August alone.

Perkin-Elmer Corp., Norwalk, Conn., whose engineering and optical division has long been a leader in missile range instrumentation, optical systems and the like, is expanding its organization with a new regional office in Monrovia, Calif. Reason is revealing: "We have seen many new names and faces in the military weapons system field," said C. W. Miller, division general manager. "Many of them are locating in the west."

Boost in mail rates (up from 1 to 2 cents per piece for bulk mailings) due Jan. 1 will cut down on businessmen's mail, somewhat. Mail-selling won't be cut out, but the rate jump will mean drastic pruning of lists now being used.

contract awards

NAVY

By Office of Naval Research:

University of Cincinnati, received $54,000 for orbit calculators for use in connection with Project *Vanguard.*

Polytechnic Institute of Brooklyn, Brooklyn, N.Y., received $35,000 for study to determine the feasibility and design of a wind tunnel to hypersonic, high-enthalpy, low-density gas flows.

AIR FORCE

By HQ, AFMTC, ARDC:

Radiation, Inc., Melbourne, Fla., received $100,000 for increase in funds.

ARMY

Ordnance District, Philadelphia:

Western Electric Co., Inc., New York, N.Y., received 25 contracts totaling $3,213,802 for *Nike* spare parts and components.

Douglas Aircraft Co., Inc., received $65,193 for *Blue Streak* and emergency spare parts.

University of Pittsburgh, Pittsburgh 13, Pa., received $27,243 for basic research entitled "Low energy nuclear and electron physics."

Spitz Laboratories, Inc., Yorklyn, Dela., received $49,652 for development, design and construction of lunar flight models.

RCA Service Co., a div. of Radio Corp. of America, Cherry Hill, Delaware, received $411,944 for installation, repairing, modifying and developing electronic and related equipment, guided missile program.

By Engineer Division, New England, Corps of Engineers, Springfield Area:

Hartford Oil Heating Co., Hartford, Conn., received $8595 for rehabilitation of existing heating system, group headquarters, *Nike* battery.

Blount Brothers Construction Co., Montgomery, Ala., received $3,245,869 for construction of SAC missile facility.

By Boston Ordnance District:

Raytheon Mfg. Co., Andover, Mass., received $2,085,530 for *Hawk* missile repair parts.

By Ordnance District, Los Angeles:

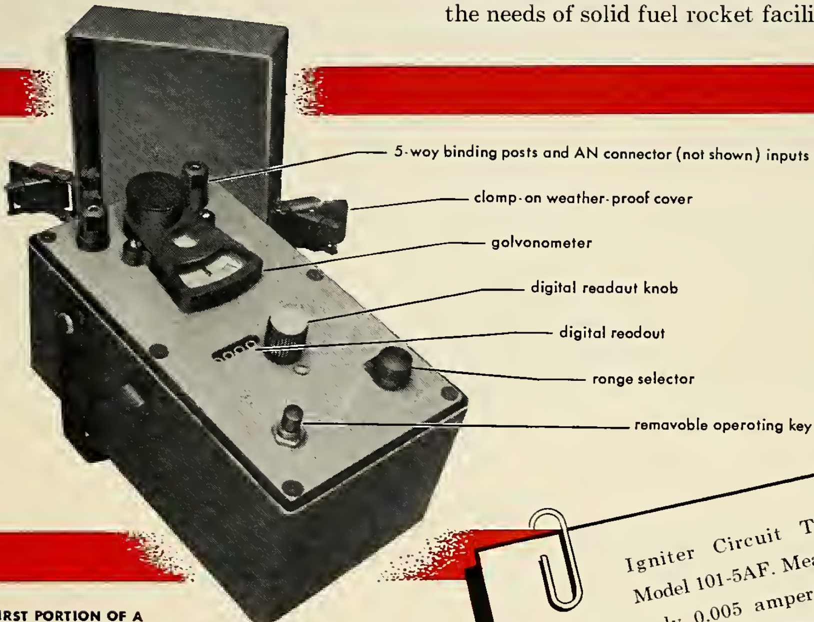
Firestone Tire & Rubber Co., Los Angeles, Calif., received $72,998 for procurement of emergency and *Blue Streak* repair parts.

HOW TO TEST SOLID FUEL ROCKET IGNITERS

. . . safely!

In order to prevent misfires with subsequent costly delays, most solid fuel test facilities now use an officially approved ALINCO Igniter Circuit Tester to test their igniters during manufacturing and prior to firing. The 101-5AF, the latest model of this field-proven instrument, is portable, easy to operate, accurate, and safe. The maximum output current is only 1% of the minimum firing current of a single squib, and the instrument has a measuring range to 30 ohms. It accurately measures igniter and line resistance, quickly detecting shorts, open, and intermittent circuits. Reading the instrument incorrectly is practically impossible with its four-numeral digital readout.

THE UTILITY built into this instrument typifies that of other ballistic instrumentation supplied by ALINCO for solid fuel rocket facilities. Whether a small portable instrument such as the 101-5AF, or a sophisticated system such as the Type K-4 Ballistic Computer, each instrument is carefully and specifically designed to meet the needs of solid fuel rocket facilities.



Igniter Circuit Tester, Model 101-5AF. Measuring current only 0.005 ampere. This instrument is also supplied as the Model 101-5AP, for rack mounting.

HERE IS THE FIRST PORTION OF A LIST OF OVER 100 USERS OF THIS TESTER

Aerojet-General Corporation, Azusa
Aerojet-General Corporation, Sacramento
Aerolab Development Corporation
Aerophysics Development Corporation
Allegany Ballistics Laboratory
Anniston Ordnance Depot
Applied Physics Laboratory
Atlantic Research Corporation
Avion Service Corporation

Bell Aircraft
Bermite Powder Company
Black Hills Ordnance Depot
Blue Grass Ordnance Depot

C.I.T., Jet Propulsion Laboratory
Canadian Arsenals Limited
Catalyst Research Corporation
Charleston Naval Shipyard
Chrysler Missile Operations
Convair, California
Cooper Development Corporation

Department of Defense Production
Detroit Arsenal

Eagle Picher Company
Edwards Air Force Base
Elgin Air Force Base

Fairchild Guided Missiles Division
Fort Monmouth, New Jersey

General Electric Company, Philadelphia
General Electric Company, Burlington, Vt.
Grand Central Rocket

Holex, Inc.
Holloman Air Force Base
Hughes Aircraft Company

Jefferson Proving Ground

Letterkenny Ordnance Depot
Lockheed Aircraft
Librascope, Inc.

Martin Company
Mason & Hanger, Silas Mason Company
McCormick Selph Associates
Minneapolis-Honeywell Regulator Company

ALINCO

SPECIALIZING IN SOLID FUEL INSTRUMENTATION

Allegany Instrument Company, Inc.

CUMBERLAND, MARYLAND AND GRANADA HILLS, CALIFORNIA

Tests Prove Out Missile-Sub Guidance

Navigation, the key to the success of the *Polaris* missile and the entire fleet ballistic missile system, is now undergoing the most rigorous tests and evaluation aboard the USS "Compass Island," which from outward appearances very much resembles any ordinary merchant vessel.

In the "Compass Island," however, the Navy has assembled the most amazing array of electronic navigational equipment ever put together. Important among these systems is the Ship's Inertial Navigation System (SINS), a miniaturization of the USAF system which enabled the *Nautilus* and the *Skate* to make their polar voyages under the ice cap.

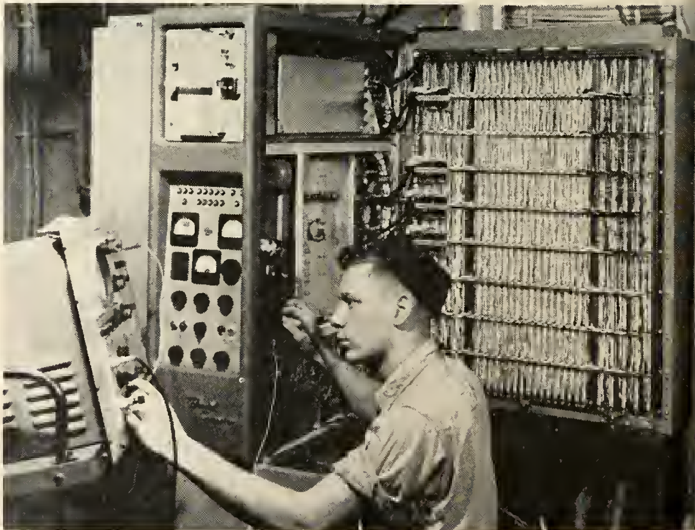
The "Compass Island's" inertial guidance system permits a vessel to keep track of its movements and more accurately determine its position than has been possible before, independent of any shore-based aids. In addition, the ship is carrying out evaluations of a new type star tracker (Farrand star tracker), computors and a variety of gyros, compasses, and other mechanical equipment used in navigation systems.

The Navy has drawn on all segments of American industry to develop the revolutionary navigational equipment. Among companies working on the fleet ballistic missile navigation system, which can be adapted to other type vessels, are the Bendix Aviation Corporation and North American Aviation.

While the "Compass Island" is carrying out the work on the navigational system, a sister ship, the "Observation Island," is being used for the preliminary tests of the firing of the *Polaris* missile itself. Navy spokesmen have indicated highly satisfactory tests to date on all components of the FBM system, which is currently scheduled for readiness status with the fleet by 1960.

NORMALLY, STABILIZER COUNTERACTS sea movement. Here, it demonstrates effectiveness by creating man-made roll.

CAMERA ASSEMBLY of the Farrand star tracker is important part of FBM system.



CIRCUITS OF COMPUTER, G-15D by Bendix, checked by Navy technician. Equipment is used to compute star fixes and can supply other navigational data.

STABILIZERS located below the water-n each side of ship assist in tests of navi-al equipment, essential for the fleet bal-missile sub in locating firing position.

LE ELEMENT of the ship's inertial navi- system is adjusted by engineer.

Business Group Hears Review Of Space, Missile Program

York, Holaday Outline Plans To Defense Orientation Conference; Stress R&D Importance In Future

by Donald E. Perry

WASHINGTON—Polar regions for pace vehicle launchings . . . exaggerated importance of nuclear rockets . . . four-ton satellite fueled by hydrogen-fluorine . . . changes in *Dyna-Soar* program . . . mating of *Eagle* with *GAR-9* . . . state of art passes *Rascal* by for big production.

These were major points brought out by Dr. Herbert F. York, chief scientist for Advanced Research Projects Agency; and Guided Missiles Director William M. Holaday, before the Defense Orientation Conference Association at the Pentagon. The association is made up of industry, business, labor, and other national leaders who periodically receive briefings on national defense.

• **Space via poles**—Dr. York apparently concurs with a theory advanced recently by Prof. Fred Singer of the University of Maryland, (m/r Sept. 1, p. 23) which postulates that particles in the radiation belt discovered in the *Explorer* program are protons, which spiral around magnetic lines of force. Thus the maximum concentration of radiation is reached at the equator, at about 1½ earth radii (6,000 miles), and at 10 earth radii, the belt will end gradually. Singer believes there is a complete absence of radiation at the poles, and escape to space may have to be made thru polar region launchings.

Dr. York said the most significant thing about the radiation belt was that its discovery "was totally unexpected." Failing to achieve adequate shielding for space vehicle occupants (he estimated one ton of shielding weight per person), "the other possibility is to go out from regions within 20 degrees around the pole."

While establishment of U.S. polar launching sites may still be just a gleam in the eyes of official Washington, Russia reportedly (m/r July 21, p. 8) is establishing major missile handling and launching capabilities in the Antarctic at its big Mirny base.

• **Nuclear rockets**—Reviewing ARPA's propulsion programs, Dr. York commented that "the necessity for nuclear rocket engines has been somewhat exaggerated," and while they are important, they are not essential for putting objects into space. He said "special staging" on either *Atlas* or *Titan* (expected sometime next year) would allow 1½ to 2 tons to be placed in orbit. If upper stages use fluorine-hydrogen combinations, three to four ton payloads can go into orbit, he added.

• **Dyna-Soar**—Dr. York confirmed to m/r that ARPA is taking a serious look at the *Dyna-Soar* program. Other sources indicated that Defense Secretary McElroy reportedly soon can be expected to assign ARPA responsibilities in the program. However, ARPA reportedly is not satisfied with certain phases of the program, and wants to take a different approach to speed its development.

According to DOD, *Dyna-Soar* "is being managed jointly by the Air Force and the National Advisory Committee for Aeronautics." If McElroy puts ARPA into the program, the decision on "who's in charge of what," probably will have to be made by the President.

• **Mating GAR-9 and Eagle**—Missiles Director Holaday brought out that the Navy's *Eagle* and the Air Force's *GAR-9*, both air-to-air missiles, "will be worked into one system." Development work on *Eagle* with its "all-weather capability," is being completed, Holaday said. About *Rascal*, Holaday pointed out that "it has been definitely limited in production because the state of the art has passed up the missile."

• **Three-stage** *Minuteman*—Holaday day confirmed publicly for the first time that *Minuteman* will have three stages. Touching on the *Bomarc* and *Hercules* controversy, he said neither program will be cancelled out. Both will be deployed to provide a "defense in depth."

When queried on whether he might become the new Defense Department director of research and engineering, Holaday said "it will not be me. I've got enough to do in my present job." The appointment appears days away.

Holaday said the U.S. has originated 74 guided missile projects but 34 were cancelled for technical difficulties. Before fiscal year 1958, he said, some $16.5 billion was spent on missile research, development and procurement. The U.S. will spend $6.7 billion in the same areas during fiscal year 1959.

Adm. Clark: He Bosses U.S. Space Projects

ARPA's top military man is a kid-gloved ramrod who gets things done by "more patience, less horsepower."

by Erica Cromley

While today's headlines spotlight the lunar-bent rockets of Cape Canaveral, tomorrow's are in the works in a suite of offices on the third floor of the Pentagon. Here, a team of 30 scientists sifts through the space proposals that have been pouring in from industry and the universities, separates the impossible from the feasible, recommends the practicable and draws up ways and means for those projects that are finally selected.

Organization of the high-voltage brainpower in the Advanced Research Projects Agency into a productive team was considered a tall order. But although ARPA has been in business only a few months, the wheels are humming over a well-prepared foundation.

Responsibility for ARPA's performance falls to its top man, industrialist Roy W. Johnson. But the man largely credited with the team's efficient operation as a unit is the agency's deputy director, Rear Admiral John E. Clark.

• **Responsibilities**—This short, wiry dynamo plays a major role in overall planning, sees that the boss's orders are carried out, makes all but the top-rung decisions and evaluates industrial space proposals. His job has been likened to that of an executive vice president; ARPA's role to that of a corporation division which has available the services of other divisions.

ARPA is the only office of the Defense Department with its own budget; it has authority to execute contracts and to deal directly with the service units without having to tangle with chains-of-command red tape.

Clark's background as an effective administrator and his familiarity with space problems as the Navy's missile boss combined to earn him the nod as ARPA's top military man.

However, another factor, probably of equal importance, is that Admiral Clark has a reputation as a successful salesman. This can be a powerful asset to a new agency that has to prove itself and that deals with a subject which is still to be sold to the public. In this respect, he has scored on three fronts: he makes a good impression with Congress, he is respected by industry and he is an effective public speaker.

Clark's one regret in his new and demanding job is that he must limit his speechmaking to one or two a month; he feels the public has a long way to go in education for the space age. ARPA gets many requests for speakers; but is able to fill only about 10%.

Cornerstone of Clark's effectiveness is his ability to fire enthusiasm over a new idea, then to organize the spreading conflagration into productive channels. Although the self-taught military space expert credits "being in the right place at the right time" with his first-stage launching onto the space scene, this is obviously not the main factor in his career.

• **Background**—The Admiral's experience in research and development began with aircraft and aircraft gunnery. In 1937-38 he was in charge of designing and manufacturing arresting gear at the Naval Aircraft Factory, Philadelphia. Several medals and assorted assignments later, when the Navy started taking a closer look at the coming missile age, the admiral was tapped to head the Air Objectives Section of the Guided Missile Division.

Said Clark, "I was captain of a ship which had just completed a mission to the South Pole when my orders came. I had no missile background. I just learned as I went along from people, books and visiting around.

"Few people realize what thin ice the country was on when the national missile program was started," Clark pointed out. "It was well understood that there was no solid foundation for design of the guided missile of the future. I don't think there was ever another time in history that man had embarked on such a vast project—a multi-billion dollar program—with so little to base his efforts on. It was as though the engineers of 50 years ago had decided to build a DC-7 immediately after Kitty Hawk."

Although Clark had had a brushing acquaintance with rockets during some earlier research work, both he and the Navy were starting pretty much from scratch. The Navy's Missile Division was drawing up requirements which were written around the state of the art at the time. It was a case of the chicken before the egg. Although crude rockets had been developed by BuAer and BuOrd, refinements were clearly necessary.

Under Clark's direction at AOS, and later as director of the Guided Missile Division, these refinements evolved, and led to such operational weapons as the Navy's *Terrier, Sparrow,* and *Regulus.*

While the country reeled from the

Sputnik-induced shock last October, Clark moved on a project he had been thinking about for a long time: He presented his plan for a space agency to the Armed Forces Policy Council.

Others had had the same thought and the ARPA organization evolved as a similar but modified version of the Clark plan. This proposed a joint Army-Navy-Air Force research unit on the grounds that "space is too big for any one service." The basic idea was bought, although as it is set up now, ARPA is an independent agency under the Office of the Secretary of Defense and is not directly related to the services.

• **Credits**—Although Clark is matter of fact about his do-it-yourself missile background, and credits much of his success to his availability, longtime Naval associates add a few factors. Here are some quotes:

—"He really worked to get into the job he has today. When he saw the missile program starting up, he took jobs where he could learn about it. He was one of the first in the Navy to feel the missile had a future."

—"Don't underestimate this man. He's a doer but he's also a deep thinker. He's well rounded out, and has a good grasp of the world situation."

—"Clark has always been interested in new things, pushing them. He was always fast to grasp new ideas."

—"He is essentially a planner who likes to look at all angles of a problem. But when he comes to a decision, he leads a very fast pace."

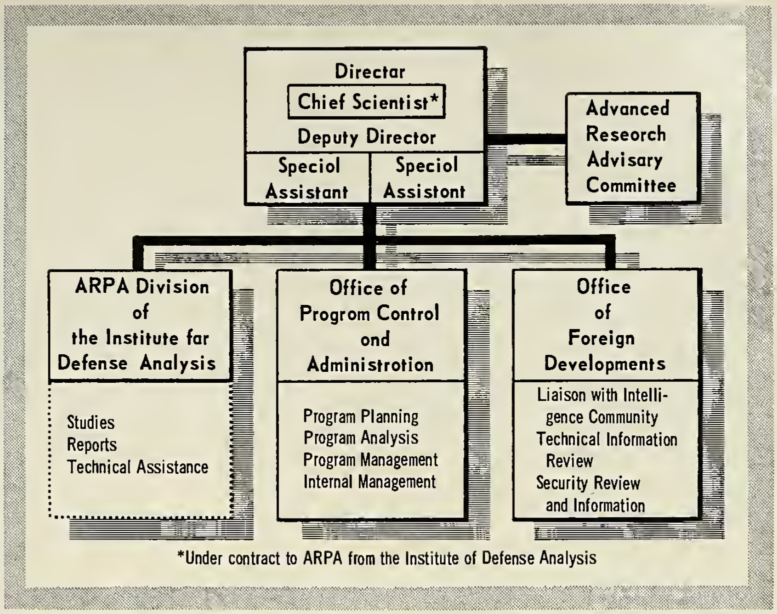
Those who work under him like his policy of exercising indirect authority without immediate supervision or command. He allows you to use your own initiative."

As ARPA's top military man, Clark keeps Johnson apprised of the military-requirements point of view. One Pentagonite pointed out that the civilian space chief "relies a great deal" on his military deputy.

Johnson quickly admits his high opinion of Clark, both professionally and personally. "He has the kind of personality you can work well with. We have a good team and he works well with them."

• **An appraisal**—While his associates are warmly articulate over the kind of job Clark is doing, he is equally vocal about his enthusiasm for the job. "It's intensely interesting. Not only because of the technological end of it, but because of the administration and organizational factors involved. This is a new idea and it presents a challenge.

"The big problem in this country," he added, "is not one of finding talent. We have the scientists, engineers, the know-how. The big problem is organizing it. We need better evaluation. Here at ARPA we've been extremely careful in picking our people—good people."



ORGANIZATION CHART of the Defense Department's Advanced Research Projects Agency. ARPA is under the Office of the Secretary of Defense.

The scientific staff is hired by the Institute for Defense Analysis, a nonprofit organization sponsored and directed by six universities, and then contracted to the research agency. This has several advantages including the bypassing of the regular involved U.S. employment procedures.

ARPA's main areas of activity are general advance space research, ballistic missile defense, and propellant chemistry.

Adm. Clark stresses that the agency likes multiple approaches on basic research and component work. "Wasteful duplication comes when too many final systems are supported." ARPA's Big Two try to see personally as many industry representatives who bear space proposals as possible. If they make their point, and their plans are feasible, a presentation is arranged before the evaluation staff.

Approved projects are contracted through military contracting agencies because though ARPA has power to sign contracts, it is more efficient to use the existing machinery.

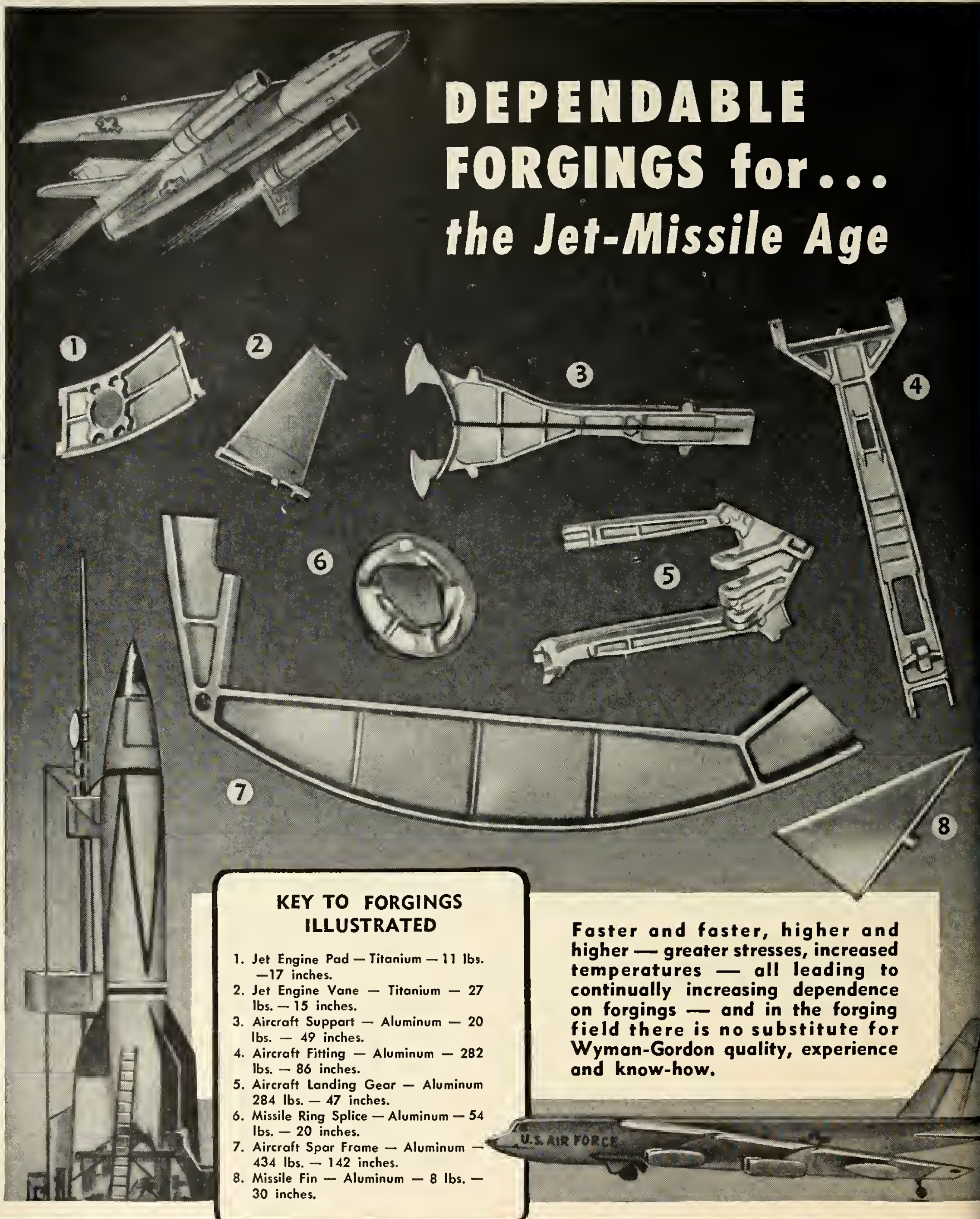
• **A long day**—Getting the new agency into its growing orbit is no snap assignment. Most of the ARPA crew's working day covers a 10-hour span—from 8 a.m. to 6 p.m.

Clark was broken into the long-workday habit early. He began working on a farm 16 hours a day during the summer when he was 14.

The admiral describes his childhood as "a normal, small-town type life." An only child whose parents were separated when he was seven, he turned to his grandfather for guidance. The old man's tales of the military histories of countries set young Clark's sights on a West Point career. But Leavenworth is an Army post town and there were many other teenagers with the same idea. When John Clark had finished high school (he had already completed the first year of college math before graduation), the military academy quota from his area was filled and he joined the Navy.

Although his whole life is space-oriented right now, Clark looks forward to his return to the seas. "There is no thrill like having command of a ship." ARPA has him for one-year and then he expects to be reassigned to ship command for a couple of years. "After that I'll probably be back here for another bout with the Pentagon."

• **Patience and fortitude**—A man with long experience in how to get things done rapidly within the Defense Department structure, Clark has been teemed by one associate "a ramrod with kid gloves." Clark smiles at this and comments, "In the whirlwind time we live in, particularly in Washington, the lasting things are accomplished by patience and insinuation and not by horsepower."★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Faster and faster, higher and higher — greater stresses, increased temperatures — all leading to continually increasing dependence on forgings — and in the forging field there is no substitute for Wyman-Gordon quality, experience and know-how.
U.S. AIR FORCE

Symposium Points To Lag In Telemetry Systems

Telemetering Session Places Blame For Slow Progress On Military and Prime Contractors; Urges Need for Attention To Components

MIAMI BEACH—The U.S. is definitely behind in the systems development aspect of telemetry. This was the general feeling of registrants at the National Symposium of Telemetering held here from September 22nd to 24th. Of a total of 75 technical papers given during the three day meeting, only a few touched on the systems concept and most of the more than 50 exhibitors featured individual components rather than completely engineered systems.

Participants of the symposium queried here felt that the lack of progress in the systems area is the fault of the military and prime contractors, especially in the missile field.

One scientist put it this way, "Today we have no choice but to leave it to other people to bring together components and make a system out of them. There are many individuals and companies in the telemetry field capable of developing systems, but as long as the military and the primes cannot make up their minds about what they want, there is nothing the telemetry manufacturer can do. We cannot afford to invest our money and talent unless we know that someone will buy the product."

• **Common Problem**—This remark pointed to a situation that is not unique in telemetry.

Any product which is produced predominately by small companies is prone to this same sort of thing. The company is not large enough to support a basic or applied research program, and the military or the primes are loath to support research with cost-plus contracts with a completed system as the end product. Their reluctance is not too hard to understand when it is probable that the systems developed will then go to other customers at off-the-shelf prices. However, this is a problem that has faced other industries before and has been solved, so it appears that, until some of the larger telemetry outfits are ready to support research programs on their own, they will have to live with the situation.

Including the general recognition of this problem, the conference was an unqualified success. More than 1,000 of the country's leading engineers and scientists in telemetry attended. The high quality of the technical papers delivered during the meeting as well as the excellent manner in which all arrangements were handled made the meeting a good one—in marked contrast to the telemetering conference held in Baltimore last June.

• **Radio Techniques**—More than half of the 75 papers delivered dealt with various telemetry problems of the missile and space age.

Leang P. Yeh of Westinghouse Electric delivered a paper on "Radio Techniques as Applied to Space Technology" which dealt with the general aspects rather than the specifics of telemetry in outer space.

Mr. Yeh discussed radio techniques which are considered applicable to space communications, the exploration of space by radio, feasible space communications systems and the utilization of bodies in space such as the moon, satellites and others for radio relay purpoes.

Most of the information presented was not new, but Mr. Yeh's survey of the general situation was well received by attendees. He concluded by outlining the future work required in space communications, and said, "At the present state of the art, it seems that the range of space communications is limited by the mechanical end of the problem such as putting larger vehicles in space so that more powerful transmitters and more elaborate antenna systems could be used."

• **R&D big factor**—Other discussion at the symposium concerned the fact that there is still much R&D to be done from the electrical end in telemetry, both in the communications and the power area.

Some of the real problems that face telemetry engineers today are: the development of high power transmitters with lower input power requirements; systems-engineered antenna systems for more overall gain through more efficient use or by time-sharing; reduction of the ambient temperature of antennas in space; reductions in bandwidth and improvements in modulation techniques; reduction of interference and noise in general; and improvement in power supplies, either through more efficient use of batteries or the development of other power sources such as radioactive isotopes or solar radiation.

It was generally agreed by participants at the symposium that, although much R&D is still required, the day when the moon or man-made satellites are used as passive reflectors for earth-to-earth communications is not too far away. Another general area of agreement was that communications between space vehicles would be limited to short range at present.

For long ranges, it is felt that we will have to wait for more transmitted power and antenna gain in space vehicles, or for the development of radically new techniques and mediums other than those known at the present time.

The symposium was followed on the 25th by a one-day classified session sponsored by the Air Research and Development Command at the Air Force Missile Test Center at Patrick Air Force Base.

DOFL Open House Marks 5th Anniversary

WASHINGTON, September 27th—Diamond Ordnance Fuze Laboratories, a Research and Development organization arm of U.S. Army Ordnance, celebrated its 5th year of operation with a limited open house for employees and invited guests today. Featured speaker was Major General John Hinrichs, Chief of Ordnance.

The outdoor exhibit, had an Army *Nike-Ajax* missile and an Army Missile Master System.

Exhibits in the laboratories applicable to the missile field included samples of the microminiaturization techniques developed by DOFL, short-pulse radar, an offshoot of proximity work done by the laboratories and non-classified fuzing and arming devices which are DOFL's specialty.

What's new in TITANIUM alloys:

Advances in aviation technology have happened so swiftly that engineering materials can no longer be selected for their broad use, but rather for the specific tasks they perform.

Today, in the face of tight budgets, the *right* material is the only sound solution to any given problem. Patch-work design, engendered by second-best materials, can only result in second-best aircraft and missiles in uniquely critical times.

To meet the constant tightening of design requirements, Titanium Metals Corporation of America has opened wide new areas of alloy development. This means: heat-treatable bar stock with *guaranteed* capabilities; higher temperature ceilings; broad new strength ranges.

Q. Are the guaranteed heat-treat alloys new?

A. The alloys are not. They have a production history of four years and a wealth of technical data to support them. Recent development of their full heat-treat capabilities has produced such dramatic results that they are considered new.

Q. What are the heat-treat alloys?

A. Ti-155A (5.5% aluminum; 1.5% iron; 1.5% chromium; 1.1% molybdenum) the highest strength bar and forging stock commercially available; and Ti-6A1-4V (6% aluminum; 4% vanadium), which in the annealed condition has already won wide designer confidence. Samples of *guaranteed* minimum heat-treat capabilities show:

	Ti-155A	Ti-6Al-4V
Section size: Up to 1"		
Ultimate Tensile Strength (psi)	170,000	160,000
0.2% Yield Strength (psi)	155,000	150,000
Elongation, % in 4D (Long)	10	10
(Trans)	8	8
Reduction in Area, % (Long)	20	25
(Trans)	15	20

Detailed information on Ti-155A is presented in a 20-page TMCA Engineering Bulletin. Additional data on Ti-6A1-4V, such as fatigue characteristics and guaranteed heat-treat capability are also available.

Q. Are there other new alloys?

A. The leading alloys nearing commercial volume are Ti-8A1-1Mo-1V, a bar stock offering excellent elevated-temperature creep strength to 1000°F, and Ti-4A1-3Mo-1V. The latter, now being produced and evaluated by the Department of Defense sheet rolling program, is designed to fill the need for high strength sheet alloy which can be formed in solution-treated condition and aged to strengths of 175,000 psi. When compared to other high-strength titanium alloys, Ti-4Al-3Mo-1V combines improved formability with outstanding elevated-temperature strength and stability.

Typical Properties — Ti-4Al-3Mo-1V

Condition	Temp. °F	0.2% YS psi	TS psi	Elong. % in 2"
Solution treated	Room	94,000	135,000	14
Solution treated and aged	Room	163,000	175,000	5
	200	142,000	169,000	8
	400	126,000	152,000	8
	600	111,000	140,000	7
	800	98,000	127,000	9

Q. How will these alloys raise temperature limits?

A. Ti-8Al-1Mo-1V is a good example. Although its short-time elevated temperature tensile properties are similar to Ti-6A1-4V, this new alloy offers as much as a tenfold increase in creep strength between 600°F and 1000°F, as shown:

Creep Comparison Between Ti-8Al-1Mo-1V and Ti-6Al-4V

Alloy	Annealing Treatment	Temp (°F)	Stress (psi)	Time (Hrs.)	Def. (%)
Ti-8Al-1Mo-1V	1400°F (24 hrs) AC	850	50,000	300	0.42
Ti-6Al-4V	1300°F (2 hrs) AC	850	50,000	300	3.6
Ti-8Al-1Mo-1V	1400°F (24 hrs) AC	950	15,000	300	0.16
Ti-6Al-4V	1300°F (2 hrs) AC	950	15,000	300	4.3

Now being evaluated by engine manufacturers, Ti-8A1-1Mo-1V appears to answer the need for light-weight strength at steadily higher temperatures. Data on both Ti-4A1-3Mo-1V and Ti-8A1-1Mo-1V alloy are available from TMCA.

All these excellent new alloys have boosted still higher titanium's major advantages of light weight, great strength, superior temperature characteristics, and outstanding corrosion resistance.

To guarantee ready availability of this important engineering metal, TMCA has opened in Toronto, Ohio, the world's first plant designed and instrumented solely for rolling and forging titanium to aircraft quality standards.

This plant guarantees more titanium at better delivery dates than ever recorded in the history of titanium metal.

A series of outstanding technical bulletins is available from TMCA, 233 Broadway, New York 7, N. Y. This literature is yours for the asking.

TMCA hopes to serve you.

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ADDRESS

CITY ZONE STATE

ISA Fears Technician Shortage

Educator's workshop at Instrument Society meeting stresses need for qualified semi-professionals

The future shortage of technicians is seen as one of the most serious problems for missile development by educators in workshop sessions at the recent Instrument Society of America Conference.

Pacing the weeklong program of clinics, professional meetings and lectures in Convention Hall in Philadelphia was the Educator's Workshop, moderated by Lloyd E. Slater, executive secretary of the Foundation for Instrumentation Education and Research. Educators attempted to analyze problems concerned with recognizing, defining and producing qualified engineering semi-professionals.

Participants agreed on one point: the technician problem is one of the lesser-known but most pressing needs in missiles today. Industry is not even quite sure of the definition of technician—at least from an educational and qualification standpoint. Even though the fad today is to decry the lack of basic science education as a prerequisite for advanced science studies, the devices that scientists and engineers develop are often failures in actual use because of improperly qualified semi-professional personnel at the launch site.

• **Key men**—According to Mr. Slater, the U.S. is faced with a dangerous shortage of properly trained technicians to install, test and maintain its burgeoning systems of instrumentation.

Pointing to several highly publicized mechanical failures in recent missile and rocket launchings, Slater said that, rather than a failure in rocket design, there was probably a shortage of properly trained personnel to service and put the birds in good working order.

"Whether or not this is true, it is a fact that some day all of the missiles, however big or small, now in development and test, must be operated by people other than scientists and engineers," Slater said.

"The problem of inadequately-trained military personnel is not too serious because of the prevailing trend to station contractor technical representatives at various installations, but the contractor himself must find his tech reps and how to determine if they are qualified or at least possible to train.

"With more and more missiles moving into the production and operational phases, it will not be too long before we feel the acute shortage of people capable of performing the less-than-scientific but more-than-ordinary technical duties."

Some of the solutions discussed at the workshop were: expansion of post-high school technical training; more applied approaches by vocational high schools; summer training courses in instrumentation for technician-training teachers; and the aid available from technical society-supported foundations such as FIER.

Panelists included: Dr. Karl O. Werwath, president of the Milwaukee School of Engineering; Thomas J. Rhodes, manager of the Process Development Department of the U.S. Rubber Institute; Abner G. Hathaway of United Electronics Laboratories; Dr. Kenneth L. Holderman, asst. dean of engineering, Penn State; W. H. Furry, director of training, The Foxboro Company; Burr D. Coe, director of Vocational and Technical High Schools, Middlesex County; Dr. John A. Hrones, vice president of Academic Affairs, Case Institute of Technology; and Herbert S. Kindler, director of Technical and Education Services, Instrument of America.

• **30,000 attend**—The Conference and Exhibit attracted more than 400 exhibitors and over 30,000 registrants. The exhibit alone included more than $500 million worth of scientific instruments displayed in an area of around 200,000 sq. ft.

Four other societies cooperated with ISA on the technical program: American Society of Mechanical Engineers, American Institute of Electrical Engineers, Association for Computing Machinery, and Institute of Radio Engineers. Besides the more than 90 technical papers presented, other workshops included Sales Engineering, Control Systems, Maintenance Management and Data Handling.

The conference was not without a trace of international flavor. Three USSR scientists, Aleksandr B. Chelyustkin, Borris N. Naumav, and Aleksandr M. Petrovskiy, were scheduled to report on their individual activities in instrumentation and automatic control. However, they were late in arriving and their part in the program was cancelled.

Another Soviet scientist, Prof. Aleksandr M. Letov, associate director of the USSR Institute of Automatics and Telemechanics, and vice president of the International Federation of Automatic Control, was scheduled to appear at the keynote session, but late arrival also prevented his participation.

Speakers at the keynote session were Dr. Norman Cousins, editor of the Saturday Review, and Dr. Gaylord P. Harnwell, president of the University of Pennsylvania.

Next years conference and exhibit will be held between September 21 and 25 in Chicago.

• **Officers and awards**—Henry O. Frost, assistant chief engineer with Corn Products Refining Co., Chicago, was named president of the Society. Major honors for this year went to William G. Brombacher, former chief of the Aeronautic and Mechanical Instruments Section of the National Bureau of Standards, who was elected to honorary membership in ISA. His citation read: "For distinguished technical contributions to the field of instrumentation, in fundamental and pioneering studies of instruments . . . for service to his country, to science and industry."

During his career with NBS, Dr. Brombacher made many contributions to the government's research program in mechanical instruments. His major interest was refining and developing more accurate standards of pressure and humidity and related physical quantities. Under his direction, NBS extended the range of precise pressure measurements up to 200,000 psi and down to 0.00001 psi.

WILLIAM G. BROMBACHER has been chosen as an Honorary Member in ISA for contributions in instrumentation.

Electric Servos Aid Solid Fuel Storage?

Long-time storage, with no loss in performance, claimed for new types of heavy duty servos, may be a solution for upcoming second-generation "birds"

by Raymond M. Nolan

With more and more missiles moving over into the second generation, problems of long-time storage are becoming the foremost challenge to designers.

One serious area is that of servo mechanisms. Since World War II, the United States has relied almost exclusively upon the use of hydraulic actuation for high performance servo systems of large output torque and wide servo band pass.

The very success of this effort has focused attention on the phase which is iminent now—the development of servos which can stand a long storage period and yet be ready for instant use. Progress in this area has been less marked.

The development of efficient servo systems has made them dependent on the viscosity of the fluid used. However, in long term storage all known fluids either cause corrosion of the container or are prone to sludging (the development of different densities and viscosities due to slow chemical breakdown of the fluid.)

In fact, some reports indicate a distressing tendency to chemical deterioration of O-ring seals during extended periods of inactive storage under normal operating hydraulic pressure.

• **Solution offered**—One solution to the problem is by the use of electric servo systems. Electric servos are in use today, but only in applications requiring either low output torque or low output response. One notable exception is the *Redstone* missile which uses a set of relay-controlled high-power electric servos for both the booster fins and the warhead fins.

The Germans made considerable progress during World War II with electric servos, but almost all were relay-controlled. The success of their program was linked to the development of a special DC servo motor capable of providing both the large output torque and wide servo band pass necessary for their requirements.

Meanwhile, Advanced Research Associates Inc. of Kensington, Maryland, has developed a high-performance servo which overcomes the relay problem. In addition, this unit develops its thrust linearly, so that some of the shortcomings of units which convert rotary motion to linear thrust, such as excessive side loading, are eliminated.

The ARA Model 1350 Servo was developed as a small, accurate power amplifying device in the range of 50 to 800 lbs. thrust for actuating drone and missile control surfaces by providing a linear thrust displacement output precisely related to a low voltage DC input.

• **Construction**—The center mount block is 2½ inches square with 2 inch diameter tubing extending from each end of the mounting block with 9½ inches between mounting centers in its retracted position. The unit consists of an electric motor and gear box with a transistorized power amplifier.

Power is transmitted from the motor to the actuator rod end by a gearbox and a ball bearing jack screw. The standard motor and gear ratio provides a stalled thrust of 150 lbs. and a free running speed of 5.6 inches per second with a maximum power output of 24 watts.

However, several types of motors and gear heads can be accommodated in the aft housing to provide displacement thrusts up to 800 lbs. and free running speeds up to 20 in. per sec.

The servo system is designed to respond to current signals. The input signal is derived from a potentiometer connected with a current source, approximated by using a voltage source in series with a fixed resistor which is connected between the potentiometer wiper and one end of the pot.

The input signal is drawn as a current from the ends of the pot into an amplifier, whose input impedance is much less than the impedance of the pot. This means that, with the wiper at the extreme end of the pot, almost all of the source current will flow through the amplifier but with the wiper at the bottom end, no flow.

The advantage of this system is that it is ideally suited to the use of a transistor first stage, so the ARA system features a totally transistorized amplifier and requires no auxiliary power supplies other than those required to operate the motor.

The use of a low (100 to 1000 ohms) resistance potentiometer and the absence of vaccum tubes keeps leakage problems down and increases the reliability of the system considerably.

• **Servo power**—The motor used in the present servo is a standard Globe or Barber-Coleman, depending on customer specification and the gearing and ball bearing screw are off-the-shelf items easily obtainable.

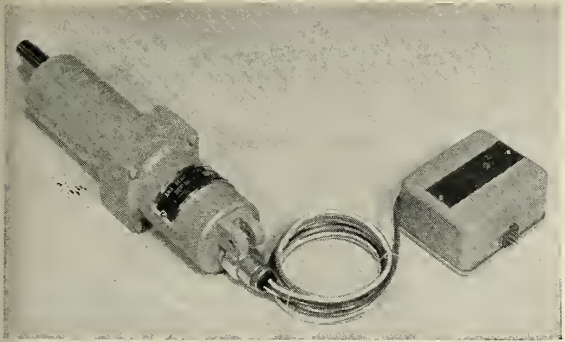
Although the Model 1350 servo competes very well with comparable hydraulic servos, Norman V. Walker, president of ARA, sees a greater potential for high power in electric servos. Units developing power on the order of one hp have been the subject of considerable study and are now operating satisfactorily in the ARA lab.

While most of the circuitry is merely scaled up from the present system, the motor has considerably improved performance and a different input arrangement is planned.

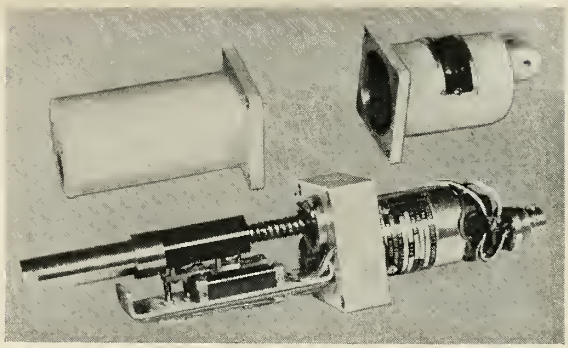
The few high-power electric servos studied by ARA are relay controlled and use an arrangement which accepts a few milliampere magnetic amplifier differential input and amplifies this input by the use of relays to about 200 amperes. The make and break contacts on the output relay carrying 200 amperes and the difficulty of adjustment with the driver relay present problems which Walker says could be more easily solved by the use of high power switching transistors.

Transistors are now available to handle up to 50 amperes in the switching mode, but current flow when the circuit is nominally open makes the use of these units questionable due to the problem of thermal runaway caused by heating from the leakage current.

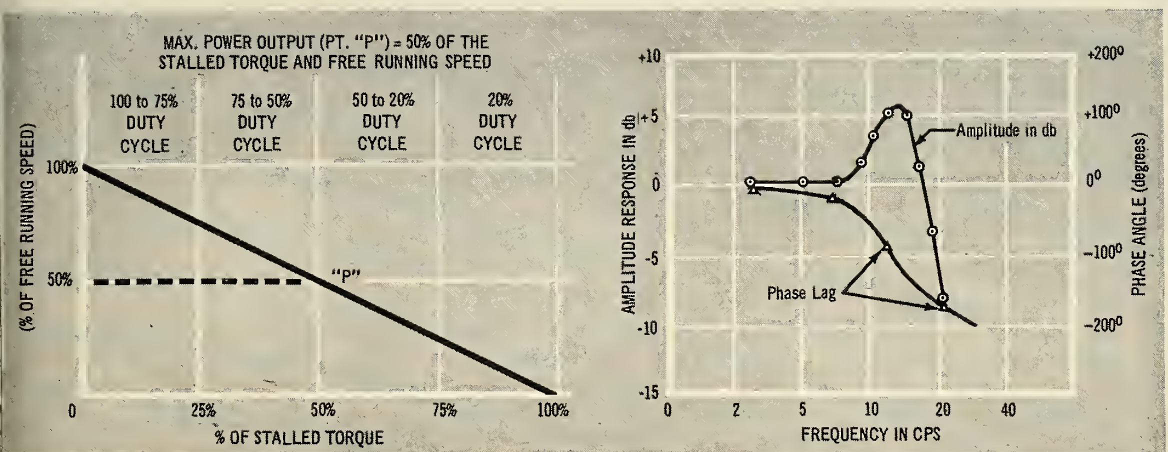
ARA proposes to solve this problem with transistor elements tempera



COMPLETE servo sub-system with plug-in transistor amplifier.



ELECTRIC SERVO, front and rear covers removed from unit.



TYPICAL DUTY CYCLE and free running speed vs. stalled torque plot. (Left). Frequency response characteristics (right).

ture-stabilized with semi-conductors. Each element would handle 30 to 40 amperes and a bank of six parallel elements would provide the 200 amps needed for high power servo.

In front of the power section, Walker would use an ARA Type 9 transistor amplifier which is capable of converting an input signal of three milliamperes to an output of two amperes at 14 volts. The amplifier includes shaping networks to provide damping signals generated by the back EMF of the motor. It occupies a volume of less than three cubic inches and weighs about three ounces.

• **Dudenhausen**—The motor used in the servo is an American-produced unit modeled after the German "Dudenhausen" motor, an extremely rugged miniature device which was produced in Germany during WWII. The Dudenhausen was designed to provide very large values of stall torque on an intermittent basis. The motor time constant was minimized by employing a relatively long armature of small diameter, together with a small air gap.

A series field was used, making the unit unsuitable for normal servo applications. The unit currently being used by Advanced Research Associates uses a strong permanent magnet field and achieves a threefold increase in total flux over the Dudenhausen motor.

Dimensions and performance data of the motor are 4.5 inches diameter by 4.5 inches long, time constant of 12 milliseconds, stall torque of 2 ft/lbs (intermittent), and no-load speed at 28 volts of 11,500 rpm.

Studies made by ARA show that a servo torque of 1500 in/lbs and an effective bandpass of 15 cycles per second are possible. The motor time constant of 12 milliseconds together with the small armature inductive lag provide a linear phase margin of about 35 degrees in the presence of servo loop gain required to provide a 15 cps bandpass.

Operating the motor at half voltage will give sufficient (1500 in/lb) torque with a gear ratio of about 170:1. This provides a maximum output shaft rate of 200 degrees per second. Sinusiodal output motions of over one degree may be obtained without limiting at a freqency of 15 cycles per second.

This, ARA believes, is adequate for actuation systems requiring between plus or minus 20 and 30 degrees for full control. By employing non-linear system design techniques, unusually small quiescent current drain can be obtained.

• **Background**—Advanced Research Associates, founded in 1957, concentrates on two lines principally—electric servos and advanced transistor circuitry. Walker's first contact with the servo problem was after WWII when, as head of Weapons Design Studies in the Royal Aircraft Establishment at Farnborough, he sifted through tons of material on the use of electric servos in German missiles.

His next assignment was as the Principal Scientific Officer of the British Joint Services Mission in Washington, where he had a first-hand opportunity to observe the servo situation in all of the U.S. missile programs.

This has led to his conviction that all missiles must eventually fall into two classes as far as servos are concerned—28-volt DC and "black box" hydraulic—the 28 volts being used on very small and very large missiles and packaged hydraulics used on medium-sized ones.

Gas Damping Extends Accelerometer Life

A new principle that is said to extend the usable temperature range of an accelerometer was displayed last week at the Instrument Society of America's exhibit in Philadelphia.

The Statham Model A501 accelerometer uses gas damping to permit accurate measurement of acceleration changes flat up to 500 cps. At temperature extremes (within the interval −65 degrees to +200 degrees F), the behavior of the A501 is approximately the same as that of a comparable oil damped accelerometer at room temperature. This extension of frequency response eliminates the need for heater jackets, making the new unit ideal for applications calling for small size accelerometers in variable temperature environments. Acceleration ranges available are for plus or minus 5 to plus or minus 50 g's, with ability to withstand accelerations up to three times the range of the instrument.

A paper describing the new principle was delivered at the ISA Conference by Dr. C. K. Stedman, research consultant to Statham Instruments.

Silicon Transistors For "Weather Eye" Satellite

All-diffused silicon semi-conductors that will allow higher power levels for transmitters, have been ordered by the U.S. Army Signal Research and Development Laboratories from Pacific Semiconductors, Inc., for use in transmission of cloud mapping data from satellites.

The transistors combine newly-developed characteristics which permit high power output at high frequencies under high temperature operating conditions. Expected to replace vacuum tubes in satellite instrumentation, the new units are to be used as oscillators to deliver three-quarters of a watt at 108 mc/s.

Use of the transistors, because of their lower power demands, will allow much longer transmission of intelligence from satellites. In some cases, germanium transistors are used now because of their superior performance at higher frequencies, but PSI claims that their product will equal high frequency performance of germanium without losing any of the high power performance of silicon.

The cloud mapping and storm tracking experiments are part of IGY scientific experiments. The experimental satellite will attempt to map the cloud cover of the earth and to locate and track major storms, such as hurricanes and typhoons, by telemetering pictures of the earth through a disc device similar to the Nipkov disc used in early television.

The spin of the satellite will serve as the line sweep for the image and the continuous advance of the satellite in its orbit will provide the advancement of the individual lines—possibly the world's first celestial TV. Photo-electric cells will convert the reflected light from the earth into electrical signals which will be recorded on a magnetic tape. The tape will then be played back and the information telemetered to earth.

Fusion Power Dominates October IRE Meeting

The critical role of electronics in the ultimate control of thermonuclear fusion for large-scale power production is one of the topics to be discussed at the two-day Electron Devices meeting to be held at the Shoreham Hotel, Washington, D.C. on October 30 and 31.

The session on fusion will be highlighted by the delivery of a paper, "Controlled Fusion" by E. W. Herold of RCA Laboratories, Princeton, N.J.

With almost all propulsion systems beyond the presently-used chemical ones utterly dependent on large amounts of electric power, one problem facing designers of ion and plasma engines is how to get this power. There is general agreement that the most promising method will be by controlled fusion, but the problems are so formidable at present that even with laboratory conditions, no practical control of fusion exists. In recent months however, the U.S., Russia and England have reported independently that they are achieving extremely high temperatures in experiments, a vital prerequisite for controlled fusion.

URSI and IRE Joint Meet To Feature Space Vehicles

USA National Committee, International Scientific Radio Union (URSI), and IRE's Professional Group on Antennas and Propagation, and Professional Group on Information Theory will co-sponsor a meeting at Pennsylvania State University, October 20-21.

The program, which includes discussions on such topics as: "Tropospheric Structure and Motions", "Beyond-The-Horizon Propagation", "Ionospheric Structure and Propagation", and "Scattered Signals", also features a symposium on "The Use Of Space Vehicles."

In the next few years, the rapid development of sounding rockets and satellites will open new research frontiers. The number of vehicles available for studies in radio science, and their capabilities, is growing rapidly. So that the greatest advantage may be taken of the new opportunities for space research, it is important that as many proposals for specific experiments as possible be brought forward and made generally known. The symposium is intended to assist in this function.

The panel will consist of experts in the field, all of whom have actively proposed experiments dependent upon the radio instrumentation of space vehicles.

July Transistor Sales Drop, EIA Reports

WASHINGTON—According to the latest figures from Electronic Industries Association, factory sales of transistors declined somewhat in July, from the June sales level.

However, the statistics of cumulative sales for the first seven months of 1958 shows a substantial increase over the high level recorded by EIA for the same period last year.

The July sales amounted to 2.632 million units worth $6.599 million. This compares with 3.558 million units and $8.232 million for the month of June, and 1.703 million units sold at a value of $4.216 million during July 1957.

The following chart, prepared by EIA, show factory sales and dollar value of transistors for the January-July period of 1958. The unit figures for the corresponding months in 1957 are included for comparison purposes.

	1958 Sales (units)	1958 Sales (dollars)	1957 Sales (units)
January	2,955,247	$ 6,704,383	1,436,000
February	3,106,708	6,806,562	1,785,300
March	2,976,843	6,795,427	1,904,000
April	2,856,234	7,025,547	1,774,000
May	2,999,198	7,250,824	2,055,000
June	3,558,094	8,232,343	2,245,000
July	2,631,894	6,598,762	1,703,000
TOTAL	21,084,218	$49,443,848	12,902,300

Glass-Fiber Launchers

British Firm Offers Units For Aircraft Use

Four types of rocket launchers made of glass fiber reinforced plastic have been developed by Microcell Ltd., of London and Camberley, England. They are: (1) Retractable 14-tube launcher mounted in the aircraft fuselage. (2) 20-four tube launcher that can be pylon-mounted under the aircraft wing. (3) 37-tube launcher pylon-mounted under the aircraft wing. (4) Retractable 24-tube launcher.

Advantages of glass fiber reinforced plastic for rocket launchers are based on a comparison with all-metal construction. Among the main advantages claimed by Microcell are:

(1) Materials of construction are readily available in the U.K.

(2) The material is non-strategic.

(3) The material is not reclaimable by an enemy in time of war.

(4) The labor used in manufacture, which in production is mainly unskilled and semi-skilled, is spread evenly throughout all stages, including material manufacture, small numbers only being used on launcher assembly.

(5) Good economy of manufacture can be achieved in production. Not only can cost saving be achieved by improved tooling, moulding techniques and assembly jigging, but also in the use of cheaper types of reinforcing glass, since the bulk of material used is of necessity not highly stressed.

(6) Storage for long periods and/or under extreme climatic conditions produces no chemical deterioration or corrosion.

(7) Complete absence of corrosion will reduce the amount of service maintenance.

(8) With production type tooling, no special finishing operations are required to produce a clean aerodynamic surface.

(9) The avoidance of thin sections, consequent on the use of a lower density material produces a more robust design for handling.

(10) The good basic impact resistance of the material also lessens the chances of damage due to shock loading.

(11) The lack of electrical conductivity of the material largely eliminates the possibility of an electrical short-circuit.

(12) The low thermal conductivity of the material ensures that the heat soakage from the rocket exhaust gases is not sufficient to burn away a significant amount of wall material, and also gives an appreciable time delay to the transmission of aerodynamic kinetic heat to the rocket cordite.

(13) The comparatively low value of Young's Modulus for the material will avoid high thermal stresses being set up.

Early LOXing Blamed For *Atlas* Failure

The unsuccessful flight of the first full-range shot of the *Atlas*-A, a great setback for the ICBM program, was apparently plagued by the outstanding bottleneck of the U.S. current missile program. Unofficial speculation and analysis of the failure blame the extended length of time the LOX was held in the missile's tanks while awaiting launch.

The *Atlas* was two hours and 26 minutes late getting off the stand, which meant that the liquid oxygen was in the tanks for over three hours. Prolonged LOX contact with the tanks and engine system initiates a multitude of flow problems and weakening of the metal parts.

The 80-second flight was only half of the burning time of the two booster engines. At about 160 seconds, the boosters would have dropped away, leaving the sustainer to propel the missile for another 2½ minutes.

This was the 13th flight of the *Atlas* and the third full-powered flight. This made the second failure since the three-engined *Atlas*-A started its flight program.

Equatorial Launch Site Hinted For Satellites

The establishment of an equatorial launch site for the first manned orbital space vehicles and space station assembly operations, was indicated by Cmdr. Robert Freitag, USN, director of planning and development for the Pacific Missile Range.

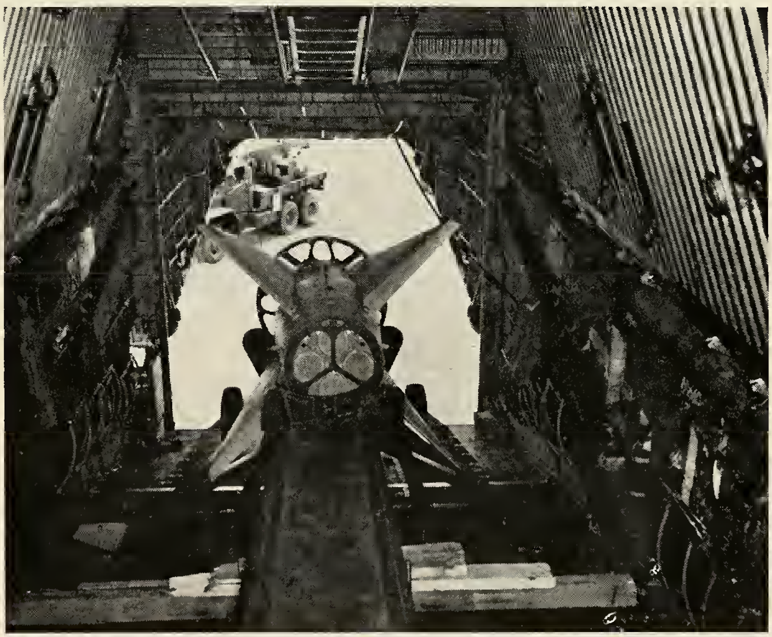
The Navy officer did not disclose any proposed location for such a site, but said that such a launching facility may be foreseen in the "not too distant future," if early steps in space exploration prove out.

Speaking before the Los Angeles section of the Institute of Radio Engineers, Freitag pointed out the advantages of an equatorial site would include a maximum utilization of the earth's rotational velocity. This would provide for a maximum payload for a given amount of fuel and allow a repetitive orbit.

"Once a satellite or a space vehicle is in orbit around the equator," said Cmdr. Freitag, "it will continually pass over the same series of stations without any regression of orbit incident to the shape of the earth."

This characteristic would minimize the number of tracking stations required for the satellite operation and permit maximum control, allowing recovery out of orbit or the joining of multiple vehicles in orbit.

Nike-Hercules Moves Fast



AIR TRANSPORT of *Nike-Hercules* missile is facilitated by handling ring on tail. Booster is shipped as a separate unit. Pacific orders have been issued for the first *Nike-Hercules* battalion. The 2nd Missile Battalion of the 71st Artillery Regiment, now stationed at Fort Bliss, has been assigned for duty to HQ US Army, Pacific.

Atomic Rocket Near Test Firing

Rover Expected to Back Proponents of Nuclear Power

by Alfred J. Zaehringer

The *Rover* Atomic Rocket is now nearing the test firing stage. If sucessful, it will back up AEC's contention that nuclear propulsion is the only real way of exploring space. Project *Rover* was undertaken by Los Alamos Scientific Laboratory on a fairly modest scale in 1955.

Work is spread over several of the laboratory's divisions, with most of the design work centered in N Division formed for this purpose. Leader of N Division is Raimer E. Schreiber with alternate leader R. W. Spence. LASL is working only on reactor-propulsion systems, not on the missiles or rockets they might propel aloft.

First tests of reactor systems at NTS (Nevada Test Site) are due late in 1958. Former Chairman Strauss has said that flight tests of rockets powered by nuclear systems are more distant than 2-3 years from now.

The atomic rocket engine, itself, will be tested in the "400 Area'" at Jackass Flats. Under construction are three major building groups with supporting roads, water lines, smaller buildings, railway line, electrical power net, and a propellant tank farm.

• **Buildings under construction**—*Control building area*—This is the major structure. Floor area is 9700 square feet. Houses controls and instruments for operating and recording tests. Construction is of reinforced concrete.

Other smaller buildings are: generator power house (auxiliary power only), administration building, two warehouses, cafeteria, plus a guardhouse. Control building area facilities are being constructed by J. A. Tiberti Construction Co. of Las Vegas on a $815,572 contract.

Test Cell Area. The cell itself will be of reinforced concrete and have an area of 1,680 square feet. The atomic rocket (illus.) will be housed on a railway flat car which can be backed up into the cell. The test cell is about 1½ miles from the control building.

The railway-mounted rocket can be moved by a remotely controlled locomotive operating on a railway line leading to the assembly-disassembly building. Near the test cell is located a tank farm which will contain the bottles of gaseous working fluid-helium or hydrogen. The Petroleum Combustion & Engineering Co. of Los Angeles has a $1,209,000 contract for construction of the test cell and tank farm.

Mechanical assembly-disassembly building. The Sierra Construction Co. of Las Vegas is building this facility under a $2,058,355 contract. The massive building is of concrete with 30,000 square feet of floor area where the atomic rocket can be assembled before test or torn down after test. The facility, therefore, will have to handle such operations remotely since radioactivity will be involved. Nearby will be a small office, warehouse, and guard building.

It is expected that the *Pluto* atomic ramjet program will utilize some of these test facilities.

• **Rocket Details**—Preliminary details on the atomic rocket earlier published in m/r (Aug. 4, 1958, p, 27) have been verified by AEC. AEC says that an atomic pile will be used to heat up a working fluid which can be exhausted through a nozzle to form thrust. As a starter helium will be used (because of its uniform behavior and inertness). Later hydrogen will be used. The first phases of the program will use the gaseous elements. Later, liquids may be used.

The pile, nearly circular in plan, will be mounted on a railway flatcar. The pile is several feet in diameter. Total weight of the test pile is 5-6 tons. Since this is a test rig, no attempt was made to cut down excess weight. Control rods will be used to regulate the amount of heat within the pile. No temperature figures were given but yellow-white heats have been mentioned. This corresponds to temperatures of about 3,000°F.

Presently-operating reactors are experiencing low lives of fuel elements at about 2,000°F. Therefore, AEC feels that it will lose fuel materials out the nozzle. Energy yield of such losses will be low-on the order of a fraction of a kiloton. "Spew-out," AEC says, will be less than a low-yield military weapon.

In addition to the exhaust products, neutrons will be generated which will be caught by shielding. However, the entire cell is expected to be "hot" for some time after test.

• **Thrust Low**—Since gaseous propellants will be used, the operating time will be restricted. Since the pile will take several minutes to come up to full temperature, coolant will have to be added during this time. This will also decrease the total full thrust operating time. Operating thrust at full power level is anticipated to be considerably less than 5,000 pounds. As a matter of fact, first tests will not be with gas fluid.

It is estimated that it will take about 6 months or so to play around with control rods and ways and means of bringing the pile up to temperature. Then, tests will swing over to the hot gas phase. Fall apart would be a more appropriate expression in the event of an uncontrolled test than the conventional blow apart with chemical rockets.

Getting the reactor, reactor materials, and fuel elements to maintain structural integrity will be a task—a task that must be solved if atomic rockets are to break the barriers now hovering just above the heads of chemical rockets. NACA sees the top for solids at about 270-300 in I_{sp} and something like 350 with liquid fluorine combinations.

The first *Rover* rocket may not get this high, but eventual hopes are for at least 400-600 in specific impulse. Big factor—to be determined at Jackass Flats—is whether a *Rover* type rocket can generate a significantly higher thrust on the basis of entire system weight as a super chemical rocket.

Right now, the radiation and temperature problems make the present atomic rocket inferior to the chemical rocket on a thrust-to-weight ratio. Theoretically, it looks good. To get anywhere near theory—well, that's an engineering problem for AEC.

. . . Plasma Jet Thrust Up

(Continued from page 11)

gine of Plasmadyne's should not be discounted. It could conceivably be powered for long-time flights by solar batteries. Some example of its potential is that a ten-pound thrust engine operating for one month could increase the velocity of a ten-ton vehicle by approximately 25,000 mph.

Other companies active in the plasma jet field are General Electric, where the free world's largest stabilized jet is used for re-entry simulation. Avco Research uses the plasma jet for re-entry simulation. Republic Aircraft recently announced that they had a magnetic pinch plasma engine in operation.

Probably the most comprehensive program in the country is being conducted by the Lewis Flight Propulsion Laboratory of NACA in Cleveland. Scientists there have been using plasma jets for high-temperature research for some time. These differ from those needed for propulsion in that their efflux is air, the gas needed for good aerodynamic heating simulation.

EIA Recommends Study Of Radio Spectrum

WASHINGTON—A government-established commission to make a long-range study of the entire radio spectrum and its administration has again been approved by the directors of the Electronics Industries Association. The action came at the conclusion of a three-day quarterly conference at the St. Francis Hotel, San Francisco, Sept. 16-18.

The Military Products Division of EIA, under chairman Sidney R. Curtis, received reports on military activities and announced two upcoming symposiums: A Military Procurement Practice Conference at the Statler Hotel in Washington, October 23. Assistant Secretary of the Army Frank H. Higgins will be the principal speaker.

Also scheduled, a symposium on the current activities of the Military services with regard to materiel support and related problems. This will be held at the Beverly Hilton Hotel in Los Angeles, October 24th.

Chairman Paul B. Wilson of the Prime-Sub-Supplier Relations Committee reported that the Small Business Administration had asked EIA to assist in the drafting of standard clauses for the protection of small manufacturers and sub-contractors. The committee also discussed plans for preparing a booklet of practical interpertations of governmental directives having to do with relations between prime and sub-contractors.

The Board of Directors approved a switch of the 1959 West Coast and New York meetings. The September Quarterly Conference will be held in New York, and the late November meeting will be held in Los Angeles.

Rese Engineering Adds Digital Department

Rese Engineering Inc., Philadelphia, has formed a Digital Systems Engineering Department, and has elected new officers for the parent company. Rese manufactures a line of instruments ranging from power frequency flux-reset core testers to millimicro-second programmed current pulse generators.

The new department will provide complete services from consultation to systems assembly of special data-handling equipment such as magnetic core and drum memories, buffers, machine tool control and digital system simulation.

Former company president Jerome . Rovins was elected board chairman and secretary; Richard O. Endres, previously secretary-treasurer, was elected president; Lowell S. Bensky was appointed vice-president for the new department.

Regulus II Takes Off At Sea

U.S. Navy

BACKED OUT OF ITS HANGAR on to deck of submarine Grayback, Chance-Vought Aircraft's *Regulus* II is readied for firing at a land target some 200 miles away.

AIMED AND READY to take off, supersonic missile gets final checkout. Wings and rudder can be folded to facilitate storage in submarine hangar.

UNDER FULL POWER of its Aeroject booster rocket, missile is on its way. Blast hides aft part of sub. A GE turbojet engine supplies thrust after booster drop-off.

Like a mobile . . . the missile market is made up of separate parts and different elements. Many industries and thousands of companies compose the mobile missile market. Aircraft companies build missile frames and prime systems. Automobile companies manufacture missile systems . . . a cereal company builds missile subsystems.

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propulsion engineering

by Alfred J. Zaehringer

Rover atomic rocket will start out as a gaseous working fluid system. Helium will be first, then a switch to hydrogen will be made. Gas will be stored in bottles. Size of bottle farm will dictate thrust level and operating time. Entire static rig weighs 10-12,000 pounds and is nearly circular. Diameter is measured in feet. Big problem will come from loss of gaseous fuel elements migrating from pile, spewing out of the nozzle. Neutrons will also be emitted. Total yield of test *Rover* is a fraction of a kiloton. *Rover* with satellite or ICBM capabilities will be less than five kilotons energy equivalent.

The "ultimate" chemical system—fluorine and hydrazine—has been run in a small rocket engine. Maximum theoretical performance is 315 seconds. The Air Force figures that such a combination in a *Thor* or *Jupiter* could place a satellite around one of the planets. All seem to agree, however, that fluorine and hydrazine will be nasty to deal with operationally. Chemical "fallout" of toxic fluorine compounds may even dictate use of conventional chemical boosters for surface operations or exclusive use of fluorine in space.

Hydrazine decomposition flames are being investigated by the University of Leeds in England. Burning velocity appears to be independent of pressure and is about 46 in/sec. In small diameter tubes, hydrazine less than 88% concentration will not burn.

Powerful fuel, hydroxylamine, is being produced by Hungarian research teams. Yields of 90% or more have been attained in Raschig synthesis. USSR has been investigating the use of this and other nitrogen fuels. Many propellant applications have been predicted for NH_2OH. NACA, for example, calculates performance of 240 seconds in stoichiometric combination with LOX or 246 with LOZ. Having about the same molecular weight as hydrazine, hydroxylamine has a higher freezing and boiling point but is less toxic. Large-scale production in US may be near.

Nitrogen fuels and propellants are arousing great interest. England's Explosives Research and Development Establishment at Waltham Abbey has reported work on the combustion of 2, 3 and 1, 4 butanediol dinitrates and some aldehyde-nitrogen dioxide mixtures. Bell Aircraft is concerned with the detonatability of fuming nitric acid-heptane-nitrogen mixes. Hercules Powder Co., a big solid rocket firm, is getting into the liquid act by constructing a nitrogen tetroxide plant at Hercules, Calif. N_2O_5 is being pushed as a storable replacement for LOX.

Pre-packaged liquid rockets by Reaction Motors uses a hypergolic combination. This leads to the belief that nitric acid or a nitrogen oxide is to be used as the oxidizer plus an amine or hydrazine derivative for fuel. Maximum I_{sp} might be on the order of 225 seconds. RMI has a $1 million contract for application of the storable liquid in the *Guardian* air-to-air rocket.

Turbulent combustion studies are still underway. Japan, USA, and the USSR were among those reporting at the Sixth Symposium on Combustion held at Yale University. The Japanese concluded that turbulent combustion is a mixing process while NACA showed that the turbulent pressure exponent was about 0.3 greater than for laminar burning. Moscow research suggests that it is possible to decrease the total flame length by decreasing burner tube length or adding ignition sources.

British *Thunderbird* Fully Mobile Weapon

The English Electric Thunderbird SAM, adopted by both the British Army and the Royal Air Force, has been developed into a fully mobile weapon system comprising ground radar, launchers, fire control units and associated test equipment.

The *Thunderbird* is transported to its launching site on a mobile launcher-erector. The wheels on the launcher are easily detachable, enabling the launcher to be deployed on rough ground, making final adjustments with permanent levelling jacks.

The *Thunderbird* has been fully proven in tests at the Aberporth, Wales, and Woomera, Australia, ranges. Several hundred have been fired to date.

The bird used a two-stage propulsion system comprising wrap-around boosters and a sustainer motor. While in flight, the missile is steered to its target by control fins. A semi-active guidance system is used which is designed to operate with existing early-warning radar. Powered by a solid propellent rocket motor, the *Thunderbird* homes on radar pulses transmitted from the ground.

Dimensions of the *Thunderbird* are: length 21 ft. 10½ in.; wing span, 5 ft. 3 in.; control fin span, 5 ft. 3 in.; center section diameter, 1 ft. 9 in.; angle of wing sweepback 45 deg. Unofficial sources quote the following additional data: launching weight, 3,300 lbs.; max. speed, 4,000 ft. per second; range, 35 miles.

Missile Firm's $10 million Debenture Oversubscribed

Testifying to the strength of missile-oriented corporations in the eyes of the business community was the reported oversubscription last week of a $10 million 4⅞% subordinated debenture issue by Garrett Corp.

The offering, made Thursday, was quickly oversubscribed, and the books closed. Late in the same afternoon, it was reported, some Wall Street dealers were quoting the new debentures at 102¾ bid, and 103½ asked.

According to the terms of Garrett's offering, the new debentures are convertible—prior to Sept. 15, 1968, into common stock at the rate of one share for every $46 of face amount of the debenture. Proceeds of the sale will be used by the company in order to repay $9 million of short-term loans. The remainder will be used for expansion of facilities.

Garrett, with home offices in Los Angeles, Calif., is heavily involved in missiles through its AiResearch Companies.

Top Brass

Frank H. Erdman has been named

president of Kett Technical Center, Inc. research and development center of U.S. Industries, Inc. Erdman succeeds **Karl Schakel** as president of the U.S.I. operation, it has been announced.

Gerald T. Halpin is now vice president of Atlantic Research Corp., Alexandria, Va. He will also continue as the company's manager of operations.

Donald J. Guth was appointed comptroller of Solar Aircraft Co., San Diego, Calif. Guth was plant comptroller at the company's Des Moines, Iowa, facility.

Roy J. Benecchi has been elected senior vice-president of Lear, Inc.; **James L. Anast, James P. Brown, K. Robert Hahn** and **Joseph M. Walsh** were named vice-presidents.

Larry Blythe was elected treasurer of Beattie-Coleman, Inc., Blythe's appointment was the second new corporate election this month. **J. A. Wilcox,** sales manager, was appointed vice president. Blythe was an accountant, assistant to the controller, division controller, general manager of the West Coast Division, and assistant to the president for Standard Products Co. of Ohio. He joined Beattie-Coleman in 1956 as controller, and served as assistant secretary.

Fred Spiegel has been elected president of Titanium Fabricators Inc., Burbank, Calif. Spiegel, founder of the company and former executive vice president, replaces O. M. Bell, resigned. Other board actions included the reelection of **Dr. Morris Asimow,** professor of Engineering, UCLA, as vice president; and appointment of **N. Ray Johnson,** Los Angeles contracts consultant, to the Board.

Training

George A. Davies, senior instructor for Rocketdyne at the Ordnance Guided Missile School at Redstone Arsenal, has been transferred to California where he will supervise the *Atlas* training program for Rocketdyne.

James Jordan, chief of Rocketdyne's components modification and repair laboratory at Redstone Arsenal, will now be in charge of a similar CMA laboratory at the Air Force Missile Test Center, Florida.

Dr. W. F. Faragher has been appointed assistant to the president, Temple Univ. Research Institute. The Institute does extensive research in the fields of chemistry at high temperatures, propellants for missiles and specialized organic chemistry.

Sales

George A. Hagerty has been promoted to manager of the marketing section of the General Electric Computer Department. He has been manager of the product planning and marketing research subsection since joining GE in 1956.

Robert J. Muth, former Los Angeles branch sales manager for Exide Industrial Division of the Electric Storage Battery Co., has been transferred to the Philadelphia headquarters of his firm as field sales manager, a newly created position.

James G. Gelder was appointed marketing manager, electronics division, Diamond Power Specialty Corp. He will have responsibility for all sales, service and application engineering activities of the division, which manufactures Diamond Industrial Television and other electronic products. Gelder was formerly sales manager, Process Control Systems, for Philco Corp.'s Government and Industrial Division in Philadelphia.

J. W. "Jack" Swan has been named representative for the Chicago district, Parker Seal Co., division of Parker-Hannifin Corp. Swan's new duties include cooperative work with the Parker o-ring distributors.

F. W. Lloyd was elected to the position of manufacturing vice president of the Northrop Division, Northrop Aircraft, Inc. **Richard R. Nolan,** formerly in that post was elected corporate vice president and general manager of the division.

Charles Vickery has been named manager of the Los Angeles marketing office of the Defense Products Division, Fairchild Camera and Instrument Corp.

William L. Vaughan, veteran of 18 years in the purchasing field, has been appointed manager of purchasing at the San Diego plant of Solar Aircraft Co., succeeding **Russell L. Stevens,** the company announced.

W. V. Warner was appointed to

the newly-created position of general sales manager of Ford Instrument Co. He was formerly manager of Air Force Contracts, and prior to this assignment functioned as head of the Ford Instrument Company's Mid-West Engineering Office in Dayton, Ohio.

Robert A. Marshall was appointed sales manager of Federal Electric Corp., Paramus, N.J., service organization of International Telephone & Telegraph Corp.

James K. Story has been named to fill the newly created post of sales manager of transducers and systems for Donner Scientific Co. Story was formerly an applications engineer in the transducer and inertial systems division of Donner.

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