SEPTEMBER 1, 1958

missiles and rockets

A MAGAZINE OF WORLD ASTRONAUTICS

News and Business Edition

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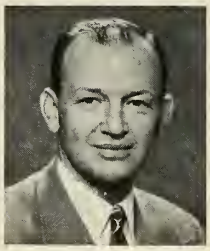
HIGH TEMPERATURES

Key to Missile Performance

by John V. Long, Director of Research, Solar Aircraft Company



HIGH TEMPERATURE presents a formidable barrier to the advancement of missile technology. Present defense requirements call for temperatures ranging from —460F to way beyond the limits of known material capabilities. New and planned developments in atomic power and space flight will mean temperature levels far outside of man's current experience.

The temperatures encountered in missile development produce startling phenomena. They are part of today's problems—affecting the very concept of the new generation of high-Mach aircraft and missiles. Laboratory experiments have produced temperatures in the million degree range. Nuclear fission and fusion reactions produce temperatures even higher.

In the all out attack on the thermal barrier, scientists and material researchers are probing the four corners of the periodic table. The goal is to develop a practical solution to the thermal problem.

The highest melting material reported is a combination of the carbides of tantalum and hafnium. Its melting point is about 7200F. Difficulty of fabrication, however, precludes its use in present day applications. And 7200F is at the cold end of the high temperature spectrum. It is obvious, then, that a solution to the materials problem cannot be based on melting point alone. Man will never beat the thermal thicket by hitting it head on. Success will come only when he has devised new methods of ingeniously avoiding it.

There is an immediate need for a combination of materials and designs which will withstand temperatures of 2000F in jet engines —and at least 20,000F for re-entry vehicles.

In an all-out effort to satisfy some needs, materials researchers are re-evaluating available elements, combinations and processes. New techniques including vacuum metallurgy, zone refining, powder metallurgy, dispersion hardening and others are providing improved metals and alloys. Molybdenum, tantalum, rhenium and tungsten show promise because of their high melting points. But no known material has the refractory property or structural integrity to withstand the temperatures that will be encountered in tomorrow's "hotspeed" aircraft and missiles.

Extreme temperature resistance is not just a materials problem, but a problem of interaction between environment and the material of the vehicle. Designers must look at the system as a whole and design "around" high temperature problems. The use of heat sinks, ablation and transpiration cooling are partial solutions. Additional improvements will come with more research.

For the present we must learn to use available materials and, through design, provide the balance of the solution. We have by no means exhausted present material capabilities. Researchers must continue to refine and extend the high temperature performance of a variety of materials.

A comprehensive knowledge of both metals and non-metals and their physical characteristics in extreme environments is necessary for successful applications. The ability to fabricate useful structures is obviously a major criterion.

Best results will be obtained through a materials systems concept. This involves close coordination among raw materials suppliers, users, materials engineers, designers, test engineers, fabrication specialists and quality control engineers.

The team effort must be enthusiastic—and it must be dedicated to ultimate success through hard work.

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HYDROSPINNING AND CONTOUR FINISH MACHINING

As the technology of missile machining progressed missilemen looked forward to the many advantages of combining hydrospinning and contour finish machining. But the technical obstacles were great and no one dared the expensive risk of this research.

Diversey tackled this technical research and now after many months of experimentation Diversey has solved this problem. Above you see the successful production line results. You are looking at a Diversey hydrospun nose section for an IRBM being contour finish machined to extremely close tolerances.

This advance of Diversey is important to the missile industry because of its flexibility, because it saves valuable metal, and because it sharply reduces cost.

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

SEPTEMBER 1, 1958
VOL. 4, NO. 9

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

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editorial viewpoint . . .

The tremendous glare of publicity in which U.S. missile experts must work while the nation tries to catch up with Russia in the race for space has brought much serious criticism of the nation's press.

Why must the U.S. advertise its failures to the world; why must it lose face in the eyes of its allies and potential supporters, and by the same token, strengthen the Russian claims that their system can outproduce a free economy? Isn't the insatiable curiosity of the U.S. press due for curbing, on the ground it injures national policy and prestige?

This kind of criticism—unfortunately coming sometimes from intelligent and highly-placed individuals—concerns us greatly. This publication has an even greater interest in such publicity than does the general press. And like all members of a free press, it has an obligation beyond that to its own specialist readers: A duty to keep the general public informed on matters in which m/r has special competence.

The facts and the reasons should be clear in everyone's mind: True, the Russians do not announce their failures, only their successes. But it is also true that Mr. Kruschev's captive taxpayers and servile press have no right to know the truth—and no means of obtaining it.

But the right to know the truth, and the equal right to know what's being done with taxpayers' money are vital to the conduct of a democratic form of government. More, the right to criticize, to demand an accounting from any official—no matter how high his position—are more than rights, they are duties. And the public press—asking questions for, and speaking for the ordinary citizen—must assume these duties. The business press, such as ourselves, must add still another duty: If the science of missilery, for a specific case in point, is to advance, its practitioners must know at once what has been done, what concepts were involved, and what happened.

It is of course a sad thing that the whole world is told of our plans and—in the event of an attempt at a moon shot—of our failure. But it is also vitally important that our own citizens know of our plans, and also know that there is no magic button called "American know-how" that can be pushed. It is of equal importance that our scientists and technicians know as much as possible about why the failure occurred, so that they can see to it that it does not happen again.

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Dr. Leonid I. Sedov, Soviet space satellite expert and well-known scientist. He holds the dual posts of Academician and Chairman of the Commission of Astronautics, Academy of Science, USSR. (See p. 10).

STRETCH

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INDUSTRY COUNTDOWN

GOVERNMENT

DOD control of security continues to tighten with the announcement that **Security Review Branch, Office of Information Services, USAF** has been abolished and its functions transferred to **Murray Snyder's Office of Security Review** . . . Because of the fear that rising costs will force the elimination of "at least" one major weapons system from the Air Force program and possible changes in Navy plans, **the Pentagon is busily engaged in a major reprogramming** for FY 1959 . . . **Newest of ARDC's 22 liaison offices** has been opened at the Naval Explosive Ordnance Disposal Technical Center, Indian Head, Maryland. The center is the primary R&D location for Army, AF, and Navy in providing techniques and devices for making safe and disposing of all types of explosive ordnance materials . . . On orders of the Assistant Secretary of Defense, Research and Engineering, **the Defense Metals Information Center has been established** at Batelle Memorial Institute in Columbus, Ohio. In addition to government agencies, defense contractors and other suppliers may use the services of the Center, which will collect and disseminate information on titanium, beryllium, refractory metals, high strength alloys for high temperature application, corrosion and oxidation resistant coatings and thermal protection systems. Information will be made available to the general public through OTS, Commerce Department . . . Two bills (H.R. 8711 and H.R. 8948), under study by the House Armed Services Investigation Subcommittee, will be presented to the 86th Congress. **Both propose amendments to the procurement act** and are a partial result of hearings held by the subcommittee in July.

EXPANSIONS

Lear Inc. broke ground for its 172,800 sq. ft. plant to be used for manufacture and assembly of missile sub-systems including gyro platforms for the *Bomarc* and *Nike-Zeus*, and servo control units for the *Sergeant*. Completion is scheduled for May, 1959 . . . Utah Governor George Clyde and Lt. Gen. C. S. Irvine witnessed opening ceremonies for **Litton Industries'** new 60,000 sq. ft. tube plant. Eventual employment is seen at more than 600 . . . **Westinghouse** has formed an Advanced Weapons Systems Planning Group to study over-all requirements of future military activities and to plan an integrated approach to the "weapons systems of tomorrow." Named as director was Allan Chilton, formerly chief engineer for the company's gas turbine division . . . **Epsco Inc.,** of Boston opened a new West Coast division. To be known as Epsco-West, the new division will design, produce and market the Epsco data processing and control systems . . . **Ford Motor Company's** Aeronutronic Systems Inc. started construction on a 115,000 sq. ft. computer development facility in Newport Beach, Calif. Occupancy is scheduled for August of next year . . . **The Branch Mfg. Co.** division of General Bronze Corp. announced the expansion of its magnetics program to include the manufacture of magnetic amplifiers and systems . . . **North American Aviation** has formed Aero-Space Laboratories at its Missile Division. Creative research will be the principal function of the new unit. One of the first steps to be taken will be to set up a satellite information center for analyzing data and publishing significant findings . . . **United Aircraft** is seeking rezoning of a 206-acre tract in Greenwich, Conn. for consolidation of it's recently acquired Norden Division.

PROJECTS

Project *Squid*, started over 12 years ago by the Office of Naval Research and managed by Princeton University, has expanded its work in propulsion basic research to include space propulsion . . . Los Angeles division of **North American** has been awarded a contract by the **Firestone Missile Division** for the manufacture of stabilizing fins for the *Corporal*. NAA will produce the metal honeycomb fins at Torrance, Calif. . . . The first military procurement of packaged liquid rocket engines was awarded recently to **Reaction Motors division of Thiokol.** The engine, which is an integral unit including propellant tankage, thrust chamber and all necessary components for operation, is said to be for an air-to-air missile (most likely *Sparrow* III) because of its small size. RMI is working on other size packages for future missiles of all sizes. Great advantage is that none of liquid's high thrust is lost even though engine can be stored in the same manner as a solid-propellant . . . *Polaris* mockups will be tested in a sort of "reverse slingshot" being constructed by **U.S. Steel** at the San Francisco Naval Shipyard. Test program, known as "Project Skyhook," will catapult concrete dummies in the air and catch them at the top of trajectory with steel cables to prevent the mockups from falling into the bay . . . **Western Electric** is being mentioned as the likely manager for the Cambridge Air Research Center when it is turned over to industrial management . . . **Marquardt Aircraft** reports that its new Astro Field Laboratory near Saugus, Calif. is now in operation. Work there is concerned with advanced combustion and aerodynamics . . . First of the 24 *Matadors* ordered by the West German Government are not likely to be delivered before mid-1960.

WASHINGTON COUNTDOWN

Despite persistent rumors to the contrary, neither Boeing nor the Martin/Bell team has the edge in the competition to nail down the *Dyna-Soar* program. Though Boeing frequently has been reported out in front, the large amount of Air Force money spent with Bell in such work, and the broad background of the Martin/Bell team, cannot be discounted. The dual effort points up the recommendations of the House Committee on Government Operations, which recently reported in favor of controlled parallel effort in the preliminary stages of such projects.

And then there is always the possibility that the Air Force will decide to choose the better elements from each team and start on the R&D cycle with a completely reshuffled new team, comprising partners from both the old teams. In any case, when the program shakes out, don't look for any drastic reductions in any one team member's efforts. The time will then be about nigh for the inevitable follow-on to *Dyna-Soar*.

With the recent lunar probe failure and half-announced plans for September and October attempts, moon gazers are almost all looking to the Air Force. However, don't discount the Army. Last week, a top Army spokesman told m/r that the Army is prepared *now* to carry out any schedule of moon probes called for. Rumors around town were placing the earliest date for an Army try as sometime in October, but recently, the date has been upped to December.

The Committee for Economic Development has published a pamphlet called "The Problem of National Security—Some Economic and Administrative Aspects." The committee, headed by James F. Brownlee, New York investment banker, analyzes the current threat to U.S. security. It makes some pretty strong recommendations: Total dollars for defense should be sufficient to limit the choices between various types of military and other programs; a sharp distinction should be made between what people are willing to spend for defense and what they are able to spend without weakening the economy; the whole weapons system concept needs a new look, and choices should be made on the basis of more information and more systematic investigation; R&D procurement practices should be revamped to give contractors more discretion; and efficiency should be increased in defense management.

The pamphlet goes into somewhat greater detail about each of the broad recommendations. Essentially it recommends an end to the normal "business as usual" philosophy.

Speaking of weapons system concepts, the House Armed Services (Rep. Hebert-D-La.) Investigation Subcommittee will hold hearings, probably in November, on "soaring costs" involved in this area. Specifically, the probe will dig into the relationships between prime and sub-contractors and the "team" concept of sharing weapons development, although Congressional spokesmen say that all phases will be explored. Also due for inspection is the subject of government-owned machine tools for private industry. Emphasis here will be on methods of inventory and dissemination of inventory.

And you can depend on the Hebert group taking a much longer look at the utilization of a large number of ordnance and other unused government plants to prevent construction of duplicate new facilities for private contractors. Sort of a follow-on to the Indian Head (Md.) Naval powder factory probe that the committee conducted last month. The charge was that Navy paid Aerojet-General several millions of dollars for solid-propellant production facilities, while ignoring its own plant, which had large-grain capability. Aerojet, by the way, was exonerated.

Sedov: Man In Space Is Next Soviet Goal

• Academy of World Astronautics Proposed

• Confusion Mars Biggest International Space Meet

By Erik Bergaust

AMSTERDAM—To put man in space soon is the Soviet's immediate goal. Dr. L. I. Sedov (see cover picture) and K. F. Ogorotinikov told mr/r editors here during the ninth International Astronautical Federation Congress.

Biggest Russian delegation ever to attend an IAF Congress was made up of top Soviet astronautical scientists. It included: Academician L. I. Sedov, chairman; Dr. K. F. Ogorotinikov, Professor V. I. Krassovsky, Dr. V. G. Kostomarov, delegation secretary. Also attending from the Soviet union were four Moscow science teachers (see box).

The Russian delegation, which swept in from Moscow in a plush TU-104 jet, was the center of interest from the large world press group covering the IAF meeting.

In an exclusive interview with m/r, Professor Ogorotinikov, famous Leningrad astronomer, said: "We are pushing the man in space program hard. This is the big thing; we are making fine progress. The re-entry problem has been solved."

Asked whether the Soviet space attempt would involve a live animal or a recoverable satellite, the Russian delegate said such a deed "would be part of the program."

Considerable confusion resulted from contradictory stories in the various press reports emanating from Amsterdam about Russia's moon rocket program.

One such story quoted Dr. Sedov as saying: "We are going to wait for the result of American experience on a moon rocket. Time will show how long we are prepared to wait."

Another report, based on "reliable Russian sources in Amsterdam" indicated that "the communist will hit the moon any day."

But in an interview, Dr. Sedov told m/r editors: "These newspapers interviews make me sick. Why not wait until after our next shoot?"

Ogorotinikov said, "Why boast now? Why not wait until after we have accomplished something?"

The Russian delegates were constantly trailed by newsmen and photographers, but said little or nothing about their space program.

Dr. Sedov added that he had been "somewhat" misquoted in m/r at the last IAF congress in Barcelona, when this magazine reported that Russia was putting full emphasis on a full fledged moon rocket program. "This," Dr. Sedov said, "is only part of our story."

Dr. Sedov was offered the presidency of the IAF for 1959, but said he would rather wait a couple of years.

• **U.S. has top group**—The attention the Russian delegation commanded, however, obscured the very high caliber of the U.S. delegation. Not only was the U.S. quantitively, the best represented nation at the IAF, but qualitywise was undoubtedly tops. Among the most prominent Americans were ARPA's chief, Roy W. Johnson, Dr. Herbert York, Dr. Theodore Von Karman, Dr. Joseph Kaplan, Dr. Richard Porter, Dr. S. Fred Singer, Dr. Hubertus S. Rughold, Robert P. Havilland, and Dr. Fred L. Whipple.

Observers agreed that the quality of the American papers presented at the Amsterdam session was higher than those given at last year's IAF congress in Barcelona. It was clear, however, that security consideration had weakened the U.S. contribution.

•**Confusion reigns**—Despite the fact that nearly all the delegates planned to use some of the time in Europe to visit the British Airshow in Farnborough, some took time out from the Amsterdam sessions to make sight-seeing trips to Brussels and the World Fair, and IAF officials were much concerned that participants might not appear at sessions.

Like most of the previous IAF Congresses the Amsterdam meeting was dominated by confusion and frustration as far as the organizational and business-meeting aspects was concerned. Despite tremendous effort from IAF and Andrew G. Haley, the meeting was a flop from the press viewpoint. There was no coordination with the press and no reprints of papers available.

Many top reporters, who had traveled thousands of miles to attend the meeting, left after a couple of days in disgust. Delegates, too, complained bitterly about the organization or lack thereof. Above all, interpretation facilities were lacking, and for the vast majority of the delegates who were not linguists, much of the value of the sessions was lost. "The IAF must realize that the world is changing, and the IAF must change with it," one prominent U.S. delegate told m/r.

• **Block school proposal**—President Andrew G. Haley told m/r he is fully aware of the need to update IAF to take account of the tremendous devel-

Top m/r Coverage For IAF Congress

The Ninth Congress of the International Astronautical Congress was attended by two m/r editors, two of its staff of contributing editors, and three members of the publication's Editorial Advisory Board.

On hand in Amsterdam last week were: Erik Bergaust, editor; Anthony Vandyk, European Director; Frederick C. Durant III and Dr. Hubertus Strughold, columnists and contributing editors; Dr. Wernher von Braun, Dr. Eugene Saenger and Robert P. Havilland, editorial advisory board members.

Von Braun Injury Causes Concern

The U.S.' Dr. Wernher von Braun found himself accused—through no fault of his own—of "sabotaging" a meeting of the Amsterdam IAF meeting, when he failed to deliver a scheduled paper, or to appear at a swank reception given by the City of Amsterdam at the Rijksmuseum.

Reason was a painful one: Van Braun fell in his room, while bending to pick up a paper from the floor. Physicians believe he suffered a slipped spinal disc in the accident.

Well enough to talk to m/r, though obviously in pain, he smiled at the talk his absence had occasioned. And he added a point of great interest: "As everyone knows, we tried to keep it a big secret. But we (Army) will try our moon-shoot in October."

Memo to: U.S. Educators

Pointing up the Russian space flight education plan was the presence at the IAF Congress of four educators as members of the eight-man Russian delegation.

They were: Dr. P. V. Pshenichsy, Dr. V. V. Zlaoga, Dr. V. Y. Likhusin and Dr. P. V. Sporojenko.

Their presence lent point to the fact that no other nation is pushing education in space flight. Dr. K. F. Ogorotinikov told m/r that the Academy of Sciences is establishing a new university in Siberia. Part of the new unit's work will be in astronautics.

opments in Astronautics that have taken place in recent years, but he is having "a hard time" carrying through these changes because of the short-sightedness of certain delegations.

Sweden's delegates, for example, were doing their utmost to block Haley's proposal for the establishment of an International Academy of Astronautics. This would be a research institute charged with the task of achieving space flight for non-military purposes.

The Swedes turned their thumbs down in this idea because they were afraid that international astronautical research would be concentrated in one country, rather than be spread all over the world. Haley's concept of an Astronautical Academy, however, does not call for any concentration.

The British are also against the idea of an Academy, because they consider that IAF is not economically capable of carrying on such an ambitious project.

However, Haley told m/r the Academy has been assured the backing of many of the world's most important astronautical nations, including the Soviet Union.

• **New task for IAF**—The extent of which IAF is achieving heightened stature is reflected in the fact that the International Radio Consultative Committee of the International Telecommunications Union has agreed to investigate an IAF proposal concerning the allocation of frequencies to space-circling vehicles and related problems.

These six points are to be studied by the committee:

1) What frequencies are especially suitable for penetration of the layers of the earth's atmosphere?

2) What are the influences on these frequencies of the hour of the day, season, the geographical location and solar activities.

3) What deviation in propagation direction can be expected by the penetration of the ionosphere?

4) What—if any—will be the differences in propagation between ingoing and outgoing signals relative to the earth?

5) Are special phenomena to be expected that do not occur in transmission between two points on earth?

6) What is the possible influence of the trophosphere on wave propagation to and from extraterrestial objects?

• **Propaganda war**—During the IAF congress m/r learned that the Russians are planning to give 500 satellite tracking telescopes to foreign countries, including Argentina and Poland, to encourage the advancement of astronautics. The Soviet give-away-program undoubtedly will be accompanied by maximum propaganda once it gets underway.

The United States has a program to counter this Soviet hand-out-scheme, m/r established in Amsterdam. However, red tape has bogged down the American program, which calls for handing out some 400 satellite tracking telescopes. "Washington has a heavy responsibility for this duty in a program where time is of utmost importance," one U.S. delegate said.

New member societies admitted to IAF during the Amsterdam meeting were from the following countries:

Japan, Canada, Nationalist China (after the Soviet delegation had tried to block it), Greece, Israel and Bulgaria. India, Hungary, and Czechoslovakia were given status (further details of the IAF congress will appear in the Sept. 8 issue of m/r).

British Setting Up First IRBM Units

The first British IRBM unit has been set up by the Royal Air Force.

A squadron of the Bomber Command will get its first missiles shortly, according to information at the Amsterdam IAF meeting. First activity for this unit, to be commanded by Group Captain F. A. Wilan, will be to improve test installation, and train personnel. USAF technical personnel will be attached to the British unit during the training period.

Four Members Added To Senate Space Committee

Four senators—Margaret Chase Smith (R-Me.), Carl Hayden (D-Ariz.), Robert S. Kerr (D-Okla.), Jacob K. Javits (R-N.Y.) won places on the Senate Space Committee, bringing total membership to 15, and assuring permanent status for the committee.

Other members of the Committee are: Sen. Lyndon B. Johnson (D-Tex.), chairman; Sens. Richard B. Russell (D-Ga.); Theodore F. Green (D-R. I.); Warren G. Magnuson (D-Wash.); Clinton O. Anderson (D-N.M.); Stuart Symington (D-Mo.); Styles Bridges (R-N.H.); Leverett Saltonstall (R-Mass.); Alexander Wiley (R-Wis.); John W. Bricker (R-Ohio); Bourke B. Hickenlooper (R-Iowa).

Hydrogen Fusion Engine Development Underway

VANCOUVER, B.C. — Research aimed at developing a fusion engine, which some scientists have theorized could provide power for a space flight through the entire solar system, was described here last week at a meeting of the American Physical Society.

Nicholas Christofilos, physicist at the University of California Radiation Laboratory, Livermore, described the construction of an Astron—a device being developed to test a new approach to the generation of the monuclear power.

The experimental Astron, being built at UCRL, will use relativistic (high energy) electrons of an energy of 3,000,000 (3-mev) electron volts to test the theoretical principles. As part of the AFC's Sherwood Project, the Astron is not expected to produce power itself, but eventually to produce low cost energy from the fusion of hydrogen nucleus.

Urey Appointed Member of Space Science Board

BERKELEY, CALIF.—Dr. Harold C. Urey, University of California, has been named a member of a 16-man Space Science Board which will "survey the scientific problems, opportunities and implications of man's advance into space," the National Academy Science has announced.

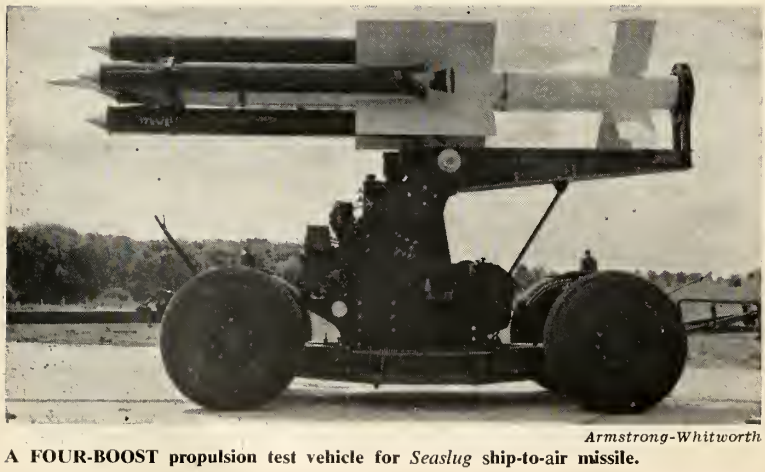
Dr. Urey will head the committee on the Geochemistry of Space and Exploration of the Moon and Planets.

The work of the new board will be coordinated with the National Aeronautics and Space Administration, the National Science Foundation ARPA and other appropriate organizations.

SWEDISH Type 304 air-to-surface missile mounted under aircraft wing.

Granskad Tillystyrkes

SWEDISH Type 315 naval surface-to-surface missile ready for launching.



Armstrong-Whitworth

A FOUR-BOOST propulsion test vehicle for *Seaslug* ship-to-air missile.

Sweden . . .

Sweden is equipping its Saab-32 Lansen all-weather attack aircraft with a recently-developed missile, the Type 304.

A rocket-powered air-to-surface missile, the 304 is reported to utilize all-weather guidance. The missile was developed by the Swedish Guided Weapons Bureau, and is being produced by the Swedish Air Force's production facilities, as well as by civil subcontractors.

The Lansen is armed with two of the type 304 missiles, and the combination is said to comprise one of Sweden's best weapons systems. The 304 has been under development in Sweden since 1950, and the first flight test of its structural components was conducted in 1954. Initial tests of the complete weapon began in February, 1955.

Another defense missile unveiled by Sweden is the type 315, a naval surface-to-surface missile for use from destroyers. The 315 is a jet-powered missile using four built-in booster rockets, but information released did not specify the type of jet engine as a sustainer.

Australia . . .

A new Australian anti-tank missile, named *Malkara,* has been ordered by the British government. The radio-controlled SSM weighs 200 pounds. Australia has sent 30 *Malkaras* to Britain for acceptance tests. The British production order involves the supply of 150 of the missiles. The unit price of the *Malkara* is about $60,000.

England . . .

The latest version of the Armstrong-Whitworth *Seaslug* surface-to-air naval missile uses a solid-fuel sustainer rocket, instead of the previously employed bi-propellant system with nitric acid. A *Seaslug* propulsion test vehicle with four booster rockets will be shown at the Society of British Aircraft Constructors' Show at Farnborough in the first week of September.

The *Seaslug* was developed by Armstrong-Whitworth in association with the following companies: E.M.I. Engineering Development; General Electric Co.; Sir George Godfrey and Partners; Imperial Chemical Industries; McMichael Radio; Metropolitan-Vickers; The Sperry Gyroscope Co.; John Thompson Conveyor Co.; Vickers-Armstrongs (Aircraft).

Earth to Moon in 80 Hours?

A manned vehicle will make the trip around the moon in 80 hours, possibly as early as 1963.

That's the conclusion of D. M. Cole and D. E. Muir of The Martin Company's Denver Division, in a paper presented at the American Astronautical Society meeting held recently at Palo Alto, Calif.

Cole and Muir see several ways in which the project could be approached, with practically the same hardware as would be used in a manned orbital flight, which would precede the circumlunar flight.

One method would use six to eight booster rockets to carry extra propulsion stages into orbit, to a rendezvous with the manned vehicle so that it would be able to make the longer trip.

An alternate method would use rocket stages in a cluster to make a single large booster, which would be combined with the orbital rocket and space cabin to make up the circumlunar configuration.

This method would require a theoretical three-stage rocket with stages weighing 160,000, 40,000 and 10,000 lbs., scaled up by a factor of four to make a larger, also theoretical, rocket. The four first stages would be clustered to a common engine of 1.25 million pounds of thrust and a single first stage would make the second stage on the larger rocket. The third stage of the big rocket would be a second stage from the smaller.

With such a vehicle, Cole and Muir estimate that the payload can be 20,000 lbs. Total weight would be 859,000 lbs and the thrust/weight ratio would be 1.45.

• **Computer does figuring**—A number of orbits were programmed for an IBM 704 computer, and from these, trip time was calculated as a function of initial velocity.

The accuracy requirement was found not to be as stringent as is usually thought. Actually, an uncorrected trajectory with an error no greater than plus or minus six minutes of arc is adequate. This did not take in account the fact that, on a manned trip, corrections could be made in flight with small expenditures of propellant.

The first leg of the 80-hour trip itself would take the form of a nearly rectilinear hyperbola from the earth to the sphere of influence around the moon, and would consume 35.35 hours. The second leg, a hyperbola around the moon, would take 9.3 hours and the return leg, identical to the first, would again be 35.35 hours, making the 80-hour total.

Cole and Muir see the desirability of making the approach to the moon's surface as close as possible, since the effect of the moon's gravity in bending the orbit back toward the antiparallel to the incoming leg will be greater for closer approaches. The closer the approach, the higher the initial velocity which can be used and the shorter the flight time.

An altitude of ten miles is suggested for the second leg, with the velocity at perilune 13,720 ft/sec for the 80-hour trip.

Re-entry would be accomplished by pilotage, and the control fins of the vehicle would provide sufficient aerodynamic control to permit landing in the desired area of the earth.

The Martin engineers sound a somber note in conclusion by saying that development trends indicate that Russia may already have structures on the moon when the U.S. vehicle orbits for its first close glimpse.

However, they indicate that since Russia will almost certainly make deep space flights before the U.S., our objective should be to accelerate our space efforts, with a manned trip to the moon as our specific purpose.

Speedup Scheduled For *Lacrosse* and *Bullpup*

ORLANDO—Navy, anxious to get *Bullpup* into the operational hands of carrier and shore-based tactical aircraft, has ordered a production speed up from 30 missiles per month to 600. Army is changing production of its field artillery *Lacrosse* from 15 to nearly 280 per month. The speedup will mean an around-the-clock production schedule for Martin Co.'s Florida Division.

The Air Force is also entering the *Bullpup* program, with the award of a new research and development program to Martin—aimed at giving Tactical Air Command and NATO nations improved air-to-ground missile attack capability.

Air Force, which has been in on some early testing of *Bullpup*, plans to use the 10-foot 550-pound missile on its F-100, F-101 and possibly, the F-105. However, Air Force wants internal stowage, radar acquisition of target and possibly a voice command or infra-red guidance system.

Production of the missile under the planned Air Force program will greatly exceed the Navy program, and can be expected to cut production costs from the present $5,000 per bird.

NACA to Spend $19.5 Million at Wallops

The National Advisory Committee for Aeronautics has announced details of its $19.5 million capital expansion program for the Wallops Island, Va., rocket research station.

Two launching areas, with a blockhouse between them to serve both sites, will be constructed at a cost of $4.68 million.

The launching pads will be connected to the blockhouse by a conduit system to handle communications and firing circuit lines. The blockhouse will be 40 x 60 ft., constructed of heavily-reinforced concrete, and covered with protective sand. It will be provided with blastproof doors and blastproof periscopes for viewing operations in the launching areas. Extensive tests will be made of hydrogen-flourine combinations.

The pads will have a rocket launcher, umbilical tower, and a movable service tower for loading and final check of guidance control and research instrumentation.

Rocket fuel and oxidizers will be handled by tank trailers provided by contractors, who will make deliveries as needed—eliminating the necessity for maintaining large liquid storage tanks and pumping equipment.

The 3,200-acre island, used for the past 13 years, is five miles long and one mile wide. Only 800 acres are suitable for use in rocket operations; the remainder is marshland.

A 20-ft. wide causeway over the marsh area connecting the island with the mainland is proposed. A 20-minute boat ride is now required to transport personnel and materials.

NACA, nucleus of the new National Aeronautics and Space Administration, hopes to acquire some 1,000 acres on the mainland. This land would be used for buildings and facilities—including antenna for long-range radio interferometer, radar, and telemetering equipment.

New mainland buildings planned include a two-story administrative and range control facility; a two-story model assembly and reliability check laboratory, and a one-story technical service structure.

Acquisition of approximately 800 acres of Assawoman Island—adjacent and southwest of Wallops Island, is required to provide space for the location of tracking sites and telemeter stations suitably removed from the Wallops launching area. Facilities at Assowoman Island would be designed for tracking instrumented models in flight after launching, and for recording scientific data relayed from the test models.

Wide World

Congress Racks Up Record Missile Legislation

- **$39.6 Billion for DOD Use**
- **Small Business Relief Okayed**
- **NASA Funds Set at $80 Million**
- **Reshuffle Strengthens R&D**

by Erica Cromley

Congress headed for home last week, after scaling a mountain of legislation that has been termed by some Capitol Hill veterans the most impressive and significant of the past quarter century.

The defense industries—directly or indirectly affected by much of this year's Congressional package—could be happy with most of the legislation.

Taking on the space challenge, Congress established the first civilian space agency, gave the President $39.6 billion for defense—$815 million more than he asked for—and the go-ahead to reorganize the Defense Department. Congress also provided funds for loans to promote science education.

The lawgivers also passed a host of bills designed to: create more jobs, aid depressed areas, give small business a shot in the arm, and liberalize social security benefits.

• **Space legislation**—Members of the Senate and House Space Committees clearly were not on solid ground when they tackled their first space problem: the "what," "who" and "how" to set up a government agency to direct U.S. civilian space activities. House and Senate hearings dragged on for weeks, as top government and industry scientists gave lawgivers a short course in space technology and advice.

Both sides of Congress differed over the top organizational setup, finally compromised on a nine-member council under direction of the President. The council will be composed of the Secretary of State, Secretary of Defense, the administrator of the new agency, chairman of the Atomic Energy Commission, one additional member from the government and three members from industry. Among the council's duties are to advise the President, and to develop "a comprehensive program of aeronautical and space activities." The new National Aeronautics and Space Administration, unlike the National Advisory Committee for Aeronautics, on which it is based, can negotiate contracts.

Congress voted $80 million to get the National Aeronautics and Space Administration into orbit. This is to cover: research and development ($50 million) construction and equipment ($25 million) salaries ($5 million). In addition NASA will receive NACA's $101 million 1959 funds, and another $117 million which will be transferred from the Department of Defense.

The legislators slipped a rider into two appropriation bills, which requires NASA to get new authorization for funds each year, in addition to getting appropriation approval through the legislative mill. Rider proponents finally settled for authorization approval for next year only. Meanwhile, the Senate moved quickly to confirm nomination of the two-man team named by the President to run the new space organization—Thomas Keith Glennan, director, and Dr. Hugh Dryden, deputy.

• **Defense appropriations**—The tone of urgency in the fact of the new Soviet threat permeated the session from the first day.

The $38-billion defense ceiling was lifted and the $1.26 billion emergency appropriations for the development of missiles, air detection devices and bomber facilities asked by the President, were quickly approved.

The whopping $39.6 billion defense appropriation set a peacetime high. It caused some bitter controversy: Democrats claimed the Administration was scrimping on research and defense efforts and that as a result, development of new missiles was impeded. Republicans countered with the charge that Democrats were belittling American military achievements to make political hay for the November election campaigns.

The new money bill emerged from the Senate-House Conference meeting with $1.193 billion more than the

House had approved and $440 million less than the Senate. Total for the three services were $17.877 billion for the Air Force, $11.359 billion for the Navy and $8.993 billion for the Army. Advanced Research Projects Agency (military space projects) was given a little over half a billion dollars of DOD's funds.

Increases approved included $638 million for four more *Polaris* submarines, missiles and equipment for a total of nine authorized; $90 million for acceleration of the *Minuteman* ICBM program, which includes $15 million for research and development; $48 million for the *Hound Dog* air-to-ground B 52 missile; Army modernization funds of $37 million for missiles and equipment, to which the Senate added $14 million.

(The Department of Defense recently revealed that programmed obligations for 1959 missile procurement, construction and research and development total $6.596 billion, compared to $5.107 billion in Fiscal 1958 (m/r August-11, p. 12). This includes those ship and aircraft costs directly associated with missiles, but does not include missile operation and maintenance costs, or military pay.)

Although the Congressional mood was to add to any item with a defense tag, it turned economy minded when it hit the military construction bill. The President asked for $1.73 billion; got $1.35 billion.

• **Small Business legislation**—The small businessman got a lot of Congressional attention this year.

One bill, which gave the five-year-old Small Business Administration permanent status, also raised the individual loan ceiling from $250,000 to $350,000 and dropped the interest rate from 6% to 5½%.

Another bill authorizes establishment of local small business investment corporations with a revolving fund of $250 million to make equity-type capital and long-term credit more easily available. To qualify for a charter, these investment companies, formed by at least 10 persons, must have a minimum capital and surplus of $300,000, half of which they can get from SBA. Loans would be limited to not more than 20% of a borrower's capital.

Small business also came in for $260 million in tax relief, included in a compromise bill which provides for a vast technical overhaul of the income tax law. Although it does not change the tax rate for small enterprises, the measure permits reduction of taxable income through deduction of a larger percentage of the cost of machinery and equipment for depreciation in the year of purchase. It permits a first-year depreciation allowance equal to 20% of the cost of investment outlays up to $10,000.

The tax law also allows business—small or large—to get retroactive tax refunds for three previous years as a result of operating losses. Formerly a loss could be carried back only to the two preceding taxable years. Included is an increase in the allowable accumulated earnings from $60,000 to $100,000 before a corporation may be subject to the accumulated earnings tax.

Another break for small business was a bill modifying certain U.S. procurement practices to help the small man get a fair share of government business. It put a new ceiling of $2,500 on open-market purchases for procurement without formal advertising.

• **Defense reorganization**—Implementation of the changes under the Defense Reorganization Act will be gradual. Prime aim is to strengthen and clarify the authority of the Secretary of Defense. For one thing, the measure puts the six unified defense commands directly under him, through the Joint Chiefs of Staff, instead of having each responsible to one of the military departments.

Assistant secretaries have been cut from eight to seven, with the post of Assistant Secretary of Defense Research, Engineering, to be upped to that of Director of RE. He will supervise, manage and direct all DOD research programs of the Advanced Research Projects Agency and the Office of the Director of Guided Missiles.

Only the Director of Research, Engineering and to some extent the Assistant Secretary of Defense (Comptroller) will be able to deal directly with the Army, Navy and Air Force.

• **Other action**—Other Congressional action:

—grants semi-permanent emergency contract powers to the Pentagon, similar to those of the expired Title II of the War Powers Act, including an insurance provision for otherwise non-insurable defense contract risks, authorization of certain advance payment amendments or modification of contracts on an emergency basis.

—extends for two years the government's power to set priorities for defense contracts, exempt cooperating defense contractors from anti-trust laws, authorize defense loans, and provide an emergency standby supply of trained executives for wartime posts.

—authorizes an additional $3.3 billion for mutual security.

—authorizes $888 million over a four year period to stimulate science and engineering education.

—extends Renegotiation Act for six months.

Small Business Gets Added Tax Breaks

In its efforts to aid small business, Congress further eased tax obligations with bills which would.

—permit certain small corporations having ten or less stockholders to be taxed as partnerships, thereby gaining a possible lower tax rate

—allow the new small business investment corporations exemption from any taxes on dividend income received from investments in small business regardless of whether they pay it out to their own stockholders; permit them to charge off their capital losses against ordinary income which is subject to a higher income tax; allow an investor in a small business investment corporation to take an ordinary loss instead of a capital loss in connection with the worthlessness or loss from the sale of stock in these corporations.

Puzzle: What's Meaning of Spending Limit Law?

One of the least understood and most controversial of this year's laws is the bill enabling the President to propose an annual dollar spending limit for each agency.

The measure, HR 8002, originally grew out of Hoover Commission proposals aimed at returning unused funds to the Treasury, and giving the Budget Bureau and Congress control over the rate of expenditures.

However, the amendment-riddled measure that emerged was in such diluted form as to be scarcely recognizable. Under it, the Senate and House Appropriations Committees can ignore the President's spending recommendations, which gave rise to the charge that the bill created no more authority than already existed.

(The Defense Department, during hearings on the measure, estimated it would have to hire from 5,000 to 7,000 additional clerical employes if the bill became law.)

Provisions include: permission of fund transfer within an agency to retain flexibility for long leadtime weapons development; assurance that defense contractors will be paid for deliveries by permitting funds to be drawn from years other than those covered by the annual limitation, if this is necessary.

Exactly how or if it will work, remains to be seen.

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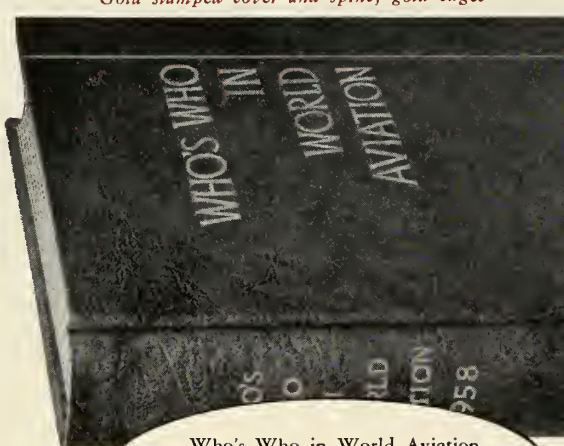

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DOOLITTLE, James Harold, v. p. and dir., Shell Oil Co. *Office:* 100 Bush St., San Francisco, Calif. *Home:* 1100 Sacramento St., San Francisco, Calif.

b. Alameda, Calif., Dec. 14, 1896; m. Josephine E. Daniels; children, James Harold, Jr., John Prescott. *Educ.:* U. of California (1916-17), A.B. (1922); Massachusetts Inst. of Tech., M.S. (1924), Sc.D., fellow in Ae.E. (1925). *Business record:* mgr., aviation dept., Shell Petroleum Corp., 1930-40; present position since 1946; first to fly across U.S. in less than 24 hrs., 1922; first to fly outside loop; win- Trophy Race, 1925; award- hy, 1926; Harmon Trophy. ndix Race, 1931; trans- 1931; winner Thomp- 1932; advisor Congres- ey Bd., 1948; chrm. mm., 1952. *Military* ir Corps, 1917-30; stigation Comm. e duty as maj., n., 1942; maj. dr. 12th A.F., Air Forces; m. See. of relation- Security essional leaf oak leaf Natl. Off.) n Le- ix de ; Grand Off. of the Order of the Crown with Palm

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propulsion engineering

by Alfred J. Zaehringer

Radiation definitely affects stability of hydrocarbon fuels. Tests on kerosene, gasoline, jet and petroleum rocket fuels with gamma and neutron bombardment indicate: increase in density and viscosity, decrease in hydrogen content, and the evolution of gas. Studies such as these are needed to determine optimum working fluids for atomic rockets.

Liquid ammonia is fuel for X-15 rocket plane. LOX will be oxidant. NACA calculates theoretical I_{sp} of this combination at stoichiometric as 249 sec. Volume performance is 210 lb-sec/cu. ft. This is one of the first major applications of ammonia as a rocket fuel in the U.S. It also marks one of the first uses of a liquefied gas as a fuel material. Low cost and high availability were other selection parameters.

Long run ramjet static test of a Marquardt engine at Naval Ordnance Aerophysics Lab at Daingerfield, Texas was equivalent to a non-stop flight three times around the world at an altitude of over 70,000 ft. Conducted at high supersonic speeds, the ramjet has already chalked up a total run time equal to a flight five times around the world.

Super pressures and temperatures may result in new propellants and motor materials. Research at Brigham Young University indicates that attainment of pressures of 3 million psi and temperatures of 5,000°F are possible and may result in the attainment of new physical and chemical properties for many elements and compounds.

Gas-producing cartridges for feeding liquid propellants have been described by the Vernon Laboratories of France. The solids are based on urea, urea nitrate, hexamethylene tetramine, ammonium nitrate, and ammonium hydrophosphite to produce a reducing gas, or with ammonium persulfate, to yield a non-reducing gas.

Low cost epoxies for solids may be possible with Mod-Epox introduced by Monsanto. The viscosity modifier, based on an organophosphorous compound, could allow the incorporation of higher oxidizer or exotic fuel loadings. Phosphorous improves stability—particularly thermal properties vital under high temperatures and long term storage. Reichold Chemicals, too, is entering the epoxy field and may mean higher interest in epoxy fuel-binders. The reactive epoxide group offers not only a way to form cross-linked polymers, but might also allow the introduction of exotic boron compounds directly into the molecule. Another way of attaching the borohydrides to epoxies would seem to lie in the use of Callery's amine-boranes to act as curing catalysts.

Future solid propellants will be a cross between today's homogeneous and composite propellants. So indicates Allegany Ballistics Lab. In homogeneous propellants, borons or metals may be added as discrete particles or in the form of molecular substitutions. For composites, more oxidizing power will be needed to take advantage of metals addition; this may come in the form of organic monopropellant materials. Thus, homogeneous propellants will have composite components while composites will resemble the homogeneous solids.

Safety with boron fuels may result from studies at Rensselaer. Hard to handle pentaborane can be inhibited from explosion by the addition of iron carbonyl.

New diborane process developed at Germany's Max Planck Institute for Coal Research uses boron trioxide and an aluminum alkyl. Trialkyl borane formed is reduced with hydrogen to give diborane. U.S. processes use halogen intermediates.

Engineer Survey Reports Career Motivations

Engineers would rather do engineering work, but feel there are more rewards to be gained by moving into jobs outside their technical specialization. This is one of the findings of a national survey of 1,500 engineers by Deutsch and Shea, Inc., technical manpower consultants.

More than 80% of the engineers responding to the survey felt that the greatest opportunities for advancement were outside of technical specialization. Sixty-five percent believed that administrative work offered greater opportunities, and 17% felt that more opportunities were available in the sales field.

However, only 42% of these engineers said they would be interested in leaving technical work if the salaries and opportunities in engineering were equal to those in administration and sales.

Davis Appointed New R&D Deputy Commander at ARDC

Maj. Gen. Leighton I. Davis, Air Force pilot, engineer, inventor and teacher, recently reported to Air Research and Development Command (ARDC) headquarters as Deputy Commander for Research and Development.

Gen. Davis's new position places him in control of scientific exploration programs and equipment development projects for the Air Force. This requires coordinating the efforts of Air Force and civilian scientists, and the work accomplished by numerous university and private industrial research firms.

Gen. Davis returns to ARDC after serving four years as commander of the Air Force Missile Development Center (AFMDC), Holloman Air Force Base, N.M. Prior to this assignment, he was ARDC's Director of Development, Baltimore, Md.

Manuscript Deadlines Set For ARS 1959 Meetings

Manuscript deadlines for the American Rocket Society's 1959 meetings have been announced. They are:

Dec. 15, 1958 for the Spring Meeting at Daytona Beach, Fla., Mar. 23-25; Feb. 20, 1959 for the National Telemetering Conference at Denver, Colo., May 25-27; March 9, 1959 for the Semi-annual Meeting in San Diego, Calif., June 8-11; May 22, 1959 for the Northwestern University Gas Dynamics Symposium at Evanston, Ill., Aug. 24-26; Aug. 17, 1958 for the 14th Annual Meeting in Washington, D.C., Nov. 16-20.

Meeting Urges Answer to Who Rules Space

SAN DIEGO—Urgent decisions are necessary to define the limit between regions of national sovereignty in the air space and free outer space. Legal questions on property rights on the moon and planets, and of our relations to probable existing inhabitants, can wait until we acquire more knowledge.

These were the conclusions heard recently at a jointly-sponsored meeting of the Air Research and Development Command, Institute of Aeronautical Sciences and American Rocket Society, San Diego. Speakers included Dr. Theodore von Karman, a member of NATO's advisory group for aeronautical research, and Dr. Donald L. Michael, Dunlap & Associates.

An agency for space administration might be a solution, according to Dr. Michael, if there is an increased trend to outlaw space missilery. Such a trend could result in an international impasse similar to that of atomic weapons. However, an agency could be further complicated by smaller nations who want a part in anything of international significance. This, in turn, can result in pressure groups and complex power politics.

If the UN should bear the costs of an international space program, it would still be costly to individual nations because there would be no military cost decrease—it would merely be added on.

• **Technical aspects**—Dr. George A. Hoffman of the Rand Corp., created considerable interest with a paper on the properties of "whiskers"—fine crystal filaments with phenomenal strength, in some cases approaching the theoretical limit of atomic cohesion. Hoffman said this high strength was due to a phenomena of strength increase in a crystal as its dimensions decrease, and is quite general in materials. "Whisker" materials could be woven into cables or formed into sheets with almost incredible results in tensile stress and modulus of elasticity.

However, Dr. Hoffman estimated, "it will take about two generations to develop a material made from whiskers."

With the current accent on "shots to the moon," much interest was generated by another Rand Corp. scientist, H. A. Lieske, in his paper on "Circumlunar Trajectories."

Describing possible free-flight trajectories of a moon rocket, Lieske emphasized the dependence of trajectory on burnout velocity of the final stage. The paper covered possible circumlunar trajectories from the classical "figure eight" orbit to distorted ellipses. Typical round trip flights would probably vary from 6 to 10 days, depending upon initial velocity of the rocket and the distance of closest approach to the moon.

Thermonuclear reaction power plants offer the most interesting possibilities if the basic problem of controlling the reaction can be solved, according to Dr. M. R. Clauser, director of Physical Research Lab, Space Technology Laboratories.

"There seems to be no further fundamental obstacle that would preclude its use for propulsion," Dr. Clauser stated.

Other methods being investigated, he said, are an ion rocket for use after a vehicle had been put in orbit about 200 miles above the earth, and a system of nuclear energy using the fission reaction. To accomplish a velocity of 40,000 ft. per sec., as required to encircle Mars, Dr. Clauser said this would would probably require development of an exotic propellant rocket motor—possibly utilizing a hydrogen-fluorine combination or a fission rocket motor.

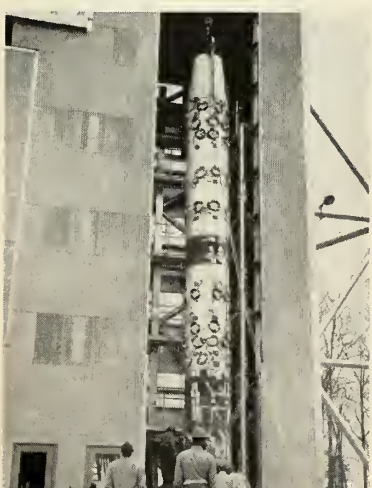
• **Launch to planets**—Krafft A. Ehricke, Convair-Astronautics, said that there will be only four periods in the next ten years, each about 90 days long, when it will be possible to launch instrumented "comets" towards Mars and Venus. Modified versions of ICBMs in current development could be used.

Launches towards Mars could be made during a three-month period beginning in August 1960; other launches could be made during like periods beginning September 1962, November 1964 and December 1966.

Six favorable periods will be available for sending instruments towards Venus, but they will last only two weeks each. These will be in June 1959; January 1961; August 1962; March 1964; October 1965; and June 1967.

Ehricke also urged an early start towards such projects—"since our competitors won't wait for us."

Missile Shaker



THE 44-FT. FIRST STAGE of the *Vanguard* rocket is being inserted into the test tower at Martin Co., preliminary to undergoing a "shake" test. This test, which uses the round wire coils as "ears," is used to conduct a ground resonance survey. These coils are used in recording informations during a test, through the use of strain guages and other devices.

Enemy Imitator

NEEDLE-NOSE *Kingfisher*, the Army's new target missile built by the Lockheed Missile Systems division, can portray enemy attackers to provide a realistic test of U.S. missile-age defenses. A radar target augmentation device in the bird simulates high-flying hostile planes or missiles, and a Lockheed-developed firing error indicator records theoretical hits.

North American Aviation Highlights SAC Operation

A comprehensive roundup of Strategic Air Command operations is featured in the current issue of North American Aviation's publication, SKYLINE.

SKYLINE covers various phases of SAC's responsibilities as a major war deterrent.

Included is a four-page article on SAC's first missile division at Cooke Air Force Base, California, which will undertake the training of 7,000 missile men within a year.

Hand-Carried Infantry Missile Due For U.S.

By Raymond M. Nolan

Slated to make its appearance in the U.S. soon is the Vickers 891 anti-tank guided weapon system (m/r August 25, p. 37—see photo).

The 891 is an Infantry anti-tank weapon which can be carried, set up and fired by one man without any special technical skill. Probably the smallest portable weapon of its type, it is a simple and powerful missile which will give an infantryman a good chance against even the heaviest tank. Its only counterpart in the free world today is the French S10 and S11 series, sometimes called the "suitcase weapon." However, the French missiles are somewhat heavier than the 891.

The Vickers system is actually a two-part weapon: the missile contained in a portable launching canister or in a bag complete with launching stand. and the control device with which the operator generates the command signals. No additional computing gear is required.

• **Guidance**—The missile is guided by means of a simple optical line-of-sight command system. Before firing, a cable is pulled out from the container and plugged into the controller unit.

Steering is by a thumb-operated stick which the operator uses to bring the missile onto the line of sight of the target. The absence of any electronic or other parts in the wire-guidance system which require warming-up make the launching sequence very rapid.

Command is exercised by changes in later velocity. As the operator moves the control stick, the velocity with which the missile crosses his line of sight is changed. Commands are transmitted by a wire-wound spool attached to the rear end of the missile and encircling the rocket motor nozzle. Power comes either from batteries or a small turbo-generator.

The body has a conical nose fitted with a contact probe. The main body sections and the pressure vessel for the motor are aluminum alloy. The four wings carry trailing edge control surfaces and plastic shells reinforced with glass cloth, and are filled with foam plastic.

The two detachable fairings, lying between the wings, are also of reinforced molded plastic. They are easily replaceable and serve the twin purpose of housing the electronic components of the control system and providing means of interconnecting equipment at either end of the rocket motor.

The solid fuel motor has a removable igniter which is screwed into position just before firing. A flare is also installed to give the operator an assist in visual tracking.

Wide World.

Designed to carry big wallop—British Army paratrooper fires a close-range guided rocket missile designed as an anti-tank weapon.

•**Launching**—The missile container becomes the launcher with the removal of a rubber plug and ring in the rear-end support pad. The container lid folds down and becomes the supporting member to achieve the 20 degree firing angle for the missile. Angle of elevation is varied by propping up the rear end.

The canister is about 15 in. square and 37 in. long. It weighs from 33 to 45 pounds, complete with missile, depending on shock protection. The missile itself is 33 in. long, with a body diameter of 4.5 in. and an 11 in. wingspan.

Vickers designed the 891 with a one-man launching team in mind. The missile is light enough to be carried, accurate enough to be effective at either end of its range, and rugged enough to be transported by jeep or helicopter, or dropped by parachute. Recent rumors that an American manufacturer would produce the missile have not yet been confirmed, but m/r has learned from sources in Washington that the 891 will be in competition with the *Dart* at an early date.

Arma Sales Drop, Merger With Northrop Considered

Sales, profits and earnings on common stock of the American Bosch Arma Corp. for the first six months of this year are considerably below those for the same period last year, the company announced.

Sales for the first half of this year were $57.7 million with a net income after taxes of $1.6, as compared with sales for the same period last year totaling $69 million with a profit of $2.9.

Earnings on common stock, after provision for preferred stock dividends, were 85 cents per share as compared with $1.56 last year. The lower profits were a result of a 25% reduction in commercial products billings, according to the company.

Arma reported that several meetings have been held with officials of Northrop Aircraft, Inc., Hawthorne, Calif., to discuss the possibility of a merger. No agreement has been reached, but talks are continuing.

AGN Scientists Seek Man-in-Space Answers

SAN RAMON, CALIF.—Scientists at aerojet-General Corp.'s Nucleonics subsidiary are convinced it is possible to build a protective capsule to take man safely through the bands of radiation into space.

Protection against natural and man-made radiation hazards is one of the space radiation research staff's main projects.

Dr. Robert P. Geckler, AGN biologist, said that bone marrow injections may be used to counteract the effects of low level radiation. Radiation protective suits have been discounted as too cumbersive and restrictive.

Scientists at Nucleonics are hopeful that the first successful lunar probe may reveal a minimum zone of radiation with comparatively radiation-free escape paths. They also feel that some day man will find a way to utilize the energy of the radiation belt's charged particles.

Most of AGN's work is channeled into the production of the Poly Pool educational and research reactor—a miniature version of the bulk shielding reactor at the Oak Ridge National Laboratory.

Missiles . . .

Men . . .

Production . . .

m r staff photos

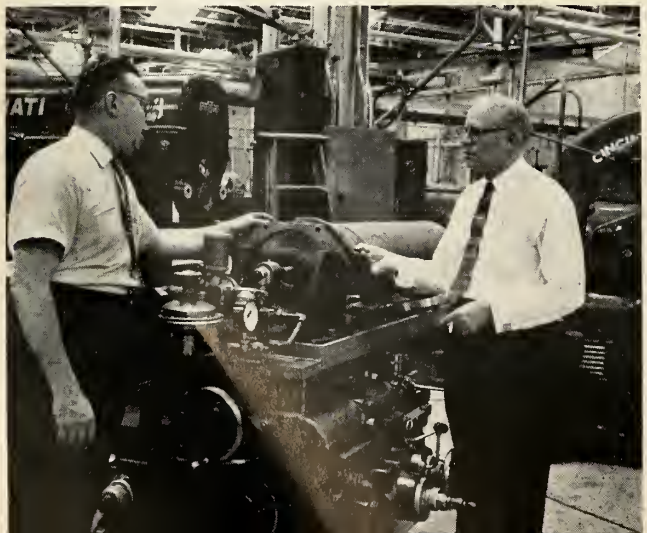
This unusual rear-view sbot of Raytbeon's *Hawks* shows details of tri-mount launcher.

Judging from the intense looks, neither a salesman nor a buyer . . .

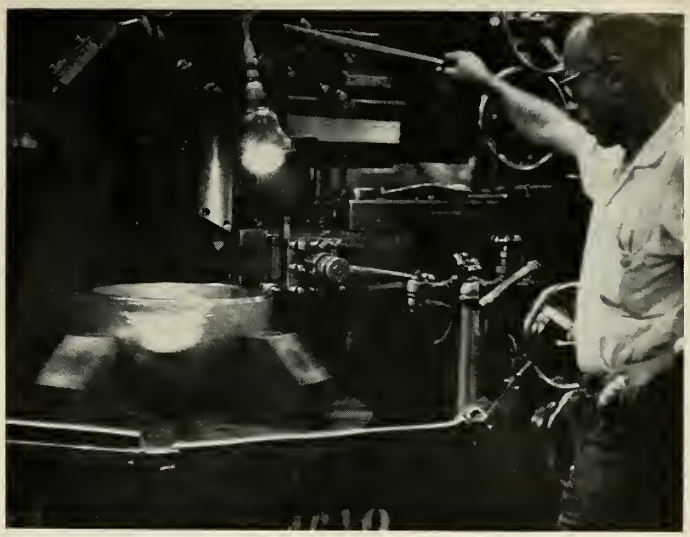
needs a lengthly caption to explain what is going on . . .

. . . in the above true-to-life picture sequence.

This specially designed tool uses hydraulic pressure between mandrel (shown) and *Terrier* solid rocket motor casing to hold piece rigid while detailed cuts are being made. This is part of a brand-new *Terrier* motor casing production plant built at Cameron Iron Work's Houston facility.

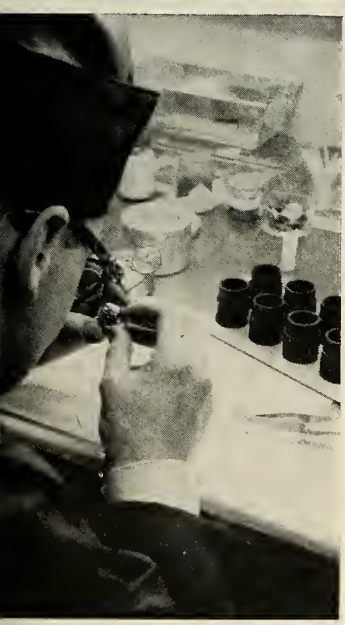


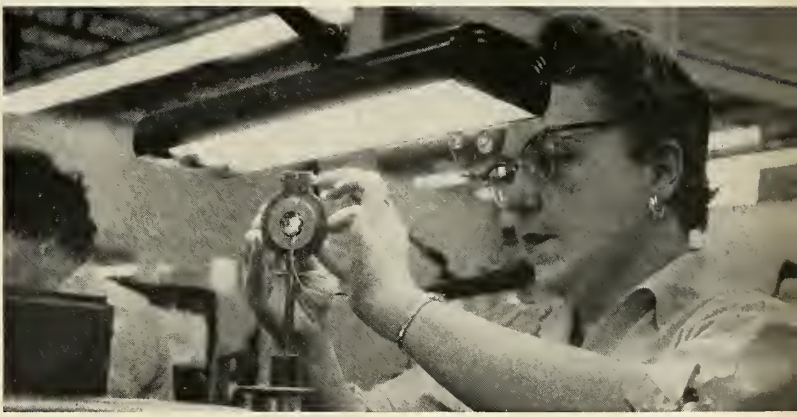
It may be a new business, but very often old tools do the job best. These tongs were made by a blacksmith at the Ladish Co.'s Milwaukee facility.



The forging for a jetavator for a modern missile receives its first machining cuts. Unusual shape is used in a solid propellant motor.

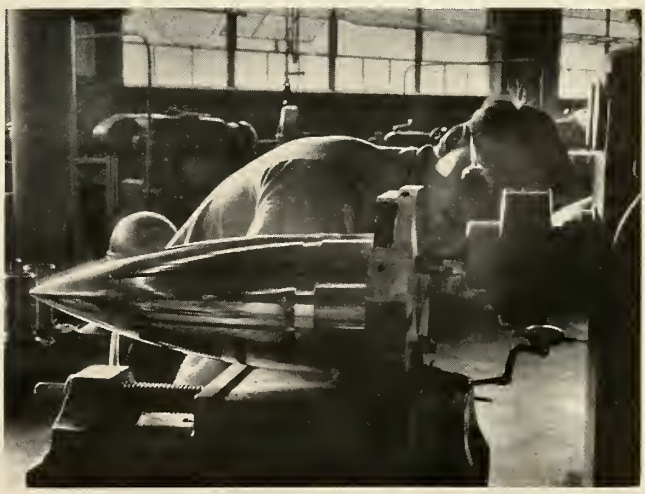
Missiles take big parts and little ones. Detail work is being done on the heart of a miniature rate control gyro.





Magnifying glasses and surgical cleanliness are required in assembling precision gyroscope assemblies at Detroit Controls division of American Standard Corp.

Peace and quiet is required in some missile work. Here, creep and yield test machines measure lives of different materials under various environments.



Machine tool precision work is required. Here, at Diversey Engineering Co., a nose cone mold is given final finish machining before shipment.

Head of Ordnance Missile Command Tells . . .

How Army Insures Missile Reliability

In this article, especially written for m/r, Gen. Medaris—Commanding General of the Army's Ordnance Missile Command—has undertaken to outline for readers the extreme care, and reasons for care taken by the Army to insure proper design and functioning of what have proved to be some of the nation's most reliable missiles.

Reliability—the positive assurance that the weapon will function effectively whenever required is the keystone of the Army's rocket and missile program.

The Army demands that reliability be achieved during the research and development phase of each weapon system, through a vigorous program of design, test and analysis. It is maintained during the production phase by a stringent quality assurance and quality control program.

The objective is to assure that existing and future weapons systems continuously perform their intended functions in the natural and induced environments in which they must operate.

Within each major element of the Army Ordnance Missile Command there is a group responsible for a reliability program for each research and development project. These programs are tailored to specific requirements. All are regularly monitored to insure adherence to Command policy.

A staff element is assigned this responsibility and also evaluates policy to determine that it is consistent with the most advanced state of the art of rocket development.

• **Considerations**—Five basic considerations enter into all reliability programs in the Command:

1. Definition of the reliability objective in each case.

2. Determination of total environmental conditions and design parameters throughout the life of the weapon system.

3. An intensive laboratory testing program and a companion flight test program to determine modes of failure, level of failure and test-to-failure.

4. Comparison of reliability test results to determine that adequate safety margins exist in the design, to insure that the probabilities are biased in favor of the system.

5. Establish quality assurance procedures which will insure conformity to the inherent reliability designed into the system.

• **Results**—The enhanced reliability of various Army-developed missile systems demonstrates improved reliability design. An outstanding example is the *Redstone* Ballistic Missile System. Here a high degree of reliability was inherent in the research and development and production phases.

The system's reliability has been demonstrated under semi-arctic and semi-desert conditions, and most convincingly by the tactical firings conducted by the 40th Field Artillery Missile Group (Heavy)—the first launchings of a large ballistic missile by U.S. troops.

In the *Jupiter* Intermediate Range Ballistic Missile System, being developed for operational employment by the Air Force, a Noteworthy degree of joint Army-contractor participation has been achieved in the resolution of reliability problems.

Perhaps the most striking evidence of this success has been the two recoveries of full-scale *Jupiter* nose cones with the assistance of the U.S. Navy. The recoveries established that *Jupiter's* inertial guidance system can deliver a warhead accurately to its target over the approximate full range of the weapon, and that the Army can protect the warhead from the aerodynamic heating encountered by an object reentering earth's atmosphere.

• **Cone recovery story**—Behind the headlines reporting the nose-cone recoveries is an efficiently organized research and development project in which the reliability philosophy has been carefully integrated.

Analysis, studies and test of aerodynamic stresses, structural designs and material composition guided the selection process. Finally prototype nose cones were developed and tested, first in wind tunnels to measure aerodynamic stability and then in the path of rocket engine jets to measure resistance to excessive temperatures.

Because of advances in reliability planning, programming and engineering, and the proper balance of laboratory and flight testing, the *Jupiter* System is expected to surpass *Redstone* in reliable performance.

How exhaustive the flight testing has been may be gauged from the average of 230 individual measurements obtained in flight on each test *Redstone*. Approximately the same number is derived from each *Jupiter* test launching. Each of the measurements is related to specific areas of investigation required by the missions of the individual missiles.

Maj. Gen. J. B. Medaris

Another example of Army-industry cooperation in reliability concerns the *Nike-Ajax* surface-to-air system. A quality assurance program was initiated in mid-1953 under Army Ordnance Auspices with the Bell Telephone Laboratories. This provided for a series of product evaluations, quality surveys and implementation of standard quality assurance procedures. An overall increase in system reliability of 12% was achieved. Better producibility as well as enhanced reliability resulted.

• **How it's done**—A continuing process of evaluation, review, analysis and corrective action is carried on. As a part of this standardization, programs seek to increase the use of interchangeable parts among the various systems. An important element in determining the need for an incorporation of design changes is extensive use of electronic data processing.

Product Improvement Committees made up of members of Army-Industry missile system teams, and representatives of the combat arms which use the weapons coordinate the review and analysis effort. Their recommendations go to the mission agency responsible for final action.

Ordnance Evaluation Laboratory facilities have been provided in the

major elements of the Command to provide more effective control of prime contractors in the reliability effort. These laboratories verify design parameters, monitor contractor reliability achievements by means of independent testing, and contribute to advancing the state of the art.

An engineering concept review is conducted within six months after initiation of the project. Then the design agency presents to all interested elements, including the user, the military characteristics of the weapon design schedule industrial plan, field support plan, and training plan.

Design engineering review is conducted as soon as basic design decisions have determined the physical characteristics of the system and detailed design of hardware is underway. Mock-ups and some hardware are employed to explain the status of design to interested elements, and future planning is outlined. This makes possible early initiation of industrial and maintenance engineering and instructor training.

Engineering design inspection takes place when the design is far advanced and industrial engineering is proceeding on the overall system. Development-type hardware is employed as test prototype. The design agency portrays the status of industrial engineering and the supply and training agencies report their progress. Engineer user test schedules are discussed.

Production design inspection is scheduled when industrial engineering is well advanced and procurement is in progress. Now the complete system is demonstrated, utilizing the first production type hardware. No change in engineering design is acceptable, except as a result of the evaluation firings, and only when the change will effect significant improvement in the use of the system by troops. Any other desirable improvements are included after delivery of the first system of tactical design suitable for deployment.

The final review action, known as Special Coordinating Inspection, may be scheduled by the coordinating agency whenever it is considered necessary.

By introducing the reliability concept into every phase of the army's missile and rocket programs, we bring the weapon to the field confident that it will perform efficiently. Our constant purpose is to arm our troops with the best possible means by which to accomplish their objectives.

Explorer V In Ocean Grave?

By Norman L. Baker

As m/r went to press, the rate of the *Explorer* V satellite was still shrouded in mystery.

Speculation is that the satellite met the same fate as *Explorer* II, which fell into the ocean shortly after launching. All four stages of the *Jupiter*-C rocket carrier are reported to have fired without achieving the proper angle of launch. The brevity of the satellite's radio transmission, received at Fort Monmouth, indicates that the final stages fired in a nose-down attitude, with the satellite landing several hundred miles from the Cape Canaveral launching site.

Explorer V, originally scheduled for flight at 2:30 A.M. on August 21, but delayed for three days due to a faulty valve, was designed to supplement the experiments of *Explorer* IV. The time of launch was calculated to put the satellite in orbit on the opposite side of the earth from *Explorer* IV.

Assigned to obtain additional data on the corpuscular radiation belt, the opposed positions of the two satellites would have furnished simultaneous readings and would have recorded any changes in intensity levels.

Explorer V was one-half pound heavier than IV as the result of heavier shielding for the counters. *Explorer* IV has one of its counters shielded by lead one-sixteenth of an inch thick, while *Explorer* V, with similar instrumentation, was equipped with shielding 3/16 or an inch in thickness.

According to Brig. Gen. John Barclay, commander of ABMA, *Explorer* V would have attempted to determine the nature of the radiation—whether the particles are electrons or protons.

If the particles of the belt are electrons, the highest intensity recorded would be about ten roentgens an hour. If the particles are protons, this intensity would be about 100 roentgens an hour. (AEC has recommended 0.3 roentgens per week as a maximum safe human exposure.)

As a result of *Explorer* IV measurements, it is now known that from 250 miles to the satellite's apogee of 1,300 miles, the intensity level of the belt doubles every 60 miles. At the apogee, the intensity is so high that no difference was recorded in the readings of the shielded and unshielded counters.

• **Radiation belt**—Prof. Fred Singer, at the 9th Annual Congress of the International Astronautical Federation held last week in Amsterdam, (see p. 10), advanced the theory that the particles in the radiation belt were protons. This reasoning is based on the fact that when primary cosmic rays smash into the earth's atmosphere and disintegrate the atmospheric Nucleus, most of the neutrons released travel upward and out of the earth's magnetic field in straight lines.

Some of these neutrons, when traveling through the magnetic field, change into protons and immediately begin to spiral around the magnetic lines of force. Singer stated that the lifetime of the protons is so long that the trapped particles start concentrating at 600 miles.

The lifetime of the particles is inversely related to the density of the atmosphere. Therefore the decrease in density with an increase in altitude increases the lifetime of the particles. Singer theorizes that a maximum concentration is reached at the equator at about 1½ earth radius, or 6,000 miles, where the intensity drops.

At about 10 earth radius, he believes the radiation belt ends gradually. The intensity is known to decrease with higher latitudes, with a complete absence at the poles.

• **Answers**—Singer proposed three possible solutions to radiation hazard:

A vehicle could be equipped with a "shadow" shielding ring. Based on the theory that trapped particles spiral mainly at right angles to the line of force, and are therefore incident mainly perpendicular to the line of force, the ring would be sufficient for trapping the particles.

Another method, based on the fact that the incident radiation is in the direction perpendicular to the line of force, would employ a coil positioned around the space station with its axis parallel to the line of force. The coil would create a small-scale dipole field, providing a magnetic screen that would turn away the radiation bombardment.

The most novel proposal suggested the use of "sweeper" satellites for cleaning a channel in the radiation belt. The satellites moving through the belt would absorb the protons, reducing the intensity to tolerable limits. This method would require several satellites having a large cross-sectional area.

Prof. Singer's proposals are significant in light of the shielding requirements for a brute force approach to travel through the radiation belt. To reduce the energy of the trapped protons to 10% would require a shell about 4 cm thick. To protect a sphere 12 feet in diameter would require over 10,000 lbs. of lead.

missile business

The growing trend toward team bidding for missile work—flagged in these columns months ago—gets a strong boost from Air Force Maj. Gen. William T. Thurman, director of procurement and production for Wright-Patterson. A circular over Gen. Thurman's name asks trade associations in the aircraft, electronics and similar industries to bring team bidding procedures to the attention of their members.

An old story in some other fields—particularly construction, where contractor "joint ventures" have ranged to such mammoth ventures as Hoover Dam and the St. Lawrence Seaway—the concept of a team operation is a simple one: A group of firms put their special capabilities together to produce a single product more efficiently and economically than any individual company could possibly do it. In missile production, where so many highly specialized pieces must be conceived, manufactured and put together, the concept is particularly valuable, thinks the Air Force.

Biggest problem in team operation—once the contract is awarded—is in management. Automatically, there are a lot of potential bosses in such a combine. The solution, says Air Force, is a special management group set up specifically to handle the joint contract, keep down paperwork, keep up vital communications, generally ramrod the job. A management advisory board, chaired by an officer of the team leader, is usually the first step, backed by necessary staff.

Air Force has also gone to some pains to reassure industry that the service won't pay for duplicate facilities or build its own, so long as it knows that sufficient capacity exists. "Air Force funding (for industrial facility expansions) will be resorted to only when private capital is unavailable . . . and program needs make government funding absolutely necessary," says AF's latest INDUSTRIAL NEWSLETTER.

Additionally, AF sets up guidelines for contractors on management of their in-plant and subcontract dollars: (1) Procurement orders or re-orders involving government-owned facilities will be screened to insure that items requiring government facilities can't be obtained through private sources; (2) "make-or-buy" studies will be reviewed to assure maximum use of the defense industry's subcontract capability; (3) new facilities expenditures will be authorized only on an absolute minimum basis, in areas beyond research and development and pilot production; (4) existing AF industrial facilities will be disposed of wherever possible.

The general business upturn—reflected in almost all barometers, both private and government—hasn't gone far enough yet to encourage real inflation-making moves in the way of drastic price rises, demands for big jumps in labor's pay, etc. But some Congressmen have already raised the cry of inflation and controls (witness Sen. Kefauver's threat to investigate the steel price increase). The Federal Reserve's move to raise the rediscount rate (in the San Francisco area, for one), is evidence that federal money managers are ready with moves to head off a too rapid rise.

The "Fed" is taking a cautious view of the upturn however, pointing out that similar early strengthening of the economy was followed by mild reversals in 1949 and 1954.

Certainly, the midyear financial reports in the past several weeks have shown a spotty picture for firms with heavy missile interests. Last week's crop, for instance, showed this picture: **Curtiss-Wright Corp.** said its second quarter consolidated net profit was $10.9 million for 1958, compared to $20.7 million a year ago; **Zero Mfg. Co.** reported a record first fiscal quarter, with sales of $797,517, compared to $675,536 a year ago.

contract awards

LAST MINUTE AWARDS

Boeing Airplane Co. gave **Tele-Dynamics Inc.** a substantial contract to design, develop, and manufacture a telemetry system for use in the operational flight testing of the *Bomarc* ground-to-air missile.

Digitron, Inc. announced the receipt of a contract to develop a high-speed electronic function plotter for Holloman Air Development Center.

The Computer Div. of Bendix Aviation Corp. was awarded a contract for the electronic computing unit of the missile impact prediction system at Cooke AFB, California.

Symington Wayne Corporation of Salisbury, Maryland and Fort Wayne, Indiana, manufacturers of gasoline pumps, hydraulic lifts, air compressors and industrial and defense products, has been awarded a government contract for slightly in excess of $1,600,000 for production of hydraulic launching equipment for the *Nike-Hercules* missile.

Zero Manufacturing Co., Burbank, California, received a contract for development of a re-usable aluminum modular packaging system for transport and storage of Naval ordnance, such as missiles and missile systems.

Allen B. DuMont Laboratories, Inc., received a contract from the Navy for developing test equipment for single sideband transmitters.

AIR FORCE

By HQ, AFOSR, ARDC:

Columbia University, New York, N.Y., received $27,839 for research on "dynamic behavior of flat plates and shells."

Cornell University, Ithaca, N.Y., received $92,960 for continuation of research "probability theory and analysis."

University of Southern California, Los Angeles, Calif., received $152,241 for continuation of research "rarefied gasdynamics."

Brown University, Providence, R.I., received $26,000 for continuation of research on "heat transfer from surfaces on non-uniform temperature distributions."

By Ogden Air Materiel Area:

Thiokol Chemical Corp., Elkton, Md., received $26,840 for igniter M-41, for rocket motors M-58 solid propellant.

By HQ, AFMTC, ARDC:

General Dynamics Corp., Convair Div., San Diego, Calif., received $533,000 for increase of funds.

Telemeter Magnetics, Inc., Los Angeles, Calif. received $25,293 for increase of funds.

Motorola, Inc., Western Military Electronics Center, Phoenix, Arizona, received $183,244 for increase in funds.

NAVY

By District Public Works Office, Ninth Naval District:

Wm. E. Schweitzer & Co., Evanston, Ill., received $104,000 for foundations and power supply for MK-10 missile launcher at the U.S. Naval Training Center, Great Lakes, Ill.

ARMY

By Engineer District, Chicago, Corps of Engineers:

Bregman Construction Corp., Chicago, Ill., received $1,617,000 for construction of ICBM/IRBM training facilities at Chanute AFB.

By New York Ordnance District:

Belock Instruments Corp., Long Island, N.Y., received $439,711 for design, engineering and fabrication necessary for development of prototype components required in a scheduled miniaturization program for reduction in size and weight of missile components.

By Ordnance District, Los Angeles:

Douglas Aircraft Co., Inc., Santa Monica, Calif., received $139,405 for blue streak & emergency repair parts for *Nike* system.

Courtland Lab., Los Angeles, Calif., received $35,390 for starting mixture.

Douglas Aircraft Inc. received $24,004,157 for *Nike-Hercules* launching area items.

Grand Central Rocket Corp., Redlands, Calif., received $36,094 for *Dart*, rocket motors and igniters.

By HQ Quartermaster Res. & Eng. Command:

Magnesium Products of Milwaukee, Milwaukee 4, Wis., received $215,155 for 14 shelters, frame type, missile storage 30 ft., with dehumidification liner.

By Boston Ordnance District:

Smithsonian Institute, Washington, D.C., received $225,637 for satellite tracking program.

Raytheon Mfg. Co., Waltham, Mass., received $745,624 for repair parts for *Hawk* missile.

west coast industry

by Fred S. Hunter

In excess of $50 million in tax money is at stake in a hearing on the calendar of the California supreme court this fall. This is the accumulation of property tax payments made by defense contractors and held in escrow pending settlement of the litigation over legality of the tax. In dispute are "possessory interests" in government owned materials and work in process. A lower court ruled in favor of the industry in 1957 on two test suits filed jointly by Aerojet-General Corp. and the Pomona division of Convair. It is Los Angeles County's appeal from this decision that comes before the state high court in October.

Meanwhile, Los Angeles, San Diego and Alameda counties continue to impose these tax assessments on government materials against the manufacturing companies. Lockheed's total tax bill this year, for example, will add up to approximately $9.35 million. Of this, approximately $3.34 million will be protested as covering property not owned by Lockheed, but by the government. Another county, Ventura, decided not to wait for the supreme court's decision. North American Aviation will get a new tax bill this year on an assessment value of $1,946,960 for its "possessory interest" in government owned property at Rocketdyne's test facility in the Santa Susana Mountains.

Background of the local tax trouble is lack of a California law. In World War II, when aircraft and other defense work boomed, county officials were patriotic and agreed that government materials should not be taxed. But after the war, when the California population gain outran tax revenues, the counties found great need for the money. If the supreme court upholds the lower court's order, the counties will undoubtedly go to the legislature for a law. The defense industry may get a refund on the $50 million paid in, but the tax on missile and other defense materials will be back again just the same.

Proposal writers for the prime manufacturers are now at work preparing their bids for the biggest phase of the *Minuteman* program, the contract for assembly and test of the solid propellant ballistic missile. By prime manufacturers, we mean not only the large airframe companies, including all six on the West coast (Boeing, Convair, Douglas, Lockheed, North American and Northrop), but such companies as Bendix, Curtiss-Wright, General Electric and the big three of the automotive industry; Chrysler, Ford and General Motors. These are the companies which recently received invitations to bid from the Air Force Ballistic Missile Division. The contract may be let by Nov. 1, possibly before, if expedited. The company that wins gets the plum of the year.

The financial agreement Summers Gyroscope Co. stockholders approved with Atlas Corp. provides the Santa Monica concern with needed working capital, and at the same time strengthens the management. It brings in Jack S. Warshaur, formerly with an Atlas affiliate, Mercast Corp., as executive vice president and chief executive officer. President Tom Summers, Jr., an inventive genius, is left free to devote himself to product activity. At first, there were plans to merge Summers with Mercast, but these were dropped in favor of a loan agreement under which Atlas has an option to acquire controlling stock in the company.

Big Blasts—North American has its Rocketdyne division at work developing a thrust chamber to provide a backup unit for Reaction Motors rocket engine, scheduled for the X-15 rocket-powered research craft. Judging from reports of the way Rocketdyne has been rocking the hills in Santa Susanna, it must be making progress in its experimentations with new liquid fuels. They are said to have four times the thrust of old fuels.

Business Good at Wescon Show; Recession Called Industry Aid

LOS ANGELES—Optimism was the theme of the 1958 WESCON meeting here in Los Angeles.

This feeling was expressed over coffee breaks between the well-attended technical sessions, and in snatches of conversation in the crowded display aisles of the 900-odd exhibits at the city's Pan-Pacific Auditorium.

The booths of various commercial firms were less ornate than in some past shows, but more purposeful. Many of the displays used missile themes as eye-catchers.

Some exhibitors said that more off-the-shelf sales were made this year than at any previous show.

One fairly typical example was Non-Linear Systems, Inc., which brought along 10 of its newly announced $985 digital voltmeters just in case some purchaser might want "immediate delivery." When the show closed after a four-day run, the company had sold four with purchasers in Los Angeles, and more were on their way to receiving rooms of show visitors from other points.

"We've been fighting off potential exhibitors," declared Bruce S. Angwin of General Electric, and WESCON executive committee chairman. But he noted that if more space had been available, the show might have reached a saturation point as far as displays were concerned.

Angwin was not sure why this year's show elicited such a great commercial response, but said he believed two main factors were involved—a return to the "hard sell," and the possibility that the electronic industry of the West Coast had not suffered as greatly as some other areas of the U.S. in the past 18 months.

Complimented on the high quality of technical papers, Angwin said that the high level technical committee which selected the topics had insisted on quality if it meant "reducing the entire meeting to one paper."

West Coast Grows—An additional reason for the show's wide interest is probably the fact that the West Coast electronic industry is principally concerned with research and development, rather than high production hardware, Angwin pointed out. This is particularly true in the missile and space vehicle field, in which the West Coast leads the balance of the nation.

There are no figures at the moment as to what percentage of area's electronic industry is engaged in missile work, but some statistics are being compiled for the future. The West Coast is presently undergoing the development of production capabilities in a "greatly accelerating curve," as Angwin puts it. Some is local expansion, the rest an extension program of many old-line mid-West and East Coast firms in the building of new facilities on the West Coast or the acquisition of West Coast companies.

Another source of optimism is Donald S. Duncan, president of the co-sponsoring West Coast Electronic Manufacturers Assn., and vice-president, general-manager, Beckman/Helipot Corp.

Duncan believes that the West Coast electronic industry has, since the first of the year, boosted itself back to the financial peak of about 18 months ago.

"The so-called slowdown has been the best thing that happened to many companies," he said. "It taught them how to chop overhead, reorganize, and in general become a better company."

There appears to be little increase in the amount of companies willing to carry programs on their own. Postwar concerns which stayed clear of government contract and put about 12% to 15% of their own funds back into research and development work, could not carry these programs when production items dropped off. But Duncan believes that production volume will increase in the future as will research and development, but the latter will increase at a slower rate.

Recession Helped—WCEMA, Donald E. Root, vice-president and administrative manager of the Cubic Corp., also belongs to the school that believes the recession was a good thing—"it forced good management," he says.

Companies that struggled to carry their research and development capabilities with out-of-the-pocket funds, now find themselves in an excellent position. This is shown that in spite of the high rate of failure on the part of marginal operators, the West Coast area surpasses any other in growth.

But, Root poses another thought that is interesting—an area in which he believes more thought should be given, especially by smaller firms.

Pointing out that about 80% of new products fail economically, he says that the West Coast electronic industry is engineer-oriented. This is extremely valuable in military areas where the final product is not a mass product. The West Coast will eventually reach high production rates, he notes, but one of the biggest problems at present is marketing.

Joins Staff

F. CLARKE NEWLON today assumes the post of Executive Editor of MISSILES and ROCKETS magazine, succeeding Erik B. Bergaust, who becomes Editor. Mr. Newlon recently retired as Assistant to the Director, OIS, USAF.

Electronics Group Hails Calibration Center Opening

The electronics industry depends heavily on accurate measurement and standardization techniques for missile and space exploration phases of the industry's development.

Robert C. Sprague, board chairman of Sprague Electric Co., told an audience of scientists and engineers at the new Electronics Calibration Center at Boulder, Colo., that the NBS program on standards for electronics "is generally advancing on a broad technical front." But he added that further attention is needed to support the mushrooming, highly technical electronics industry.

Commenting on the importance of the Calibration Center, Sprague said, "Today's long-range radar and missile guidance equipment could not possibly achieve the high degree of accuracy required of them by our military services if we did not have such reliable measurement services as are now available in the new Center and the Washington Laboratories of the Bureau."

Sprague commented that today's military electronics production accounts for more than half of the industry's dollar volume.

Heat Control Toughest Manned Flight Job

SAN DIEGO—Ignorance of space-heat relationships has made temperature control the number one problem in providing an artificial environment for manned space vehicles.

More data on the magnitude and nature of solar loads on a stabilized orbital vehicle must be gathered before intelligent decisions can be made. Lacking other data, it may be assumed that heat loss will be a major part of the problem, and man himself may prove to be the best heat source in an artificial environment.

These thoughts were expressed in a paper by Air Force Lt. B. Pinc, Bio-Astronautics Section, ARDC, presented to a recent joint ARDC/IAS/ARS regional meeting on "Space Exploration" in San Diego, Calif.

For orbital flights of short duration, environmental systems will be essentially identical to these in current high-performance aircraft. A high pressure gas, reduced and metered on demand to a full pressure suit and vented overboard, will supply an "atmosphere." Temperature control will be handled by a ventilation garment and a circulating fan system. Simple in-flight or survival rations will take care of food requirements. Waste management will be achieved by pre-flight diet, pharmaceutic control or simple stowage.

Many of these devices or systems are not practical for longer flights with limited weight-volume-time parameters. The future approach must consider some sort of a re-cycling system, or in the ultimate form, a true closed ecology.

Lt. Pinc defined such a system as "a complex of mechanical, inorganic and organic subassemblies which independently maintain a principal inhabitant in a state of psycho-physiological homeostasis and permit useful operant performance." These ends must be achieved with negligible system constituent loss, maximum waste recovery and conversion, low weight, extremely high reliability and a high time-over-energy ratio, he added.

• **How about food?**—Included in the environment is a nutrient sub-cycle to provide devices for the storage, preparation and ingestion of nutrients such as calories, bulk, vitamins, fats, carbohydrates, proteins, metals and water in the proper amounts. This cycle also incorporates solid and liquid waste recovery, conversion, reconstitution and reconstruction into food of tolerable acceptability and palatability.

There has been considerable work in this area, mainly slanted towards biological waste conversion, reconstruction and reconstitution. However, at the present laboratory bench level, these approaches require relatively huge amounts of power, weight and volume. The answer does not point to miniaturization, compaction and high-yield formulations. Such steps can be taken only after basic feasibility has been demonstrated. Present work in reconstitution and reconstruction of wastes is still based on conjectural biochemistry.

The AF officer suggested that the use of common green algae, as has been proposed, is not the way out. The algae is deficient in many aspects as a nutrient. He also suggested that an ancillary amino acid cycle might be employed using either bio-synthetic or physiochemical synthetic means, or else an extremely efficient waste recovery system must be envisioned.

• **Work and rest**—A second sub-cycle, designated the psycho-operant sub-cycle, is required to provide good work and rest area equipment and physical layout of the vehicle's interior. Designed to assure job performance and job satisfaction, the sub-cycle would provide opportunities for rest diversion, physic support and sleep—all necessary to help control fear and aid in motivations and control.

Work must be done on the problem of decoding what functions can be relegated to or performed by man, and then designing instruments to let him perform the job.

The third sub-cycle is that of ambient environment to measure, purify, pressurize and supply or control, within close tolerances, all constituents of the gaseous environment. The system must also measure and control the total heat balance of the microecology. This is the most difficult system of all and the most seriously needed. The other two sub-cycles or systems are not really needed until very ambitious flights are planned.

• **Air control**—For the control of carbon dioxide, Lt. Pinc ventured four methods: (1) scrubbing with chemical absorbents; (2) photo-synthetic reduction which seems to have the same problems as the use of green algae; (3) physiochemical which requires too much energy; and (4) a method that is hypothetical at present, but considers an extra atmospheric heat sink as a cold source to achieve gas freezeout and the use of solar heat for selective gas vaporization. Lt. Pinc pointed out in conclusion that the heat sink approach might also be used in humidity control.

Begin X-15 Engine Testing

READY TO BEGIN static testing of the *Pioneer* rocket engine for the X-15 research aircraft is this new concrete and steel test stand built by Reaction Motors division of Thiokol Chemical Corp. The sloping tank (at left) is one of two propellant tanks which are an integral part of the stand. The large tank (background) is the division's 150,000 gallon water tank which supplies the entire test area.

Instruments Survive Re-entry

HUNTSVILLE—Instrumentation carried in the full-scale *Jupiter* IRBM nose cones, recovered May 18 and July 17 after successful launchings, (m/r July 14, p. 14) came through the gruelling test entirely undamaged, and could be used for another launching, m/r has learned.

This could also mean that proximity fuzing, active or passive homing devices, and circuitry would not be affected by re-entry, thus making possible less critical accuracy requirements for homing equipment during the missile's flight. Combined with a multi-megaton warhead, this could bring the nation much closer to operational IRBM and ICBMs.

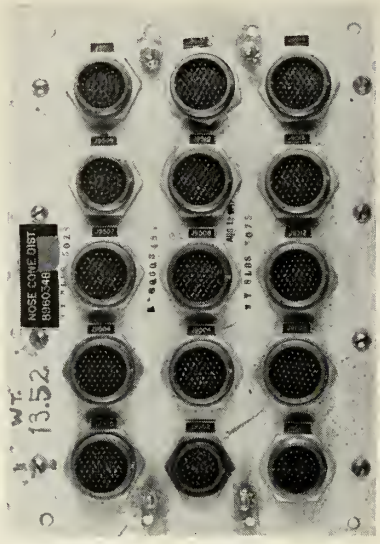
The "nerve center" of the nose cone functioned perfectly, the Army said, in spite of tremendous forces of vibration, acceleration, aerodynamic heating and velocities of more than 9,000 mph.

It was the second time that such electrical instrumentation has been carried into outer space and recovered for evaluation. Connectors were opened and solder connections visually inspected. Inspection of the wiring installation disclosed no damage to harness insulation lacing cord, rubber clamps or cables positioned next to the skin.

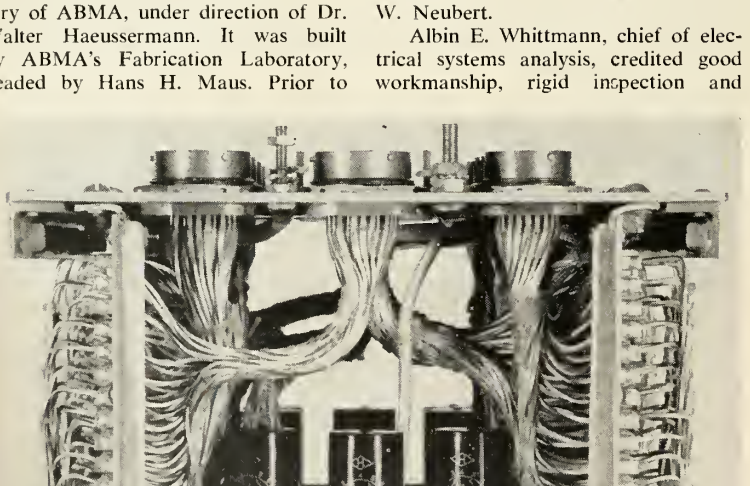
The distributor system was designed by the Guidance and Control Laboratory of ABMA, under direction of Dr. Walter Haeussermann. It was built by ABMA's Fabrication Laboratory, headed by Hans H. Maus. Prior to launching, the system underwent acceleration and functional performance testing in the Systems Analysis and Reliability Laboratory directed by Erich W. Neubert.

Albin E. Whittmann, chief of electrical systems analysis, credited good workmanship, rigid inspection and "know how" for the successful nose cone test.

"If man is to go into outer space and return safely," remarked Whittmann, "he can have nothing but the best in missile components and instrumentation."



TAKEN SHORTLY AFTER A *Jupiter* full-scale nose cone was recovered, this view shows the 15 miniaturized connectors which act as major cable inlets to various components necessary for functioning of re-entry equipment.



U.S. Army photos

THE NOSE CONE DISTRIBUTOR (side view) flown in the full-scale *Jupiter* nose cone re-entry test. Three of the eight relays, which control electrical functions by remote control, are visible (center). Not even solder connections were damaged. Manufactured by the Hart Mfg. Co., the relays were functionally tested prior to flight.

High-Temperature Plastics Promising For Missiles

What may prove to be a major breakthrough in materials for missile nose cones has been announced by Taylor Fibre Co., Norristown, Pa., as a result of research in composite laminated plastics carried on during the past several years.

The company refuses to assert categorically that the new material is the best for nose cones, until tests have been made under conditions which parallel those encountered by missiles during re-entry into the atmosphere. However, tests indicate that the composite laminate plastic holds great promise.

The tests showed that in five minutes (which exceeds the maximum time a missile is subject to atmospheric friction on re-entry), the composite material conducts about 25% less heat from the surface to the interior than the most effective homogenous material tested. Surface temperature was 2,000 degrees F.—about the same as that generated by missile re-entry.

Navy Lets Contracts For Two Fleet Ballistic Subs

Two fleet ballistic missile submarines will be built in the Navy's fiscal 1959 shipbuilding and conversion program, it was announced by the Navy. One each will be constructed by the Portsmouth Naval Shipyard, Portsmouth, N.H., and the Newport News Shipbuilding and Drydock Co., Newport News, Va.

These submarines, designed specifically to carry and launch *Polaris* missiles, will be similar to three ballistic missile submarines now under construction.

Japan Taking Delivery Of Swiss Oerlikon Missiles

The Japanese Defense Ministry is taking delivery of Oerlikon 56 surface-to-air missiles this month.

The Swiss missiles represent the first surface-to-air missiles purchased by Japan from any foreign power. Initial shipment will consist of one launcher and ten missiles.

Test firings are not expected to start until next February, and will be designed to obtain information on the producibility of the missile by Japanese plants.

world astronautics

by Frederick C. Durant III

If you want to go college to study astronautics, where would you go? Of course, CalTech, M.I.T., Princeton, Purdue, State Univ. of Iowa and a few other names may come to mind. But what other schools offer courses you would require? The American Rocket Society (ARS) is finding out for you.

The Technical and Educational Subcommittee of the Space Flight Technical Division recognized the need for a survey of all U.S. institutes of higher learning. M.I.T. Prof. Paul Sandorff (who conducts an Orbital Vehicles course) prepared the questionnaire. A preliminary report by Sandorff indicates that 104 replies (out of 189) have been received. Sixty percent of those responding "offer or plan to offer courses in fields of study related to space flight"; while 44% "offer research opportunities" in these fields. Very heartening indeed! The published final report should be most interesting.

The international value of the oblateness of the earth is being found in error, according to preliminary analysis by the Army Map Service. H. G. Hertz and M. Marchant have calculated the value from NRL data on 1958β. They obtain an oblateness value of $1/298.38 \pm 0.07$ which is considerably smaller than the widely accepted value of 1/297.0. Calculations based on 1958γ yield $1/298.0 \pm 0.3$.

German moonwatch teams have been organized during the past six months and a number of radio tracking stations have been set up. Among the professional groups participating are the Max Planck Institute for Aeronomy at Lindau and Weissenau, the Technical University of Munich and the Astronomical Observatory of the University of Bonn. The Federal Ministry of Posts in Darmstadt serves as data-collection and communication center.

At a meeting this spring, H. K. Paetzold of Max Planck Institute presented some findings from analysis of the extensive records of 20 and 40 mc. emmissions of *Sputnik* I and II. One anomaly observed was reception of the signals "suddenly and with high intensity when the satellite was still far below the visual horizon." A conclusion reached was that the ionosphere itself acts as a conductor of radio waves. Much higher temperatures (1000°K at 200 Km.) at high altitudes have been concluded also. The reason for these higher temperatures is believed to be related to exchange reactions between stratospheric and interplanetary hydrogen and helium.

Another observation is that the braking effects of the atmosphere on the satellite are apparently not due solely to a higher density of the exosphere as such. It is believed "that they are also produced to a very appreciable extent by the satellite becoming electrostatically charged in its orbit. This then leads to the formation of a cloud of ions surrounding the satellite and tending to increase its virtual diameter with respect to the braking action of the stagnant parts of the exosphere."

Notes from all over—The ARS expects to welcome its 10,000th member before the end of the year . . . Dr. T. E. Sterne of Harvard Observatory has developed a simple and useful formula for inferring atmospheric density from earth satellite data. Bessel functions are used . . . June issue of RUIMTEVAART, bimonthly publication of the Netherlands space flight society, carries an interesting article (in English) on design and use of satellite optical observation equipment, by K. A. Thernoe . . . Helmut Gröttrup, former leader of German rocket team in U.S.S.R. after WW-II, is on editorial staff of RAKETENTECHNIK UND RAUMFAHRTFORSCHUNG (R und R), technical journal of the German rocket and space flight society. Gröttrup now lives in Pforzheim, Germany . . . The possibility of a "cold fusion reactor" is discussed in the latest issue of R und R.

Gatling-gun Rockets Developed at Armour

The Mechanical Engineering Research Department of Armour Research Foundation currently has two gun-boosted rockets under development, the T-134 and the T-132. Both use the high firing rate Gatling-type gun.

The T-134E1 automatic rocket launcher is a powder-gas accelerated, multi-barrel weapon designed to fire the 2.75-inch boosted rocket, T-131. The weapon is capable of achieving firing rates well above those of currently-used similar models. Included in the launcher mechanism is a powder-gas operated brake, which will stop the launcher in case of a hangfire round and when burst firing is completed. The gun is light in weight. Design, fabrication, and development is for the Air Force, under an ordnance contract supervised by Rock Island Arsenal.

The 38-mm T-132 launcher is another Gatling-type weapon that automatically fires at high rates. The T-225 boosted rocket is continuously fed during firing. Experimental models have been successfully tested, and several prototype launchers are now incorporating accessory devices designed to achieve burst firing control. The program is an Air Force development and is conducted under sponsorship of Redstone Arsenal.

A program to design and install the T-132E2 rocket launcher in an F-89 aircraft is being conducted by Armour Research. Sponsorship is by the Air Force, Air Materiel Command. Technical supervision is under Air Force Armament Center, Eglin Field, Florida. The program includes development of the feeding, ejecting, and gas-purging subsystems. Preliminary firings have been conducted with the launcher installed in an F-89 nose section.

Army Indicates Interest In Solid Fuel Rockets

An indication of Army interest in solid fuel rocket motors was a recent visit of Dr. Wernher von Braun, the Army's missile expert in the liquid propellant field, to Aerojet-General Corporation's solid fuel development areas near Sacramento, California.

Von Braun spent several days at the A-G plants at Sacramento, and exhibited interest in the company's solid fuel rocket motor developed for the Navy's *Polaris* program.

The Army expert also expressed interest in the dual first stage liquid fuel engine now in production for the Air Force *Titan* ICBM.

Space Exploraton Plans Seen "Inadequate"

Present space exploration plans—based on extrapolation of the nation's current rocket capability—are falling far short of what is needed for long-range planning of astronautical research and development.

This is the opinion of astronautics project manager John DeNike, of the Advanced Design Department, Martin Company.

DeNike, who lead a Martin team in preparation of a moon-base study program that was published two weeks before *Sputnik* I was launched, believes that studies of bases—for the moon, Mars or Venus—without regard to the purpose of the base, will bring about a definition of objectives for the nation's astronautics program, and a means of defining the research and development programs to accomplish these objectives.

The researcher, now in the process of defining the moon's environment and subsystem design, points out that the U.S. has produced programs for space exploration at a rate which rivals TV "western" outputs. "Basing man in space is the real mission—of which but a small part is Mission X—whether Mission X is scientific, military or commercial," he said. Only with this can the required systems—rockets, guidance, airframe—be realized, he added.

• **Moon base studies**—Martin has completed the initial phase of a moon base study. The company assumed a six-step development of the lunar base: these steps were initial landings, site selection, build-up and construction, beneficial occupancy, initial operational capability and moon base expansion. Five men were chosen for each of the first two missions; an Aviation Engineering Battalion for the build-up; 230 men for the occupancy; and about 1,000 for the initial operational capability.

Expansion was not numbered. Martin found the selection of numbers of men not critical to the requirements in all but the initial phases. Initial material requirements ran 2.4 tons per man; resupply of material was 52 pounds per man per day, oxygen requirements were 10 cubic feet per man per hour; and water was 20 gallons per man per day. Constructional material was pegged at 10,000 tons, about half the tonnage required to build a medium bomber base. Time for construction was estimated to be from four to six months.

Martin is on the second part of the study defining the environment and subsystem design. Defining the lunar environment is an extremely difficult task, the company discovered. After defining gross features—size, shape, mass, physiography—there is a divergence of opinion.

However divergence is not affecting design work, for the subsystem is largely independent of the physical property. While in most cases it is possible to resolve the differences in the light of latest experimental findings or theoretical work, Martin is treating the unknown as parameters in design work.

Foreign Information Center To Process Soviet Data

The Office of Technical Services of the Department of Commerce has begun operation of a Foreign Technical Information Center to provide American science and industry with access to translations of a large amount of Soviet technical data.

The services of FTIC include publication of abstracts of all articles appearing in 141 Soviet technical journals, translations of important sections of REFERATIVNVY ZHURNAL (the Soviet Union's own abstract journal), and a semi-monthly review of various areas of Soviet science.

Abstracts of each issue of the 141 journals may be published from OTS on a subscription or single issue basis, as also the Central Intelligence Agency's SCIENTIFIC INFORMATION REPORT.

The volume of material collected and disseminated by OTS is estimated to run at 50,000 abstracts and 10,000 complete translations each year. Congress has appropriated more than half a million dollars for the operation of the technical information center in FY 1959.

Missile Company To Study Utility of Sub Cargo Ship

The utility and feasibility of an underwater cargo vessel is currently being investigated by Aerojet-General's Underwater Engine Division, under a working study contract with the U.S. Maritime Administration.

The six-months program includes both analytical and experimental hydrodynamic studies. These tests will serve as a basis for the preliminary design of a ship which, when underway, will be submerged with only a thin strut or fin piercing the water's surface. This fin will sustain an above-the-water gondola in which the navigating and living areas will be located.

Preliminary design of this high speed subsurface vessel is oriented toward commercial rather than military lines.

Douglas Gets $24 Million for *Nike* Base Conversion

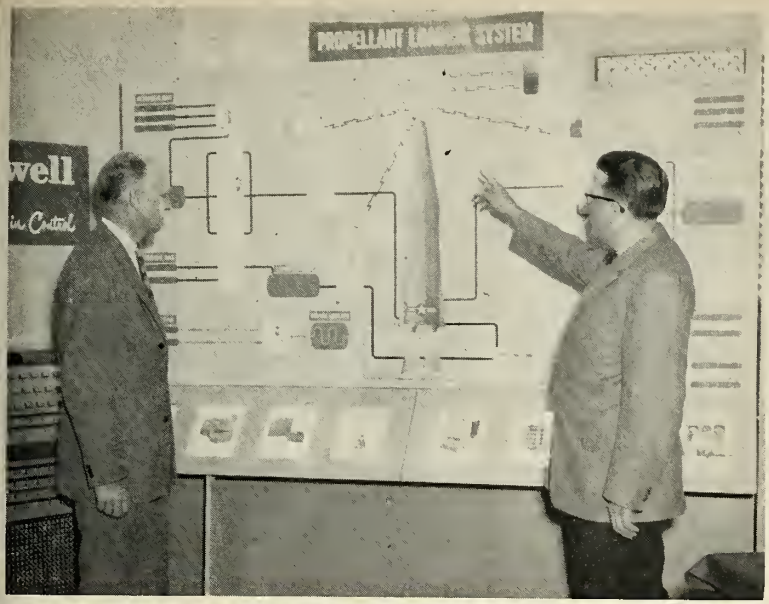
Army Ordnance has awarded Douglas Aircraft a $24,004,157 contract for launch equipment units as an addition to an original $48 million contract authorized to convert *Nike-Ajax* sites to *Nike-Hercules*.

Avco Expands R&D Space

Avco's Research and Advanced Development Division recently began the first part of its move into the corporation's new $16 million facility at Wilmington, Mass. The Avco Research Laboratory, a separate division of the corporation, is scheduled to move into the new facility later in the fall.

Some Research and Advanced Development Division operations are already underway in Wilmington. Dr. Lloyd P. Smith, president of the division, said that with the exception of some units of the Electronics Systems Department (which will remain in Boston), all units are now in full operation.

The new complex, designed to provide Avco with permanent facilities for work in basic and applied science and engineering, will total 440,000 sq. ft. in four integrated buildings. Additional buildings of 8,000 sq. ft. will house Avco's ballistics range, and 20,000 sq. ft. will house an arc wind tunnel.



COUNTDOWN TIME in firing liquid fuel missiles will be speeded by propellant loading system. Exhibit shows how system permits rapid automatic transfer of missile propellants. System can be modified for use in ground support of any liquid fuel missile.

Propellant Loader Speeds Up Missile Firing

A propellant loading system that materially shortens countdown time in firing liquid fuel missiles has been developed jointly by A. D. Little, Inc. and Minneapolis-Honeywell Regulator Company.

The system, first for any U.S. missile, was developed primarily for the Air Force's 100-ton *Atlas* intercontinental ballistic missile. It permits the rapid automatic transfer of liquid propellants from launching base storage tanks to the missile. Human error is eliminated, increasing accuracy and reliability in fuel transfer. The system, with modifications, can be incorporated into the ground-support equipment of any liquid fuel missile.

Honeywell's Missile Equipment Division in Pottstown, Pa., developed the control system under contract to the Little firm (of Cambridge, Mass.), a prime contractor to the Air Force Ballistic Missile Division.

The *Atlas* uses liquid oxygen (LOX), RP-1, a hydrocarbon—and helium pressurizing gases.

The propellant loading system consists of a relay matrix-type sequencer, indicating and control devices, high pressure shut-off valves and the necessary storage tanks and piping.

The sequencer is the "heart" of the control system, monitoring the action of other system components. It programs the succeeding steps in the loading sequence by verifying its own action.

Automatic programming of the propellants is done with high accuracy, in a safe manner and under stringent requirements, so that there is a minimum of loss of propellants before and after loading a missile.

Two of the precision valves, for example, are designed to exceed rigid military specifications. One, a 10,000-pound high pressure valve with a 6,000-pound differential across it, has a guaranteed leakage rate of no more than one cubic foot per year. Another, a 12-inch LOX valve, has a guaranteed leakage rate of less than 1/200th part of one percent.

Ultra High-Strength Steel Aids Missile Production

An ultra-high-strength steel that is said to make simplified production of missile parts possible, has been announced by U.S. Steel Corp.

According to U.S. Steel President, Clifford F. Hood, the new steel will outmode huge tanks used to oil or salt-quench large fabricated sheet steel missile components.

Designated "Airsteel X-200," the new material was developed after more than two years of research effort, and is the result of "proper balancing of various alloying elements," Hood said. After tempering, it develops tensile strength levels in the 280,000 psi area, without oil or salt quenching; has a tensile strength level six times that of sheet steel used in automobile bodies; and can be welded by conventional methods with an "unusually high" weld seam strength.

The metal is produced in an annealed (soft) condition, and, according to the manufacturer, can then be readily worked or formed to missile configurations. After forming, the section is heated and left to cool at normal air temperatures, in order to develop strength and hardness.

Its advantage, according to the steel company, is that missile steel of this strength level, chemical composition and weld effectiveness usually requires quenching in oil tanks to develop high mechanical properties in thin-walled missile applications. Airsteel, however, won't need such tanks as a part of the manufacturing operation.

Navy Awards Contract for Packaged Liquid Engines

In an action said to be the first military commitment for production of such units, the Navy last week awarded a contract for production of packaged liquid rocket engines. The move was said to be the first step in development of a "family" of liquid propellant rocket engines based on a specialized design concept developed by the manufacturer.

The contract, for an undisclosed amount, went to Reaction Motors Division of Thiokol Chemical Corp., Denville, N.J. Under the cognizance of the Navy's Bureau of Aeronautics, the contract covers production of the rocket engine which Reaction Motors has designated as the *Guardian*.

The engine, LR 44-RM-2, can be supplied in fully-loaded condition, complete with propellants loaded at the factory, Reaction Motors said. Based on simplicity in design and operation, the *Guardian* engine is said to be an integral unit which includes propellant tankage, thrust chamber and all components necessary for its operation. Officials said the engine can be safely stored, and fully loaded with propellants for "extended periods" of time.

Lockheed To Produce Ground Support Equipment

One of the nation's largest aircraft manufacturers has announced it has entered the allied field of producing ground support equipment for missiles and aircraft.

Lockheed Aircraft Corp., Georgia Division, has established a "Special Products" branch to design, develop and produce support equipment. It will also sub-contract work for other companies on tools, parts and assemblies, and sell services.

- **Ground-Support for Missiles Calls for Special Design**
- **Few Single Firms Can Supply It. That's Why . . .**

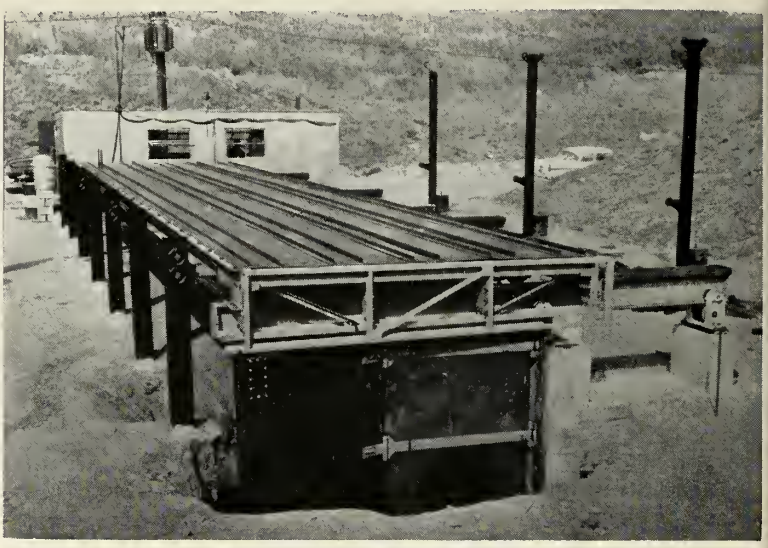
Thompson Products Assembles A Special Team

by Richard Van Osten

LOS ANGELES—With ground equipment reaching the economic proportion of 70% of the cost of a missile system, industry is faced with a new challenge—the creation of simple, economic hardware that performs with reliability and precision.

That's the spur behind the recent creation of the Tapco Group by Thompson Products, Inc. This move by Thompson's management places the company's five divisions—Accessories, Jet, Electronics, Pneumatics and West Coast—under a single sales, engineering and administrative management team to coordinate the design of components and subsystems for missiles.

Among the products undertaken by these divisions, either individually or cooperatively, are: a mobile launcher for a tactical missile; a mobile ground checkout system for a missile autopilot; a hydraulic supply unit; a launch pad cooling system; a checkout building coolant system; and a fuel transfer service vehicle.



SHELTER for *Bomarc* poses problem in mobility and weight-carrying.

• ***Bomarc* shelter**—An example of the projects that missiles have made necessary is the Thompson-built roof panel and door actuation system for the *Bomarc* missile shelter (see photo). This task was assigned under contract with Burns & Roe, Inc., prime contractors for *Bomarc* handling and service equipment. First installation of the system is to be at Suffolk AFB, N.Y., in late summer.

Design requirements for the roof and door actuation took the job out of any run-of-the mill project class.

The 10 x 60-ft. roof panels, weighing nearly 15 tons each, present an effective roof area of 10 x 80 ft. With all possible wind and snow loads taken into consideration (max. snow load assumed at 30 lbs. per sq. ft.) the total roof load could reach 54,000 lbs. The specification further required that the roof must open fully in less than five secs.

Coupling the folding end doors with roof panel actuation leaves the 20 x 60-ft. inter-panel space with open ends. The unsupported concrete side walls are subject to the missile's full initial blast, and as the vehicle rises, the power plant's stream is thrown against the extended roof panels.

The final actuation system is a combination of mechanical, hydraulic and electrical components. There are actually two identical interlocked systems, one for each roof half and set of end doors.

• **How it works**—Principal power is supplied by 3,000 psig hydraulic accumulators, one for each system half. A 4,500 psig auxiliary system is provided by a separate component of the system in the event of primary system failure.

Hydraulic fluid is transmitted through a control valve system to a seven-ft. long, double rod end hydraulic cylinder. Stroke of the power cylinder is 71½ in., and the bore is 4.022 in. Drive racks attached to each cylinder end furnish a rotary motion to double pinions mounted in housings in line with each cylinder end. Rack-to-pinion gear ratio is 1:1.833.

When the lower pinion rotates, power is transferred to the roof rack through a second gear keyed to the pinion shaft. Roof, or driven racks, are located at 90° to the shelter walls. Thus, a linear motion parallel to the wall is transferred to a linear motion parallel to roof movement.

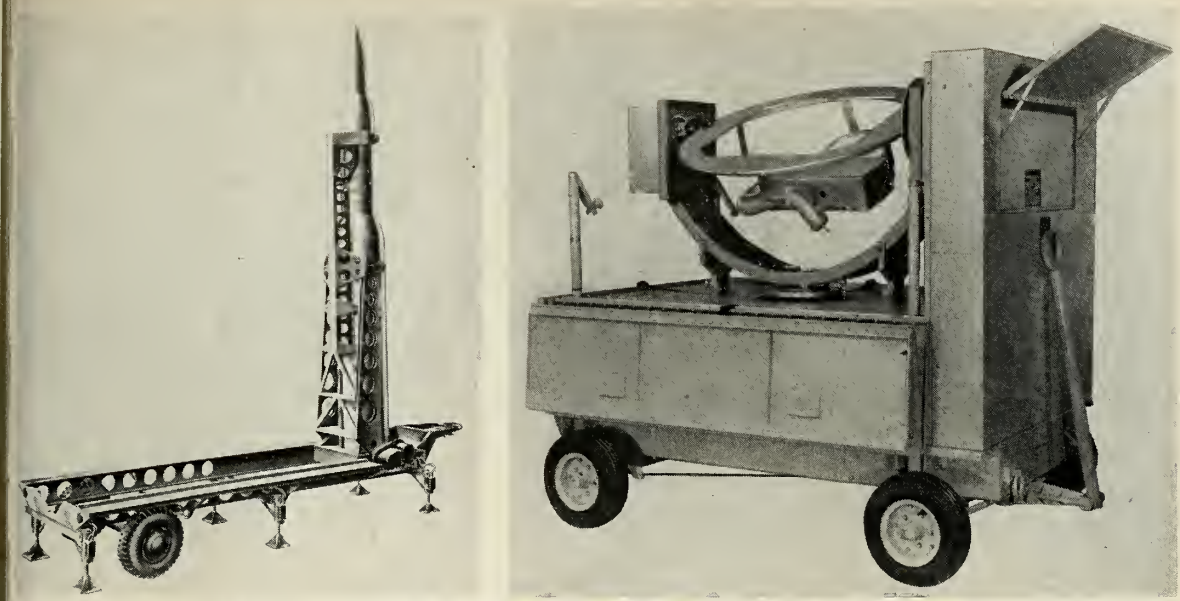
A roof latching mechanism is mounted on the housing and pinion assembly. This consists of a hydraulic cylinder, latch bar and a switch actuating arm. The cylinder piston is actuated by hydraulic pressure for its downward motion and by a spring for upward travel. Switch actuation is integrated into the system's operational sequence.

The 22-in. thick roof panels are held by latch bars which engage slotted brackets mounted on structural roof members.

Adjustment for roof rack-to-gear mesh is provided by a rack mounting that allows for temperature variations without additional stresses. Also, there are two possible locations for each housing and pinion assembly.

Roof deceleration is controlled by a valve which is actuated by a cam bar on the power piston rod. During roof opening, the bar is pulled between the deceleration valve plunger and a back-up roller. When the cam profile depresses the valve plunger, oil flow is diminished and the roof slowed down.

High pressure oil to the power cyl-



MOBILE LAUNCHERS and ground check-out vehicles are only part of the support equipment that must be produced.

inder is controlled by a four-way, pilot-operated, double solenoid, spring offset hydraulic valve on the manifold block. A similar single solenoid valve controls oil flow to the latch cylinders.

A check valve in the manifold block ensures minimum pressure in the hydraulic circuit at all times. Another check valve in the line from the manifold block to the power cylinder allows free oil flow for roof opening, but restricts flow when the roof is closing.

Thompson has built an $80,000 full-scale mockup of one roof panel and end door at its missile subsystem and test center near Roanoke, Va. Approximately 600 test cycles have been run to date with 925 cycles necessary for test completion. Specified service life is 10 years, but cycles completed equal 25 years of operation.

• **Trailer erectors**—The Tapco Group is also developing a trailer-erector mobile launcher for a tactical missile that will transport the missile over rough terrain as well as highways. Incorporating elevation and positioning mechanisms, the missile may be fired directly from the transport without deflection or damage to the vehicle.

Simple in design, the launcher can be positioned, leveled and stabilized and ready to fire in less than 25 minutes. The elevating mechanism returns the missile to transport position if plans are changed. All accessory power is supplied by a prime mover attached to the transport-launcher during the mission.

Several design criteria were established by Tapco to meet basic logistics of high mobility, utility and minimum setup time for the launcher.

The first was reliability for safe and successful mission completion. This led to a high degree of vehicle utilization and reduced over-all system cost. Second criteria was low weight and minimum size to increase mobility and air-lift capability. Lower weight also means lower costs.

Maintainability was the third criteria. An attempt was made to reach an optimum balance between feasible levels of personnel efficiency and mechanical complexity to minimize maintenance problems.

• **Organization**—Several divisions of the Tapco Group as well as other Thompson divisions are supporting the development program. The automotive divisions are contributing to the design and production of running gear parts—brakes, axles and suspension systems. (The company late last week also acquired Federal Industries, Inc. of Detroit, a producer of transmissions and power-steering pumps.)

The West Coast division will furnish the hydraulic actuators and control valves, and the Electronics division is involved in assembly and fabrication of the control console prime mover connection. Some component fabrication and all system assembly and test will be done at Thompson's Cleveland, Ohio plants.

Phase I, an eight-month development program, includes design completion, component procurement, preliminary qualification tests and the delivery of several research and development units to the prime contractor.

Phase II will include Thompson's participation in contractor field tests, including actual firings. These and other tests will be required to qualify the unit for production release.

In the design and development of the ground checkout vehicle for a missile autopilot, Tapco's Electronics division delivered two completed units within seven months of starting the project. For such units as the hydraulic supply system, launch pad coolant system, checkout building coolant system and the fuel transfer service vehicle, the Accessories division was ideally suited for the tasks because of its experience in design, development and production of aircraft hydraulic, pneumatic and fuel system components and accessories.

The Thompson group reflects a growing trend throughout the missile industry—a gathering of corporate ability to diversify activities. It might be roughly described as a variation of the much-overworked term "systems management," which is little more than coordination of proven capabilities.

In Tapco's field of activity, ground support equipment, this coordination of effort should take on new importance as more and more weapons systems come into operational use. Present estimates range from 30 to 70% as the figure which will represent the ground support's share of the missile dollar when most of the weapons systems now in various stages of development become tactical devices in the hands of troops.

missile people in the news

Management

Harold E. Gruen recently joined Delta-f Inc., Batavia, Ill., as vice president of Engineering. Delta-f designs, develops and manufactures precision frequency control equipments and systems for the electronics industry. Gruen comes to Delta-f from Armour Research Foundation, where he served as a research engineer.

Dr. Stephen F. Malaker was elected to the board of directors of Trio Machine Works, Inc., Philadelphia. Dr. Malaker is president of Stephen F. Malaker Associates of Newark, N.J., consultants in atomic energy and electronics, and professor of nuclear engineering at the Newark College of Engineering.

Lt. Gen. Roger M. Ramey (USAF Ret.) has become a corporate vice president of Northrop Aircraft, Inc., in charge of the company's district offices. Gen. Ramey will supervise the activities of Northrop offices in Washington, D.C.; Dayton, Ohio; Omaha, Neb.; Ogden, Utah; Huntsville, Ala., and Colorado Springs, Colo.

John J. Black was elected assistant treasurer in recent action by International Business Machines Corp. He was formerly controller for the company's Data Processing Division, which manufactures and markets IBM computers, and accounting machines.

Richard M. Johnson was appointed president of Koehler Aircraft Products Co., subsidiary of New Britain Machine Co. The announcement was made in conjuction with the retirement of **R. T. Firsbie,** chairman of New Britain's executive committee.

William H. Balentine, manager of the Instrument Division, has been named a vice president of Thomas A. Edison Industries. He will continue as manager of the division, a post he has held since August, 1957.

Everett J. Long was appointed director of the Transducer Division, Consolidated Electrodynamics Corp. Long was formerly assistant director for operations of the Transducer Division. Joining CEC in 1952, he was manager of the Special Products Divisions before becoming production manager of the Transducer Division.

Warren F. Morgan has become vice-president in charge of marketing at Federal Electric Corp., Paramus, N.J. He had been vice-president in charge of customer relations.

Department Heads

Oscar B. Robey has joined Motordyne as head of the company's new Gyro Division. The new division will manufacture precision gyroscopes for the aircraft/missile industry, in addition to various gyro-type devices such as "pancake" synchros and special torque motors.

Edward R. Nauman has been appointed general manager of the Longhorn Division, Thiokol Chemical Corp. He succeeds **W. R. Ignatius,** who recently died. As general manager, he will direct activities at the Longhorn Ordnance Works, a government facility Thiokol operates for the Army.

A. J. Toering has been named manager of the new Defense Products Department of Callery Chemical Co. The new department will offer technical service on fuels and propellants to the aircraft and missile industry and to the Department of Defense.

Roy J. Sandstrom was appointed to the post of technical director of the Martin-Bell management team for the Dyna-Soar manned space vehicle, Bell Aircraft Corp. As technical director of the Dyna-Soar project, he will be in complete charge of design, planning and construction of the space vehicle.

Jay L. Fisher has been named production manager for the Federal Instruments group of the Industrial Products Division of International Telephone and Telegraph Corp. He will be responsible for planning and directing plant production, purchasing and production control operations for the division's large screen oscilloscopes, bar graph oscilloscopes, swept frequency generators and other electronic precision instruments and instrumentation systems.

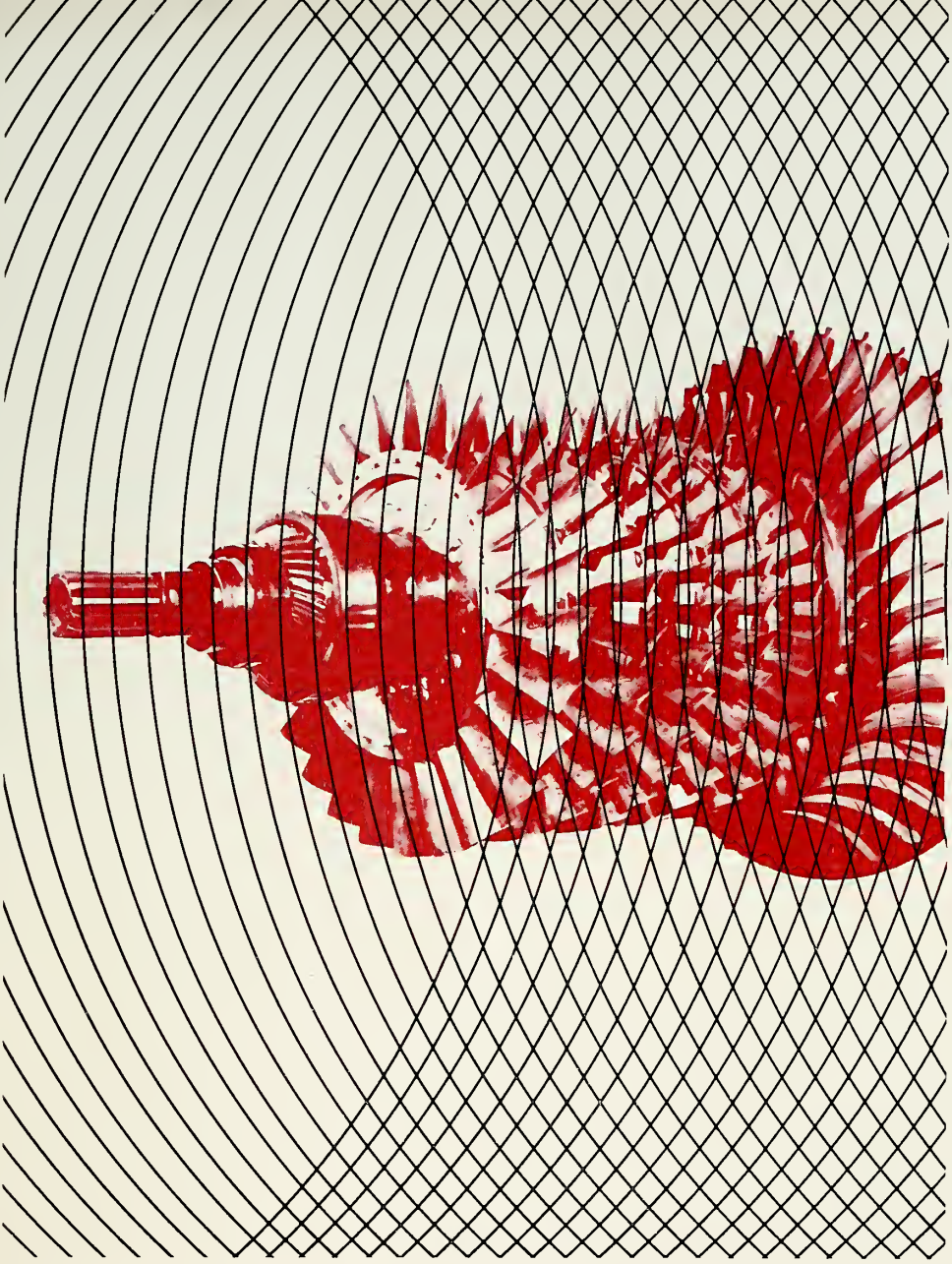
A. A. Sroka has been promoted by Ampex Corp. from instrumentation sales manager in its Central Atlantic district to national sales manager for its Instrumentation Division.

Harry A. Carragher was appointed District Representative in the Washington, D.C. office of Land-Air, Inc. He will be responsible for government activities of the company's Washington District.

Engineering

Homer Austin was appointed by Whittaker Controls Division of Telecomputing Corp. as field engineer in charge of its new Fort Worth-Dallas Field Engineering Office. Austin brings to Whittaker experience in the aviation and missile controls field through service with Lockheed, North American Aviation, and Aviation Maintenance Corp.

Jack D. Zeff, formerly a chemical production engineer with the Toni Division of the Gillette Co., has been appointed a research engineer with American Machine & Foundry Co.'s Mechanics Research Division.



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