DECEMBER 5, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY

esting Centaur's Liquid Hydrogen System

NTERVIEW WITH AF'S WILSON—

)o We Have 'Second Chance' in Space . .

\utomation Enhances Component Testing . . 40

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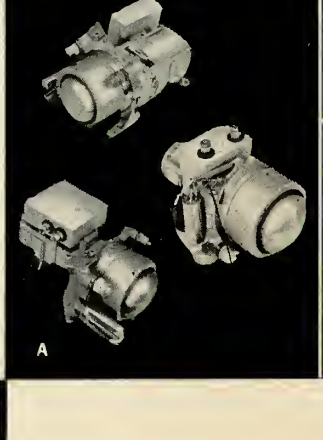

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missiles and rockets

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THE COVER

Special test rig at Point Loma, near San Diego used by Convair for cold flow tests of heavy-walled second stage tank for liquid hydrogen system of Centaur. See p. 38.

DECEMBER 5 HEADLINES

OPTICS

ENGINEERING

SPECIAL FEATURE

ADVANCED MATERIALS†

PROPULSION ENGINEERING*

ELECTRONICS

DEPARTMENTS

*U.S. Reg.
†U.S. Reg. Pdg.

32,794 copies this issue

letters

On Space Photography

To the Editor:

I read, with great interest, your editorials. On account of my early connection with the Guided Missile program, I find it helps to keep me up to date on this important segment of our scientific developments for our services.

Your editorial of Nov. 7 ("Samos—and What Happens Then?") raises the question of space photography. For me, it is still simple. Traditionally, we have allowed photographers to break down privacy. Always, somewhere around, there seems to be someone with a flash camera who shows up and takes pictures of individuals at the most unsuspecting moments. Those who take them think they have the privilege, and about the only defense the individual has is, if the man is close enough, to kick the camera or smash it up; then you are a nasty aggressor and unsocial, because you are denying, to the curious, certain assumed privileges. In reality, these privileges are really the privilege of the photographer making his living and the newspapers making their product more desirable to more and more readers.

With the tremendous developments in photography and the long range at which pictures can be taken, you get into technical question of how much space belongs to the separate and national boundaries. You can take quite a number of pictures in Russia without being technically over Russia. It therefore seems to me that this international problem is not going to be solved on technical grounds. It will be only a short time, relatively speaking, until hardware will be developed that will shoot down satellites or make them inoperative. Then the problem will be, "How will you control your retaliatory hardware so that it does not bring down a satellite that is technically above some geographic location other than the boundaries of the nation shooting it down?" Therefore it seems to me that this is not going to be solved by words. And here again, the advantage is going to go to those who are technically- and hardware-equipped to best exploit this field.

K. T. Keller
Detroit

Pye and Spadeadam

To the Editor:

I have read your article on "Britain's Big Rocket Test Centre" (M/R, Sept. 19, p. 52) and think that, in general, it is a very good article.

I consider, however, that you have not done full justice to the contribution made by my Company to this project. You do say on page 54 that "The control room for this Site has been instrumented by Pye Ltd.," but that is all. In fact, my Company was one of the major sub-contractors on this project and was responsible for the whole of the instrumentation of the Site,

t only of the Engine Control Room.
I trust that you will not mind my inting this out to you. It is quite possiy our fault for not having advertised ir wares previously, but this has been ie to security restrictions.

T. Dorricott, Project Mgr.
Spadeadam Group, Pye Ltd.
Cambridge, England

M/R 'Gaffes'

the Editor:

Permit me to make one remark rerding the story "MATRA-Mirage: An ll-French System" (M/R, Sept. 26, p.).

You state that the air-to-air *R. 530* obably has thrust/guidance control unke the *Falcon*. Our missile has aerodynaic controls like its predecessor, the *R. 1*.

As for tactical aircraft equipment, our mpany manufactures most of the airunched free-flight rockets used by the rench forces.

R. Robert, Technical Director
Engins Matra
Boulogne, France

the Editor:

We are always pleased to have our oducts appear within the covers of ISSILES AND ROCKETS. We are particurly pleased when our products are identd as such, rather than as the products some other company, something which curred on page 24 of M/R, Oct. 10. e *5103* is Nord's and not Matra's. At st this was the position you took in a cent issue when you did a very excellent ticle on the *5103*.

Donald G. Agger, Director
American Office
Nord-Aviation S.A.
Washington

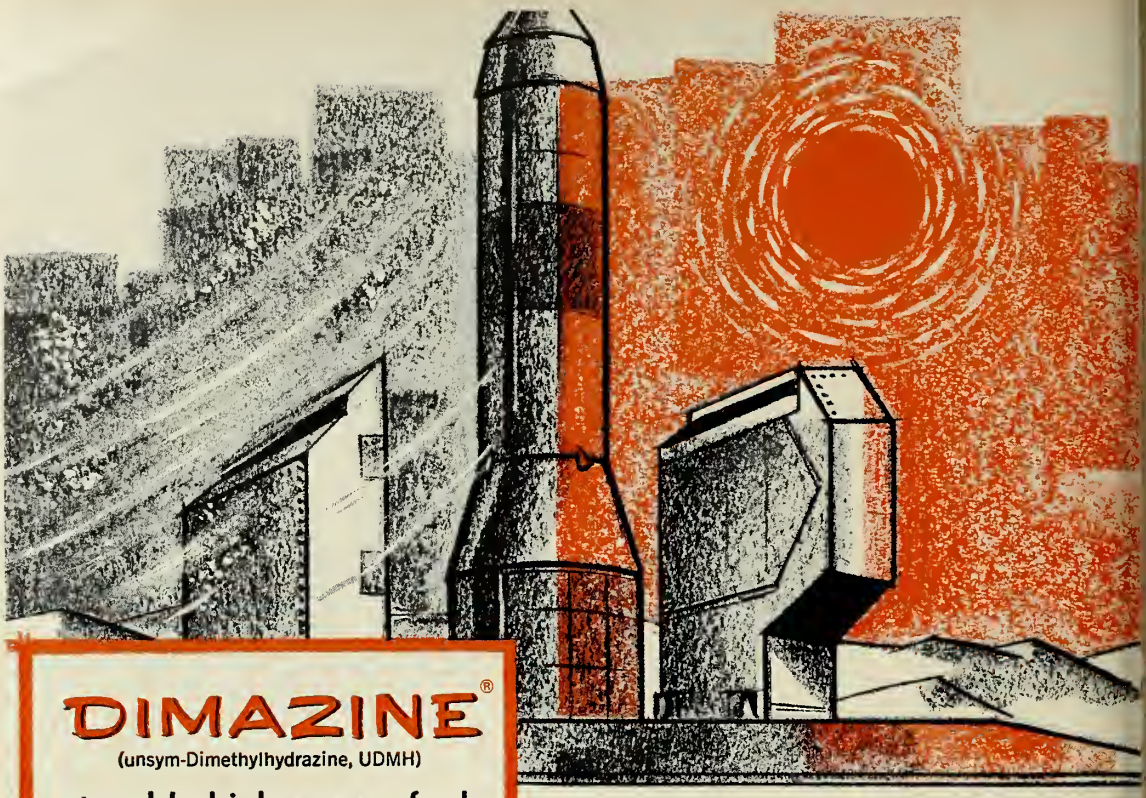
yna-Soar Propulsion

the Editor:

I wish to call your attention to an consistency in your November, 1960, trolog. The *Dyna-Soar I* propulsion ntractor is listed as The Martin Comny. Since the description for the *Dynar I* lists the booster as a *Titan I*, the opulsion contractor should be Aerojeteneral, as you have correctly listed for *itan I*. The Aerojet-General Corporation ill supply man-rated propulsion systems r the Air Force *Dyna-Soar* "man in ace" program.

W. G. Cowdin
Technical Program Manager
Dyna-Soar Program
Aerojet-General Corp.
Sacramento, Calif.

M/R intended no slight regarding erojet-General's work on the Dynaar program. The R&D contract arngements for Dyna-Soar I call for using itan I as the booster. Since The Martin . is prime contractor for the Titan I issile, it is in this sense the propulsion ntractor for Dyna-Soar I.—Ed.



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The Countdown

WASHINGTON

Smoke Along the E-Ring

Whatever rejuggling takes place in the Pentagon under the new administration, the Army and the Navy can be expected to remain "allies" against the Air Force. They are sticking together in hopes of getting a bigger percentage of the DOD budget for limited war. First show of strength could come over the Navy's bid for more *Polaris* subs faster and the Army's bid for *Pershing II*.

Squeeze on Weather Satellite

COUNTDOWN hears the Eisenhower Budget Bureau is allowing the Weather Bureau to request just $2.2 million in FY '62 for R&D in using satellite weather information. It also is being allowed a $1 million downpayment for a special communications net. This is $300,000 less than the bureau wants for R&D and $1.5 million under its communications requirement. But the picture could change in a Kennedy supplemental budget.

Whither Defender?

Insiders tell COUNTDOWN that ARPA's Project *Defender* may need several more years—at least—to gather sufficient data for development of an advanced antimissile system. The present *Defender* budget is running about $130 million.

Shillelagh Still Swinging—Slowly

The Army is still keeping the wraps tightly wound around the R&D program aimed at bringing forth the lightweight *Shillelagh* missile. (So secret is this bird, that the Army isn't even saying what it is for. Best guess: anti-personnel). It is understood that one of the problems in pushing the program along may be money. And the Army would like to give it a shot of funding.

Pickering for Dryden?

Government transition watchers are placing bets that Dr. William H. Pickering, JPL director, will get the job of Dr. Hugh L. Dryden, who will retire in January as NASA deputy director.

Saipan 'Fence'

There's word that the whole north portion of Saipan is being fenced off by the U.S. Reason: possibly to build a Navy ULF radio station for communicating with Pacific-based *Polaris* submarines.

Resuming Nuclear Tests?

Diplomatic circles are buzzing with reports that the U.S. will drop its nuclear test ban soon after Kennedy takes office. The British are said to be so certain of this that they are already preparing another series of tests on Christmas Island in the Pacific. Presumably they would be firing bigger weapons than those now in stock.

Beacons in the Deep

Some Navymen are pretty certain Soviet hydrographic expeditions are laying short-range (about 1 mile) radio beacons on the ocean floor. Beacons would be used by missile-equipped Red subs to home in launch positions without the need for *Polaris*-type inertial navigation.

INDUSTRY

Reviving Renegotiation

Industry has until Dec. 15 to submit suggestions for improving the Renegotiation Act to the Joint Internal Revenues Taxation Committee. The Committee expects to include the suggestions in a report to Congress next March 31. The recommendations should avoid the procurement area which is being handled by the Armed Services Committees.

Titan Bugged

Launch of the first *Titan* at Vandenberg AFB from a silo configuration, originally set for this month, has now slipped several weeks. GSE reportedly has developed electronic bugs which caused the shot to be removed from the launch schedule.

Base Building Speeds Up

Army Engineers report time lost through strikes on ICBM base construction sites dropped 30% in the six months ending Oct. 31. They expect further improvement in the current period. Several more *Atlas* pads are expected to be turned over to SAC in the next few months.

Sonar Proficiency Down

Navy recently tested 400 Pacific fleet sonarmen and came up with this disturbing report: "On the average, ability of sonarmen to operate electronic test equipment. . . . was poorer than desirable." Efforts are now underway to raise proficiency.

INTERNATIONAL

Secret British Missile

Reports are circulating in London of a new British air-to-ground missile which can fly at treetop height. The secret bird is said to be intended for the RAF's new bomber, the TSR 2, which is designed for land "contour" flying to get under enemy radar.

Firestreaks Score 80% Hits

In first full-scale training firings from Sea Vixen aircraft, the British Navy's air-to-air *Firestreak* is reported to have scored 80% successes against target aircraft. The Defense Ministry is said to be pleased.

Overseas Pipeline

Dr. Theodore von Karman is the first director of the newly formed International Academy of Astronautics, headquartered in Paris . . . Japan's Defense Ministry is earmarking $2.2 million for lead production of 11 different missiles (a total of 1217 rounds) most of them air-to-air . . . and Swedish Prof. Torbnjoern Caspersson reveals the invention of a microspectograph which he believes may be able to determine whether life exists on other planets.

Soviet View of Polaris

A Russian Water transport newspaper, *Vodnii Transport*, in a two-part series has reported details of the *Polaris* system. Most significant items: *Polaris* missiles are launched while the sub is "at a depth of 25 to 30 meters" and ignite "20 to 25 meters above the sea's surface"; U.S. nuclear submarines "stay under 95-98% of the time with speeds up to 30 knots instead of 10 knots . . . although speeds of 40 to 60 knots are now possible."

OPERATIONAL!

Just 46 months from scratch, the
arms its first Polaris missile subm

The Navy's Fleet Ballistic Missile weapon system is now operational. Somewhere in the seas that cover t
fourths of the earth the USS George Washington is on station, armed with 16 Polaris missiles. Thus
a race against time; thus begins a new hope for peace. Lockheed, prime contractor and missile system n
ger, hails Aerojet-General, General Electric, Westinghouse, and the thousands of associated contra
large and small, who helped bring the Polaris missile to operational status.

LOCKHEE

MISSILES & SPACE DIVISION • SUNNYVALE, CALIFO

The Missile/Space Week

SAINT Contract Opens Way for Satellite War

The possibility of future satellite wars in space moved a step nearer reality this week with Air Force's selection of RCA to demonstrate the feasibility of a satellite rendezvous and inspection system.

The system—unofficially known as *SAINT*—would involve launching satellites capable of determining whether other satellites contained scientific or military equipment.

Lt. Gen. Bernard A. Schriever, ARDC commander, said flatly that *SAINT* is not "in any sense of the term offensive in character." He said *SAINT* satellites would "carry no armament and represent no threat to any other nation."

However, it was certain that the Air Force would seek development of a complementary system to combat any offensive satellites that *SAINT* might discover.

RCA will develop the final stage vehicle and inspection payload for *SAINT*. BMD will manage the program. Aerospace Corp. will provide technical supervision. The first launching to test rendezvous techniques is expected within a year.

NATO, 'The Bomb' and the Growing Nuclear Club

The issue of arming the NATO Alliance with nuclear-tipped missiles is continuing to claim prime attention in military conferences and debate.

U.S. Military leaders from round the earth gathered at SAC headquarters in Nebraska this last week to discuss American military posture—and particularly the assignment of strategic targets. High on the agenda: The future role of NATO in the strategic forces of the Free World.

Meantime, Gen. Lauris Norstad, NATO commander, said at Rome that his proposal to make NATO a "fourth atomic power" would not expand the national membership of the Nuclear Club.

Two days later a Dutch defense spokesman hinted that the Club already has been expanded. He said Holland has a stock of nuclear warheads for use by the Dutch and West German armies. Source: unknown.

Transit Schedule Jolted by Launching Flop

The failure of a *Thor Able-Star* booster to place the Navy's *Transit III A* navigation satellite in orbit last week appears to have at least partly wilted hopes of beating the planned 1962 operational date (M/R, Nov. 28, p. 15).

The Nov. 30 launching attempt was a double header. The booster carried both *Transit III A* and a second smaller satellite as did *Transit II A* last June. The booster was destructed shortly after take-off.

At present, possibly six more *Transit* satellite launchings are planned in the Navy's R&D program.

Ranger

Final configuration of lunar landing capsule being built for JPL by Ford-Aeronutronic has dumbbell shape. 300-lb. capsule should telemeter data for month after hitting moon.

Does the U.S. Have 'Second Chance' to Beat Russia?

America is still in a better position than Russia to win military control of space, says AF R&D boss, but 'we have no time at all' to get moving

by James Baar

THE CHIEF OF AIR FORCE R&D said this week the United States must win military control of space or face losing the world to Russia.

The statement by Lt. Gen. Roscoe C. Wilson forcefully underlined one of the coming key defense decisions that confronts the new Kennedy administration.

The question in its simplest terms is: How important is military control of space within the next decade to the security of the United States and the Free World?

The Eisenhower Administration consistently has taken the position that space is of little military importance beyond a few hundred miles out at the very most. President-elect Kennedy sharply disagreed during the election campaign. He said military control of space is of vital importance.

Lt. Gen. Roscoe C. Wilson
IF WE SQUARE while they cube, we've had it.

The public argument has generally stopped here. So far, little attention has been paid to the military thinking behind statements advocating a much greater military effort in space.

Here is how General Wilson expressed that thinking in an interview:

"The essence of military supremacy is access," the graying, 55-year-old general said, speaking in the quiet tones of a university scholar. "This made Britain dominant in the Naval Age. This made the United States dominant in the Air Age. It doesn't take much imagination to carry this into the Space Age.

"Russia sits right in the ancient heartland surrounded by buffer states. The only thing that has kept Russia under control is our supremacy in the air. The air alone did this until the missile came along and the missile won't last forever. The means of access to Russia will be aerospace. Turn that around a little and you're looking down at the United States."

Wilson paused and lit a cigarette.

"Whoever dominates space is going to dominate the earth," he said.

Wilson talked while sitting at his desk in his fourth-floor Pentagon office. He was dressed in a well-cut gray suit. Books were piled on a nearby table and on top of crowded bookcases along one side of the room. All four of the room's softly-shaded blue-green walls were hung with paintings and etchings depicting the exploits of the Air Force in the three great wars of the last fifty years. Behind Wilson stood his red-and-white three-star flag.

"There is no doubt in my mind that the Russians are moving toward control of space as fast as they can," he said. "But in order to do this they are going along a very narrow path. Here is where we have an advantage today.

"The United States is in a much better position to beat Russia to the draw in achieving this kind of capability in space because we have a much wider technological base. And we are generating more new technology than the Russians."

But Wilson emphasized that he believed the present U.S. technical advantage was ephemeral.

"I would say that we have no time at all," he said. If we were to maintain our present pace, we would very shortly be behind. We must accelerate in all our fields at least as fast as Russia—which is exponentially. If we square while they cube, we've had it."

Wilson said a fact many people still do not appreciate is that human knowledge is increasing at a tremendous rate.

"Leonardo da Vinci was the great genius of the Renaissance, he possessed what was then considered universal knowledge," the general said. "Today, Leonardo's knowledge would be considered on about the level of a bright high school senior.

"The knowledge of mankind appears to increase by

generations on a curve which is rising exponentially. And, interestingly, it just about matches the curve of population increase."

Wilson grinned.

"Is it our knowledge and brain power or do we imply have more people thinking? I think it is a synthesis. But whatever, the great increases are a fact—and we must keep up. The answer is hard work.

"I myself have little trust in relying on the inventor. The guy who wakes up with a new idea generally is wrong. The true invention really comes from the man who is the heir to all the generations and who has applied himself. By grace of God, we have people working in every field."

• **Propulsion urgent**—Turning to specific U.S. needs, Wilson said "the outstanding area" where the United States must advance is in the field of propulsion.

"We are limited in everything we do by necessity," he said. "We haven't really begun to exploit all we know about chemistry. And there is a great field of effort waiting for us in such areas as nuclear propulsion, plasmas and electrical systems.

"However, propulsion is only the outstanding area. We must carry on basic research in every field. We must increase our basic research. We must do a great many things in applied research.

"The Air Force is spending some $42 million this year on basic research exclusive of our in-house work. We hope to double this within the next few years. Today we are funding only half of the things we think we should. But I would hope that by the time we have doubled our money, we would have many new things that we should begin working on. If you are ever convinced that you are doing everything that needs to be done in research, you are out of progress."

Wilson said the speed with which many of these needs are fulfilled depends directly on "our ability to bear the expense and industry's ability to reduce the cost."

"Here's a pincer movement to get working on," he said. "It now costs us $1000 to put one pound in orbit. If we're going to think about military space systems we must work to get the price down to $100 a pound.

"We must increase reliability. We must improve support systems. We should make boosters recoverable. This kind of thing will bring down the price. It will take a lot of money to do it."

• **Realization**—However, Wilson said he believed that the United States was coming to realize that the effort must be made.

"The United States and Russia are engaged in a struggle that will determine whether the state is going to own man or man is going to own the state," he said. This is what is at stake in space.

"The Russians are ahead of us in many areas of space, but they got there by the accident of developing a big booster early. That happy accident gave them a leg up and they've exploited it. But because of our technological advantage we have come along with our missiles and now we have a second chance to go ahead in space."

Wilson tapped his desk to emphasize his words.

"If we want tomorrow's world to evolve in the image of our desire, we better by a damn sight take that second chance." ⌗

Scholarly General

ONE OF ROSCOE CHARLES WILSON'S earliest memories of military life is of the day he spent in the guard house at Wyoming's old Ft. Russell when he was about eight years old. He was put there by his father, then an infantry captain, for swiping some .22 ammunition while his father's regiment was on maneuvers.

Today Ft. Russell is Warren AFB, site of three of the nation's first *Atlas* squadrons. Wilson is a lieutenant general and Air Force Deputy Chief of Staff/Development.

The changes both have witnessed in nearly a half a century are almost equally revolutionary.

The tall, soft-spoken general's entire military career has formed a pattern of shifts from operational duty to the classroom to technical staff assignments.

He returned twice to West Point to teach after his graduation in the Class of 1928. He served during World War II with a B-29 wing in the Pacific. He was commandant of the Air War College. He commanded the Third Air Force in Europe in the mid-50's.

Significantly, this scholarly general has geen associated with nuclear weapons since their inception.

During World War II he was the Air Force liaison officer with the Manhattan District. He personally selected the site at Alamogordo for the first atom bomb test. He organized and equipped the unit to send the first A-bombs against Hiroshima and Nagasaki. He was one of the first Americans to inspect the ruins of Hiroshima after the war. And in the late '40's he helped direct further development of nuclear weapons leading toward the H-bomb.

The Air Force named Wilson to his present post in July, 1958. He brought to the job one of the most wide-ranging and literate minds in the Air Force.

The man who passes on all Air Force R&D programs is also highly knowledgeable in such diverse fields as history, English and classic literature and Renaissance art. He has been known to pause at a place like Concord and point out where various Minutemen fell. He can explain in detail the tactics of Marlborough at Waterloo. Elucidate a complicated problem in physics. Discuss the merits of a painting by El Greco or Titian.

Wilson's daily routine sheds much light on his personality.

He assimilates great amounts of information swiftly and makes the most of every moment of the working day. But he never takes a jammed briefcase home to Bolling AFB where he lives with his wife. (His Parkinsonian theory is that the time a job takes always expands to fill the time available.) And he almost always eats lunch alone in his office in order to read a book.

Wilson in civilian clothes could pass for a university president or a diplomat as well as a general. His cordial, literate tones only accentuate the sharpness and military decisiveness of his approach to scientific problems. And his cultured wit serves him well in driving home a point.

Recently one of his favorite quips when speaking about a number of programs has been: "Nunquam facibimus."

"Literally that means 'We will never make it,' " he dryly told some associates. "You might freely translate it: 'You can't get there from here.' " ⌗

DOD Okays NASA Repeater Satellite

Space agency will work on lower orbit communications for present; Senate Space Committee report calls for accelerated effort

THE DEPARTMENT OF DEFENSE and the National Aeronautics and Space Administration have agreed that NASA may develop an active repeater communications satellite, a field previously exclusively occupied by the military.

The agreement, between NASA Administrator T. Keith Glennan and Deputy Defense Secretary James H. Douglas, was reached last Aug. 27. Glennan disclosed its existence last week in a reply to an inquiry by Vice President-elect Lyndon B. Johnson, in his capacity as chairman of the Senate Space Committee. The committee released the letter as part of a staff report on space telecommunications problems.

Glennan said NASA will concentrate for the immediate future on communications satellites in orbits ranging in altitudes from 2000 to 6000 miles, while the DOD Project *Advent* concentrates on the 24-hour orbit of 22,300 miles. However, Glennan said NASA's plans and research "will not overlook" the application of 24-hour communications satellite systems to nonmilitary uses.

• **More funding likely**—The NASA administrator indicated a supplemental Fiscal Year 1961 appropriation might be sought to get the project started. But he said the project's timing depends "not only upon fund availability but also upon such factors as vehicle and launch facility availability."

The 2000-6000-mile orbit area passes through the Van Allen belt. Glennan said NASA intends to concentrate in the near future on the effect of radiation on solid-state components such as solar cells.

The space agency chief told Johnson no legislative changes are needed to make it possible for NASA to enter the active repeater satellite field. He said the plan to make vehicles and launch facilities available at cost to industry represents approved policy, but any final action will have to have specific approval before funds are requested.

Johnson asked: "Who will be the judge of whether communication satellite activities of the military are 'well conceived' in deciding whether to duplicate such activities?" Glennan replied that DOD is responsible for military space activities and NASA for nonmilitary. Where there is potential duplication, he said, the issue will be resolved by agreement between the two agencies arranged through the Aeronautics and Astronautics Coordinating Board.

• **Speedup urged**—The Senate committee staff report called for review and possible acceleration of communications satellite research plans, so that results will become available by the end of 1962—in time for consideration at the 1963 Extraordinary Administrative Radio Conference of the International Telecommunications Union.

The report noted that the Department of Defense is investigating active repeater communications satellites through Project *Advent* but added: "It is not clear to what extent such information can be employed by NASA to prevent needless duplication or how much cooperation there will be between these agencies in jointly planning programs to assure achievement of goals promptly, effectively and economically."

Speedup is vital, the report went on, because of the possible opposition by the Soviet bloc to proposals of the United States for increased allocation of frequency channels for space. The Soviet bloc, which controls a large land mass, may be able to obtain the frequencies it needs by readjusting domestic frequencies.

The committee staff also called for thorough study by the Executive Branch of government to determine policy related to:

–Identification of a central federal authority for communications policy.

–Evaluation of policies in the context of space communications.

–Implications with regard to the traditional U.S. practice of assigning communications responsibilities to private commercial interests, rather than the government.

–Mechanism of coordination between government agencies concerned.

–Need for determining the responsibility of NASA for operations in space, rather than research.

NEXT WEEK

In Missiles and Rockets

HOW WILL the Kennedy Administration approach the problem of Civil Defense? Pat Frank, author of the controversial *Alas, Babylon* and other novels, makes a keen analysis of the problem in the Dec. 12 issue. He suggests how the much-neglected Civil Defense Administration could be incorporated into the U.S. deterrent forces -- and why it should be done.

Goal of 270 ICBM Pads Seen Met by End of 1963

PADS FOR 270 *Atlas* and *Titan* ICBM's presently are expected to meet their target completion dates—the last one by the end of 1963.

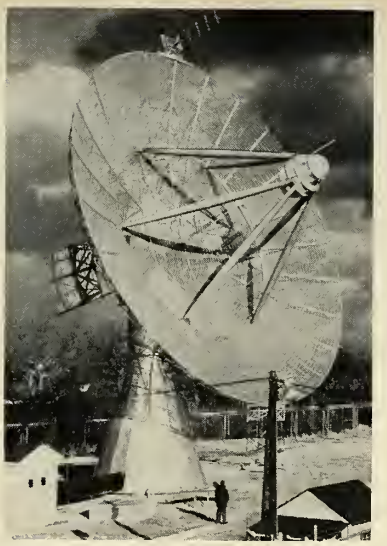
Lt. Gen. Emerson C. Itschner, chief of the Army Corps of Engineers, reported last week that slippage in the $1.2 billion construction program has ended, and building of the complexes is "essentially on time."

Six *Atlas* missiles, all at Warren AFB, Cheyenne, Wyo., are in the hands of operational SAC crews now. Several more pads are expected to be turned over next year, including the first *Titan* nine-missile complex at Lowry AFB, Colo.

The general revealed that at Lowry 300 design changes already have boosted the brick and mortar bill by 60%. Design changes also are responsible for the one-month delay in letting bids for the first 150-*Minuteman* complex at Malmstrom AFB, Mont. Bids were to have been let in November for this base, which has a target completion date of June, 1962 (M/R Oct. 17, p. 29).

Speedup in the program has been effected through a reorganized and streamlined management of the Air Force's AMC and the Corps. Strikes by construction workers have been reduced 30% since May and bottlenecks in delivery of manufactured items also have been cut down, Itschner said. But he said that as long as there are design changes construction costs will rise.

Tiros II Maps Hurt By Poor TV Photos



TIROS II signals are received by 60-ft. dish at Army's Belmar, N.J., station.

by Jay Holmes

WEATHER BUREAU meteorolo-ists began producing Neph analyses cloud-cover maps) from *Tiros II* pic-ures last week but the first one was displaced 400 miles to the west.

Their work was hampered by poor quality pictures from the wide-angle television camera aboard the satellite. Narrow-angle pictures were of top quality but they covered such small areas that it was difficult to identify the locations they showed.

Infrared data, needed for basic research into weather processes, was coming in well.

• **Jurisdiction problem**—Meanwhile, a top-level committee agreed that operational use of data from weather satellites would be under complete control of the U.S. Weather Bureau. The question of ultimate control of weather satellite launchings was left up in the air.

The still unresolved question is whether control of satellite launchings should go over from the National Aeronautics and Space Administration to the Weather Bureau when satellite forecasting becomes operational.

At a meeting Nov. 26, NASA Administrator T. Keith Glennan, his deputy, Hugh L. Dryden, Lt. Gen. Donald N. Yates and Chief F. W. Reichelderfer of the Weather Bureau agreed that weather satellites will remain under civilian control and the Weather Bureau will be the operational user of the data. NASA officials maintain that weather satellites are far from operational and that full control must remain for the time being with them as the R&D agency.

• **Mixed returns**—Between the launching Nov. 23 and noon Nov. 28, *Tiros II* transmitted 998 picture frames to the readout stations at the Army's Evans Signal Laboratory in Belmar, N.J., and the Navy's San Nicolas Island, Calif., Pacific Missile Range Station. Of the 312 frames from the narrow-angle camera, 85% are useful. Of the 686 wide-angle frames, 5 to 10% contain some useful information. Corrected orbital elements are: perigee 386.9 statute miles, apogee 453.2 miles, period 98.37 min. and inclination 48.53°.

The satellite's spin rate was increased twice by firing pairs of small Atlantic Research Corp. spin rockets. The first firing, at 9:14 a. m., EST, Nov. 25, increased the spin from 8 to 10.8 rpm. When it was noted that the axis still was precessing slightly, another shot brought the rate up to 13.9 rpm and corrected the situation.

The reason for the poor quality wide-angle pictures remains obscure. However, the trouble is in the lens, not the TV transmitter. A + mark on the center of the Vidicon target is transmitted clearly even though the pictures are fuzzy.

Some improvement in the quality of pictures between Nov. 23 and Nov. 25 gave rise to speculation the problem might eventually clear up. However, it became apparent that the improvement was merely in the reproduction of the existing poor image.

• **Tracking sequence**—At the Army's Belmar, N.J., ground station, satellite signals are received by a 60-ft. dish antenna, which can be operated either manually, by an automatic lock-on to the satellite's 108 mc beacon or by a slave operation following a program calculated by a computer from the satellite's ephemeris.

Normally, operators on a crew headed by George Goubeaud of the Signal Corps and Ciro Martinelli of RCA operate the antenna manually for the first two minutes after it comes over the horizon ("Alarm 1") and then switch to automatic tracking, called "Alarm 2." The slave program, which is somewhat less accurate since it is based on a 15-point orbit connected by straight lines, is used as backup in case the automatic track fails.

For the first four to six minutes after Alarm 2, depending on the height of the pass, the satellite is commanded to send direct pictures from its TV cameras. Then readout of the 32 pictures stored on tape begins, taking 108 seconds. Infrared data is read out simultaneously, taking 3 minutes, 14 seconds.

Next, the TV cameras are programed for the next orbit. The cameras are instructed to begin operating at a given time after a time signal, called "Alarm 3," a signal which is the last given before the *Tiros* goes below the horizon.

John Maskosky of the Signal Corps is in charge of the readout station, which also develops 35-mm films and transmits them to NASA's Goddard Space Flight Center for Facsimile.

• **Interpretation**—Copies of the films meanwhile are rushed a half-mile away to Building 4, where Edward (Jeff) Albert of the Weather Bureau heads a staff of 14 including experts from the Air Force, the Navy and Allied Research of Cambridge, Mass.

Allied Research invented the procedure by which the *Tiros* pictures are "rectified" so that a picture taken at an angle to the earth can be converted to a sketch of clouds as they would appear when observed from directly overhead.

Sub-points and the satellite altitude are obtained from the ephemeris. Attitude angles are obtained from graphs worked out by Allied. This can also be obtained by visual inspection of the height of the horizon on the picture.

The picture is displayed on an enlarger against a chart showing latitude and longitude curves. Such charts have been prepared in advance for attitude angles varying at 2½° intervals from 0° to 90°.

Next, cloud features are transferred manually from the curved, foreshortened image taken by the satellite to a Mercator grid transfer chart.

The key to the entire operation, of course, is identifying the location of the satellite. Some information can be drawn from the ephemeris. But identification of geographic features is essential. The pictures from the wide-angle camera, covering areas 800 by 1000 miles, make such identification easy. ⌘

Ostrander warns . . .

Space May Cost $3 Billion Yearly

ONE OF THE BIGGEST QUESTION'S facing the Kennedy Administration is a hard decision on whether America really means to explore the moon and the planets.

The cost will be much larger than previously estimated. Maj. Gen. Don R. Ostrander, director of launch vehicle programs for the National Aeronautics and Space Administration, contends as NASA—if it continues the job—may need to spend as much as $3 billion a year by the late 1960's.

Ostrander's figures refer only to projects on the NASA 10-year program. He assumes that the Department of Defense will continue vigorous activity in space, and that NASA will continue to benefit from the fallout.

• **Three approaches**—Probably the biggest single item in the 10-year program, Ostrander feels, will be the launch concept after *Saturn*, to provide for manned lunar landings and return.

At present, the space agency is contracting with industry for a series of studies of three alternative means of providing the launch power. All are extremely expensive. The studies will provide answers to such questions as cost, time of development and scientific and technical personnel required. The approaches are the all-chemical *Nova* vehicle, with perhaps 12 million lbs. booster thrust; the chemical-nuclear vehicle, with a somewhat smaller chemical booster thrust; the chemical-nuclear veorbital rendezvous and orbital launch, based on multiple *Saturn* launchings.

If he had to start a crash program today for a moon launch vehicle, Ostrander said, he would have to choose the all-chemical *Nova*. The reason is that not enough is known about either nuclear propulsion or rendezvous problems.

Fortunately, however, there is a year or so of leeway available for study, Ostrander maintains, because the reentry and man-in-space problems related to the payload will not be solved sooner.

• **Billions for nuclear rockets?**—To put men on the moon would require a booster capable of accelerating to escape velocity a package weighing 100,000 to 250,000 lbs. NASA studies indicate this would provide for a return capsule weighing 8000 to 15,000 lbs. By the all-chemical route, such a mission would require a booster in the thrust range of 9 to 12 million lbs.

Ostrander declared there is no doubt in his mind that a nuclear rocket can be developed that will reduce considerably the size of the booster—perhaps to the thrust range of 3 million lbs. The booster cost would thus be reduced.

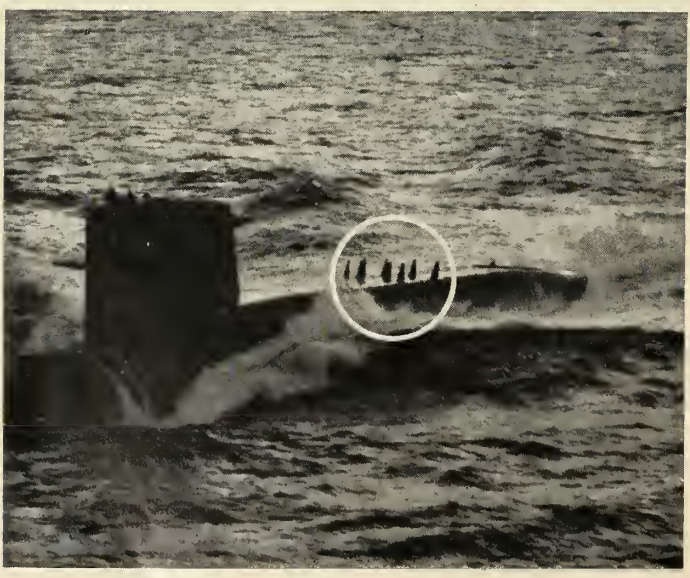
But he maintained that a national decision is required on whether to go ahead with the big nuclear rocket—a multibillion-dollar program.

"There is no doubt in my mind," Ostrander asserted, "that we can develop a workable nuclear rocket if we spend the necessary dollars."

He predicted that within a year NASA will go to industry to begin design studies of a vehicle to build around the *Rover* nuclear rocket. An engine development contract is to be awarded early in 1961.

Before the vehicle goes into development, Ostrander maintains, the nation will have to make a firm decision on whether to go into an expensive nuclear rocket. He added:

"This is part of a still bigger question, the really fundamental one: are we serious about going to the moon and the planets?" ⁂



Fins for Polaris Submarine

FLOW STABILIZER FINS (circle) on deck of George Washington are to correct faulty hydrodynamic characteristics, apparently caused when 130-ft. missile section was inserted in Skipjack-type hull to get sub built in time. AT RIGHT: first photo of GW's missile section interior. Note launch control switches at left. Sub is now on station off Russia.

the elements of Command Control:

Data Acquisition and Application
The measure of any command control system is time. Success depends on how fast the system can close the loop between detected action and counteraction. Command control begins with data acquisition and ends with data application. Here, IBM's experience encompasses subsystems for the acquisition of information from distant and varied sensing devices, and for the presentation of refined data to commanders for military action.

Data Communication
High-speed networks that link command control computers require facilities to assemble and direct masses of data. Time is important. IBM data communication capabilities are evident in systems such as SABRE, a real-time activity control network; and INFORMER, a rugged, mobile field control center. These systems employ communication techniques involving real-time data channels, data conversion and message switching.

Data Processing and Control
Information must be quickly reduced and refined through computer processing to prepare it for command decision. Here again time is paramount. IBM has solved special data processing problems with standard systems such as the 709, installed for space vehicle orbit computations, and advanced systems such as the AN/FSQ 31V, in production for the Strategic Air Command Control System.

...all systems capabilities of IBM

IBM solutions to command control requirements range in scope from antisubmarine warfare studies to Air Force control systems like project 473L, and from the compact INFORMER to STRETCH, the world's largest computer. From study to implementation, IBM has proved its ability to solve the problem of time in all three elements of command control systems.

Federal Systems Division, 326 East Montgomery Avenue, Rockville, Maryland IBM

ARDC Told of Dramatic Advances in Solid Motors

SIGNIFICANT SIZE AND WEIGHT reductions in solid-propellant rocket motors have been achieved by the Air Force.

At last week's ARDC Science and Engineering Symposium in Boston, Edwards AFB scientists described a "headless motor concept" 24% lighter and 37% shorter than a conventional solid ICBM.

Such an order of improvement could have tremendous implications in the U.S. ballistic missile program, opening the way to spectacular performance gains without improvements in propellant energy.

Two new approaches were integrated in the development. The first involved two- and three-grain propellant designs. These are fabricated so that the rocket motor is 100% volumetrically loaded, capable of simultaneous burnout at all points on the case wall, and producing constant mass flow with zero sliver loss. The second provided a multi-stage vehicle design with considerably more propellant-loading volume than in conventional designs.

To prove out the concept, two three-stage missiles were designed—one with conventional solid stages and the other using the headless motor and multi-grain propellant. The results showed that the new missile—the *Muroc*—was significantly smaller and weighed much less than the conventional design.

• **Ceramics for space** — Another Symposium paper described Air Force work in organic coatings for space vehicles. Research to date points to the use of ferrocenes—a class of metallo-organic sandwich compounds which show unusual thermal stability. Preliminary results indicate that such material may be suitable both as a plastic covering and as an improved ultraviolet light absorber.

This is the first material with complete ultraviolet stability ever reported, the speaker said, and it may form a building block for plastics and coatings suitable for very long space exposure such as would be required for use in a space station.

Other significant results from the organic coating research produced the coating for the *Transit* satellites, which established the feasibility of organic temperature coatings for extended space exposure. Also, two organic temperature control coatings have been synthesized for the *Journeyman* space probe.

• **Astronomy aids defense**—A valuable side effect of radio and radar astronomy has been significant contributions to the defense effort, particularly in communications and detection technology, another speaker reported.

Radio maps of the sky provide data for improvement of receiving systems. Solar observations set limits on the side-lobe level of defense radars. Solar measurements have shed considerable light on the communications problems associated with ionospheric and magnetic storms generated by solar disturbances. Antenna calibration and correction techniques have been improved by use of information gained from refraction and absorption measurements of sun and radio star sources.

Optical reflection and back scattering tests conducted at Wright Air Development Division have led to the conclusion that the directivity of passive satellite reflectors can be improved up to 20 times (13db). A paper told how a study was made of three types of reflecting elements: corner reflectors, conical elements, and dipole arrangements. Dipole arrays were found to yield the highest improvement. However, a combination of lenses and reflecting surfaces showed extremely high directivity and versatility in reflection patterns and pointed to their future use in passive communication satellites.

• **Easing re-entry heat**—A new family of guidable re-entry bodies has grown out of work conducted over the last two years at Arnold Engineering Development Center, described in yet another paper. Three variations of a smoothly contoured basic shape with extendable or functionally integral stabilizing surfaces were tested in the Arnold wind tunnel at velocities up to Mach 20. Results showed that the natural fit of the re-entry bodies to the conditions of the heat flow rate equations inherently alleviated re-entry heat problems.

Other papers presented at the Symposium covered such subjects as inertial guidance, bionics, environmental testing, communications, orbit determination, radiation, and high-temperature and high-pressure research. Over 300 DOD scientists, engineers, and delegates attended the sessions. They were welcomed by Lt. Gen. B. A. Schriever, ARDC commander. Dr. Edwin H. Land, president of Polaroid Corp., delivered the keynote address. Sessions were chaired by Dr. A. H. Flax, AF chief scientist.

At 00h00m01s GMT, December 1, 1960, Martin logged its 757,380,000th mile of space flight

PERSHING—*in test at Cape Canaveral*

***Martin-built Pershing**—a major breakthrough for the Army in its program to develop the modern missile as a mobile field artillery weapon. Pershing moves over the roughest terrain on its own mobile launcher, is ready to fire within minutes.*

MARTIN

SUPPORT EQUIPMENT

DAMP Ship Being Modified

Installation of new L-band tracking radar is the primary item in a $2 million modification on Army's American Mariner, AMR Downrange Anti-missile Measurement Program (DAMP) ship. The highly instrumented ship—part of ARPA's Project Defender—is used in making measurements of the physical characteristics of reentry bodies. Modifications are being made by RCA at Capetown, S. Africa.

Army to Centralize Missile Parts Procurement

Procurement of Army missile parts will be centralized under a new Missile and Rocket Inventory Control Center to be set up at Redstone Arsenal. Shipping documents and inventory control will be handled by a digital computer to speed up spare parts order processing.

Recon Satellites for Space Surveillance

Reconnaissance satellites such as *Saint* may provide an improvement in the orbit determination of other satellites, according to an ARDC astronautics expert. Advantages cited include no ionospheric refraction problems, freer choice of radar frequencies, and continuous knowledge of launches and space vehicle maneuvers anywhere on or about the earth.

ELECTRONICS

Cascaded Energy Converters Double Output

A thermionic and a thermoelectric energy converter in cascade have been operated by General Electric researchers to produce double the output of a single unit but without the need for additional heat input. The thermoelectric generator used rejected heat from the thermionic converter. Efficiencies up to 16% or better now are believed possible by the company (existing percentages are from 2.5 to 6%).

Solar Flare/Weather Tie-in Studied

Russian studies of solar phenomena during the last 15 years indicate a decisive relationship between cyclical and maximum activity and global weather, says N. V. Kolobkov in *Priroda*. Observations have proved that in years of high activity there is extraordinary intensification of the circulation of air masses. The result is contrasting and stormy weather and a higher probability of global meteorological catastrophes. Researchers are developing fundamental laws which may be the basis of a method for better long-range weather forecasts.

Semiconductor Sales Level Off

Sales of semiconductor devices for second quarter 1960 failed to increase for the first time in their spiralling history. Decline in transistor shipments was counterbalanced by increase in diodes and rectifiers to make total output about equal to previous quarter. Shipments of other electronic components remained at first quarter levels.

S-45 Satellite to Probe Ionosphere

Valuable data on the effects of the ionosphere on space-to-earth radio propagation is expected from NASA's ionosphere research beacon satellite (S-45), scheduled for launch early in 1961 by a *Juno II*. The satellite will simultaneously transmit on six frequencies: 20, 40, 41, 108, 360, and 960 mc.

PROPULSION

Lunar Leap-frog Proposed

An Aerojet-General scientist says that the only practical way to get to the moon is with a triple-play shuttle system. First leg would be to an earth-orbiting station then, via ion-power, to a moon-orbiter. From here, a rocket-powered landing craft would go on to the moon. All vehicles involved would be reusable. Estimated time for the shuttle would be 3 days, 12 hours, and 20 minutes.

Solid-Motor Size Reduction Seen

Multi-propellant, 100% volumetrically loaded grain designs may produce some significant reductions in the size of solid-propellant motors. Air Force work on the "headless motor concept" has shown that such missiles can be 24% lighter and 37% shorter than a conventional solid ICBM. The technique produces a motor capable of simultaneous burnout at all points on the case wall, producing constant mass flow with no sliver loss.

Heat Shields Protect Saturn Fuel Tanks

The *Saturn* booster, redesigned for its second series of static tests, has two layers in the tail section designed to protect the LOX and fuel tanks against the radiant and conductive heat from the eight engines. A heat shield at the level of the engine throats, and a flame shield between the inboard engines, provide primary protection. Above them, a fire wall protects propellant tanks in event of fire in the engine compartment.

Nuclear Propulsion Offers Big Weight Saving

The all-chemical *Nova* launch vehicle, with 5 or 6 stages and total takeoff thrust between 10 and 15 million lbs., would return a man to earth from the moon in a capsule weighing 10,000 to 15,000 lbs., says Harold B. Finger, NASA-AEC chief of nuclear propulsion. By comparison, a chemical-nuclear vehicle would have only four stages and takeoff thrust would be 3 to 4½ million lbs. The all-chemical vehicle would stand 300 to 350 ft. tall, while the chemical-nuclear vehicle would be between 200 and 300 ft.

ADVANCED MATERIALS

Foam Furniture for Space

Shelter and furnishings may be fabricated of polyurethane foam on the spot by visitors to the moon or planets. A compact, lightweight kit would contain all the materials required for the Space-Age do-it-yourself project. Small quantities of the plastic foam have been produced at Wright Air Development Division and tested in space-simulating low-pressure environments.

760 Million Pounds of Mo Found

The existence of a large molybdenum deposit near Questa, N.M., has been confirmed by Molybdenum Corp. of America, owners of the property. Sample assays indicate that 260 million tons of ore containing about 5 lbs. molybdenum disulphide per ton are contained in the deposit. Moly from mine concentrates currently goes for around $1.25 per lb. and there is an estimated 760 million lbs. of the concentrate in the new field.

Tracker's Range Reaches to the Stars

Military shows interest in Optron system based on an electron tube which provides very accurate tracking data when joined with an auxiliary telescope

by Charles D. LaFond

A VERSATILE AND UNUSUAL electro-optical tracker has been developed which can follow an object with great accuracy over almost any range from 3 feet to stellar distances.

The first prototype has been demonstrated recently by its developer, Optron Corporation of Santa Barbara, Calif. Although it is strictly an in-house-sponsored product so far, several of the military services have expressed considerable interest in the system.

Heart of the equipment is the Model 650 electron tube. Range variations are determined by the accompanying lenses, terrestrial or Cassegrainian telescopes employed with the system.

Range of the tracker, depending on the particular equipment configuration can be 3 ft., 15 ft., 100 ft., or from several miles to stellar distances. Response is from dc to 5 kc with a resolution of 1 part in 1000 (under ambient illumination of 40 foot-candles or resolution of 1 part in 3000 at 100 foot-candles). With these ranges it can be used to measure vibration on a shake table or track a missile in flight.

• **Operation**—Essentially, the Model 650 Tube reacts to the displacement or motion of an object. Through an optical arrangement, the image of a black and white target is formed on the photocathode. The electron image is then presented at the dissecting aperture. (Refer to diagram.)

The "light" portion of the image emits more electrons while the "dark" portion emits fewer electrons through the dissecting aperture to the multiplier.

If the target moves laterally to the right, the multiplier is exposed to more electrons; if target moves to the left, it "sees" fewer electrons.

Multiplier output is fed to horizontal deflection plates. This feedback helps counteract motion as the target moves in space and it tends to keep the electron image at the dissecting aperture. The controlling feedback then is a measure of the displacement of the target.

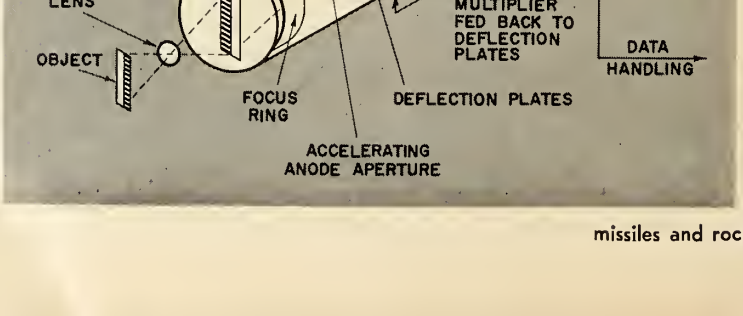
By this means a voltage is developed at the output terminals of the tube that is a direct measure of motion by the object.

Time constant of the tube is 1 microsecond, defection sensitivity is 800 volts/inch, and output voltage is 10 volts full scale at 150 ohms.

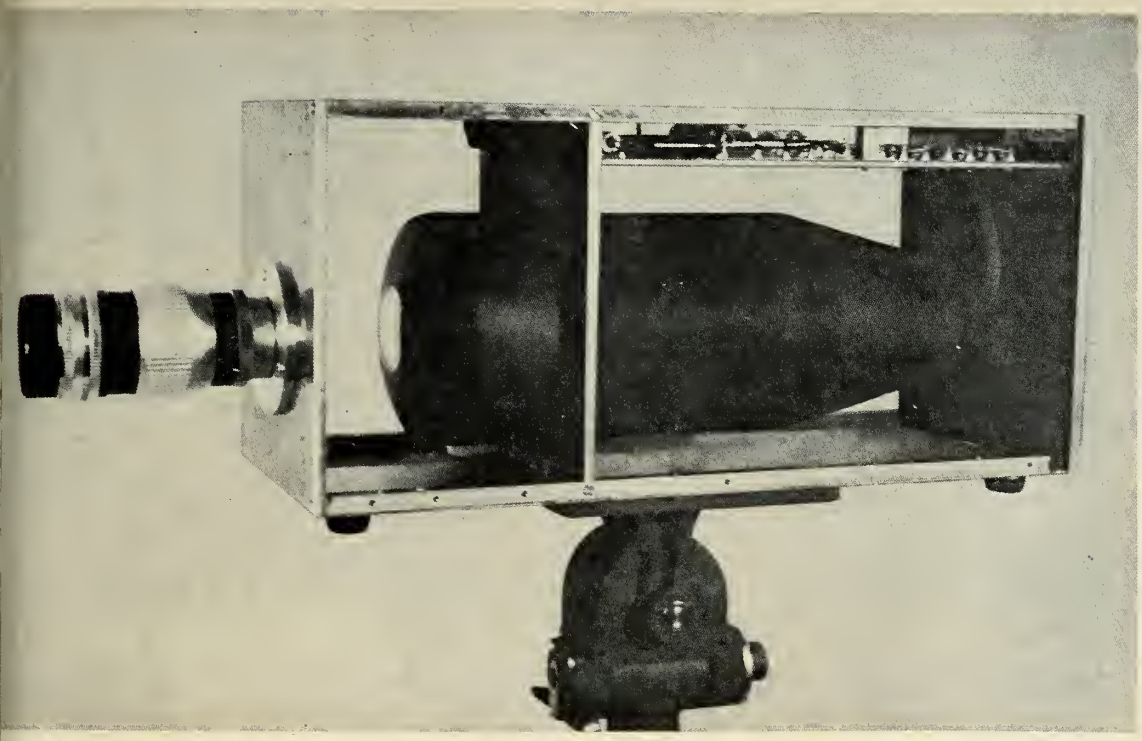
• **Applications**—The system could be coupled with a telescope to provide azimuth and elevation data while tracking a missile. Coupled with such an auxiliary telescope, Optron believes it could be mounted on an Askania or Contraves tracking theodolite to provide highly accurate tracking error measurements in real time during missile flights.

With a 40-inch focal-length telescope Optron feels tracking accuracies of ± 10 seconds are attainable. Also, it feels that a resolution of 0.05 milliradian in a field of view of 10 milliradians is possible.

In this application the visual range of the spectrum toward blue at 4400 Angstroms would be used. A 2 to 130-mile range could be attained and digital



FUNCTIONAL diagram of Optron Corp.'s Model 650 tube in "locked-on" condition and tracking an object in space.



UTAWAY MODEL shows lens and Model 650 tube. Internal ultiplier section is at right in tapered end of tube, and 1-inch-diameter active area of the photocathode can be seen at the left end. Time constant of the tube is 1 microsecond.

ata output would be coincident in me to ± 1 millisecond to the read-ut of the test tracking mounts.

Other applications suggested by its evelopers are for:

–Remote measurement of danger-us solid rocket propellants (for tensile sts, etc.)

–Nozzle-deflection measurements of rocket engine on static test stand.

–Remote measurement of any mo-on, vibration or displacement.

• **Typical targets**—As noted earlier, ie brighter the target presented, the etter the resolution of the electron nage on the photocathode.

For laboratory or standard test easurements, the target may be il-uminated with a light beam from a C source to further enhance resolu-on.

Typical targets for the Optron sys-m might be a black-and-white image n stiff card stock, any bright reflective achined edge or a dark non-reflective dge set off by a bright background, ny optical discontinuity, or a self-uminous white-hot specimen.

For precision measurements, the lodel 650 Tracker should be mounted n a seismic stand, a company engineer aid. This provides isolation from the oor and permits three-axis swivelling gether with XYZ micrometer position-g leadscrews. ⁂

Hoffman Shows High-Speed Mesa Diode

SANTA BARBARA, CALIF.—A high-speed mesa diode of gallium arsenide has been developed by Hoffman Science Center, a new division of Hoffman Electronics Corp. The company says its response time is less than one-billionths of a second—more than an order of magnitude better than any similar device now commercially available.

Other new developments reported by the facility include a silicone coating for solar cells and an improved fuel cell.

President H. Leslie Hoffman announced these developments during the recent dedication ceremonies at the center.

He said special characteristics of gallium arsenide compounds make them more versatile for electronic equipment requiring high-speed semiconductor devices than the silicon compound now being used. Gallium arsenide compounds combine the capacity for high-temperature operation and high speed response to changing potentials, as well as permitting fabrication of devices with greater stability and reliability than silicon equivalents.

One particularly interesting device being investigated by Hoffman scientists is the parametric amplifier. Use of gallium arsenide makes possible a high or low frequency amplifier which apparently will have greater versatility than transistor devices. When fully perfected, the device is expected to be valuable for increasing the range of communications and radar equipment without requiring an increase in the transmitted power.

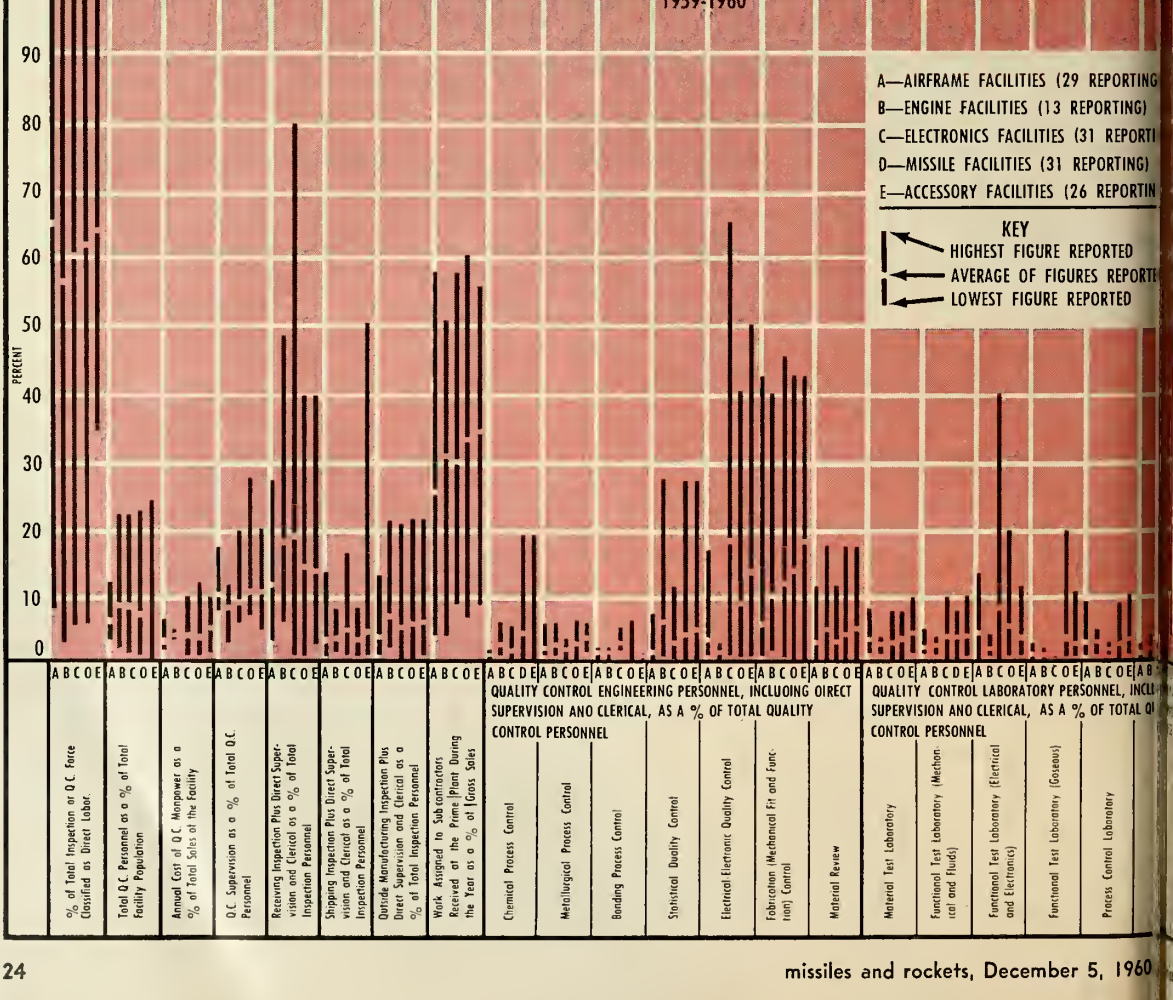
• **Aspirin-size cells**—A laboratory model of the improved fuel cell was demonstrated at the dedication of the center. Developed by Dr. Joseph S. Smatko, senior scientist at the research facility, the unit is a self-contained, sealed device about the size of a one-pound coffee can. When used as secondary power sources, cells of its type can be made as small as an aspirin tablet, according to Dr. Smatko. The cell can produce open circuit voltages of 2.8 volts per cell and is expected to have an estimated lifetime in excess of 10,000 charge-discharge cycles.

A new silicone coating for solar cells developed by Hoffman Science Center may increase protection to the cells while maintaining efficiency. The inexpensive method of coating a solar cell by paint-brush or spray technique may also significantly reduce the total weight of the cell, according to Hoffman scientists ⁂

Industry Reliance on Quality Control Checks Continues to Increase

by William Beller

BELOW: *A graphical summary shows personnel and related data comparison resulting from the seventh AIA survey of the industry's quality control problems. This year's report, covering 1959-60, is compiled from a greater number of returns than any of the preceding surveys, and hence is probably most accurate.*



THE TAR-BABY QUESTION o "How much quality control?" got some statistical answers last week.

The respondents and their repre sentatives were gathered in Dallas fo a joint industry-government session o the Aerospace Industries Association' 10th annual quality-control committe meeting.

Up for presentation was the com mittee's 1959-60 "Quality Control Sys tems Study," based on data furnishe by 98 aerospace companies.

To give all data proper weight, th AIA committee additionally terme "companies" those organizations tha in actuality are divisions or facilities o parent companies. Thus, 130 organiza tions were surveyed—29 airfram facilities, 13 engine, 31 electronic, 3 missile and 26 accessory manufactur ing.

Some of the chief findings:

–Quality Control influences th selection of vendors by maintaining

eview of their quality performance, or 96.1% of the companies; by keeping track of the vendors' capabilities, or 94.6%; and by reviewing or approving purchase orders, for 70.7%.

–A reliability group or its equivalent xists in 85.4% of the companies. Last ear this figure was 81.4% and the ear before, 61.5%.

–Quality Control gives management end reports of manufacturing performance in 70.7% of the companies.

–Most of the companies surveyed re doing business with the Air Force, 4.6%; second most popular agency, Navy's Bureau of Weapons, 49.2%; ederal Aviation Agency, 31.5%; rmy Ordnance Corps, 23.7%; and ne Army Signal Corps, 12.3%.

• **A quantitative study**—This is the eventh AIA survey of industry's uality control problems. The project as started in 1954 when it was proosed by Paul E. Allen, manager of uality control and customer service at eech Aircraft Corp.

Still directing the work, Allen states that its purpose "is to provide Quality Control managers with a periodic survey of quality control systems and techniques, to be used for comparative reference in evaluating various phases of their control systems."

To avoid having the survey's data used for determining quality control procedures in particular companies, AIA holds all replies to its questionnaires anonymous. This procedure is also said to assure honest answers.

The current report is almost entirely statistical, with scant attention paid to interpretation of the figures. The committee explains that the results are meant to show individual companies only how they compare with their competitors; the report is not meant to say which procedures are best.

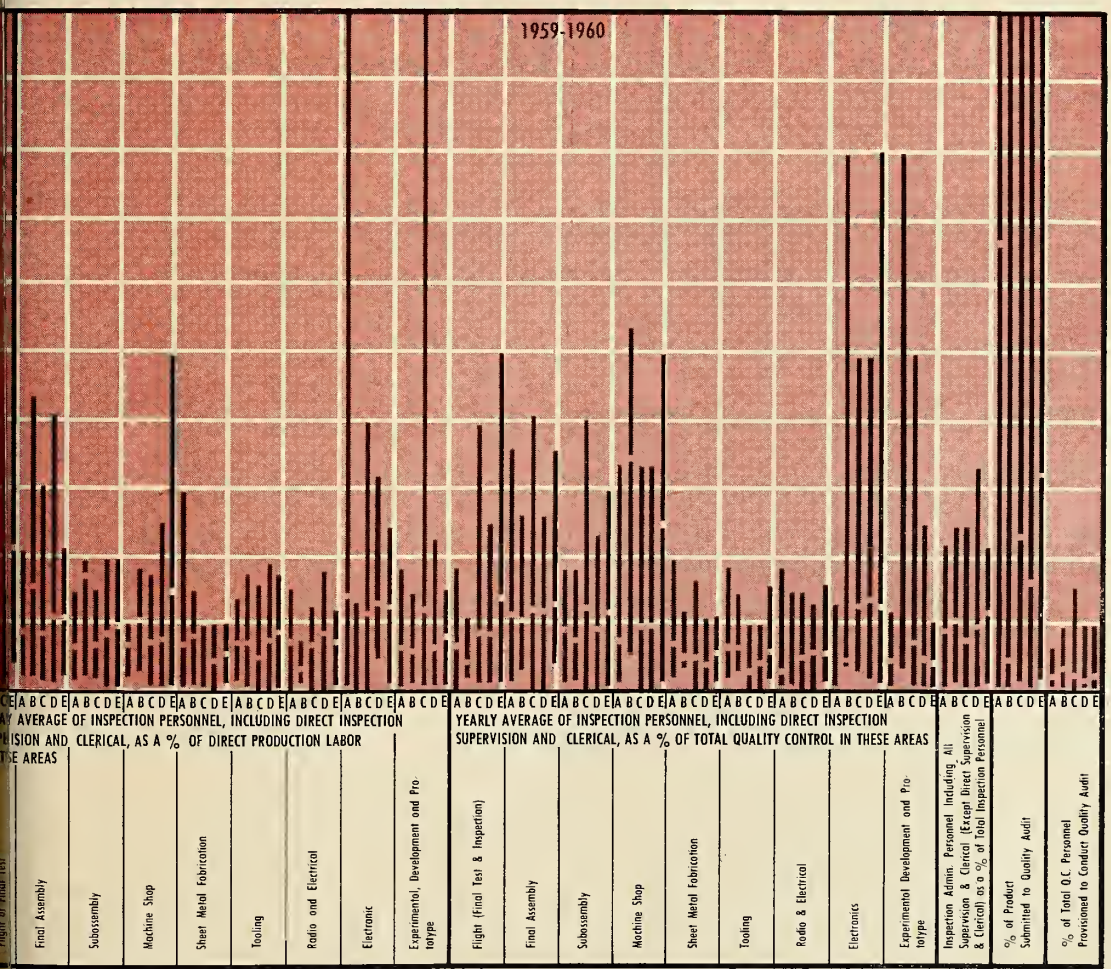
Allen emphasized this point by stating that the report "cannot be used as a departmental measuring stick without analyzing the specific administrative, manufacturing, engineering and management participation within the companies being compared."

He added that if detailed evaluation or comparison is desired, then "it will be necessary, through individual solicitation, to locate the companies who are operating with the techniques or manpower distribution concerned, and individually study the systems on a comparative basis."

Other findings pointed up by the survey:

–Quality Control budgets are based on the percentage of direct labor serviced in 62.3% of the companies, a fixed rate in 13.1% and other methods in 36.1%.

–Sampling inspection of vendor items is performed by 96.1% of the companies, and partial use indicated by 6.2%. None of the companies reported that they did not inspect samples of vendor items. MIL-STD-105 is used by 78.4% of the companies and a



locally developed sampling program by 50.8%.

–The lot is returned to the vendor by 81.5% of the companies if it is not acceptable under the sampling plan used.

–A preferred source list based on vendor quality history is maintained by 88.4% of the companies. Three additional companies indicated they are in the process of making up such a list.

–The manual system of recording inspection data is again the predominate method with 93.8% of the companies; 62.3% also use IBM type and 8.4% key sort.

–Quality control inspects all tools in 70% of the reporting companies. Acceptance of tools based on the acceptability of parts produced was used by Quality Control in 75.4% of the returns.

–Quality Control maintains standards and calibrates working gages in 80% of the companies. In some instances, this is limited to mechanical or dimensional standards only; the electrical and hydraulic standards are an engineering responsibility. ¤

Simple Detector Seen Ideal for Satellite Use

A VASTLY SIMPLIFIED solid-state particle detector, now in pilot production, answers the need for smaller, more reliable instrumentation in satellites.

Developed by Semi-Elements, Inc., Saxonburg, Pa., the new semiconductor product can be used to detect X-rays, gamma rays, and other types of radiation.

The detector, according to Semi-Elements, changes resistance by an amount which varies as the radiation level.

Its sensitivity reportedly can be compared directly with that of crystal photomultiplier X-ray detector combinations now in use. Response is somewhat slower, but the company says it anticipates improvements during the next few months.

Another advantage over contemporary detectors is the absence of fatigue effects over prolonged periods of radiation.

The company feels the tiny element has application not only for missile/space use but for such jobs as X-ray inspection on final assembly lines. The detector would pick up variations in intensity during quality control inspections.

The company's laboratory is working to develop more efficient solid-state particle detectors for gamma rays using another single crystal element.

"Scratch the contact—it's a whale."

The false alarms which have continuously plagued antisubmarine warfare operations will be eliminated by a new sonobuoy under development by Chance Vought Electronics Division under the sponsorship of the Navy's Bureau of Weapons. This unique electronic device is being tested now against Navy surface ships and submarines at Key West, Florida.

Vought sees this sonobuoy as part of a family of new ASW systems which would converge from the sea, air and space to pin down enemy subs. Other links in this three-dimensional defense are also taking form at Chance Vought, where the combined resources of all divisions provide the broad capability required.

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Applying Nature's Secrets to Machines

How Air Force scientists search for engineering principles in the sensory, nervous and memory-storing abilities of living things

by Dr. Harvey E. Savely

Director of Life Sciences
Air Force Office of Scientific Research

WE ARE WITNESSING today a rapid "coming of age" of biology as an analytical science. This is due in part to developments in the physical and chemical sciences which are now being applied to the study of the fundamental patterns in living systems. The Air Force, along with other military services, has recently shown an increasing interest in biology as a source of principles applicable to engineering.

The reason is clearly that our technology is faced with problems of increasing complexity. In living things, problems of organized complexity have been solved with a success that invites our wonder and admiration. It is natural, therefore, that we look to these successful inventions in nature for clues, as well as inspirations, for new classes of man-made machines with greatly increased capabilities.

Three interrelated aspects of the nervous system have been occupying much attention in the Air Force. They are 1) the sensory receptors of animals, 2) the integrative action of their nervous system, 3) the storage and retrieval of information.

• **Subhuman sensitivity**—The sensory receptors are the transducers by which animals stay attuned to significant events in the world around them, as well as in the machinery of their own bodies. We commonly think of them as the basis of our five senses. But the receptors are much more varied than we might infer from our human sensations.

Only a few years ago Dr. Bulloch and his associates at UCLA described the sensitive infrared sensing organ in the rattlesnake. This organ, which is located in the pit between the nostril and the eye, is so sensitive that it responds to a change in temperature of .001°C.

Another form of energy which most animals cannot sense except as a shock is electrical energy. Yet at least three families of fish existing in the tropical areas can detect small changes in the electrical field of their surroundings

These fish emit pulses of low voltage in the order of 1 volt—either in bursts or continuously throughout their lives. The frequency and pulse form is characteristic of each species, and ranges from 50 to 1600 cps.

In one species studied by Prof. Lissman of Cambridge University, it was found that the fish was sensitive to a change in the electrical field in the water of .003 microvolts/mm, and could be trained to distinguish between two non-conductors placed in the tank.

• **Beetle dividend**—The ability to make pattern recognition and detect motion has arisen independently in three of the great groups of animals, the vertebrates, the arthropods and the mollusks.

We are encouraging work in all these forms in the belief that analysis of these separate developments in nature could have important implications for pattern recognition and the science of automata.

Studies on insect vision have already yielded an unexpected payoff. Dr. Hassenstein and Dr. Reichardt at the Max Planck Institute have spent several years studying the response of a beetle to moving light patterns.

When the results were expressed in the language of control systems' theory it appeared that the beetle could derive velocity information from a moving randomly shaded background.

The payoff is that these workers have initiated the design of a ground speed indicator for airplanes which works like the beetle eye and is based directly on the function of just two of the hundreds of facets that make up the compound eye of this insect. Other insects have more highly developed eyes and appear to have pattern recognition and color vision as well.

• **Smell and hearing**—The chemical sensing organs are another class of receptors that reach a high degree of development in many classes of animals. It is highly developed in man and some of the other vertebrates, and perhaps is more sensitive in some of the insects. Detection of a variety of odors and of chemical substances is possible in amounts so dilute that it is estimated that one molecule may be sufficient to fire off a receptor. In some cases the receptor is sensitive to specific chemicals and even to separate chemical isomers. This ability makes it possible for a male moth to "home in" on the odor from a female from great distances.

You are probably all aware of the echo location ability in bats, porpoises and other animals that have a kind of sonar. The acute hearing of the owl enables it to be guided accurately in the dark to high-pitched noises of mice.

Perhaps you have not heard of the moth that has developed a highly effective hearing organ, composed of only two cells, which can detect the ultrasonic cries of bats, and which enables it to take evasive action just before the bat makes a meal on it.

There are undoubtedly undiscovered sensory transducers. Birds perform great feats of orientation and navigation by quite unknown sensory systems. There is growing evidence that some of the night migrators may be using some aspect of night sky—perhaps stars—for navigation. These, like some other classes of problems in biology, are still in the phenomenological and descriptive stage, which must precede the identification of sensory mechanisms and analytical studies of their function. This whole area of biological transducers is one that deserves considerably more attention from both biological and physical scientists.

• **Integrative actions**—After the transduction of the physical energy into a nerve impulse having a characteristic digital code, the central nervous system of the animal must carry out digital to analog conversions of the signal for the purpose of analysis and mixing with other disturbances in the nervous system. Here we come up against organized complexity carried to the unimaginable extremes.

Fortunately we do not have to solve the most difficult of these problems first. We have before us in nature millions of examples of information handling, in all degrees of complexity.

We have every right to expect we will be aided in gaining understanding of the more complex systems by first studying them in simple organisms. To understand this aspect of the nervous system new concepts in physics and mathematics may well be needed. It is here too that the application of computer simulation techniques may play an important role. For we still do not have the methods for tackling problems of organized complexity which is characteristic of living systems.

• **Mystery of memory**—A third aspect of biological systems that should ultimately have profound implications for engineering is the ability of living things to store and retrieve information. This is a characteristic phenomenon of all living things even at the cellular level, where metabolic activity is influenced by preceding events occurring hours, days, or generations before.

In the nucleus of the cell is stored the pattern on which an additional copy of the organisms can be built. We know nothing about the code by which this pattern is stored or expressed. To reflect for a moment on the mass of detailed information which must be needed to guide the development of an animal—such as ourselves—is to be awed by this problem. A beginning is being made on the problem by the study of the structure and characteristics of the large molecules that carry out the transmission of genetic information. Great strides have been made in the last 10 years. They promise to have far-reaching importance for all the sciences and the technologies that rely on them.

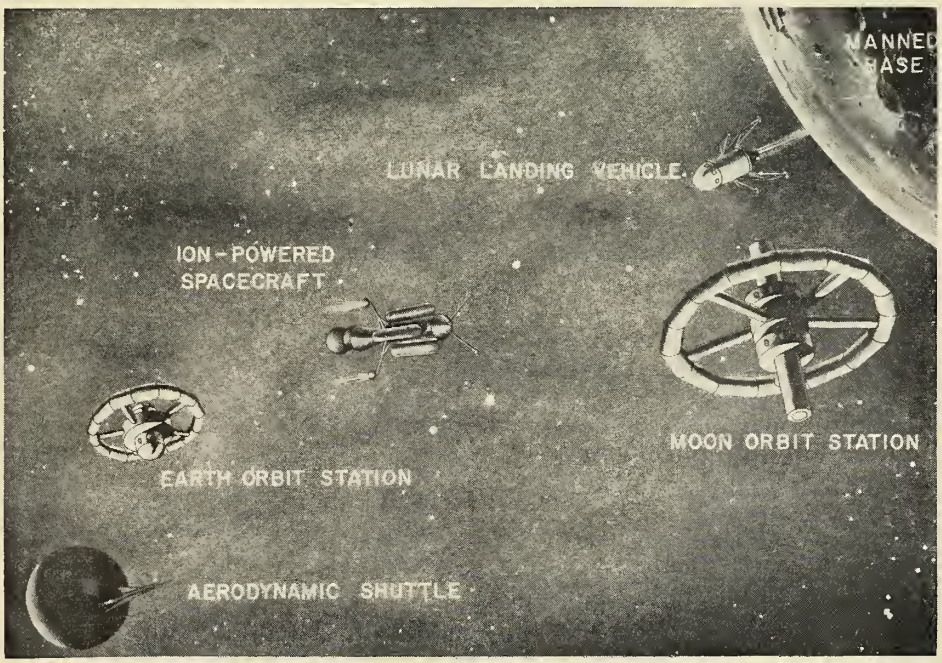
Storage and retrieval of information at the level of the central nervous system underlies both the conscious behavior in man and the short and long span memory in animals. Unfortunately, we can say very little about the biologically fundamental aspects of the molecular systems that are at work in all cells. It stands as another aspect of the great challenge of the biological sciences. Its implications are so great that it must be a part of any military program of basic research.

In discussing living systems as prototypes for engineering application one should take note of a conservative attitude which may be encountered among some biologists. The biologist is greatly impressed by the scope of his ignorance, and rightly so. He realizes that he does not have in hand the fundamental laws that govern the phenomena with which he deals. He may feel that the strategies appropriate to the physical sciences, which have dealt mostly with unorganized complexity, will not be adequate to deal with the organized complexity of living systems.

• **Nature's limitations**—Above all, he fears that the engineering scientist may be misled into thinking that ready-made solutions to his problems may be hidden in the biologists' notebooks. The biologist must point out that nature has been limited to building upon and modifying pre-existing structures to produce new systems; as a result she often takes a roundabout way to solve her problems. Imitation of nature's solutions may not be practical. First what is needed is to understand the underlying principles involved. Then we may be able to apply them in ways that may not exist in nature.

Compare bird flight to airplanes, for example. Imitation here did not get us very far. A basic research program 60 years ago on the structure of feathers would obviously have led us into a blind alley. It was the understanding of the physics of air flow that spurred our development. In the same way we must look for the fundamental principles at work in the nervous system and not be tempted to imitate what may turn out to be the "feathers."

I am optimistic about the applications of biology to engineering. My optimism is based on the solid progress now being made by analytical approaches to biology and in the attraction of mathematicians and physical scientists to its problems. ⁂



Three-Stage Moon Journey

ARTIST'S concept by Aerojet-General shows aerodynamic shuttle leaving earth (lower left) to discharge men at earth orbit station from whence ion-powered craft would take them to moon orbit station. Final landing would be by rocket-powered lunar landing vehicle.

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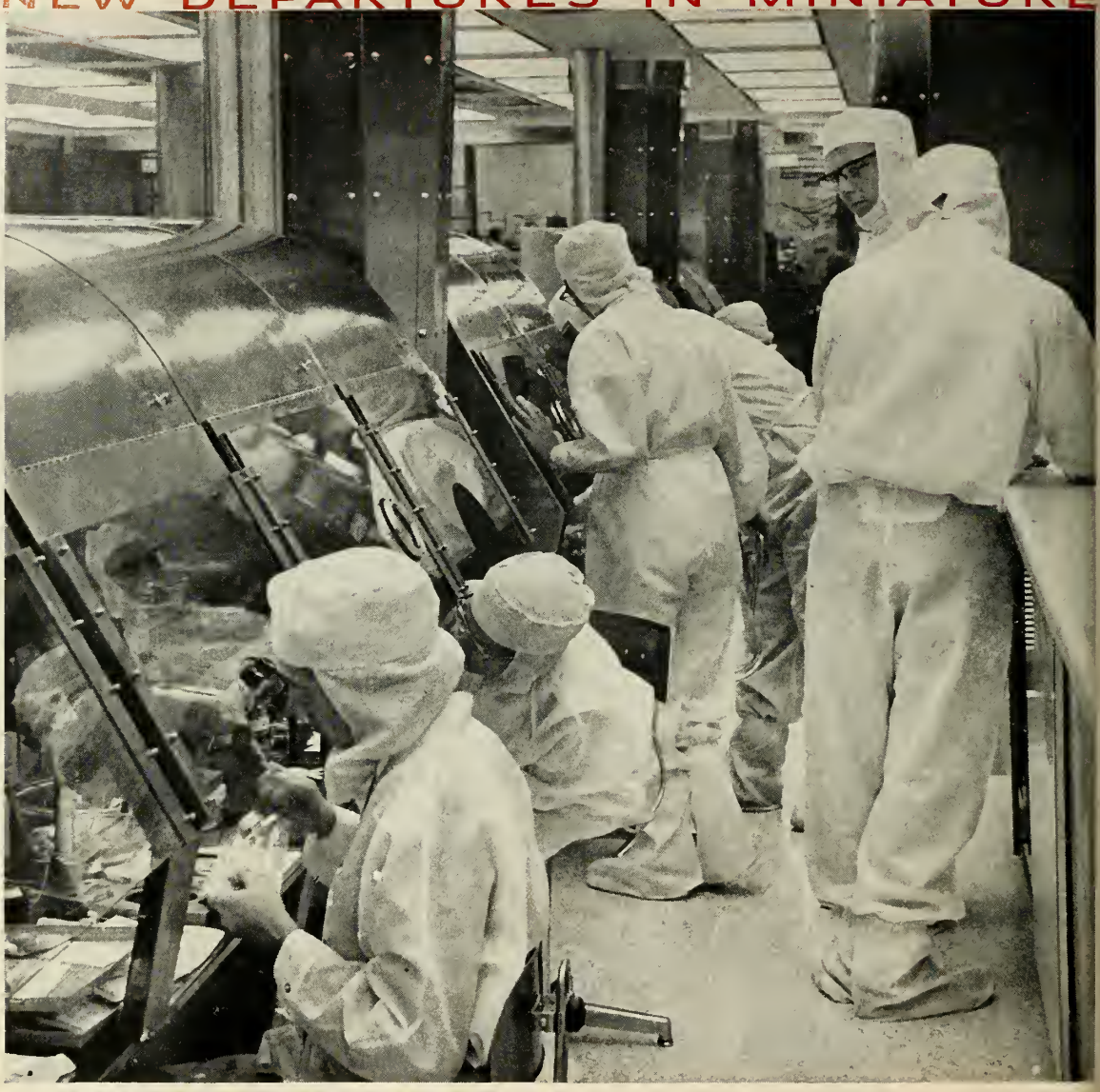

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Redstone Culprit

Stray Current Foiled Launching on Nov. 21

A FREAK STRAY CURRENT resulting from faulty circuit design in the *Redstone* booster has been identified as the cause of the Nov. 21 *Mercury Redstone* failure. The circuits are being redesigned and another launch will be scheduled soon.

Dr. J. P. Kucttner, *Mercury* project officer at the NASA Marshall Center in Huntsville, Ala., said a few milliseconds delay between the unplugging of two clocks in the battery control circuitry caused a bogus engine cutoff signal, which actuated the launch tower jetison normally programed for 34 miles altitude.

• A 'First' of sorts—

Although a similar premature cutoff would have been possible on any of the previous 60-odd *Redstone* flights, it never had occurred, Kuettner declared at a NASA press conference. He said it is possible that the improved relays added to the circuits for the man-in-space program were more sensitive to such a tiny stray current.

After the Nov. 21 failure, NASA engineers waited 31 hours for the *Redstone's* LOX to boil off before returning to inspect the *Mercury* capsule. But if a similar incident took place with a man in the capsule, a long boom device called a "cherry picker" would have been used to get to the astronaut and remove him.

Normally, in the event of malfunction on the pad, the capsule escape system would lift the capsule free and return it to earth by parachute. However, the escape rockets were on open loop for the MR-1 test and the capsule escape could have been actuated only by ground command.

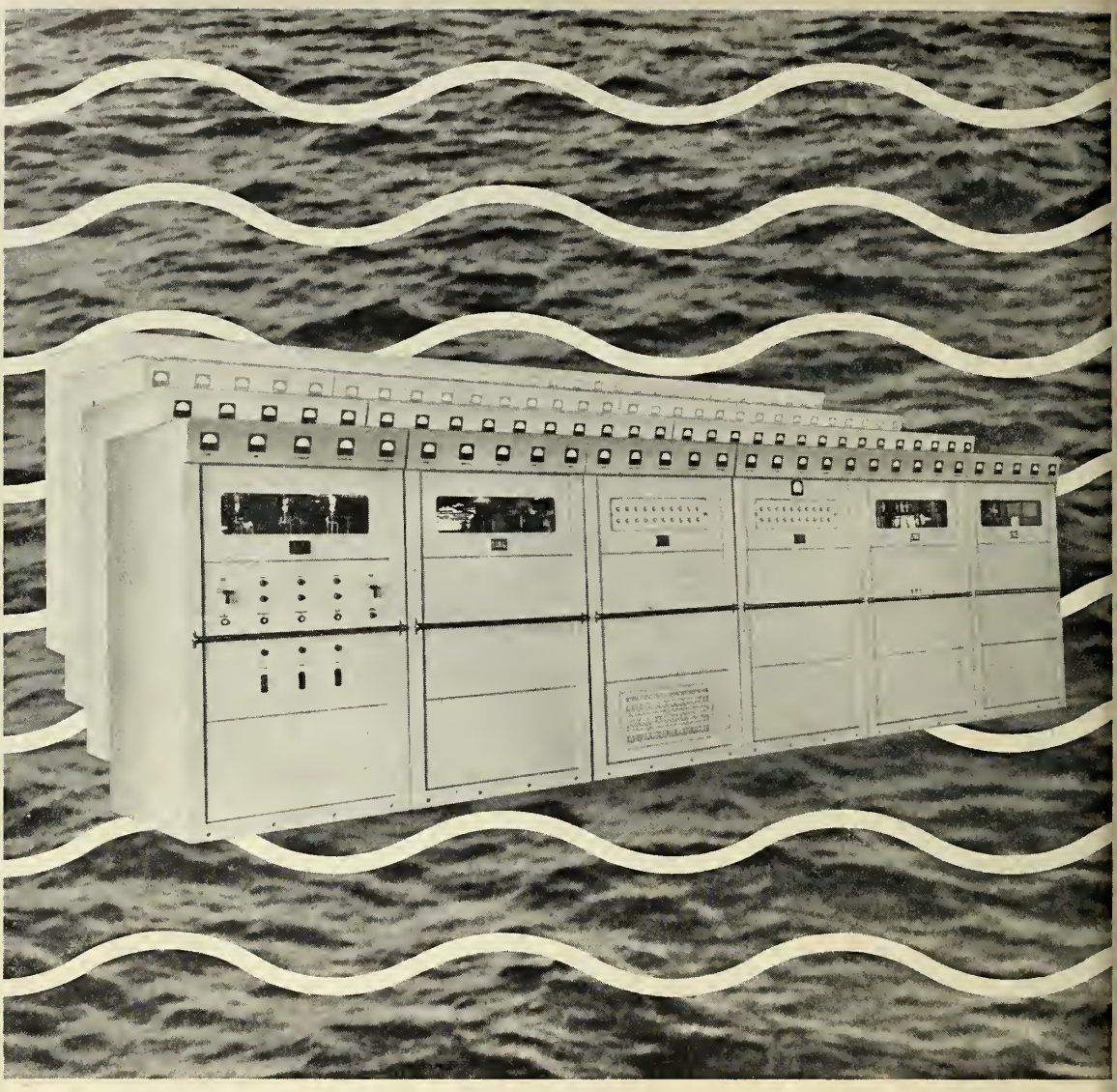
Robert R. Gilruth, Project *Mercury* director, reported that the Nov. 8 failure of the escape mechanism in a flight from Wallops Island, Va., had been traced to a spurious signal from a limit switch.

• Vibration villain—

He explained that the program of the *Little Joe* flight called for opening of a clamp ring between capsule and booster, which would have actuated a limit switch, which in turn would have signaled the firing of the escape rockets.

However, during launch, high dynamic air pressure apparently caused vibration in a limit switch and set off the escape rockets before the clamp ring opened. As a result, the capsule never separated from the booster.

The circuit is being redesigned to eliminate the *Little Joe* difficulty too, Gilruth reported. ⌗



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DOD Tells AIME of Need To Cut Lab-to-Hardware Lag

PHILADELPHIA—Heavy emphasis on research by both the Defense Department and industry in general appears to be creating a problem of increasing proportions.

The conversion of the laboratory development into usable engineering materials and processes is moving too slowly.

The Fall Meeting of the Metallurgical Society of the American Institute of Mining Engineers heard Army and Defense spokesmen point out that our lead time runs almost eight years from lab to hardware, while the Russians have cut their engineering gap to five years.

Meanwhile, the American Society for Metals was told by Edward G. Budd Jr., of the Budd Co., that much of the progress made in research has not yet been put to work because American industry is caught between inflation and corporate taxes. Not enough money is available to take advantage of the laboratory advances. Budd was speaking specifically of depreciation allowances, which practically force industry to operate with obsolete production equipment.

J. R. Townsend, Special Assistant to the Director of Defense Research and Engineering, told the AIME that the DOD is "vitally interested in the possibility of creating ductile ceramic materials."

Recent "breakthroughs" listed by Townsend included: single crystal beryllium, production of amorphous metal by rapid cooling from the liquid state, refractory material forming by exploding wires and the pulse forming of metals.

Other AIME sessions covered pressure vessels, cryogenic propellant tank materials and nuclear metallurgy.

• **Explosive forming competitive**—Cost savings of about $10,000 over other processes have been achieved by use of explosive forming methods to square the ends of rocket-engine thrust-chamber tubes, according to Dr. L. C. Stukenbruck, supervisor of explosive forming activities, Rocketdyne division, North American Aviation.

"We have demonstrated conclusively that the repetitive forming of common metals can be achieved at competitive costs," he told the A.S.M.

The thrust-chamber tubes described are made from nickel and 20CB steel. Over 2000 tubes have been processed to close tolerances by explosive forming with "neglible rejections."

Although the high-energy forming process has been developed with an accent on its application to difficult, high-strength materials, Stukenbruck emphasized its application to less exotic problems. Rocketdyne has used the method to form a quantity of small, stainless steel thrust chambers for a drone rocket engine, and to form pylons of 6061 aluminum (T-4) used to attach *Hound Dog* to B-52G wings.

Much of the saving possible with explosive forming is in die costs. Tooling costs were cut almost $500,000 over comparable costs for the male and female dies, drop hammer approach to fabrication of stiffeners for a large B-70 bulkhead. The part was formed explosively with a single, female die. ⌗

Cornell Finds Way to Stop Convection Heat Transfer

Cornell University scientists have discovered a phenomenon that may go a long way towards solving the cooling problem of re-entering space vehicles.

The find, made in connection with an Avco Corp. re-entry research program, is that heat transfer by natural convection may be halted by spin.

Convection is that form of motion in a fluid or gas caused by density differences and gravity. The motion is created by the application of heat, which usually results in a localized decrease in density.

Cornell researchers have shown that when spin is introduced about a vertical axis, an additional stabilizing force retards heat transfer by convection.

Secondly, when instability does occur under spin conditions, the resulting motion may be oscillatory rather than in a single direction.

Using mercury as the liquid medium, researchers have succeeded in stopping convection heat transfer at a spin rate of 6 rpm when under a heat flux of 1725 Btu/hr/sq. ft.

A variety of containers and liquid metals are under study. Investigations are proceeding under a $72,100 National Science Foundation grant.

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Wire Yields Surprising Heat Volume

Cohn Corp.'s 'Pyrofuze' composite looks useful for detonators; low-temperature ignition and controlled reaction

by John F. Judge

A VERSATILE WIRE composite leveloped by Sigmund Cohn Corp., Mt. /ernon, N.Y., provides an unusually ırge amount of energy when ignited at elatively low temperatures.

The development has resulted in the ɔrmation of a Cohn affiliate, Pyrofuze Corp., which is manufacturing and ıarketing specially processed pyroforic roducts bearing the name Pyrofuze.

Initial experiments with Pyrofuze ire indicate that it may have applica- on in the field of detonating devices, here its behavior is a singular ad- antage. Pyrofuze is composed of pal- dium and aluminum in intimate con- ct. When the system is heated to the elting point of Al, an immediate othermic alloying action takes place nd a surprising amount of heat is berated.

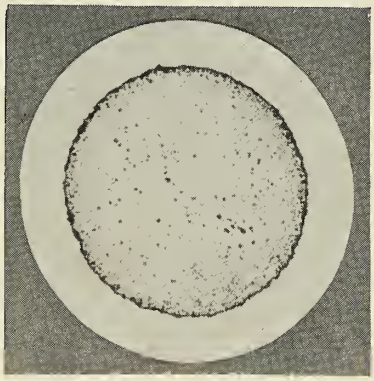
• **Controlled ignition**—The reaction ccurs at a rapid but predictable rate; can be limited or controlled by vary- g the amounts of constituents or anging the ratio of surface area to lass. Normally, ignition is triggered ith a small amount of electrical ıergy.

Calorimetric measurements show at 327 calories per gram are liberated resulting in temperatures in the range 2200° to 2800°C. The reaction takes ace equally well in air, in inert gases in a vacuum. The end product is an loy of the starting materials in the rm of small particles which have been attered by the force of the reaction. some cases, small amounts of alum- um oxide have been found.

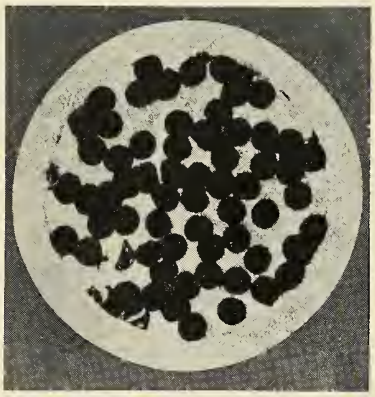
It is believed that the alloying ac- n is the source of the heat, but it is so possible that certain quantities of cluded oxygen are contained in the etals.

Since Pyrofuze is all metal, the re- tion is neither an explosion nor a rning process in the ordinary sense.

In practice, both palladium and aminum are rather soft, weak, and of v electrical resistivity. Improvements i tensile strength and electrical proper-



CROSS-SECTION of Pyrofuze wire shows the intimate metal contact attained.



ALTERNATE form of the wire consists of multiple Pd and Al wires in an Al jacket.

ties are gained when 5% magnesium is added to the aluminum and 5% ruthenium to the palladium.

The material is usually supplied in the form of a wire having a single concentric core of aluminum and an outer layer of palladium. In the manufacture of single-core Pyrofuze, an aluminum rod is inserted into a tightly fitting palladium shell and the composite drawn into wire. As far as the reaction is concerned, it does not matter which material is used in the core; to facilitate drawing, however, the harder metal is chosen.

In order to prevent the possible formation of a barrier layer of aluminum oxide, the aluminum is electroplated with a thin, non-reactive film of either gold or nickel. As the drawing progresses, this film becomes so thin as to be virtually non-existent.

The firm has drawn Pyrofuze to 0.0009 in. diameter and it is available in this and larger sizes. There is some indication that even finer diameters will be drawn in the future. An alternate form consists of multiple palladium and aluminum wires closely pressed together in an aluminum jacket.

• **Assorted shapes** — Considerable success has been achieved with the pressing of the metals as powders into pellets and other special shapes. These react with greater violence than the wire—probably because of their confined volume with respect to surface area.

If Pyrofuze wire is ignited at one end by any means, the reaction proceeds steadily with a reliable and predictable rate of speed to the other end. The rate of travel will vary with the diameter but may also be adjusted to suit particular requirements. This is accomplished by changing the ratio of the metals or by using multiple strand wire.

If the wire comes in contact with a heat sink, the reaction will extinguish itself. The reason is that the sink reduces the temperature below the critical level. Thus it is possible to stop the reaction at any point through the location of a heat sink.

The material is stable in any form at ambient temperatures. But if it is kept for long periods at elevated temperatures, a slow diffusion may take place between the metals, and the wire may ultimately become inactive. Since both time and temperature is involved, detailed information is not available.

Pyrofuze is not a replacement item. It must be designed into a system. According to the firm, the material's versatility lends itself to this approach. ⌗

Centaur Set for First Engine Tests

by William J. Coughlin

THE FIRST *CENTAUR* VEHICLE is now installed in a test stand at Convair's Sycamore Canyon facility near San Diego.

This is a propulsion test vehicle which will be used to check out the complete propulsion system in a mating of the two Pratt & Whitney liquid hydrogen engines with the Convair airframe.

It is the forerunner of six flight vehicles which Convair will build under its present NASA contract (M/R, Nov. 21, p. 43).

The LR 115 engine has already achieved firings up to 5 and ½ minutes at P&W's West Palm Beach facility, according to Richard C. Mulready, project engineer. In a paper prepared for the upcoming ARS convention, he disclosed that 2500 test hours—some 500 on bearing configurations alone—have accumulated since engine development began in Oct., 1958.

The hydrogen and oxygen propellants produce a specific impulse of 420 seconds—35% higher than LOX-RP. Mulready said the LR 115 rated 15,000 lbs. thrust. The engine operates at a nominal chamber pressure of 300 psia with a nozzle expansion ratio of 40 to one.

First flight of *Atlas/Centaur* is scheduled on the Atlantic Missile Range by mid-1961.

Centaur's first mission will be an attempt at a 24-hour orbit, although initial flights will not be directly connected with the *Advent* communications satellites to follow.

Much of the instrumentation in the first vehicle will be aimed at evaluation of zero-g conditions.

Problems associated with the storing and pumping of liquid hydrogen under zero-g conditions are of prime interest in the initial tests.

The first flight *Centaur* will carry a TV system to monitor by means of telemetry the behavior of the propellant in the tank. Thermocouples will be welded to the wall of the tank and liquid gas sensors will monitor the system.

Extensive cold flow tests of the liquid hydrogen system already have been carried out on the ground in a special test rig set up at Point Loma near San Diego (cover photo).

AERIAL VIEW of Complex 36 at Atlantic Missile Range, being built for launch of Centaur before mid-1961. Note the unusual right-angle flame deflector.

• **Some specifications** — Newly-disclosed design details of the space vehicle indicate that the total length of *Atlas/Centaur* will be about 110 ft., including booster, *Centaur* and payload. First stage is a basic *Atlas D* modified for space use. This will fly on a programer with no first-stage guidance, although it will be possible to use second-stage guidance with the first-stage autopilot.

The *Atlas* tank structure, tapered for missile use, will be held to a constant 10-ft. diameter for use with *Centaur*.

The high-energy *Centaur* second stage, about 35 ft. in length including nose fairing, will be powered by two LR 115's. Gross weight of the second stage will be in the neighborhood of 32,000 lbs. Like *Atlas*, the *Centaur* upper stage is built of thin-gage stainless steel (301 series) lightly pressurized to maintain shape. Fibreglass and honeycomb also are used in the construction.

Pitch, yaw and roll control will be maintained with the aid of a sun sensor and 10 Bell hydrogen peroxide rocket motors, including four 50-lb.-thrust ullage rockets and six smaller verniers.

A weight saving of hundreds of pounds has been achieved in *Centaur* with an unusual boost pump system for the liquid hydrogen. Use of a boost pump in the line to the engine, together with the engine pump, permits an initial low tank pressure of 5-6 lbs. This has made it possible to design tanks with thinner skin and to reduce the amount of helium required for pressurization.

Pumps for the system, built by the Pesco division of Borg-Warner, will be run by a hydrogen peroxide turbine drive built by General Electric.

• **Components cut** — Simplicity of the engines is the key to what is expected to be high reliability for the vehicle. Considerable reduction has been achieved in the number of components. There are, for example, only three valves in each engine. Engine development is well along, with Convair, NASA and P&W reportedly well satisfied with results to date. Some later engine tests will be carried out at Edwards Air Force Base.

The same engine, uprated to 17,500 lbs. thrust, will be used to power the *Centaur* upper stage for *Saturn C-1*, as well as the second stage under development at Douglas Aircraft.

All-inertial guidance system will weigh about 145-lbs., employing a four-gimbal platform with three-axis stabilization and a digital computer. Contractor for the system is Minneapolis-Honeywell, with Librascope as a subcontractor on the computer.

A *Centaur*-type vehicle was first proposed by Convair in December, 1957, shortly after *Sputnik I*. The initial $7-million contract for *Centaur* was let to Convair in December, 1958. ⌗

'HANKS, MONSIEUR CORIOLIS, BUT WE PLAY IT STRAIGHT!

our theory is a little complicated for us. Rather than work in rotating coordinates and ompensate for your famous acceleration, we avoid the problem. Our guidance system plat- rms are stabilized in inertial space instead of rotating Earth space. The result is simpler uidance system computations for missiles like Titan. If you are challenged by reducing assic theory to practical hardware, and have a BS, MS or PhD in Physics, ME, EE, or Iath, please contact Mr. C. D. Allen, Director of Scientific and Professional Employment, 929 S. Howell, Milwaukee 1, Wisconsin.

AC SPARK PLUG ❀ THE ELECTRONICS DIVISION OF GENERAL MOTORS

Automation Promises Better Testing

- *Douglas Servo Lab expects its system to give more accurate data than manual tests—faster and cheaper*
- *Increasing requirements and costs of accompanying expansion forced firm to turn to test automation*
- *RW-300 computer, heart of the system, replaces human control of adjustment and measurements*

by B. C. Moore
Flight Test & Research Specialist
Testing Division
Douglas Aircraft Co.
Santa Monica, Calif.

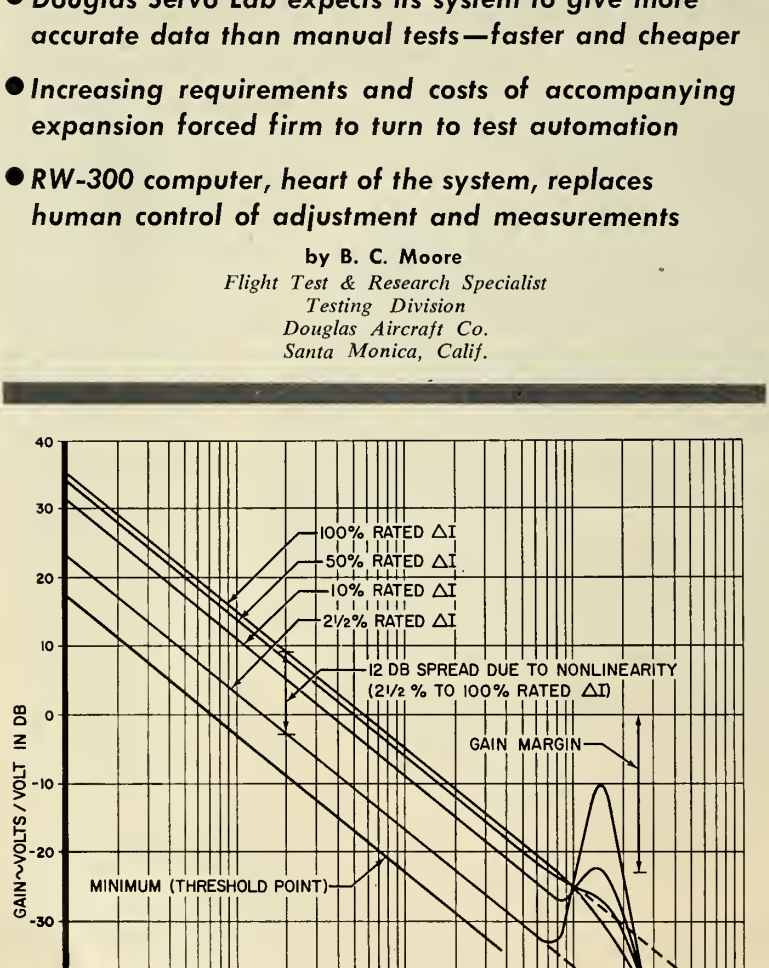


FIGURE 1—Typical test data from the Douglas Servo Laboratory's test system shows the slim margin between high- and low-gain limits, due to valve nonlinearity.

TECHNIQUES THAT MAY revo lutionize the art of components testin are now being used by Douglas Ai craft Company.

Through automation, the Company Servo Laboratory believes it can pr vide more accurate test data than wa ever obtained manually—and do faster, cheaper and with less part breal down. The same techniques of aut mation can be applied to almost an kind of test of components or system

Douglas began extensive respons testing of hydraulic servos during th development of *Nike-Ajax*, almost l years ago. In those days, the serv were a continual bottleneck. Rejectio rates were high, production rates lo

Good valves were flown directly t White Sands Missile Range for firin Rejected valves were rebuilt again an again. Costs of testing ran many tim the cost of production.

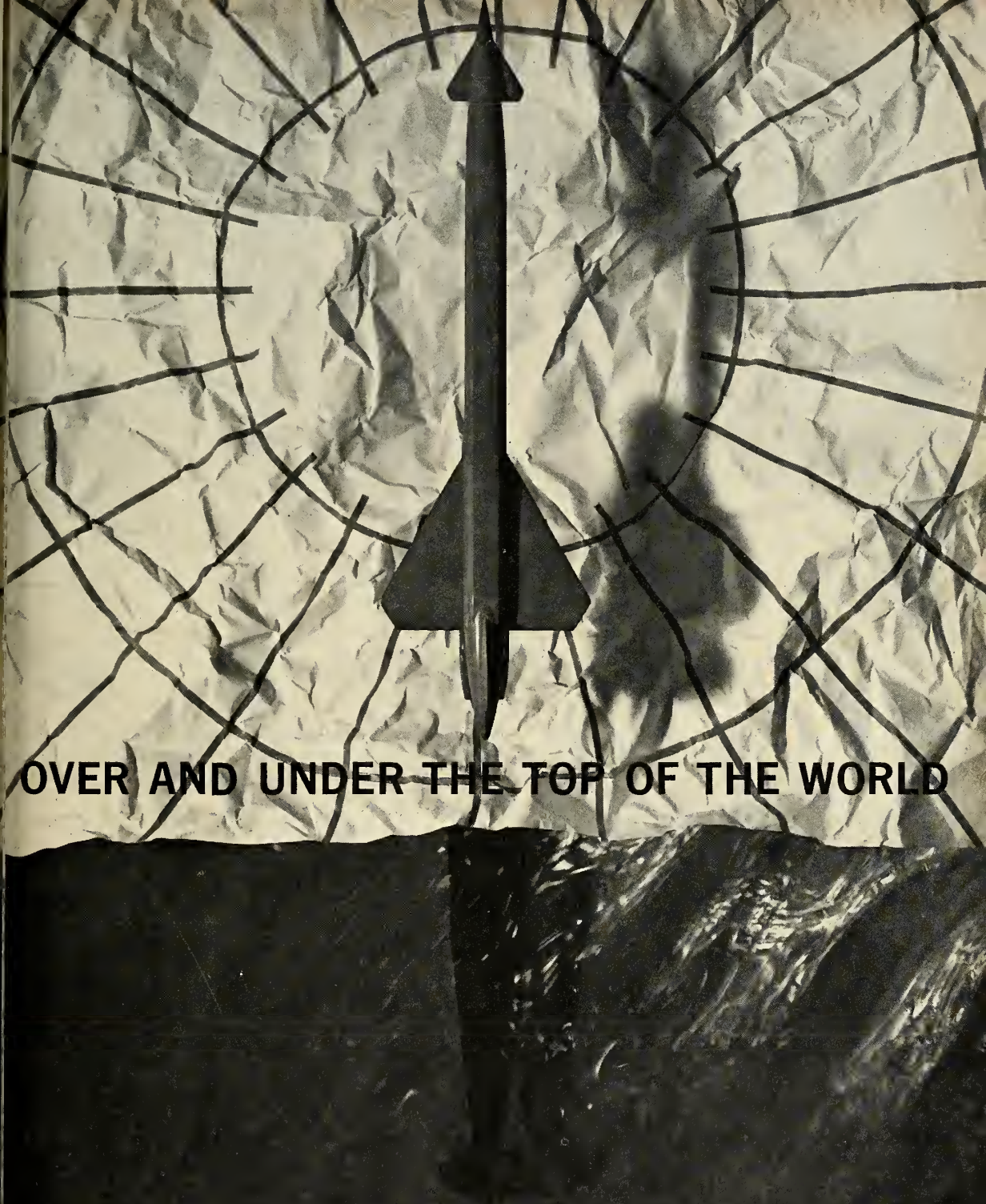
Why must servos be tested so e tensively? Servo gain is always limite top and bottom. High gain caus oscillation of the inner loop, often at mechanical reasonance of the serv load (such as missile fin and driv shaft). Typically, this is a high-energ oscillation-bursting forth with muc noise and vibration, breaking parts i a very short time.

Low gain causes hunting or sligl changes in direction of the comple missile in the valve "dead spot." Th margin between high and low gai limits is slim, eaten away by valv nonlinearity. (See Fig. 1).

• **Servo gain tests**—Servo gain tested by driving with a sine wave an measuring the response. Frequenci must be varied from the low missil hunting frequency up through the inne loop resonance.

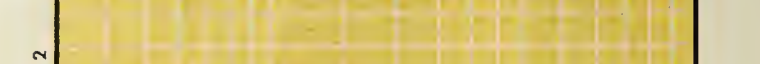
At each frequency this nonline system must be tested from the thresl old of motion up to full throw (fro stop to stop). As a cross-check on th sinusoidal response data, the servo driven unstable by increasing the gai

Equipment for conducting the response tests has evolved graduall with considerable experimentatio Driving and feedback sine waves a displayed on an oscilloscope togeth with reference voltage lines. Amplitud



In early 1960, American craft pierced the North Pole in two elements. Fathoms below solid ice, the USS Sargo probed unerringly to "90 North"; miles above, a GAM-77 missile on a B-52 pinpointed the featureless goal. Both used Inertial Navigation systems by Autonetics—where today's results pave the way for tomorrow's breakthroughs.

Electromechanical Systems by **Autonetics** Division of North American Aviation



are measured by adjusting reference voltages to match the sinewave peaks, while relative phase is measured with Lissajous patterns.

• **Skill-level high**—A built-in problem is the fact that highly skilled operators are needed to make these measurements—servos driven at high frequency and full power simply don't last long. An inexperienced operator will break down the servo before the first test is finished. Since he is unsure, his response is not quick enough. O-rings often fail, spraying hydraulic fluid at 3000 psi; the bearings are beaten out, changing the response data. Occasionally a shaft breaks.

• **Requirements have tightened**—Over the years, the test requirements have steadily increased. Servo performance has been measured at arctic temperatures (where the oil gets thick and the dead spot increases), at high temperatures where O-rings fail, with g-loads and vibration effects causing spurious valve response, with the use of contaminated fluid to jam the valves, and with simple wear.

Higher flow rates, higher temperatures, more linearity, and more reliability were continually being developed.

• **Facility costs grow**—Facilities developed exponentially. A dust-free area was built—and then expanded. Test cells for high and low temperatures were built with fire-proof doors and closed-circuit TV for safe, remote operation. Hydraulic pumps for hot and cold fluids and electronic servo drives were continually added. Total investment passed $1 million, and more than 30 engineers and technicians were needed full time.

This expansion road could not be followed indefinitely. In the fall of 1957

Figure 2
Results of Typical Test

Outcome of an automatic servo test at Douglas Aircraft Co. At right, columns of results from the computer. At left, curves reflecting a portion of the data in the columns. The unit tested was a hydraulic servo. The computer and associated equipment were provided by the Thompson-Ramo-Wooldridge Products Co.

a study was initiated to develop future facility requirements. The possibility of making better use of existing facilities through test automation was very attractive. For example, fast testing might permit simple blowdown hydraulics for extreme temperatures, rather than requiring expensive pumps with heaters and coolers for steady flows.

• **Automation the answer**—The more automation was studied the better it looked. In May, 1958, bids were invited to a performance specification.

Industry responded generously with some very interesting analog systems, paper tape controlled systems, and general purpose digital computer systems. The comparison of these systems included cost vs. speed (or cost per test station); reliability (the penalty for down time is enormous); accuracy of data and flexibility.

A contract was awarded in August, 1959, to Thompson-Ramo-Wooldridge Products to supply an RW-300 digital computer and associated equipment. Delivery followed in May, 1960. This was integrated with Douglas Aircraft Co. (DACo) built equipment and placed in operation.

Results of an automatic test of a hydraulic servo are shown in Figure 2.

• **Equipment setup**—A block diagram of the automatic servo tester is shown in Fig. 3, in which the heart of the system is the RW-300 computer. A drum machine, with 8000 word storage, it is highly reliable.

Operating records indicate 1000 hour mean time between failures; a guarantee of 500 hours was given. Program input is through a Flexowriter on paper tape. Switches (54 provided) can be sampled by the program for additional data or instruction and four

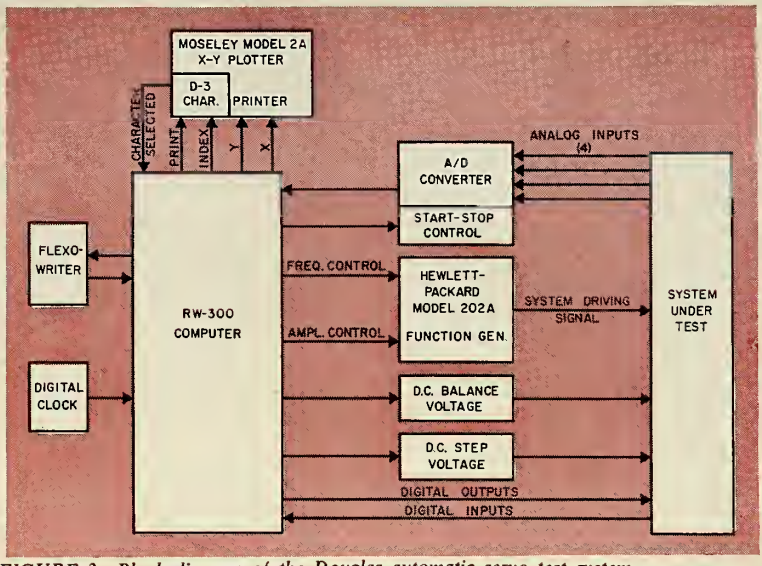


FIGURE 3—Block diagram of the Douglas automatic servo test system.

analog voltages can be sampled on program command.

A short burst of 1024 words in about ¼ second can be written on the drum for later analysis—or a continuous sampling mode can be commanded.

The computer controls peripheral equipment through relays. It operates the Flexowriter and X-Y plotter, adjusts the frequency and amplitude of the driving signal, adjusts dc voltages used for balance and step inputs to the servo, selects the servo amplifier networks and gain, picks the signals to be measured and adjusts signal-sealing amplifiers.

In short, it performs all the previous manual adjustments and measurements.

Much of the peripheral equipment is thus a very simple development over the previous manual gear—the hand switches and adjustments have been removed and replaced by relays.

• **Programing and operation**—Programing the computer was of course a major work package. Sine waves are analyzed by a Fourier integral, insuring accurate measurement of the fundamental component even in the presence of noise and non-linear distortion. Other subroutines include such items as vector division, rectangular to polar conversion, set frequency and set amplitude. Setting routines are closed-loop—i.e., a measurement follows the adjustment and any errors are corrected.

All pheripheral equipment is thus calibrated against the analog-digital converter (in turn checked against a standard cell). Simple controls can be used, and no periodic calibration is needed.

The test engineer may specify any arbitrary frequency and amplitude. He chooses amplifier configuration, signals measured, and data to be printed.

The central computer may be connected to any one of ten test stations manually, with both local and remote switches for safety. While the test is running, the test engineer can watch on closed-circuit TV, and observe typed and plotted results. Additional data may be taken immediately, to follow up unusual results.

This real significance of the advances made by Douglas in improved service is that it has been achieved with conventional equipment—well within the state-of-the-art. It is efficient, has saved time and money; above all, the results are more accurate. ⌗

0959
RUN 1247
FREQUENCY RESPONSE

FREQ.	AMPL.	VFB2/E1		VFB2/E2		VFB1/E1		VFB1/E2	
3.964	0.492	-0.136	-197.3	10.51	-92.94	-5.125	-112.6	5.531	-8.246
	0.968	-0.136	-197.1	10.35	-94.27	-5.574	-107.6	4.921	-4.730
	2.062	-0.148	-195.6	11.36	-95.50	-7.980	-108.2	3.535	-8.109
	2.953	-0.125	-195.3	11.47	-95.68	-9.789	-105.0	1.816	-5.347
	3.523	-0.042	-194.8	11.91	-95.25	-10.99	-106.7	0.968	-7.078
5.929	0.503	-0.648	-205.8	6.468	-92.37	-8.488	-120.6	-1.367	-7.191
	0.957	-0.515	-204.7	7.007	-94.42	-9.210	-116.9	-1.683	-6.644
	1.972	-0.429	-202.6	7.957	-97.11	-11.39	-114.6	-3.003	-9.140
	2.95[illegible]	-0.2[illegible]	-201.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
	0.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	2.007	-14.02	-320.1	-15.42	-146.5	-44.65	-244.4	-46.05	-70.85
	2.996	-12.31	-322.7	-13.91	-149.6	-44.24	-268.9	-45.83	-95.91
	3.457	-11.58	-322.8	-13.42	-150.4	-43.08	-250.3	-44.92	-77.99
102.3	0.503	-24.01	-338.6	-24.64	-160.1	-48.09	-11.83	-48.72	-193.2
	1.007	-21.09	-335.3	-21.80	-157.7	-54.25	-314.3	-54.96	-136.7
	2.031	-18.62	-334.0	-19.54	-156.9	-49.33	-355.6	-50.25	-178.5
	2.941	-17.10	-335.5	-18.25	-158.8	-53.99	-314.9	-55.13	-138.3
	3.484	-16.22	-335.4	-17.44	-158.9	-47.46	-288.3	-48.68	-111.7

contracts

AIR FORCE

$201,902—Goodyear Aircraft Corp., for continued repair and maintenance of map synthesis equipment in the electronic guidance system of the TM-76A *Mace* missile.

NAVY

Lamtex Industries, Inc., Farmingdale, L.I., N.Y., for development and manufacture of rocket motor cases for the second-stage propulsion system on the *Polaris*.

$3,000,000—The Bendix Corp.'s Bendix-Pacific Div., N. Hollywood, Calif., for antisubmarine warfare sonar equipment.

$885,000—Vitro Electronics, Los Angeles, for a substantial portion of the systems engineering and instrumentation of two additional tracking ships assigned to the Pacific Missile Range Fleet.

$100,000—Instruments for Industry, Inc., Hicksville, L.I., N.Y., for transmitter system development. Subcontract from Sanders Associates, Inc.

ARMY

$1,223,600—Raytheon Co., Waltham, Mass., for four sets of *Hawk* ground support equipment.

$300,000—Hughes Aircraft Co., Culver City, Calif., for developing a guidance unit for the *Mauler* air defense system. Subcontract from Convair.

$300,000—The Eureka Williams Co., Bloomington, Ill., for production of fuses used in the 20 mm. conventional spotter rounds of the *Davy Crockett* weapon system.

$115,000—Giannini Controls Corp., Duante, Calif., for pressure transducers for the control system of the *Nike-Zeus*. Subcontract from Western Electric Co.

MISCELLANEOUS

General Dynamics Corp., New York City, has received a contract for "pulsing" atomic reactor designed especially to provide important data on the biomedical effects of nuclear radiation. Amount not disclosed.

General Mills, Minneapolis, for development of a manipulator system to be used in remote handling of rocket fuels and rocket motors. Subcontract from The Dow Chemical Co., Midland, Mich.

$1,200,000—Leventhal Electronic Products, Inc., Palo Alto, Calif., for a high-power tube-testing facility. Subcontract from Varian Associates.

$207,000—The York Body and Equipment Co., York, Pa., for electronic shelters. Subcontract from Raytheon Co.

NASA

Lockheed's Missiles and Space Division, Van Nuys, Calif., for design and building of a prototype sterilizing unit to insure that the first American lunar landing space vehicle will be germ-free when it hits the moon.

$500,000—General Electric Co.'s Defense System Dept., Syracuse, for high-precision radar display and computing equipment for use at the Flight Research Center, Edwards AFB, during tests of the *X-15*.

$84,000—Douglas Aircraft Co., for a comprehensive study of operations phases of a three-stage *Saturn C-2* system.

With its tremendous thrust, *Zeus* can intercept attacking missiles far from the area it defends

Zeus is designed for a hit every time on supersonic bull's-eyes!

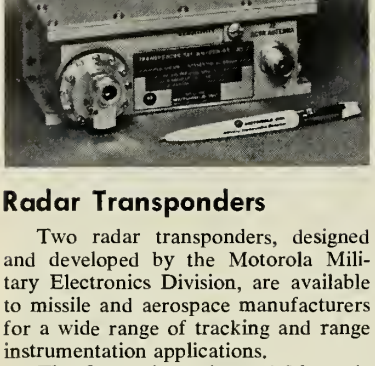
At best, an anti-missile defense will have only a few minutes to react ... and no "second barrel" to fire at its supersonic target.

Nike Zeus needs none. Tests of this new anti-missile missile show that it will attack enemy ICBM's with 100% accuracy at a distant interception point. There its nuclear warhead will be detonated to blanket the approaching ICBM with an explosive curtain.

The newest member of the famous Douglas *Nike* family, *Zeus* was developed in a joint Western Electric, Bell Telephone, Douglas Aircraft project. Its design combines the most successful lessons learned from *Ajax* and *Hercules* — *Nike Zeus* predecessors that are on duty around many important U. S. cities and industrial centers and with NATO forces overseas.

DOUGLAS

MISSILE AND SPACE SYSTEMS • ANTI-SUBMARINE SYSTEMS • MILITARY AIRCRAFT • DC-8 JETLINERS • TRANSPORT AIRCRAFT • AIRCOMB® • GROUND SUPPORT EQUIPMENT



Radar Transponders

Two radar transponders, designed and developed by the Motorola Military Electronics Division, are available to missile and aerospace manufacturers for a wide range of tracking and range instrumentation applications.

The first unit, designated Motorola Type SST-101 (AN/DPN-63) is a general purpose, crystal-video transponder intended for use in tracking intermediate range missiles, drones and piloted aircraft.

The second unit, known as the Motorola SST-102 (AN/DPN-66), was developed for long-range missile tracking applications. It is a general purpose superheterodyne pulse transponder intended for use with precision C-Band tracking radars such as the AN/FPS-16 and AN/MPS-26 and features an all-solid state modulator switch.

Circle No. 225 on Subscriber Service Card.

Synthetic Mica Paper

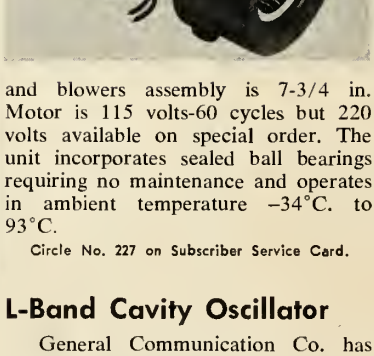
Synthetic mica paper is available from Synthetic Mica Co. in pilot plant quantities.

SYNTHAMICA 202 has a melting temperature of 1365°C and an operating temperature up to 1000°C. Electrical properties include a dielectric constant of 3-4 with a dissipation factor of 0.0005-0.0020, a dielectric strength of 600-1000 volts/mil and volume resistivity 5 x 10^{15} ohm/cm at room temperature.

Circle No. 226 on Subscriber Service Card.

Lightweight Dual Blower

A light weight Model 8481 Dual-Outlet Blower for heat dispersion has been added to the line of the Ripley Company Inc. The one-piece, impact resistant phenolic plastic housing with aluminum motor-plate is 6-3/8 in. from top to bottom. Total width of motor



and blowers assembly is 7-3/4 in. Motor is 115 volts-60 cycles but 220 volts available on special order. The unit incorporates sealed ball bearings requiring no maintenance and operates in ambient temperature −34°C. to 93°C.

Circle No. 227 on Subscriber Service Card.

L-Band Cavity Oscillator

General Communication Co. has available an L-band planar tube oscillator which is tunable from 920 to 1400 megacycles. A dual cavity with tuned plate and tuned cathode is controlled by a single leadscrew. The resulting single dial control covers the entire range with relatively small change in output level.

Circle No. 228 on Subscriber Service Card.

FM Telemetry Transmitter

A transistorized FM telemetry transmitter is available from United Electro Dynamics, Inc. for the firm's FM/FM and PCM systems. Specifications of th TR-10 include: 2.5 watts output wit true FM modulation over complete 21 265 mcs telemetry band; 99.9% relia bility for 500 hours; modulation fre quency response ±2 db from 3 cps t 300 KC; vibration-induced noise les than 1.5 KC deviation at 20 G's fror 20 cps to 2000 cps; and modulatio linearity less than 1% from straigh line at 125 KC deviation.

Circle No. 229 on Subscriber Service Card.

Stored Welding Power

A 100 watt-second stored energ welding power supply designed espe cially for the electronic componer packaging field has been developed b Hughes Aircraft Co.

Model VTW-30 delivers a step-fre adjustable range of power of 0.5 t 100 watt-seconds. A pulse width of les than 1.5 milliseconds assures no burnin or discoloration of the weld area an no heat damage to the componen being welded.

Circle No. 230 on Subscriber Service Card.

Traveling Wave Tubes

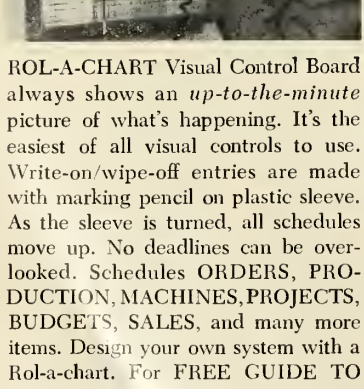
Sylvania Electric Products Inc. marketing two temperature compe sated, magnetically shielded, travelin wave tubes, designed for "close qua ters" in airborne and missile applic tions.

The components (TW-4002F an TW-956H) employ periodic permane focusing and are designed for bo pulse and CW operation.

Both types operate without heat blankets from −65° to 72°C wit minimum performance degradatio They have a relatively flat frequenc response over an octave, from 2.0 t 4.0 KMC. Each unit weighs approx mately 3 lbs., is about 15 in. long, an has a 1.4 in. capsule diameter.

Circle No. 231 on Subscriber Service Card.

Fast, Automatic Scheduling With Rotating, Plastic Sleeve



ROL-A-CHART Visual Control Board always shows an *up-to-the-minute* picture of what's happening. It's the easiest of all visual controls to use. Write-on/wipe-off entries are made with marking pencil on plastic sleeve. As the sleeve is turned, all schedules move up. No deadlines can be overlooked. Schedules ORDERS, PRODUCTION, MACHINES, PROJECTS, BUDGETS, SALES, and many more items. Design your own system with a Rol-a-chart. For FREE GUIDE TO ROL-A-CHART VISUAL CONTROL METHODS *with full scale chart section to try,* write to: ROL-A-CHART, 494 Jefferson St., San Francisco 9, Calif.

Circle No. 16 on Subscriber Service Card.

Five European NATO nations will produce the U.S. Army Hawk missile as the primary ground-to-air defense weapon in Western Europe. Raytheon, developer and prime contractor in the U.S. for the Hawk, is supplying technical assistance to manufacturers selected by these NATO countries.

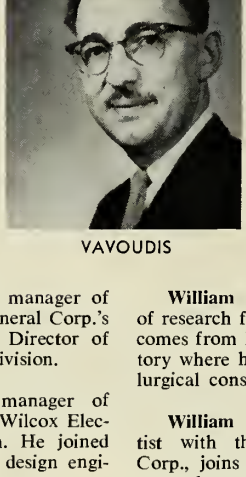
RAYTHEON COMPANY

WALTHAM, MASSACHUSETTS

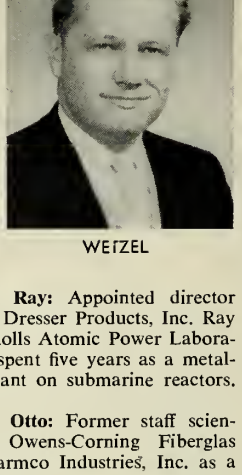
RAYTHEON

EXCELLENCE IN ELECTRONICS

BOSSERT



VAVOUDIS



WETZEL

Joseph Havrylak: Former manager of manufacturing for Aerojet-General Corp.'s Avionics Division, appointed Director of *Midas* programs within the division.

Lewis Bossert: Elected manager of magnetics marketing for The Wilcox Electric Co.'s Magnetics Division. He joined the firm two years ago as a design engineer.

Dr. Domenic Bitondo: Joins the Aerospace Corporation as manager of the Aeromechanics Dept. in the Systems Research and Planning Division. Previously held positions with STL, Northrop and the Aerophysics Development Corp.

William E. Ray: Appointed director of research for Dresser Products, Inc. Ray comes from Knolls Atomic Power Laboratory where he spent five years as a metallurgical consultant on submarine reactors.

William H. Otto: Former staff scientist with the Owens-Corning Fiberglas Corp., joins Narmco Industries, Inc. as a research specialist for the Research and Development Division.

Fred J. Wetzel: Named field engineer by Vitro Laboratories and transferred from the Silver Spring, Md., Laboratory to its Sunnyvale field office. He will conduct liaison with local *Polaris* contractors. Prior to this assignment, he participated in Vitro studies of shipboard missile handling, stowage and safety.

Joseph Rambusek: Former vice president in charge of sales for Bogue Electric Manufacturing Co., joins The Siegler Corp.'s Magnetic Amplifiers Div. as sales manager.

Sprague Electric Co. announces the following promotions within the company: **William J. Nolan,** senior vice president in charge of legal affairs; **Neal W. Welch,** senior vice president, marketing and sales; **Wilbur A. Lazier,** senior vice president, technical director; **Robert C. Sprague, Jr.,** senior vice president, industrial relations; **David B. Peck,** vice president, special products; **Hollis R. Wagstaff,** vice president, fiscal; **Carroll G. Killen,** vice president, industrial and military sales; **Bruce R. Carlson,** vice president, corporate planning and systems.

Socrates N. Vavoudis: Former director of engineering for Itemlab Inc., joins United Aircraft Corp.'s Norden division as supervisor of the environmental laboratory. Prior to joining Itemlab he served in various engineering capacities with General Precision Laboratory and Electricoil Transformer Corp.

Dr. Erwin M. Koeritz: Appointed manager of manufacturing, Metallurgical Products Dept., General Electric Co., Detroit. Dr. Koeritz has been manager of manufacturing engineering in the firm's Silicone Products Dept. since 1956.

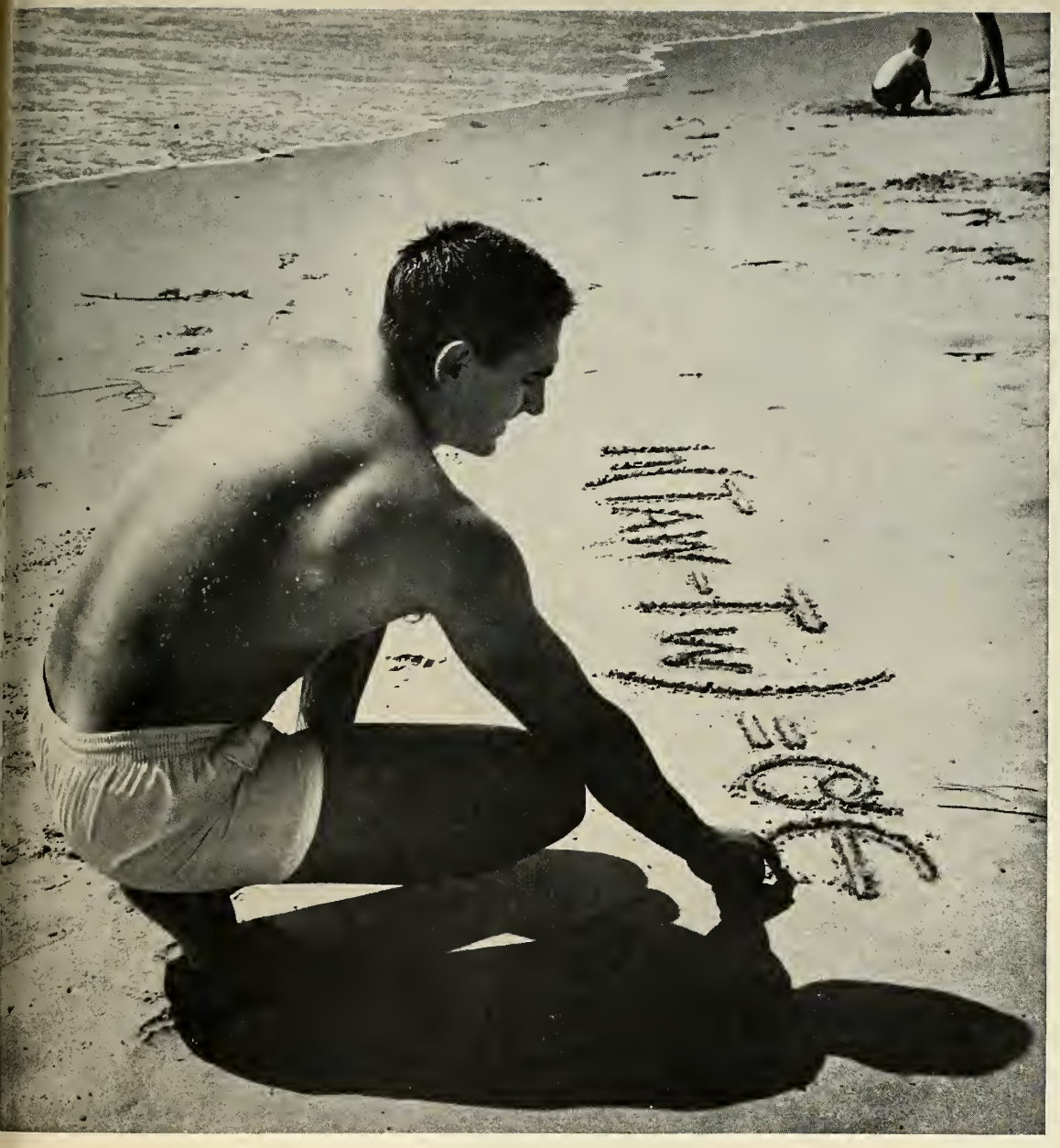
Edward L. Lavine: Formerly eastern regional sales manager of Ling Electronics, Inc., named vice president and general manager of Communication Measurements Laboratory, Inc.

B. A. Erickson: Former manager of flight and chief engineering test pilot in the B-58 supersonic bomber program at Convair-Fort Worth Division, promoted and given an executive special assignment in the office of the assistant manager for operations.

J. L. Bromberg: Appointed director of programs—Defense Programs for Douglas Aircraft Co. Was formerly program manager for the *Nike-Zeus* project and prior to that was one of the key members of the Air Force-industry team which developed the *Thor*.

Maj. Gen. Raymond C. Maude (USAF-ret.): Elected director of field operations for Philco Corp.'s Government and Industrial Group. Was formerly executive vice president of International Electric Corp.

Dr. R. H. McFee: Former director of research for Aerojet-General Corp.'s Avionics Division, appointed director of research for the firm's Advanced Research and Products Division.



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FOR MORE INFORMATION on how the Department developed the articulating rack hoist drive, a key feature of the MK 12, write to Mr. L. A. Collins, Manager—Ordnance Sales, for the brochure, "Articulating Rack Hoist Drive."

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ADVERTISERS' INDEX

Exhibiting Our Space Achievements

SECRETARY OF STATE Christian Herter is not a man to write letters of commendation freely.

Yet he took the time recently to write such a letter commending the National Aeronautics and Space Administration team which conceived and put together a comprehensive space exhibit for the recently closed Montreal International Trade Fair.

The Secretary's letter didn't say so, but it indicated a growing realization on the part of State that our prestige abroad is clearly linked to our space achievements.

It also indicated the knowledge that while the Russians are ahead in spectacular—and certainly in strategic—space feats, some of ours are not so bad and that it is high time we told this fact to the world.

The Montreal exhibit was well-planned and well-executed. In language the layman could understand it told the facts of the American *Discoverer* series. *Tiros, Transit* and *Echo*. It was the most popular exhibit at the Fair and was seen by some 175,000 persons—including, incidentally, other exhibitors from France, Italy, Belgium, Japan and Mexico. The president of the Montreal Fair called it "the magnet which drew the crowds which made the fair successful."

The exhibit is now en route to Chicago, where in January it will be shown at the Chicago Museum of Science and Industry, with an expected draw of well over a million people.

Here, however, it may well end its exhibit life unless the Kennedy Administration recognizes the value of such demonstrations of American technical ability and makes provisions for their continuance.

There was no money in the 1961 NASA budget for the Montreal exhibit. Its cost was about $85,000 and the money was "scrounged" from any loose funds the Exhibit Branch of the Technical Information Office could find.

Future showings of this exhibit would cost simply transportation, although one exhibit won't stretch very far across the reaches of America. To build additional exhibits would cost probably half as much a copy as the original.

The 1962 NASA budget has, reportedly, about three-quarters of a million dollars for exhibits. If granted this will not be available until July, 1961; in any case, it is completely inadequate to the need.

NASA has received certain invitations to exhibits, including the British Columbia International Trade Fair in May and the American Rocket Society "Space Report to the Nation" in October, 1961. But it is not sure it can accept.

BEYOND THESE "DOMESTIC" opportunities, consider the educational influence such American space achievement exhibits would have in other parts of the world—in Africa, India and Indonesia.

The United States Information Agency (which has little or no money for such purposes either) could keep a dozen such exhibits on tour continually for months. Visual and easily comprehensive, these exhibits would do more, we believe, to successfully demonstrate U.S. space achievements and posture than any one other thing upon which we would spend equal money.

The State Department has taken one step in recognizing their importance. We most sincerely hope that State and USIA will help to present a case for them when the new Administration considers the budget, both supplemental and regular.

Clarke Newlon

Portrait of a Mach number

Air blasting across an acrodynamic shape at Mach 2 (above, left) records its image on film. In private industry's most extensive complex of wind tunnel installations, Boeing engineers and scientists are defining the shape of the future in supersonic and hypersonic flight. A new hypersonic tunnel, the nation's largest privately owned facility of its kind, tests up to Mach 27.

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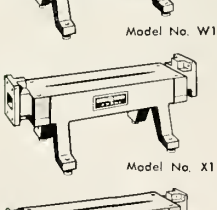

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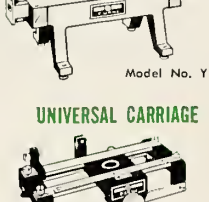

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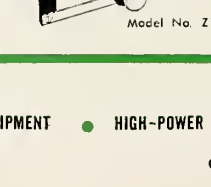

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