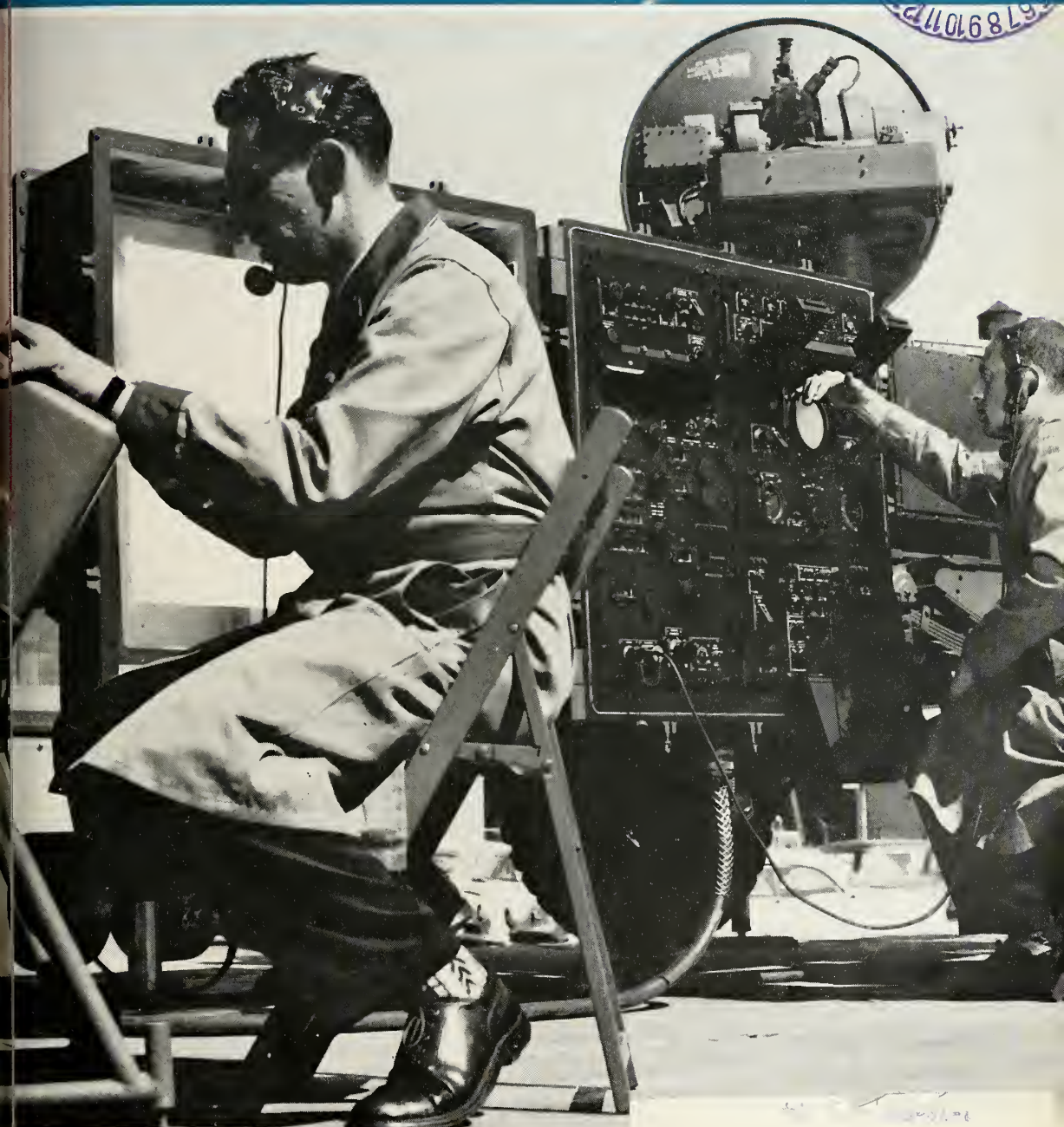
OCTOBER 24, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY



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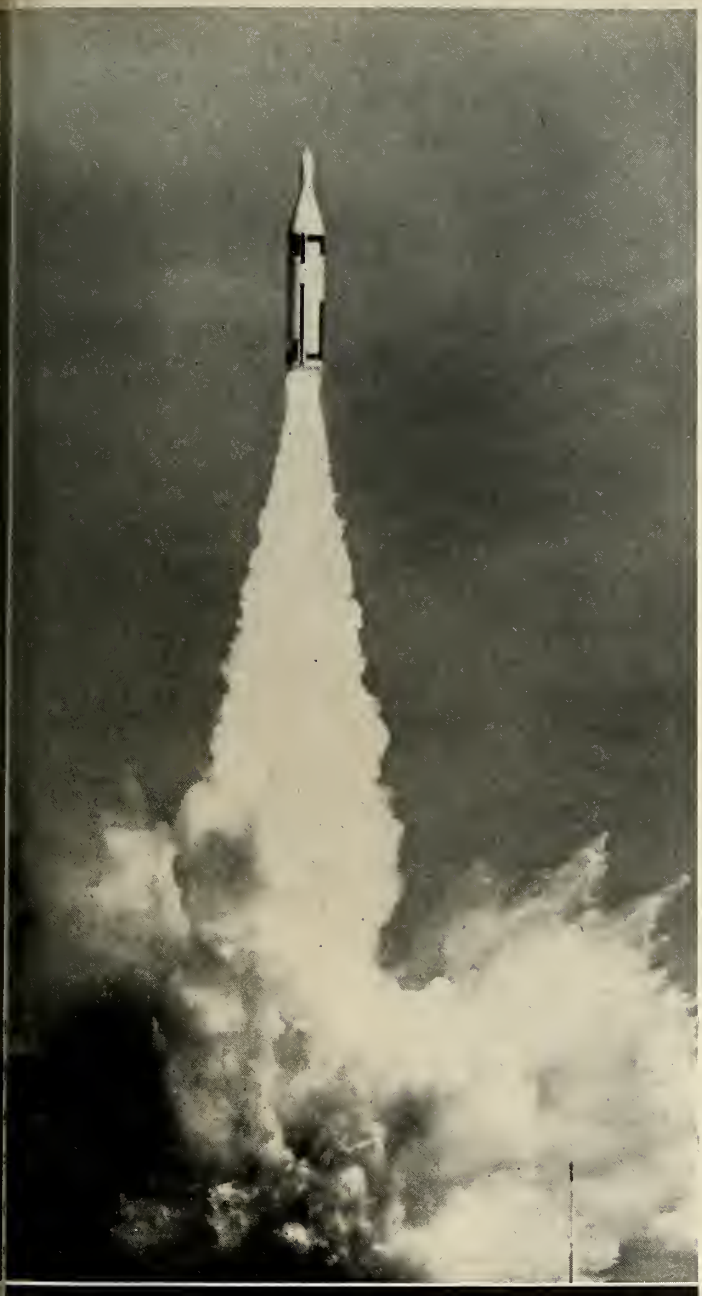

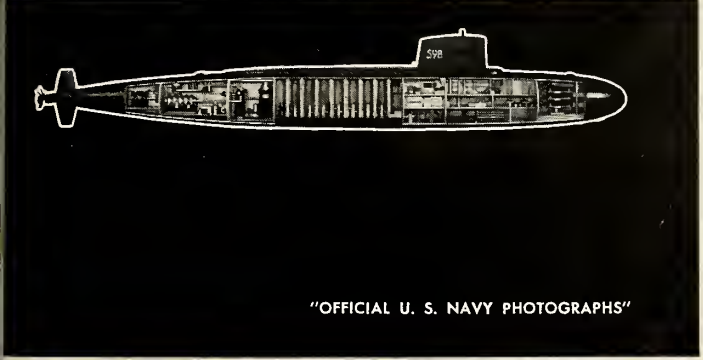

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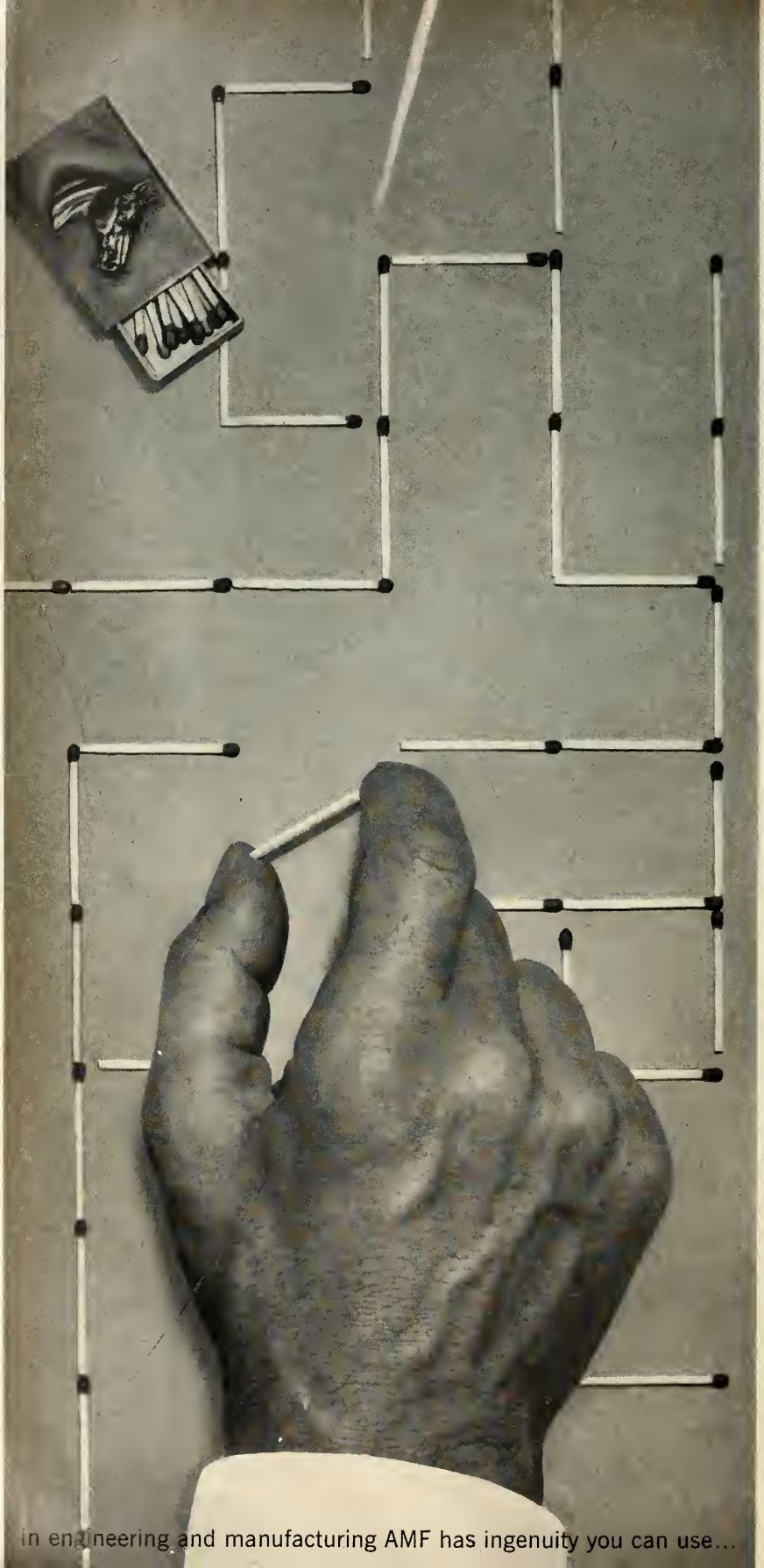

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THE MISSILE / SPACE WEEKLY

missiles and rockets

October 24, 1960 Volume 7, No. 17

shed each Monday with the exception of the Monday in December by American Aviation cations, Inc., 1001 Vermont Ave., N.W., Washn 5, D.C. Cable Address: AMERAV.

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ec. Vice President and General Manager

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Vice Pres. and Editorial Director

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cription rates: U.S., Canada and Postal Union ons—1 year, $5.00; 2 years, $8.00; 3 years,). Foreign—1 year, $10.00; 2 years, $18.00; 3 , $26.00. Single Copy rate—$.50. Subscriptions solicited only from persons with identifiable mercial or professional interests in the missile/ e industry. Subscription orders and changes ldress should be referred to Circulation Fulfill- Mgr., M/R, 1001 Vermont Ave., N.W., Washn 5, D.C. Please allow 4 weeks for change to me effective and enclose recent address label ssible.

THE COVER

Heart of the new remote control system for surveillance drones, developed for the Army by Ford Instrument and successfully tested. See story on p. 40.

OCTOBER 24 HEADLINES

ENGINEERING

ADVANCED MATERIALS

GROUND SUPPORT EQUIPMENT

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SPECIAL FEATURE

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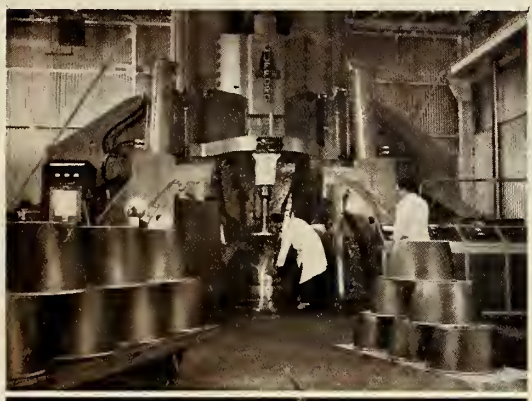

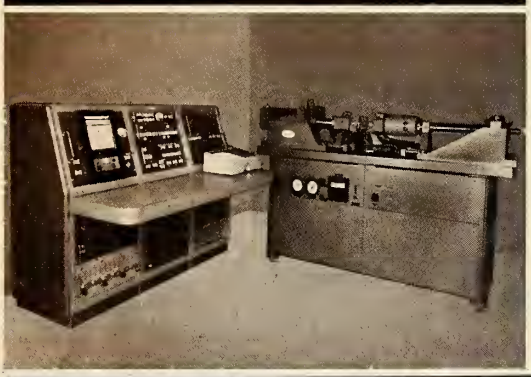

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letters

eal Originator

) the Editor:

My friend, Dr. John Pierce, will be e first to deny your statement in the ugust 22nd issue that he originated the ea of communications satellites in 1955.) the best of my knowledge this con- ption was first put forward by myself the October 1945 issue of the British urnal *Wireless World* in an article under e title "Extra-terrestrial Relays." In this ticle I pointed out that satellites might ovide the only practical solution for orld-wide communications and in partic- ar I stressed the importance of the tationary" or 24-hour satellite. The con- ption reached a wider public in my oks *Interplanetary Flight* (1950) and *he Exploration of Space* (1951) and was irly common in the literature of Astro- utics during the early 1950's. I believe at John Pierce and his colleagues were e first to suggest the use of passive bal- on type communications satellites such the recently launched *Echo* and cer- inly they deserve most of the credit for tting this conception realized in practice.

Discussions over priority are usually dious and unprofitable, but I feel rather rongly on this point as so far my total ancial reward for the conception is 50 llars—the fee for the original article. f course, it may yet turn out that Oberth Tsiolkovsky thought of the idea first, ough this seems a little unlikely as the hole art of communications was in such primitive state when they proposed their riginal ideas on spaceflight.

Arthur C. Clarke
Clarke-Wilson Associates
Colombo, Ceylon

Optics Slip-ups

o the Editor:

I assume that either Dr. K. Pestrecov r Mr. Glenn Wooters of Nortronics have ritten regarding the errors in your article escribing the "60" mm Ballistic Camera. s the author of the specification under hich Nortronics is designing the camera was surprised that the two important oints were muffed, i.e., it will have a re- active lens of 600 mm with an aperture atio of f/2. The large aperture particu- rly is felt to be quite an advance in de- gn considering the relatively long focal ngth.

Another error cropped up concerning nother specification I wrote while at atrick AFB, and that is for the SORTI Star Oriented Real Time Instrument). adiation Company is at present working nly on a study contract to investigate ie feasibility, and if feasible, to offer de- gn approaches to fabrication. No hard- are is involved in the present contract, nd it is unlikely that any procurement ill result in the immediate future. There also a strong argument against an in- rument of the nature of SORTI being lassed as a camera or even in optical nstrumentation, since the stipulation of real time puts this in the same areas as infra-red, neither beast nor foul.

In spite of the various errors, however, I think all of us in optical instrumentation got quite a lift out of the feature article in M/R. As was pointed out the budget for optics has increased steadily the last few years, as it has become more evident that electronic instrumentation, while making even faster strides than optics, can not carry the entire load.

Carleton C. Emery
Project Engineer
RCA Service Company
Camden, N.J.

Black Brant Roles

To the Editor:

The brief mentions of the Canadian *Black Brant* rockets on pages 23 and 25 of your 3 Oct 60 issue contain several mistakes which should be corrected, particularly in connection with industrial participation in the program.

The Defense Research Board of Canada (DRB) has been responsible for the Canadian rocket research program at Fort Churchill up to the present time. The *Black Brant* vehicle has been used there by the Canadian Armament Research and Development Establishment (CARDE) to carry out seeding experiments intended to determine the density of atomic oxygen and nitrogen at an altitude of 100 km. The 1960 program includes use of the *Black Brant* by the DRB's Defense Research Telecommunications Establishment in studies of radio absorption effects in the auroral zone. Both DRB and the National Research Council of Canada plan instrumentation of *Black Brant* vehicles for 1961.

The development of the Canadian rocket has been the responsibility of CARDE. Commencing with the successful development of the propulsion test vehicle known as *Black Brant I*, the program has now progressed to the design and manufacture of a vehicle called *Black Brant II*, which is scheduled for test launchings at Fort Churchill in the fall of 1960.

In the development of these vehicles CARDE has carried out all the solid propellant research and also is the exclusive manufacturer of propellant and filler of engines. Bristol Aircraft Limited of Winnipeg, Manitoba, produced the engine casings and was responsible for the configuration of *Black Brant I*. The design of *Black Brant II* has been largely the responsibility of Canadair Limited of Montreal, Quebec.

Provided that the development of *Black Brant II* is successful, it will be used exclusively for firings in the 1961 program to attain higher altitudes with larger payloads.

E. W. Greenwood
for Defence Research Member
Department of National Defence
Canadian Joint Staff
Washington, D.C.

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WASHINGTON

Zeus: Ike Says, 'No'

Within days, the Eisenhower Administration again has turned down an Army request to begin immediate production of the Western Electric *Nike-Zeus*. The decision—said to have been made by the White House—would delay any final okay for production of the A-ICBM until after the full system is testing in 1962. The result: *Zeus* then would not be deployed before the mid-60's at the earliest. Originally, it was to have been operational in late '62 or early in 1963. However, there could be another switch—after a new administration takes over in January.

Zeus: NORAD Says 'Yes'

The North American Defense Command is understood to be strenuously objecting to the two-year shelving of *Zeus*. NORAD is calling for a program that would protect more than 50% of the nation's urban population. Estimated cost: $8 billion.

Fever Chart

Public temperature-takers in both the Nixon and Kennedy camps are still undecided whether anything is to be gained politically by debating the coming Missile Gap in Detail. Some feel the issue is so complicated that the public is bound to misinterpret it as meaning the nation is weak today—a pitfall for either candidate.

Skybolt Jr. Needed?

Proposals in favor of developing an ALBM with a range of 500 miles—half that of the Douglas *Skybolt*—reportedly are being made to the Air Force. The argument for the junior version: *Skybolt* is understood to be too large to use on the B-58 Mach 2 bomber. Backers of a smaller ALBM contend further that it would be as effective when combined with the B-58 as the *Skybolt* with the slower B-52.

More Atlas Pads at Ready

First operational bird is now at Warren AFB (Cheyenne, Wyo.) Site 2, indicating that the pads are approaching the point where they can be turned over to SAC. Site 2 will add three more combat *Atlases* to the six already in war-ready status at Warren.

Bigger Hydrofoils Next

COUNTDOWN hears from a top source that the Navy is considering designs for a fleet of hydrofoil warships displacing up to 500 tons. Prototypes are expected to be available for testing "in the next few years." Prime mission for these warships will be ASW and as anti-missile missile launchers.

INDUSTRY

Clamping Down on Contractors

Both the Air Force and Navy are warning their contractors to cut their costs—or else. The "or else" will come from Congress. AMC Gen. S. E. Anderson says bluntly that an across-the-board procurement cut (3% in 1960) could be hiked next year to 18% by Congress "if this upward geometric progression continues."

ASW Market Boost

Look for a sustained contract fallout from the Navy's proposed AUTEC (Atlantic Underwater Test and Evaluation Center) for several years. Cost of this ASW range is estimated at $100 million (see page 15) over a 10-year period—but this is believed to be just the beginning.

Base Activators Move

ICBM site management officials—now under AMC's Ballistic Missile Center—are moving from BMD headquarters in Inglewood to Norton AFB, San Bernadino, Calif. Vacated facilities will be occupied by BMD rapidly expanding space operation.

Missile City

Big pitch for locating a 150-*Minuteman* ICBM squadron around Cheyenne, Wyo., will probably come after the election. The town's leaders—who already have embraced the location of 24 Warren AFB *Atlas* pads—are pressing for the *Minuteman*.

INTERNATIONAL

Irish Space Center

A major space research center for Western Europe is being established at Queen's University in Northern Ireland. The center is being built in cooperation with ARPA. Facilities will include a $150,000 digital computer. Total cost the first year will be about $200,000; more than $50,000 a year from then on.

Dutch Missile Strength Revealed

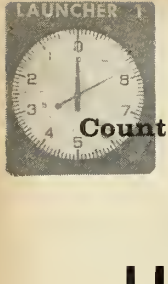
The Royal Netherlands Air Force is scheduled to have four Western Electric *Nike* squadrons by the end of next year. Meantime, the Dutch Army is expected to begin buying JPL Sperry *Sergeants* and Nord *S-11's*.

Argentina Sets Missile Pace

The Argentines are continuing to lead South America in many fields of missile development. Fabrica Naval de Explosivos is manufacturing solid propellant for short-range rockets. Meantime, Universidad de La Plata has picked up government research funds for work on special liquid propellants.

Victor Scrubbed for Skybolt

The British are understood to have decided to put the Douglas *Skybolt* on Avro Vulcan bombers only. The Handley Page Victors will not be used with the U.S. ALBM. The Vulcans will join B-52's in test launching *Skybolts* from Florida.



U.N. Space Effort Stalled by Soviet

United States is ready to blast Russian obstruction of the year-old Committee on Peaceful Uses of Outer Space which has yet to hold a meeting; debate could affect campaign

UNITED NATIONS—The United States is expected shortly to accuse the Soviet Union of blockading efforts to insure the "peaceful" exploration of space through the United Nations.

The charge could be injected into the disarmament discussions before the U.N.'s 99-member Political Committee or put directly before the General Assembly. As such, it could become a key side issue in the general disarmament question.

For almost a year, MISSILES AND ROCKETS was told this week, the Soviets have succeeded in preventing the U.N. Committee on the Peaceful Uses of Outer Space from being organized. The committee has no work program, no rules of procedure, and no officers.

Indeed, it has never met.

The situation is rather painful to the United States and the Eisenhower Administration—since it was the prime mover in getting the committee created on Dec. 12, 1959. While the committee was not intended to establish controls over the use of space for military vehicles, it was hoped the group would take the lead in exploiting space for the benefit of all nations—through improved weather forecasting and communications, and in the orderly conduct of space exploration.

This high-minded aim is in danger of becoming a monumental flop.

• **Fight for chair**—In the past year, during numerous preliminary talks, the Russians have insisted that they should head this potentially enormously powerful committee.

The Soviets claim they should have the chairmanship, U. S. sources say, because "they claim they are ahead of everyone in space and the big job on the committee is therefore rightfully theirs." They also are contending for other key committee jobs.

The United States has balked down the line. Handing Russia control of the committee would open the "Prestige Gap" in space still further. So the U.S. has insisted there be no change in the normal procedure for electing committee officers.

Under the structure of the committee, Russia is clearly outvoted. There are 12 Western, 5 neutral and 7 Communist bloc nations in the group.

It is understood that the Russians also are fighting for one or more chairmanships of three subcommittees. These include legal and technical subcommittees and a third to set up an "international scientific conference" to be held in 1960 or 1961.

• **Time running out**—Until now, the impasse precepitated by the Russians has been discussed only in private. Officials concerned have hoped the Soviets would eventually agree to participate—as they did, after much footdragging, in the International Atomic Energy Agency. But, as the months have worn on, they have become increasingly discouraged, so that the only recourse seemed to be to force a solution before the General Assembly.

Time is pressing. Membership of the 24 nations extends only until the end of next year. The present session of the U.N. affords the only opportunity to get the committee in operation. Already, the chances that an international scientific conference sponsored by the group will be held in 1961 appear remote.

It is doubtful in the extreme whether the committee, even if it were grappling directly with the problem now, would be able to dampen the military aspect of space in the current international climate. The United States is pushing development of the *Samos* and *Midas* satellites as warning systems against a Soviet missile attack. Both nations are working on manned orbital vehicles—the Russians reportedly far ahead of the U.S. in development of a *Dyna-Soar* type space "bomber."

Against this rush of spacebound military hardware, the U.N. is powerless. It has no police force nor any foreseeable means to regulate the u of space.

Thus the dilemma of the U.N. Co mittee on Peaceful Uses of Outer Spa may seem academic. However, the are observers here who feel that floor fight—if properly managed could serve a useful purpose in focu ing world attention on a threat lo ignored by the general public, t strategic use of space to dominate t globe.

• **Campaign overtones**—There some question whether a debate ov the blockading of COPUOS would ta this tack because it is part of the d armament issue. Domestic political co siderations of the Eisenhower Admin tration also may be a factor.

Rightly or wrongly, many peop have looked to the committee as means of regulating the military us of space; a first step, perhaps, towa carrying out President Eisenhowe suggestion at the beginning of this U.N session that space be made "off limit to military vehicles.

To have the committee fail in showdown with Russia would be setback to the West, and conceivab could have repercussions in the closin weeks of the U.S. presidential can paign. For Vice President Nixon ha so far avoided debate over the sta of the nation's defenses or the strateg implications of space.

Senator Kennedy, on the othe hand, has stated (M/R, Oct. 10, p. 1 that the U.S. is in a strategic spac race with Russia "and we have bee losing." He said further in respons to an open letter from MISSILES AN ROCKETS that "freedom of space mu be assured, preferably by mandate o the United Nations."

If the question of the future of th Committee on Peaceful Uses of Oute Space is argued in the U.N. on thes terms, the issue could set the cam paign on fire. The next few days coul decide whether it will.

as election nears . . .

Nixon 'Declines' to Join Defense/Space Debate

WITH LITTLE MORE than two weeks to go in his campaign for the Presidency of the United States, Richard M. Nixon has thus far refused to take a definitive stand on the issue of defense and space.

In a brief and almost off-hand reference to defense before the American Legion convention in Miami on Oct. 8, he mentioned "survival of the nation" and said, according to United Press International:

"This is not the time to discuss these problems from a political standpoint. This I decline to do."

There is no obtainable record that he has said anything at all on space exploration or its part in national defense.

In an open letter to both candidates on Sept. 27, the editors of MISSILES AND ROCKETS asked each to make known publicly his stand on the defense/space issue. The letter contained a nine-point proposal (see box, page 4) advanced as a working basis during the next four years for achievement of parity or better with Russians in national defense and the race for space.

The open letter was published in Oct. 3 M/R. Senator Kennedy's prompt reply was published in this magazine the following week, Oct. 10.

Both the Nixon-Lodge headquarters in Washington and Herbert Klein, the Vice President's press adviser with the Nixon party, have informed MISSILES AND ROCKETS almost daily that Nixon was personally studying a reply to the open letter but was holding it up because he expected to make one and perhaps more speeches on the defense/space issue.

Letters to M/R published this week and in previous editions strongly indicate that the public is interested in this issue and wants to see it brought into the open in any form—major speech or reply to the open letter.

Nixon's "This I decline to do" statement before the Legionnaires makes it seem unlikely that he intends any public discussion.

It also makes it seem unlikely that he will reply to the M/R letter.

The attitudes of the two candidates on the defense/space issue are presented herewith as outlines in their public utterances during the campaign. Kennedy gave his in reply to the open letter, and has repeated them frequently since.

KENNEDY

–We are in a strategic space race with Russia and we are losing.

–Control of space will be decided in the next decade, and the nation which controls space can control the earth.

–This is the new age of space exploration. We must expedite accomplishment of a space platform, placing an American on the moon, nuclear power for space exploration, a combined aero-spacecraft.

–Freedom of space must be assured, preferably by the United Nations. The U.S. must have pre-eminence in security as an umbrella under which we can explore and develop space.

–The Defense Department must be reorganized.

–We should study the feasibility of reorganizing the military services according to functions and missions.

–He would request a supplementary budget appropriation in January to accelerate *Polaris* and *Minuteman* programs, expand U.S. conventional forces, provide immediate reaction to nuclear attack, harden and disperse aircraft and missile bases, speed up submarine defenses, develop space warning and anti-missile systems.

–Defense spending must be based on security and not on predetermined budget ceilings.

–We must establish and promote national scientific goals.

–He would issue a mandate to speed the decision-making process for defense/space projects.

NIXON

(In the Nixon-Rockefeller agreement before nomination).

–Create a nuclear retaliatory power capable of surviving a surprise attack to inflict devastating punishment on any aggressor.

–Possess a powerful second-strike capability, a modern flexible and balanced military establishment.

–Provide more and improved bombers, airborne alert, speeded production of missiles and *Polaris* submarines, accelerated dispersal and hardening of bases, modernization of equipment, an intensified program for civil defense.

(In Detroit on Aug. 24)

–"Today we can say categorically and we can say proudly that the United States is first in the world militarily."

"We must always take advantage of the new technological developments, we must not be frozen into acquiring and depending upon the weapons of the past to fight the wars of the future.

(In Beverly Hills on Oct. 14)

–He would establish a committee in the Department of Defense of all secretaries and chiefs of staff to re-evaluate defense policies.

Although Nixon seemed disinclined to make known cleary and unequivocally his stand on the defense/space issue, it seemed to some observers that his advocacy of more and more committees was a partial reply to Point Nine of the M/R proposal.

This was to restore decision-making to defense and space organizations—where industry has long complained that decisions are all too often passed fruitlessly from committee to committee.

Horner Calls for Diversified Effort

Broad Program Needed

To the Editor:

As regards the substance of your proposal, I think I should say that generally I am in agreement with the principles set forth but feel obligated to take exception with some of the details. There can be no question that the fact and character of Russian space accomplishments have had, and should continue to have, a bearing on our space activities. In the world of today, we could ill afford to ignore the accomplishments of a people that live by an ideology so foreign to our own. This is especially true in an area of effort so visible as that of space exploration.

I have long felt that the real long-term gains for the United States in the space exploration program will accrue because it is so effective in supporting and advancing out technology. We should, therefore, not compromise the quality of these gains by limiting our activity to only those specific areas in which the U.S.S.R. seems to be active at the moment. Rather, it is important that a broad, diversified program be undertaken which will optimize all of the returns and at the same time be comprehensive and energetic enough to assure a liberal share of recognizable firsts for prestige purposes. I am convinced that these two objectives need not be in conflict and are reasonably available within the resources that the nation can and should afford.

I believe some of your specific proposals for space accomplishment are subject to question. The difficulty lies with the relative priority which seems to be established by the proposed time of accomplishment. For example, the proposed "U.S. citizen on the moon" in the 1967-68 time period may very well be imposible at any price. I am certain that, under the best of circumstances, the cost would be so high as to raise the question as to whether the expenditure rate was justified by the end result.

This would be especially true if it necessitated the dislocation of the defense program or the rest of the space effort in order to make the necessary allocation of resources—people and facilities as well as money. There is no question that it can be accomplished at some point in time, but I am sure you would agree that we should not arbitrarily throw our total effort off balance without very careful consideration.

In response to the third of your itemized proposals, I must state that I believe there is a great deal of confusion surrounding the phrase "freedom of space." If it revolves around the question of jurisdictional authority over vehicles in low orbit as they pass over national boundaries, then I suspect that this might some day become a debatable issue on the geopolitical front and specifically as regards the boundaries of free space.

It is interesting to note that one does not usually hear the term "freedom of the seas" in reference to relative undersea forces. I can't help but feel that this stems partly from the frustration of the problem of denying undersea space to any National entity. At least we seldom voice concern that we might be denied the use of this space in projecting our national interests, although I would suspect that the relative balance of U.S.S.R.—U.S. effort is, or has been, more unfavorable to us in the field of submarines than in the field of space activity.

Another way to look at this, of course, is that if the U.S.S.R. set out to deny space as a medium to the U.S., I believe we could make it terribly expensive for them for a relatively modest expenditure of our own, and I have seen no inclination on the part of the U.S.S.R. to indulge in those kinds of games.

By this discussion I don't mean to suggest that the U.S. military should not play a major role in developing and carrying out projects for applications in space. The individual projects, however, should be judged on the basis of their military utility in space and not simply on the basis of the prestige of being in space or the even more nebulous need of establishing our right to be there.

Most of the rest of your individual proposals bear on specific defense questions. I don't believe it would be useful or appropriate for me to comment on them individually. The combined space-defense area certainly provides many problems for government administration and program management in both government and industry. Most of the problems probably do not have perfect solutions and, of course, it is frequently too expensive to pursue alternative courses. It is, therefore usually impossible to say, even in retrospect, that optimal arrangements have been used. It is safer to assume that there is always room for improvement, and we should seek it with all of our energy.

Publications such as yours have a tremendous responsibility as organs of communication and instruments of national conscience. I believe sincerely you are doing a fine job in fulfilling the responsibilities. You have my very best wishes for your continued success.

Richard E. Horner
Northrop Corporation
Beverly Hills, Calif.

M/R's Proposal

1. Recognize as national policy that we are in a strategic space race with Russia.
2. Establish pre-eminent strategic, tactical and defensive forces with representation from all goals;
   - Manned space platform—1965
   - A U.S. citizen on the moon—1967-68
   - Nuclear power for space exploration—1968-69
   - A spacecraft which can take off from earth, travel to and in space, return and land under its own power—1968-69.
3. Recognize that "space for peaceful purposes" is possible only if "freedom of space" is ensured; hence that the U.S. military must be given a predominant role in developing and carrying out the projects necessary to guarantee freedom of space.
4. Establish pre-eminent strategic, tactical and defensive forces with representation from all services.
5. Recognize the necessity of greater defense funding to accomplish this, including a supplemental budget in January, 1961, to make it possible to:
   - Speed up to a maximum degree the construction of ICBM launching bases, Polaris submarines and the Mach 3 missile-carrying B-70.
   - Provide the Army with funds to begin the immediate procurement of already-developed modern missiles, other weapons and airlift.
6. Establish further-on defense spending by need and not by budget ceiling.
7. Streamline defense regulations and procedures to make industry's role in the U.S. defense and space effort more effective.
8. Take what steps may be necessary to establish and promote national scientific objectives.
9. Re-establish decision-making in the U.S. defense and space organization.

Gov. Stresses Dedication

To the Editor:

I read with interest the Open Letter Senator Kennedy and the Vice Presiden

MISSILES AND ROCKETS is to be co gratulated for its forthright proposal.

No American can doubt the imperat for an accelerated development in the co quest of space. This will call for mo money and for a dedication of America to the idea that a "second class Americ is not good enough.

I have reservations, however, abo setting a timetable for the accomplishme of our objectives. If we fall short of o target date we are held up to internatior ridicule even if we succeed at a later da

What we need is not a time table, it a rededication to the greatness of Americ

What we need is not simply mo money. It is the desire on the part of t President to make that money produ for America.

Edmund G. Brown
Governor of Californ
Sacramento

Calls It Lobbying

To the Editor:

With respect to the nine-point proposa I cannot, in good conscience, participa in an exercise so obviously directed "lobbying" for one segment of our indu try.

A. W. Betts
Brig. General, USA
Director
Advanced Research Projec Agency

For Quick Action

To the Editor:

I have read your article and wish t join you in the appeal for a frank discu sion and quick action.

Philip S. Morse, President
Morse Sewing Machine & Supply Cor New York City

House Group to Study FCC Move on Gigacycle Spectrum

T&T announces meantime that it hopes to launch a test ommunications satellite at private expense

Key members of the House Com-erce Committee said this week the ommittee "certainly" will look into e FCC decision against reserving rt of the gigacycle spectrum for mmercial communications satellites.

Both Committee Chairman Oren arris (D-Ark.) and Rep. John Bennett R-Mich.), ranking minority member, id the committee will look into the ue after the congressional session ens in January.

The FCC issued a 6-1 decision Oct. to open the gigacycle spectrum—the icrowave spectrum above 890 mega-cles—to use by point-to-point com-unication systems. A number of com-on carriers had asked the FCC to fer action on the entire spectrum or serve several bands for use by com-unications satellites.

Meantime, the American Telephone Telegraph Co. said it is negotiating ith telephone systems in Britain, rance and Germany with the hope of launching an experimental communications satellite in about a year.

The Bell Telephone satellite, weighing about 150 lbs., would be launched into an orbit of 2200 miles altitude. The vehicle would be a *Thor-Agena* provided by the National Aeronautics and Space Administration at a cost to the companies of about $4 million.

AT&T said that if launch facilities are made available as indicated by NASA Administrator T. Keith Glennan earlier this month, it and any other private companies interested would pay the entire cost of developing commercial satellite communications.

A company spokesman said AT&T's spending plans are not limited by the figure of $50 million previously given as the cost of an operational system of 30 satellites. Frederick R. Kappel, AT&T president, said that at its present spending rate the giant utility will plow $1 billion into R&D over the next decade.

Navy to Begin AUTEC Next Year

The Navy is understood to be plan-ng to begin construction of its pro-sed Atlantic Underwater ASW test nge before the end of next year.

Cost of building the Atlantic Under-ater Test and Evaluation Center AUTEC) is now reported to be esti-ated at about $100 million. That is 30 million more than earlier estimates.

No location has been chosen def-itely.However, the Navy is under-ood to be negotiating with the British r use of Exuma Sound and Tongue the Ocean—deep, ideally-suited ater areas south and southeast of assau. (M/R, Aug. 1.)

The Naval Bureau of Ships held a eeting with several dozen interested ntractors earlier this month to ask r proposals on a half-million-dollar udy contract covering operation and sign of the range.

The proposals are reported to be e about mid-November. A contract expected in December. Results of the udy are expected about the middle of xt year.

Meantime, the Navy also is ex-cted to award a contract for an eanographic survey of whatever area is selected for the range. Cost of the survey is expected to run about $2 million to $3 million.

The Navy is planning to construct the range over the next five to 10 years. Construction will be directed by the Bureau of Ships.

The range will give the Navy for the first time the capability of fully instrumenting the operation of such ASW missiles as the Goodyear *Subroc* under nearly wartime conditions.

Instrumentation planned for AUTEC will make it possible to obtain the same kind of data on underwater missile launchings that is now obtained on missiles that travel through the atmosphere and space.

At present, much of the test data obtained during R&D launchings of ASW missiles is considered crude at best.

For example, one method used for testing the Minneapolis-Honeywell *Asroc* is for a submarine commander to report whether his submarine has been hit by an *Asroc* launched from a surface ship. Hits are occasionally determined by subsequent examination of the submarine for paint scratches.

First Details of Avcoite Nose Cone Covering Given

Avcoite—an ablating material used to protect ICBM nose cones on atmospheric re-entry—is made up primarily of fuzed quartz and molybdenum honeycomb.

First mention of the composition of the hitherto secret material was made by Lt. Gen. Bernard Schriever who stated that the RVX 1-5 nose cone presented to the Smithsonian Institution was covered with a "quartz coating." This was the first nose cone to go the full ICBM range and be recovered to prove out the ablation theory of re-entry protection.

Still secret are details as to exact makeup, thickness, additives, etc. It is understood that the coverings can be produced in a wide variety of compositions to fit differing applications. The material was developed by Avco Research and Advanced Development Division.

In constructing the ablative nose-cone coverings, the body was covered with a high-strength alloy (molybdenum) honeycomb and the interstices filled with the fuzed-quartz ceramic. As the body builds up friction heat in the atmosphere, the covering slowly melts away, carrying off the tremendous heat generated and protecting the missile payload. This was a vital problem in designing a successful long-range ballistic missile and its solution made possible a delivery system for nuclear warheads.

In presenting the RVX 1-5 to the Smithsonian for the Air Force, Gen. Schriever said it "represents an outstanding achievement in space science and technology, in every sense of the term." The nose cone will become a permanent part of the Institution's exhibit of historic vehicles in aviation and space science.

Hawaii ARS Section To Be Set Up by January

A Honolulu section of the American Rocket Society is expected to be chartered by next January. Twenty-five have already submitted applications for membership in this first ARS section in the fiftieth State.

Organization is being spearheaded by Capt. Mike Sellars, USN, past president of the Florida Section and ex-boss of the Navy's *Polaris* unit at Cape Canaveral.

Hawaii is rapidly gaining importance as a tracking and instrumentation center for the Pacific Missile Range and the U.S. space program.

The Missile/Space Week

Four Shots and a Scottish Port for Polaris

The *Polaris* submarine Patrick Henry is undergoing final checking for operational duty after a secret demonstration of her mighty war potential.

The 6000-ton nuclear-powered sub—second of the *Polaris* fleet—successfully launched four *Polaris* missiles in four attempts under nearly tactical conditions between Oct. 15 and 18 while submerged 500 miles east of Florida.

Meantime, the United States and Britain were reported to have completed secret negotiations for the use of a Scottish seaport as an overseas base for the *Polaris* sub fleet.

The unidentified port would be used for the most part by the *Polaris* tender Proteus. The Proteus will provide the nuclear-powered subs with fresh food, fresh crews and other supplies including spare missiles.

AF Builds Full-scale Dyna-Soar, B-70 Test Facility

The Air Force plans to have a full-scale heat-stress test facility for B-70's and *Dyna-Soars* operational by next January. The $7.7-million facility is being added to the present stress testing complex at the Wright Air Development Division near Dayton, Ohio.

Bomarc B Flies—the Air Force Buys

The Air Force will soon begin accepting deliveries of the Martin *Bomarc B* in quantity. More than 200 are scheduled to be deployed in the United States and Canada.

The Air Force officially accepted the *Bomarc B* for production on Oct. 13. The next day the 400-mile-range air defense missile ripped from its launcher at Eglin AFB, Fla., and intercepted an electronically simulated target 345 miles away over the Gulf of Mexico—the longest flight of a *Bomarc B* to date.

Minutemen May Dot South Dakota

The barren prairies around Ellsworth AFB, S.D., are expected to become the nation's second *Minuteman* base.

Surveys of the area are under way in advance of an Air Force request for authorization and funds.

So far, the Air Force has authorization and money only for building sites for the first three *Minuteman* squadrons around Malmstrom AFB, Mont. First of the three 50-missile squadrons is scheduled to be operational in mid-1962.

Missile Defense: Tests, Contracts, Advice

Activity in the complex and boggy field of missile defense cropped up in a number of places in recent days.

Item: The third-stage, small solid motor for Western Electric's *Nike-Zeus* underwent its first captive test firing Oct. 7 at Thiokol's Redstone Arsenal plant. It was successful. The unusual spherically-shaped motor will provide *Zeus*' nuclear-packing third stage with the ability to manuever in order to intercept an incoming ICBM warhead.

Item: Douglas picked up a $60 million contract from Bell Telephone for another year of R&D work on *Zeus*. The contract was Douglas' slice of the supplemental $199-million contract awarded Western Electric by the Army for the program.

Item: ARPA established a technical advisory group to provide recommendations for advanced missile defense systems. The group will be comprised of representatives of laboratories under contract to ARPA for Project *Defender*—ARPA's $110 million dollar advanced missile defense research program.

Committee to Watch for AF Duplication of Apollo

The House Space Committee is investigating possible duplication between the manned space flight plan of the Air Force and the National Aeronautics and Space Administration.

Chairman Overton Brooks (D-) reported that his committee is keeping a close watch on NASA's Project *Apollo* and an Air Force study begun last year by Aeronutronic Division, Ford Motor Co.

Under Project *Apollo*, NASA plans to award by Nov. 14 two or three contracts for six-month feasibility studies of a three-man space ship that could orbit the earth and make a circumlunar flight. The current NASA budget includes $1 million for the contracts.

Brooks said the $161,000 Aeronutronic study, now nearing completion, is concerned with the structure of a three-man vehicle that would remain in orbit for extended periods of time.

In a statement Sept. 19, Aeronutronic said the 18-month guided study authorized by Wright Air Development Division, Air Research and Development Command, covers proposing structural configurations that could be applied to "very advanced Air Force vehicles."

• **Conflict denied**—Last week, Ford spokesman emphasized that the work is on structure only, and does not conflict with the overall systems study required for Project *Apollo*. He noted that Aeronutronic is on a team with North American Aviation bidding for an *Apollo* contract.

Brooks said there had been reports that the concept involved in the Aeronutronic study is quite similar to that of *Apollo*. "If so," he continued, "the two agencies should work together in the interest of saving both time and money."

A NASA spokesman said the two agencies are cooperating. At the request of the Air Force, he said, NASA structures engineer from Langley Research Center helped evaluate industry proposals.

The Air Force said NASA scientists and engineers were kept fully informed of progress and results; by means of discussions and symposia. The Air Force emphasized that the studies concerned structures only, and did not consider overall system parameters.

In its September statement, Force said that, following structural tests it will build a working model of the space structure designed in the study.

The structure, a stiffened cylindrical shell of double-wall construction, could act as shield against solar and cosmic radiation and meteoric impacts.

Explorer VII Still Sends After Cut-off Timer Fails

Explorer VII, the so-called "radiation satellite" launched Oct. 13, 1959, crowding the 20-megacycle band with unwanted information because a transistorized timer failed to cut off transmissions after a year.

The signal, from one of two transmitters originally installed, is providing information on two experiments and temperature measurements in various parts of the satellite. A tracking beacon at 108 mc failed last Dec. 5 when its chemical batteries became exhausted. The best hope for clearing the 20-mc channel seems to be a component failure or loss of power from the solar cells powering the transmitter.

The two experiments for which data still coming are the cosmic ray measurement designed by Dr. James A. Van Allen of the State University of Iowa and the earth infrared heat balance measurement designed by Dr. Verner E. Suomi of the University of Wisconsin.

• **Mysterious failure**—At a press conference Oct. 14, the day after the timer was to shut off the transmitter, Hans J. Fichtner of the NASA Marshall Space Flight Center, Huntsville, Ala., said he did not know why the timer failed to operate. It was built for the Marshall Center, at that time a division of the Army Ballistic Missile Agency, by the Bulova Research and Development Labs.

Fitchner reported that Bulova built the timer, a 2½-in. cube, on a crash basis in two months from the time the contract was awarded in February, 1959. The timer was tested for vibration and environment and, later, in a vacuum. However, there was not time for the full year's test to prove it out beyond the shadow of a doubt.

Fichtner bristled when an M/R editor asked whether spending a year passing through the heaviest portion of the Van Allen belt might have damaged the timer's transistors enough to cause failure. He said an experiment aboard the satellite designed by Huntsville personnel showed that radiation does not damage a solar cell. Thus, he concluded, the same level of radiation could not have damaged transistors in a relatively shielded internal location.

• **Data gained**—These scientific results from *Explorer VII* were reported:

–The first proof that a solar flare "dumps" electrons from the outer Van Allen belt into the atmosphere came last Nov. 28 when the satellite passed over the top of an aurora in Montana. It was the first time a satellite with radiation detectors passed over an aurora at the same time a man was below, photographing it.

Dr. Brian O'Brien, an aide to Van Allen, said that on the corresponding pass, the next night, most of the particles had gone from the radiation belt.

–A surprising and so far unexplained indication that the flux of primary cosmic particles with atomic number 6 or higher and energy upwards of 1.5 million electron volts is greater on the dark side of the earth than in sunlight.

Dr. Philip Schwed of the Research Institute of Advanced Studies, Baltimore, said the result is still tentative but there is indication that the flux is 50% greater on the dark side. He said the detector, which rejects all nuclei and nuclear particles of lower atomic number than 6, responds in the most intense portion of the lower Van Allen belt. Researchers are trying to determine why.

–The total heat flow to and from the earth is being reconstructed from data provided by two bolometers coated so they would respond differently to heat radiation. Rough comparisons have been made with the weather maps for corresponding days.

Dr. Suomi said the data on this experiment is about half processed, but data analysis is just beginning.

Revolution in Production Of Stainless Steel Strips

A revolution in stainless strip steel manufacture is under way at Wallingford Steel Co., Wallingford, Conn.

For the first time, thickness variations across the width of steel strip can be held to less than 0.0005 in. on a production basis.

The innovation is an abrasive belt grinding line with a unique crown grinding feature. The line replaces two former grinding lines which included five machines and reduces the three shift operation to one with an improvement in quality.

The two grinders, with their coated abrasives running in a flood of sulfurchlorinated oil, were built by the Hill Acme Co. from designs modified by Abrasives engineers of Behr-Manning Co., division of Norton Co., Wallingford and Allegheny Ludlum Steel Corp. also cooperated in the development.

Savings of over $91,000 per year will result from reduced labor and abrasive belt costs alone. Another economy is the ability to salvage entire coil.

Solids Advance

NASA Awards Contracts And Schedules Shots

by Jay Holmes

SOLID-PROPELLANT rocketry advanced on a broad front last week at the National Aeronautics and Space Administration. These developments took place in rapid succession:

–Preliminary design contracts were awarded to three companies for six-month paper studies of solid boosters of 1 to 7 million lbs. gross weight, with thrusts of 2 to 3 times that weight.

–A $6 million one-year prime contract was awarded to Chance Vought Aircraft, which adds final assembly and launching to its responsibilities in the development of the *Scout* launch vehicle.

–NASA said the next *Scout* shot, an attempt at orbit, will take place before the end of the year.

–The new *Iris* sounding rocket, a 1 and ½-stage vehicle costing about half as much as a partly liquid competitor, scored its second straight success by lifting 125 bs. of instruments to an altitude of 140 miles and 230 miles downrange from Walops Island, Va. One flight remains in the *Iris* qualification series.

The solid booster contracts, totaling $225,000, went to Aerojet-General, Grand Central and Thiokol. Grand Central will design a booster in the 1 million lb. class, Thiokol in the 7 million lb. class, and Aerojet one in each class.

The NASA program is aimed at learning whether a big solid R&D program can be carried out within the limits of NASA funding. This contrasts with an Air Force study begun by Aerojet last spring to determine whether a big solid booster is feasible at all, with cost a secondary question.

A decision on going into an R&D program on a big solid booster is conceivable after the completion of the three studies. However, it is also possible another round of studies might go into such detailed questions as nozzle design, ignition, and logistics. Since any big solid booster would compete with *Saturn*, a go-ahead probably would require White House approval.

In the *Scout* program, Chance Vought formerly had responsibility for only the launch tower fabrication and manufacture of airframes and motor transition sections, which it also supplies for the Air Force *Blue Scout*. Aeronutronic Division of Ford Motor Co. has the prime on *Blue Scout*.

NASA declined to say how many *Scout* vehicles are involved in the Chance Vought contract.

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Technical Countdown

ELECTRONICS

ur For The Price of One

A multi-polarized antenna, whose elements resemble a altese Cross, has been developed by Chance Vought. It es the work of four separate units. Remote switching or tomatic selection for instant response gives the system mplete polarization coverage for tracking, telemetering, or mmand control. The system costs the same as conven- nal helical arrays, but is one fourth their size and is de- ribed as having lightweight, low-drag design. The unit ll be installed aboard USNS Range Tracker, a tracking ssel for the Pacific Missile Range, which is being instru- ented by Chance Vought.

ot Too Little, Just Too Late

Armour Research Foundation has just made available oceedings of the Annual Computer Applications Sym- sium held during October—last year, that is. It is para- oxical that it took one year to disseminate these details of vanced programing and operating techniques and state-of- e-art discussion—in an industry which is not only the test growing in the world but one in which speed itself is paramount virtue.

ckets to Aid Geodesy

A new Air Force project for exact measurement of rth distances will be carried out by launching a series of flash cartridges. These will ignite in rapid succession at itudes up to 1000 miles. Observation from widely scat- ed points will provide distance calculations by triangula- n. Launchings of Aerolab *Argo D-8* sounding rockets m Wallops Island, Va., are tentatively scheduled for nuary. For lower acceleration and longer burning, rockets ll be modified by substituting a *Yardbird* for *Recruit* urth stage and a baby *Sergeant* for the T-55 fifth stage.

nsitive Tube Photographs Cosmic Rays

A new electronic tube developed by Westinghouse is so nsitive it can "see" individual particles of light. The tracon tube is being used to photograph the tracks of smic rays as they move at speeds near the velocity of ht through a solid crystal.

easurement Handbook Available Soon

A new handbook on precision measurement and cali- ation will be issued soon by the National Bureau of ndards. The compilation, called Handbook 77, lists in ee volumes all important NBS publications in the areas electricity and electronics, heat and mechanics, and tics, meteorology, and radiation.

mog Scatter' for Communications

A Hughes Aircraft engineer has found that the tempera- e inversion layer responsible for Los Angeles smog can used to aid VHF radio transmission over long distances. e ham operator has successfully transmitted signals on 144 and 222 mc bands from California to Hawaii—a ord distance of 2540 miles—with the technique.

Tunnel Transistor in Development

Cal Tech scientists are reportedly at work on a "tunnel transistor." Even though it doesn't work too well yet, researchers are optimistic that the device has a potential operating range in the high-gigacycle frequencies.

Reds Develop Electromagnetic Rock-Crusher

Disintegration of rocks by electromagnetic waves reportedly has been demonstrated by Russian mining engineers. The report does not specify the distances from which the device operates.

GROUND SUPPORT EQUIPMENT

Nuclear-Powered Radar Being Built

The world's first nuclear-powered radar unit is being built near Sundance, Wyo., for the AF Air Defense Command. The $6-million installation—possible forerunner of many such power sources for remote locations—is scheduled to be in operation in 1962.

ADVANCED MATERIALS

Russians Used Nuclear Emulsions

Blocks of thick, layered nuclear emulsions, weighing about 60 kg, were carried into space and returned in Russia's second "spaceship" last August. In one of the photoemulsion blocks, provisions were made for developing the emulsion while in flight.

New Teflon Can be Cemented

DuPont has developed a new type of Teflon film, one side of which is cementable with ordinary adhesives. This supplants earlier methods, which involved treatment with alkali metals in organic media for adhesive receptiveness or heat sealing and bonding for lamination.

Columbium Alloy Fusion Welded

A columbium-base alloy, containing 32% tantalum, is being welded and machined by Ling-Temco Electronics Inc., in connection with the Air Force's Refractory Metals Structural Development Program. The alloy, a product of Fansteel, retains usable structural properties up to 2500°F.

OAO to Have Titanium Skin

The 1½-ton Orbiting Astronomical Observatory Grumman is developing for NASA will have titanium skin and aluminum interior construction.

PROPULSION

Mauler Propellant Contract Awarded

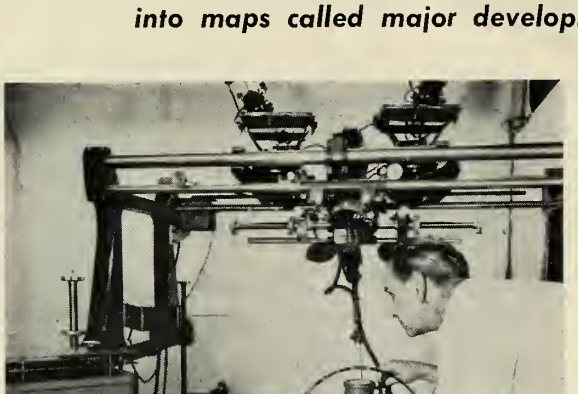
Grand Central Rocket will develop the propulsion system for *Mauler,* the Army's mobile surface-to-air missile, under a $643,000 subcontract with Convair/Pomona.

Centaur Testing Starts This Winter

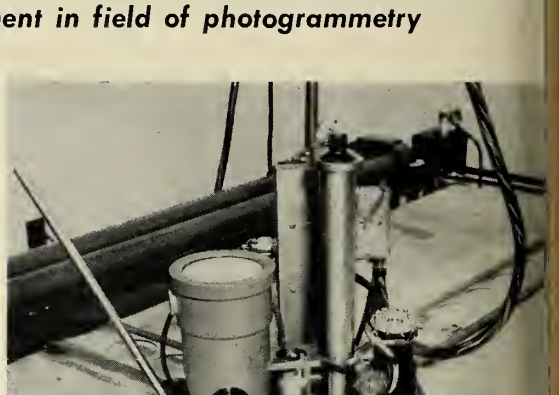
Convair plans to start *Centaur* static testing this winter, for flight tests beginning next spring. Planning calls for two restarts of the liquid hydrogen-LOX powerplant during each mission.

'Stereomat' to Speed Photo Conversion

Canadian's invention for processing aerial photos into maps called major development in field of photogrammetry



VIEW OF AUTOMATIC stereoplotting device installed on Nistri Photomapper. The electronics console is at the lower left, the optical duplexers are at the top of the photograph.



CLOSE-UP OF C.R.T. scanning head and tracing device. Image seen on the tube face are correlated by detecting points in th stereos that have similar density characteristics.

by William Beller

A MAJOR SPEEDUP in processing photographic reconnaissance data now appears possible—just in time to handle an expected flood of material from *Samos* and new aerial surveillance systems.

For the first time, chart and map-making from photographs can be converted from laborious "hand work" to an automated process through the invention of a Canadian engineer.

With this new invention raw aerial photographs may be turned into maps —in as little as one-twentieth the time a qualified technician takes.

Cartographers are hailing this development as the most exciting since the advent of aerial photography itself. The reason is that they are frighteningly short of means to process data. In a single day's flight, a reconnaissance aircraft can take enough pictures to keep a major map-making service busy for almost a year.

Just to extract the information from one pair of aerial photographs takes an operator from 20 to 40 hours. It is no wonder that national mapping organizations are laboring under backlogged loads of urgently needed maps that are still years from being made.

• **One-twentieth the effort**—The inventor of the "Stereomat," the device that is expected to revolutionize cartographic techniques, is electrical engineer Gilbert L. Hobrough of Hunting Associates Ltd., Toronto. He is co-inventor of the Airborne Profile Recorder (APR), also classed as a fundamental contribution to photogrammetry. When installed in an aircraft, the APR determines and draws the terrain over which it is flying.

"Hobrough has given as much or more than any of his contemporaries to the field of photogrammetry," says Charles Spooner, Chief of Department of Advanced Research of the Geodesy Intelligence Mapping R&D Agency (GIMRADA) under the Army Corps of Engineers.

Labeling the Stereomat "a major and fundamental contribution in the technique of photogrammetric engineering," Spooner illustrates its value by noting that the development "should decrease the number of man-hours currently expended to extract contour information from aerial photographs by a factor of approximately 20.

• **The old method**—The way con tours and profiles are usually derive from aerial photographs is this: A pai of photographs, which show a give terrain at slightly different angles, ar examined stereoscopically. This is easil managed by the technique of wearin glasses with different colored lense through which a composite of the tw photographs is viewed, each photo graph being the color of one of th lenses. This may be remembered as th way one sees "3-D" movies.

In practice, the photographs are firs made into transparencies through whic the appropriately colored lights ar passed and then combined to form joint image on a platen below. Whe first seen, this image has two kinds o parallax in it, brought about by the si degrees of freedom of the photograph ing aircraft. By suitably orienting th projectors of the colored lights wit their associated transparencies, techni cians remove all parallax except tha coming from the contour of the lan itself. This is called the "*x*-parallax."

Since the *x*-parallax is a function of the altitude, its removal by an ap-

ropriate raising or lowering of the laten is a measure of the altitude of ne neighborhood being examined. In is way—by height adjustments of the laten—aerial photographs are con-ured and profiled and the data used or building maps.

This process is still held by many eople to be a subjective one, depend-ng on a person's seeing two slightly iffering images and then combining nem in the brain to form a single ereoscopic vision. The act of "combin-ng them" in the brain is believed to e a psychological one and therefore ne that can not be automated.

• **The new method**—Hobrough de-nolishes the Gordian knot in the fol-owing fashion. Electronically, he scans he same neighborhood on each of two erial photographs making up the stereo nage. Thus, the *x*-parallax between he two is perceived. It is removed in manner similar to the way a human perator would remove it, by raising r lowering an analog of a platen. ince the travel of the platen is a neasure of the altitude of the neigh-orhood, the contouring or profiling of he area can be made to proceed auto-natically.

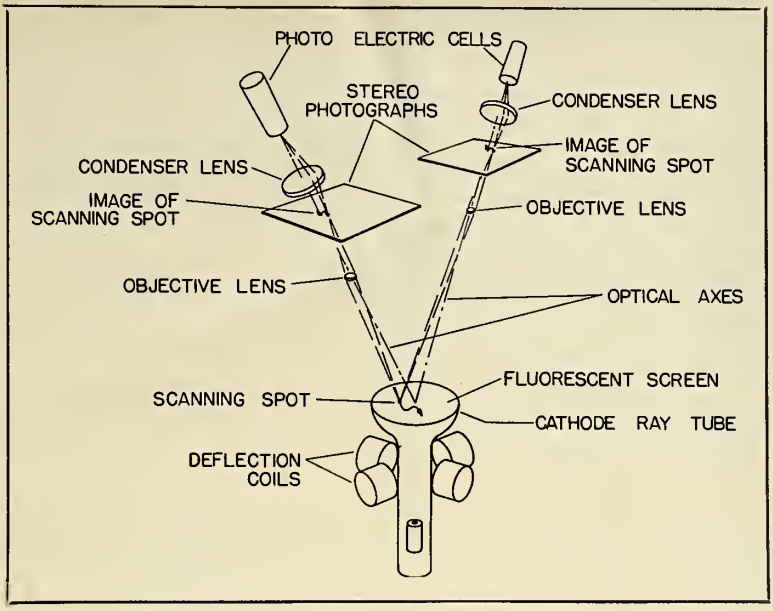
In automating the process, Ho-rough turns it upside down. The laten becomes the light source, and wo photoelectric cells acting in com-ination become the receivers of the tereo image.

The light source is a scanning spot f light on the face of a cathode ray ube. The spot is produced by an elec-ron beam hitting the tube's fluorescent creen. Motion of the beam is con-rolled by voltages applied to external eflection coils. Like the platen, the RT can be raised or lowered.

The two stereo transparencies are uspended at a small angle to each ther above the tube. They are ad-usted in space so that an objective ns below each will be directing the ght from the scanning spot onto the ame neighborhoods in the transparen-ies. After passing through the trans-arencies, the now attenuated and pat-rned light is gathered by condenser nses and sent into the photoelectric ells. Here, electric signals are gen-rated whose differencies are subse-uently correlated and translated into n *x*-parallax.

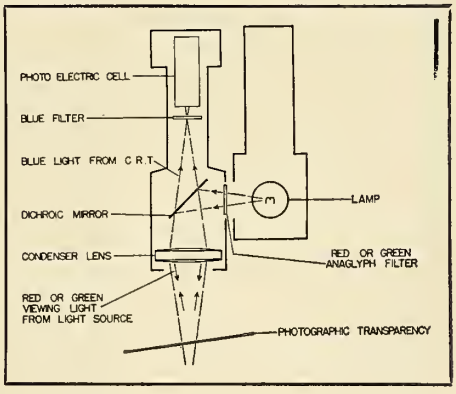
The CRT is then appropriately oved up or down by servos until the arallax is eliminated. Thus the alti-ude of the neighborhood is determined —"twice as accurately as a technician an," avers Spooner.

• **Army's buying another**—Colonel eonard L. Haseman, Director of IMRADA (Fort Belvoir, Va.), has een evaluating the Stereomat since is past August when his organization

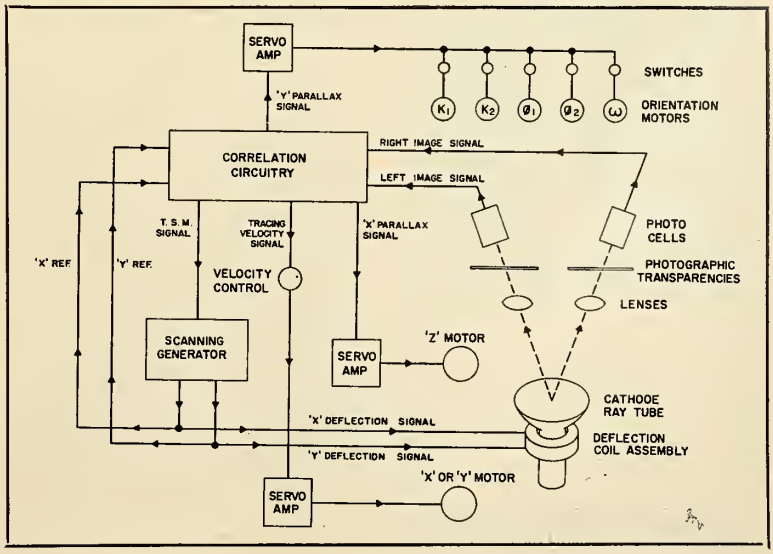


ABOVE: Scanning spot of light examines the same neighborhood on pair of stereo photographs.

RIGHT: Optical duplexer. An anaglyph image projected on face of C.R.T. lets operator see area being "viewed."



BELOW: Block diagram of complete Stereomat arranged for "normal mode" operation, including orientation.



received a pilot model, probably the only model made so far for sale. Kent T. Yoritomo, GIMRADA project engineer for Stereomat, reports running the profiling speeds up to 53 mm/sec, and the contouring speeds up to 39 mm/sec. Even at these high speeds, the results showed no decrease in accuracy with respect to a human operator's results, which come at about 8 mm/sec.

The results quoted fall in line with the accepted estimates that for a given accuracy the Stereomat can do contouring 4 times faster, and profiling 6 times faster than a human operator.

Theoretically, these figures can be raised to a ratio of 100:1. However, it is felt that the mass and inertia of the system would halt advancements beyond the 20:1 mark.

It is clear, then, why Colonel Haseman joins the general enthusiasm and calls the development "very interesting," and admits that "We're very pleased." He has already called for a more advanced model, one that would eliminate the "bugs" found in the present one.

The system has its limitations. It runs into problems when dealing with very steep slopes, with horizontal plane areas and with redundant observations —but so do human operators. The machine is confused by trees and by buildings. Neither can the present device plot planimetric details automatically. Its biggest problem would be having to establish the profile of Manhattan's skyline.

In July, the National Research Council of Canada observed that "there is no doubt that the device . . . presents the first and most successful attempt towards automatic stereoplotting." There are drawbacks, the investigators admitted: for example, the limited light energy supplied by the projection system is a serious limitation that has direct bearing on the accuracy and speed of automatic operations.

NRC softened its criticism by adding that "the repeatability and the accuracy of determination of spot elevations is remarkable."

• **Domestic Stereomat** — Hunting Associates has assigned world-wide manufacturing and sales rights for Stereomat to Benson-Lehner Corp. of Los Angeles. As a result, GIMRADA has awarded Benson-Lehner an advanced development contract for devising means for hastening production of "urgently needed" maps. Subcontractors are being negotiated with Hunting Associates, which will be continuing its automatic stereo work; the Zeiss Co. in Germany, which will be developing instrumentation for aerial triangulation; and the Wild Co. of Switzerland, which will be developing photogrammetr plotting instruments.

It is reported that a Stereomat h: been ordered by USAF for its A Research and Development Comman Research Center at Rome, New Yorl

If the device proceeds to live u to the hallelujahs that is greeting i then stereo-plotting machine operato will find themselves relieved of muc of their detail work; they will be abl to concentrate more on interpretiv functions of which there are many

Hobrough expects that the gre capacity of automatic methods will lea to a new disposition of photogram metric and cartographic facilities. Thu he envisions data reduction cente where cartographic data would be proc essed. The next big problem—and monstrous one—would be how to stor and retrieve the enormous amount o image data that lunar and planetar photography will soon be giving us.

Weather Bureau Sets Up Special Mercury Office

The U.S. Weather Bureau ha established an office to provide specia forecasts for the Project *Mercury* man in-space program.

The group, at Suitland, Md., ad joining the National Meteorologica Center, will forecast winds, state of th sea, cloudiness and visibility for area beneath the proposed orbit, wit emphasis on planned recovery areas i the central Atlantic.

The Suitland group will have unit at Cape Canaveral and the Nationa Hurricane Center in Miami. The grou will also supply climatological and meteorological guidance for designing future rocket and spacecraft systems.

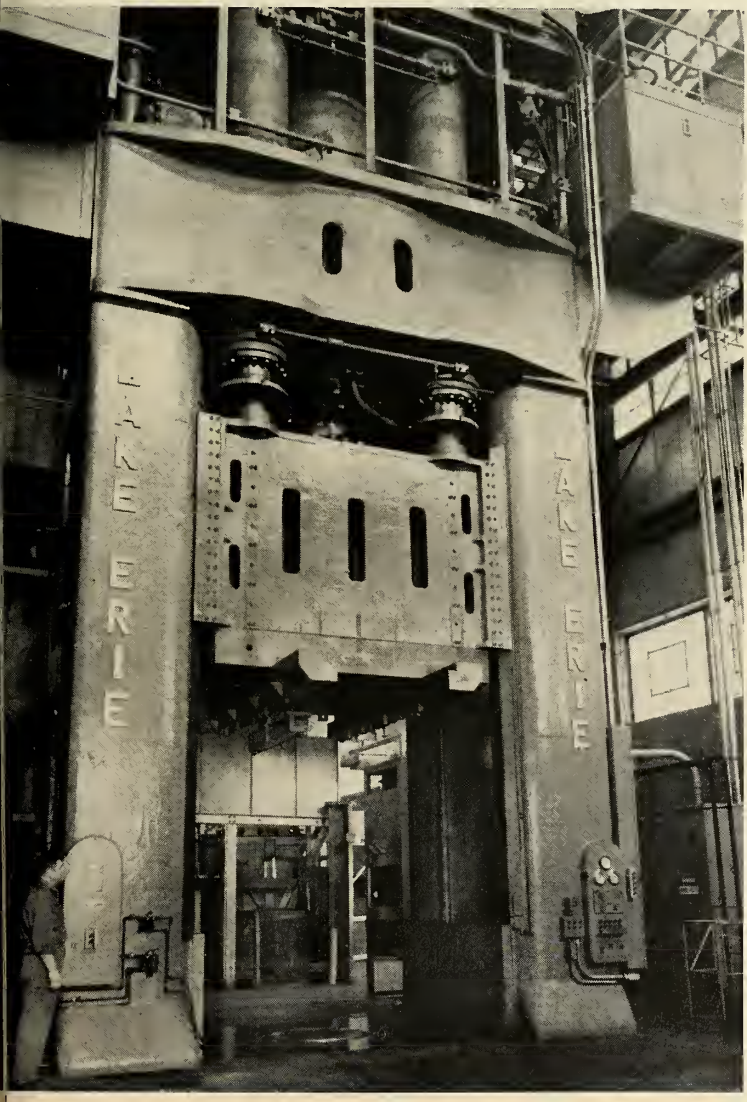
The seven-man Miami unit will develop methods for preparing and transmitting composites of weathe radar pictures in the Florida and Caribbean areas, for use in predicting weather in launch and recovery zones. During operational periods, it will prepare and transmit to the Cape the Atlantic outlooks and forecast. Composite radar pictures of Florida and the near Atlantic will be transmitted by facsimile.

The four-man Suitland staff will collect weather information from other areas of the world between the 35th parallels. For most of the Northern Hemisphere, such information is received as a routine. Arrangements will be made to have special surface and upper air analyses sent from other centers in Africa, Australia and the Western Pacific. If a weather satellite is in operation, it will be a primary tool.

The Suitland staff also will develop procedures for using manned orbital flight as a scientific tool.

Lyon Ready to 'Flood' Navy with One-piece Polaris Cases

Veteran firm will use unique hot cup-cold draw technique which has many advantages including the complete elimination of welds in critical areas



DOUBLE-ACTING hydraulic press at Lyon is the largest of its kind in the United States. It was designed specifically for close-tolerance deep drawing

by John Judge

DETROIT, MICH.—An energetic metal fabricator is tooling up for high speed volume production of one-piece *Polaris* motor cases.

Lyon Inc., will use its unique hot cup-cold draw process for the job and, says Wayne Martin, chief engineer R&D, they can ". . . flood the Navy with production cases."

Backed by years of experience in high quality-low cost ordnance items, and an extensive practical knowledge of the metals involved, Lyon is no newcomer to the missile case field. The development of one piece rocket engine cases has been demonstrated—dimensionally, metallurgically and ballistically.

Production centers around a 5000 ton press, designed for the close tolerance, deep drawing of steel. Part of the system includes large salt-bath annealing furnaces and cleaning, pickeling and phosphate coating tanks.

The final element is a production crew as well trained in each other's tasks as they are in their own. This last is an added guarantee of continuous production to the end of the $1.4 million Navy contract.

• **No joints**—The greatest single advantage of the deep drawn cases is the total elimination of welds in critical areas. This eliminates the time consuming welding itself along with the detailed inspection processes involved.

Other advantages from the method include a lessening of the criticality of non-metallic inclusions and a reduction in the amount of discarded scrap for each case.

There are also some less obvious benefits accruing to the process.

The Lyon method eliminates dependence on flat steel stock. Instead, the disc that serves as the blank, from which the case is drawn, is obtained

PANCAKE pressed from machined ingot results in formation of radial flow lines ideal for deep drawing.

EXPERIMENTAL motor chamber was drawn with integral ribs. This allowed simple, accurate attachment of fins.

from the ingot itself by hot pressing. Thus every ingot producing steel company is a potential source of supply.

A further advantage from this method is that the surface imperfections are machined away before pancake pressing. In addition, the "as cast" structure of the ingot section flows uniformly into a flat disc according to a definite procedure.

The metal in actual contact with the faces of the upper and lower dies does not flow but transmits the pressure in an axial direction to the center of the ingot section. This force is transmitted in a radial manner from the midsection to the outer edge giving the pancaked blank radial flow lines.

This is the most ideal condition for deep drawing. In fact, this transmission of the pressing effect through the center of mass of the ingot is a prime factor in the success of the deep drawing operations.

Lyon's deep draw techniques have been applied to low drag bomb casings. Martin points out that same procedure is aptly suited to the fabrication of one-piece solid rocket motor chambers.

Ignoring the type of steel involved and hence the numerical temperature data, the Lyon deep draw process can be outlined in general, using the bomb casing as an example.

• **Low drag bomb parallel**—In the pancake forming operation, the machined ingot is brought up to working temperature in a salt bath. Upon completion, the pancaked disc is transferred swiftly to a cupping die to take advantage of the heat still contained in the workpiece.

After formation of the cup, it is immediately placed in a furnace to bring it to temperature for the first drawing operation. This fast transfer of the workpiece permits the utilization of the heat remaining in the body to shorten the process time for the first hot draw.

As far as the bomb casing is concerned, the piece is hot enough after the first draw to permit annealing without reheating. After quenching, pickeling and lubrication with phosphate, the second and third drawing operations are performed cold. For the 500 lb. bomb, the tonnages required were 1475 and 1300 tons.

In the third draw, the bomb is drawn all the way through the die for the last time. The fourth draw is cold and the body is drawn to a definite length through the die, retaining a portion of the thickness left by the third draw. On the return stroke of the press, a knock-out in the bottom pushes the bomb body back up through the die.

Lyon then headed the bottom of the body into a shape that allowed utilization of the center for the base plug instead of being scrapped.

After trimming, the mouth end of the body was annealed for a distance of 5 in. and phosphate coating applied. The mouth anneal is necessary for the fifth draw, since the top part of the die is tapered to give a developed form to the upper sidewall at the mouth end and a uniform taper for the ogive after nosing.

After the fifth draw and final trimming, the bomb body is mouth-annealed for a distance of 9 in. and completely lubricated.

Then one stroke of the press p forms three distinct operations. Redra where the tapered outside section pushed to the inside of the case; ba taper, where the base of the case pushed to a definite stop; and first n ing, where the ogive is formed with uniformed tapered wall section by to nage alone.

Finally there is a small amount machining and a heat treat step to o tain the desired physical properties.

Lyon's first venture into rocket cas came in the latter part of 1956 wh the U.S. Naval Ordnance Test Stati (China Lake) contracted for one-pie deep drawn chambers. These were a proximately 12 in. in diameter a about 57 in. long.

An independent venture resulted the successful drawing of integral ri on engine cases which allowed a simpl but accurate means of attaching fins.

• **Alloy familiarization**—Lyon h completed material fabrication inves gations showing the adaptability several alloy steels to the hot cup-co draw method for cases. These alloys a 4140, 5% Chromium, High Silicon a AMS 6434 (Mod). All of these allo have been hot pancaked, hot cupp and cold drawn without difficulty.

The same type of study was appli to Tricent (300-M) with like results.

Engine cases manufactured by t deep draw method from one or more the above alloys contained physic properties that exceeded 250,000 p yield strength, 325,000 psi ultima burst and 8 to 10% elongation.

These properties were determin through internal hydrostatic pressu stress analysis tests using both the stre coat and electrical resistance stra gages. The yield and burst data w obtained on one piece, cases, 12 in. 56 in. with a wall thickness of 0.100 i

In the case of each and every allo Lyon conducted an exhaustive series tests on a laboratory scale from t ingot on up through the final produ before committing one workpiece to t big press.

These studies were verified by the close correlation to the actual full sca deep draw process. Lyon has also den onstrated its deep draw ability with T Ladish Co.'s D-6 alloy composition The 5% chromium alloy is similar Vascojet 1000. Lyon's familiarity wit these compositions is such that the bur level and point can be predicted wit accuracy.

The press itself is a Lake Erie 500 ton double acting, hydraulic affair wit 160 in. of daylight and 120 in. stroke. It has a capability of drawin items up to 40 in. diameter, and 106 i long or up to 80 in. diameter and 7 in. long.

High-intensity Cryogenic Magnet to Weigh 50 lbs.

Designs for an electromagnet with a 100,000 gauss field intensity but weighing only 50 lbs. are being proposed by scientists at the National Bureau of Standards Boulder Laboratories, Boulder, Colo.

The magnet would employ seven stacked "flat doughnut" coils of aluminum foil operating at liquid hydrogen temperatures. Each coil measures 11 in. across with a 3-in. cylindrical hole in the center. The coils would be separated from each other by insulated ribs and connected electrically in series.

The design departs from the traditional approach. If past experience were to be the guiding factor, such a magnet operating at room temperature and throughout the same volume would weigh tons. Its power requirements would approximate the demand of a city of 40,000 people—some 7 million watts. This is 2000 times the power needs of the proposed magnet.

The low-power, steady-state magnet was designed by John Purcell and Errol G. Payne of the NBS Cryogenic Engineering Laboratory.

Aluminum was chosen because, if pure, its resistance in cryogenic temperatures is lower than all normal conductors except sodium. This low resistance, plus the gain from the stacking design, make possible intense magnetic fields over a cylindrical volume 3 in. in diameter and 8 in. long.

When completed, the pilot magnet will be used to study properties of materials at various temperature levels.

AEC Member Denies U.S. Covets Congolese Uranium

A member of the Atomic Energy Commission indicated last week the United States is no longer vitally interested in Congo uranium.

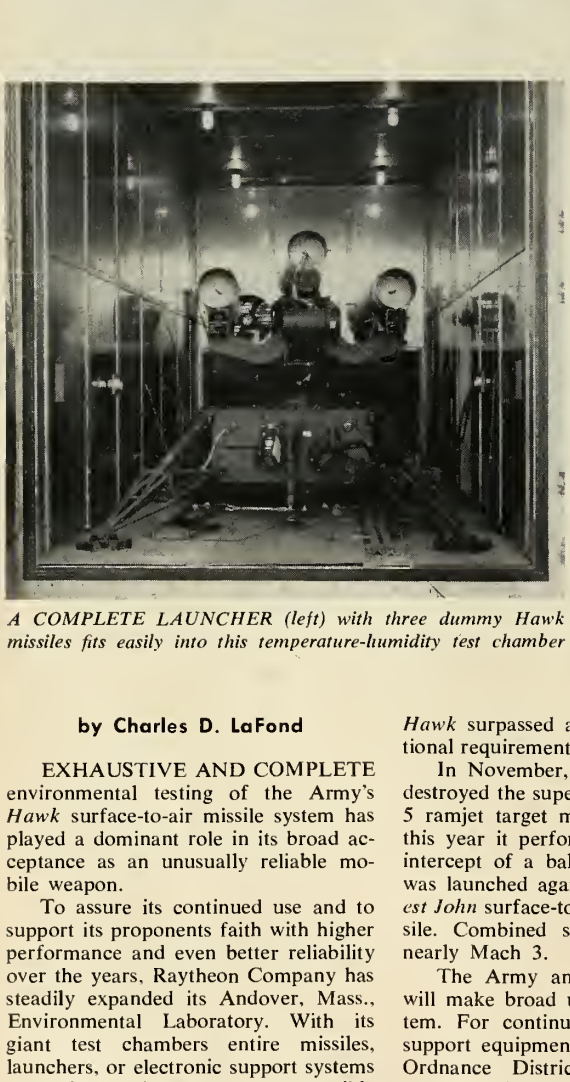
Commissioner L. K. Olson told the American Mining Congress at Las Vegas that the Shinkolobwe uranium mine in Katanga Province has been exhausted and was closed last April, months before the Congo attained independence.

Olson was commenting on recent remarks by Patrice Lumumba, the pro-Soviet sometime Congo leader, who said troubles in Katanga were caused by U.S. interest in uranium. Olson said he understood the mine at the time of the disturbances was still operating to clean up existing stocks.

The commissioner, in a review of the uranium purchase program, recalled that buying in the U.S. and Canada has been cut back as a result of reduced requirements, although he said the long-term prospects are good.

Painstaking Environmental Tests A

Raytheon's huge test chambers at Andover subject missiles and their transport and support systems to extreme physical punishment



A COMPLETE LAUNCHER (left) with three dummy Hawk missiles fits easily into this temperature-humidity test chamber

at Raytheon's Andover Environment Lab. (Right) The ent CW acquisition radar is housed in the same climatic facil

by Charles D. LaFond

EXHAUSTIVE AND COMPLETE environmental testing of the Army's *Hawk* surface-to-air missile system has played a dominant role in its broad acceptance as an unusually reliable mobile weapon.

To assure its continued use and to support its proponents faith with higher performance and even better reliability over the years, Raytheon Company has steadily expanded its Andover, Mass., Environmental Laboratory. With its giant test chambers entire missiles, launchers, or electronic support systems are being subjected to every possible combination of physical misery as a part of the normal production routine.

End result, says Raytheon who has been prime contractor for *Hawk* development and production since 1956, is a tactical weapon capable of transport by any mode and of operation anywhere in the world.

Designed primarily for defense against low level attack aircraft, the *Hawk* surpassed all of its early operational requirements.

In November, 1958, it successfully destroyed the supersonic Lockheed XQ-5 ramjet target missile. In January of this year it performed the first known intercept of a ballistic missile when it was launched against the Army's *Honest John* surface-to-surface artillery missile. Combined speed at impact was nearly Mach 3.

The Army and the Marine Corps will make broad use of the *Hawk* system. For continued R&D for ground support equipment, the Army's Boston Ordnance District recently awarded Raytheon $10.5 million. On Sept. 30, 1960, this same agency awarded the company four letter contracts for $29 million for continued production of *Hawk* missiles, electronic support systems, and engineering services.

First overseas use of operational *Hawk* units by the Army will be in Okinawa and the Panama Canal Zone.

The Marine Corps has announced activation of its first *Hawk* missile battalion at Twenty-nine Palms, Ca With four firing batteries plus he quarters and service battery, the 6 man unit is already equipped and undergoing intensive training.

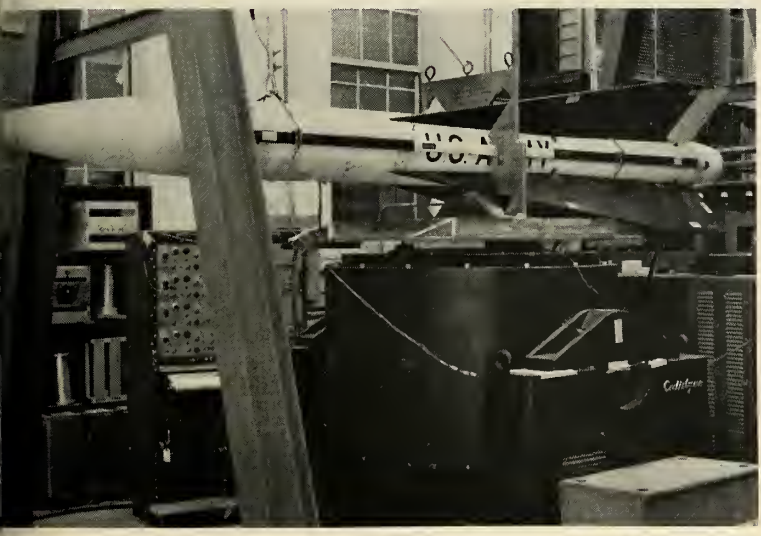
For NATO use, Raytheon has censed SETEL (La Societé Europé de Téléguidage) in Europe to bu *Hawk* missiles. SETEL serves to ordinate the industrial output of manufacturers—one each from G many, Italy, Belgium, Holland France—who will individually prod portions of the system. Raytheon assist in setting up their production li and also will supply some portions the GSE.

• **Testing role increases**—The of environmental testing for such m siles as the *Hawk* has become incre ingly important in recent years, unti has become an integral part of the p duction of any weapon system ma factured today. It is destined for e greater emphasis in the future.

A highly mobile missile system s as *Hawk* must be capable of operat

ey to Hawk Reliability

POPULAR HAWK will be used by Army, Marines, NATO.



HAWK missile undergoes vibration testing with 15,000-force-pound shaker as a part of normal production environmental test program.

nder the environmental conditions ound in any part of the world. The auncher and the missile also must withtand extreme vibration and shock orces at launch and the missile must unction under extremes of tempera-ure, acceleration, vibration, and alti-ude during its flight.

The *Hawk* system's mobility also ex-oses it to severe transportation en-ironments. Being transportable by ship, anding craft, helicopter, rail, aircraft, r truck, it is subject to a wide variety f vibration and shock.

To assure reliability and effective-ess of the *Hawk* system in every trans-ort and operating environment, the nvironmental Laboratory at Raythe-n's Andover Plant was established.

While environmental testing of me-hanical and electronic components is ssential to assure their reliability, it oes not necessarily predict the be-avior of a major tactical unit in a iven environment. What was needed, ccording to John G. Bernard of Ray-heon's Missile Systems Division, was a laboratory that could, so far as practical, subject complete missiles and whole units of ground support equipment to the environmental extremes expected in both transport and operation.

In setting up the lab over a 3-year period, many special problems arose which required custom designing of some of the facilities to meet unusual needs and applications. In some cases a joint effort on the part of Raytheon and the equipment manufacturers was necessary to produce the facilities required.

• **Physical extremes simulated**—All of the necessary equipment has been installed in a new 8000-sq.-ft. building. In addition to just about every known climatic and dynamic extreme, Raytheon feels its facility can provide simultaneously in-flight conditions such as high-frequency vibration, extreme low temperature, and high altitude.

The altitude-temperature-humidity chamber has a free test space 20 ft. x 8.5 ft. x 8 ft. high. It is capable, said Bernard, of simulated altitudes up to 100,000 feet, temperatures from –100°F

Breakdown of Recent Raytheon Hawk Contracts

Finalized—Sept. 30, 1960

	(millions)
GSE & Test Instruments	$ 4.673
NATO Support	4.019
Military Assistance Program	1.873
Total	$10.565

Letter Contracts—Sept. 30, 1960

Hawk Missiles	$16.900
GSE	8.056
Engineering Services	3.267
Field Maint. & Test Equipment	1.374
Total	$29.597
Total	$40.162

to +350°F, and relative humidity from 20% to 95% over a dry-bulb range of +35°F to +185°F.

This chamber has been specially constructed to accommodate a 5000-force-pound vibrator capable of operating under any of the conditions that the chamber can produce.

One of the smaller chambers provides wet and dry climatic extremes: simulated rainfall up to 4 inches per hour; or simulated solar radiation adjustable from 100 to 140 watts/sq. ft., with air at +125°F. Infrared, ultraviolet, and visible light lamps combine to expose *Hawk* equipment to the thermal and actinic effects of the sun in a desert location.

Another aspect of the desert climate is simulated in the sand and dust chamber. A complete 16-foot, 1300-pound *Hawk* missile can be subjected to blowing sand and dust at velocities up to 2300 ft./min., so that engineers can study the effects of dust penetration on the capabilities of the missile.

Salt air and spray exposure can be effected to simulate either a transport or an operating environment for any part of the *Hawk* system. Corrosion and electrolysis caused by this environment are investigated in the salt spray chamber, so that possible trouble spots can be eliminated before delivery of the equipment.

The largest chamber—for temperature-humidity studies—has internal dimensions of 25 ft. x 12 ft. x 15 ft. high. Major tactical units of the *Hawk* system (launchers, loaders, radars, etc.) can be operated here at temperatures from −100°F to +200°F and at any relative humidity from 20% to 95%.

Movable banks of infrared lamps designed to simulate solar heating add to the versatility of this chamber. Provision also has been made to accommodate the 5000-force-pound vibrator for dynamic testing under these different environments.

Automatic programing controls enable the climatic chambers to operate for extended periods with minimum supervision. Temperatures at various points on the equipment being tested are monitored by copper-constantan thermocouples connected to a multichannel recorder, which provides a permanent printed record for future reference. Other recorders provide permanent records of wet- and dry-bulb temperatures during humidity cycles.

• **Shakers and accelerators used**—Dynamic testing, said Bernard, is the other half of the environmental testing picture. It is extremely complex and the value of the information obtained depends greatly on the kind of facilities used. Just about any transport, operational, or in-flight vibration, acceleration, or shock likely to be experienced by the *Hawk* system can be reproduced in the Andover Environmental Laboratory.

A low-frequency vibrator simulates severe transport conditions for complete tactical units of the *Hawk* system. A 15,000-force-pound vibrator is capable of testing the *Hawk* missile or other large items. (As noted earlier, the 5000-force-pound vibrator can operate under the environments obtainable in the two largest chambers.)

A rotary accelerator 16 feet in diameter applies forces up to 100 g's to missile control packages and components. Set in a concrete pit for safety the accelerator has a 5-ft. cube free test space at each end of the rotor and can accommodate test specimens weighing up to 500 pounds.

Three sizes of shock testers, capable of pulses up to 75 g's, complete the list of dynamic testing facilities. Between them they can test components ranging from small parts up to 1500-lb. radar consoles.

A sequence of eight tests has evolved with experience in the Environmental Laboratory from which Raytheon engineers believe maximum information may be obtained:

–High temperature (or solar radiation)
–Low temperature
–Vibration
–Shock
–Humidity
–Acceleration
–Sand and dust
–Salt spray

With its ability to assure more positively the reliability of major assemblies and tactical units under a wide variety of climatic and dynamic conditions, this laboratory has contributed much to the effectiveness of the *Hawk* system.

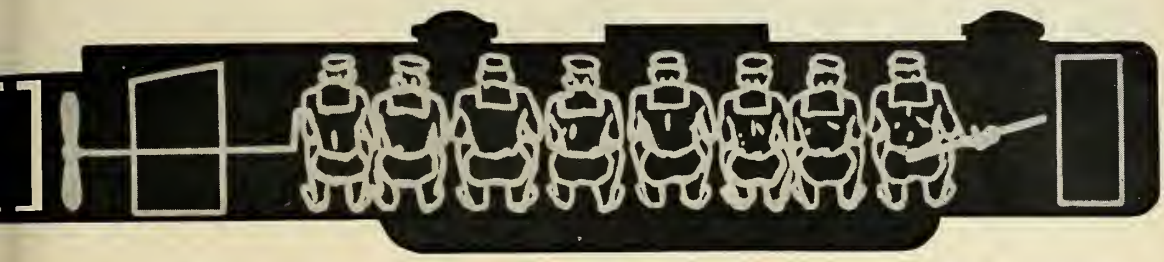
Certainly, this belief by those who know the *Hawk* is borne out by its past high performance and its present widespread popularity. ⌗

Grounded Bird

"FRUSTRATED FALCON"—a non-flying missile—is being used by the Air Force to train pilots and check performance of actual missiles and the launching aircraft's armament control. Instrumentation in the dummy Falcon records data on simulated or live-firing missions to pinpoint any erratic operation of the missiles or launching system.

Submarine Ideal for Surprise Attack

An expert traces development of the sub from Revolution to the present; he notes that ASW progress has failed to keep up since WW II



CUTAWAY OF CONFEDERATE SUBMARINE Hunley, first sub to sink a ship in war, shows crew seated at crank shaft used to propel vessel. Hunley sank the USS Housatonic in 1864, but explosion also sank sub and drowned its crew—Navy Photo.

by Vice Adm. Harry Sanders USN (Ret.)*

FOR A COMPANY to participate effectively in the search for better ASW vehicles, weapons and equipment, it must have some understanding of the nature of the submarine and the environmental problems of undersea warfare. These two things determine tactics and techniques.

I have not listed strategy because strategy is usually a very simple thing —such as hitting the enemy hardest where he is weakest. Also, strategy is one of the few professions in which the amateurs know more than the professionals.

One of the main elements of tactics is mobility. There have been times when the principle has been overlooked. *Atlas* and its fixed launching pads lack, as a system, mobility. The advent of *Polaris,* however, and the current plans to put *Minuteman* on flat cars are evidence that the importance of mobility is well recognized.

• **Ideal for surprise**—The main advantage of the submarine is its ability to operate with stealth—unseen and unheard. It is the ideal weapon for surprise attack. For this reason, the submarine has always been the weapon of the weaker naval power. When Robert Fulton persuaded Napoleon to test the Nautilus, it was only because Napoleon recognized what such a weapon could do to the British fleet. The Nautilus blew up a ship as a part of its tests but when it failed to sink any British vessels blockading the French coast, Napoleon cut off the funds.

The long reluctance of the British to have anything to do with the submarine was based upon their recognition of its power. They were afraid that if they built submarines other countries would and that would spell the end of British sea power. History has proved them right.

The easiest way to understand the capabilities and weaknesses of the modern submarine is to look at submarine warfare as it developed and then to try to evaluate the effects of the latest technological developments.

• **Frightened by bit**—The first submarine attack on a war ship was made during the Revolutionary War by a one-man submarine against a ship of the British fleet anchored off New York. This submarine, called the Turtle, looked like a fat pineapple. It was made of oak and iron bands. Its propeller was driven through gears and shafts by the one-man crew. Its weapon was a "mine," really a delayed-action time bomb, carried outside the hull.

The bomb was supposed to be attached to the underwater body of the target by a brace and bit arrangement through the hull. The Turtle made a good submerged approach and the operator started to attach his mine. Unfortunately, the British ship he picked had a copper-sheathed bottom instead of a wooden bottom and he couldn't get the bit through. He therefore backed clear and made a submerged retreat.

Although he didn't succeed in blowing up a British ship, the result was a victory because the incident so frightened the British that they moved their fleet to a safer anchorage farther away.

• **First blood**—The first ship to be sunk by a submarine in war went down in 1864; the USS Housatonic was sunk in Charleston Harbor by the Confederate submarine Hunley. This craft, really a submersible designed to run awash, was propelled by eight men working on a crank shaft. The explosion also sank the Hunley, and her crew of nine drowned.

In World War I, the submarine, though much larger in size, was essentially a surface vessel which could

First of Series

This is the first in a special series of articles intended to acquaint readers with the nature of the submarine threat, the ASW engineering problems involved, and the means or lack of means for solving them. Written by authorities in the ASW field, future articles will deal with environmental factors, sonar, hydrodynamics, oceanography and ASW weapons systems.

** Admiral Sanders is Corporate Director, ASW Engineering, Chance Vought Aircraft, Inc., and a member of* MISSILES AND ROCKETS *Magazine's Editorial Board. Part II of this two-part series, a look into the future of submarines and antisubmarine warfare, will be published at a later date.*

USS HOLLAND, built by John Holland, was accepted by Navy in 1900. Note the tube in bow, from which an aerial dynamite torpedo was launched by compressed air.

submerge for short periods. It could not go very deep, only to about 200 feet. Much of its time had to be spent on the surface charging its storage batteries and looking for targets. It was very fragile. A hole in the hull caused by gunfire or ramming would make the submarine plunge to the bottom like a rock.

Submarine torpedoes were good enough. There was no torpedo control system in the modern sense, although the captain did have a sort of circular slide-rule. He estimated the target speed and its course. In the periscope was a telemeter scale which provided a rough range estimate. With these inputs, the circular slide rule worked out the angle of lead at which the torpedo should be fired.

Because of the crude state of antisubmarine measures, torpedoes could be fired at close range and, because the ships were sitting ducks, they were effective. The deck guns on submarines also accounted for heavy losses in Allied shipping.

• **Early defenses**—Antisubmarine warfare in those days consisted of gunfire and ramming. The depth charge and rudimentary hydrophones were then developed. Guns were put on merchant vessels, decoy ships such as the British "Q" ships were introduced, destroyers and small craft were fitted with hydrophones and depth charges, and the convoy system evolved.

Aircraft were equipped with bombs. Mine fields were laid, particularly the vast North Sea mine barrage; completed in 1918, it consisted of about 96,000 mines. This field accounted for some six submarines during the short remaining period of the war.

WORLD WAR II

By 1939 both the submarine, and antisubmarine measures, were greatly improved. The submarine had achieved higher surface speed and a marginal improvement in submerged cruising radius. The range of torpedoes was increased and torpedo control systems had been developed. Submarine communications were improved, permitting them to cooperate with aircraft and to assemble into wolf packs.

By the beginning of World War II, surface ship sonar was greatly improved. Magnetostriction devices had been developed commencing in 1929. The main antisubmarine developments came, however, during the war. The sonobuoy, which permitted aircraft to obtain indications of the sounds made by submerged submarines, was developed in 1941 by the Naval Research Laboratory. In 1943, the Naval Ordnance Laboratory developed the magnetic anomaly detector (MAD). This device was effectively used in the aircraft patrol of the Straits of Gibraltar.

Early in the war, submarine detecting radar was installed in aircraft. By 1942, German submarines were installing a radar search device which was effective against the long-wave radar (1½ meter) in British aircraft.

Microwave radar was then developed in this country. It was very effective in spotting submarines on the surface at night, and it forced the U-boats to remain submerged for much longer periods, thus greatly reducing their effectiveness.

It took the Germans several months to develop a search device which could pick up the microwave radar, becau they thought at first that the micr wave radar was an infrared devic Hitler, in a burst of exaggerated r crimination, said that airborne micr wave radar by itself spoiled his U-bo campaign.

• **Shifting tactics**—The tactics submarine warfare in World War had to change under the impact of the new devices. Until the convoy syste could be put in operation on the maj sea lanes, the German submarin went after independent shipping an they made a killing.

For example, after the Unite States got into the war, our lack surface escorts forced us to wait fro six to seven months before a coast convoy system could be set up. Durin this period German submarines san some 400 merchant vessels within 30 miles of the coasts of North and Sout America. Our lack of ASW aircra prevented us from taking effectiv measures from the air for sever months.

In March, 1941, Britain gave us 2 antisubmarine trawlers and 10 co vettes, all with crews. By May 1 1942, the first well organized convo sailed from Hampton Roads for Ke West. The system was then extende to New York and Halifax. The Ge mans, always anxious to attack wher we were weakest, then shifted the major efforts to the Gulf of Mexic the Gulf of St. Lawrence and off th coast of Brazil.

• **Spotting subs**—One of the firs requisites of antisubmarine warfare i to know where the submarines are This was accomplished in World Wa II by the high-frequency radio direc tion finder net. Radio direction finder were installed on the eastern edge o the Atlantic from Jan Mayen to Afric and on the western side from Green land to Brazil. When a German sub marine transmitted a message, th whole net could be alerted in a matte of seconds.

Although the U-boats message were transmitted in very short bursts the HFDF net could be alerted an get cross bearings. The Navy Depart ment and the British Admiralty wer thus able to transmit each day to al ships at sea the positions of Germa submarines.

Convoys were routed across th ocean on tracks designed to evade sub marines. Thus the route of the convo looked like anything but the shortes distance between two points. This wa called "evasive routing."

• **Closing circles**—The main ide of the submarines was to find the con voys. Marshal Goering made some o his Focke-Wulf aircraft available t

work with the U-boats and to direct them toward the convoys. The high surface speed of the U-boats and the lack of adequate Allied air cover in the early years of the war enabled the submarines to gang up and attack convoys spotted by the Focke-Wulfs.

The establishment of air bases for ASW patrol aircraft in Greenland, Iceland, Bermuda, Trinidad, and Brazil forced the submarines within the operating radii of the aircraft to stay under. Convoys were able to take advantage of this so that the Germans had to shift their submarines outside of these air patrol circles.

After Mr. Churchill dug up his 100-year-old treaty with Portugal, which permitted us to set up airfields in the Azores, the submarines had to move their operating areas to locations in mid-Atlantic not covered by shore-based aircraft. The U.S. Navy then (in 1943) moved hunter-killer groups, consisting of a jeep carrier and four or five destroyers, to attack the submarine concentrations in these mid-ocean areas.

By this time we had also installed in our destroyers a good surface search radar. The submarines, until this time, could operate on the surface at night, and by their superior surface speed (17 knots for the submarines against 8 to 10 knots for merchant convoys and 12 to 15 knots for troop convoys) overtake the convoys and attack them from the quarter or rear.

Imagine the surprise of Admiral Doenitz when one night in 1943 two or three U-boats suddenly were sunk in the dark when they made the usual attack on the surface against a convoy. It did not take him long to guess that, in addition to the radar-controlled 5-in. guns in our destroyers, we now had a good surface search radar. Thereafter, the surfaced U-boats could not approach any convoy.

• **Other developments**—The British were very alert to the advantages of aircraft in ASW. Their Coastal Command aircraft were put under Navy control early in the war, and they used jeep carriers accompanied by destroyers to operate against submarines independently. They were also aware of the need for aircraft in the vicinity of the convoys.

The Germans developed torpedoes with acoustic homing heads; by the summer of 1943 they were distributed to the U-boats. U.S. destroyers then began to outfit themselves with torpedo deflecting gear. This contraption consisted of a small wooden raft with metal pipes towed astern. The metal pipes vibrated in the water, and the homing head of the torpedo was supposed to seek the raft instead of the destroyer's propellers.

One of the great mistakes the Germans made was their failure to attack our escorts rather than the merchant ships in the convoy. If they could have equipped their submarines with acoustic torpedoes earlier in the war and if they had then concentrated upon the destruction of escorts, the battle of the Atlantic might have taken a different turn. In December, 1943, I asked a German submarine commander why he had not fired his acoustic torpedoes at my ships. He replied that he would have liked to, but that the torpedo tube shutters had been jammed by depth charge explosions and he could not, therefore, open the torpedo tube doors.

This incident is typical of submarine warfare. Depth charge explosions normally do not sink but only damage a submarine. Either the diving planes or the rudder for their operating gear is jammed, or the hull begins to leak. In either case, the submarine is forced to surface. When that happens, the destroyer's guns make short work of the surfaced submarine.

• **Snorkel arrives late**—The growing antisubmarine air offensive, due particularly to the great increase in the number of ASW aircraft and to the employment of microwave radar, forced the Germans to design and install snorkels in their submarines. The snorkel was a great invention because it largely nullified the capabilities of aircraft and permitted submarines to cruise submerged at speeds of nearly 18 knots and also to charge their storage batteries submerged.

The snorkel, however, was introduced in the later stages of the war when our antisubmarine effort was very powerful. This device, like the acoustic torpedo, if introduced earlier would have changed the course of the submarine campaign. Winston Churchill remarked that the snorkel in Soviet hands was one of the hazards of the future. We can only guess what his remarks would have been if he could have foreseen the nuclear submarine.

Since World War II, the development of the submarine has proceeded at a fantastically rapid pace. Nuclear propulsion has revolutionized the submarine—and perhaps naval warfare itself. Ballistic missiles, particularly the long-range *Polaris* type, have given the submarine a tremendous capability for deterrence and retaliation.

The concurrent progress in ASW has been comparatively very small indeed. Although the U.S. Navy, the American scientific community and industry have made great efforts, the problems that face us are the most difficult in the whole area of defense. ⌗

(Part I of a two-part series)

U.S. Firms Nail Down European Markets

Prospective $2 billion annual propellant sales stir purchases and mergers with European manufacturers

by S. David Pursglove

U.S. PROPELLANT firms are moving into Europe to cash in on a more than $2 billion per year propellant market now forming in NATO countries and other Western European nations.

Some American chemical and propulsion system companies have bought European firms, some have merged, others have created European divisions for production and marketing. Some simply have established contacts to exchange information now, to help sell later.

No matter what form the action, it has been prompted in each case by bold handwriting on these three walls:

–The new tariff-oriented trade groups are here to stay.

–The U.S. is insisting more strongly that propellants be supplied locally.

–European governments are starting to put more money into propellants R&D.

European tariffs have traditionally favored the Continent's and England's strong chemical industries. This has been especially true in several of the nations important to the missile business: Belgium, England, France, and Italy. Acceptance of the European Economic Community (Common Market, or Inner Six) and the European Free Trade Association (Outer Seven) soon will make American firms' jobs in Europe harder. It will be almost impossible for U.S. chemical companies to compete in Europe without manufacturing there, or without selling through favored European affiliates. This is the consensus of American chemical company representatives, government trade authorities, and even the Defense Department officials who may be unwillingly abetting the situation.

• **Why worry about Europe**—Is there really a propellant market in Europe? The total Western European defense budget for the next twelve

PAUL M. TERLIZZI, of Stauffer Chemical Co., which is busy in Europe.

months is $12 billion. Authorities believe about $700 million will be spent by these countries on propellants. Up to that same amount will be spent for propellants by U.S. forces in Europe. This is a significant, but not large, market. However, if the U.S. does not pull its missiles back into a "Fortress America," and if Europe's own plans are mostly fulfilled, the European propellant market in less than three years will far exceed $2 billion per year.

Much of this money will be American. However, it will be U.S. money spent in Europe to buy native propellants that do not have to be shipped. The Pentagon is urging more local purchasing of propellants (in spite of this month's token reversal of the off-shore procurement policy in other areas). Defense officials want an on-hand propellant capability for each new missile base that we build, or that we promote through NATO.

The list of missiles already in Europe, and which must be supplied with propellants, is impressive:

Thor (LOX and RP)
Mace (Solids and JP)
Jupiter (LOX and RP)
Matador (Solids and JP)
Corporal (Nitric acid and aniline)
Honest John (solids)
Nike-Hercules (solids)

Close observers of the European military rocket scene say don't discount the solid fuels in this list. Some of these missiles will be replaced by those using storable liquids, some older ones may be fitted with "fresh" engines, and finally they point out that it may be economical to ship missiles from the U.S., and install solid motors cast in Europe. All chemical firms are looking to two moves that definitely are in the cards, moves that will create an even bigger market directly in chemicals: (1) A switch to storable liquids, (2) use of high energy propellants. They particularly look forward to *Hawk*-type programs involving missiles using high energy propellants that must be produced locally. The *Hawk* program is for $500 million, with about $100 million going into low-cost propellants. In planning for a major European market propellants firms and other chemical companies envisage larger programs calling for more expensive propellants.

• **Private spending to go up**—The requirement that propellants be purchased locally will be enforced even more rigidly with the arrival of later generation missiles requiring higher energy or otherwise more sophisticated propellants. This leads to the third reason that nearly every U.S. chemical firm is rushing people to Europe:

Observers report that European governments are about to increase many-fold, their spending on propellants R&D in private firms. Until now the little government money spent for propellants research has gone to government installations and university laboratories. Suddenly Europe finds itself called upon to produce great quantities of propellants, and to gear-up for propellants that haven't even been fully investigated yet. The governments are turning with open pocketbooks to private industry to meet the challenge.

Much money is being diverted from university basic research to industrial applied research and development. (However, American contracts and grants—mostly through ARPA, ARDC and the Navy—are filling what could become a void in basic research.)

U.S. firms stand to benefit from this new impetus by more than just production contracts executed through affiliates. Unless all past experience suddenly loses meaning, the heavy pressure on propellant firms will mean important new technical developments in Europe. These will be developments that can be applied in the U.S. by affiliates of European patent holders.

• **Joining in**—Most U.S. propulsion firms and chemical companies interested in propellants are climbing on the European bandwagon. Some are tiptoeing, cautiously feeling their way; some are jumping on enthusiastically and noisily. Typical of a mid-way approach are the moves being made by Stauffer Chemical Company.

Paul M. Terlizzi, asst. to the vice pres. (research), says Stauffer believes it is in about the same planning state as are many other companies. Stauffer is developing European contacts in industrial chemistry on one hand, and is building up a rocket propellant research expertise and production capability on the other hand. When the budding European market blooms, the company need only bring the two areas together in order to bring in its share.

Terlizzi is a research representative in Washington; however, much of his effort is in working with Stauffer's newly created International Division to determine the pros and cons of rocketry ventures in Europe. His Washington headquarters keeps him in close contact with Federal policy makers and spenders, NATO officials, and European embassies and trade missions.

The International Division under general manager F. W. MacMullen opened its Geneva office last year to handle Stauffer's European industrial accounts—boron and sulfur products, and medicinal chemicals—and to keep in touch with European rocket business developments. In this latter area, the Geneva office's major interest is in boron compounds.

• **High energy fuels**—Boron, fluorine, and lithium are the important conversation topics today in Europe. The newer U.S. missiles, and probably some NATO aircraft, will call for high energy fuels. Boron promises to provide the first economical, truly high energy fuels practical for wide use. However, Europe has only two important sources of boron compounds: Larderello, of Pisa, and Suddeutsche Chemische Werke.

SCW, wholly owned by Stauffer, produces refined borax, metallic borates, and boron fluorides from crude borates shipped by Stauffer's U.S. facilities. Production is for industrial accounts, but the company's experience on the scene and its marketing organization, besides its production facilities, are available for any Stauffer move into the European rocketry market. The International Division already has developed important contacts among R&D firms and universities during work on H-E fuels, and has supplied some of them with boron compounds and technical assistance.

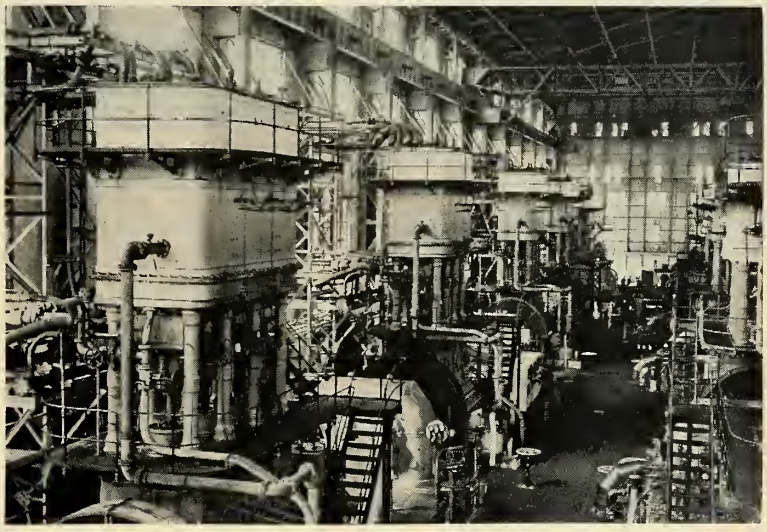
Like most chemical companies, Stauffer found propellants old hat, but propulsion something new. An early move to develop expertise in propulsion was the formation with Aerojet-General of the Stauffer-Aerojet Chemical Company to investigate H-E fuels under an Air Force contract. This is one of the few organizations not hurt by the Defense Department's cut-back in the high energy fuels program last year. The company has put on stream a major pilot plant to prove-out a new process for low cost manufacture of classified H-E fuels intermediates.

• **New contacts open**—One of Stauffer's big moves last year was to form Kali-Chemie-Stauffer G.m.b.H. jointly with Kali-Chemie, A.G., of Hanover. The firm will produce insoluble sulfur at a plant now under construction in Nienburg, W. Germany. The sulfur itself may find a rocketry market, but more important to Stauffer's planning are contacts and marketing organization soon to be available.

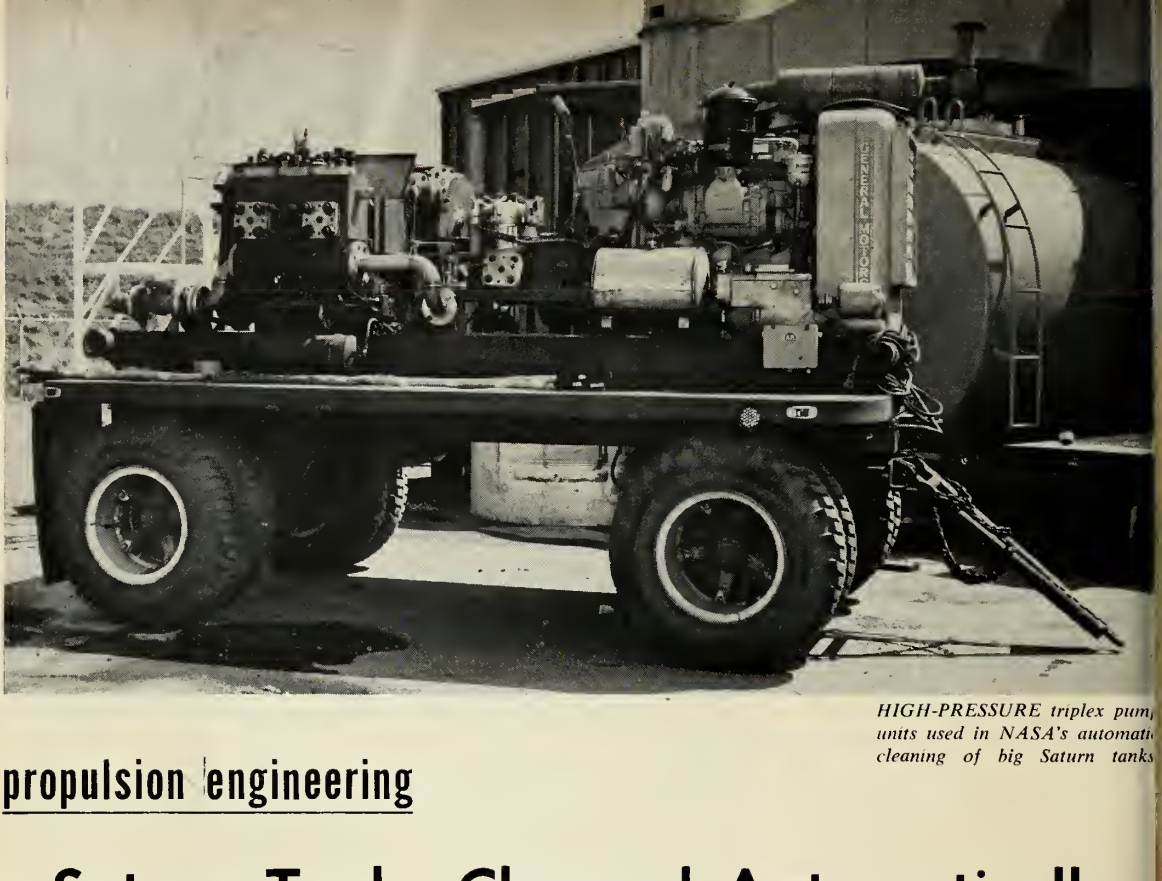
Such contacts are more important than they seem. Recently, Callery Chemical Company announced a program of boron chemistry information exchange with one of the world's largest chemical firms, Imperial Chemical Industries (ICI), England. A Callery official points out that traditionally information exchange programs are forerunners to cross-licensing agreements, and often lead to marketing relationships. He cannot say whether this is in the cards for the Callery-ICI venture, but the word has spread that technical representatives of the two companies are already enthusiastic about certain mutual interests that involve military as well as industrial boron applications.

Several top Callery officials recently returned from a European survey fired with prospects in military rocket fuel areas. So far, Callery believes it will be unnecessary to set up an overseas organization to market propellants in Europe. The Firm is jointly owned by Gulf Oil and Mine Safety Appliances. Both have well-established European operations available to Callery.

Besides such liquid oxygen suppliers as Linde and Air Products, who are doing well in Europe, some other U.S. chemical firms that are expanding in propellants and European interests simultaneously are Esso Research and Engineering, American Cyanamid, Dow Chemical, Food Machinery & Chemical, and several divisions of Union Carbide. Some of their relationships with the European rocket and propellants business will be discussed later in M/R in a roundup of what European and South American companies and their governments are doing and plan to do in propellants. ⌗



LARGEST CHEMICAL FACTORY in the British Commonwealth is Imperial Chemical Industries, Ltd., plant at Billingham. ICI is trading boron data with Callery.



HIGH-PRESSURE triplex pump units used in NASA's automatic cleaning of big Saturn tanks

propulsion engineering

Saturn Tanks Cleaned Automatically

HUNTSVILLE, ALA.—Engineers here have developed a pressure-driven automatic method of cleaning the huge *Saturn* propellant tanks after use.

The automatic method promises to reduce the trouble, effort and expense formerly involved in hand-cleaning tank interiors after they leave the fabrication shop.

Frederick J. Beyerle of the Marshall Space Flight Center, National Aeronautics and Space Administration, says center bulkheads in the tanks prevented the use of pressure cleaning of *Redstone* and *Jupiter* missiles.

Cleaning of both fuel and LOX tanks is necessary, he noted. If numerous particles of large micron size should gain entry into either tank, orifices downstream might be clogged, causing a valve malfunction that could lead to the loss of a multimillion-dollar booster. In the LOX systems, all hydrocarbons or organic contamination must be removed. As these are LOX impact sensitive, an excessive buildup could cause fire or an explosion.

• **Joint development**—Dow industrial service, a division of Dow Chemical Co., and personnel of the NASA group, formerly with the Army Ballistic Missile Agency, developed the cleaning process jointly. Equipment consists of a high pressure triplex pump, a deionizer, high and low-pressure micronite filters, a high-pressure heat exchanger, centrifugal pumps, stainless steel storage tanks, reel and hose actuator, high-pressure jet-spray devices and interconnectors and lines. The stainless steel parts are lined and gasketed with Teflon where applicable.

The outer *Saturn* tanks, with diameter of 70 in. and length of 60 ft., are cleaned in a vertical position by spraying detergent water at a pump pressure of 2000± 500 psi at a rate of 60 to 80 gal./min. from a head fed by a flexible hose.

Rotation on the vertical axis assures complete coverage of the interior. The spray is centered by observing the vibration resonance. The head, rotated at 5 to 6 rpm, has a travel speed of 3 to 4 ft./min. The hose reel is operated hydraulically.

The detergent solution is at a temperature of 125° to 130°F, which aids in removing some organic contaminants and later in drying the tank. After the detergent spray is completed, the same operation, using the same pressure ratings, flow rates, spray head revolutions and travel speeds, is carried out with demineralized water.

• **Air dried**—Drying is accomplished with missile grade air or nitrogen of less than 3ppm hydrocarbon until an anhydrous condition of 0 to 5% shows on the dew-point indicator.

LOX containers are purged with trichlorethylene at ambient temperature and a pressure of 100 psi. A 3-ft. double-armed umbrella jet spray device spins at 4 rpm and moves 3 to 5 ft./min. to remove organic contamination. Then the container is dried with missile grade air or nitrogen.

On the discharge side of the tank the effluent demineralized water is sampled on a continuous flow basis to determine particle sizes. NASA specifications allow 5 particles between 175 and 700 microns, one between 700 and 2500 microns and none above 2500 microns per square foot of surface area.

The effluent trichloroethylene is also sampled on a continuous flow basis during the one-cycle operation to determine hydrocarbon levels. Maximum hydrocarbon concentration allowed is .005 gram per 500 ml of solvent per square foot of surface area. ⁂

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U.S. Hikes Funding for Life Research

Seven agencies tell ARS meeting they'll support studies ranging from radiation to extraterrestrial life

by Heather M. David

DAYTON—As many as seven agencies now offer funds for life sciences research applicable to space, in contrast to the two or three of a few years ago.

Among the National Institutes of Health, the Air Force, the Army, Atomic Energy Commission, National Aeronautics and Space Administration, Office of Naval Research and the Office of Science in the Department of Defense, there is a huge potential source of funding for both practical aspects of space medicine and basic research on the laboratory level.

In the highlight of the first American Rocket Society meeting on human factors and bioastronautics, seven representatives from government grant-giving or contracting agencies told of potential support in their agencies.

• **National Institutes of Health**—The giant of the grant givers, NIH covers all medical and biological fields and has a yearly budget of several hundred millions. Last year just under half its applications were granted.

Dr. Ernest M. Allen pointed out that as spaceflight becomes more and more a public concern, NIH will award more money in related health research.

Working entirely on the grant system, money is given in lump sums with no restriction on how it's spent to accomplish the research purpose. The institutes are: Cancer, Heart, Allergy and Infectious Diseases, Arthritis and Metabolic Diseases, Dental Research, Mental Health, Neurological and Diseases.

Possibly most interesting to the space medicine field is NIH's Division of General Medical Sciences, which covers any program not specifically concerned with the seven Institutes.

• **Atomic Energy Commission**—The Division of Biology and Medicine offers four areas in which a scientist interested in working on radiation hazards could find support.

Dr. Max R. Zelle outlined these as: 1) effects of radiation on biological systems—constituting 37% of the division's total program; 2) problems arising from AEC operations (accidental exposures etc.)—35%; 3) radiation protection—6%, and 4) exploitation of radiation for beneficial aspects —22%.

The AEC division does about two-thirds of its work in its own labs, but has some 600 current outside contracts. Although AEC works on the contract system, Dr. Zelle pointed out that 90% of its contracts are unsolicited and applications can be made at any time. Funds are relatively unencumbered, he noted.

• **NASA**—The National Aeronautics and Space Administration offers both grants and contracts in the full gamut of research related to the human or animal system in space, including the search for extraterrestrial life.

Awards are made in the three divisions of the Life Sciences Office: space biology (molecular biology and cellular environmental physiology and extraterrestrial life), space medical and behaviorial sciences (neurophysiology and psychology, metabolism and nutrition and cardiovascular and respiratory physiology), and flight medicine and biology (experiments in the space environment and biotechnology).

Dr. Freeman H. Quimby called for both instrumentation and experiments to be carried on space probes and laboratory studies. One prime area of concern in the space medicine and behaviorial sciences area is to find protection beyond conventional means for radiation.

Proposals are evaluated by the NASA staff and examined by the NASA Life Sciences advisory committee for each field. (M/R, Oct. 10, p. 32).

• **Army**—Although the Army has no bioastronautics program as such, it supports research which also might have spaceflight application, according to Lt. Col. Richard R. Taylor.

Contracting is done exclusively by negotiation and is generally unsolicited. The Army mostly deals with non-profit organizations for basic research and with universities.

Some of the current space-applicable studies supported by the Office of the Surgeon General are: chemical protection against radiation, effects of stress on soldiers, effects of noise in relation to performance, and the medical aspects of nutrition, such as algae studies.

• **Office of Naval Research**—The Navy also offers aid to programs in its field which also might have space application, such as some aspects of the submarine program. Studies of toxicology, stress physiology and hydrobiology could have dual application.

ONR's program comes under the Biological and Physiological Sciences Division. Research programs are, of course, unsolicited.

An interesting point brought up by Dr. Sidney Galler was that ONR does not advocate "short forms" in proposals. He noted that ONR's reason for granting funds for basic research might not be because of the scientist's objective, but because ONR wanted research in the field for different reasons. The details which might attract ONR might not be mentioned on a brief form and the proposer would not get the contract.

• **Air Force**—As in NASA, both grants for basic research and contracts for specific programs are awarded.

Most of the Air Force's space medi-

cine and life sciences programs are administered by the Air Research and Development Command. Contracts are awarded at the division and center level, such as at AFMDC for the School of Aviation Medicine, or WADD for the Aerospace Medical Laboratory.

Basic research related to the field is handled in both grants and contracts from AF Office of Scientific Research, Washington, D.C. Industry, as well as non-profit organizations, can receive OSR support.

Air Force interest is broken down into four general areas: biologistics, support of man in his natural environment; biomechanics, man's relation to operationally induced environment; radiobiology, and human performance.

Bionics has been treated as one of these areas, but the Air Force is considering separating it as a fifth area, according to Dr. A. W. Hetherington, Technical Director of the Directorate of Life Sciences, ARDC.

Dr. Hetherington suggested that unsolicted proposals to the Air Force be drawn up in short form, eliminating considerable expense. He answered the complaint from a small company representative that unsolicited proposals were sometimes taken and opened for bids—then given to another contractor.

• **Department of Defense**—Col. John M. Talbot reported that although the Secretary of Defense Office of Science relies on the three military services for action in the space area, there could be some dovetailing fields of interest with DOD.

The Defense Atomic Support Agency, for instance, might entertain proposals on radiobiological effects, especially if they were not particularly appropriate to any single service.

There are still some dual areas in the Advanced Research Projects Agency, although it is no longer concerned directly with space.

Other fields covered in the meeting were bioinstrumentation, anthropometrics, bionics and human factors.

Unfortunately the ARS Conference received only sparse attendance. Only about 125 representatives attended the three-day session, although the delegates ranged from university people to industry.

ARS officials blamed the poor attendance on the fact that a huge WADD-sponsored Bionics Symposium had been held in Dayton only the month before, and that programs had not been distributed early enough.

The ARS Human Factors and Bioastronautics Committee is considering future joint meetings with the Aerospace Medical Association and the Human Factors Society of America. ¤

Mice to be Bred after Trip into Van Allen Belts

Medical and nuclear authorities are closely scrutinizing some 600 lbs. of experiments—including three black mice—which made a 650-mile high trip into the Van Allen belts.

The heaviest payload ever to be recovered by the U.S., the mice and over ten other experiments rode in a General Electric RVX-2A nose cone on an Air Force *Atlas* missile. The trip took them 5000 miles down the Atlantic Missile Range, where they were recovered several hours after impact.

Within weeks results from some of the experiments will be known. The mice so far have shown no ill effects and no premature graying from their exposure to radiation. The male-Moe-will be mated with either of the females Amie or Sally to study genetic effects.

Dr. Hans Clamann, Chief of the Department of Space Medicine for the School of Aviation medicine, said it would take about a year to get complete results on the mice—the first animals to be recovered from the Van Allen belt. Some preliminary ideas can be obtained within a month, he indicated.

Physiological data telemetered to Cape Canaveral for the first 17-minutes of the half-hour journey showed normal heart beat, temperature and muscular movement, except for a brief moment at launch. Medical experts attribute this to fright at the noise and g-forces of acceleration. Data was transmitted from signals emanating from a transistorized meter weighing a quarter of a pound. Only one of the females wore the tiny bioinstrumentation package.

• **Not purpose of trip**—Although publicly the most popular members of the flight, the mice actually rode the *Atlas* on a space-available basis. Primary objective was to test a new ablative nose cone material developed by General Electric, called GE Series 100. The recovery vehicle is undergoing evaluation together with the telemetry data.

Other experiments in the 12-foot nose cone included two space power systems, radio measurements, and a number of radiation measuring devices. GE was systems coordinator for AFBMD. Experiments were:

–An experiment to help crack the telemetry blackout occuring when a space vehicle re-enters the atmosphere. These radio measurements were provided by the Wright Air Development Division, ARDC, Ohio State University and General Electric.

–An experimental GE fuel cell tested particularly for its behavior during weightlessness. A closed-cycle device, it operates by oxidizing hydrogen and oxygen to produce water, then regenerating itself by electrolysis of the water back to hydrogen and oxygen.

–A magnetohydrodynamic generator developed by Space Technology Labs.

–An attempt to discover the rate which radiations in the Van Allen belt would enter the human skin. Air Force special Weapons Center provided this experiment, results of which will be correlated with the SAM mouse biopack data.

–AnSTL and University of California Lawrence Radiation Lab nuclear emulsion package, designed to measure the flux and energy distribution of protons and electrons in the belt.

–Air Force Cambridge Research Center's highly-sensitive cosmic ray measuring device, consisting of an emulsion package and monitor designed to measure trapped and primary cosmic radiation which might have escaped previous detection.

–Emulsions provided by NASA to measure flux, composition and energy distribution spectra of particles in the lower edge of the inner Van Allen Belt. The University of Minnesota, University of Rochester, Naval Research Laboratory and NASA Goddard Space Flight Center cooperated on this project.

–A proton-measuring device including a variety of emulsion packages to provide more knowledge about the sharp changes in radioactive energy characteristics in the belts. The Los Alamos Scientific Laboratory designed this experiment.

–Ultraviolet-sensitive proton counters hoped to shed light on effects of solar radiation on the upper atmosphere. Wright Air Development Division, and Armour Research Foundation combined on this device.

–An experiment developed by WADD and Ohio State University to measure the reflection of radio and radar signals and the undesirable retuning of antennas caused by ionization.

...est we 'run out of gas' . . .

A Call for Intellectual Innovations

by Lt. Col Francis X. Kane, USAF*

AMERICA'S TECHNOLOGICAL rive to outrace Russia today is facing ıe danger of running low on gas.

The gas of technology—the fuel that ıakes possible the so-called techno-ɔgical breakthroughs of our era—is rawn from our civilization's pool of asic scientific knowledge.

It is the current rapid emptying of ıat pool which confronts us.

A space system which can function nattended and achieve performance of ıe reliability such as some scientists ave proposed deserves the description f "remarkable" and "ingenious." Simi-rly, the miniaturization of a computer ın appear as nothing short of fantastic.

Yet, almost without exception, such chievements are the products of past ıtellectual advances. They are not truly ınovations; they are extensions. Op-mism for the future founded on such ı approach is an empirical extrapola-on which may not be well founded. 'he achievements of the future will be-ome a reality only if there are signifi-ant intellectual innovations today.

Our terminology indicates that the elationship between intellectual ad-ances and technical progress is not ompletely understood.

For example, when the U.S.S.R. aunched its first *Sputnik* the achieve-ıent was decried by some as being a brute force" solution. Our satellites are eemed to be somehow superior be-ause the systems are more refined and maller. But our follow-on projects de-end directly on a "brute force" solution ı propulsion. Bigger payloads in orbit vill be possible by larger propulsion ackages, once again an extension of he past and not truly a "breakthrough," lthough the term will surely be used in escribing coming advances.

• **Leaping ahead**—The missing ele-ıent in our approach is the realization ıat the extensions we see today result rom intellectual "breakthroughs" of ıe past. Empirically, the course of the ıture depends on whether or not "quantum leaps" in ideas are occurring now and will continue to occur.

The question of time is a basic factor in military considerations. There is periodic re-examination of the time-span from drawing board to inventory, that is the elapsed time between the initiation of the development of a weapon and its eventual use by the operating forces. An even more basic consideration is the total time-span from conception of a new idea to its acceptance and from acceptance to application to a military problem.

Let us examine some historical experience in this field.

Einstein freely acknowledged his debt to several of his scientific predecessors. Maxwell announced his findings on electromagnetism in 1864. Mach first proposed his concepts of the limits of the classical laws of physics in 1883. Einstein published his first paper on the Theory of Special Relativity in 1905.

Thus the first phase of the process, the appearance of a radically new approach to physics, covered some 30 years. The potential of Einstein's theory was recognized almost immediately, but the debate on its validity lasted another 20 years. Bohr and de Broglie attest the importance of the debate at the Solvay Conference in 1927 in the process of acceptance. The intellectual stimulus which Einstein provided and the eventual application of the resulting new knowledge to military use followed by another 20 years, a total of some 70 years.

And even then, this application would not have occurred except for the circumstances of the war and probably not at all except for Einstein's direct appeal to President Roosevelt. The appeal carried weight mainly because of the stature of Einstein which followed from the acceptance of his ideas by the scientific community.

Another example is the modern computer. Boole's *Laws of Thought* appeared in 1854. The *Principia Mathematica* of Whitehead and Russell came some 60 years later (1910-1913). The marriage of mathematics and electronics occurred only after World War II, a period of another 30 years. The refinement of the basic application has taken another 10 years. So that in this instance, the total period covers a century.

• **Conception to drawing board**—Thus, to the military man, the significant time period is not from drawing board to inventory. This is a fraction of the total process even though we consider it a breakthrough if the interval is reduced from 8 to 5 years. The really significant time period is from the intellectual breakthrough to the drawing board.

Here we are talking in terms of possibly two generations of scientists or more. We are dealing with two processes, each of which spans the life of a group of scientists. One period covers the development and spread of a new concept; the other period covers the acceptance and initial application of the concept.

From another point of view, we could say that the scientists of today are restricting themselves too much to the process of deduction. They seek ways of applying general principles to specific problems. A great search is on in the intellectual residue of the past in order to achieve the technical breakthroughs of the present.

In part, this phenomenon results directly from the contemporary environment. The military man is pressing the scientist to conduct such a search because of the great danger to our national security and the seemingly insurmountable problems which come from meeting the threat. Under this stimulus the scientist is "pinned down," fixed on a given task of applying existing knowledge and proven ideas to specific problems. General problems, or lines of investigation which will come to fruition in the future as well as ideas which are radically new are of lower priority.

While we postulate a continuing and growing threat to our security, we are following a course of action which depends on intellectual achievements of the past. Our unformed assumption here is that a series of limited technical advances will give us a total of achievements sufficient for our security. Whereas, an intellectual breakthrough could lead to a major advance which would insure our technical lead.

The Air Force recognizes the vital role of basic research. This is well illustrated by the growth of the funding of our programs. We have identified the need for new knowledge in various areas, such as materials and propulsion. We are pressing chemists and other

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* *Lt. Col. Francis X. Kane is a spe-al assistant to the Air Force Deputy hief of Staff/Development. The opin-ns expressed in this article are his vn and do not necessarily represent e official thinking of the Air Force or epartment of Defense.*

we wait for state of the art . . .

scientists to create new ideas which will have an impact similar to those which revolutionized the science of physics. All these endeavors to break with an "archeological" approach to security are steps in the right direction.

In approaching this task there is one unknown which we will always face. It is impossible to forecast the nature and content of creative human action. Bergson once said that if such vision were possible, he would be busy producing such advances. But having identified the need and having indicated the areas which scientists should investigate, we can anticipate that innovations will occur.

Here we should keep clearly in mind that the breakthroughs we seek are of the type achieved in theoretical physics. Advances, such as the two examples already cited, resulted from a questioning attitude toward accepted "classical laws." They arose not from applying ideas of the past, but rather from departing from the past to make a new future.

In discussing archeology or innovation, we are dealing with technological strategies. It is generally recognized that there are two basic strategies for using technology to meet military needs.

Advances in weapon systems and capabilities may be tied to the "state of the art." Under this strategy the man in uniform waits for the scientist to produce and prove new theories and for the engineer to make them practical realities.

The advantage of this strategy is that "proven" systems or components may be introduced into the inventory at forecast times. It is thus a "low risk" approach. One of the main concerns for the military man is that technological surprise may occur. This strategy is valid as long as rates of advance are of the same order of magnitude and as long as potential enemies do not make specific applications which result in major increases in military capabilities.

• **Invention by timetable**—Under the other strategy the military man tries to determine the rate of advance by stating requirements for the scientist to meet. The major objection here is that the scientist must "invent on schedule." As we have seen, it has been impossible to forecast when specific advances will occur. Thus this strategy is a "high risk" approach which may lead to high levels of research and development spending and to disruption of future capabilities if systems or components do not materialize at forecast times. However, this approach can result in major advances in capabilities.

These two strategies need not be applied uniformly throughout a research and development program. They can be applied to parts of the program or to specific projects within the program. Also, the strategy for a specific project can be varied depending on the circumstances and the need.

This can be seen by comparing the Russian missile program with ours. The Soviets placed their emphasis on propulsion presumably because the state of their art in nuclear weaponry was more primitive. Thus their strategy was to stress requirements for propulsion. Our strategy was to wait for technology to give us a major advance in nuclear weaponry. When this advance was forecast to be in the offing, we started to place requirements on other components of missile systems, such as guidance and propulsion.

• **ANP frustration**—One of the most striking examples of varying strategies is the program to develop a nuclear powered aircraft. This is typical of the technological strategy of letting "state of the art" determine rate of advance. At times there have been attempts to find backing for military requirements so as to put more emphasis on the program. The outstanding attempts were the agitation for a supersonic airplane and the CAMAL concept —a nuclear-powered airborne missile launcher. Both of these came to nought and we are continuing to let technology determine the time when the first flight will occur and usable military systems will appear.

When we examine the basic approach to nuclear powered flight we see that it is a form of microminiaturization. We have spent 15 years and nearly a billion dollars in trying to reduce the Soldiers' Field atomic pile to jet engines proportions. Our effort has concentrated on refining reactor technology.

The military interest in nuclear powered flight comes from the attraction of great endurance. Freeing the aircraft from the limits imposed by the propulsion system would give us strategic and tactical possibilities which have long been sought. But after such a prolonged effort and faced with the prospects that a feasible system is still some years away, we may well ask if we are on the right technological path. Perhaps we have asked the scientists the wrong question.

• **Single approach**—The problem is to use nuclear energy for propulsion. This is not necessarily the same as developing a reactor for the propulsion system. The scientist could properly ask "what other technical approach possible?" At the present time th answer is "none." This is really th heart of the problem of nuclear pow ered flight. And, as long as we have a archeological viewpoint, the answer wi be the same.

We need an "intellectual breal through" in nuclear theory. It has no been some 20 years since the theorie of Bohr, Fermi, and others were prove to be a practical system for the cor trolled release of nuclear energy. O the basis of historical experience a ne theory should be forming in the scie tific community. The possibility of suc an occurrence should be enhanced b our concentrated effort in nuclear tecl nology. The emphasis which we hav put on this part of our scientific effo has given us a broad foundation c which a new synthesis may be built. Bu as already described, the time of th appearance and the content of such a advance depends on outstanding i dividuals in the right circumstances.

As we have seen, the appearanc of a new theory is far from the reali of meeting military needs. If it tak two generations of scientists to go fro theory to application, we will be in th next century before today's ideas w result in a nuclear powered aircra This span of time reflects historical e perience. It will be a fixed period f the future only if we do not learn fro the past.

• **Military urgency**—There a marked dissimilarities between the pa and present which result from th urgency of military needs. The A Force has a basic research progra measured by its funding (some $42 m lion a year and scheduled to double the next few years). These funds a concentrated on a search for new idea

Also, while we cannot anticipa specific creative ideas, there are tw areas in which we can assist "intelle tual breakthroughs." These are reco nition and acceptance. The time-sp of the two phases can be greatly r duced over previous experience. Cor munication of ideas, both through th forum and translation, is much mo rapid than in the past. Thus, concei ably, the problem of recognition c be simplified.

The same is true for acceptan which follows only after debate, evalu tion and verification.

In the field of military research a development, various practical measu have been proposed. They cent around the approach of "breadboa testing" of new concepts as they a recognized. This approach would me an expanded and thus more costly a plied research program. Hardware wou

(continued on page 49)

Orbits through space

The space-flight paths diagrammed above represent a closed elliptical orbit, a parabolic orbit, and, on the outside, an open, hyperbolic orbit characteristic of the start of an interplanetary flight.

Orbital flight mechanics is one of the many areas of advanced investigation at Boeing. The staff of the Boeing Scientific Research Laboratories, for example, carries out basic research in such fields as energy conversion, hypersonics, magneto-hydrodynamics and plasma physics.

Other Boeing scientists and engineers are working toward the advancement of supersonic flight, propulsion systems, gas turbine engines, commercial and military aircraft, vertical and short take-off and landing aircraft.

Professional-Level Openings

The wide scope of Boeing programs in all areas of manned and unmanned flight, from theoretical research to advanced precision fabrication, offers careers of unusual interest to professional specialists in engineering and scientific fields, as well as in other-than-engineering areas. Drop a note, mentioning degrees and major, to Mr. John C. Sanders, Boeing Airplane Company, P. O. Box 3822 - MIJ, Seattle 24, Washington.

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Cover Story

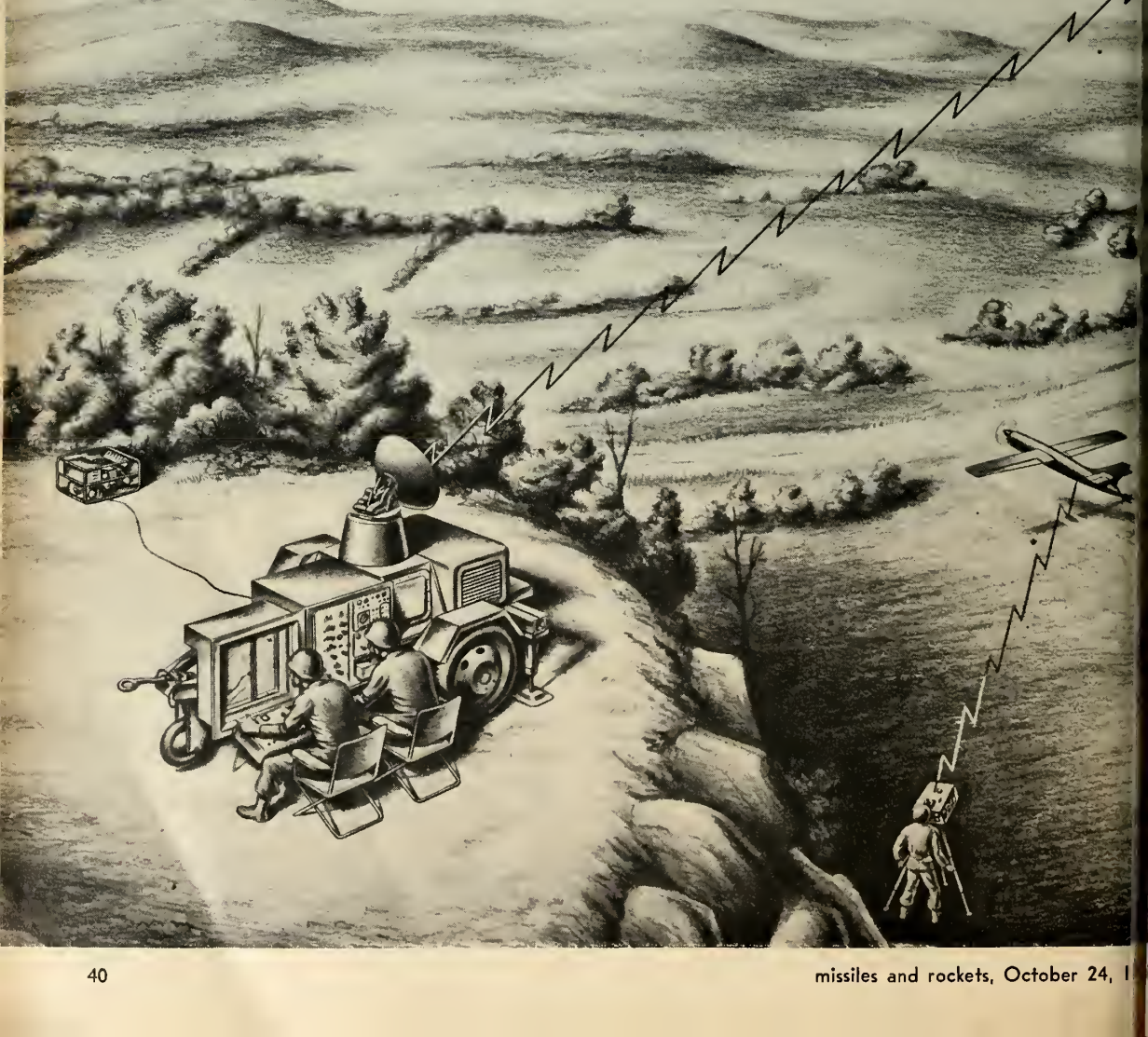
Army Proves Out Its Drone Control System

Rugged system developed by Ford Instrument rides herd on surveillance craft from launch to recovery

FT. HUACHUCA, ARIZ.—Fi
tests of a new battlefield remote c
trol system for surveillance drones h
just been successfully completed by
Army at its Electronic Proving Grou
here. Helicopter flight tests were flo
from nearby Cochise County Airp
at Willcox.

The system uses trailer-moun
radar and computing equipment
guide reconnaissance drones carry
cameras, radar, infrared sensors,
other devices to gather intelligence o
enemy or friendly territory.

Officially named Surveillance A
craft Flight Control System AN/UP
1, the equipment was developed
the Army Signal Corps by Ford
strument Division of Sperry R



ɔrp. The complete system consists of dar, computer, plotting board and rtable power supply units mounted a trailer, and two auxiliary units—portable controller and an optical ıcker.

Designed for battlefield use, the ghly mobile system is rugged and htweight. It can be set up and put to operation in a very short time. Two en operate the equipment.

• **All-the-way control**—The AN/PW-1 controls a drone flight from unch to recovery. The flight path of e drone is automatically traced on a otting board map on the trailer. As e drone takes reconnaissance pictures -by photography, radar, or infrared—its location at the time of exposure is automatically marked on the plotting map. Observations are thus related back to its precise location.

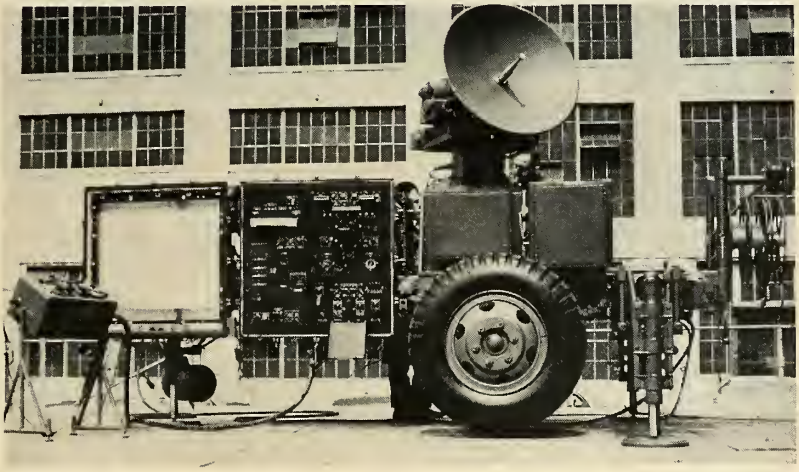
An internal telemetering link allows the control crew to monitor actions and events in the drone.

When its mission is completed, the drone is guided back to a predetermined recovery area, its engine stopped, and parachute released.

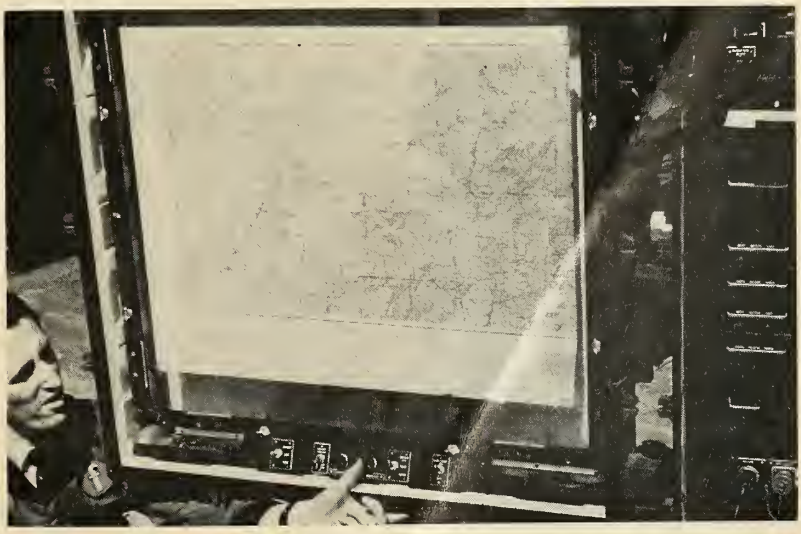
A portable "manpack" controller is included in the system to supplement the trailer unit. In cases where the trailer must be located away from the launch site, the portable controller can launch and visually control the drone until it can be taken over by the trailer radar. This portable unit can also be located at a forward post to take over operation of the drone for close visual control over surveillance targets.

An optical tracker, connected to the radar unit, is used as an aid in acquiring a drone returning to radar control. After visual acquisition, servo signals from the optical unit orient the radar which then takes over control.

Project officer for the flight tests was Mr. Otto F. Dworsky of the Ground Radar Division of the Combat Surveillance and Avionics Department, Fort Huachuca. Project engineer was Captain Augustus O'Brien of the Signal Corps Research and Development Laboratories, Fort Monmouth, N.J. A team of 28 military and civilian technicians took part in the Army tests. ⁂



ARMY'S AN/UPW-1 CONTROL system tracks surveillance drones by radar and remotely controls their flight over battlefield targets. Flight path is automatically plotted on map along with position data to mark observation locations. All primary units—radar, computer, control console, and plotting board—are trailer-mounted. Portable remote controller and optical tracker are also part of system.



Magnetic Film Thickness Gages

Mikrotest Dry Film Thickness Gages are available in two ranges—one for lacquers, enamels, etc. having a range of 0 to 20 mils, while the other model is for measuring platings, galvanizing, etc. This has a range from 0 to 2 mils. Both are available from the Nordson Co.

The two gages will measure a thickness of any non-magnetic coating on a magnetic (iron, steel, etc.) base. Maximum error is 10% + 0.0004.

Both of these instruments are extremely easy to use and both respond with a click that can be both heard and felt when the correct measurement is made.

An important feature of these gages is the fact that human differences in touch do not affect the readings. In other words, a number of workers can test the same coating and get the same result at a given spot.

Circle No. 225 on Subscriber Service Card.

Largest Voltage Divider

The largest precision resistor voltage divider built to date is manufactured at Resistance Products Co. The network was built on special order as a precision 30 megohm, 100 to 1 divider to operate at 30,000 volts with 0.05 accuracy. Independent tests established that ratio division was maintained within 0.01%.

Circle No. 226 on Subscriber Service Card.

Cryogenic Liquid Sampler

A device for obtaining accurate samples of cryogenic liquids is now available from Air Products, Inc. The batch sampler, which meets Air Force specifications MIL-P-25508B, will sample and prepare for analysis any low-boiling-point liquid.

Circle No. 227 on Subscriber Service Card.

Miniature RLC Filter

To the standard line of high performance broad band RF filters, DEVCO, Inc. has added another L-Cap. The characteristics of this unit exceed those of the standard L-Cap line which in themselves are unique in the electronic field. The L-Cap, significantly increases the low frequency attenuation characteristics of the basic L-Cap design while maintaining the inherent advantages of small size, light weight and unmatched high frequency attenuation. DEVCO laboratory tests have show better than 40 DB attenuation at 15 KC, rising to over 85 DB at one mega cycle. Insertion loss remains above 8 DB up to more than 1000 megacycle

Circle No. 228 on Subscriber Service Card.

E-M Radiation Meter

An advanced lightweight self-cor tained instrument for making accurat power density measurements of rada and transmitting equipment is bein manufactured by Sperry Microwav Electronics Co., Division of Sperry Rand.

In operation, a technician can rea power density directly on one of fou scales, from 0 to 20 mw/cm² over frequency range from 400 to 300 megacycles. An antenna and bolomete bridge are used only on the 0-20 m

range, while a second antenna, cryst detector and amplifier assembly ar used on the three more sensitive range (0-.02 mw/cm², 0-.2 mw/cm², 0- mw/cm²). Designed for simplicity c operation, an adjustable control pro vides a red visual alarm light when th power density of any desired level reached.

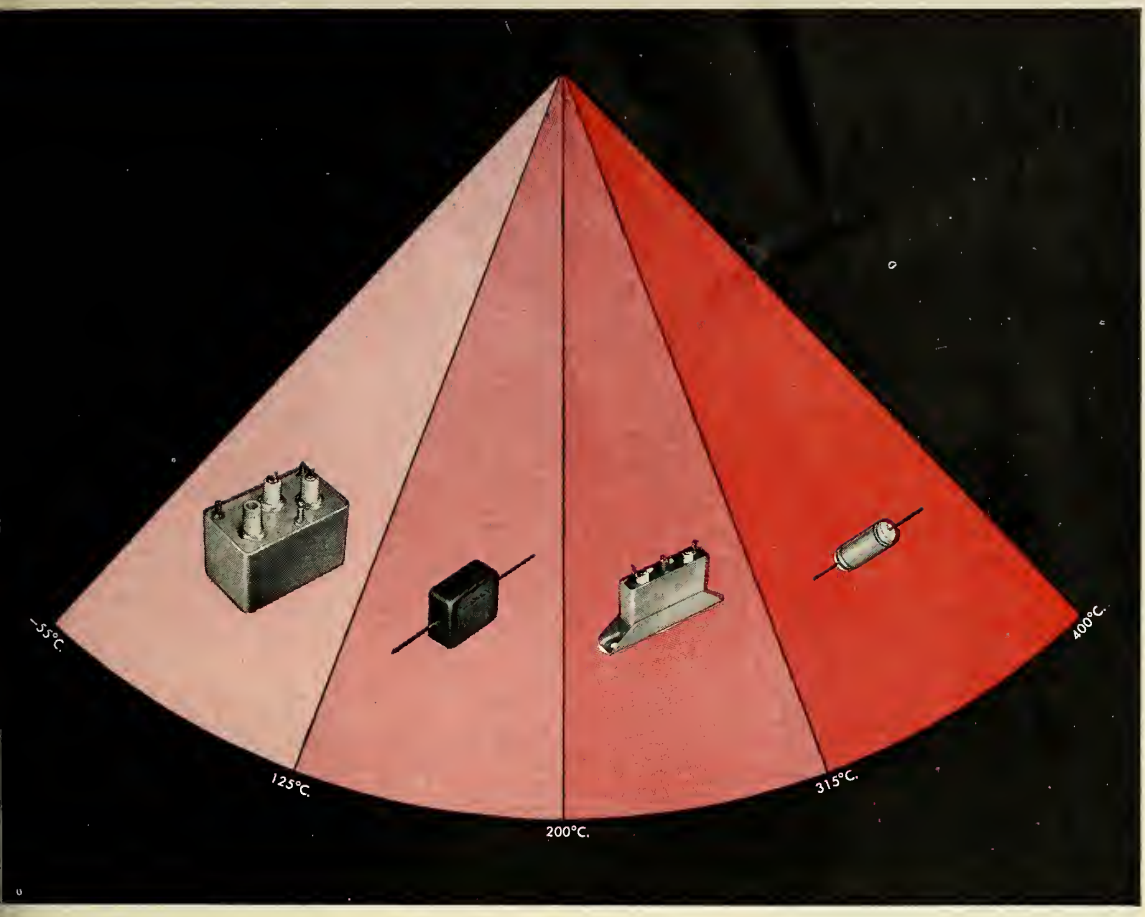
Circle No. 229 on Subscriber Service Card.

Wide Range Test Chamber

A temperature test chamber fo −300° to 1000°F is available from Mi simers Inc.

Designed to be used with a vibra tion exciter in combined environment testing, this self contained chamber equipped with casters for portabilit and is adjustable in height to accomm date various sizes and types of vibratio shakers.

High temperature operation of th combination chamber is accomplishe by electrical heating with temperatur



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Under 125°C.—Specials
Size and weight reductions at high voltages • Drift—.25% capacitance change typical from −55°C. to +125°C. • High I. R.—1500 megohm X microfarads typical at 25°C. • Solid impregnants—no liquid leakage.

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.001 to 6.0 mfd., 200 V to 3 KV, specials to 10 KV. • Molded and metal housed; tubular and rectangular • Size and weight reduction—over plastic film and stacked mica types, particularly at high voltages • Drift—1% capacitance change typical from −55°C. to +200°C. • High I. R.—50 megohm X microfarads typical at 200°C. • Proved in 4 years' usage.

200°C. to 315°C.—In production
• .05 to 4.0 uf, 600 V and up • Drift—3% capacitance change typical from −55°C. to +315°C. • High I. R.—10 megohm X microfarads typical at 315°C. • Nothing smaller at 315°C.

315°C. to 400°C.—In development
• .001 to 6.0 uf, 150 V and 600 V • Drift—5% capacitance change typical from −55°C. to +426°C. • High I. R.—1 megohm X microfarad typical at 400°C. • Prototype availability • Only inorganic materials used.

For full details, write:

Scintilla Division
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THE Bendix CORPORATION

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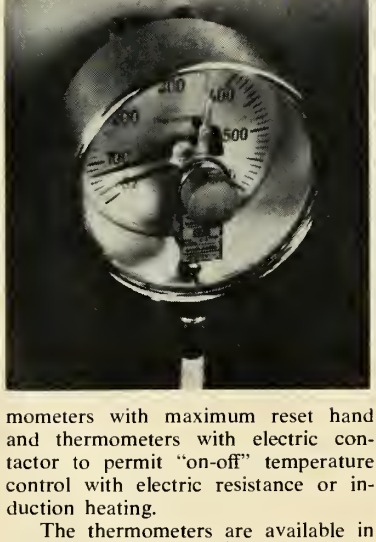
from ambient to +1000°F in 45 min. Expendable refrigerants provide the cooling, with CO^2 used for economy where moderate low temperatures are desired (ambient to −100°F) in approximately 20 to 30 min. For lower temperatures, liquid nitrogen is used for −90° to −300°F in 20 min.

Circle No. 230 on Subscriber Service Card.

Dial Thermometer

A line of new magnetically attaching bi-metal dial thermometers is being manufactured by Industrial Service Co. for temperature measurement on ferrous materials.

The three styles of thermometers available are thermometers for temperature measurement only, ther-



mometers with maximum reset hand and thermometers with electric contactor to permit "on-off" temperature control with electric resistance or induction heating.

The thermometers are available in various temperature ranges from −60°F to 700°F and have accuracies of better than 2%. They are held to steel and other ferrous materials by permanent A1 Ni Co magnets.

Circle No. 231 on Subscriber Service Card.

DC Milliwatt Motor

A miniature DC motor, requiring as little as 0.3-v starting voltage and capable of operation from a solar source or use as a DC integrator, has been developed by Giannini Controls Corp. This milliwatt motor will operate on DC current for an appreciable time in a vacuum over a wide ambient temperature range and will withstand 50-g shock and 20-g random noise vibration.

Friction level is held very low by use of a small commutator, approximately 0.075 inch in diameter, and by use of cone pivot ball bearings. Gear reduction (5:1) is built as an integral part of the armature to reduce the friction level and to be compatible with cone-type ball bearings.

Circle No. 232 on Subscriber Service Card.

Self Activating Stripper

Epoxy and polyester resins can now be removed from potted components 10 times faster without damage to parts or materials with a new self-activating stripper, Tele-Solv, developed by Electronic Components Division, Telecomputing Corp.

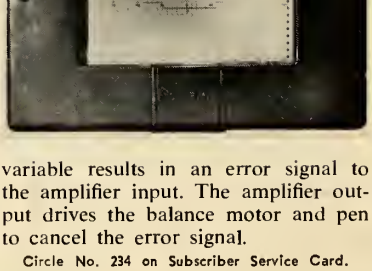
Tele-Solv will not corrode, discolor or otherwise affect copper, aluminum, ferrous metals or resin-based enamels. A controlled stripping agent, the Tele-Solv process can be stopped at any time for removal of small parts when complete de-potting not required.

Circle No. 233 on Subscriber Service Card.

Strip Chart Recorder

Two strip chart recorders for use in indicating, recording or controlling dimensional variables, are available from Schaevitz Engineering.

The recorders, designated Models MR1SL and MR2SL to differentiate the single pen from the two pen units, feature the continuous null balance principle as their method of measurement. The accurate null balance system compares the output of an external linear variable differential transformer (LVDT) with a signal derived from an internal LVDT. The position of the balance system is indicated by the pen on the chart. A change in the measured



variable results in an error signal to the amplifier input. The amplifier output drives the balance motor and pen to cancel the error signal.

Circle No. 234 on Subscriber Service Card.

Transistorized Gaussmeter

A direct-reading, completely transistorized gaussmeter, combining the convenience of portability with high

sensitivity, has been designed, developed and tested by F. W. Bell, Inc.

The instrument measures directi and magnitude of magnetic flux densi and reads from one gauss, full sca to 30,000 gauss, full scale, in 10 rang A principle innovation in the Mo (No. 110) is the Zero Center Met which indicates immediately the dire tion being read and does away with a necessity for a reversing switch.

Circle No. 235 on Subscriber Service Card.

Target Missile Checkout

R S Electronics Corp. has design and produced several preflight che out systems for use with the RP- Rocket Powered Target Missile. T System tests the performance of t missile tracking, guidance, radio a safety equipment. An important s tem feature includes automatic a fail-safe operation. Operation of electronic and electrical subsystems c be verified.

Circle No. 236 on Subscriber Service Card.

Heated Flexible Laminate

Flexible, thin, reinforced plas laminates with embedded electric hea elements are available from Riversi Plastics Division of the Bischoff Che ical Corp.

The laminates can be designed various watt densities with maximu surface temperatures in the 400° 500°F range. Sheets only 0.021 thick resist electrical breakdown saline immersion under 250 volts.

Circle No. 237 on Subscriber Service Card.

our-Way Air Valve

A 4-way, ¼ in. 5-ported pilot-operated air valve has been developed by lkon Products Corp. for a wide variy of bleeder operations. It is capable over 1000 cycles per minute and has life expectancy exceeding 50,000,000 cles.

Small bleeder operators which feare a hardened ball nose plunger can e mounted anywhere, thus saving pipg and wiring costs. Operators can e mounted so they will be tripped by e moving parts of machinery. They n also be used as a 2-way normally osed valve in other circuitry requireents.

Circle No. 238 on Subscriber Service Card.

djustable Sequence Timer

Acton Laboratories Inc., a subdiary of Technology Instrument Corp., marketing a new miniature adjustable quence timer Model 4-23—a 3 in.-ide lightweight timer featuring micro djustable cams that can be easily and uickly set within 0.1% of the total riod.

The unit surpasses specification IL-E-5272C for vibration, shock and celeration. Its accuracy exceeds 3%. e adjustable time span is 1 second to minutes.

Circle No. 239 on Subscriber Service Card.

uorocarbon Fluid Seals

Fargo Rubber Corp. has developed elastomeric compound with capaities for seals, O-rings, and packings precision instruments and systems ntaining fluorocarbon fluids and lucants, and helium gas.

Accelerated service tests involving ultaneous interexposure of the new mpound, FR 6-60-13, fluoroester ohol, fluorocarbon oils, and copper ulted in no discoloration of the fluid, d no corrosion of the metal.

Circle No. 240 on Subscriber Service Card.

ur Electrode Switch

The Burroughs Corp. announces the roduction of a multiposition elecnic switching device with a fourctrode structure per position. The rth electrode, called the shield grid, been incorporated in the BEAM-X itch, Type BX-1000. The shield grid kes possible three new functional racteristics—a "straight-line" or stant switching input requirement ffected by output level, target opion over a wide range of output ages never before possible; and the ration of devices having non-linear ing characteristics.

Circle No. 241 on Subscriber Service Card.

new literature

MOUNTING SENSING ELEMENTS—A bulletin describing methods of mounting temperature and strain measuring elements by means of ROKIDE ceramic spray coatings is available from Norton Co. This technique is being used to mount such elements in areas subject to high temperatures, such as rocket nozzles, gas turbines, and nose cones, particularly in testing operations.

Circle No. 200 on Subscriber Service Card.

TANTALUM SLUG CAPACITORS—The line of tantalum slug wet electrolytic capacitors is covered in an Ohmite Manufacturing Co. release, Bulletin 159E. With two new case sizes added, Ohmite is now supplying all three case sizes called for by military specification MIL-C-3965B, for Styles CL44 uninsulated, CL45 insulated. The bulletin lists as stock all the MIL capacitance and voltage values called for in these sizes.

Circle No. 201 on Subscriber Service Card.

SPACE ANTHOLOGY—A compilation of five technical articles, four of which deal with the application of Doppler principles to space navigation, is available from GPL Division of General Precision, Inc. The fifth explores the possibilities of untraviolet's having space signal value.

Circle No. 202 on Subscriber Service Card.

AUTOMATIC MEMORY CORE HANDLER—Technical Bulletin 60-A from Rese Engineering Inc. describes Model CH-58 Automatic Memory Core Handler, a fully automatic, production type, memory core feeder which grades and sorts standard 80 mil or 50 mil miniature ferrite cores at continuous operating speeds of over 16,000 cores per hour. The two-page illustrated bulletin fully describes the machine's electro-mechanical operation for both semiautomatic laboratory analysis and full-scale production testing.

Circle No. 203 on Subscriber Service Card.

CAPACITOR CATALOG—A Manufacturers' Capacitor Catalog has been published by Centralab, The Electronics Division of Globe-Union, Inc. The 20-page book covers the complete line of Centralab general-purpose disc and tubular ceramic capacitors. Included are detailed specifications on temperature-compensating, temperature-stable and semi-stable, bypass, high- and low-voltage types as well as Tube-R-Cap resistor-capacitor combinations.

Circle No. 204 on Subscriber Service Card.

RADIO INTERFERENCE CONTROL—A technical paper recently presented by Fred J. Nichols, President of Genistron, Inc. at the Fourth Conference on Radio Interference Reduction and Electromagnetic Compatability sponsored by the Armour Research Foundation of Chicago, Illinois has been printed into a 32-page booklet. The paper discusses in detail the radio interference spectrum and associated problems encountered with the use of diodes. Included are copies of actual test results.

Circle No. 205 on Subscriber Service Card.

missiles and rockets

2nd ANNUAL MISSILE/SPACE MATERIALS ISSUE

- *What problems missile makers face in coping with temperatures from—459°F to 15000°F.*
- *What materials missile suppliers have available to meet missile/space requirements.*
- *Encyclopedia of materials now used in major missile and space projects.*
- *Missile/space materials requirements of government and military agencies.*

Advancement in materials remains one of the most critical problems facing today's missile/space industry. Material used in the structures of missile and space vehicles face unprecedented temperature extremes. Temperatures may rise as high as 15000°F in rocket nozzles. And they fall as low as −434°F in liquid hydrogen fuel tanks and outer space.

The problems of high and low temperatures will be explored in depth in Missiles and Rockets 2nd Annual Missile/Space Materials issue. In a series of articles, *materials specialists* for prime missile and space vehicle contractors will outline their requirements in high and low temperature areas. To round out the picture, M/R Editors will also detail the materials needs of government agencies. In a second major section, *missile suppliers* will discuss developments in space age materials and their performance at high and low temperature extremes.

A new Missile/Space Materials Encyclopedia will provide an extensive review of the materials currently being used in major missile and space projects. Compiled in easy-to-use form, this encyclopedia will bring together information not available from any other single source.

If you have a materials or capability story this special editorial issue is doubly important to you. First, it enables you to capitalize on the major attention which it will focus on the critical area of missile/space materials. Second, you reap the benefits of repeat readership and long reference life which result from this once-a-year undertaking.

Plan now to take advantage of the intense interest which this issue will generate among technical management and engineering readers in every phase of the missile/space market. For additional information, contact the **MISSILES AND ROCKETS** regional advertising manager in your area.

Published November 28, 1960

Closes November 7, 1960

contracts

AIR FORCE

Aerojet-General Corp., Azusa, Calif., for *Ablestar* second-stage boosters to be used in future launchings of *Transit* and *Courier* satellites.

Texas Instruments, Inc., Dallas, for work on Project *VELA*, a program for developing methods of detecting and identifying nuclear explosions.

$4,400,000—Avco Corp.'s Lycoming Div., Stratford, Conn., for production of additional missile rocket chambers. Subcontract from Aerojet-General Corp.

$1,000,000—The Martin Co., Baltimore, for repair and modification of AN/DJW-4 inertial guidance systems and components and related ground support equipment for the *Mace*.

$940,000—General Electric Co., Schenectady, for electron tubes.

$466,720—RCA Service Co., Camden, N.J., for architectural engineering services and engineering studies for final design of aerospace systems environmental Chamber Mark I.

$79,075—Radio Corp. of America, for electron tubes.

$74,951—The Emerson Electric Manufacturing Co., St. Louis, for inspection, test and repair of major components and subassemblies of the MD-7 fire control system.

$50,000—Crosby-Teletronics Corp., for *Atlas* missile guidance system test equipment. Subcontract from The Arma Div. of American Bosch Arma Corp.

$47,124—Sylvania Electric Products, Inc., Salem, Mass., for electron tubes.

NAVY

Rand-Air, Inc., Chicago, for electronics engineering services in the field of electro-mechanical and electrical equipment used with radar and fire control systems.

Packard Bell Electronics Corp., Los Angeles, for producing a key portion of *Transit*, a satellite-controlled navigation system. Subcontract from Applied Physics Laboratory of Johns Hopkins University.

$200,000—Gladding, McBean & Co., Los Angeles, for further production of ceramic radomes for the *Sparrow III*. Subcontract from Raytheon Co.

ARMY

$30,000,000—Douglas Aircraft Co., Santa Monica, for research and development of the *Nike-Zeus*. Subcontract from Western Electric Co.

$2,000,000—Telecomputing Corp., Los Angeles, for guidance and control gyros to be used in the *Nike-Hercules*. Subcontract from Western Electric Co., Winston-Salem.

$1,374,317—The W. L. Maxson Corp., New York City, for further work on components for the *Hawk* missile.

$1,359,000—Aerojet-General Corp., Azusa, Calif., for rocket motors for the *Hawk* missile.

$799,990—Sperry Rand Corp., Salt Lake City, for research and development on the *Sergeant* missile system.

$642,170—Raytheon Co., Waltham, Mass., for concurrent repair parts for the *Hawk* missile system.

$79,460—Douglas Aircraft Co., Inc., Santa Monica, for *Nike* repair parts.

$54,752—Sperry Rand Corp., Salt Lake City, for *Sergeant* missile ground handling equipment.

$47,331—Harvey Aluminum Inc., Torrance, Calif., for production engineering study.

NASA

$1,087,692—Hayes Construction Div., Inc., a subsidiary of Hayes Aircraft Corp., Birmingham, Ala., for installation of fueling and launching equipment at the *Saturn* launch facility, Cape Canaveral.

$107,914—Brown Engineering Co., Inc., Huntsville, Ala., for ground equipment test set, engineering, fabrication and related services.

$15,994—Linde Co., Birmingham, Ala., for liquid oxygen and liquid nitrogen.

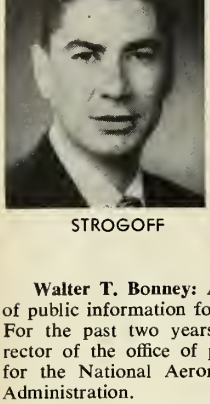
MISCELLANEOUS

Corkey-Moore Associates, Torrance, Calif., for production of transponder test units. Contract from Convair Astronautics Div., General Dynamics Corp.

$105,200—The Electrada Corp., Beverly Hills, Calif., for titanium pressure vessels for missiles. Subcontract from Lockheed's Missile and Space Div., and Convair's Astronautics Div.

$50,000—Houston Fearless Corp.'s Marchetti Div., Natick, Mass., for design and manufacturing of communications subsystem for the Atlantic Missile Range.

names in the news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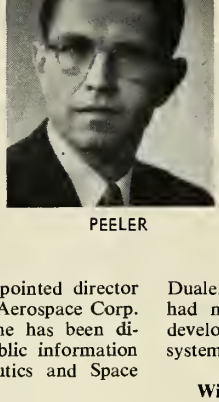
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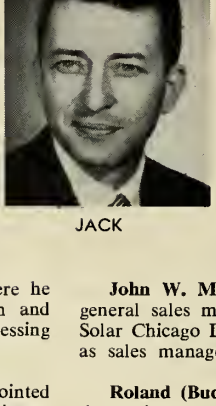
JACK


OGLETREE

Walter T. Bonney: Appointed director of public information for Aerospace Corp. For the past two years he has been director of the office of public information for the National Aeronautics and Space Administration.

Donald Lincoln Herr: Former president of Mark Instrument Co. joins the engineering staff of Belock Instrument Corp. as a specialist in design and development of miniaturized computer and control components.

Stephen Jack: Former missile and space systems sales engineer for United Aircraft Corp. joins the Northrop Corp.'s Norair Division as chief of astronuatics marketing.

William F. Kyle and **John A. Williams Jr.:** Join the Data Storage Dept., Information Technology Div. of Lockheed Electronics Co. Both were formerly associated with the Ampex Corp.

Dr. William J. Jacobi: Appointed vice president of Litton Systems, Inc., and general manager of the Guidance and Control Systems Division. He has been with Litton Industries since 1958 as director of advanced systems engineering for the Electronic Equipments Div.

Brig. Gen. Lester W. Light (USAF-ret.): Appointed director of Government Relations for Transval Electronics Corp.

Mike Cannon: Named director of public relations and advertising for General Precision, Inc.'s Librascope Div., succeeding **Ken Slee.** Was formerly advertising manager for the division.

L. Peter Retzinger: Appointed director of the Computer Systems Laboratory of the Guidance and Control Systems Div. of Litton Systems, Inc. **Francis Dedona** is now assistant director of the laboratory.

Alfred Strogoff: Former vice president of marketing elected vice president and general manager of Adler Electronics, Inc.

Sergio A. Alessio: Named senior staff engineer, Staff Research and Engineering, Amphenol-Borg Electronics Corp. Was formerly associated with Bell and Gossett Dualex Div. and Panellit, Inc., where he had major responsibility for design and development of digital data processing systems and components.

William G. McLoughlin: Appointed chief of research at Del Mar Engineering Laboratories. Was formerly chief of research for The Hayes Corp.

George D. M. Peeler: Named Senior laboratory director of the Aero Geo Astro Corp. Was manager of the Microwave Development Dept. Missile Systems Div. of the Raytheon Co. where his work centered around the *Sparrow III, Hawk, Nike Zeus, Polaris* and other weapons systems.

W. A. Ogletree: Former manager of engineering for the Military Electronic Computer Div. of Burroughs Corp., joins Computer Systems, Inc. as general manager.

Walter S. Attridge, Jr.: Former associate head of The Mitre Corp.'s Weapons Control and Sensor Systems named head of the department.

Dr. Gilford G. Quarles: Chief scientific adviser of the U.S. Army Corps of Engineers appointed to the new post of director for long-range military planning for The Bendix Corp.

Roland P. Andelson: Named assistant manager in charge of Hughes Aircraft Co.'s ground systems group activities in Washington, D.C. succeeding **James E. McHenry** now assigned to the Fullerton facility as manager of the industrial sales department.

Tore N. Anderson: Executive vice president moves up as president of FXR, Inc. succeeding **Henry Feldmann,** who moves into the newly created post of board chairman.

A. N. Brown: Former vice president-sales for Bach-Auricon, Inc. joins Magnasync Corp. as marketing manager of the firm's Nomad Division.

Brig. Gen. Don Flickinger: Assigned staff supervisor for the Air Research and Development Command's bioastronautics research program. He also serves as assistant for Bioastronautics to **Lt. Gen. B. A. Schriever.**

John W. Maybaum: Former assista general sales manager of U.S. Industrie Solar Chicago Div., joins Vacudyne Cor as sales manager.

Roland (Bud) Carlson: Former execu tive assistant to the Army's Chief of R search and Development joins The Ma tin Co.'s corporate staff at Baltimore.

Melvin B. Zisfein: Appointed manage of Giannini Controls Corp.'s newl formed Astromechanics Research Div sion. Was formerly chief of Aeroelastic ity at Bell Aircraft Corp.

Richard C. Hensbaw and **Stephen W Carter:** Named vice president-operation and vice president industrial relations, re spectively, at Lord Manufacturing Co.

Frank C. Bumb, Jr.: Appointed vic president-engineering for American Con certone, Inc., a Division of the Astro Science Corp.

Michael A. Auro: Joins the market ing staff of Kay-Fries Chemicals, Inc Was formerly associated with Dow Chemi cal Co.

James A. Ross: Former engineerin department manager promoted to equip ment division manager.

George Dunn, Jr.: Named senior de velopment engineer for Silicon Transisto Corp. Was formerly an engineer wit RCA's Advanced Development Group.

Norman Altman: Field sales manage for Magnetics, Inc. joins Norbatrol Elec tronics Corp. as director of marketing, a newly created post.

Herbert K. Weiss: Elected manager o Military Systems Planning for the Tech nical Staff at Ford Motor Co.'s Aero nutronic Div. **Morgan M. Blair** succeed him as manager of Advanced System Development.

Eugene J. Ziurys: Former engineer fo advanced design in General Electric Co.' Aircraft Nuclear Propulsion Laboratory joins Thompson Ramo Wooldridge Inc. as a consulting engineer in Preliminary Design department of Tapco Groups' New Devices Laboratories.

Innovations . . .

(Continued from page 38)

be bent and models constructed to test the feasibility of ideas.

The attractive features of this approach are that it would provide a systematic way of testing new ideas and that the testing would occur when the costs are lowest in the development cycle. Some variation of this approach must surely lie in the future of military research and development. Costs notwithstanding, urgency and complexity demand a reduction in the time necessary for the acceptance of new theories. Such a reduction will result if our approach is changed from archeology to exploration, from applying the principles of the past to proposing theories for the future.

The rate of technological advance, the "explosion," bears a marked similarity to the rate of population growth. However, the discoveries which gave impetus and direction to this growth still are the consequence of the appearance of men of genius. Their appearance on the scene of history cannot be forecast. Past experience would indicate that the individuals who give direction to science appear only once in each century. If this is so, this century has already seen its most significant advance. We must mark time until history gives us our next genius.

This is a theory which is based on the assumption that history occurs and is not made. If we base our analysis of the future on the assumption that history is the record of human action, i.e., purposeful action toward selected goals, we can hope to stimulate the appearance of genius and thus look for major advances in technology. An effort to break with this theory lies beyond the military sphere. It can come only from our society at large.

In a century characterized by and dependent on innovation, it is a remarkable fact that a systematic effort has not been made to study and stimulate innovation.

The importance of cultivating this talent is seen in the fact that, regardless of which strategy the military man follows in research and development, the key to future weapons is the strategy followed by the scientist. The scientist warns the military man to avoid "product improvement programs"—they produce only incremental advances for large investments. The military man should also be aware of the difficulties of "idea refinement programs."

Intellectual innovations are as important as weapons system innovations. Awareness of this fact, together with measures which make realities of ideas, is essential to future technological strategies. ⌗

when and where

OCTOBER

ASME-American Society of Mining, Metallurgical and Petroleum Engineers, Fuels Conference, Daniel Boone Hotel, Charleston, W.Va., Oct. 24-25.

Medical and Biological Aspects of the Energies of Space Symposium, sponsored by USAF Aerospace Medical Center (ATC), Granada Hotel, San Antonio, Tex., Oct. 24-26.

Seventh Annual East Coast Conference, Aeronautical and Navigational Electronics, Lord Baltimore Hotel, Baltimore, Oct. 24-26.

Government Contracting Course, National Defense Education Institute, sponsored by NSIA and Harbridge House, Inc., Detroit, Oct. 24-Nov. 4.

Eleventh National Conference on Standards, Sheraton-Atlantic Hotel, New York City, Oct. 25-27.

1960 Computer Applications Symposium, Armour Research Foundation of Illinois Institute of Technology, Morrison Hotel, Chicago, Oct. 26-27.

1960 Computer Applications Symposium, sponsored by Armour Research Foundation, Morrison Hotel, Chicago, Oct. 26-27.

AIEE-IRE Conf. on Non-Linear Magnetics and Magnetic Amplifiers, Bellevue-Stratford Hotel, Phila., Oct. 26-28.

IRE Professional Group on Electron Devices Meeting, Shoreham Hotel, Washington, D. C., Oct. 27-28.

IRE, 13th Annual Conference on Electrical Techniques in Medicine and Biology, Sheraton-Park Hotel, Washington, D.C., Oct. 31-Nov. 2.

1960 Fall Radio Meeting, sponsored by Electronics Industries Association, Engineering Dept. and IRE Professional Groups, Hotel Syracuse, Syracuse, Oct. 31-Nov. 2.

NOVEMBER

Conference on Electrostatic Propulsion, ARS and U.S. Naval Postgraduate School, Monterey, Calif., Nov. 3-4.

Government Contracting Course, NDEI, sponsored by NSIA and Harbridge House, Inc., Dayton, Nov. 7-18.

First National Die Casting Exposition and Congress, Society of Die Casting Engineers, Detroit Artillery Armory, Detroit, Nov. 8-11.

National Convention, National Aeronautics Association, Indio, Calif., Nov. 14-16.

Sixth Annual Conference on Magnetism and Magnetic Materials, sponsored by: AIEE, American Institute of Physics, ONR, Institute of Radio Engineers, American Institute of Mechanical Engineers, New Yorker Hotel, New York City, Nov. 14-17.

IRE Mid-American Electronic Convention, (MAECON), Hotel Muehlebach, Kansas City Mo., Nov. 14-16.

IRE 4th Annual Conference, Professional Group on Production Techniques, Sheraton Plaza Hotel and Commonwealth Armory, Boston, Nov. 15-16.

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editorial . . .

The FCC Gives Away a Public Heritage

THE RECENT ACTION of the Federal Communications Commission in throwing open the microwave spectrum above 890 megacycles for private, point-to-point communications reveals an incredible lack of vision and a remarkable lack of concern for conserving a valuable natural resource.

This communications area, which normally carries from 890 megacycles to 10,000 as a matter of power practicability, is the last remaining uncrowded region for space communications.

Upon its proper allocation and utilization depends our global ground-to-ground communication by satellite, as well as our future communication with space vehicles and celestial bodies—or between any of these.

In a report prepared for the Senate Space Committee, Edward Wenk, Jr., senior specialist in science and technology of the Legislative Reference Service, writes:

"Within only a few years, literally hundreds of space vehicles will most certainly be launched, each with its peculiar demand for radio communication.

"With the apparently unlimited breadth of the radio frequency spectrum, it would appear at first glance that an exceedingly large number of transmitters could operate side by side in the spectrum without interference. The facts, however, indicate that this is by no means so.

"In the first instance, much of the band is already allocated to other uses and the practical problems of massive allocation render this course of action unacceptable.

"Next, not all of the remaining unsaturated frequencies are suitable for space communication. That is, by virtue of the low power and small size of antenna, of the propagation characteristics of the upper atmosphere and other technical factors, only certain of the frequencies can be effectively utilized for space."

By its October 5 decision, the FCC denied the pleas of scientists and of the large U.S. "common carriers" of communication that a portion of this 890-10,000 mc area be set aside for future public use.

Instead, it threw open the entire area for private, point-to-point communication.

In refusing to reserve any portion of the spectrum, the commission voted six to one that space communication would not become necessary "for 20, 30 or 40 years." The commission also felt that the scientists and common carriers were asking for too great an area reservation.

So the commission decided to give the entire spectrum away.

AT FIRST GLANCE this action might seem to be a decision against big business and in favor of the little man who wants a private communication system for perhaps 200 miles.

Actually, the decision is against Joe Doakes, the ordinary citizen who uses the telephone, sends telegrams and cables, listens to the radio and watches television. All of these services can be provided worldwide via satellite—and they are not 20, 30 or 40 years off. They are feasible and likely within the next two to five years, through international cooperation—if the necessary communications bands are left free.

The shortsightedness of the FCC lies not in giving radio space to the point-to-point users. It lies in giving it *all* to them. Certainly it makes sense to reserve enough of the spectrum for public and scientific use—whether for television of the Olympic games in Japan in 1964, or for communications with a space ship at about the same time.

Clarke Newlon

The first version of *Saturn* will be 185 feet tall . . . 21 feet across the base . . . will contain 14 rocket engines!

Douglas-built second stage is as tall as a 5-story building.

The rocket that will lead the way to space travel is now in development

Space researchers at Douglas Aircraft are already working on the design and construction of the second stage of the huge NASA *Saturn* rocket.

Saturn is the first program which is designed, from the ground up, to provide the capability of putting tons of payload into orbit or thrusting manned capsules beyond the earth's pull. It will initially be able to orbit 20,000 pounds around the earth, or deposit 6,000 pounds on the moon.

Future configurations of *Saturn* will have even greater thrust and payload, paving the way for round trips to the planets.

Fantastic as these predictions sound, they are the solid convictions of the men at Douglas whose skills have been behind the production of nearly 30,000 rockets, missiles and space vehicles. These include the *Thor* IRBM which has boosted more successful space payloads than all other U.S. boosters combined.

DOUGLAS

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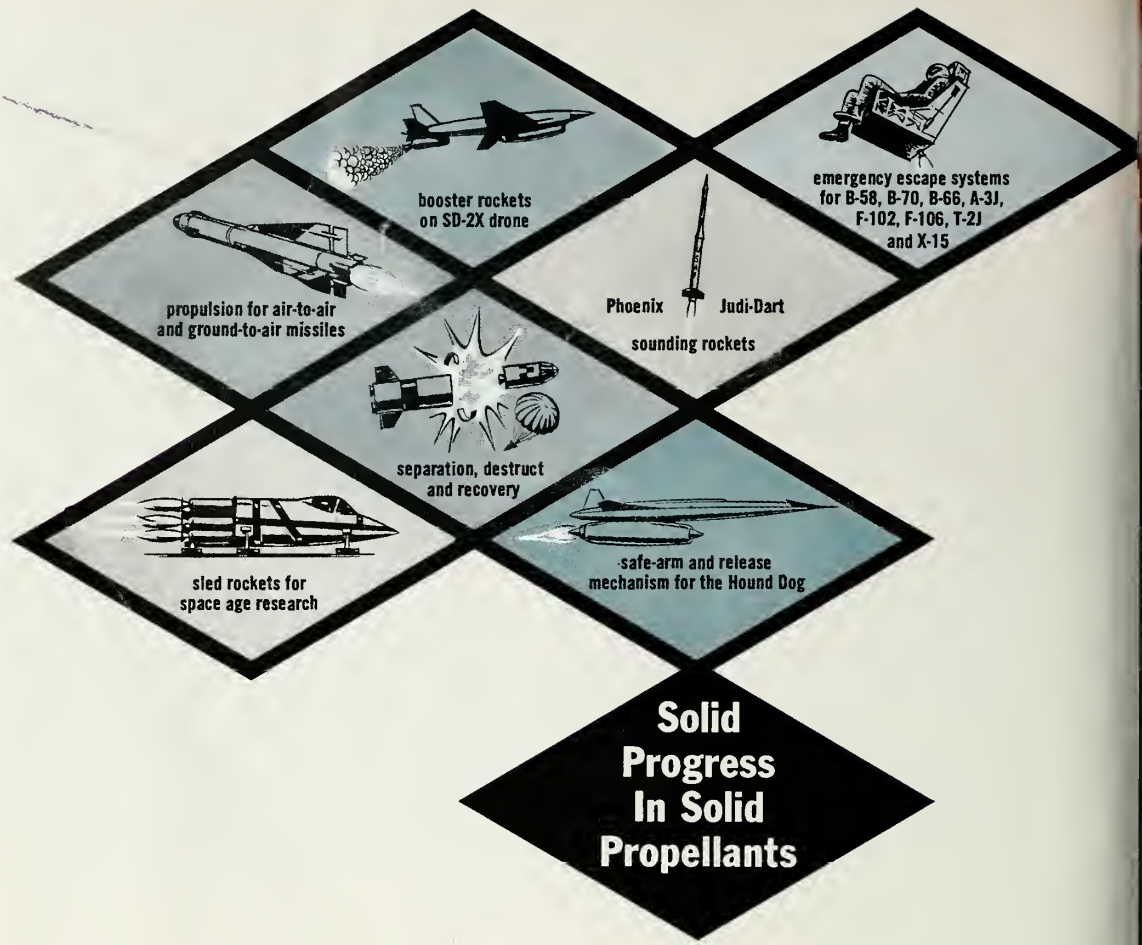

Space Age Support *from* ROCKET POWER / TALCO

During the past twelve months the Rocket Power/Talco team has proven its capability b accomplishing such space-age developments as —

- The Phoenix . . . a 250 mile sounding rocket
- booster rockets for the SD-2X drone
- rocket-propelled escape systems for the X-15, B-70, F-106 and other operational aircraft
- the safe-arm and release mechanism for the Hound Dog
- the Judi-Dart . . . a 50 mile meteorological rocket
- a variety of high-performance, on-the-shelf sled and booster rockets

For the future, RP/T is pioneering research in solid propellants, exotic fuels and other energ forms. ◆ Rocket Power's complete, proven capability is ready to assist you in your next soli propellant, rocket, or ballistic system requirement. Write for complete information.

CHARLES E. BARTLEY
president

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