JULY 4, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY

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THE MISSILE SPACE WEEKLY

missiles and rockets

July 4, 1960 Volume 7, No. 1

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An American Aviation Publication

THE COVER

The Army's 4.5 multiple rocket launcher fires one of its 25 rockets during the recent mass demonstration, Project Man, at Fort Benning, Georgia.

JULY 4 HEADLINES

ASW ENGINEERING

PROPULSION ENGINEERING

ADVANCED MATERIALS

SPECIAL SECTION

MANAGEMENT

ELECTRONICS

SPECIAL SECTION

DEPARTMENTS

30,432 copies this issue

letters

Experts Praise Fuel Story

To the Editor:

I was delighted to have the opportunity recently of reading the excellent "Missile Market and Product Guide Edition" put out by M/R (May 20). It is a fine piece of work. However, even more importantly, we were most pleased to see the story on rocket fuel development on page 74 of this edition. It is an excellent job and we believe it accurately covers the subject. We are, of course, pleased to see Grand Central Rocket mentioned so prominently and do appreciate being a part of your story.

J. T. Harker, Director of Marketing
Grand Central Rocket Co.
Redlands, Calif.

Harness by Lockheed

To the Editor:

On page 30 of the June 13 M/R you published a picture with a caption stating: "Harness and sensors are worn by subject of Air Force space medicine school to measure his reactions to conditions of stress." The article concerns "Ways Sought to Ease Ordeal of Space."

We should like to point out that the subject in the picture is Dr. O. S. Adams, psychologist with Lockheed's Human Factors Laboratory (Operations Research Division) at Marietta, Ga. The equipment is Lockheed's bioelectric harness.

Dr. Adams was project leader on the recently completed space-type investigation which Lockheed's Human Factors Laboratory conducted, under contract, for the Air Force's Aero-Space Medical Laboratories.

We are enclosing a news release on this investigation, feeling that you would be interested in full information about the study and Dr. Adams. Two Strategic Air Command crews wore bioelectric harnesses such as Dr. Adams demonstrated in the picture which you published.

We certainly would appreciate your clarifying this caption.

M. L. St. John
Manager, Newsbureau
Georgia Division
Lockheed Aircraft Corp.
Marietta, Ga.

The photo of Dr. Adams got separated from the news release to which it was originally attached and was misfiled under "School of Aviation Medicine." M/R is happy to give due credit to Lockheed's laboratory.—Ed.

reviews

FUNDAMENTALS OF ROCKET PROPULSION, Raymond E. Wiech, Jr. and Robert F. Strauss, Reinhold Publishing Corp. 130 pp.

This book provides an all-inclusive review of the rocket engine—its history, fundamentals of operation, design of components and methods of applications.

Chapters advance one step at a time through the basic laws governing rocket engine design; the design and operation of current engines; the need for and probable design of future engines; and the rocket engine's job in space flight and satellite missions.

The book fully describes all rocket engine types so that the function and operation of each is understood clearly.

SIXTH MATERIALS REVIEW, A. Lyem. Order PB 161463 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 92 pp., $2.25.

Worldwide research and development progress in polymers and plastics are highlighted.

Categories discussed include high polymers, plastic materials, synthetic fibers, metals and inorganic materials.

AERO-THERMODYNAMICS AND FLOW IN TURBOMACHINES, M. H. Vavra, John Wiley & Sons, New York, 609 pp. $14.50.

This text will probably become a standard in the library of every engineer designing turbomachines. The book is built upon the classical principle of thoroughly developing the theory—here, the flow relations—and then applying the results to the design of practical machinery.

This is a book for mathematically oriented engineers who prefer making their errors on paper to making them in hardware. For those students who may have forgotten some of their mathematics, an extensive appendix gives a review of vector analysis, and an introduction to operations involving dyadics.

A REVIEW OF CERTAIN FERROUS CASTINGS APPLICATIONS IN AIRCRAFT AND MISSILES, J. Varga, Jr. Order PB 151077 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 54 pp., $1.50.

This report describes significant advances in foundry technology that have recently enabled foundries to produce complex aircraft castings.

The report gives requirements for aircraft and missile steel castings and various castings processes. Tensile properties of heat-treated alloy steels are listed in tables.

CONTROL SYSTEMS ENGINEERING, Edited by William W. Seifert and Carl W. Steeg, Jr. McGraw Hill. 964 pp., $15.

This is a relatively complete coverage of the mathematical aspects of modern control systems engineering, as applied in the study of complex, large-scale automatic control systems.

The book has drawn on the specialized talents of 11 different contributers, all whom are former members of the Dynamic Analysis and Control Laboratory at Mass. Institute of Technology.

The first two chapters introduce the general subject of control-systems engineering. The remaining 15 chapters are devoted to a systematic development of the theoretical techniques used in the analysis and synthesis of control systems.

A thorough coverage is included on modern control system theory from the trial-and-error procedures which are commonly used in the design of linear systems to the application of game theory in the synthesis of complex systems.

COMPOSITE MATERIALS AND COMPOSITE STRUCTURES (Proceedings of the Sixth Sagamore Ordnance Materials Research Conference) Order PB 161443 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 562 pp., $7.

Recent advances and probable future developments in the physical, mechanical and metallurgical behavior of composite materials and structures are surveyed in a comprehensive collection of papers delivered by forty specialists in metallurgy, plastics and related fields.

The papers cover metal composites, glass reinforced plastics, laminated and other plastic structures, and materials for ablating composites.

Separate sections in the volume are devoted to glass reinforced plastics, composite systems for thermal protection metallic composites and composite materials and structures.

THE WELDING OF TITANIUM AND TITANIUM ALLOYS, C. E. Faulkner and C. B. Voldrich. Order PB 151079 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 69 pp., $1.75.

This report discusses advances in titanium welding, including the use of inert gas shielded metal-arc welding in the production of titanium assemblies.

The study also covers general welding procedures, surface cleaning, quality control, stress relief treatment, and the mechanical properties of welded joints in titanium mill products.

STANDARD DESIGNATIONS OF ALLOYS FOR AIRCRAFT AND MISSILES, J. J. Vagi. Order PB 161192 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 65 pp., $.50.

Metals and alloys used in aircraft and missile construction have been tabulated by trade designation, material specification and other standard categories as an aid in classifying metallurgical data.

There are separate tables for hot-work tool steels and selected high-strength and heat and corrosion resistant alloys.

Also included is an alphabetic list of major producers of high strength metals and alloys.

when and where

JULY

Metallurgical Society of American Institute of Metallurgical Engineers, Conference on the Response of Materials to High Velocity Deformation, Estes Park, Colo., July 11-12.

Third International Conference on Medical Electronics, sponsored hy Institution of Electrical Engineers, Olympia, London, July 21-27.

Pennsylvania State University, R&D Management Development Seminar, University Park, July 24-29.

Denver Research Institute, Seventh Annual Symposium on Computers and Data Processing, Stanley Hotel, Estes Park, Colo., July 28-29.

AUGUST

Fourth Global Communications Symposium, co-sponsored by IRE, Prof. Group on Communications Systems and Army Signal Corps, Statler-Hilton Hotel, Washington, D.C., August 1-3.

Massachusetts Institute of Technology, Special Summer Program on Modulation Theory and Systems, Cambridge, August 1-12.

American Astronautical Society, Western National Meeting, Olympic Hotel, Seattle, August 8-11.

American Institute of Electrical Engineers, 1960 Pacific General Meeting, Cortez Hotel, San Diego, Calif., August 9-12.

ASME-AICHE Heat Transfer Conference and Exhibit, Statler-Hilton, Buffalo, N.Y., August 15-17.

XIth International Astronautical Congress, Stockholm, Sweden, August 15-20.

Cryogenic Engineering Conference, University of Colorado and NBS, Boulder, August 23-25.

German Rocket Society, Annual Meeting, Hanover, Germany, Aug. 26-28.

University of Connecticut, Eleventh Annual Basic Statistical Quality Control Institute, Storrs, Aug. 28-Sept. 9.

SEPTEMBER

13th General Assembly of the International Scientific Radio Union, University College, London, Sept. 5-15.

Society of British Aircraft Constructors Show and Flying Display, Farnborough, England, Sept. 6-11.

Electronics Industries Association, Second Conference on Value Engineering, Disneyland Hotel, Anaheim, Sept. 7-8.

Joint Automatic Control Conference, Massachusetts Institute of Technology, Cambridge, Sept. 7-9.

American Chemical Society, 138 National Meeting, New York, Sept. 11-16.

The Countdown

WASHINGTON

Hush-Hush Rocket Deals

The State Department will deny it, but COUNTDOWN hears that two very important deals have been concluded between SEPR—the French rocket company—and two American firms. One deal is with the Rocketdyne Division of North American Aviation for liquid-propelled engines, and the other is with Thiokol Chemical for solid motors. Losing competitors on the deals are Aerojet-General and the British.

Corvus Almost Combat Ready

Final push is on to make the Navy's carrier-based *Corvus* operational. The radar-homing air-to-surface missile with a nuclear warhead is now in the pre-operational testing phase and should be ready later this year.

Cutting the Fuze

Marines are still completing final evaluation of the West German-made *Cobra* anti-tank missile. This has pushed the final decision on whether to buy until the end of July. Look for the Army also to reach a decision on the *SS-10* and *SS-11* by August 1.

Specs for Dyna-Soar

DOD is setting July 31 as the target date for completing its clearance of specs on the *Dyna-Soar* boost-glide bomber. This will be followed by a bidders conference at Boeing in Seattle, with a resulting alignment of subcontractors. Preliminary specs for the subs are being drawn up now by WADD. Mock-up of the new system is due for completion next June.

Secret Navy Missile

Navy has placed a contract with Electronic Communications Inc.'s Advanced Technology Corp. for feasibility study of a new missile. Type and purpose of the new bird are classified.

Space Tellerisms

Dr. Edward Teller, physicist "father" of the H-bomb, casts a jaundiced eye on the stars. From a recent speech on "peacetime uses of space:"

". . . somebody in this lifetime could go to Andromeda, but I recommend against it."

". . . if there is life out there, then where is everybody?"

". . . don't be premature and ask for a purpose in our space research. After all, Columbus set out to solve the trade problem with China, and that still isn't solved."

INDUSTRY

Ampex Merger May Be Coming

Industry insiders are watching a possible merger between Ampex Corp. and Telemeter Magnetics. If it comes about, the deal is expected to involve a swap of two shares of Telemeter for one of Ampex.

Mid-summer Minuteman

Expect the Air Force to award the hotly-contested *Minuteman* third-stage motor contract by the latter part of July. Hercules Powder, which is battling down to the wire with Aerojet-General for the big award, reports successful test firings of *Minuteman* motors made with plastic cases. Hercules claims its double-base fuel has the "highest I_{sp} measured" for a solid.

High Polaris Production

Production capacity for *Polaris* is now geared to insure deliveries of the sub-launched ICBM to the Navy and still permit release of land-launched versions to NATO. While policy of priority delivery to the Navy will be maintained, it is believed concurrent deliveries overseas are contemplated.

Whitson Elected Martin V.P.

Dr. William L. Whitson—former Daystrom vice president and onetime ARPA chief scientist—has switched to Martin. Whitson was elected a vice president by the Martin Board.

Plant Shuffling at Ogden

The word now is that the Air Force won't be taking over the Marquardt plant at Ogden, Utah, as a *Minuteman* maintenance plant after all. The apparent reason: Congress has put the Boeing *Bomarc-B* back in business and the plant will be needed to turn out engines.

INTERNATIONAL

European Space Pact

A committee for promoting European space research cooperation is awaiting formal governmental approval by at least six of 10 nations involved in the venture. This was decided at a meeting last month in Paris. The committee, which may use the British *Blue Streak* for a vehicle, is composed of representatives from Sweden, Norway, Denmark, Holland, Belgium, Britain, France, West Germany, Switzerland and Italy.

Pills for Space

Russian pharmacologists are now engaged in the Soviet man-in-space program. They are reported to be experimenting with tranquilizers, compounds for toning the circulatory and respiratory systems to protect space travelers.

Italian Sounding Rocket

In shots this summer from Sardinia, the Italian Aeronautical Ministry will be using three-stage high-altitude rockets. First stage will be a *Nike* booster, the second, an *Asp*, and the top a *C-7* made by Bombrini-Parodi-Delfino. There also will be some two-stage vehicles composed of *Asps* and *C-7's*.

Aerospace Corp. to Help Mak

New non-profit organization will help Air Force achieve advanced ICBM, an AICBM and method to detect nuclear tests in space

by William J. Coughlin

Aerospace Corp. will provide the Air Force with systems engineering and technical direction for three planned new missiles and the means to detect nuclear tests in space, MISSILES AND ROCKETS has learned.

They will be:

• An advanced ICBM smaller than *Minuteman* with improved guidance accuracy and a "substantial" nuclear payload capacity.

• A defensive missile for use against the ICBM—a step beyond *Nike-Zeus.*

• An advanced ballistic missile of intermediate range for possible NATO use. It will be the AF entry along with Navy's *Polaris* and Army's *Pershing.*

• A study phase of ARPA's project *Vela,* detection of nuclear tests in outer space by measuring existing background radiation. It would be carried out if Russia and the U.S. agree to an earth nuclear test ban. Nuclear testing in space would add measurable amounts of radiation.

Aerospace Corp., the non-profit organization set up to meet congressional criticism of the relationship between Air Force and Space Technology Laboratories, will take over only a minor portion of the work STL is doing for the Ballistic Missiles Division.

It is expected to hire about 1300 of the 5181 persons now employed by STL. Only 250 are scientists and engineers from STL's technical staff, and most of these will come from STL's Advanced Systems Planning Division. Presumably, A. F. Donovan, vice president and division director, will remain with STL.

STL contracts with BMD for systems engineering and technical direction of the *Atlas, Titan* and *Minuteman* weapon systems will be continued to avoid disruption in development.

In addition to new missile weapon systems, Aerospace Corp. will support BMD in management of early warning, reconnaissance and communications satellites and advanced planning for other military space systems. It also will engage in advanced R&D in these fields. The *Sky Bolt* program will remain at Wright Air Development Division because of the complexity of integrating aircraft and missiles.

Aerospace Corp. also will be active in such areas as advanced re-entry vehicles and penetration aids, new propulsion and guidance systems, satellite communications systems, satellite inspection systems, manned military space systems and other corollary undertakings.

The company also plans to accept projects from other agencies such as National Aeronautics and Space Administration and Advanced Research Projects Agency, according to Board Chairman Roswell L. Gilpatric.

STL, in its approach to new business, will continue its interest in systems engineer-type programs but avoid management-type projects which would impose the same limitations on hardware development that existed in its association with BMD.

The company now has many proposals into government agencies stressing capabilities in experimental fabrication work, assembly and test, research studies, plus systems engineering.

• **New challenge**—At a press conference in Los Angeles to announce organizational details of the company, spokesman for the organization and Air Force made it clear that Aerospace Corp. is moving into new fields rather than assuming major tasks now handled by STL.

Board Chairman Gilpatric termed it a unique approach and a unique response to a "new challenge."

Asked what was new about the challenge, Undersecretary of the Air Force Joseph V. Charyk explained the Air Force looks at present missiles as the early phase of a whole series of missile and space weapons which will form the U.S. military forces of the future.

For these weapons, a new management approach is needed to blend advanced technologies in such exotic fields as electronics and nuclear rocketry, he asserted.

Lt. Gen. Bernard A. M. Schriever, Commander of the Air Research and Development Command, said USAF needs the most competent technical people in the country to provide it with management of high caliber.

"You can't run programs of this magnitude just by wishing," Gen. Schriever said. "You've got to have people and Aerospace will be part of the management team."

• **Room for growth**—Board member Trevor Gardner, now chairman and president of Hycon Manufacturing Co., said the new corporation will provide for the Air Force a skilled mass of objective talent which it does not have available through any other channel at the moment. Active recruiting for top scientific and engineering talent will get under way immediately but board members declined to say what ultimate size of the Aerospace staff might be.

The 250 members of the technical staff who will go to Aerospace Corp. are being selected by IBM machine on the basis of the amount of time they have put in on the projects which are being transferred. They will be discharged by STL and hired anew by Aerospace Corp. STL has made it clear to the Air Force that it expects no objections to this transfer.

The 1150 support personnel going to Aerospace Corp. will be those who are doing basic work on Air Force programs in such fields as technical training and USAF mail service, and some of those who are in allied fields such as technical writing and security. The latter groups will be apportioned between STL and Aerospace Corp. on the basis of need.

Aerospace Corp. is operating on a letter contract with the Air Force while a firm contract is under negotiation. Estimated dollar volume of contract has not been disclosed.

STL's business with the Air Force last year totaled $68.5 million.

New Missiles

• Not a competitor—Formation of Aerospace Corp. followed criticism of the relationship between the Air Force and STL on the grounds of conflict of interest with the commercial activities of the Thompson Ramo Wooldridge, parent company of STL, and with STL's own profit making nature.

"Unlike STL, this is a non-profit organization," Gilpatric said." "There is no question of competition with industry: no question of getting into hardware."

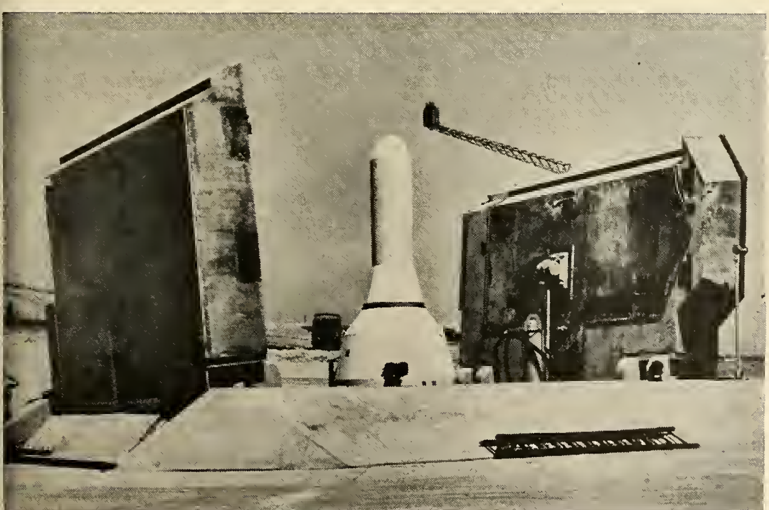
The Air Force is purchasing the sprawling new El Segundo facility of STL for use by Aerospace Corp. under a facility contract. Value of the purchase was not disclosed because it still is "under active negotiation"—but it is believed to be well in excess of $20 million.

Although it is expected that Aerospace Corp. ultimately will occupy the entire research and development center, the facilities initially will be shared by Aerospace Corp., the Ballistic Missile Division, the Ballistic Missile Center, and units of STL which are at work on Air Force programs.

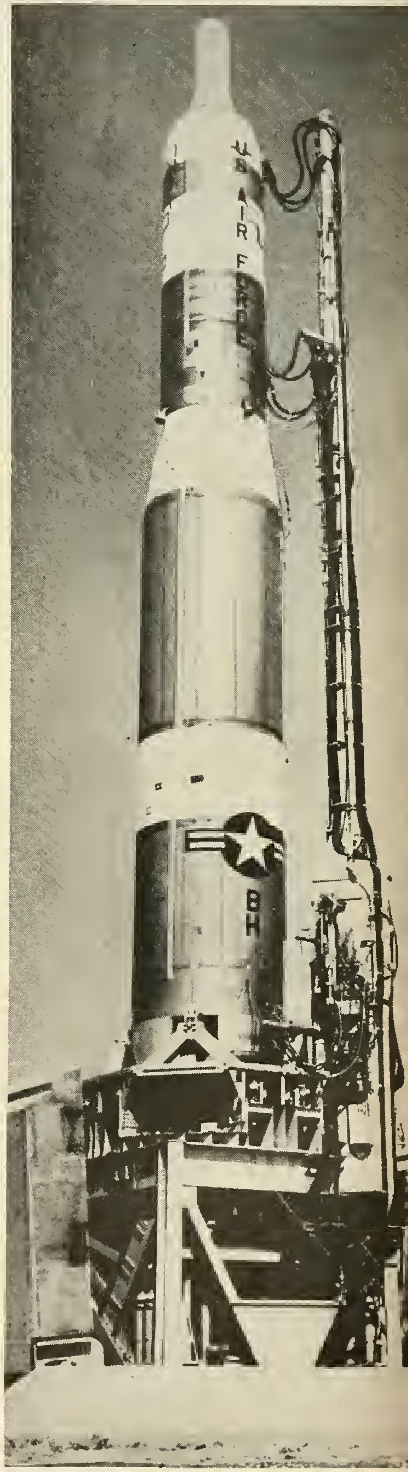
Among the programs which Aerospace Corp. will take over are *Samos*, *Midas*, and *Discoverer*, in which STL played a relatively small role. Aerospace participation will be considerably more active, it was indicated by Gen. Schriever.

The ARDC commander said the Air Force does not plan any changes in the contractural arrangements with its present contractors. He added, however, "We intend perhaps to do a little more looking down their throats."

No president has yet been named for the company. Head of the executive committee is Dr. Charles C. Lauritsen, California Institute of Technology. Other board members include Dr. Clifford C. Furnas, President, University of Buffalo; Edwin E. Huddleson, Jr., of Cooley, Crowley, Gaither, Godward, Castro & Huddleson; Roger Lewis, Vice President, Pan American World Airways, Inc.; Maj. Gen. James McCormack, USAF Ret., Vice Pres. Massachusetts Institute of Technology: Gen. Earle E. Partridge. USAF (Ret.); Arthur Raymond, Former Vice President, Engineering, Douglas Aircraft Co.; Dr. Chalmers W. Sherwin, Professor of Physics, University of Illinois; Dr. Jerome B. Wiesner, Director, Research Laboratory of Electronics, Massachusetts Institute of Technology.



FIRST PHOTO of *Titan* underground elevator launch facility at Vandenberg AFB, Calif. Missile is being elevated to firing position through 200-ton steel and concrete protective doors. American Machine & Foundry designed and built prototype and will construct 36 more under a $81,576,000 Air Force contract let last week.



CHECKOUT missile has been raised from silo and is in firing position. Firing of a *Titan* from this prototype operational facility will take place sometime this year.

What Congress Should Do About the . . .

RENEGOTIATION MESS

FRIEDMAN

A special House Armed Services Procurement Subcommittee has recommended that the present Renegotiation Act be enacted into permanent law. The subcommittee also has rapped Defense Department reliance on negotiated contracts and incentive contracting—holding any savings to be a "fallacy." The House has urged passage of HR 12572 to impose new restrictions on incentive contracts. In the following critique, Mr. Jacob Friedman takes a hard look at the issues involved in renegotiation and proposes specific solutions to the dispute. Mr. Friedman is a registered professional engineer and Washington business-engineering consultant. He formerly was a Navy facilities contract negotiator and, in 1951, a deputy director of the National Production Authority's tax amortization division.

by Jacob Friedman

Renegotiation today is the harshest word in the defense industry's vocabulary.

Scratch a missile contractor and he'll tell you the Renegotiation Board is nothing more than a band of pirates who grab hard-earned profits year after year.

But scratch almost any congressman and he'll praise the board as a group of sainted heroes who each year justifiably recover millions of dollars in excessive profits.

Both these viewpoints are extreme. While they portray the focal point of the dispute that has raged almost since the inception of the Renegotiation Act in 1951, neither gets down to the real issue—the law itself.

Criticism of the Renegotiation Board, insofar as the defense industry is concerned, is so much wasted motion. The Board is merely the instrument of the law.

If inequities in Renegotiation Board actions are to be corrected, then the law must be corrected. That the whole renegotiation process today stands in need of drastic correction, there can be little question. For the law—notwithstanding its objective to recapture excessive profits—is having some profoundly adverse effects on the defense industry at a critical period in the nation's history.

To obtain the proper remedies, objective concessions are needed from both sides.

No argument is being advanced here to forget all about renegotiation and let extra profits become a form of subsidy. On the contrary, renegotiation fulfills a necessary function. It is needed particularly in the area of fixed price negotiated contracts where there are unknown factors affecting costs and profits. But renegotiation must be made to function under firmer ground rules.

Consider the case of Boeing Airplane Co. A Regional Renegotiation Board determined that no excessive profits had been made by the company during FY 1952. However, the National Board overruled this decision and made a finding of almost $10 million in excessive profits. Boeing appealed and—a full eight years later—the case is still awaiting a final determination by the U.S. Tax Court.

Without attempting to pass on the merits, we can readily see that this case at least indicates a lack of consistency in interpreting the statutory factors.

• **Double standard**—Much of the strife over renegotiation presently lies in conflicting values established by the Defense Department under Armed Services Procurement Regulations for certain fixed factors and those established by the Renegotiation Board in accordance with the law.

These factors—character of business, amount of Government-owned facilities, range of subcontracting, pricing risk, etc.—are known and agreed to in contract negotiations. But, when the Renegotiation Board looks over a contractor's total renegotiable business for a given year, these fixed factors may be assigned a different value—in effect overruling the Defense Department.

Testimony before the House Ways and Means Committee in April, 1959, pointed up this conflict in a 1954 case involving Lockheed Aircraft. The National Board told Lockheed in a letter introduced in the record:

"Notwithstanding the decrease in sales and profits from the prior year and the contractor's acknowledged efficiency and lowered costs, the Board has concluded that the contractor's renegotiable profits, accompanied as they were by substantial Government assistance and subcontracting as well as the minimal risks to which the contractor was exposed by reason of 94.9% of its production being either CPFF or fixed price incentive, are greater than can be considered reasonable."

It is significant that each of these factors—on which excessive profits in the amount of $6 million was determined—may have been fixed factors considered as a basis for the contractual agreement and not affected by conditions thereafter.

• **The profit incentive**—Primarily, Congress should concern itself with reduction of overall costs in defense buying. But there is a large question whether the Renegotiation Act obtains this objective.

Profits from incentive contracts, while a small portion of total defense costs, represent the bulk of those considered excessive by the Board. In theory, the incentive contract holds out the promise of more profits as a reward for reducing overall costs. This, in turn, is intended to establish patterns for lower production costs in the future.

However, contractors frequently complain that they are not being treated fairly in the case of price reductions on incentive contracts resulting from their efficiency of operation. This introduces the question whether or not the contractor reduced costs through efficiencies not normally expected.

The Board, however, considers that jobs done for less than the target cost do not necessarily represent savings at all, since the yardstick for determining the target cost may be inaccurate. Other factors having no bearing on the contractor's efficiency also may arise.

The incentive to industry is profit. To take away any part of the target profit when the actual cost does not exceed the target cost is short-sighted. It defeats the purpose of the incentive contract. For unless the contractor can feel that the lower his costs are, the more his profit, then incentive contracts are "incentive" in name only.

Renegotiation of incentive savings depends on differences of amounts—rather than magnitude of the amounts—of actual costs and renegotiated target costs. Thus, in order to maintain the incentive for lower overall costs, the Board should tend to become more liberal in renegotiating target costs as actual costs reach lower levels. This would take coordination with the procuring agency to obtain pertinent information regarding the original negotiations. In turn, the Armed Service Procurement Act should provide for penalties when contractor withholds from contract negotiator information affecting target costs.

The actual elimination of any profits would depend upon the profit determinations relative to the remainder of the contractor's renegotiable business. However, under pending legislation (H.R. 12299) wherein contractors must prove that incentive savings are due entirely to skill, efficiency or ingenuity as a condition precedent to retention under each contract, a portion of such profits will be eliminated before consideration by the Board on an overall basis. Such a proposed law not only appears questionable as to practicality and intended purpose of an incentive contract; it also appears unfair in that losses on other renegotiable contracts will not offset such eliminated profits.

(This proposed provision has been dropped in accordance with the recent proposed provision in H. R. 12572, which calls for adjustment in target cost or price to exclude any sum found after audit resulting from inaccurate, incomplete or noncurrent data.)

It is noted that higher profits are realized on incentive contracts through lower overall costs—in contrast to higher profits through higher overall costs on cost plus percentage contracts, which are now illegal. Nevertheless, public policy dictates that excessive profits by a contractor should not be made on Government contracts. On this basis, a strong justification that the renegotiation function on a backward-look basis should continue is a high volume of contract work accomplished under fixed price incentive contracts. When industry concedes this point it will the in a more constructive position to receive cooperation from Government that will lead to objective results.

What's Wrong . . .	*How it Can be Corrected . . .*
• "Double standard" exists between DOD Armed Services Procurement Act regulations (ASPR's) and the Renegotiation Act. ASPR's take into account such fixed factors as character of business, amount of Government-owned facilities, range of subcontracting, pricing risks, etc. in determining profits on negotiated contracts. But, the Renegotiation Board may assign different values to these fixed factors on the overall basis of renegotiable business during each fiscal year, thus making Government's word uncertain.	• Change the Renegotiation Act to limit the Board to consideration only of variable factors in determining excessive profits. Furthermore, fixed factors and those subject to variation should be spelled out wherever practicable in the law, including a provision that if a fixed factor changes during the term of a contract it then becomes a variable factor subject to the renegotiation process.
• Emphasis on incentive contracts is not presently directed to consideration of lower overall costs.	• Provide that there can be no reduction in target profit (based on target cost or subsequent adjustment thereof) if actual cost is less than target cost. This in itself does not encourage enough incentive to reduce costs to the lowest practical levels. Therefore the Act should further provide that the Board generally give more favorable consideration in renegotiation of incentive savings as actual costs reach lower levels. In turn, ASPR's should provide penalties for contractors who withhold information from the contract negotiator relative to target cost.
• Consideration of private investment in plants, which affects return on net worth, is emphasized in determination of excessive profits; yet risk of private expansion of the unconventional and expensive facilities for production required currently only in limited quantities is now greater than at any time during the last decade.	• Restore accelerated tax amortization to encourage industry to risk its own capital on plant and equipment which will be used for defense research and development.
• Contracts resulting from advertised procurements where three or more bidders compete are subject to renegotiation notwithstanding the current status of competitive pricing.	• Change the Renegotiation Act to provide that total contracts awarded to a company under advertised bidding should not be subject to renegotiation except at the option of the contractor (to offset possible excessive profits from negotiated contracts). Exceptions to this provision would be contracts awarded when there are not more than two bidders; or if the procuring agency determined that a unique situation, e.g., proprietary items, limits a source of supply and makes a particular contract subject to renegotiation.

Congress Adds Less Than $.5 Billion to DOD Budget

Congress spooned a half-hearted increase into the FY '61 defense budget last week prior to recessing for the presidential nominating conventions.

Net additions to President Eisenhower's budget totalled less than one-half billion dollars, practically erasing the defense issue from the forthcoming presidential campaign insofar as GOP and Democratic spending philosophies are concerned.

Apparently the Democratic leaders were anxious to avoid the "spender" label.

Major additions to the $39.2 billion Administration bill were:

- $241 million for *Polaris* missiles and submarines.
- $160 million for Army modernization—mostly for ground equipment and chemical rockets.
- $190 million to restore the Air Force B-70 to full weapon system status.
- $100 million for the procurement of any type of fighter as a safeguard if the *Bomarc* air defense missile fails.
- $83.8 million to be used at AF discretion for *Minuteman, Midas, Samos,* and *Discoverer*.
- $85 million move for storing parts for a bomber alert.

Offsetting these additions, which run to $859.8 million, was an across-the-board $400 million cut in DOD procurement. The House conferees had insisted upon this 3% cut, apparently getting it in return for keeping the Eisenhower request for $293 million to build a conventionally-powered aircraft carrier.

The other principal tradeoffs centered around *Bomarc* and the B-70.

The biggest concession wrung from the House was the restoration of money for *Bomarc B*, a program it had voted to kill altogether. The $244 million put in the compromise bill conforms with the Administration's appeal for the final funding of nine squadrons. Another $75 million is provided for two northwest *Bomarc* sites.

For further flexibility, if *Bomarc* six is successful, the conferees said the $100 million earmarked for fighter aircraft could be used for the B-70 if progress warrants. The bill was expected to be sent to the White House this week.

In other defense developments:

- The first *Polaris* missile submarine, the George Washington, arrived at Cape Canaveral to prepare for its first underwater missile launch, expected sometime this month.
- A *Nike-Zeus* AICBM test missile exploded in an underground launching cell at White Sands, N.M. The cell was a new design, eliminating the exhaust vent.

Lack of Tactical Missiles Cited

The Senate Preparedness Subcommittee this last week attacked the Administration for failing to provide the Army with sufficient new tactical missiles and other modern weapons.

The subcommittee—headed by Senate Majority Leader Lyndon B. Johnson (D-Tex.)—demanded an immediate "searching inquiry" by the Defense Department into the adequacy of the weapons in the hands of Army combat troops.

The subcommittee's attack and accompanying demand for a study underlined growing concern among many top Army officials as to the adequacy of current tactical missile procurement programs. These officials fear the United States may be faced with a "tactical missile gap" in the 1960's. (M/R, May 9, p. 11)

The subcommittee specifically listed six new Army missiles in a report and bluntly made clear that the Army had insufficient funds to purchase any of them in needed quantities.

The list and the subcommittee's comments:

- *Little John*—"substantial quantities are needed."
- *Sergeant*—"only one sixth of the active Army requirements are under contract."
- *Pershing*—"only two are on order at present" for training.
- *Hawk*—"only one third of active Army requirements are in production today."
- *Redeye*—"none are in the hands of troops although an urgent need exists."
- *Davy Crockett*—"hundreds are on order when thousands are required."

The subcommittee called the two air defense missiles and the four surface-to-surface missiles "essential . . . to bring about the modernization of our ground forces to the peak necessary."

"These are the items which provide Army troops with the punch they need," it said. "Missiles are fast becoming the core of firepower for a modern armed force."

Labor Troubles Continue —With Some Bright Spots

Unsettled labor conditions still plagued the missile industry this week, with negotiations at some companies ending in hopeless deadlock.

On the brighter side, International Association of Machinists members at Convair and Douglas have ratified earlier agreements made by their bargainers to accept the companies' last offer. Machinists represented by the United Auto Workers had accepted a Douglas offer earlier.

Negotiations between the IAM and Lockheed's Missiles and Space Division at Sunnyvale, Calif., disintegrated after the machinists rejected the company's last offer by an overwhelming vote. The Lockheed strike is expected to continue for some time.

Boeing is still being threatened by an IAM strike at its plants in four states. The union has voted to strike and has rejected the company's last offer.

UAW employees at Chance Vought and Bell Aircraft have also given their leaders the power to call a strike. The Bell machinists are presently working without a contract.

38,000 United Aircraft IAM and UAW employees are still out at the company's plants in Connecticut.

Soviets Set for More Shots into South Pacific

This week the Soviet Union is expected to begin lobbing multi-staged 7000-plus-mile missiles at another Pacific Ocean target area—apparently to solve re-entry problems.

The Russians warned ships to stay out of a 50,000-square-mile area near Palmyra Island, 1000 miles southwest of Hawaii, between July 5 and July 31. This target area is 150 miles further southeast than the one the Soviets used in January, indicating that the rockets may be launched from a different base.

As has been the case with previous "spectacular" demonstrations of Soviet rocket prowess, the tests presage visits by Premier Nikita Khrushchev to Western nations. Khrushchev will begin a nine-day official visit to Austria on the eve of the test period.

Underplaying the military significance, the Russians have stated the tests are for the peaceful purpose of developing rockets that can reach Venus or Mars.

The announcement followed speeches by Khrushchev and Soviet Defense Minister Rodion Malinovsky asserting that Soviet military forces were being strengthened and their shift to missiles was being accelerated.

First Deep Space Travelers May Be Rated 'Expendable'

Los ANGELES—The first interplanetary travelers may have to be considered "expendable"—if they stay in space too long.

David Reitz of Martin-Denver puts a time limit on space flight of around 100 days. He suggests that longer periods of exposure to cosmic radiation might prove fatal.

The researcher told the Institute of Aeronautical Sciences last week that the solution lay in speedier propulsion and faster trips.

"Lunar trips can be undertaken," Reitz said in his paper, "but excursions to other planets, where distances are of the order of millions of miles instead of several hundreds of thousands, will in 130 days subject men to doses from cosmic radiation alone equal to 25 rem. This is the maximum allowable for a single emergency exposure."

Additional radiation probably would be received in passing through the Van Allen radiation belts, he pointed out.

Reitz noted that the first expected relatively safe periods for interplanetary travel will be during periods of low solar activity in 1963-66 and 1975-77. He indicated that even during those periods more than 100 days of travel time would be dangerous.

"Should propulsion units not be capable of obtaining this kind of performance," he said, "it may well be decided that the first interplanetary travelers are expendable or can at least receive a dose greater than 25 rem."

He said, however, that outlook for such a propulsion requirement being met successfully appears to be favorable for the 1975-77 period. If this is accomplished with a nuclear reactor, he noted, then radiation from the reactor must be added to cosmic radiation in determining the allowable flight time.

• **Orbital exposure**—In regard to manned orbital missions, Reitz said that a study of cosmic ray intensity indicates that a near-circular orbit which lies below the inner radiation belt will not expose a human being to a dose greater than the allowable 5 rem yearly for any orbital inclination less than 48 degrees or greater than the allowable 13-week dose of 3 rem for any inclination less than 71 degrees.

He said the minimum allowable time in a 90-degree orbit at an altitude of 400 km. or less is about 80 days.

"At 3,500 k., only orbits of inclination less than 25 degrees do not expose a human being to a dose greater than 3 rem during a 13-week period, while at 6,000 km. all orbits have an exposure time limitation."

Reitz said that experiments with shielding materials indicate that lead and lithium hydride are nearly as efficient for gamma rays and fast neutrons as any which have been tested. He said, however, that lithium borohydride might prove an even better neutron shield than lithium hydride.

He indicated that cosmic and nuclear radiation would become less of a handicap as the ability to carry heavier shielding increased due to improved propulsion systems.

Pentagon Moves to Cut Down Security Stamping

Department of Defense security classifiers are expected to be a little more discriminating in using their rubber stamps under a DOD directive attempting to eliminate unnecessary secrecy.

The new policy, according to a DOD spokesman, should result in significant savings in time and money for the 24,000 contractors engaged in classified defense work, including the added saving created by large reductions in security personnel.

The latest DOD attempt to bring order to its sometimes illogical security specifications system is for the censors to concentrate only on the details or components of a weapons system or program which clearly need protection.

The revision involves a rewritten DOD Form 254 security check list attached to defense contracts, which will afford timely identification of information requiring classification while determining the lowest acceptable level of security.

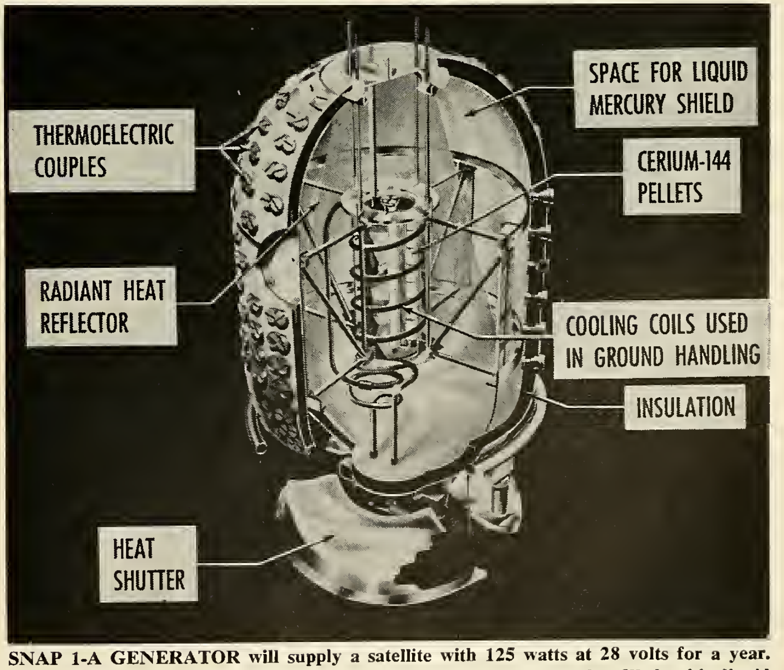
Under the new regulation an automatic annual classification review is mandatory.

Human Neuron Duplicated In Device by Aeronutronic

Aeronutronic Division, Ford Motor Co., last week announced development of a tiny electronic device that duplicates a neuron—the learning unit of the human nervous system.

The electronic neuron, called MIND (Magnetic Integrator Neuron Duplicator), is about one-fourth the size of a penny and consists of a magnetic core with an inner hole through which wires are strung. It was developed as part of a research program, sponsored partly by the Department of Defense.

Year-long power source



SNAP 1-A GENERATOR will supply a satellite with 125 watts at 28 volts for a year. The 175-lb. device, being developed by The Martin Co., can be filled with liquid mercury to shield the radioactive heat source during ground handling. Studded with 277 thermocouples, the generator is equipped with a temperature-sensitive shutter which assures a constant electrical output.

Atlas Flight Is Victory For All-Inertial Guidance

All future Atlases will carry the proven Arma System, but radio-inertial package will be retained on Atlas-D

HEMPSTEAD, N.Y.—Recent success of the *Atlas* ICBM all-inertial guidance does not mean it will displace radio-inertial systems already in use, says the Air Force.

At a joint Air Force/American Bosch Arma Corp. press conference here describing Arma's advanced inertial package, Lt. Col. Frank Box, AF Ballistic Missile Div., ARDC, said radio will continue to be used in the *Atlas* D-series. All future models will have the all-inertial system.

(The D-series *Atlas* is now operational although test shots for system improvement will continue for some time. The E-series, which will get the new guidance, is in static test now. It will be flight tested within 4-5 weeks, according to Convair.)

The June 11, *Atlas* firing from Cape Canaveral placed another star in missilery's progress report—the first successful free-world ICBM flight fully controlled by an all-inertial guidance system.

With the ink hardly dry from history's last addition, new components and state-of-the-art packaging techniques for tomorrows ICBM guidance will be even more accurate, smaller, and more reliable. Its developer, Arma Div. of American Bosch Arma Corp., already is well along with second and third-generation guidance packages.

During this first release of information to the public concerning the still highly classified system, an Air Force official said the guidance package exceeded all design requirements. (A statistical accuracy of falling within a 2-mile target circle was probably the minimum requirement, since radio-inertial guidance systems previously used have reportedly halved this mark.)

• **Radio-inertial still used**—In describing the *Atlas* guidance program, Col. Box emphasized that radio command guidance is still in use and will continue to be used.

Radio-inertial guidance was initially selected by the Air Force because its state of development offered minimum time and cost for completion to use in the accelerated ICBM program. Although very accurate, and small in weight and volume, it has one big limiting factor: It necessitates a relatively tight grouping of launch pads to permit firing in salvo. This makes the entire complex vulnerable to one direct hit or one catastrophic accident.

Development costs to date of the Arma system are in the "tens of millions of dollars," said Col. Box. Up to 10 shots probably will be made before the guidance is declared ready for operational use.

Started as a company-sponsored project six years ago, Arma guidance won a feasibility contract in 1955 and the development award in 1959.

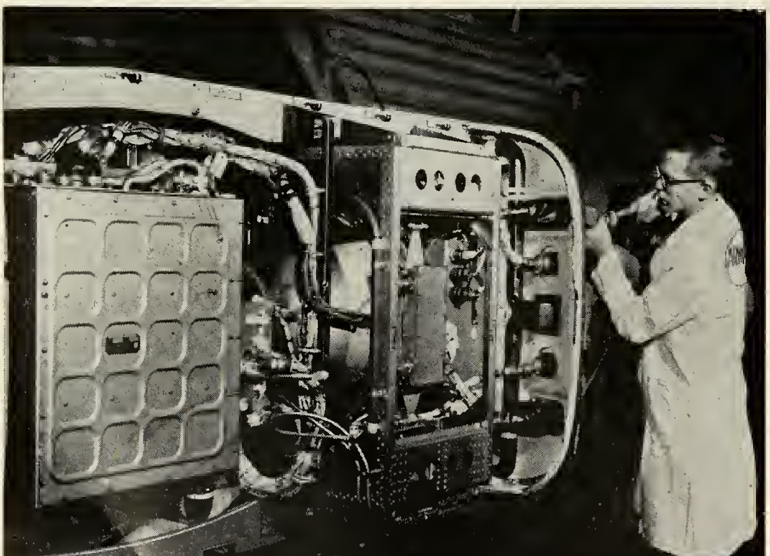
First flight test of the system occurred March 8. A dry run of the system generated all necessary signals for telemetering to a ground station. Actual performance data from the radio-guided missile was used for comparison with the inertial steering signals.

• **Size reduction soon**—The present missile-borne system is large, consisting of three basic units: the all-inertial guidance platform, the solid-state digital computer, and the control central.

The platform uses two 2-degree-of-freedom fluid-suspended Arma gyros. (These cover 2 axes each with a redundancy in azimuth.) Three precision accelerometers are used to sense vehicle motion in space, operating with an accuracy of 1 ft./sec.

For the future, size and weight will be reduced greatly. Already, the gyros have been cut by 75% in size, the accelerometers 80%. The control-box electronics has been repackaged within the platform outer sphere to further reduce total volume and weight. Finally, with microminiaturization techniques the guidance computer has been reduced 70% in size.

Accuracies in the improved components are vastly superior to the currently used parts, said an Arma official.



ARMA'S ALL-INERTIAL guidance system gets final adjustments prior to its June 11 test flight in the *Atlas-D* ICBM. Installed in an external pad on the missile are the computer (left), stable platform (center), and control central (right).

Tapco to Build Closed-cycle Torpedo Engine for BuWeap

Tapco Products Group of Thompson Ramo Wooldridge, Inc. has been awarded a cost plus fixed fee contract of about $300,000 for research and development of a closed-cycle torpedo engine for Bureau of Naval Weapons.

The contract strengthens the company's position in the secondary power generation field. Only recently, it received a contract for the National Aeronautics and Space Administration's *Sunflower II*.

Testing of first versions of the silent-running engine is expected in 18-24 months. Presumably the engine will use a solid fuel as the basic energy source. Under the closed-cycle system, fuel is expanded, enters through a turbine and is cooled and condensed. It then goes back to its original fuel state.

Tapco first entered the auxiliary power generation field when it furnished liquid, self-contained units for *Bomarc* and *Terrier*.

Polaris Guidance Needs Are Critical

by Frank G. McGuire

COLORADO SPRINGS, COLO.—A velocity error of as little as 5 ft./sec. at warhead separation will cause the *Polaris* ballistic missile to miss its target by a mile.

Separation—which occurs within a minute or two after launch, when the missile is only one-sixteenth of its way to the target—is the "moment of truth" in the trajectory. Any errors at this point will be reflected, and even multiplied, in deviation from the planned impact point. An error in lateral position at separation, for instance, will cause an impact error 15 times as great.

These critical requirements of the *Polaris* inertial guidance system were pointed out here last week by Rear Adm. J. A. Jaap, Navy director of development programs, at the annual meeting of the Institute of Navigation. Citing other critical examples, Admiral Jaap said that the warhead is separated when the missile is traveling at a speed of 14,000 knots at an altitude of 70 miles—and still climbing. The guidance equipment must be sufficiently precise to correct velocity errors of only a few feet per second and position errors of one foot at this point.

The position of the launching submarine is not so critical, the Admiral said, but errors cannot be allowed to accumulate. Submarines will carry three inertial navigation systems and an electronic computer to instantaneously fix positions as accurately as possible.

The Navy's *Transit* satellites are designed to give submarines a position fix within one-quarter mile. Ultimate goal is one-tenth mile.

• **U-2 cosmic research**—In another paper, Dr. S. Fred Singer, Professor of Physics at the U. of Maryland, discussed problems of radiation in space. He said that research on cosmic radiation has been undertaken by the Air Force since early this year with special equipment mounted on U-2 high-altitude aircraft.

He praised the Air Force's "well organized and excellent program" on radiation problems in space. Much of this research is being carried out over North America and the polar areas, he said, noting that aircraft are better than satellites for some phases of the program because they travel a controlled trajectory.

On the dangers of the radiation belts surrounding the earth, Singer said they present little danger if they are crossed quickly and in the right place. In another side, however, he remarked "until rocket reliability is greatly increased, the radiation belts present little hazard to manned space flight."

• **U.S. guidance defended**—Soviet success in hitting the moon with an instrumented payload while similar U.S. attempts failed was not necessarily due to any greater capability in accuracy, Dr. Newell Sanders, Assistant Director, Office of Space Flight Development, National Aeronautics and Space Administration, told the ION.

He said the apparently poor accuracy on the part of American probes was due partly to the use of solid propellant final stages. Deviations in separation velocity of the payload package could easily throw the probe off its intended trajectory by a substantial margin, Sanders said.

"In practice," Sanders noted, "We have injection accuracy of one part in 5000. This would easily put us within 20,000 miles of Mars. A lunar probe would be more accurate, due to the shorter distance involved," he added.

Our ability to track a vehicle in space is just as impressive, Sanders said. NASA currently has the capability of determining—at interplanetary distances—a probe's velocity to within one meter per second through use of Doppler radar, and its range to within ten meters through use of pulse radar.

This capability becomes necessary in using radio command guidance correction techniques during the course of a flight.

The best area for course correction during a lengthy interplanetary flight is early in the trajectory and at least before the payload gets one third of the way to its destination. Corrections can be made later in the flight, but only at greatly increased payload penalties as the probe progresses.

After the one-third point in the trajectory, the curve of payload penalty versus distance back to true course rises with great rapidity. The propellant required to regain proper heading is carried at the expense of useful payload.

• **'Pseudo targets'**—In a paper describing a new system for computing guidance parameters for interplanetary flight, Dr. R. M. Leger, Chief of Flight Performance and Analysis at Convair-Astronautics, presented a possible solution to disadvantages posed by necessity for launching at an exact time, to achieve a desired trajectory.

The "pseudo target" method proposed by Leger would simplify the explicit computations and provide a maximum amount of decoupling between launch time and other dispersions.

Noting that "the facts of life" in launching of interplanetary vehicles saddles scientists with the problem of coping with a three dimensional guidance situation, he describes the pseudo target system as a hybrid method set up in terms of polynomial expansions. The guidance system then controls to the pseudo target by explicitly computation of Keplerian orbits.

Previous methods of guidance have utilized two opposing techniques, Leger said. One is the use of pre-computed flight data reducing the guidance reference to a series of polynomials which are evaluated in flight. The other is in-flight computation of the required conditions for target impact.

Polynomial expansions have the advantage of summarizing the effects of many detailed perturbations in a relatively compact form. These perturbations usually require extensive computation.

The disadvantage of the polynomial, however, is that they have a tendency to be limited over the range of variables, and are inherently associated with a specific coordination system.

Extension of the polynomial method of handling variable launch times leads to two alternatives, according to Leger:

Compute a complete set of guidance coefficients for each of the several specific launch dates under consideration. Try to launch at the first of these times then the second in case of initial failure then the third alternative launch date and so on. Fine adjustment in this system is accomplished by holding the actual launch until the precise time on the selected date.

Add terms involving the launch time parameter to the polynomial expansions and launch at any time within reasonably limits.

Both the foregoing require considerable preflight computation. The former also requires either a rapid reload capability on the art of the guidance computer, or enough storage capacity to store all coefficients for all possible launch times. "Direct computation of precision trajectories has usually been found to be too time consuming to be carried out in flight for launch guidance purposes," Leger said.

Giving extensive technical description of the pseudo target system, he said Convair found the system to be little more complex than single-launch-time systems using polynomial expression. He added, however, that much work remains to be done on the method.

NASA Receives ABMA Men, Facilities

HUNTSVILLE, ALA.—In a brief ceremony Thursday, the Army transferred 4700 employes and turned over $100 million worth of buildings and equipment to the National Aeronautics and Space Administration.

NASA's new Marshall Space Flight Center, headed by Dr. Wernher von Braun, became fully operational upon receiving the personnel and property of the Development Operations Division, Army Ballistic Missile Agency. The property affected is part of Redstone Arsenal here and part of the facilities at Patrick Air Force Base, Cape Canaveral, Fla.

Participants in the ceremony included Maj. Gen. August Schomburg, commanding general, U.S. Army Ordnance Missile Command; von Braun; and Col. Richard Hurst, commander, ABMA.

Marshall Space Flight Center came into being in March but had only a small staff planning organization for the remainder of the fiscal year. The civilian employes involved remained on the Army payroll.

Marshall Center now becomes the NASA operations center for development of vehicles and propulsion and for launch operations. Its activities are supervised by the NASA Office of Launch Vehicle Programs, headed by Maj. Gen. Don R. Ostrander, USAF.

In another development, it was announced that Commander Bart Slattery, USN, will move to Huntsville later this summer as public information officer for the Marshall Space Flight Center. He is now stationed at the Pentagon.

mergers and expansions

FORD MOTOR CO. has established a Special Military Vehicles Operations department as part of its Defense Products Group. Frank S. Kipp, formerly manager of Defense Contract Administration, has been appointed general operations manager. His former office, together with Special Military Vehicles Office, and Mobilization Planning and Defense Sales Department, has been transferred to the new department from the Defense Products Group.

C-E-I-R, INC. has merged with General Analysis Corp., operating under the C-E-I-R name. General Analysis, with divisions at Dugway, Utah, and Fort Huachuca, Ariz., and headquarters at Los Angeles, has had annual sales of about $700,000 and a current backlog of $1.4 million. GAC Stockholders will receive 9 shares of stock in C-E-I-R for 20 GAC shares.

LOCKHEED ELECTRONICS CO. formalized its decision to make headquarters near Princeton, N.J., last week. The Lockheed Aircraft Corp. subsidiary bought 210 acres on which it will begin development in 1961.

ROCHESTER MANUFACTURING CO. has embarked on a long-range research and development and expansion program including a 10,000-sq.-ft. addition to one of its plants in Rochester, and a move to a new plant by its West Coast subsidiary.

NATIONAL CASH REGISTER has established a Military Development and Marketing Department to include its electronic, electromechanical and mechanical systems and components in such areas as airborne, digital and analog computers, related communications equipment, simulators and other devices.

HOUSTON FEARLESS CORP. has acquired Marchetti Associates, Boston electronics research-engineering company formerly affiliated with Avco Corp.'s Crosley Division. Marchetti will operate within the Houston Fearless Federal Group.

COMPUTRONICS, INC. has been formed in Denver, Colo., to develop, manufacture and sell components and systems for instrumentation, computers, controls and data handling. Although a completely independent firm, Epsco, Inc. is a major stockholder, and two Epsco officers serve on the board of directors.

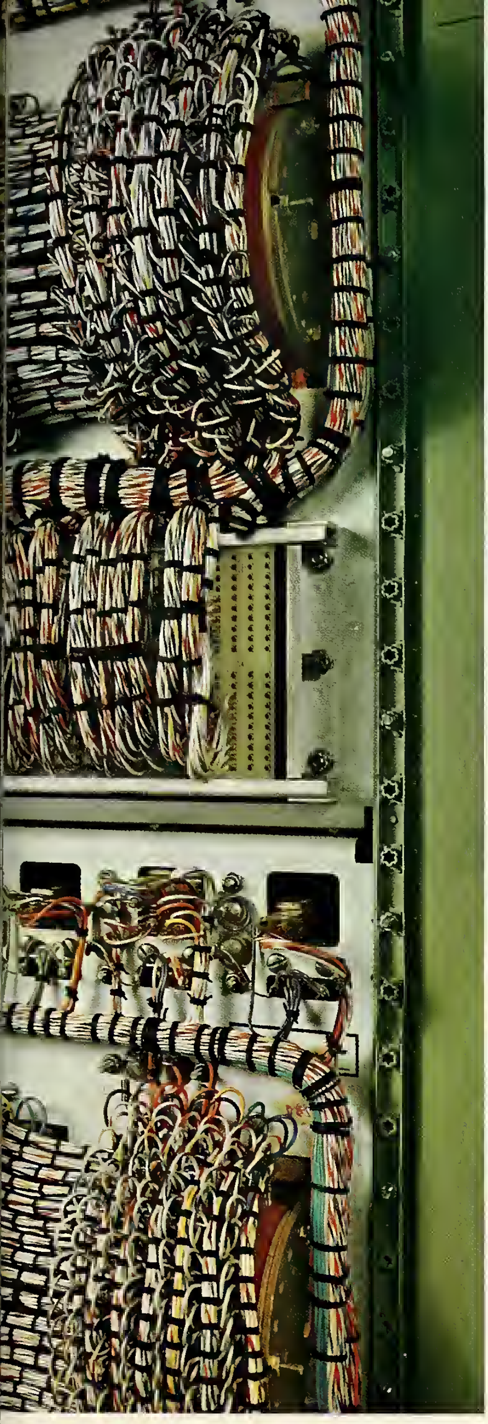
Quail Moves Nearer Operational

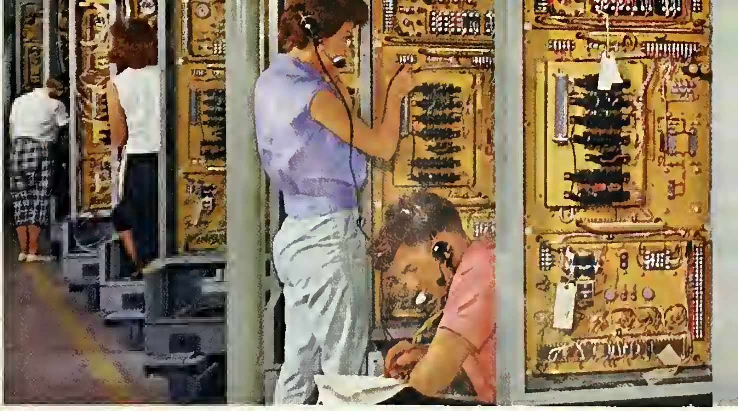
A COVEY OF THREE Quail decoy missiles was salvoed from a SAC B-52G for the first time June 24. The successful test at Eglin Gulf range pushed the divisionary missile a step closer to operational status. The 10-ft. Quail, with electronic augmentation, produces a blip on radar similar to that of a Bomber.

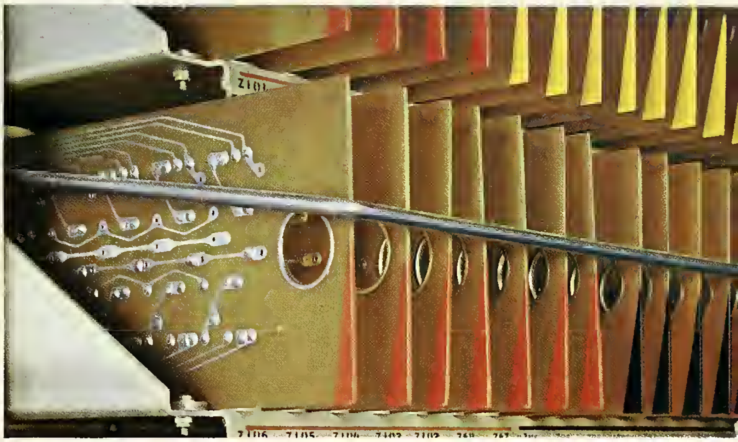
financial

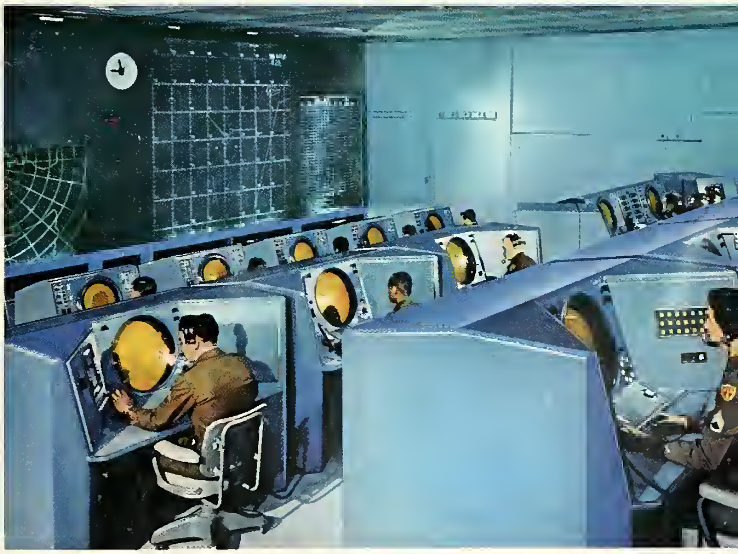
United Industrial Corp.—UIC is distributing as dividends to its own shareholders stock in two of its subsidiaries, Aircraft Armaments, Inc. and U.S. Semiconductor Products. The move is designed to: 1) promote autonomous expansion of certain of its subsidiaries; 2) enable its holders to participate in the equity ownership of such subsidiaries and 3) provide the parent company with additional funds to further its own plans for future acquisition and development.

Avco Corp.—Earnings in the fiscal second quarter ending May 31 climbed to an indicated $3.1 million from $2.9 million for the previous year's period. Indicated sales rose to $86.8 million from $80.7 million for the second quarter period last year.





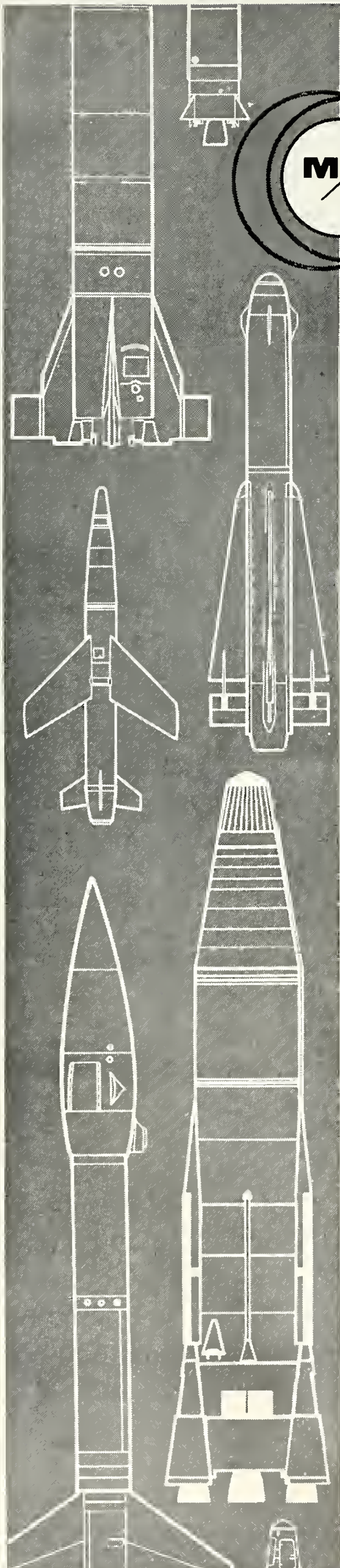




On guard against air attack—The Martin Missile Master electronic air defense system will protect ten major metropolitan areas by year's end. First installations have been delivered ahead of schedule and are now operational. According to the Army, Missile Master "will provide the most efficient and economical control and distribution of firepower available for the defense of strategic areas in the continental United States."

At 00h 00m 01s GMT, July 1, 1960, Martin logged its 590,304,000th mile of space flight

MARTIN



Technical Countdown

ELECTRONICS

Free Radicals Harnessed

The energy released by free radicals can be captured and converted to useful power, according to Energy Conversion Laboratories. The reactions are reportedly being controlled at near room temperature to directly produce electricity. The company offers to demonstrate the technique to any interested parties.

Welded Circuitry Next Step?

Welded-wire matrix circuitry looks like the next major breakthrough in electronics. The big potential of the technique is in adaptability to computer design and automated manufacturing. Circuitry is flexible, has high volumetric efficiency, and offers high-temperature stability and resistance to thermal and physical shock. (Details will be covered in later issue of M/R.)

New Antenna Concept for Hard Bases

"Ring-arrays" may be the answer to problem of hardened antenna installations at missile bases. Such an electronically scanned antenna—now under development at General Electric—would be entirely flat except for small vertical radiating elements arranged in widely spaced concentric rings. For higher-elevation coverage, the radiators could be slots, with no vertical elements.

Lighter and Cheaper Solar Cells

An evaporated coating for solar cells is reported by Bausch & Lomb to have several advantages over the more conventional glass cover slip. Although efficiencies run slightly lower, the process reduces total cell weight about 10% and costs only one-fifth as much as the glass cover. There are no thermal stress problems and no cement (which may solarize and darken to reduce efficiency after exposure to ultraviolet).

Higher Component Densities

Component density continues to increase in missile electronics. The *Sky Bolt* computer is reported to have 3-5 times the density of any other existing ballistic missile guidance computer.

PROPULSION

Thrust compromise for Centaur

Thrust of the uprated Pratt & Whitney LOX-liquid hydrogen *Centaur* engine probably won't quite reach 20,000 lbs. NASA propulsion specialists are convinced the engine can be modified to boost thrust that high from its present level of 15K, but they question whether it will be worth the money involved. Also, they are afraid reliability may fall off when the engine is pushed so hard. A compromise of 18 or 19K is likely to emerge from the contract negotiations this summer.

J-2 Weighs in at 2500 lbs.

The Rocketdyne J-2 200,000-lb.-thrust engine for *Saturn* will weigh about 2500 lbs., excluding tanks. Present plans are to build it into a four-engine 800K second stage with burning time exceeding 100 seconds. Start will be based on a gas generator that, like the engine itself, burns LOX and liquid hydrogen.

Storable for Mach-2 Drone

Typical of the best storable propellants for drone engines is hydrogen and inhibited red fuming nitric acid, says Rocketdyne. Successfully tested in a sustainer-booster system, data indicated that the storable could give Mach-2 performance to a drone for a substantial time period.

Solid-Propellant Torpedo Next

Navy's solid-propelled torpedo program for ASW is advancing. One manufacturer reportedly has test-fired such a torpedo at depth below 1000 ft. and at speeds above 35 knots.

MATERIALS

Self-coating Ceramic for High Temp

Boeing ceramists have developed a ceramic graphite-base material which forms its own protective coating when exposed to high temperatures. The oxidation-resistant coating forms at 2200°F in a typical composition of 50% graphite, 24% molybdenum disilicide and 25% titanium boride. Current work is directed toward using the composite graphite bodies in environments in excess of 3000°F for extended periods.

Meteoroid Impact Simulated

Plastic projectiles will be slamming into materials specimens at speeds up to 26,000 mph as soon as Republic Aviation engineers finish building the actuator—a high-powered hydrogen gun. The hydrogen gas, heated to 15,000°F by an electrical spark discharge, ruptures a metal diaphragm and forces the projectile down a gun barrel.

Modern Technique, New Application

Reporting success in the explosive forming of thrust chambers for drones, Rocketdyne calls its development a feasible production technique.

ASW ENGINEERING

Needed: Standard Depth Terminology

The word "depth" means many things to many people engaged in underseas technology, and there's agitation for standardization of terminology such as used in describing frequency bands. Very deep water (VDW), ultra deep water (UDW), etc., have been suggested. The designation doesn't make any difference as long as a common range definition exists.

NuPad Ranging Has 10-yr. Life

Martin Company's 30-man ASW department is working on a NuPad concept (nuclear-powered active detection). Application is isotopic decay for an electric power source with no moving parts. Active ranging system would be expendable and would have life of 10 years.

Acoustical Lab Submerged

The Martin company has created its own underwater sound laboratory at Middle River, Md. It's dredged an inlet down to 25 ft. depth. The lab can supply power up to 1500 watts and handle transducers up to 1000 lbs. in weight.

Undersea Area Needs Fresh Thinking

A Discussion of:

- Major research program for accurate underwater maps and sub-surface current tables.
- Fixed (anchored) telemetering stations at many locations with instruments that will combine accurate, rapid data acquisition from near-surface depths to 15,000 ft. with equally rapid analysis and readout. Variables to be taken simultaneously are depth ±1 ft., temperature, ±0.01°C, current velocity ±0.1 knot, direction, ±5°; sound velocity, ±0.1 ft./sec., plus direct reading of salinity.
- A propelled deep-diving "fish" to obtain profile data rapidly by fast descent-ascent recording and telemetering either to an aircraft or a mother ship.
- A good underwater buoyant material, probably a plastic, with a near-constant density less than sea water at any depth.
- Electronics without maintaining atmospheric pressure.
- Providing the submariner with accurate information about the immediate volume in which he is operating—a water velocity meter with an accuracy of ±0.1 knots and a sound velocity meter with an accuracy of ±0.1 ft./sec.

by Richard W. Van Hoesen and Marvin S. Weinstein

Underseas technology is a new region of discovery to be explored and treated, just as the atmosphere and outer space. It needs whole new families of instrumentation—but most of all it needs a cross-fertilization in the scientific community of new ideas, new thinking and drastically new approaches.

The problem area covers every bit of navigable water, principally the oceans and salt water harbors of the world and secondarily the navigable rivers and bays. "Area of interest" is not really a correct term, for in reality we are interested in the vast water volume of our globe.

A true understanding of all the variables existing in the volume must be obtained if we are to make full use not only of our present surface and subsurface vessels, but also of planned and future developments. The total mass of analyzed data now available only begets the need for more and better information.

• **Physical variables**—Let's concern ourselves with the military problems of surface and subsurface vessel design, navigation, detection, ranging, ordnance, ordnance control systems and evasive action. We will not dwell on the equally important topics of marine biology and chemistry but shall concentrate on physical variables in the sea.

A modern meteorologist preparing a gross weather map requires at least three accurate bits of information gathered simultaneously at each of many stations on the earth. The variables are: surface air temperature, barometric pressure and wind speed and direction.

This information is not sufficient for the flight meteorologist. He needs additional information on the gradients between the earth surface and the operating ceiling of the aircraft. He needs accurate data on wind, temperature and humidity sampled at many points in the air volume. Further, he requires more frequent sampling since the air space is in use around the clock by more and more aircraft of ever-increasing variety and flight capabilities. The flight meteorologist long ago discovered that fixed station, earth-bound data collection is not enough. He reached out first of all with manned aircraft, sampling over fixed areas. He then increased his data collection capability manyfold by using free floating balloons.

The radiosonde, complemented by RDF and backed up with visual (theodolite) tracking, multiplied his capability many times—and yet he found that the gaps between measuring sites were not being adequately filled. He now has at his disposal special, far-reaching weather radar to fill part of the gap and present constantly changing information.

Let us now examine the lot of the naval meteorologist, responsible for giving advice to ships transiting the open ocean. Weather stations on all land masses surrounding the ocean and island weather stations provide him with the previously discussed weather data. He has in addition data of variable worth collected at various times, from ships transiting the area.

The ships, for instance, give him information on estimated sea state and local wind conditions. He does not have a good profile of surface waves and currents in the transit area at the time of departure. All such vital facts must be calculated from the meager information available. Obviously, he is at a disadvantage in comparison to the continental air meteorologist. This in itself is a good introduction to the vast problems to be solved in this field. We have not yet breached the surface of the sea and a major need has been revealed.

But now let us just dent the surface of the sea. This really is all that a search sonar transducer mounted on the bottom of a destroyer does. The range capability of a sonar in perfect operating condition is severely limited by ever-changing water conditions. Sound refraction at a thermocline can prevent detection of a submarine lurking beneath the thermocline, but well within the maximum range capability of the sonar.

Gross data is now obtained by dropping a B-T (Bathythermograph) over the side on a length of wire, recovering the B-T and determining the depth-versus-water temperature curve under the ship at the particular time of measurement. This information can then be used to obtain gross information on change of sound velocity with depth.

Certainly, this information is better than none, but what is really necessary is a device which will give an accurate picture of the depth-versus-sound velocity contours in a wide area around the ship and which can obtain this information quickly and frequently as the ship moves along on patrol or in escort service.

The same information is of course desired by the submarine. A modern destroyer with Variable Depth Sonar would increase its capability manyfold if it had sufficient information to adjust the sonar depth to varying sound conditions. Likewise the submarine skipper could use the information—offensively for better detection range or defensively to provide cover for efficient evasion tactics.

• **Accurate charts**—We can now descend deeper into the sea and concern ourselves with submarines. The submarine USS Triton just completed a successful submerged circumnavigation of the earth. This voyage was likened to Magellan's voyage. Truly the Triton's voyage was a remarkable feat—and certainly as pioneering as Magellan's.

It would have been even more hair-raising if it had been accomplished far below periscope depth. This would have been entirely analagous to Magellan's venture. Accurate charts were not available to Magellan, nor are underwater profile charts available to the submariner. Magellan had to put up with surface current conditions as he encountered them. This also would have been the lot of the Triton's skipper. Just as Magellan had no advance weather information the Triton could not have any advance subsurface temperature and current information.

Rather than belabor the analogy further, it need only be said that the minimum information felt necessary for reasonable safe surface and air navigation is not available to the deep-running submarine. The Navy needs accurate underwater maps and subsurface current tables. Since no one is absolutely sure of all the variables that enter into subsurface currents, a major research program must be undertaken to include several years of investigation, with the hope that significant trends will be observed from which accurate long-range predictions can be made.

The submariner also must have accurate information about the immediate volume in which he is operating. He needs a water velocity meter with an accuracy of ±0.1 knots and a sound velocity meter with an accuracy of ±0.1 ft./sec. The sound velocity instrument must be capable of giving information at the ship and sampling a large volume around the ship.

• **What's being done?**—The United States must embark on a major oceanographic research program. Various starts are being made in this direction; one is a bill before Congress to provide the funds necessary to build a small fleet of oceanographic research vessels. It is necessary, however, to equip these ships and many more, both military and civilian, with a whole new family of instruments. Instruments must be designed which will combine accurate, rapid data acquisition from near surface depths to 15,000 feet with equally rapid analysis and readout.

The minimum variables to be taken simultaneously are depth ±1 ft., temperature ±0.01°, current velocity ±0.1 knot, direction ±5°; sound velocity ±0.1 ft/sec. It would also be desirable to have a direct reading of salinity. The instruments to make these measurements are not available today. The current techniques for deep sampling are many years old, require time and use indirect methods to obtain vital information.

The most used item on an oceanographic cruise is the Nansen bottle wire cast. The Nansen bottle is an ingenious metal flask, to which two very accurate reversing thermometers are attached. One thermometer is open to sea water pressure and the other is protected from the pressure by a heavy glass enclosure. The combination instrument is slowly lowered to the approximate depth as calculated by wire paid out and the angle measured to the vertical at which time a heavy metal "messenger" is slid down the cable.

VAN HOESEN

WEINSTEIN

The authors are senior scientists and founders of Underwater Systems, Inc., a Wheaton, Md., engineering corporation specializing in acoustics, underwater sound, ultrasonics, magnetics, pressure and sub-audio signals, magnetic tape and direct data recording, and electronic instrumentation.

Both men are electronics engineers and physicists. Mr. Van Hoesen, previously associated with Naval Ordnance Laboratory, Naval Research Laboratory, and Vitro Laboratories, is president of Underwater Systems. Dr. Weinstein, former chief of the hydroacoustics branch of Naval Ordnance Laboratory, is the firm's senior scientist.

When the "messenger" reaches the Nansen bottle valve, capturing a sample of sea water and simultaneously separating the mercury column in the thermometers, the bottle is then raised to the surface, the thermometer readings recorded and the water transferred to a flask for later analysis.

The entire measurement process takes much time and limits the number of observations that can be made in any one location. To obtain true water temperature and absolute depth from the thermometer readings requires much additional work.

• **New thinking required**—The Nansen technique is given only as a concrete example of one present-day technique, not as a criticism of the Nansen bottle-reversing thermometer system as an accurate scientific instrument. It has indeed had the test of time since it is essentially the same as when it was invented by Fridtjof Nansen near the end of the 19th century. This is however, the middle of the 20th century: we need new instruments, new thinking, drastically new approaches, and an opportunity for scientific hybridization.

While most readers of this magazine are not specialists in the underwater medium, they are nevertheless thinking scientists and engineers. We all must think of the vast volume of water as a new region to be explored. We should treat it just as we treat the atmosphere and outer space.

• **How do we do it?**—First of all, we need fixed (anchored) telemetering stations at many locations, fully equipped with instruments to sample the entire depth. These would correspond to fixed weather stations.

Next we should consider a propelled deep-diving "fish" to obtain profile data rapidly by rapid descent-ascent recording and telemetering either to an aircraft or a mother ship. These would correspond to high-altitude sounding rockets. It may be very desirable to obtain data at a constant depth over a long track. This could be accomplished by a propelled underwater fish, programed to maintain depth and course, record all data and then rise at the end of the track and telemeter the data to a shore station, mothership or aircraft.

The latter, could conceivably be used in combination with the vertical sampler to find a depth for optimum detection range or a safe zone for high-speed undersea travel without risk of being detected.

It is obvious that a whole family of instruments is needed. The needs range from single variable to multi-variable acquisition. Furthermore, simple medium accuracy, dependable and expendable devices are needed to fulfill certain tactical military needs. Relatively complex, expensive and highly precise equipment is needed for the research work.

Does this not strike a familiar chord with the missile scientist? We hope we have not lost materials engineers, propulsion specialists and electronic circuit and components men along the way. Every one of these specialists and more are required if this underwater frontier is to be crossed.

Let's cite just two examples in materials and electronic components. The first concerns body and buoyant material for underwater "satellites." A good underwater buoyant material ideally would have a constant density less than sea water at any depth. The best material at present is gasoline. Gasoline, for example, with all its hazardous drawbacks, is the material used to buoy the bathyscaph Trieste. A safe, compact inexpensive material is needed. Probably a plastic will be found to fill the bill.

The second example concerns electronic parts for the deep-diving measuring and telemetering systems. Every present-day underwater electronic system is enclosed in a heavy metal case to protect elements from sea pressure.

The cases become bigger, heavier, more difficult to handle and prone to leaks as the need for greater depths increases. How much simpler it would be if we could enclose the electronics in an oil-filled compliant chamber and forget about maintaining atmospheric pressure in the electronics compartment. To do this will require study of solid-state devices (obviously vacuum tubes are out) and the behavior of components under great pressure. This could open a new field in component design and materials testing.

In this article, we have only scratched the surface of the problem. It has been written only to whet the scientific appetite, not to pacify scientific hunger pangs. More ideas must come from more minds if we are to be successful.

Chemical Booster Proposed For Manned Moon Missions

NASA official urges clustered base for direct shot of Super Nova, sites nuclear need beyond moon

A chemical-nuclear *Super Nova* vehicle for manned moon missions in the early 1970's is proposed by a high official of the National Aeronautics and Space Administration.

Harold B. Finger, NASA chief of nuclear engines, suggests that the vehicle might be based on a clustered chemical booster with thrust of 2 to 3½ million lbs. Such a vehicle would accomplish the same manned lunar landing mission as an all-chemical *Nova* vehicle with about 10 million lbs. takeoff thrust.

Finger told the American Nuclear Society in Chicago that NASA recognizes that it must begin soon the design of a vehicle capable of lunar landing missions. Two approaches are possible: space rendezvous and orbital refueling on the one hand, a direct shot from earth and return on the other.

The all-chemical *Nova* and the chemical-nuclear *Super Nova* are designed to accomplish the direct shot, Finger explained. The space rendezvous and orbital techniques will be studied actively at the new NASA Marshall Space Flight Center in Huntsville, Ala., based on the use of several *Saturn* vehicles.

Finger did not elaborate on the chemical booster proposed for his nuclear-chemical vehicle. However, it is known that NASA is studying several concepts based on a single 1½-million-lb.-thrust Rocketdyne F-1 engine, rather than a cluster of F-1's as in the more well known *Nova* concept. The single F-1 would have a circle of 188,000-lb.-thrust H-1 engines around it. H-1 is the engine unit in the *Saturn* cluster.

Beyond the lunar mission, Finger declared, "for interplanetary missions, nuclear rocket stages are so far superior to chemical systems in delivering high payloads that their development becomes a necessity if we are to have real freedom to travel at will in space.

"For such missions, I like to quote numbers that show that a 150,000-lb. nuclear powered space ship can be started up in an earth orbit, orbit Mars, and return to the earth orbit with approximately 20,000 lbs. or about 7 times as much as can be returned with an all-chemical system."

Present NASA plans call for flight-testing a nuclear rocket stage as an orbital start stage by 1965, Finger declared. The nuclear engine will be boosted into orbit by a two-stage *Saturn* vehicle.

Noting that other flight-testing methods have been proposed, Finger said none had been ruled out of the NASA program. Among the other methods, he listed ground-launched test shots and limited range flights over water with a nuclear second stage. "They are being evaluated before the flight test system and program are finalized," he added.

The NASA propulsion chief said a major advantage of the orbital start test is in the fact that it appears to have the potential for development to operational status. The other testing methods are advocated as preliminary to an orbital start—to demonstrate the feasibility of nuclear flight.

A two-stage chemical *Saturn* with a nuclear third stage would deliver about twice the payload of an all-chemical *Saturn* for an escape-velocity mission, Finger asserted. He continued:

"It is, however, my attitude that even if such a configuration gave no payload increase, such a three-stage chemical-nuclear *Saturn* should become an operational vehicle in order to supply us with operational experience on nuclear stages."

Finger said such experience would develop reliability and a feeling of confidence in the engine's capability and that operating problems have not been overlooked. "Such a feeling of confidence is essential if we are to commit our stable of vehicles beyond *Saturn* to nuclear systems," he added.

Kiwi A Instrumentation Near Perfect

Instrumentation of the Project *Rover* nuclear rocket test area operated with an overall error of under 1%—less than the statistical sum of all the component errors—during the Kiwi A test.

This performance was achieved despite some unique problems, according to spokesmen for Edgerton, Germeshausen and Grier, Inc., *Rover* instrumentation contractors, who recently outlined their design philosophy before the American Rocket Society.

The low error was probably brought about by compensation between individual parts of the system, said Bryant L. Hanson, EG&G senior scientist.

Hanson's firm has a subcontract from the J-8 division of Los Alamos Scientific Laboratory of the University of California to instrument the *Rover* test area.

The system is designed to provide more than 800 channels for measurement and control, resulting data being telemetered over two miles of cables. This media was chosen in preference to radio because designers had more confidence in the final accuracy of its data transmission—and also because of its relative simplicity. The maintenance and disassembly building (MAD Building), test cell, and control point complex are mutually separated by about two miles.

All connections between the flatcar-mounted Kiwi A reactor and the test cell are of the breakaway type, so that the reactor can be returned to the MAD building via remote-controlled locomotive. These connections contain gaseous and fluid services, as well as instrumentation.

Subsystems for handling propellant, purge gases, cooling water, and heavy water were designed for remote control operation. "An unusual degree of flexibility in subsystem control was necessary," according to Percival T. Gates, another senior engineer with EG&G, "to allow measurement of engine response as a function of rod position and frequency, mass flow and various other parameters—as well as to incorporate suitable means to operate the power control system under closed loop conditions using an analog computer."

• **Bugaboos**—The serious consequences inherent in a failure of the instrumentation were an overriding consideration in all planning, since nonreversible processes at moderate power levels "could define a point of no return in so far as subsequent hot runs of a particular core" might be involved.

"Loss of data under these circumstances would be most unfortunate," Gates added.

Control system failure was another bugaboo, since an emergency "scram" would subject the entire assembly to intolerable thermal stresses.

Scram refers to emergency action taken to rapidly reduce the reactivity of a nuclear reactor of this type. It can be accomplished by using control rods to sharply cut reactivity, or by dumping a selected material, in many cases boron, into the core to speed the dropoff.

Boron acts as an absorbent to neutrons, the particles necessary to sustain a nuclear chain reaction; when these are absorbed, the reaction drops. This system is quite similar to that applied to the Tory 11A reactor in the *Pluto* nuclear ramjet program previously described. (M/R June 20 Pg. 30)

Some characteristics of the system:

• Most analog measurements are in real time outputs.

• Accuracy of one percent was required, (and achieved with Kiwi-A), of subsystem performance and core diagnostic data.

• Channels are instrumented for bandwidths from DC to 40 cycles per second.

• Due to use of an unshielded reactor, locally mounted transducers are subjected to severe neutron and gamma fluxes.

• Multiple range measurement capability is incorporated, to obtain accuracy sufficient in view of wide dynamic range or uncertainty of expected values.

• Data reduction system is not required to be of high capacity or speed, because of the length of the test cycle and the nature of the data—which was, in the case of Kiwi-A, taken for analysis only in event of malfunction.

• Large investment involved in producing a relatively short high power run dictated a requirement for extreme reliability.

• No attempt was made to develop a prototype of flyable instrumentation.

The instrumentation system is basically a conventional analog system using proven equipment and techniques wherever possible, according to Hanson. But a high degree of refinement and specialization was needed to adequately handle the particular task of testing the nuclear reactor.

The system utilizes chopper preamplifiers, multi-channel strip chart recorders and DC meters. Conversely, it is devoid of multiplexing equipment and radio telemetry. Heart of the quantitative channels are the Offner electronics chopper preamplifiers which drive Sanborn multi-channeled direct writing recorders through approximately two miles of wire.

• **Data guarded**—Gain controls are incremental, rather than continuously variable, on preamplifiers and recorder amplifiers. Gain accuracy and stability specifications for both these inputs are such that an overall accuracy of 1% is probable, independent of detailed voltage calibration.

This philosophy was followed, Hanson said, so that a failure of the voltage calibration system would not prevent scientists from obtaining usable data based upon the station log of gain settings. Values of the fixed gains are chosen so that, for all signal levels between 0.83 and 400 millivolts, it is possible to get at least 75% full-scale recordings on the recorders.

All the channels have approximately a ten-volt DC full-scale signal on the long lines. To minimize cross-talk and pickup effects, the transmission of power level AC signals over the long lines is "religiously avoided," and other steps are taken to eliminate these undesirable effects.

The possibility of an error being introduced into the system due to the radiation environment of the reactor core area was considered, and an analytical method was developed and solved, based on a Laplace transform.

Results indicated that when the thermocouples were intimately bonded to the core structure, the error introduced was approximately 0.8%. If the thermocouple junction is suspended freely in the gas channel, the error may be increased to as high as 2%. Transient response of the thermocouples in all cases is approximately .2 sec., Hanson stated.

• **Alternatives**—Gates spelled out considerations affecting future instrumentation for nuclear reactor tests in the propulsion field. He listed possible choices between analog/digital systems, hard wire/radio transmission, and continuous/sampled data systems.

For Kiwi-A, as an example, a direct wired analog system was chosen, "with the full realization that special design efforts would be required to achieve the accuracy and reliability implied by the testing concepts."

This choice was made for several reasons. First, hard-wire was chosen over radio transmission because of its simplicity and confidence in its accurate transmission performance.

Secondly, it was recognized that any sampled data schemes considered would require high sampling rates to cover a 40 cycle bandwidth. Also, the need for a high percentage of analog data in real time would require extensive and complex demodulating equipment. Relative cost, availability and a strong desire to stick with simple circuitry mitigated against sampling techniques, Gates said.

Finally, the advantages of the pulse code system, especially that of ease in achieving high transmission and data handling accuracy, appeared most applicable.

For the majority of analog measuring channels involving subsystems and core diagnostics, low-level transducer signals are run 400 feet from the test cell to a distribution bunker through a tunnel. Signals are preamplified prior to transmission through the long lines to the control complex.

At the control point, signals connect directly to conditioning amplifiers of strip chart recorders. Auxiliary recorder outputs allow paralleling meters, limit circuitry, and computer inputs with the recorded signal level.

The long lines are 19 gage wire in 51 pairs of buried cables. Balanced conditions are maintained at driving and load ends. Measurement signals are not mixed with switched or carrier type channels in the same cable.

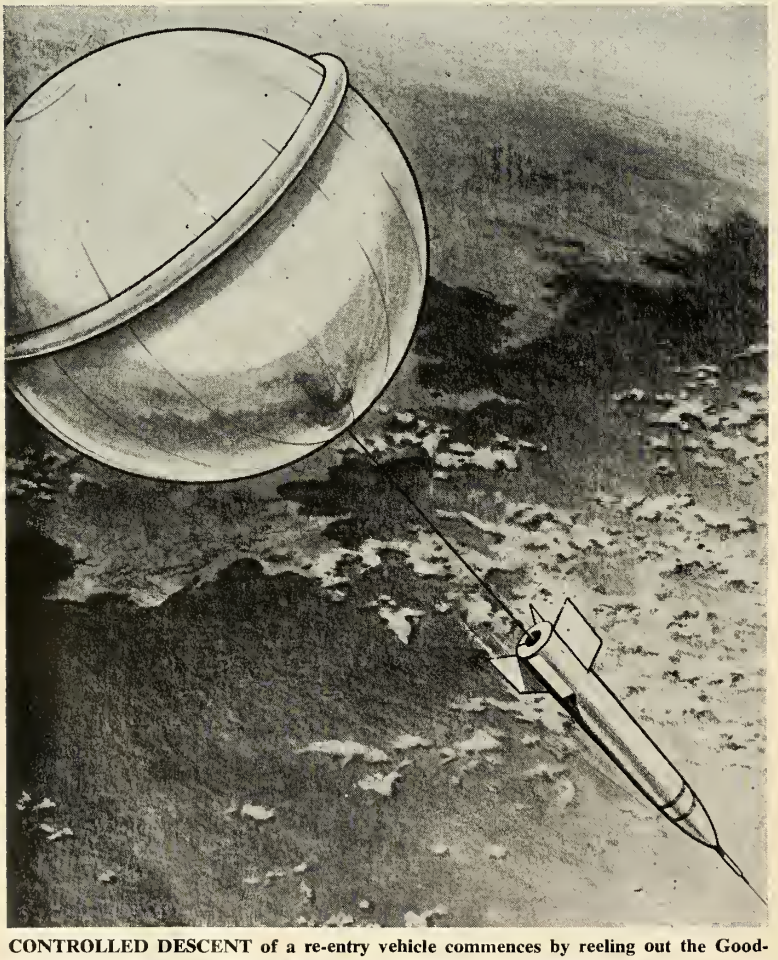
- **Easy reliability**—Enhancing the reliability of the system required no elaborate measures.

Primary measurements are dually or triply instrumented. In some cases, provisions are made through meter observations to select the most reliable signal for closed loop system usage, although all signals are recorded.

All power supplies are doubly protected. DC supplies are run in parallel through diodes with a battery standby. An auxiliary alternator is kept on the line in case of power failure, with provisions to automatically dump nonessential loads. A spare transducer excitation oscillator is kept in standby.

Balloons to Aid Vehicle Recovery

Balloon-parachute systems, designed to stabilize, decelerate and recover re-entry vehicles, are being developed by Goodyear Aircraft Corp. for the Wright Air Development Division of the Air Force's Air Research and Development Command.



CONTROLLED DESCENT of a re-entry vehicle commences by reeling out the Goodyear balloon until it reaches a flow region suitable for maximum drag. After a considerable reduction in speed, a parachute completes the recovery.

In operation, the balloon will be ejected and inflated directly behind the primary (re-entry) body. Once the primary body is stabilized, the balloon will be slowly reeled out until it reaches a flow region suitable for maximum drag.

When the primary vehicle has slowed sufficiently, a parachute will be ejected to complete the recovery. The combination is necessary because parachutes are not reliable at speeds greater than Mach 2 and one alone will not stabilize a high-speed vehicle.

Initial flight tests, involving a 9-ft.-diameter balloon and modified *Cree* test missiles from Cook Electric Co., will take place within a month.

The first flight is expected to hit speeds of Mach 2 at 150,000 ft. Subsequent experiments will reach speeds of Mach 3 and altitudes of 200,000 ft.

The coated fabric balloon is treated with temperature-sensitive paints. Instruments will measure the drag forces on the cable and check the internal balloon pressure.

The balloons have proven perfectly stable in a series of wind tunnel tests at the Langley and Lewis research facilities of the National Aeronautics and Space Administration. Quarter-scale models reached simulated altitudes of 155,000 ft. and speeds approaching Mach 3.5.

Goodyear spokesmen said that flight tests at speeds up to Mach 10 and at 200,000 ft. are contemplated as a probable follow-up to the initial *Cree* experiments.

Inflation time for the balloons is around 0.10 sec. In addition to the recovery aspect, they may make it possible to reduce significantly the heat shielding of a re-entry vehicle.

Pneumatic Bar Aids Saturn Welding

by Jay Holmes

HUNTSVILLE, ALA.—An engineer here has developed a tricky gadget that solves the problem of matching wrinkly edges of thin aluminum to be welded into *Saturn* LOX and fuel tanks.

William J. Franklin, a mechanical engineer from Oklahoma, has produced a pneumatic stainless steel circular backup bar that presses the huge cylindrical tank sections into position for accurate circumferential welding.

The large diameter and thin shell of the propellant tanks create a vexing problem in fabricating the huge booster rocket. *Saturn* tanks come in two sizes: a central tank 105 in. in diameter and eight outer tanks 70 in. in diameter. The 70 in. tanks vary in thickness from 0.05 in. to 0.19 in. The 105 in. tanks vary from ¼ in. to ⅜ in.

And to make matters more difficult, the welding backup bar must be removed after welding through a hole 15 in. in diameter.

Here is how Franklin solved the problem: Stainless steel bands are slipped over the outside of the cylindrical sections near the edges to be welded. Then the circular backup bar is assembled inside the tank sections. The outer ring of the bar is segmented stainless steel. Inside the stainless steel are successive layers of high-temperature plastic and rubber.

After the two cylinders are brought together, air is pumped into the rubber sections so that the circles expand and stretch the diameter of the skins by about ¼ in. Now that the skins are stretched to an exact fit, welding is performed.

• **Stress relieved**—After welding, the backup bar is released, allowing the aluminum to contract to its original position. This relieves some of the tensile stress in the welded area.

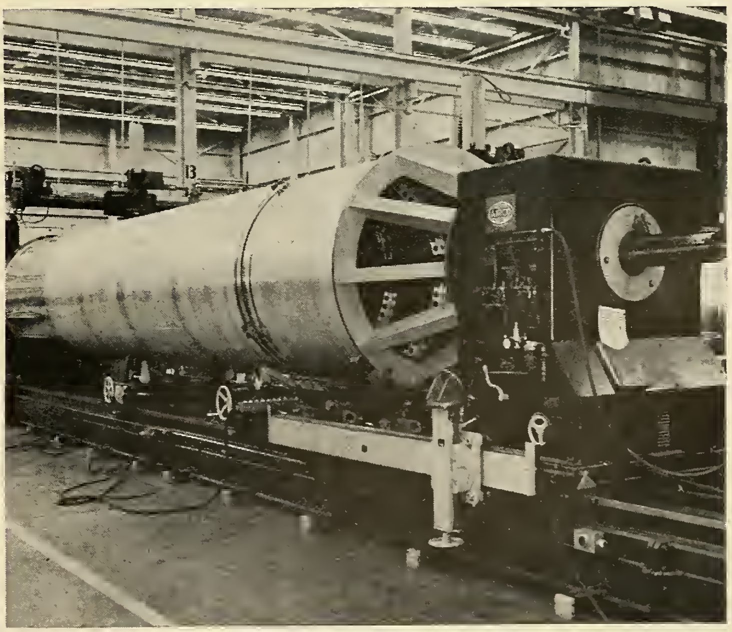
When the last section of tank containing the front end is welded into place, one man remains inside. Afterward, he disassembles the backup bar and passes the pieces out through the opening. The aluminum skin is strong enough to hold a man walking around inside. However, he must wear clean, rubber-soled shoes.

The new backup bar was developed in time for use on the *Saturn* fabrication. The circular bar used to weld *Jupiter* tanks at the Army Ballistic Missile Agency was rigid and did not follow the material completely.

Franklin, chief of the tool engineering section in the Fabrication Laboratory of ABMA's Development Operations Division, said tooling for welding has been a problem since first attempts were made to provide a pressure-tight weld seam and still maintain a high-quality, porosity-free weld with high joint efficiency on tanks for the *Redstone* missile.

The new device, which Franklin calls the Serpentine Segmented Backup Bar, can be controlled to allow for different thicknesses of metal in the exterior skin. He said the bar provides the same reliable and uniform backup pressure throughout the entire 360° of the weld, since the internal rubber bladder supplies equal pressure both radially and circumferentially.

Franklin, 38, has been a missile designer for six years and transferred to the National Aeronautics and Space Administration this month, with the switch of the ABMA group to NASA's George C. Marshall Space Flight Center.



BACKUP BAR is fitted into a section of a 70-in. *Saturn* tank by worker at Redstone Arsenal. Air is pumped through tubes to inflate pneumatic ring, providing pressure that holds thin aluminum skin to circular shape. At right, cylindrical sections are held in position for welding. Stainless steel bands on either side of seam provide countertension.

Missiles and Rockets

ASTROLOG

A status report on U.S. missiles and rockets and all space vehicles presently in orbit

★ *Indicates change since May 2 edition*

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
SPACE VEHICLES			
ADVENT (ARPA-Air Force)	GE-Bendix prime for polar-orbiting phase	New overall name for advanced communications satellites STEER, TACKLE and 24-hour instantaneous repeater called DECREE	R&D
AGENA (Air Force)	Lockheed, prime; Bell, propulsion	1700-pound satellite after burnout	Used in DISCOVERER program; larger model to be used with ATLAS and THOR under development; NASA also will use to take place of cancelled VEGA
ATLAS-ABLE (NASA)	STL, prime; GE/Burroughs, Arma, guidance; Rocketdyne, Aerojet-General, ABL, propulsion	Orbit 200-lb. vehicle around moon or send into deep space	Two lunar orbit attempts beginning this summer
★CENTAUR (NASA)	Convair, prime; Pratt & Whitney/-JPL, propulsion	Pair of LOX-liquid hydrogen engines, 30,000 lbs. total thrust, atop ATLAS booster, capable of orbiting 8000 lbs. or accelerating almost 3000 lbs. to escape velocity.	First test flight in 1961
COURIER (ARPA-Army)	Army Signal Corps, prime	Delayed repeater communications satellite	R&D; satellite in advanced stage; first to be launched in spring
DISCOVERER (Air Force)	Lockheed, prime; GE, re-entry vehicle	THOR-AGENA launchings of early stabilized satellites	Of first 11 launched, 6 stabilized in orbit; ejected capsules not recovered
DYNA-SOAR I (Air Force)	Boeing, space craft and systems integrator; Martin, propulsion	Boost-glide orbital space craft; first space bomber; TITAN booster	R&D; first glider flights from Edwards AFB by 1962; intensive material studies underway
★ECHO (NASA)	Langley Research Center, prime	Puts 100 ft. inflatable sphere in 1000 mile orbit; passive communication satellite	First launch failed in May. Another due in July
FIREFLY (NASA)		Geodetic survey satellite	
JUNO II (NASA)	ABMA/Chrysler, prime; Ford Instrument, guid.; Rocketdyne/JPL, prop.	Early deep space booster; small payload	Five more shots planned
★MERCURY (NASA)	NASA, prime; McDonnell, capsule	First manned satellite	Capsule tests on ATLAS to begin; manned capsule launching by REDSTONE down Atlantic this summer; first manned flight scheduled in 1961.
★MIDAS (Air Force)	Lockheed, prime	Early-warning satellite; detect ICBM launchings by infrared before birds leave pad; R&D models weigh 2 tons; operational system to have 12-15 satellites	R&D; second launching May 24 partial success.
★NIMBUS (NASA)	Contract to be let shortly	Follow on to TIROS weather satellite	First launching scheduled for late 1961
NOVA (NASA)	No prime announced; Rocketdyne, propulsion	Clustered 6-9 million lb. booster plus upper stages	Early R&D on 1.5 million lb. F-1 engines
ORION (ARPA-Air Force)	General Atomic	Space station launched by series of atomic explosions	Advanced engineering studies underway; tests may be attempted; program shifted to Air Force alone

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★PROJECT 3059	No contracts announced	Solid motor in 1 million to 2 million lb. thrust class	Research determining feasibility; study contract expected soon; NASA contracting for complementary studies with United Technology Corp.
★SAMOS (Air Force)	Lockheed, prime	Reconnaissance satellite; formerly SENTRY	R&D; stabilization already achieved in DISCOVERER series; first test launching scheduled this year; scheduled to be operational late 1963.
★SATURN (NASA)	NASA Marshall Center, prime and booster; Douglas and Convair, upper stages; Rocketdyne, booster and mid-stage engines; Pratt & Whitney, top-stage engines	Series of multistage vehicles based on 1.5-million-lb. clustered booster and upper stages using combinations of LOX-liquid hydrogen engines. Earliest model will orbit 23-25,000-lb. payload	Static firings of clustered booster in progress successfully since April; first flight test spring of 1961; flight with live upper stages scheduled 1963
★SCOUT (NASA-Air Force)	Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Allegany/Thiokol, propulsion	Solid four-stage satellite launcher; 200 lb. payload in orbit	Air Force and probably Navy also to use for research; first test in April partially successful; AF test expected soon
★THOR-ABLE (Air Force-NASA)	STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion	Three-stage vehicle with orbital capability of 200 lbs. New ABLE-STAR upper stage has restart engine, boosts heavier payload	THOR-ABLE phasing out. THOR-ABLE-STAR operational in TRANSIT and will be used for COURIER
★THOR-AGENA (Air Force)	Lockheed, prime; Bell, propulsion	Two-stage vehicle capable of orbiting more than 300 lbs. AGENA-B restartable upper stage boosts payload capacity to 1250 lbs.	Operational in DISCOVERER program. AGENA-B first used May 24 to launch MIDAS II. NASA to use extensively beginning late '61
★THOR-DELTA (NASA	STL, prime; IT&T, guidance; Rocketdyne/Aerojet-General/Allegany,prop.	Improved THOR-ABLE with 480-lb. payload capability	Nearly operational; to be used in ECHO and TIROS programs
★TIROS (NASA-AF-Army-Navy-Wea. Bu.)	RCA-Army Signal Corps, prime	Meteorological satellite; TV pictures of cloud cover	R&D; three launchings this spring; first launching in April a success; two more scheduled; one late this year.
★TRANSIT (ARPA-Navy)	Johns Hopkins Laboratory, prime	Navigational satellite; R&D model weighs more than 250 lbs.; operational model about 50 lbs.	TRANSIT IB R&D satellite put in orbit April 13; IIA plus piggyback satellite successfully in orbit June 22, four satellite transit systems scheduled operational 1962.
TRIBE (ARPA)		Family of space launching vehicles	Planning
YO YO (Navy)	No contract announced	Tactical sea-launched one-pass reconnaissance satelloid	R&D
★X-15 (NASA-AF-Navy)	North American, prime; Thiokol, propulsion	Rocket plane; 3600 mph; flight at edge of space; on AF model each XLR-11 rocket engines develop 16,000 lbs. of thrust; later XLR-99 engines to develop 50,000 lbs. Three planes delivered	Powered flights in progress; plane #1 has hit Mach 3 and more than 80,000 ft. with XLR-11 engine; plane #2 out of operation for installation of XLR-99 engine for fall flight; plane #3 heavily damaged by fire June 8 in test prior to flight with XLR-99
MISSILES & ROCKETS			
ALFA (Navy)	Avco, prime	ASW surface-to-underwater; 500 lb. solid; conventional; formerly called ABLE	Deployed on destroyer escorts
★ASROC (Navy)	Minneapolis-Honeywell, prime; Sangamo Electric, Sonar; Torpedo, GE; depth charge, M-H.	Surface-to-underwater; solid rocket torpedo or depth charge; nuclear or conventional: range about 8 miles.	R&D; operational on Destroyers Norfolk & Peary; plans call for deploying on 150 destroyers and cruisers.
ASTER (Navy)	Ford Instrument, prime	Antisubmarine rocket launched from surface ships; 30-35 mile range; marriage of TERRIER and torpedo	R&D
ASTOR (Navy)	Westinghouse, prime	ASW underwater to underwater; rocket torpedo; nuclear	R&D
★ATLAS (Air Force)	Convair, prime; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE, re-entry vehicle	ICBM; more than 5500-to-9000-mile range; liquid; nuclear	49 military launchings: 31 successes, 8 partial, 10 failures; 6 scientific launchings: 5 successes; 1 failure. Two operational at Vandenberg; 11 scheduled sites for 13 squadrons named
ARM (Air Force)	No contract announced	Anti-radar missile	R&D

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
BOMARC-A (Air Force)	Boeing, prime; Westinghouse, guidance; Marquardt, propulsion	Ramjet surface-to-air interceptor; liquid booster; 200 m. range; Mach 2.7; nuclear	First squadron operational at McGuire AFB, N.J.
★BOMARC-B (Air Force)	Boeing, prime; Westinghouse, guidance; Thiokol, propulsion	Ramjet, surface-to-air; solid booster; Mach 2.7; more than 500 m. range; nuclear	Ten launchings: 2 success, 8 failures; first successful flight April 14. Production program sharply cut back by Air Force.
★BULLPUP (Navy-Air Force)	Martin, prime; Martin, guidance; Thiokol (Reaction motors), propulsion	Air-to-surface; 4-8 mile range; conventional 250-lb. bomb; new model has pre-packaged liquid; nuclear-tipped model under development	Deployed with Atlantic and Pacific Fleets; bigger model under R&D; Air Force buying modified version; Marines launching BULLPUP from helicopters
COBRA (Navy)	No contract announced	Anti-ship radar missile	Early R&D
COBRA (Marines)	Boelkow Entwicklungen, West Germany, prime; Daystrom, U.S. distributor	24.6-pound anti-tank missile; 1 mile range; 191 mph speed; solid propellant	Marines planning to purchase; Army considering them; already operational with West German troops
CORPORAL (Army)	Firestone, prime; Gilfillan, guidance; Ryan, propulsion	Surface-to-surface; 75-mile range; liquid; nuclear	Deployed with U.S. & NATO troops in Europe
CORVUS (Navy)	Temco, prime; W. L. Maxson guidance; Reaction Motors, propulsion	Air-to-surface; pre-packaged liquid; radar homing; about 100-miles range	First successful test July 18, 1959
CLAYMORE (Army)	No contract announced	Anti-personnel missile	R&D
CROW (Navy)	No contract announced	Air-to-air missile	R&D; has been flight tested
★DAVY CROCKETT (Army)	In-house project at Rock Island, Ill., arsenal	Surface-to-surface; solid; bazooka launched; sub-kiloton nuclear warhead; two launchers of different size for various ranges; vehicle mounted or carried by two men	R&D; operational in FY '61; first NATO deliveries also FY '61
EAGLE (Navy)	Bendix, prime; Sanders, guidance; Aerojet propulsion	Air-to-air; 100-mile range; nuclear; for launching from relatively-slow aircraft	Early R&D
★FALCON (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion	Air-to-air; 5-mile range; Mach 2; solid; conventional; GAR-11 has nuclear warhead	GAR1 through GAR4 operational; GAR9 & 11 R&D
GENIE (Air Force)	Douglas, prime; Aerojet-General, propulsion	Air-to-air; unguided; 1.5-mile range; nuclear	Operational
GIMLET (Navy)	No contract announced	Air-to-surface; unguided; considered highly accurate	R&D
HAWK (Army)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 20-mile range; solid; conventional; designed to hit low-flying planes	Operational; units training for early deployment to Europe and Far East; advanced Hawk under development; Jan. 29 successfully intercepted Honest John, first known intercept of one tactical missile by another
HONEST JOHN (Army)	Douglas, prime; Hercules, propulsion	Surface-to-surface; unguided; 16.5-mile range; nuclear	Operational; deployed in Europe
HOUND DOG (Air Force)	North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion	Air-breathing air-to-surface; 500-mile range; Mach 1.7; turbojet; nuclear	Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400; training fully underway; B-52 launched one in April after non-stop flight with it to North Pole from Florida
★JUPITER (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion; Goodyear, re-entry vehicle	IRBM; liquid; nuclear	To be deployed with Italian troops in Italy and may be used as AICBM target drone; 29 military launchings; 22 successes; 5 partials; 2 failures. One 15-bird squadron to be deployed in Turkey. Last R&D test shot launched Feb. 4
LACROSSE (Army)	Martin, prime; Federal Telecommunications Laboratories, guidance; Thiokol, propulsion	Surface-to-surface; highly mobile; 20-mile range; solid; nuclear	Operational; 4 units being trained; 3 more planned for 1960; to be deployed in Europe and Far East; advanced LACROSSE R&D program dropped at least temporarily
LITTLE JOHN (Army)	Emerson Electric, prime; ABL, propulsion	Surface-to-surface; unguided; 10-mile range; solid; nuclear	Operational this year; units training with it

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
LOBBER (Army)	No contract announced	Surface-to-surface; cargo carrier; 10-15 mile range; also can drop napalm; LOBBER with warhead called BALLISTA	Studies
LULU (Navy)	No contract announced	Surface-to-surface; nuclear	R&D
MACE (Air Force)	Martin, prime; AC Spark Plug, guidance; Allison, propulsion	Air-breathing surface-to-surface; more than 650-mile range; turbojet & solid; nuclear; B model has 1000-m. range	Being deployed with U.S. troops in West Germany; now all mobile but hard-base version in R&D
MATADOR (Air Force)	Martin, prime; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; 650-mile range	Being turned over to West Germans; also deployed in Far East
★MAULER (Army)	Convair, prime	Surface-to-air; IR guidance; highly mobile antiaircraft and antimissile missile for field use; to be on trucked vehicle	R&D; NATO may buy
★MINUTEMAN (Air Force)	Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Avco, re-entry vehicle; AMF-ACF rail launcher	2nd generation ICBM; solid; fixed or mobile; nuclear; 3 stages	R&D; scheduled to be operational mid-1962 at Malmstrom AFB; launching of eight tethered birds from silos successfully completed in May; first full R&D launching from Cape in Dec.
★M-55 (Army)	Norris Thermodor, prime	Four-inch diameter, small, short-range poison gas rocket; to be fired from 45-tube launchers	Operational
MISSILE A (Army)	ARGMA to act as prime; six R&D contracts for components scheduled to be let soon	Surface-to-surface; 65-70 mile range; solid	Design studies
★NIKE-AJAX (Army)	Western Electric, prime; Western Electric, guidance; Hercules Powder, propulsion	Surface-to-air; 25-mile range; Mach 2.5; solid & liquid; conventional	Deployed in U.S., Europe & Far East; about 170 batteries in U.S.
★NIKE-HERCULES (Army)	Western Electric, prime; Western Electric, guidance; Hercules & Thiokol, propulsion	Surface-to-air; 80-mile range; Mach 3+; nuclear; claimed effective against air-launched air-breathing missiles	Rapidly replacing NIKE-AJAX; estimated 80 batteries deployed in U.S.; N-H soon to have tactical anti-missile capacity
★NIKE-ZEUS (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol and Grand Central, propulsion	Anti-missile; 3-stage; 200-mile range; solid; nuclear	R&D test launchings at White Sands at the rate of about one a month beginning Aug. 26. 8 launchings; 5 successful, 2 partial, 1 failure. Test shots in the Pacific planned in mid-1961. Administration has refused to okay Army recommendation to begin major production
★PERSHING (Army)	Martin, prime; Bendix, guidance; Thiokol, propulsion	Surface-to-surface; two-stage solid; under 700-mile range; nuclear	R&D; to replace REDSTONE; first R&D launching Feb. 25 from Cape; four launchings: 4 successful; first stage only live
★POLARIS (Navy)	Lockheed, prime; GE, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle	Underwater and surface-to-surface; solid; 1200-mile range can hit more than 90% all targets in Russia; nuclear	67 launchings of test vehicles; 46 successes; 18 partial; 3 failures; launched from surface ship Aug. 27, 1959; expected operational late in 1960; 1100-mile plus range vehicles under test at Cape Canaveral; first sub launchings this summer; 21 subs authorized or planned by Administration to date
RAVEN (Navy)	No contract announced	Air-to-surface; about 500-mile range	Study
★REDEYE (Army)	Convair, prime; Atlantic Research, propulsion	Surface-to-air; 4-foot, 20-lb. bazooka-type; IR guidance; solid; conventional; container-launcher disposable	R&D; Marines also will use; NATO may buy
REDSTONE (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion	Surface-to-surface; liquid; 200-mile range; nuclear	Deployed with U.S. troops in Europe
REGULUS II (Navy)	Chance Vought, prime; Stavid, guidance; Aerojet-General, propulsion	Surface-to-surface; turbojet & solid; 500-mile range; nuclear	Deployed aboard U.S. submarines; used as target drone
SERGEANT (Army)	JPL/Sperry, prime; Sperry, guidance; Thiokol, propulsion	Surface-to-surface; solid; more than 75-mile range; nuclear	Production. To replace CORPORAL this year
SHILLELAGH (Army)	Aeronutronics, prime	Surface-to-surface; lightweight; can be vehicle-mounted	R&D; expected to be operational mid-1960's

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
SIDEWINDER (Navy)	GE-Philco, prime; Avion, guidance; Naval Powder Plant, propulsion	Air-to-air; IR guidance; 6-7-mile range; conventional; new I-C models to have switchable IR and radar-guided warheads	Deployed with Navy and Air Force; all-weather type under development
★SKY BOLT (Air Force)	Douglas, prime; Nortronics, guidance; Aerojet, propulsion; GE, re-entry vehicle	Air launched ballistic missile; more than 1000-mile range; solid; nuclear	R&D; to be purchased by British; operational 1964-65; both U.S. and British planes to test launch from Eglin AFB, Fla.
SLAM (Air Force)	No contract announced	Surface-to-surface; low-altitude; supersonic; nuclear-powered ramjet; nuclear	Study-R&D
SNARK (Air Force)	Norair, prime; Northrop, guidance; Aerojet-General, propulsion	Surface-to-surface; 5500-mile range; solid and turbojet; Mach .9; nuclear	Deployed at Presque Isle, Maine
SPARROW III (Navy)	Raytheon, prime; Raytheon, guidance; Aerojet-General, Thiokol, propulsion	Air-to-air; 5-8 mile range; Mach 2.5-3; solid and pre-packaged liquid; conventional	Operational with carrier aircraft; earlier SPARROW I obsolete; new contract aimed at extending range and altitude
★SUBROC (Navy)	Goodyear, prime; Kearfott, guidance; Thiokol, propulsion	Underwater or surface-to-underwater; 25-30 mile range; solid; nuclear	Estimated operational date: 1961. To be installed first on Thresher Nuclear-powered attack submarine
SS-10 (Army)	Nord Aviation, prime	Surface-to-surface; primarily anti-tank; 1600-yards range; 33 lbs. solid; wire guided; conventional	Operational with U.S., French and other NATO and Western units; battle-tested in North Africa
SS-11 (Army)	Nord Aviation, prime	Surface-to-surface; also helicopter-to-surface; 3800-yard range; 63 lbs.; wire guided; conventional	Operational. Under evaluation by Army.
TALOS (Navy)	Bendix, prime; Farnsworth/Sperry, guidance; Bendix/McDonnell, propulsion	Surface-to-surface; 65-mile range; solid & ramjet; Mach 2.5; nuclear	Operational aboard cruiser Galveston
TARTAR (Navy)	Convair, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 10-mile range; Mach 2; 15 feet long & 1 foot in diameter; solid dual-thrust motor; conventional	Many test firings in Pacific; expected deployment 1960 as primary armament of guided missile destroyers; production
TERRIER (Navy)	Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion	Surface-to-air; 10-mile range; Mach 2.5; 27 feet long; solid; conventional	Operational with fleet
TERRIER-ADVANCED (Navy)	Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion	About 100% performance improvement over TERRIER	Operational Advanced TERRIERS to be deployed about mid-1960
★THOR (Air Force)	Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE, re-entry vehicle	Surface-to-surface IRBM; 1500-mile range; liquid; nuclear	Operational; 4 bases set up in England. 63 military launchings: 44 successes; 11 partial; 4 failures; 29 scientific launchings; 24 successful, 2 partial; 3 failures; R&D and "hot rod" advanced tests completed Feb. 29.
★TITAN (Air Force)	Martin, prime; Bell, Remington Rand, guidance; Aerojet-General, propulsion; Avco, re-entry vehicle	Surface-to-surface ICBM; 5500-mile range; liquid; 90 feet long; nuclear TITAN I nearing operational status, burns LOX-Kerosene; TITAN II, two years off, has storable propellants, inertial guidance, bigger payload	16 launchings test vehicles: 12 successes; 1 partial; 3 failures. Five sites for 8 sites for 11 squadrons named; 14 squadrons planned; operational spring 1961; first Vandenberg launchings scheduled this Oct.; operational "J" series of launching begins this Summer
★TYPHON (Navy)	Westinghouse, prime; Bendix propulsion	Medium and long range seagoing anti-missile missiles; formerly called SUPER TARTAR and SUPER TALOS; solid booster and ramjet sustainer; conventional; supersonic	Early R&D; may be used on hydrofoil destroyers
WAGTAIL (Air Force)	Minneapolis-Honeywell, prime	Air-to-ground; low-level; solid; designed to climb over hills and trees	R&D
WILLOW (Army)	Chrysler, prime	Highly-classified missile	R&D
ZUNI (Navy)	Naval Ordnance Test Station, prime	Air-to-air, air-to-surface; solid; unguided rocket; 5-mile range; conventional	Operational

SATELLITES

SATELLITE	COUNTRY	STATUS
★EXPLORER I (30.8 lbs.)	U.S.	Launched 1/31/58, est. life 3-5 years. Orbits earth, perigee: 216.8 m., apogee: 1198.3 m., period: 107.9 min. (Discovered Van Allen Belt)

SATELLITE	COUNTRY	STATUS
★VANGUARD I (3.25 lbs.)	U.S.	Launched 3/17/58, est. life 200-1000 years. Orbits earth, perigee: 405.7 m., apogee: 2460.6 mi.; period: 134.1
LUNIK I "MECHTA" (3245 lbs.)	Russia	Launched 1/2/59. Believed to be in orbit around sun on 15 mo. cycle.
★VANGUARD II (20.7 lbs.)	U.S.	Launched 2/17/59, est. life 10 years +. Orbits earth but is "wobbling," perigee: 346.9 m., apogee: 2045, period: 125.3 min., inclination to equator: 32.88°.
PIONEER IV (13.40 lbs.)	U.S.	Launched 3/3/59. Orbits sun, and achieved primary mission, an Earth-Moon trajectory.
★EXPLORER VI "PADDLE-WHEEL" (142 lbs.)	U.S.	Launched 8/7/59, est. life: to Aug. 1961. Orbits earth, former perigee: 156 m., former apogee: 26,357 m., former period: 12½ hours, present orbit unknown; speed: at perigee 23,031, at apogee: 3126 mph., inclination to equator: 46.9°.
★VANGUARD III (about 100 lbs.)	U.S.	Launched 9/18/59, est. life 30-40 years. Orbits earth, perigee: 318.8 m., apogee: 2330.2 m.; period: 130
LUNIK III (about 614 lbs.)	Russia	Launched 10/4/59, est. long life, orbits earth-moon; took first picture far side of moon; est. perigee: 30,000 m., apogee: 291,000 m.
★EXPLORER VII (91.5 lbs.)	U.S.	Launched 10/13/59, est. life 20 years, orbits earth, perigee: 343.7, apogee: 672.4; period: 101.2; transmitter to cut off in October.
DISCOVERER V CAPSULE (less than 300 lbs.)	U.S.	Launched 8/13/59. Satellite burned up in atmosphere Sept. 28. Capsule also thought to have been destroyed, but it was later rediscovered and first thought to be an unidentified Soviet satellite. Est. life several months. perigee: 134, apogee: 1074.
★PIONEER V (94.8 lbs.)	U.S.	Launched 3/11/60, est. life: forever orbits sun, interplanetary radio communication satellite, passed 20 million miles June 20.
★TIROS I (270 lbs.)	U.S.	Launched 4/1/60, est. useful life: 3 mos., perigee: 428.9 m.; apogee: 468.5; period: 99.2. Picture-taking weather satellite.
★TRANSIT IB (265 lbs.)	U.S.	Launched 4/13/60, est. life: 16 mos. minimum; perigee: 229; apogee: 456.4; period: 95.6. First R&D navigation satellite.
★SPUTNIK IV (10,008 lbs.)	Russia	Launched 5/15/60; est. life: relatively brief; original perigee: 188; apogee: 229; changed to 191/429 on May 19. Test of support systems, cabin, for manned space flight; attempt to return from orbit failed because of poor orientation of retrorocket.
★MIDAS II (5000 lbs.)	U.S.	Launched 5/24/60; est. life: 40 months; perigee: 300.1; apogee: 319.6; period: 94.4; Telemetry for IR scanning failed two days after launch.
★TRANSIT II-A (223 lbs.)	U.S.	Launched 6/22/60; est. life: 50 years, perigee: 382; apogee: 657.
★NRLI (40 lbs.)	U.S.	Launched 6/22/60 with TRANSIT II-A; Solar radiation measuring satellite.

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management

AF Applies Weapon System Concept

by Don Zylstra

BEDFORD, MASS.—Techniques that produced the nation's family of ballistic missiles in a record compression of development time are being applied to harness Air Force control of its vast war-making potential.

The Ballistic Missile Division's weapon system concept is being introduced into command and control electronics at Laurence G. Hanscom Field here. The huge electronic complex welds together the Air Force Research and Development Command, Air Materiel Command and electronics systems "users." Their task is to make communications and control systems for all weapons compatible—and instantly responsive to direction and control at any command level.

Electronics systems testing and development have been assigned to the Command and Control Development Division, promptly dubbed C Square D Square ($C^2 D^2$), one of four divisions in the major reorganization of ARDC. Logistics counterpart of $C^2 D^2$ is AMC's Electronics Systems Center. To insure compatibility of weapons systems and the men who will live with them as operators, the Command and Control Defense Systems Office (CCDSO) represents the Air Defense Command at Hanscom. Plans call for other systems "customers," including TAC, SAC, and air training commands to be represented too.

Maj. Gen. Kenneth P. Bergquist heads the Command and Control Development Division and Maj. Gen. Clyde H. Mitchell the Electronic Systems Center at Hanscom. Directing the Command and Control Defense Systems Office for ADC is Brig. Gen. Loren G. McCollom.

$C^2 D^2$ is an outgrowth of the Air Defense Systems Integration Division (ADSID), a tri-command group to integrate electronic units subordinate to SAGE with air-breathing weapons systems and the ground environment. With the growth of ballistic missiles projects and their electronics systems, ADSID was expanded into $C^2 D^2$ and the relationship of ARDC, AMC and ADC was retained in the enlarged Hanscom complex.

• **Applying civilian know-how**—MITRE Corporation, organized as a non-profit technical advisory group to ADSID, for systems analysis and

Hanscom Complex Leadership

BERQUIST

MITCHELL

McCOLLOM

HALLIGAN

Civilian and military personnel man the Satellite Situation Display Room in Hanscom's Space Surveillance Control Center.

mmunication

engineering, continues to serve $C^2 D^2$ n the same capacity. MITRE was organized a year and a half ago when Massachusetts Institute of Technology decided technical management exceeded the research functions that were properly the province of its Lincoln Laboratory; it sponsored establishment of MITRE as a non-profit corporation.

C. W. Halligan, on leave from Bell Telephone Laboratories, is president of the group. Robert R. Everett is vice president for technical operations, and Peter J. Schenk is executive vice president. MITRE has been unlike Space Technology Laboratories in its relation to BMD in the systems management area; it has never served in a "line" capacity as STL once did in early missiles development. Administrative direction of contractors remains solely with $C^2 D^2$, following MITRE's recommendations.

Indications are that the Air Force may follow this procedure in establishing "Aerospace Corp.," non-profit successor to STL.

MITRE is often asked for "recipes" for merging two types of electronics systems. The group also makes preliminary designs of new concepts, digesting new military needs and smoothing requirements before they are proposed to industry.

Typical of MITRE's services to $C^2 D^2$ is the survey begun Jan. 15 by the Winter Study Group under the corporation's sponsorship. Where BMD was able to set its own new pattern of weapons systems offices and projects, $C^2 D^2$ inherited existing electronics projects and programs. These enterprises are under scrutiny by the Winter Study Group to decide how they fit the new development division and what's next in terms of new programs.

Personnel total about 100, half of them military. Twenty-five per cent are from MITRE and the others are specialists, borrowed wherever their know-how could be found—from Systems Development Corp., The Rand Corp., Bell Laboratories, and others.

• **Master plan is goal**—Panels listed by the Winter Study Group include: design methodology, weapons, logistics, reliability, vulnerability, threat, people, data processing equipment, data processing utilization, display, communications equipment, sending equipment and cost. Dr. A. G. Hill of MIT heads a steering group to advise Winter Study personnel. Technical director for the group is Gordon Thayer, an American Telephone and Telegraph vice president. Assisting him are $C^2 D^2$ Lt. Col. John L. Lombardo and J. F. Jacobs, MITRE technical director.

The study group hopes to "finish a one-shot survey of all existing electronic systems, those in development and in planning stages by midsummer," Peter Schenk said. Their report will advise $C^2 D^2$ how to tailor them into a master reaction plan.

A possible following study would be a similar survey, including a review of related systems in other armed services—probably at a Joint Chiefs of Staff level.

• **Division of duties**—Within $C^2 D^2$ are four directorates—only two performing line functions. Systems Management directs 13 "L" systems project offices or ESSPO's (counterpart of BMD's WSPO's). Spelled out, ESSPO becomes Electronic Supporting System Project Offices. The Technology directorate has systems planning and applied research functions designed to usher in the next generation of electronics systems.

AMC's Electronic Systems Center divides its approach to the 13 systems under three directorates—(a) command control and communications systems, (b) intelligence and warning systems, and (c) weapons control systems.

$C^2 D^2$ systems management covers the entire electronics field—including SAGE, designated 416-L; a weather observation system integrated with FAA and the Department of Commerce, 433-L; BMEWS, known as 474-L; and the Space Surveillance Center or space track facility, 496-L. The latter, located at Hanscom keeps tab on all man-launched space vehicles.

The Hanscom complex deals entirely in complete systems in both the development and logistics area. Agencies for the development and procurement of electronic systems components are now the responsibility of the Rome Air Materiel Area, Rome, N. Y.

• **Keeping on fairway**—Unlike weapons system development, where there is usually a definite break between systems models or refinements, development of electronics systems implies a carefully planned "evolution." Such progress involves changes made without interrupting the 24-hour operation of electronics and communication systems, because most such facilities are one-of-a-kind projects.

In summing up his view of AMC's task at Hanscom, Gen. Mitchell put it this way: "If we didn't continue research during the whole span of systems development, we would inevitably deliver an obsolete system. The twin ghosts of inflation and obsolescence cast their dark shadows over the drawing board of the electronics engineer just as they plague the aeronautical engineer. A sign on the wall in the office of one of our electronics plants reads, 'if it works, it's obsolete.' Amusing perhaps—but often painfully true. The other side of the coin is that, if it doesn't work, we're doomed. If I may switch my metaphor, we've got to stay in the narrow fairway between these two out-of-bounds markers."

Historically, the world's armed services have acquired new weapons and methods for using them from dedicated groups of zealots impressed with the potential of the weapons they developed. Fighting and defense forces have been assembled by bringing these weapons "building blocks" under a single command. Whether such arms collections adapted themselves to each other, or were readily brought to bear in a concerted military effort, were secondary considerations when months and years were available to prepare to deploy them.

• **Electronic reduction**—But complex weapons systems in the Space Age have sown the seeds of their own frustration by compressing reaction time into minutes—to the point where less than half an hour may be available to react effectively to enemy attack. Supersonic aircraft and a growing variety of missiles, plus refinements in all fields of weapons, propulsion and transport, extend the arms and legs of the fighting man to carry nuclear warheads swiftly to any point on earth.

A Space Age electronics revolution has provided the "reflexes" that govern the response of individual weapons systems to awesomely complex stimuli. The Air Force is welding them into a reaction pattern corresponding to extensions of the eyes, ears and brain of the fighting man. To achieve the optimum planned response at all levels of command and control is Hanscom's function.

In governing a striking power multiplied a hundredfold in speed and capacity since World War II, electronic devices must control weapons reaction instantaneously, with miniscule selectivity. They must reduce upper-echelon command problems to a few straightforward decisions left for top military commanders—ultimately the nation's chiefs of staff and the President himself.

This implies a series of electronic systems imposed one above the other—elements in an ascending pyramid, climaxing in ultimate command and control. At the base of the pyramid, these systems will perform functions akin to the most automatic human reflexes. At higher levels they will respond to planned inputs—as the human system does to carefully learned habit patterns.

And, at peak levels in the structure, the response will correspond more closely to reasoned human response to stimuli gathered by the brain through the eyes, ears and other senses.

To approach desirable efficiency, the Air Force command and control complex must deal with intelligence gathered by every conceivable means. The spectrum of this data extends from radar impulses spelling out the path and speed of incoming targets, the information supplied by underwater sonar and ASW gear, or airborne surveillance cameras, to the reports from consuls and military attaches.

All of this disparate data must be sorted, weighted and fed into the command and control complex at the point where it will have its appropriate effect on the ultimate decision.

"Unfortunately none of these sources oblige by yielding their data in computer language," Schenk said. "All of this welter of information must be translated into figures, the computer's universal tongue, and programed to enable the machine to supply an answer. 'Electronic brain' is a misnomer too readily applied to our computers. At best they can digest masses of information—even offer a variety of possible decisions—but ultimately the commander must command.

"To enable him to reach the best answer, the data sifted by the computer must be selective. Insisting on every detail isn't technically feasible or even humanly desirable. But by using electronic aids correctly we *can* transmit, process and display the data needed for decisions that will control our Space Age war machine."

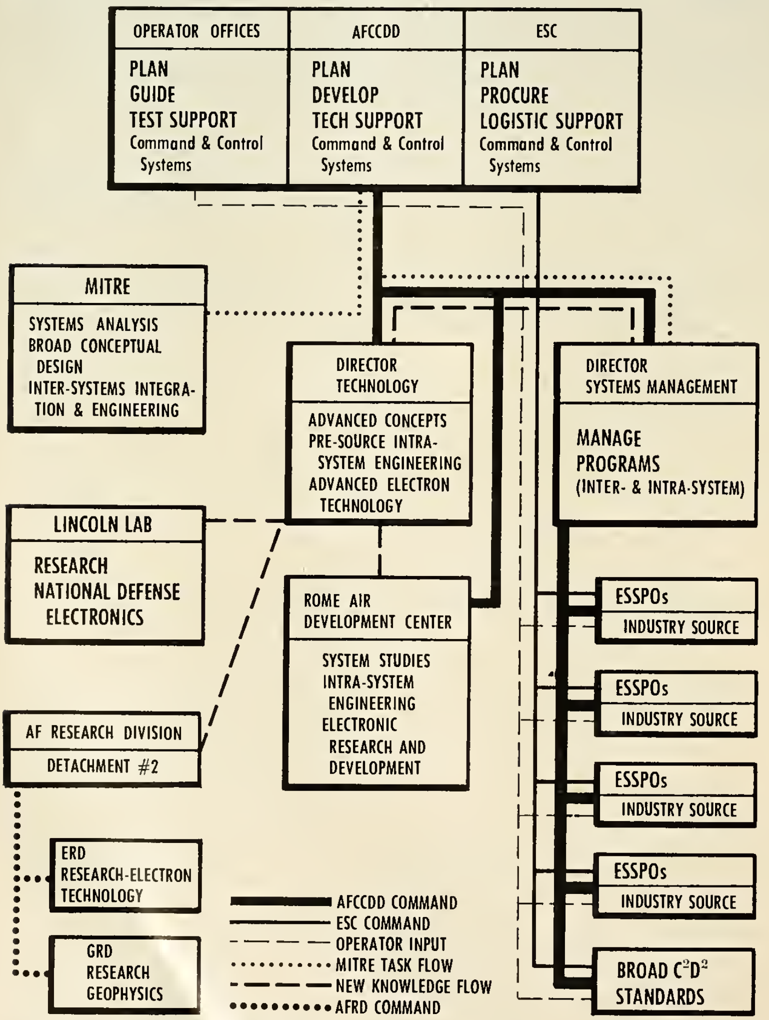
While the computer far exceeds the humain brain in speed and accuracy once it embarks on its pre-arranged task, the information it "displays out" must be available for human decision and control at any command level.

Human override must remain a possibility—to prevent, for instance, shooting into an unsorted cluster of mixed enemy and friendly flying objects, if the computer hasn't been supplied the entire "friendly list."

Typical human intervention at a command post such as NORAD might involve human estimates of the degree of weapon readiness, whether to bring forces into play in a token or massive strike, estimates of the relative "hotness" of the war in related areas, how much force to withhold for a follow-on strike.

Establishment of the Hanscom complex answers the need for an infinitely sophisticated command and control network.

Until C^2D^2 was established, no single Air Force Agency had focused on command and control integration. Even when this coordination is well advanced we will still be without a true, nationally commanded defense system. At best we have "watch committees" of senior officers, observing potential external threats and controlling our retaliatory forces.



RELATIONSHIPS of the Hanscom complex.

Isolator Solves Vibration Problems

Kerley's tuned cable mounts use unique construction to block build-up at resonance, will not bottom out under overload

by Charles D. LaFond

Problems of simultaneous shock, vibration, and noise in missiles and ground support equipment are being solved successfully by a versatile cable isolation mount developed by Kerley Engineering, Inc., Washington, D.C.

Competitively priced, the anti-resonance tuned isolators employ a unique steel cable construction which, its developers say, is effective in any plane, withstands tremendous shock and steady-state g loads, limits noise transmission, and will not bottom out under overload. Because of its modular, all-metal construction, applications appear to be nearly unlimited—temperature, humidity, salt spray and radiation effects are negligible.

Not touted as a cure-all for every design deficiency, the cable isolation mount is being pushed as a new medicant for the troubled designer facing impossible specification requirements.

The units are being tested by various military agencies and industry in everything from gyros to generators. The high interest follows reports that they have been used successfully to solve "impossible" problems.

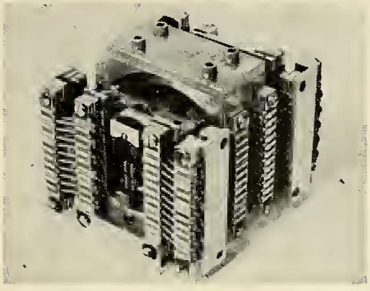
In one test program alone (for the isolation of a *Mercury* capsule radar beacon), Kerley's system successfully endured test of —100° to +1000°F and shock of 80 g's to simulate re-entry. The beacon survived too.

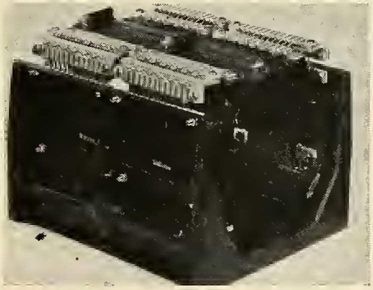
• **Construction unique**—Essentially, the Kerley mount consists of a short L-beam joined to flat-stock extensions of each leg by continuous S-shaped cable wound through "combs" (see photographs).

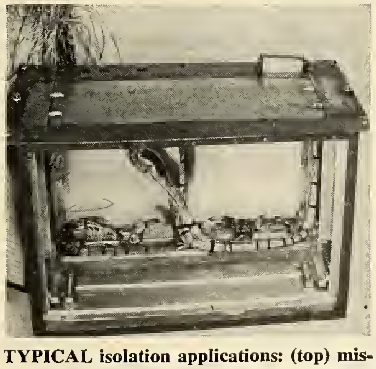
Diameter of the holes through which the cable is strung is smaller than the cable diameter. Thus, the cable must be twisted to pass through each hole. Tolerances on the holes are held to ±0.001 or 0.002 inch.

The plurality of cable and the total number of cable strands provide most of the surface for friction damping—no snubbers are needed.

Cable arrangements provide anti-resonance features; the random arrangement of strands builds a nonuniformity into the assembly, preventing high build-up at resonance. Prestressing the cable makes response nonlinear, and further breakup at resonance is achieved.







TYPICAL isolation applications: (top) missile gyro designed to take 20 g's from 5-10,000 cps; (center) *Mercury* capsule test radar beacon isolated from re-entry violence; (bottom) B-58 electronics-cabinet corner mounts.

After passing the resonant point, there are no secondary harmonics causing additional response buildup. The output goes down and—without exception—stays down, according to Kerley.

Under heavy shock, energy is absorbed through several motion cycles; the cables act as parallel linkages, rotating the motion into another plane. Bottoming is thus prevented.

Under severe overload, the cables give—but the isolator does not bottom out. If damage occurs, it is to the mount, not the item being supported. A few strands may break and the natural frequency is altered but the isolation still exists.

• **Costs competitive**—Per item costs for small (1/8-in. cable, nominal length) are double that of standard rubber mounts. As size increases, comparative costs decrease. A 1/4-in. cable unit is about the same price as a rubber mount designed for the same load.

But Kerley feels it can do a better job with fewer isolators. Also, as production in its New Jersey plant increases, quantity lots will be considerably lower. (A 30-40% reduction on large quantities will soon be available.)

Reductions are due to the higher production yield of mounts now possible. Reproducibility to spec requirements is held to a very close tolerance—no failures have ever been reported by users, said Kerley.

• **One big use barrier**—Biggest hurdle now faced by Kerley is to teach users how to install the mounts.

Use of the isolators today is largely an art, not a science, principally because fundamental knowledge of vibration and shock damage is scant. The same holds true for the performance of the cable isolators. Kerley's present successes are due in large part to personal experience, difficult to pass on to customers.

Arthur D. Little, Inc., Cambridge, Mass., has just started a program to study performance characteristics of the Kerley mounts. It will perform a complete mathematical analysis of the units. From these studies, instructional material will be prepared for future users.

• **Are claims justified?**—Kerley Engineering says it is solving the multi-directional shock and vibration problem—effectively, safely, inexpensively. To investigate these claims, M/R asked recent users, all associated with the missile/aircraft industry. Here are representative comments:

• Melpar, Inc., Arlington, Va., feels that the isolators have saved it "several hundred thousand dollars" on its contracts for electronics equipment for the B-47 and B-58 bomber programs.

Company officials said they had a very serious problem after testing the first of a large order of rack-mounted sets. Rigidly mounted, according to specifications, they failed shock and vibration tests. Because of space limitations, conventional MIL-spec rubber mounts could not be used, so they tried the cable isolators. So successful were the units that Melpar recently purchased 10,000.

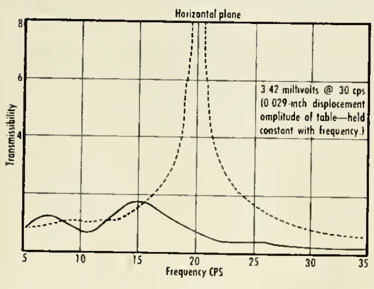
• AeroGeoAstro Corp. of Alexandria, Va., used the mounts to isolate the radar beacon altimeter carried in a *Mercury* capsule test. Fired with the Big Joe *Atlas-Able*, Sept., 1959, the equipment was recovered intact. A company spokesman said that when it was tested on a vibration table, the 12 g's applied was effectively reduced to 4 g's by use of the isolator system. As mentioned earlier, the beacon survived re-entry and was recovered intact.

• Jansky & Bailey, Inc., Washington, a subsidiary of Atlantic Research Corp., mounted sensitive electronic test chassis with the isolators on a rugged *Nike-Hercules* test console built by Bell Laboratories. A company mechanical engineer chose the isolators because of ease of installation in a tight space and because of the multi-directional protection offered.

• In exhaustive road-bounce tests of motor generator sets on the Corps of Engineers, Fort Belvoir test range, the truck driver reported (after 100 times around the course) that the equipment was fine but that he and the vehicle couldn't take any more.

• The same result occurred at the University of Michigan. Extensive vibration tests of the mounts at resonance were halted at the end of a month when a cam on the shaker unit gave way—the mounts were unscathed.

These represent a sampling of responses to M/R, but in checking out what appears to be a better "mousetrap" one thing stood out: There were no serious critics among any of those who have tested and used the new isolation mounts.



COMPARISON of transmissibility tests at resonance performed by a Navy laboratory on a typical gyro mount using Kerley cable isolation system and then standard MIL-type rubber mounts.

Recruit Center

Joint Interviews Set During WESCON Days

Los Angeles—An unusual approach to proselyting of scientists and engineers will be evident at the Western Electronic Show and Convention (WESCON) Aug. 23-26. A large centralized recruiting center is to be set up in the Shrine Exposition Hall, not far from WESCON's location in the Los Angeles Memorial Sports Arena.

The center will be sponsored by Careers, Inc., the same firm which undertook a similar venture at the Institute of Radio Engineers (IRE) meeting in New York last March. Company President William Douglass said the IRE effort resulted in hundreds of interviews for the 27 companies which took part.

He expects 50 companies to participate in his unusual recruiting effort at the Shrine, which Douglass admits is timed to coincide with WESCON. Free shuttle buses will operate every five minutes between the recruiting center at the Exposition Hall and the WESCON exhibition at the Sports Arena. They will carry billboards urging WESCON visitors to visit the recruiting center.

• **No objection**—Asked whether the center could be considered a violation of WESCON efforts to discourage recruitment at the meeting, Douglass cited a letter received from a WESCON official which states: "We, of course, have no objection to the fact that the career center will be conducted in the same city and on the same dates as WESCON."

Prospects visiting the Shrine hall will find a large reception and registration room containing brochure racks where each participating employer will list employment requirements and information on his firm.

At each side of this area will be registration booths where the prospect can complete a registration form. This form, identifying him only by number, is duplicated and goes to all employers taking part in the center. On the form, he may indicate those firms in which he is particularly interested.

• **Behind curtains**—Any company interested in interviewing the prospect may send his number up front where it will be posted on large call boards in the outer lobby. If the prospect wishes to talk to the company, an appointments desk will arrange an interview.

Each participating employer is provided with a 20-ft. x 16-ft. screened interviewing unit. This includes a curtained reception area and three small interview cubicles.

Cost to each employer participating is $1275, which includes rental for the interviewing area as well as administrative services. Douglass believes this will enable companies to carry out recruiting at a cost considerably below that of the usual practice of maintaining so-called "hospitality" suites in convention hotels.

"Employers like to do things in a dignified way . . . to escape dark corners and tapping men on the shoulder," says a Careers, Inc., brochure on the program. "They avoid this and achieve success by cooperating in a single center where engineers can come to see what new development in their field may be of interest to them."

Douglass says the average cost per hire for employers participating in the New York program was $200.

RCA Proposes Maneuvering Satellite-chasing Camera

Use of a maneuverable satellite-chasing camera is being proposed by RCA's Astro-Electronic Products Div., Princeton, N.J., which is currently developing a high-resolution space camera suitable for the technique.

The camera was described by Spencer Spaulding, Astro-Electronic manager, in a recent speech before the American Rocket Society in Los Angeles.

The camera could be launched either separately or with a satellite and ejected later. In either event, the objective would be for the camera vehicle to remain roughly 100 ft. from the satellite to observe satellite performance.

By preprograming and radio assist from ground tracking stations, the camera would photograph its subject from different locations. If a pulsed light source were used for control, illumination also would be provided for use in the earth's shadow, said Spaulding.

The new camera records images in the form of electrical charges on sensitive tape. Capable of storing up to 300 pictures, the equipment would transmit data to earth, using standard television techniques, on radio command after each orbit is completed.

World's Largest Antenna Getting Final Evaluation

Service test evaluation of TAHA (Tapered Aperture Horn Antenna)—reported to be the world's largest receiving antenna and the only one of its type—is scheduled to be completed next month. The tapered-aperture antenna is 1000 ft. long, 500 ft. wide, and 250 ft. high. It was developed by Developmental Engineering Corporation for the Army Signal R&D Laboratory under a $900,000 contract.

Long-Range IR Detector Made by ITT for Air Force

A new ultrasensitive infrared search system using a liquid nitrogen miniature cooler will detect enemy jets at long distances, according to the Air Force.

Developed by International Telephone and Telegraph Corp. for the Air Research and Development Command, the system will be used to guide interceptors toward penetrating bombers after initial ground-radar detection.

Actually, two units will be used, said ARDC. One is the long distance search unit. A second scanner is locked on target for continuous tracking after the search unit locates the target.

A test model of the search-track equipment, designated AN/AAR-21, has been delivered to the Air Force for flight evaluation.

Shell Casting Produces 100-lb. Parts

New method fills gap between solid-mold and frozen mercury investment casting processes and preserves details

by John F. Judge

GROTON, CONN.—A bright new chapter in the development of investment casting is being written by the Arwood Corp. For the first time, the process is being released from its inherent size limitation.

Investment casting blossomed during World War II and has grown phenomenally, even though until now the largest part produced could be easily held in the palm of the hand.

The Arwood technique turns out intricately shaped castings—weighing up to 100 lbs.—without sacrificing detail. The process fills in the gap between the old solid-mold casting and the recent frozen-mercury method.

• **"Lost" wax**—Solid-mold casting consists of forming wax patterns in a die, placing the patterns in a flask and surrounding, or "investing" it with a ceramic material. The wax is then melted out or "lost", leaving a cavity into which the molten casting metal is poured. Size is severely limited.

The frozen mercury process replaces the wax with mercury. Liquid mercury is poured into a die and frozen. The pattern is invested with ceramic material and the mercury withdrawn. This method is best for extremely large castings.

The ceramic shell molding technique developed by Arwood fits in between these two processes.

• **Coating is critical**—Shell casting is essentially a mold consisting of successive ceramic layers deposited around a wax or wax and plastic casting setup. Initially a wax or plastic pattern is produced by injecting the material into a machined or cast injection die.

One or more patterns are assembled into a casting setup, and the ceramic coating operation begins. The assembly is dipped into the primary refractory ceramic slurry and drained to obtain a thin, uniform coating. This coating is critical: it determines the surface finish of the final part.

While wet, the coated assembly is stuccoed with a fine refractory grain. This establishes a sort of priming surface for the next coating. After the assembly is dried in a controlled temperature-humidity area, the backup coats are applied in the same manner. The number of coats depends upon the thickness required to withstand the pressure of the molten metal during casting.

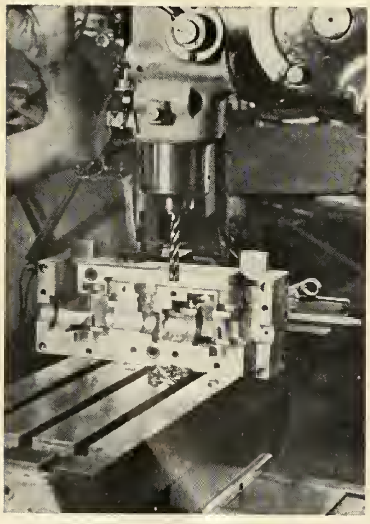
The shell is flash-dewaxed at 1800°F, and is ready for casting.

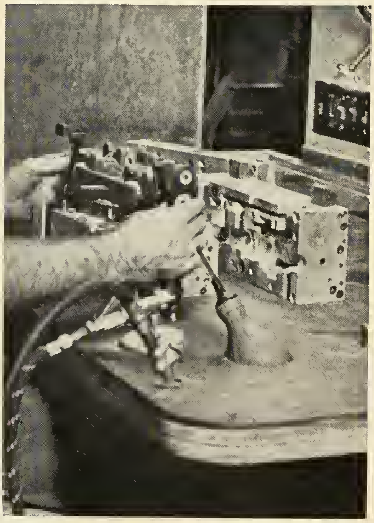
• **Reliability**—Painstaking quality checks follow each crucial step of the process. The wax patterns in a normal production run are visually examined before being set up. The castings themselves are subjected to a series of inspections beginning with a visual check. Non-magnetic alloys receive a fluorescent penetrant scrutiny. Magnetic castings are checked by Magnaflux.

A thoroughly equipped X-ray facility rounds out the quality control process. (One casting involved seven different radiographic shots.)

The initial casting in a series receives the most rigid inspection—be-

The Casting Cycle at Arwood





PROCESS BEGINS WITH the construction of the die. The wax pattern is shown being separated from the die. Water-soluble core inserts are visible in the pattern just above the operator's hand.

ginning with the pattern and running up to the finished piece. Critical dimensions are carefully measured with special gages. If an extended production run is planned, all possible trouble spots are cataloged so that the visual inspectors will know what to emphasize during their section of the process.

Heat treating facilities are available at all of the firm's five plants.

According to Arwood, castings made by the shell method have a finer grain structure, better and more consistent surface finishes, and are generally sounder than solid-mold products. The firm did not reveal the composition of the waxes and ceramic slurries.

Arwood is equipped to use all three methods, and spokesmen point out that the new development is definitely not a panacea. Process choice depends on the particular part to be cast, and the technical and economical factors involved.

Almost every missile has Arwood-cast products in it somewhere. Component chassis, instrument housings, mass balances for elevator leading edges, gyroscope components and pump housings constitute just a small portion of these missile parts.

Arwood engineers worked with the Shaw Process (M/R, June 27, p. 33) for two years, but decided that it did not satisfy their needs.

Although castings larger than 100 lbs. are possible with the shell method, the difficulty is in the necessary equipment. It seems to be a job of scaling up the current process stages.

Casting geometry and cost may well be the limiting factors in striving for larger and larger shell molds.

Beryllium Output Hiked by Deposit Discovery, Detector

The predicted big boom in domestic beryllium production seems to be under way. Indications from several sources bear out the optimistic forecasts voiced last year by mining and metallurgical experts.

• Vitro Corp. revealed the discovery of a "significant deposit" of the element in the Topaz Mountain area of Utah. The new ore is in disseminated non-pegmatic deposits, much of it lying close to the surface where it can be mined by open-pit techniques.

• A group of scientists at the University of Manitoba, Winnipeg, Canada, have developed an instrument which indicates the amount of beryllium in an ore sample. The value of the instrument, a berylometer, lies in the fact that beryllium occurs in the combined state and almost defies identification by standard prospecting methods.

• **New source**—Discovery of the Topaz Mountain deposit touched off a claim-staking race reminiscent of the early days of the uranium rush. Vitro is one of the largest claimholders in the area. The Topaz ore seems to be readily soluble in sulphuric acid and is apparently amenable to conventional hydro-metallurgical processing.

In addition, Vitro geologists say the ore contains a new beryllium mineral which they propose to name "vitroite."

• **New detector**—More than 20 of the Canadian berylometers have been sold by Nuclear Enterprises Ltd. of Winnipeg. The instrument utilizes a unique property of beryllium—its ability to throw off neutrons when subjected to radioactive bombardment.

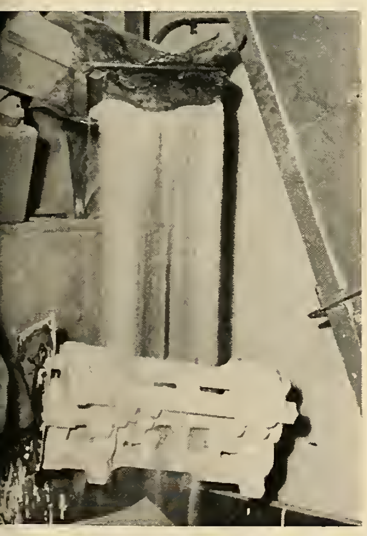
A radioactive source, Antimony 124, is contained in the berylometer. The amount of beryllium in a sample is indicated by the number of neutrons emitted. The instrument counts the neutrons, immediately informing the operator of the beryllium percentage.

The instrument cannot penetrate more than a few inches of covering material—so deep deposits will not be detected.

International Minerals & Chemical Corp. is already surveying its property holdings with the berylometer. The $2500 instrument is carried to the field in a lead vault aboard a station wagon.

The firm's survey team has already checked mineral samples from all over the world collected in libraries at Northwestern University, University of Chicago, the Chicago Museum of Natural History and the large sample library at International.

Beryllium consumption in the U.S. was about 800,000 lbs. last year—only 35,000 lbs. of it from domestic production. The U.S. has been importing the ore from 12 countries—mostly from Brazil, Argentina and Mozambique. The price averages about $300 per ton at foreign ports.



SUCCESSIVE CERAMIC LAYERS are applied by dipping in the refractory slurry and stuccoing. This phase of the operation is slated for mechanization. The final product is shown in comparison to the usual investment casting.

NASA

Atkins & Merrill West, Inc., Anaheim, Calif., for building a series of scale lunar capsule models supporting the Ranger Program. Subcontract from **Ford Motor Co.'s Aeronutronic Division.** Amount not disclosed.

$897,946—**Electronic Associates,** Long Branch, N.J., for analog computer equipment.

$149,921—**Simmons Precision Products, Inc.,** Tarrytown, N.Y., for antennas and receivers.

MISCELLANEOUS

Lear, Inc.'s Astronics Division, for an undisclosed quantity of automatic tracking telemetry receiving systems. Subcontract from **Lockheed's Missile and Space Division.** Amount not disclosed.

NAVY

Electronic Communications, Inc.'s Advanced Technology Corp., for applied research and analytical studies for the *Semper* missile program. Amount not disclosed.

The Garrett Corp.'s Air Cruisers Division, Belmar, N.J., for nearly 100 pairs of air springs designed to provide *Polaris* missiles with the softest cushion possible during transportation and storage. Subcontract from **Lockheed's Missile & Space Division** and **Beech Aircraft.** Amount not disclosed.

CWS Waveguide Corp., Lindenhurst, Long Island, N.Y., for 17 submarine antennas. Amount not disclosed.

Westinghouse Electric Corp., Pittsburgh, for launching equipment for *Bullpup.* Amount not disclosed.

$34,000,000—**Ryan Electronics, a division of Ryan Aeronautical Co.,** San Diego, for AN/APN-122(V) Doppler navigation system with spares, documentation and other special equipment.

$4,740,000—**Leach Corp.,** Compton, Calif., for high frequency power generation equipment for Missile Project and Armament Building at the Pacific Missile Range.

$2,500,000—**Aerojet-General Corp.,** Azusa, Calif., for production of the *Tartar* guided missile solid-propellant motor.

$470,479—**Midwestern Instruments, Inc.,** Tulsa, Okla., for magnetic tape recorder reproducer.

$375,000—**Beckman Instruments, Inc.,** Richmond, Calif., for high-speed EASE analog computer to be used in developing and testing of the *Polaris* missile and its components. Subcontract from **Lockheed's Missile and Space Division.**

$47,308—**Westinghouse Electric Corp.,** Washington, D.C., for engineering services in connection with propulsion control for emergency propulsion motors.

AIR FORCE

Chrysler Corp.'s Missile Division, Detroit, for design and development of a prototype of a high-precision optical aiming device for use with *Minuteman.* Subcontract from **North American Aviation, Inc.'s Autonetics Division.** Amount not disclosed.

Horkey-Moore Associates, a division of Houston Fearless Corp., Torrance, Calif., for fabrication of antenna assemblies for use with *Atlas-Able.* Amount not disclosed.

$81,576,000—**American Machine & Foundry Co.,** for construction of 36 *Titan* launcher systems to be installed in six squadrons.

$12,905,000—**North American Aviation, Inc.,** for long lead time items for GAM-77A.

$3,500,000—**Continental Electronics Manufacturing Co.** (subsidiary of **Ling-Altec Electronics, Inc.**), Dallas, for additional super power radar transmitters for BMEWS.

$3,338,258—**Chance Vought, Electronics Division,** Dallas, for continued development and manufacture of a highly advanced actuator system for *Minuteman.* Subcontract from **Autonetics.**

$1,800,000—**General Electric's Electronic Specialty Capacitor Product Section,** Irmo, S.C., for R&D on high-reliability capacitors for the *Minuteman* guidance system. Subcontract from Autonetics.

$855,231—**Budd Lewyt Electronics, Inc.,** (subsidiary of the **Budd Co.**) Long Island, N.Y., for pre-production and production of quantities of multiplexers with gap-filler input converters for use at heavy radar sites of the *Sage* system.

$503,847—**Federal Electric Corp.,** Paramus, N.J., for installation and operational testing of the Time Division Data Link Subsystem for use with *Sage* system. (Two contracts.)

$500,000—**Corning Electronic Components,** Corning, N.Y., for development and testing of extremely reliable glass capacitors for the *Minuteman* and associated ground control systems. Subcontract from Autoetics.

$350,000—**Ets-Hokins & Galvan, Inc.,** for design and installation of the cable system for ground support equipment at the Convair Astronautics Test Facility at Sycamore Canyon and Patrick AFB. System is for test, launch control and instrumentation of the *Atlas-Centaur.*

$310,125—**General Precision, Inc., Librascope Div.,** Glendale, Calif., for design, development, fabrication and test of two digital celestial trackers.

$244,000—**Bulova Research & Development Laboratories, Inc.,** Woodside, N.Y., for developing a new type of safing-arming device for use in missile warheads.

$180,000—**Hydromatics, Inc.,** Livingston, N.J., for liquid oxygen Flo-Ball valves to be used in hardened sites for *Atlas* missiles.

$84,191—**Sundstrand Corp., Turbo Division,** Pacoima, Calif., for continuation of research on "Investigation of Rational Scaling Procedures for Liquid-fuel Rocket Engines".

$67,584—**Radiation, Inc.,** Melbourne, Fla., for study of feasibility of real-time-data gathering instrument.

$60,000—**Douglas Aircraft Co., Inc.,** Santa Monica, for facilities for the GAM-87 program.

$44,000—**General Electric Co.'s Missile and Space Vehicle Dept.,** Philadelphia, for research entitled "Fundamentals of MRD Flows".

$40,900—**Coleman Engineering Co., Inc.,** Torrance, Calif., for guidance test sled.

$32,000—**Hughes Aircraft Co.,** Tucson, Ariz., for calibration of GAR 3/3A weapon system.

ARMY

$18,853,460—**The Martin Co.,** Orlando, for continued production of *Lacrosse* missiles and ground support equipment, engineering services and maintenance.

$7,875,000—**Chryler Corp.,** Detroit, for *Jupiter* missile system. (Two contracts.)

$7,780,916—**Aerojet-General Corp.,** Azusa, for rockets for *Hawk* system.

$3,389,928—**Raytheon Co.,** Andover, Mass., for repair parts for *Hawk* system.

$3,235,861—**Western Electric Co.,** Greensboro N.C., for *Nike-Hercules* missile components.

$2,199,964—**Sperry Rand Corp.,** for research and development of the *Sergeant* missile system.

$2,001,944—**Sperry Utah Engineering Laboratory,** for *Sergeant* missile system production.

$1,653,082—**Raytheon Co.,** Andover, Mass. for repair parts for *Hawk* System.

$1,500,000—**General Electric Co.,** Schenectady N.Y., for safing, arming and fusing equipment for *Little John* rocket.

$993,486—**Western Electric Co., Inc.,** New York City, for research and development of the *Nike-Zeus* system.

$915,000—**Chrysler Corp.,** Detroit, for continuation of the *Redstone* missile flight evaluation program.

$637,500—**Swanson & Youngsdale,** Minneapolis, for construction of missile assembly building at Schilling AFB.

$250,005—**Chicago Bridge & Iron Co.,** Birmingham, Ala., for liquid oxygen storage tanks.

$235,365—**Electronic Systems Div., Telecomputing Corp.,** N. Hollywood, Calif., for digital control and data handling system.

$199,938—**The Emerson Corp.,** St. Louis, for industrial engineering for improved *Honest John* rocket motor.

$175,622—**Intercontinental Manufacturing Co., Inc.,** Garland, Tex., for nozzle assembly blast tubes.

$153,480—**Motorola, Inc., Western Military Electronics Center,** Scottsdale, Ariz., for telemetry set.

$145,277—**Sperry Rand Corp.,** for *Sergeant* ground handling and test equipment.

$99,992—**Firestone Tire & Rubber Co.,** Los Angeles, for engineering services for *Corporal* and ground handling equipment.

$99,970—**The Alloyd Corp.,** Cambridge, Mass., for study of electron beam welding of metals for use in large solid-propellant rocket motors.

$96,759—**The Martin Co.,** Orlando, for concurrent repair parts for the *Lacrosse.*

$96,280—**Sperry Farragut Co., division of Sperry Rand Corp.,** Bristol, Tenn., for refinement and manufacture of components for *Saturn* stabilizer platform.

$92,911—**Brown Engineering Co., Inc.,** Huntsville, for engineering and design services relating to the missile system.

$85,959—**Emerson Electric Corp.,** St. Louis, for 76 mm rocket fin.

$67,700—**Nuclear Development Corp. of America,** White Plains, N.Y., for research and development involving studies for "Analytical Investigation of Transportation and Film Cooling of Solid Propellant Rocket Nozzles."

$59,656—**Gilfillan Brothers, Inc.,** Los Angeles, for engineering services related to *Corporal* missile system.

$57,357—**Sperry Gyroscope Co., Div. of Sperry Rand Corp.,** Long Island, N.Y., for experimental study of beam-generating techniques for optical beam riding at missiles.

$55,055—**Spaco Manufacturing Co.,** Huntsville, Ala., for fabrication service, *Saturn.*

$48,450—**Western Electric Co.,** New York City, for *Nike* repair parts.

$43,570—**Clark Cable Corp.,** Cleveland, for electronic tool kit for *Hawk* missile.

$29,933—**California Institute of Technology,** for wind tunnel testing for *Nike-Zeus.*

$26,750—**Wiancko Engineering Co.,** Pasadena, for automatic pressure calibration system.

names in the news

Curtis M. Lee: Former assistant manager of New Product Research and Development at Rheem Manufacturing Co., joins Wyle Manufacturing Corp. as chief engineer responsible for all phases of design and engineering.


ANSOFF


LEE

Dr. H. Igor Ansoff: Appointed vice president of Lockheed's newest subsidiary, Lockheed Electronics Co., responsible for planning, programing and market research. Since 1957 he has directed Lockheed's diversification task force.

Oakley N. Dean: Promoted to vice president-manufacturing for The Electric Storage Battery Co.'s Exide Industrial Division.

Paul E. Doucette and **Harry Shwerz:** Join the research and development staff of Hysol Corp.

J. Gordon Vaeth: Named manager of Reflectone Electronics, Inc.'s newly-opened Washington, D.C., office. Was formerly a member of the Institute for Defense Analyses.

Dr. Robert E. Wall, Jr.: Joins Electro-Optical Systems, Inc., as senior scientist in the Energy Research Division. Was formerly an assistant professor of electrical engineering for the University of Washington.

Thomas L. K. Smull: Appointed director of NASA's office of Research Grants and Contracts, succeeding **Lloyd A. Wood,** named scientist for Advanced Technology in the office of Program Planning and Evaluation.

Howard Morrison: Director of market development with Trans-Sonics, Inc., joins International Resistance Co. as marketing manager of the firm's Control Components Division.

Brig. Gen. John G. Shinkle: Commanding general, Army Rocket and Guided Missile Agency, named commanding general of White Sands Missile Range, N.M., succeeding **Maj. Gen. Waldo E. Laidlaw,** retiring. **Col. John G. Zierdt** succeeds Gen. Shinkle at Redstone Arsenal.

O. A. Linse: Former assistant to the president and sales manager of Burton-Rodgers, Inc., appointed assistant to the vice president of the Pomona Division of The Marquardt Corp.

Melvin N. Gough: Director of NASA's operations office at Cape Canaveral, named director of CAB's Bureau of Safety.

Dr. John I. Slaughter: Named supervisor of chemical research in Allis-Chalmers Manufacturing Co.'s Research Division. Previously served with Corning Glass Works and Standard Oil of Indiana.

Thomas A. Carter, Jr.: Former chief mechanical engineer for the Technical Products Division of Waste-King Corp., named manager of the Cryogenics Division of Standard Steel Corp.

John E. "Soapy" Watters (USA-ret.): Joins Motorola's Western Military Electronics Center as engineering manager.

Dr. Mandell S. Ziegler: Appointed director of research and development for the Russell Reinforced Plastics Corp. Was previously associated with the research and sales divisions of the polychemicals department of E. I. duPont deNemours & Co.

Arthur H. Williams and **Robert F. Hunter:** Elected director of research and development and chief engineer, respectively, of Shafer Bearing division of Chain Belt Co.

Patrick B. Daniels: Former Electronic Research Associates assistant to the president, named executive vice president of Pyrofilm Resistor Co.

Dr. France B. Berger: Former director of planning and requirements, named director of research at GPL Division, General Precision, Inc. **Harry J. Reed** and **Raymond Klemmer** assume the respective positions of director and associate director of planning.

H. J. "Joe" Cassidy: Appointed assistant to the marketing manager for Defense Products at Instrument Development Laboratories, Inc. He replaces **F. J. "Fran" McGinn,** opening up a new regional sales office in Chicago.

Wayne D. Moyers: Named vice president-engineering for Efcon, Inc. Recently with North American Aviation, Inc.'s Autonetics Division, he was responsible for the creation and implementation of the *Minuteman* missile-capacitor reliability improvement.

Sol Greenberg: Elected director of engineering at Lambda Electronics Corp. **Benjamin Shmurak** succeeds him as chief engineer.

Alfred F. Kaspaul: Technical Director of the Solid State Physics Department of CBS Laboratories, promoted to manager.

Hugh Boyd: Goodyear Aircraft Co. vice president named chairman-planning committee for the Anti-Submarine Warfare Advisory Committee of the National Security Industrial Association. **T. C. Smith,** vice president of Daystrom, Inc., elected chairman of the Detection and Classification Task Committee succeeding **R. A. Wilson,** vice president of General Mills, who has resigned. **Vice Adm. C. B. Momsen** (USN-ret.), a consultant for Bendix named chairman of the Decoys and Countermeasures subcommittee. **Rear Adm. C. H. Andrews,** (USN-ret.) is chairman of the subcommittee on Personnel Training Problems and **David Heehner** of Hughes Aircraft is chairman of the ASW Weapons subcommittee.

Stuart L. Dance: Former manager-marketing representative of RCA's Airborne Systems Division, joins HRB-Singer, Inc., a subsidiary of The Singer Manufacturing Co., as head of the marketing department.


DANCE


ROTH

Dr. Ludwig Roth: Joins Northrop Corp. as director of research in the company's Norair Division. Was previously chief engineer at Solar Aircraft Co. Dr. Roth was chief of preliminary design at the German rocket center at Peenemuende and later assistant to Dr. Wernher von Braun in the U.S. Army Ballistic Missile Agency at Redstone Arsenal.

Joseph L. Keefe: Joins American Potash & Chemical Corp. as a market development representative located at the company's New York office. Was previously with Texas-U.S. Chemical Co. and U.S. Testing Co.

Martin Boe: Promoted to weapon system manager of the GAM-77 *Hound Dog* program for North American Aviation's Missile Division, replacing **Dale Myers,** now the division's engineering vice president. Was previously assistant manager of the weapon system, and prior to that engineering manager on *Hound Dog* and project engineer on *Navaho.*

Missiles and Rockets Editorial Index

Readers are invited to save the following six-month index covering M/R issues of Jan. 4 through June 27, 1960, as a reference guide to major news and technical articles published during the first half of the year.

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TITAN COMPLEXES PUSHED BY MARTIN; Activation Division presses facilities work at Vandenberg and Lowry. Unusual construction techniques employed, by William J. Coughlin, M/R West Coast Bureau Chief, 1/11/60, p. 32.

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ROVER SUPPORT WORK TOPS BUILD-UP AT LOS ALAMOS; 6/27/60, p. 41.

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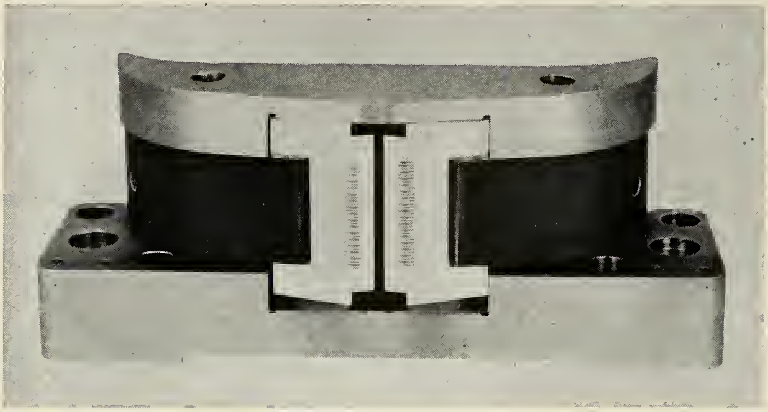


Magnetic Tape Head and Tape Guide

Shepherd Industries, Inc. is marketing a digital magnetic tape head, Model DTH 2132. This head is a 32-track interlaced head for 1-in. tape, employing a unique core design which affords extremely high efficiency, both in record and playback of digital data. The gap length of this head is 10 microinches, which allows its use at extremely high bit densities in the order of 6000 flux reversals per inch in contact. The electrical characteristics of this head are also unique in that the Q is approximately 12, the write current requirements are 1 amp. turn, while contemporary heads require 3 to 4 amp. turns to saturate tape. While the head is primarily designed for digital applications, analog recording and playback is possible at frequencies up to 10 mc.

The new precision Tape Slot Guide, Model TG Series, nearly eliminates tape skew and scrape-flutter. The width of the highly polished hard chrome slot is held to the order of millionths of an inch, thus providing superior guidance while greatly reducing tape curl and wear. The Tape slot guide provides highly improved tape damping and improved start-stop characteristics as well.

Circle No. 225 on Subscriber Service Card.

Seamless Fuel Bladders

Dragon-Kote, a flexible film developed by Chemgineers, Inc. and containing Teflon, is now being used by the firm to manufacture clear, seamless fuel cell bladders. The firm reports that it formulated this material specifically to cope with temperature extremes, corrosive characteristics and other problems involved in the safe handling of today's liquid-propellant fuels and oxidizer systems. Dragon-Kote has the lowest permeability rate of any known flexible material.

The bladders can be designed in unlimited sizes and fabricated to any desired configuration.

Circle No. 226 on Subscriber Service Card.

Fast Digital Computer

Packard Bell Computer Corp. announces an ultrafast, general purpose digital computer. Designated the PB-250, it combines a large, expandable memory and a versatile command structure with computing speed in the microsecond range.

Specifications of the PB250 qualify the computer for either on-line or off-line applications. The PB250 excels as an engineer's desk-side computer, and an on-line computer for process monitoring, process control, data-logging, and alarm generation. Microsecond Speed . . . Add/subtract—12 μsec, multiply—276 μsec, divide/square root—252 μsec are some of the features.

Circle No. 227 on Subscriber Service Card.

Non-Stall Airmover

A compact vaneaxial with a "non-stall" characteristic has been designed to deliver air at high pressure for cooling tightly packed electronic components and other related applications in missiles, submarines, and aircraft, according to IMC Magnetics Corp.

Largely through the development of a special non-stall blade, the new unit successfully eliminates the dip in the pressure-flow curve inherent in normal vaneaxials.

The new non-stall blade provides a steadily ascending pressure without interruption. Thus the unit can be used at any air flow in its range without producing stall effect.

Circle No. 228 on Subscriber Service Card.

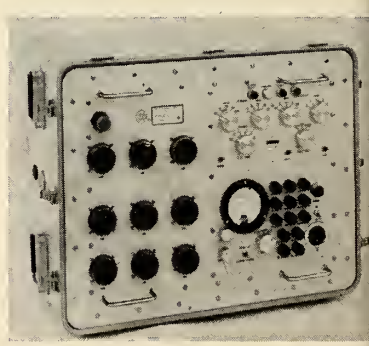
High Dielectric Ceramic

Thin sheet ceramic is now being provided by Mullenbach Division Electric Machinery Mfg. Co., in dielectric constant ranges of 1200, 1600, 1800, 1900 and 2200 for capacitor manufacture or substrate applications. Capacitance varies only plus or minus 10% for 1200°K and plus or minus 15% for higher values from −55 to plus 150°C. Leakage resistance 20,000 megohm-microfarad. Stock thicknesses are 3 to 10 mils with extended range of 1.5 to 20 mils available.

Circle No. 229 on Subscriber Service Card.

Cable Harness Analyzer

A Model 196 Militarized Cable Harness Analyzer, developed by California Technical Ind., allows simple and complex branch circuits to be high-potted and measured for leakage to all other circuits. Simultaneously with the leakage test, continuity (conductor resistance) is measured. In automatic operation the wires under test are checked at a maximum rate of five



wires per second. When a fault occurs the tester stops and indicates the circuit and type of fault.

The Militarized (MIL-T-945A) Cable Tester will check 150 simple circuits, 75 main circuits with any combination or number of branch circuits to a total of 75 branches, or any intermediate combination of main and branches up to a total of 150.

Circle No. 230 on Subscriber Service Card.

Pressure Transducers

A high accuracy differential pres-sure transducer for use in extreme environmental conditions, has been de-veloped by Servonic Instruments, Inc.

Measuring 1¼ in. square by 4½ in. long, and weighing but 16 oz., the Model H-137 is available in 16 dif-ferential pressure ranges between ±300 psia and ±5000 psia. H-137 trans-ducers are designed to operate in the temperature range between –65° and 125°C, with case pressures to 10,000 psia.

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new literature

MISSILE WEIGHT MEASURE-MENT—Details are given on the six component force system used on the *Atlas* to measure thrust, pitch, roll, yaw, and side forces in a bulletin issued by Gilmore Industries. Also described is the weighing system for measuring the empty missile, monitoring fuel and oxidizer loading, and indicating take-off weight. Specifications are also in-cluded on the Field Standard Calibra-tion System. A second technical bulle-tin TD-102 describes an installation at Edwards Air Force Base—designed for captive testing of all present and planned aircraft. Basic measurements of the system are aircraft weights up to 1,200,000 lbs. and thrusts up to 500,-000 lbs. forward and 250,000 lbs. reverse.

Circle No. 200 on Subscriber Service Card.

SOLID FILM LUBRICATION—A four-page, four-color brochure describ-ing "Almasizing" a solid-film lubrica-tion and protective coating process, has been published by The Almasol Corp. The brochure explains briefly the principles of the process, outlines its basic applications and catalogs the special series of lubricants and protec-tive coatings which have already been developed for certain extreme lubrica-tion needs.

Circle No. 201 on Subscriber Service Card.

HIGH PURITY GASES—Properties, applications and storage of ultra-high purity gases are the topics of interest in a new 16-page booklet offered by Linde Co., Div. of Union Carbide Corp. In addition to information about each gas, the booklet contains charts and graphs showing the results of ex-tensive testing including the areas of heat conductivity, excitation potentials, and discharge characteristics.

Circle No. 202 on Subscriber Service Card.

REFRACTORY METAL CHART—Fansteel Metallurgical Corp. has pub-lished a convenient chart showing the complete properties of the metals tungsten, tantalum, molybdenum and columbium. The reverse side contains a temperature chart for conversion of degrees Fahrenheit to degrees Centi-grade or vice versa. It is scaled from absolute zero to 3600°C (6512°F) and includes formulas for exact conversions arithmetically.

Circle No. 203 on Subscriber Service Card.

COAXIAL CABLE CONFIGURA-TIONS—The Electronics Division of the American Tube Bending Co. has published a new four-page, two-color, fully illustrated catalog on configura-tions of Phelps Dodge aluminum sheathed air dielectric coaxial cable. The new processes, developed by the American Tube Company, allows the use of highly complicated shapes and configurations of Styroflex, Spirafil and Foamflex coaxial cable ranging in size from 3/8 in. to 3 1/8 in. diameter without mechanical or electrical dis-turbance. Unbroken "termination to termination" use is possible without affecting the cable's characteristics.

Circle No. 204 on Subscriber Service Card.

MISSILE POWER SYSTEMS—A complete line of power systems for missiles and spacecraft applications is described in a new bulletin released by Vickers Inc., Division of Sperry Rand Corp. The 11-page brochure discusses the development of complete and sep-arate power generating systems leading up to the present Vickers line of pack-aged flight vehicle power systems. Four basic types of systems for missile appli-cation are described. These include the hot gas motor, hot gas servo, silver-zinc battery, and flywheel. Details are also presented on a hydrogen-oxygen system using a positive displacement engine for spacecraft application.

Circle No. 205 on Subscriber Service Card.

HANDBOOK OF THE ALLOYIST—This technical bulletin pinpoints the advantages of several groups of alloys used in the electrical and electronics industries. Prepared by technical spe-cialists of Riverside-Alloy Metal Div., H. K. Porter Co., Inc., the eight-page pamphlet includes a discussion of the properties of each alloy suitable for use in the industry. Typical applications are also given for each alloy.

Circle No. 206 on Subscriber Service Card.

RELAY CATALOG—The most com-plete catalog of relays ever published is now available from Relay Sales, Inc. Over 20 leading relay manufacturers' lines are listed with complete descrip-tion and prices. A new thumb-indexed table of contents speeds finding of any relay desired.

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CLASSIFIED

editorial . . .

The Bright New Galaxy

What is the proper role of the government in space exploration?

Ralph J. Cordiner, Chairman of the Board of General Electric Co., dealt with this and related questions in a recent lecture at the University of California entitled "Competitive Private Enterprise in Space."

"In my preparations for this lecture," he said, "I was surprised to learn how many people have simply taken for granted that space is a natural domain of the government.

"Almost no one had looked forward to the time when space will have been explored, to ask whether its development shall be under our traditional competitive enterprise system or whether—unlike the rest of the economy—space shall be pre-empted for government enterprise."

Mr. Cordiner feels that the proper role of the government in relation to space is no different from the government's role in our other economy.

"Government," he said, "should do for the citizens, at their expense, only those things that the citizens cannot do for themselves through their private institutions.

"National defense is necessarily one of the services provided by the government, but in an age when military power depends less on standing armies than on technological maneuver, the role of private industry is vital.

"The exploration of space is a project that proceeds from a mixture of strategic motives, including military, political, economic and ideological. It, like the national defense, will necessarily require a close partnership between the federal government and private industry."

Mr. Cordiner thinks that space, like past frontiers, will be developed in three main stages: exploration, economic development, and mature economic development.

"Generally speaking," he said, "the exploratory stage is likely to be government-directed with substantial industry participation; the stage of economic development will be marked by government phasing-out and commercial industry phasing-in; and the stage of mature economic operation will—if private enterprise is to survive in the space industries—be primarily based on private ownership and operation under suitable government regulation, including some form of international law or agreement."

The first era, he noted, is already launched. It is basically a stage of scientific research and offers few opportunities for commercial business.

The second stage he sees as one of infant industries and expensive risks—with the first commercial operations being world-wide communication by satellite, private weather forecasting and high-speed earth transport by rocket.

Much of the early research and development financing will be done by the government, because of its interest in establishing U.S. leadership, but private industry must contribute also.

During the third stage—mature development—the government, Mr. Cordiner thinks, will phase itself out of economic and technical work while encouraging the growth of competitive private enterprise.

What will the industries be? Raw materials, new and rare minerals and chemicals, new sources of energy, of food, of medicines, interplanetary tourism—what limits are there?

Mr. Cordiner's lecture encompassed much more than can be told in this space—all of it in the great tradition of private, capitalistic enterprise, aided and encouraged by government. We applaud his vision. Once it was a bright new world. Now—a bright new galaxy.

Clarke Newlon

The Phoenix...re-born in Flame...

WITH PACKAGED ENERGY *from* ROCKET POWER/TALCO

Like the mythical bird of immortality which arose from its own flames to seek new life, this modern Phoenix—a space probe designed and built by Rocket Power/Talco—is seeking new information in the upper atmosphere. ◆ Designed to lift a 10 pound payload to a height of one million feet, the Phoenix was produced for the University of Maryland under a United States Air Force research program. Rocket Power/Talco accomplished the project, from design to successful firing. ◆ For information on this lightweight, portable sounding vehicle and Rocket Power's wide capabilities in solid propellants and ballistic components—write Rocket Power/Talco, Falcon Field, Mesa, Arizona.

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