JULY 14, 1958

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

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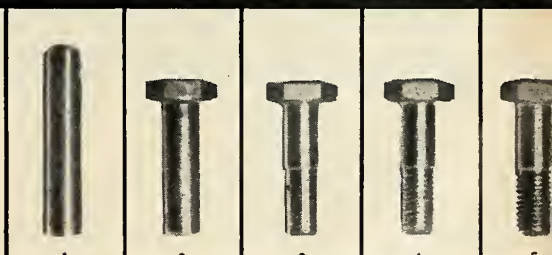

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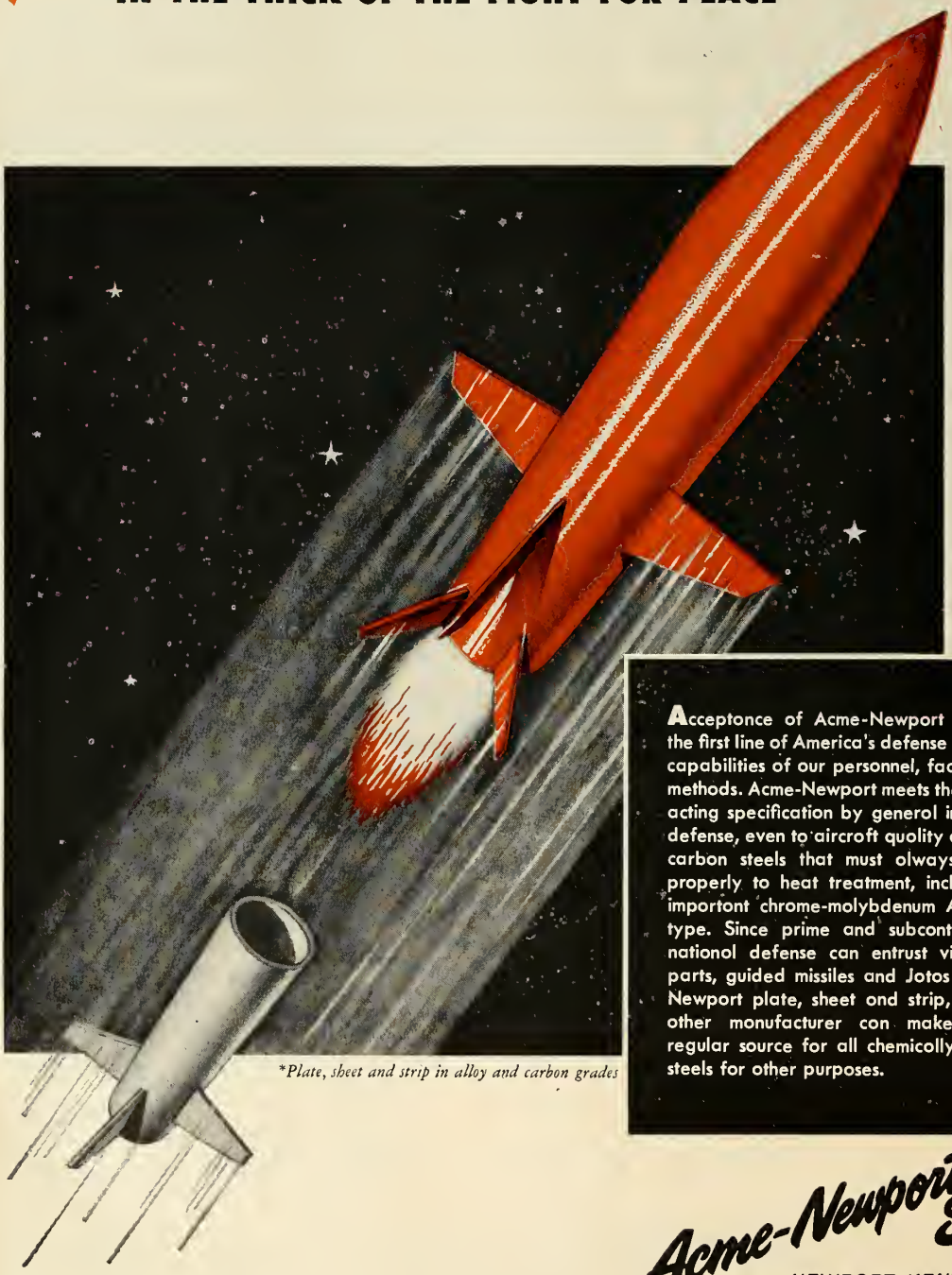

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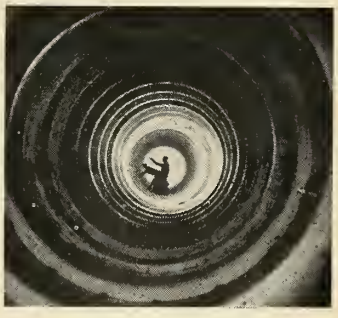
Contents

news

features

columns

departments



cover

Not another tube for the Hudson River, but the outer shell and inner reinforcement rings of liquid oxygen loading tanks for Douglas Aircraft's Thor IRBM missile system. Here, inspectors at Cambridge Corp's. Lowell, Mass., plant check the fit-up of rings and outer aluminum skin. (See story on page 24.) Cover photo by Seabrook Hull.

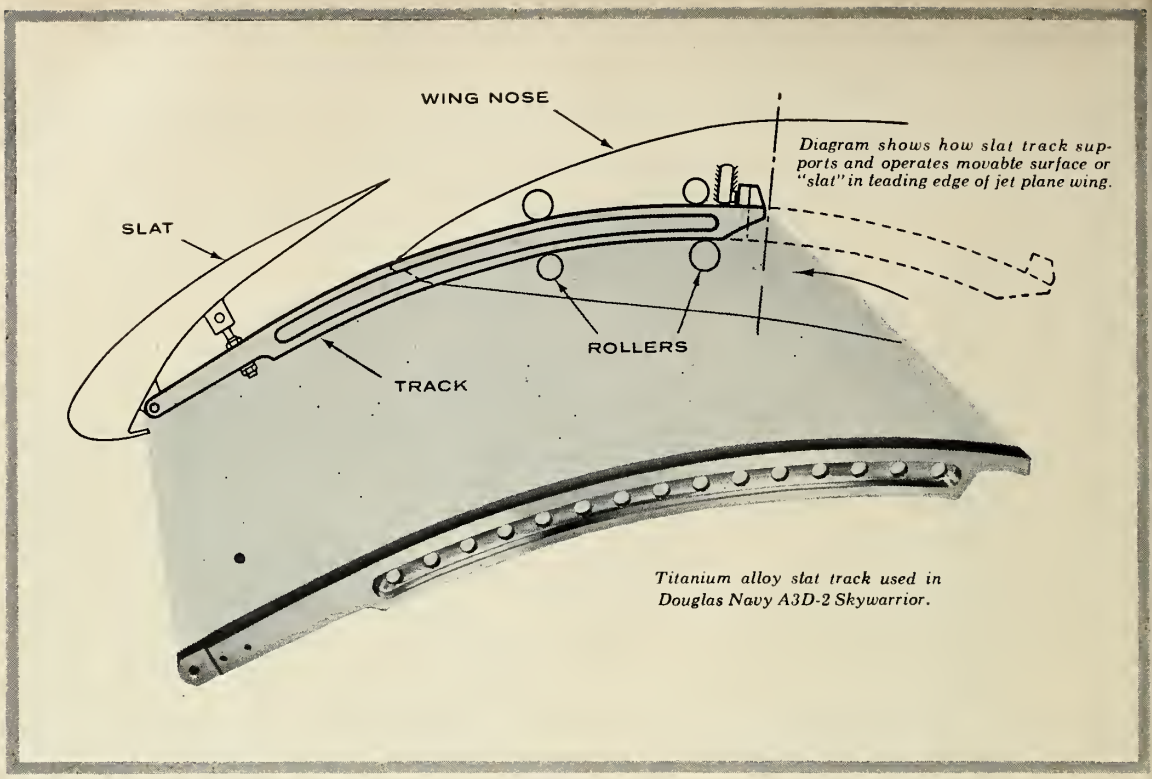


Diagram shows how slat track supports and operates movable surface or "slat" in leading edge of jet plane wing.

Titanium alloy slat track used in Douglas Navy A3D-2 Skywarrior.

How Douglas Aircraft used Titanium to gain

44% WEIGHT SAVING...IMPROVED PERFORMANCE

Douglas engineers faced numerous problems in designing the Douglas A3D-2 Skywarrior slat tracks. Among these were problems of weight reduction, high inertia forces, corrosion and compass deflection.

The application called for a metal with high strength-to-weight ratio, superior corrosion resistance, and non-magnetic properties. Engineering evaluation pointed to heat-treated 6Al-4V titanium alloy as being most suitable for this application.

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2. *Plating problems encountered with steel tracks were eliminated.*
3. *Titanium's non-magnetic properties minimize compass deviation.*
4. *Repeated impact loads against the stop (20,000 cycles) caused no cracks or failures of any kind.*

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Property	Douglas Min Design Requirements	Average Test Results (formed and heat treated)
Ultimate Strength, psi	150,000	150-159,000
Yield Strength (0.2% Offset), psi	135,000	136-146,000
Elongation (in 4D), %	8	13
Reduction of Area, %	20	40-43
Rockwell C Hardness (max)	42	—

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ARPA – The Great Experiment

Basic research, for more years than we like to recall, has been the whipping boy of the nation's defense budget. Year after year, less than one percent of U.S. defense money has gone for basic research. Almost all activities in this forward area were predicated on the so-called necessity of tying research to a specific military objective.

Practically nothing was done to look ten, fifteen, or twenty years into the future in problem areas to see what could be attained in the way of perfecting a better weapon system than the current year's model—or in preparing a defense against an enemy weapon realized through some technological breakthrough.

Rocket engines are just one of many examples that come to mind. Our military objectives precluded development of chemical boosters of 500,000 pounds thrust or more. While we waited, Russia acted in research and development. *Sputniks* I, II, and III are the results.

We have concentrated, quite thoroughly, in spending billions for production of missiles and aircraft, which, by the time they become operational, were obsolete. Early decisions in the research and development phase could have prevented costly production of many weapons which perform similar missions.

Another example: in the early development years of ICBMs and IRBMs, little money support was given to what should have been a paramount research objective: namely, basic work into missile flight phenomena which would bring us closer to an effective defense against the ICBM. We still lack the defense today—and must wait and wonder.

Five months ago, the Defense department—under Presidential pressure—made a decision which, although we think it may be a little too late, is a good one. The Advanced Research Projects Agency was organized and told to manage defense research, eliminate costly duplication of weapon systems, and to assign research to the military departments according to capabilities, rather than roles and missions.

For the first time, research, under ARPA, is getting a healthy shot in the arm. For fiscal year 1959, $520 million is programmed for ICBM defense, military reconnaissance satellites and space technology (see p. 14 of this issue).

Some of the organizations that are already working under ARPA have compared the direction to that of a board of directors—able to weigh individual requests in the broad sense which the U.S. missile and space effort has required for so long. A "board of directors" able to consider everything proposed to it in a dispassionate sense—and with the authority to choose the best approach for any given project—is almost without precedent in our military establishment; more so when the "board" is run primarily by civilians.

Many times in the past, committees have been formed and staffed by competent men, given definite missions, a definite budget, and a definite time limit.

But over and over again, these groups have made studies and the results were never brought to light because the sponsor of the study didn't agree with the results. Sometimes, results have been buried because members of the committee had no real identification with the objective. We can never hope to achieve goals when committee members are operating on the basis of "look in once a week and say yes or no." This, fortunately, is not the way that ARPA is set up to operate and, apparently, is not the way it is operating. We can be thankful for this.

Under the leadership of such dedicated men as ARPA director Roy Johnson, deputy director Rear Admiral John E. Clark, and chief scientist Herbert York, ARPA is fast emerging as the one Defense department agency that is not interested in empire building, but in bringing a forward look to Pentagon management. ARPA's methods of operation could well be duplicated by other defense organizations.

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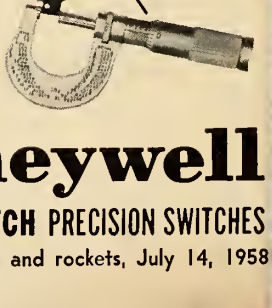

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An m/r staff report from WASHINGTON

• **SECRETARY OF THE ARMY BRUCKER** took a step this week to ward off any catastrophic publicity, such as resulted when *Vanguard* fizzled, when he issued a statement hedging on an Army try to launch a lunar probe before the end of July, as reported in last week's m/r. He said the report has no basis in fact. However, in the same statement he urged defense agencies to "proceed speedily, and without fanfare" toward further achievement in space exploration.

• **THE NAVY MOVED AHEAD** in replacing guns with missiles with the award of a $10.3 contract to the Sperry Gyroscope division of Sperry-Rand for the direction equipment for *Talos*. Now operational on the cruiser Galveston, *Talos* will make up the main battery of the cruisers Little Rock, Oklahoma City and Albany, and the first nuclear-powered surface ship, the cruiser Long Beach. (see also p. 11)

• **THE PRESIDENT'S REORGANIZATION PLAN** got a pat on the back from Army's Chief of Staff, Gen. Maxwell Taylor when he appeared before the Senate Armed Services Committee. The General, however, steered clear of the controversial 200-mile limit for Army missiles saying it would fall in the "twilight zone" of combatant functions as defined by the Key West Agreement, and wouldn't opine how reorganization might affect it.

• **BACKING UP HIS CHIEF**—Brigadier General A. W. Betts, of the Office of the Director of Guided Missiles, in an address before the National Federation of Business and Professional Women's Clubs in Seattle, Washington, backed up Gen. Taylor. He said that there are two aerodynamic missile systems now operational, the *Regulus* and the *Matador,* with essentially the same range, accuracy and warhead capabilities. Betts pointed out that a Defense organization of the nature proposed by the President would have prevented this unnecessary duplication. For the same amount of dollars invested in the two programs, we could have had a 25% greater military capability with a single missile.

• **LEGISLATORS UNHAPPY WITH *POLARIS* PROPELLANT CONTRACT.** The House Armed Services Investigation Subcommittee will look into at least five cases of multi-million-dollar contracts being let to private industry for procurement, which could be filled by government-owned facilities. Maryland legislators, miffed because of a $10 million facilities contract to Aerojet General for *Polaris* propellant grains, while the Indian Head (Md.) powder factory was laying off 2,000 workers, have prodded Rep. F. Edward Herbert's subcommittee into asking Navy officials to explain. Herbert says the Indian Head situation will be studied as a representative case.

• **WASHINGTON TALK THIS WEEK** concerns several developments in the Thompson Products, Inc. area. First, Space Technology Laboratories was established as a wholly-owned subsidiary corporation; then Thompson Products announced the formation of the TAPCO group, comprising five divisions of the Thompson organization; and then the final statement—that Thompson and Ramo Wooldridge would combine to form a new organization called Thompson Ramo-Wooldridge. It is reported that T-RW is being considered as prime contractor for *Minuteman*.

• **AIR FORCE BUDGET** request for **FY 1959** includes delivery of about 15 C-133 transports—and AF wants about 50 of these big planes. They are the only transports that can carry *Atlas* ICBM's intact.

The engineers got a close-up view...

but this AUTO ZOOM Lens took the risk*

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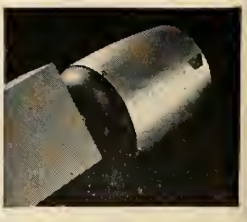

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JULY 14, 1958
VOL. 4, NO. 2

missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

Balanced Program Places Navy First

Congress Told That Cutbacks in Ship Construction Will Be Offset by Missile Power of Vessels Approved

by William O. Miller

Navy scientists, hardware experts and strategists are quietly working to put the Navy in the world's number one spot insofar as missiles are concerned, if indeed, it does not already hold that place. There is no lack of confidence, even if there is what Navy men consider a shortage of funds—less than half the dollars allotted the Air Force for missiles.

The Navy alone has had at least one guided missile in each category—surface-to-surface, surface-to-air, air-to-surface, and air-to-air—in production for Fleet use for several years. Second generations of these missiles, all with improved capabilities, are almost ready for deployment.

Citing an old ordnance adage, "the longer the range, the greater the error," one Navy spokesman said:

"The ICBM is for the birds. We'll have the equivalent of an ICBM in *Polaris*, with distinct advantages an ICBM does not have:—(1) mobility of launching site, (2) greater accuracy, (3) solid propellant, and (4) the secret hiding places the vast ocean depths afford."

Recent cutback in funds for guided missile ships in no way indicates a downgrading of their importance—or a waning of interest—in the Navy's surface-to-air or surface-to-surface birds.

That's clear enough after a close check in Washington. The reason for the cutback—and it is to the tune of more than $490 million—is the fact that the Navy had to do something to balance rising costs against budgetary limitations.

Result: nine ships were listed by the Secretary of the Navy for elimination from the current program. Six of these were guided missile vessels—four frigates and two heavy cruisers—which would have carried the *Terrier* and *Talos* missiles.

Of course, there's more than cost increase in shipbuilding involved, Navy planners readily admit. Much of the increased cost results from innovations and new-model equipment that is asked over the four-year lead time normally required for construction.

• **Hope for replacement**—Testimony before the House subcommittee on appropriations pointed out the Navy's thinking on how to make cuts without losing effective power.

Rear Admiral J. E. Clark, until recently head of CNO's Guided Missiles Division, said:

"The Navy is now developing three missiles, in three sizes, for three types of ships. For destroyers, the *Tartar*; for destroyer leaders and frigates, *Terrier*; for cruisers, *Talos*. Objective of a 10-year program is improvement of these missiles, so that *Tartar* will eventually yield the performance of *Terrier*, and *Terrier* will equal *Talos*."

Overall, the Navy included in its budget requests funds for only 11 missiles. They eliminated two (*Sparrow* I and *Petrel*), and cut funds for another (*Regulus I*) to just $1.5 million, to cover field service to the missiles already in hand.

In addition to the 11 operational missiles—including two air-to-air birds—the Admiral testified that several others are in the research and development stage, giving the Navy a present stable of about 14 missiles.

Inasmuch as improvement of the present missiles is the crux of the Navy's program, according to Adm. Clark, research and development must continue improving reliability, extending ranges and increasing resistance to countermeasures. Twelve missiles have been eliminated from the Navy's program in line with this reasoning in the past eight years.

A number of factors went into picking the six guided missile ships that were cut from the program. Most important, contracts had not been signed for new construction of the destroyers or the conversions of the cruisers. Consequently, the expense of contract termination on other vessels was eliminated. Other factors included location of the yards doing the work, and work already underway on similar types.

The cruisers eliminated—the "Chicago" and "Fall River"—may be put back in the next year's budget. In any case, follow-on types in succeeding years might provide the balanced fleet the Navy says it needs to fulfill its role.

The contract price of $14 million for the conversion of the "Little Rock" is subject to redetermination when the work is 70% complete. The $14 million contract for the conversion of the "Oklahoma City," and the $13 million figure for the work on the "Springfield" is subject to adjustment when 30% completed.

• **Construction work**—The only new construction work in the guided missile cruiser program is the "Long Beach," the Navy's first nuclear-powered surface ship. This will be the Navy's first ship to mount three missiles—*Terrier*, *Talos* and *Regulus* II.

Complete contract figures are not available, but Westinghouse has an $18-million contract for the reactor com-

Electronics Spending Tops 1957 Totals

Defense electronics procurement during the first nine months of FY 1958 had reached a total of $2.863 billion, vs. $2.451 in FY 1957, according to figures released by the Electronics Industries Association.

Current estimates are that spending for the entire year will be substantially over the $3.5 billion recorded last year and may reach $3.9 billion, the largest sum ever spent for electronics by the military in a single year.

The EIA computation, intended primarily to be used to depict trends, and subject to later revision, shows the following electronic figures (in millions) for the first nine months of FY 1958, ending March 31:

Budget Category	1st Quarter	2nd Quarter	3rd Quarter	FY 1958 to date:
Aircraft	$340	$346.0	$359.0	$1,045.0
Ships-Harbor Craft	23	25.0	24.0	72.0
Combat Vehicles	1	—.2	—.1	.7
Support Vehicles	1	.7	.6	2.3
Missiles	273	299.0	319.0	891.0
Elec. & Comm. .	204	214.0	183.0	601.0
Research & Dev.	73	74.0	75.0	222.0
Miscellaneous ..	11	9.0	9.0	29.0
Total (FY 1958)	$926	$967.5	$969.5	$2,863.0
Total (FY 1957)	$637	$876.0	$938.0	$2,451.0

. . . balanced missile fleet

partment components alone. General Electric has the $4-million job of building the main propulsion turbines and gears. Bethlehem Steel received a letter contract for $2.5 million for preparation of working plans.

The "Albany," the only one of three heavy cruisers selected for conversion from the active fleet, will be the first of the "double-ended" conversions. It has *Talos* fore and aft, and *Tartar* for the anti-aircraft battery.

Partial conversions have been completed on four other cruisers, giving them a limited guided missile launching capability. They are the "Los Angeles," "Macon," "Toledo" and "Helena."

Although the four frigates (DLG) were eliminated by the June cutback, six guided missile frigates and one nuclear-powered guided missile frigate have been requested in fiscal 1959.

An $11.9 million contract has been awarded to General Electric for the design and furnishing of a long-lead-time reactor compartment component for the nuclear powered frigate (DLGN).

The contract price for the first three of the DLG's, to be built by Bethlehem Steel, Quincy, totals $52.4 million. The Bath Iron Works $40.5 million contract covers the last two in DLG's in the current construction.

Name	Desig.	Building Yard	Date Complete	Cost	Fiscal Year Authorized	Missiles
Cruisers						
Bastan	CAG 1	(active)	---	---	1952	Terrier
Canberra	CAG 2	(active)	---	---	1952	Terrier
Galvestan	CLG 3	(active) commissioned 5/58	---	---	1956	Talos
Little Rock	CLG 4	NY Shpbldg., Camden	1959	$14,000,000	1957	Talos
Oklahoma City	CLG 5	Beth Steel, SF	1959	$14,000,000	1957	Talos
Providence	CLG 6	Boston NavShpyd	1959	na	1957	Terrier
Springfield	CLG 7	Beth Steel, Quincy	1959	$13,986,000	1957	Terrier
Tapeka	CLG 8	New York NavShpyd	1960	na	1957	Terrier
Lang Beach	CG(N)9	Beth Steel, Quincy	1961	na	1957	Terrier, Talos, Regulus II
Albany	CG 10	Boston NavShpyd	na	na	1958	Talos, Tartar
Frigates						
Farragut	DLG6	Beth Steel, Quincy	1959	$52,429,000	1956	Terrier
Luce	DLG7		1960		1956	Terrier
MacDanaugh	DLG8		1960		1956	Terrier
Caantz	DLG9	NavShpyd, Puget Sound	1960	na	1956	Terrier
King	DLG10	NavShpyd, Puget Sound	1960	na	1956	Terrier
Mahan	DLG11	NavShpyd, SF	1960	na	1956	Terrier
Dahlgren	DLG12	NavShpyd, Philadelphia	1961	na	1957	Terrier
Wm. V. Pratt	DLG13	NavShpyd, Philadelphia	1961	na	1957	Terrier
Dewey	DLG14	Bath Iron Works	1959	$40,536,800	1957	Terrier
Preble	DLG15	Bath Iron Works	1960		1957	Terrier
Destroyers						
Gyatt	DDG1	(active)	---	---	1956	Terrier
Chas. F. Adams	DDG2	Bath Iron Works	1960	$44,045,600	1957	Tartar
John King	DDG3	Bath Iron Works	1960		1957	Tartar
	DDG4	NY Shpbldg., Camden	1960	$49,123,500	1957	Tartar
	DDG5	NY Shpbldg., Camden	1960		1957	Tartar
	DDG6	NY Shpbldg., Camden	1961		1957	Tartar
Henry B. Wilson	DDG7	Defoe Shpbldg., Bay City	1960	$34,445,243	1957	Tartar
Lynde McCormick	DDG8	Defoe Shpbldg., Bay City	1960		1957	Tartar
Towers	DDG9	Todd Shpyds., Seattle	1961	$18,487,400	1957	Tartar
	DDG10	Bath Iron Works	1961	$34,133,200	1958	Tartar
	DDG11	Bath Iron Works	1961		1958	Tartar
	DDG12	Defoe Shpbldg., Bay City	1961	$33,140,520	1958	Tartar
	DDG13	Defoe Shpbldg., Bay City	1961		1958	Tartar
	DDG14	Todd Shpyds., Seattle	1961	$17,819,924	1958	Tartar
Submarines						
Tunny	SSG282	(active)	---	---	1952	Regulus I
Barbera	SSG317	(active)	---	---	1955	Regulus I
Grayback	SSG574	(active)	---	---	1953	Regulus I,II
Growler	SSG577	NavShpyds., Portsmouth	1958	na	1955	Regulus I,II
Halibut	SSGN587	NavShpyds., Mare Is.	1959	$54,000,000	1956	Regulus I,II
Permit	SSGN594	NavShpyds., Mare Is.	1961	na	1958	Regulus II
	SSGN595	NavShpyds., Portsmouth	na	na	1958	Regulus II
	SSGN596	(Private yard, unassign.)	na	na	1958	Regulus II
	SSBN598	Electric Boat, Groton	1959	$105,000,000	1958	Polaris
	SSBN599	Electric Boat, Groton	1960	$85,000,000	1958	Polaris
	SSBN600	NavShpyds., Mare Is.	1960	$85,000,000	1958	Polaris

• *Tartar* **destroyers** — Fourteen guided missile destroyers (DDG) are in the current program, including the active "Gyatt," with her *Terrier* battery. The remainder will mount *Tartar*. Five DDG's have been requested in the fiscal 1959 program. The $44 million Bath Iron Works contract for the first two destroyers in the new construction includes $9.5 million for preparation of plans and other data for the whole class.

Although the heart of the future missile program is the Fleet Ballistics missile submarine, the Navy is continuing plans for *Regulus* II boats. Six are in the current program, and one nuclear powered *Reg* II boat is requested in the 1959 supplemental budget.

The three Fleet Ballistic Missile boats, designated SSBN, are to be followed by at least two and possibly six more in the 1959 fiscal budget. Only two additional SSBN's are provided for in the upcoming budget, but the House, after testimony by top Navy men, has voted money for six additional boats. This provides the nine-boat program the Navy testimony made clear that the service needs.

Thiokol Executive Dies

W. R. Ignatius, 52, general manager of Thiokol Chemical Corp.'s Longhorn Division, died at his home this week in Marshall, Texas. Ignatius joined Thiokol after a career in the Navy, where he became one of the country's top specialists in submarine construction and operation.

Ignatius joined Thiokol in 1950 as head of the statistical engineering department of the Redstone Division, Huntsville, Ala.

ARPA Puts Damper on Roles & Missions Battle

by Donald E. Perry

With a new approach to advanced research for space age weapons, a new defense agency now holds the key to whether the U.S. will match and surpass Russia in the arms survival race.

The agency is ARPA (Advanced Research Projects Agency), which promises to be more than just another acronymic extension to the Pentagon's long line of alphabetical agencies.

Born five months ago under Presidential pressure, and told to bring management to advanced research, ARPA has been christened with a healthy Congressional bankroll, and given far-reaching authority to bypass traditional chains of command.

Results: ARPA is succeeding where many have failed. It is adequately managing a nation's advanced scientific research program for tomorrow's weapons and military space technology, without fighting the Pentagon battle of service roles and missions.

• **Boss gets credit**—How is it being done? A good deal of credit goes to ARPA's boss, white-haired Roy W. Johnson, 53, who in April gave up a yearly salary in excess of $250,000 as a General Electric vice-president, to become director, at $19,000.

On his first day at work, Johnson made it clear that ARPA was not going to be an empire. He set limits on the number of people ARPA would hire. He received the enthusiastic support of the services by declaring the agency was a managerial team—it would not take over their research, their laboratories, or their facilities.

Johnson's tactics brought acceptance from an admiring Congress. An appropriations subcommittee, which normally is opposed to high-dollar funding for any new agency, regardless of purpose, promised $520 million in fiscal year 1959.

• **Across roles & missions**—The emergence of ARPA as the fair-haired agency quite naturally has resulted in the military services coveting many of its assignments. But so far, ARPA has resisted most advances and is assigning research tasks to the individual services depending on their capabilities.

And the services—at least on the surface—harbor no resentment. Many service leaders have openly said the agency is performing a real role in preventing duplication and waste.

ARPA is critically aware that with the constantly increasing cost spiral for modern weapons, the nation can

Wide World

Roy W. Johnson . . . he provides management for research . . .

ill afford to create and operate duplicate weapon system complexes that can perform similar missions. And, it is just as aware that individual services should be permitted to follow parallel courses toward objectives, for competition is still important.

The Defense Department admits its has produced too many missiles and other advanced weapon systems. A reason: key decisions were not made in the early stages of research and development.

This is ARPA's job, and with less than 35 scientists and management experts, it is making daily decisions on research projects before permitting them to go into costly production.

In the past, many forward-looking research programs were retarded by the necessity for a formal military requirement. ARPA has changed this. No longer is U.S. military science tied to a specific weapon objective.

ARPA is free to explore scientific areas 10 to 15 years in the future which may lead to a better weapon, and prepare for defense against any surprise enemy weapons that may come. This, many defense leaders feel, is giving the nation for the first time a military science that can compete with Russia, which for years has not tied scientific research to a specific objective.

• **Agency assignment**—ARPA today has three general assignments: military space science and technology; development of a ballistic missile defense; and research in propellent chemistry. The President or Secretary of Defense will assign additional tasks.

Pending passage of legislation which will form the National Aeronautics and Space Agency, and the capability of NASA to carry out programs for peaceful exploration of space, ARPA is doing the job. The coming lunar probes using *Thor-Vanguard* and *Jupiter-Sergeant* combinations is one purely scientific task ARPA is doing for NASA. Another task which probably will be given to NASA is the development of high-thrust, on the order of one million pound chemical rocket engines. The military, at this time, has no operational requirement for such an engine.

• **How to cut waste**—How is ARPA preventing wasteful duplication? It reviews, programs, directs, and expedites advanced research. It deals directly with the operational service element which will perform the research without going through time-consuming channels of command.

By holding advanced research purse strings, and simply transferring the money as needed to the responsible service, ARPA can make its decisions effective. In dealing with industry or educational, research, or scientific institutions, ARPA requests a military contracting organization to execute and administer a contract. Or it can execute a contract and "farm it out" to one of the services for administration.

ARPA did this for its lunar probe project. In 12 days (m/r July 7, p. 9) orders were issued direct to Air Force and Army operational elements. Normally, it would have taken months.

When an ARPA project passes beyond the research and development stage, ARPA assigns it to one or more of the military departments for engineering, production and operation. Here comes ARPA's real test.

For, if a military department takes issue with an assignment of some project to a sister service in the perennial roles and responsibilities arguments, it has the right of appeal to the Secretary of Defense. So far there have been no major difficulties, but Johnson feels there can be.

He's not worried though, because the agency is growing in technical competence. "I have no qualms about getting the right answer and being able to pick the right one," Johnson says.

Johnson already has made one choice against the Air Force, which eventually will get more than 50% of ARPA funds. He's made it stick, too. For research on the *Pied Piper*, or *Sentry* military reconnaissance satellite, Air Force asked for $215 million. ARPA came up with a $152 million figure.

Operation *Gaslight*: Anti-Missile Breakthrough

The Army has made a major breakthrough in anti-missile missile research.

In an exclusive interview with m/r, Dr. Ernst Stuhlinger, Director of the Research Projects Laboratory at the Army Ballistic Missile Agency in Huntsville, Ala. said, concerning the studies of the Jupiter re-entry May 18:

"One of the most important things we learned during 'Operation *Gaslight*' was how to discern a warhead from a missile body as it re-enters the atmosphere. This is extremely important from an anti-missile standpoint."

Dr. Stuhlinger was referring to the photographic, spectrographic and radiometric studies made of the re-entry.

The photographic studies were made from a destroyer escort ship loaned by the Navy. The photographs show three brightly glowing objects: The nose cone, the booster or missile body and finally, the instrument package. They appeared at practically the designated position, re-entering the atmosphere in single file.

"Within three seconds after the first re-entry light was observed," the official ABMA report said, "the phenomena had blossomed into three distinct objects. The brightest object, which was assumed to be the booster, appeared similar to a huge magnesium flare. The light emitted by this object definitely pulsated."

The brightness of the booster was estimated by observers to be 1,000 times that of the planet Jupiter.

Ahead of the booster was a smaller light, caused by the nose cone's re-entry. The third and final section, the instrument package, was the first to burn out.

Of significance also was the re-entry of the three components in the impact area, with the nose cone falling within 30 miles of the picket ship. The picket ship could have been closer if damage was not a consideration.

• **Added significance**—Further findings of "Operation *Gaslight*" which are considered new and highly significant discoveries in identification and re-entry problems heretofore considered immensely difficult to solve, Dr. Stuhlinger said, include:

"From these experiments we wanted to find out what happens to the re-entry bodies temperature-wise, both from a color and intensity standpoint. That is, what sort of heating processes occur in the atmosphere layer immediately surrounding the re-entering body."

Dr. Stuhlinger went on to say that from the studies, it was learned that the temperatures in the boundary layer are extremely high. In fact, the radiation (electromagnetic energy) from all portions of the spectrum, including both the visible and the infra-red, was so high that it saturated some of the instruments. Many of the photometers and the radiometers were driven off scale by the intensity of the radiation.

"It is not possible to simulate in ground experiments the high speeds, the densities, and the extremely high temperatures," Dr. Stuhlinger said," therefore it is essential to continue to make the experiments in real flight, photograph them and evaluate the photographs to determine the distribution of temperatures in the boundary layer."

"Operation *Gaslight*" was directed by David D. Woodbridge and Ray V. Hembree, two of Dr. Stuhlinger's assistants at ABMA. The team aboard the picket ship included scientists and other personnel from Barnes Engineering, Stamford, Conn. which was chosen by ABMA to perform the spectral and radiometric measurements; AVCO Research Laboratory; Aerojet General Corp.; and Air Force Cambridge Research Center.

Among special instruments designed by the Stamford firm for use during the operation was a meteor-type spectral camera. The camera employs six individual cameras to attain a view of approximately 70° vertically and 100° horizontally. The huge complicated arrangement was stabilized on board ship by mounting it on one of the five-inch gun mounts, and using the ships gyroscopic control to the mount to counteract the roll and pitch of the vessel. Other instruments included specially designed radiometers. The spectacular photographs of the three components of the *Jupiter* re-entering the atmosphere were made by a hand-held 35mm motion picture camera.

Color-wise, the radiation of the booster was like a magnesium flare, the instrument package in the visible spectrum was blue and the nose cone an orange-red. All three passed behind a cloud shortly before the nose cone plunged into the sea with the radiation from the missile parts illuminating the whole cloud.

The successful recovery of the nose cone demonstrated that such a cone is capable of incorporating a nuclear warhead and protecting it from destruction by the aerodynamic heating upon re-entering the atmosphere. (Editor's note: See m/r next week for picture story of "Operation *Gaslight*")

Urge Reorganization of ARDC

To overcome a "growing lack of trust" in the capabilities and performance of individuals and companies at the working level—a phenomena that has increased expenses and duplication in management—the Air Force must revamp its research and development operations.

That was the report to the Chief of Staff of the Air Force, contained in a long-awaited report of the so-called Stever Committee—a scientific advisory board chaired by Dr. H. Guyford Stever, associate dean of engineering at M.I.T.

In a summary of his committee's findings after long study of R&D activities, Stever also called for:

1. A sharp reduction in administrative control and detailed technical direction exerted by higher echelons, both within and without the R&D chain of command;

2. Reorganization of ARDC along functional lines—policies, resources, requirements and program evaluations—with deputy commanders in charge of each functional division;

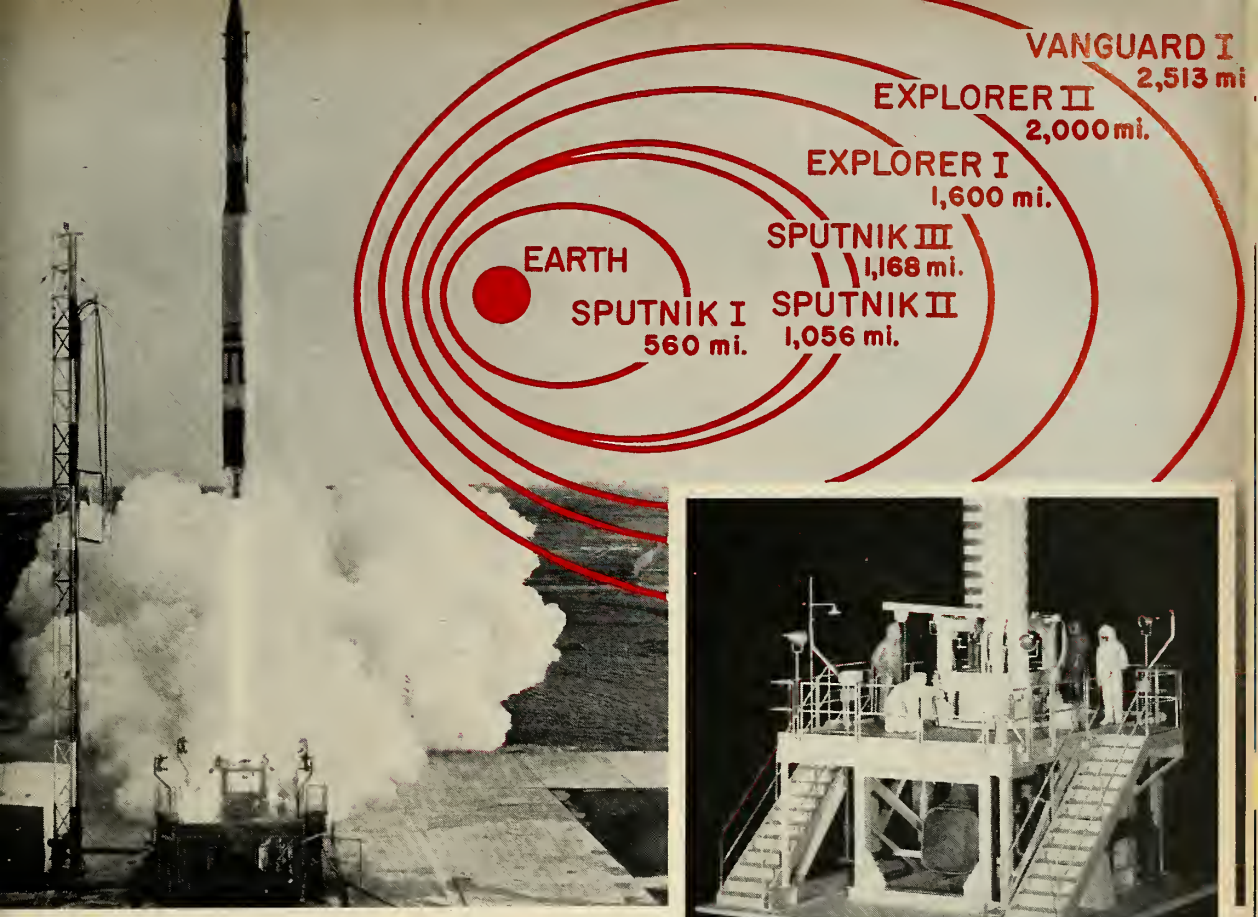
3. Substantial increases in budget for research, state-of-the-art development and development of radically new weapons, and all R&D appropriations to be placed completely under the Deputy Chief of Staff, with ARDC designated as the procuring activity;

4. Expansion of the concept of giving R&D a "package"—funds, facilities and personnel;

5. Give more incentive to contractors doing R&D work.

Commenting on the "lack of trust" statement, Stever said:

"There is a growing lack of trust in capability and performance of individuals at the working level . . . not only in the Air Force but throughout government. This has resulted in taking away from the working level authority, but not responsibility, for R&D, increased staff work, increased detailed technical direction, increased constraint in use of money, people and facilities, and resources required. Lack of trust is extended to contractual relations. Unless this trust is restored, the Air Force cannot hope to reduce the length of its development cycle."



Vanguard I being launched into orbit from Loewy-Hydropress flight-firing installation at Cape Canaveral, Fla.

Scale model of Loewy launching platform and rocket stand.

Loewy launching installation helps boost American moon to highest altitude of all satellites

On March 17, the Navy's Vanguard rocket, built by The Martin Company, soared from its Loewy-Hydropress launching installation into the blue and into orbit at the greatest altitude of all satellites—2500 miles from the earth at apogee.

When Vanguard misfired, on December 6, 1957, in this country's first attempt to put up a satellite, the conflagration could have completely destroyed the launching facilities. But Loewy had designed and built them so well that damage was extremely limited. The fire-fighting system released a torrent of water fog to combat the intense heat of the burning rocket fuels. Within an hour of the mishap, Loewy engineers were assessing the damage and lining up repair crews. Within a week, the static and flight-firing facility was repaired, and Vanguard's second stage was erect and under test. One more week and the first stage stand and weight recording system were completely repaired and operational.

The launching pad is 15 x 20 ft. in area. On it is erected a 6-ft. cubical test and flight-firing stand. Equipped with mechanical, hydraulic and electronic instrumentation, a unique flame-deflecting system and fail-safe devices, this installation has the function of static testing and flight firing. It also weighs the rocket and its fuel and measures the thrust of the first and second stage engines.

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What's the Law in Outer Space?

What are the legal elements in the international control of outer space?

Arnold W. Knauth, a member of the American Bar Association's Committee on the Law of Outer Space, discussed the problems the Committee is facing in an address before the American Association for the United Nations, Washington.

Knauth summarized the types of law that might be applied to outer space—natural law, positive law, public law and private law. He pointed out that natural law is the law of man's conscience, and in that sense, it does not exist unless men are present. "Nature's laws presumably exist in outer space, but there will be no natural law there until men arrive," he said.

Positive law is made by legislative bodies. In the sense of outer space, there would most probably be positive law in international legislative acts and national legislation.

Private law is of no practical importance in outer space, Knauth stated, as no business relations or contracts are being committed there in the present. "When the law of outer space is considered, therefore, it is not a system of private law between man and man as exists on earth, but rather of international law in the public sense."

• **International control** — Knauth outlined aspects of the public international law of outer space, as suggested by the Committee:

a. Objects hurled by human beings into outer space should be catalogued and registered; their characteristics recorded and reported.

b. For the present, the gathering of samples and picking up objects in outer space is like fishing on the high seas—"free to anyone who cares to go to fish."

c. Rules of the road to prevent the interference of paths of the various satellites. "To date," Knauth stated, "there are not enough facts to construct a legal system of the law of collisions."

Other considerations mentioned by the Committee—if a space vehicle fails, should the manufacturer be liable?

Also, what is the possibility of criminal law as it affects outer space? "The launching of every satellite is due to a human hand and will on Earth," Knauth said, "and it could be an offense to launch an unregistered and unlicensed satellite, and to cause a satellite to do various things which are damaging to the inhabitants of the Earth."

• **International cooperation**—Insofar as the laws of outer space deal with international cooperation, Knauth outlined the political, economic, social and defense elements which must be considered:

a. Politics will be controlled on Earth, and not in outer space. "As far as we know," Knauth said, "there will not be nationals claiming to have been born or naturalized in outer space for some time to come."

b. Economic interests in outer space have not been explored, and therefore are still unknown.

c. Social interests are also largely on the Earth's surface, rather than in outer space. "Again," Knauth said, "in order to have social interests, there must be inhabitants."

d. Defense interests, as suggested by the Committee, might be broken down as follows: Sovereignty of outer space extends no further than the point at which an object propelled outwords comes down again. Anything beyond that point might be controlled by the U.N. A U.N. agency will register and license satellites, space platforms, and any other vehicle that may be designed for entering space.

Any man who puts anything from the Earth's surface into space without registration and license will be a "pirate" subject to universal jurisdiction. "In other words," Knauth stated, "space activity will be subject to a U.N. veto."

• **Veto control**—In the U.N., there soon will be a small handful of members possessing the ability to shoot into outer space. However, a large majority will not possess such abilities, and may wish to veto all further space exploration.

Those with the ability and the will may go ahead; however, launching of a satellite will have to be kept secret. "Therefore," Knauth pointed out, "in all probability the veto is an unwise idea; better to seek simple publicity than to foster a situation which would encourage secrecy."

• **Constitutional control** — Knauth also brought up the problem of the U.S. Constitution as it might apply to the sovereignty of outer space. Three suggestions named by the Bar Association member are as follows:

To amend the Constitution to declare that U.S. sovereignty does not extend beyond some particular altitude; to amend the Constitution that sovereignty over outer space may be managed by the U.N.; or to obtain a decision in a Constitutional manner that the sovereignty of the U.S. in space has a top limit.★

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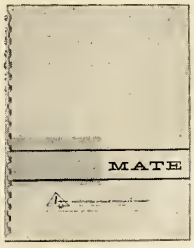

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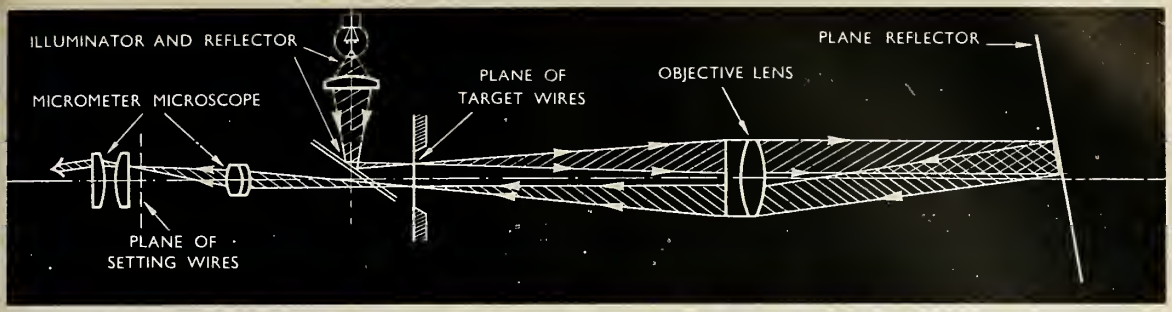


A MICROPTIC AUTO-COLLIMATOR consists of a telescope with a pair of cross-wires set in the focal plane of the objective lens and illuminated. Light emerges from the lens as a parallel beam, and projects onto a plane reflecting surface. The reflected beam is received back into the optical system, forming an image of the cross-wires in the same plane as the cross-wires. Displacement of the image is measured to an angle of tilt of the reflecting surface, as little as 1/10 second of arc.

Optical Checks Reduce Tooling Costs

by Peer Fossen

THE FACT THAT LIGHT TRAVELS in a straight line may have far-reaching effects on the economics of the national rockets and missiles program. Costs are forcing abandonment of the shotgun approach to missiles development. The program has become selective, not only as to *what* shall be developed, but *how*.

While no one instrument has a monopoly on measurement and alignment, optical tooling provides a unique opportunity to the engineer. And of the optical tools available, the auto-collimator is one that can help do two things: achieve greater precision in components and in assembly of those components—and reduce costs.

The essential considerations of parts and assembly precision derive from the basic question: "Will it work?" ie., "Will it hit the target?" With air-to-air missiles costing from $1,200 to $50,000 each, this is no idle question.

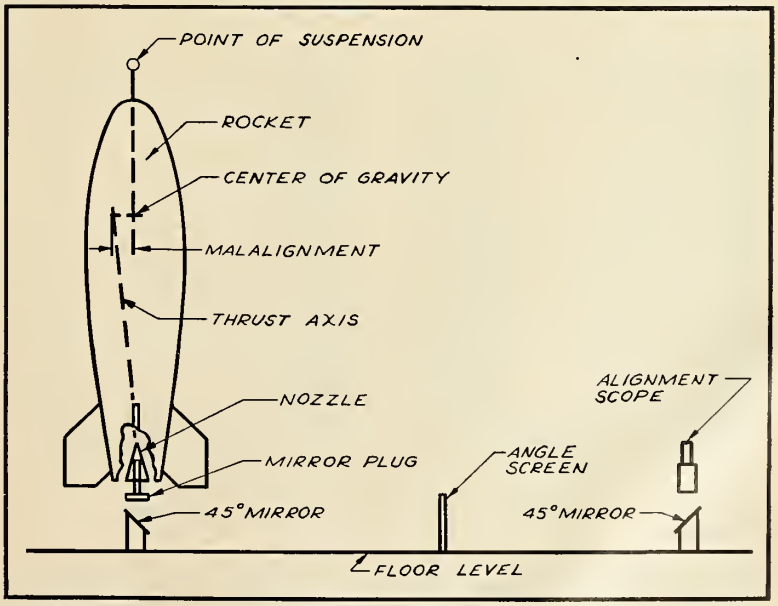
Every engineer is familiar with the way tolerances multiply through a series of production processes, and that the closer the end-tolerances or the fit tolerances, the finer the process tolerances must be, and the more costly the machine or bench operation.

Such demand for eventual accuracy means that attention must be paid to problems of alignment in constructing the missile to avoid thrust troubles due either to mis-location, or to the tolerances and fits of the internal components. It means that care must be taken in the alignment, tolerance, and fit of guidance mechanisms. Also, attention must to paid to alignment in ground support mechanisms, to say nothing of the alignment problems involved in aiming and firing the missile itself.

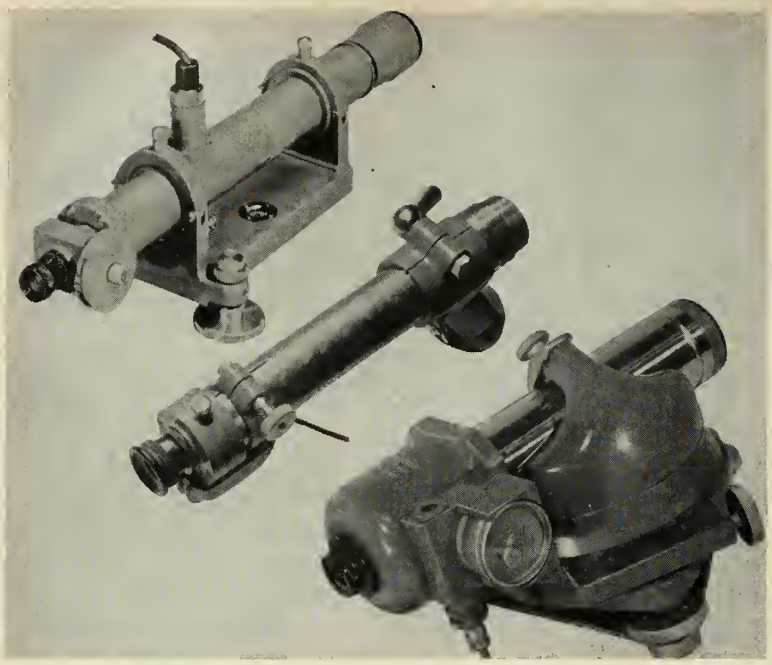
• **Why optical?**—One of the simplest illustrations of missile alignment problems is shown in a schematic of an optic test for rocket thrust malalignment, described by R. M. Leard, Head, Quality Engineering Division, Engineering Department, U.S. Naval Ordnance Test Station, in a paper presented to the American Ordnance Association.

According to Leard: "Limits on the alignment of components . . . generally take the form of a tolerance on the angle between the axis of the nozzle cone and the seating surface of the nozzle plate, as well as squareness tolerances on the ends of the motor tube. Tolerances are rather close on these angles, because the variation in angle will be multiplied many times, as the center of gravity of most rockets is well forward."

Leard's group use an auto-collimator to check the squareness of nozzle axes to their seating shoulders individually. Optical tooling, including the auto-collimator, is also used in the



ALIGNMENT TELESCOPE measures thrust-to-rocket-axis by means of angle screen and mirrow plug. Accuracy is on the order of an angle of 1 minute, 15 seconds.



FROM TOP LEFT: Watts Microptic Auto-Collimator, Hilger and Watts angle Dekkor, and Taylor-Hobson Auto-Collimator. Eyepieces and micrometers are scaled to read the angle of tile on the reflector directly.

manufacture of components for many missiles.

Leard also said that ". . . it was found that it was possible to measure a displacement (with the alignment telescope set-up shown) of .010 inch which corresponds to an angle of about 1 minute and 15 seconds. The system employed was found to be of sufficient accuracy for the measurements desired, however, it should be pointed out that a considerable refinement could be made in the accuracy of the angle measurement by employing a collimator, if it were desirable."

One immediate cost-reduction and labor saving presented through optical tooling is in the design and alignment of the production equipment itself so that work may be produced consistently to repeatable tolerances. Grinder and planer manufacturers have found that the use of optical tooling has cut down costly hand-scraping of machine ways. It has also enabled them to build machines whose performance accuracies are far greater and more dependable.

With optical tooling, for example, Barber Colman Co. produces the Hendey Lathe, with a headstock spindle mounted in a casting on three bearings, the centers of which are in line and concentric to within .00015 inches. Rockford Machine Tool Co. produces hydraulic planers which plane directly to less than .001 inch.

• **Another use**—Machine tool builders know that "good enough" is no longer good enough—that their machines must always be better in order to produce better.

Several years ago, Northrop Aircraft, Inc., faced the problem of cutting missile gears to a tolerance of plus or minus five seconds of arc. Incremental cutting methods were used to eliminate the normal gear-train errors from the gear cutting process.

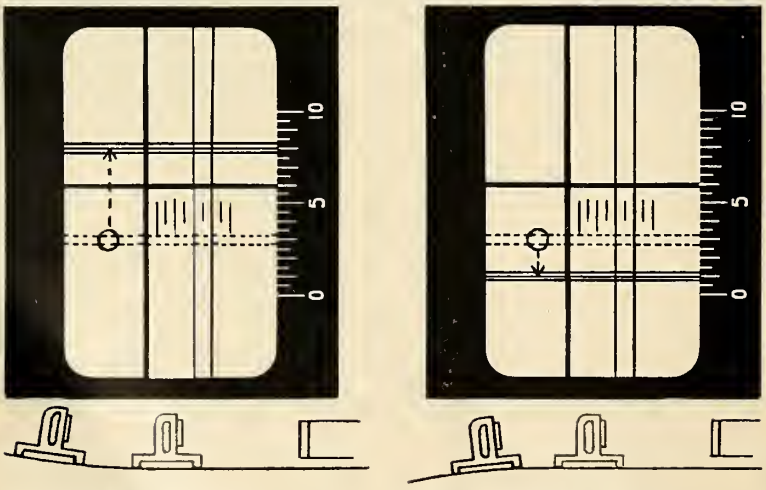
According to R. E. Gagon, Northrop senior engineer, this was done because "long range missile and guidance control systems require gears of unusual accuracy. Missile control is influenced by angular shaft movement. A very small error in angle may produce a very large lateral or longitudinal error in trajectory."

In the original process, angles were assembled with angle gage blocks and checked with a Hilger & Watts Microptic Auto-Collimator. However, to remove the errors introduced by improper wringing of the gage blocks, the Northrop optical laboratory prepared glass angle blocks ground and polished to the required angle with an error of less than half a second of arc.

The accuracy of these blocks could be demonstrated directly with the Microptic Auto-Collimator, since the instrument reads directly to a tenth of a second of arc. This instrument was used, together with a microptic circular table and other supporting optical and mechanical equipment, to calibrate the sector gears required for prototypes and early production runs of the product.

Routine production machine inspection by optical methods can support quality control procedures. In some instances, optical measurement can be used effectively to check prototype parts while production methods are being developed.

• **How it works**—The importance of the auto-collimator in precision measurement and alignment of rocket and missile components springs from the fact that precision measurements—on the order of half a millionth of an inch per inch—can be made without



"Plus" Readings **"Minus" Readings**

CROSS-WIRES are represented by heavy, black lines. Tbin vertical and parallel horizontal lines are the setting lines. Regardless of original setting lines, this reading on the micrometer drum becomes datum.

gage blocks or complex measuring instruments, by using the principles of auto-collimation and geometry.

Essentially, an auto-collimator is a telescope, incorporating a lens system from which light emerges in a beam of paralleled rays. The light passes through a reticle containing cross-wires, and is projected out onto a plane reflecting surface, usually a front-surface mirror.

The reflected beam is simultaneously received back into the optical system, forming an image of the cross-wires in the same plane as the cross-wires. If the reflecting surface is tilted, the returning beam is deflected through twice the angle of tilt, and the image of the cross-wires is displaced proportionately.

The position of this image is, of course, independent of distance, which makes it possible to measure widely-spaced locations. The displacement of the image is observed in the eyepiece, against a scale, and measured by an optical micrometer reading directly to 1/10 of a second of arc, which represents roughly half a millionth of an inch per inch.

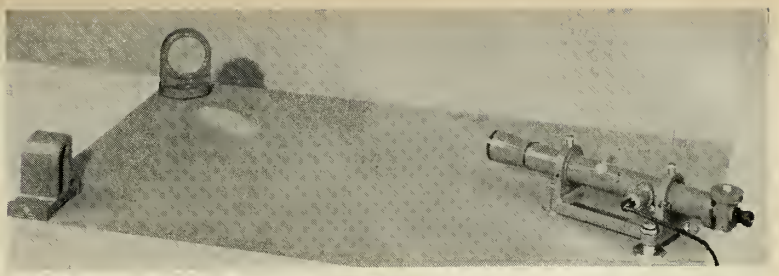
Although the values produced by the auto-collimator are angular values, they are quickly converted into linear measurements through simple trigonometry. The instrument is thus not only enormously sensitive, but quite versatile. Its use and versatility is greatly increased by such accessories as the optical square or penta prism, the various optical polygons, and other devices.

The other factor which gives the auto-collimator such a high degree of precision is its self-checking capacity. The quick and convenient reversal of a set-up involving reflector, optical square, or other accessories, provides a simple 180° indexing of the measurement so that any errors may be meaned out. In the same fashion, the auto-collimator may be used to check all of its own accessories as well as other optical (or mechanical) measuring instruments.

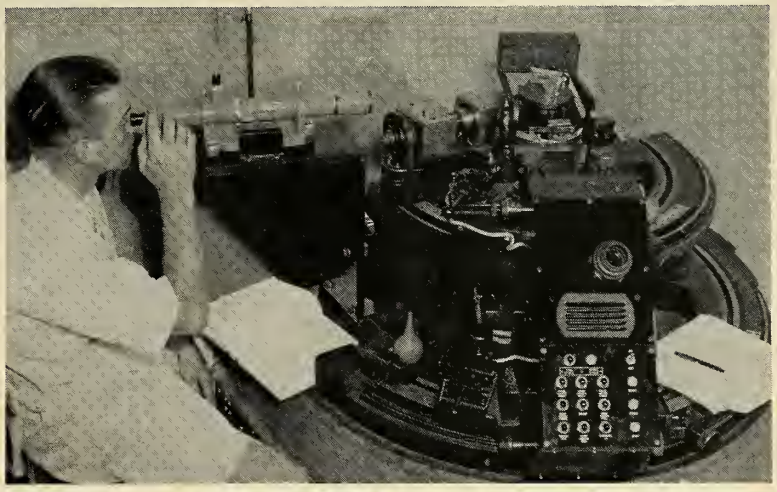
The Hilger & Watts Microptic Auto-Collimator is distributed in the U.S. by Engis Equipment Co., Chicago.

• **Future use**—Further developments in optical tooling have taken place along the line of projection-type equipment, where the cross-wires or scales in the target are no longer observed through an eyepiece, but are projected on a screen as an enlarged image. Result is, with suitable fixturing, rapid piece-part inspection with precise optical measurement is becoming commonplace on the production line.

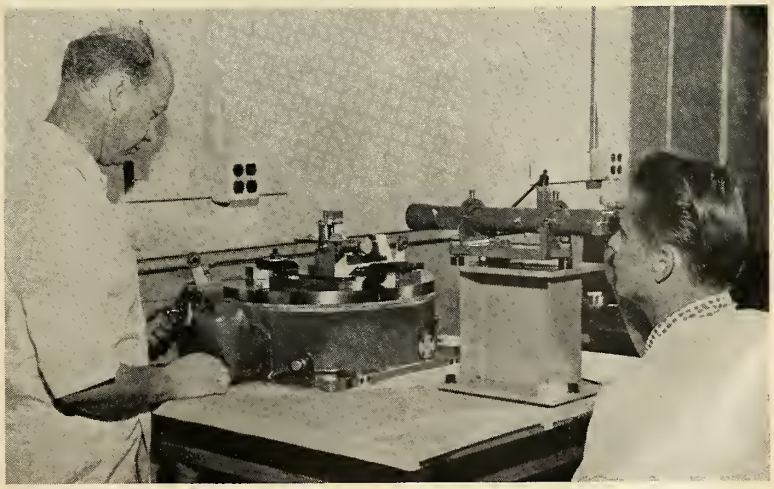
Optics has been felt in new concepts of specifications, in the development of production methods to meet those specifications, in gage control, and in production parts inspection.★



CHECKING SURFACE PLATES for flatness. Here is a typical arrangement. A Watts Microptic Auto-Collimator, corner mirror, and mirror carriage is moved along the line being read for flatness. Demand for more and more precision in missile engineering today makes laboratory equipment, such as surface plates, a critical item in measurement and check-out of precision components.



INSPECTION OF PRECISION MISSILE GEARS at Northrop Aircraft comprises a primary and secondary optical system. This allows a two-way check of the indexing system, and holds it to a tolerance of 1/10 second of arc (half a millionth of an inch per inch). The operator is shown using an auto-collimator to readjust the machine's calibration every 7½ degrees of carriage travel to correct any accumulative error. This installation is perhaps the most accurate indexing system in use in the U.S.



TECHNICIANS from Northrop Aircraft check high-precision missile gear with Watts Microptic Rotary Table and Watts Microptic Auto-Collimator. The Auto-Collimator is sighted into surface mirror, attached to the spindle of the table at the fulcrum point of a master work gear. Variance is held within close tolerance. Tolerance build-up in conventional gears causes serious problems in missiles.

Neon "Sign" May Map Radiation Belt

Satellite Proposed to Place Gas In Order That U.S. Scientists Can Plot Danger Zone for Man

by Savo Coric

A NEON "SIGN" in the heavens may be the best means of measuring the extent and density of a band of heavy radiation that could block manned space flight.

The radiation belt—detected by Geiger counters in *Explorers* I and III —is estimated by Dr. James Van Allen, who advanced the theory of a radiation belt, to stretch from 600 to 8,000 miles from the earth. According to this theory, the belt is probably a plasma of protons and electrons—particles of ionized hydrogen atoms ejected in space by the sun and held away from the earth by the earth's magnetic field.

To measure this belt, and the ion concentration of the plasma, would involve the installation of a vessel containing a compressed gas, preferably neon, in a future satellite. This vessel would be constructed so as to allow its contents to be ejected into space upon a signal from a Geiger counter, and heat or light sensing device.

The mechanism for opening the vessel would be preset to function only when the satellite's Geiger counter registers a counting rate considerably above normal, and the satellite is in the shadow of the earth.

• **Creating a glow**—Upon leaving the vessel, the gas would expand, be bombarded and excited by the electrons of the plasma, and then emit its characteristic bright red/orange glow. This glow would probably be visible from earth with the naked eye, providing the satellite emits a large enough amount of gas.

This artificial aurora borealis would be easily discernible from the natural one because of its red/orange color, its location along the satellite's orbit, and because it would not be confined to the polar areas. The rate of expansion of neon gas in the belt, easily observable from earth, will lend itself to measurement, or at least to an evaluation, of the original ion concentration in the radiation belt.

This rate of expansion is a function of both the temperature of the belt and the density of the hydrogen ions which push the neon atoms violently around. While the first of these is measured by appropriate temperature instrumentation aboard the satellite, and radioed to earth, the second can be deduced.

Even the shape of the brilliant neon cloud and its deviation from the satellite's orbit could indicate a great many things about the currents of charged particles around the earth in this radiation belt. These currents are supposed to provoke the disturbances in the earth's magnetic field one or two days after a period of increased activity of sun spots.

In this case, the mechanism for releasing the gas from its container can be activated upon a command signal from earth, to enable its use at any desired time, such as increased solar activity.

• **Shows punctures**—This phenomena can also indicate when a satellite orbiting in the belt has been punctured by meteors or if its transmitter suddenly ceases operation. (This happened to *Explorer* III in May, and it was presumed that meteors had punctured its hull and knocked out the radio equipment. However, the satellite resumed transmissions later.) Now, every satellite is filled with gas for maintaining internal temperatures within tolerable limits, so that the gas will escape into space in event of a meteor puncture, and thereby indicate the presence of such a puncture.

In addition to the primary objective of investigating the theorized radiation belt around the earth, this method also offers a means of simply and efficiently exploring the depth of the radiation belt around the moon, if there is one.

The existence of a belt would tend to prove that the moon also possesses a magnetic field, which in turn would help explain why the earth has a magnetic field. To date, there has been no satisfactory explanation of this phenomenon.

This detection of the moon's radiation belt would be done in a similar manner to that already described, but with two modifications. First, there would have to be a timing device which would connect the Geiger tube to the gas-releasing mechanism only when the moon-rocket is within the moon's radiation belt, not when it is passing through the similar belt around the earth.

Secondly, observation of the glowing gas could be done only with telescopes or by spectroscopic means, unless an enormous amount of gas is released.★

THE EFFECT OF A METEORITE PUNCTURE of a neon-gas-filled satellite would be similar to that shown in this NACA photo. The radiation belt surrounding the earth would act on the neon and make it glow as it rushed from the satellite. Deliberately releasing large quantities of neon in this belt would cause a large glowing area in the sky and permit observation and measurement of the area.

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Huge LOX Tanks:

A Cold Problem In A Hot Business

Photography by Seabrook Hull

HERE ARE THE WORLD'S LARGEST airborne storage vessels. The business end of *Thor's* 13,500 gallon capacity liquid oxygen loading tank shows the size of the fabrication job. Cambridge Corp. builds tanks for Douglas Aircraft.

SEGMENTS of tank's hemispherical heads are formed by a 500-ton hydraulic press. These LOX tanks are giant double-shell dewars with a high vacuum between the shells.

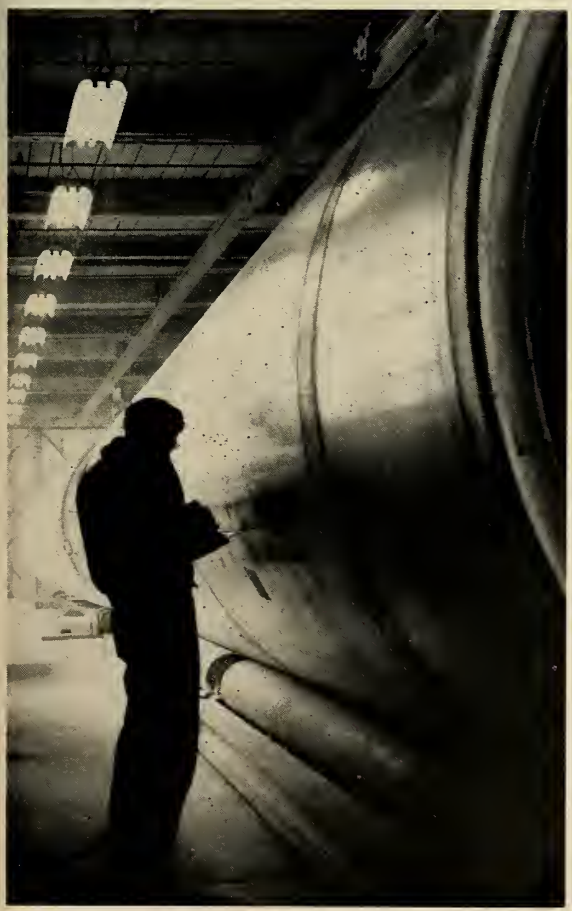
A WELDER works in the shadow of completed hemispherical head assemblies. These tanks, despite their size, are completely air transportable in currently available aircraft.

SPECIAL JIGS AND FIXTURES, such as this welding positioner, are needed in assembling stainless steel inner and aluminum outer shells.

SEGMENTS of the hemispherical head are being fitted together on a welding positioner. Tanks such as these will accompany *Thor* squadrons overseas (to Britain) this fall.

CLEANLINESS is an absolute necessity, not only to assure structural integrity, but to preclude any contamination of the liquid oxygen. Here oxides are removed prior to welding.

STAINLESS STEEL inner shell sub-assemblies for huge tanks. Automatic welding head in the upper foreground is an example of the kind of fabrication required.



THERE CAN BE NO LEAKS in the evacuated area between the two shells. Here, an inspector checks the condition of welds in the outer shell of aluminum plate.

VENT LINE expansion bellows must be carefully inspected during liquid nitrogen run-down test. Note the ice that has formed on the equipment. Tank is ready for shipment.

MAGNETIC TAPE APPLICATIONS 15

AMPEX CORPORATION

How to improve component reliability by better shake tests

Magnetic tape simplifies complex-wave testing and lessens human error

Many of the components that got their first ride on this tape-driven shaker are now circling the sky in Explorer I, our first successful earth satellite. It is highly significant that the California Institute of Technology Jet Propulsion Laboratory which led the development work on this satellite also pioneered complex-wave vibration testing. In this technique, magnetic recording plays many vital roles.

THE WAY TO OUTGUESS THE UNKNOWNS

Is simple sine-wave vibration testing sufficient? Or is a closer simulation of the missile's actual vibration environment a necessity? Results are not the same. Sinusoidal simplification often demands knowledge more complex than the complexities of a realistic test itself. Rocket components can bear neither the weight of excess safety factors nor the risks of conjecture – reasons why JPL chose random noise and complex waves.

Telemetered vibration tapes from actual missile flights are often used on shakers to assist development of test procedures. But this is not a complete answer. Different flights yield different vibration environments. A more ideal test-programming tape is a synthesized composite or envelope of the more severe conditions from many flights. This tape often combines random noise of engine vibration and complex waves from aerodynamic properties and structural resonances. And just as the missile's mass, velocity and surrounding atmosphere will change rapidly with time – so the taped program must change too.

Once on magnetic tape, any test program stays intact. It is repeatable without tedious setup and time-varying control of separate signal sources. With a properly calibrated tape, there is little chance that an operator will accidentally create destructive forces by errors in frequency or gain settings. Tape eliminates many possible sources of human error. It also leaves personnel free to concentrate on other requirements of shaker operation and test observation.

TAPE PASSES ALONG THE "IDEAL" TEST

So that co-contractors and subcontractors will run desired shake tests correctly on the components they furnish, Caltech's JPL frequently sends them program tapes. These contain calibration data in addition to the program itself. Thus a similar shake-table setup on the other side of the country can exactly duplicate the tests run in JPL's own laboratory. The tape lessens chance of misinterpretations and additive safety factors.

As quantity production of missile components gets under way, magnetic tape offers a means to run optimum shake tests on large numbers of components at widely separated manufacturers. From copy tapes, test programs of complex waves can be run almost as easily as a simple sinusoidal scan. Individual users need not have equipment to generate their own shaker-control programs. Prime contractor or research co-contractor can furnish the tapes. And since any number of duplicates can be made, a well-conceived test program can have unlimited circulation.

May we send you our 16-page brochure on magnetic-tape instrumentation plus further information on the use of tape for vibration testing? Write Dept. B-15

Glass-ceramics— New Vista for Radomes

A MAJOR ADVANTAGE of the glass radome material is its transparency before the ceraming process, thus affording visual inspection opportunity.

by Norman L. Baker

DERIVATION of the word radome is simple—merely join two words,—radar and dome—basically explaining the function. A more precise definition might be: a radome is an enclosure which permits passage of microwave radio frequencies for guidance of a missile, and protects the internal guidance equipment from its operating environment.

In missile applications, the radome must withstand high temperatures and thermal shock; sudden aerodynamic pressures; vibration and destructive erosion by raindrops moving at enormous relative velocity.

A new and versatile family of materials, glass ceramics, has now emerged to do this vital job.

While it is protecting internal guidance instruments from this hostile environment, a radome must maintain stable dielectric characteristics for continuous, accurate guidance.

In addition to these two major requirements, the ideal radome must meet the need for minimum weight and reasonable cost, and be reproducible on a mass production scale.

Currently, three different materials are available for radome applications. They are alumina ceramics, fiber glass laminates and, recently developed, glass-ceramic crystalline materials known as Pyroceram.

Pyroceram is an entire family of new materials, perhaps as numerous and varied as glass itself. Although not developed specifically to meet radome requirements, it has been used first in that application.

• **Development**—The chain of events that led to the development of Pyroceram can be traced back to 1938. Dr. Robert H. Dalton, a Corning Glass Works chemist, produced a deeper color in ruby-hued glass by irradiating it with ultraviolet, then heat-treating it. This discovery made it possible to produce controlled patterns of color in glass by selecting the areas exposed to ultraviolet.

The investigation was taken up three years later by Dr. S. Donald Stookey, a young chemist who had just joined Corning's research organization. Searching for a way to produce opal white images in glass, he studied the effects produced by ultraviolet.

This study led to the development of a true photosensitive glass, in which white, three-dimensional images could be reproduced precisely in the glass. Ultraviolet radiation acted as the sensitizing agent, and double heat treatment developed the image. But, unlike ordinary photographic printing, the image was reproduced not only on the surface but in and of the glass itself.

Dr. Stookey soon found that the white portions of the new glasses differed in several respects from the untreated glass. He experimented with acids and found that the white image dissolved much more quickly than the adjacent clear glass.

This fotoform process, in effect, produced a basic new material, with thousands of new applications for glass that could be chemically machined with precision. For example, in fine mesh screens for electronic tubes, the process creates wafers of glass with as many as 560,000 evenly spaced holes per square inch.

During a test of the new material, a plate of fotoform glass was left in a laboratory furnace with a faulty heat controller. The heat inside rose more than 600 degrees F. above the level for which it was set. When the test plate had turned a dark brown, it was as solid as before. Investigation showed that the overheated piece of fotoform had undergone a basic physical transformation.

• **Structural change**—Unlike most substances, the basic structure of glass

does not change from a liquid to a solid at any fixed temperature. It retains the characteristics of a liquid made of fused, inorganic materials. Because of this fundamental behavior, true glass is noncrystalline.

In the overheated test plate, it was found that the basic structure had been changed from noncrystalline glass into a crystalline, ceramic-like material. It possessed unusual electrical properties, was harder and three times stronger than the parent glass and had a higher softening temperature. The new material was named Fotoceram.

The discovery of Fotoceram took place in 1953. At that time, Corning's research laboratory was involved in a radome material testing program with the Applied Physics Laboratory of Johns Hopkins University. Some of Corning's glass samples performed well under tests for electrical and thermal properties, but rain erosion tests presented an obstacle. Shortly after Fotoceram was developed, and before complete data on properties was available, samples of the new material were submitted to APL.

While the tests were underway, the exploration of the unusual characteristics of Fotoceram was continued. It was realized that there would be a great advantage in bypassing the photosensitive process and producing the crystalline material by a more direct method. Since heating schedules affected the size and density of the tiny crystallites in Fotoceram, an effort to trigger crystal growth by heat alone was undertaken.

• **New material**—In less than three months the attempt was successful. Special chemicals added to the glass batch acted as seeds for crystal growth, and it was soon possible to produce glass-ceramic materials directly from glass through a careful schedule of heat treatments. The substances were melted, formed and cooled like a glass, then transformed into the crystalline material by heat.

As the new compositions were melted and tested, it was found that the glass-ceramics—now called Pyroceram—could be made as hard as high-carbon steel, several times stronger than the parent glass, and could be heated to 1300 F, then plunged into ice water without breaking. Some types could withstand temperatures above 1,800 F without deformation.

It was also found that Pyroceram could be made an opaque white or a transparent material. Because it is first a glass, the new substance can be formed into any shape that can be

IMMEDIATELY AFTER forming, the glass radome is placed in annealing kiln. This removes stresses before machining.

achieved with glass, using the same glass forming processes—blowing, pressing, drawing, centrifugal casting. Some types can even be cast like metals.

Because the properties of Pyroceram could be tailored for particular electrical, thermal and hardness requirements, samples were sent to APL. The samples tested out so well that negotiations for radome development contract for the *Terrier* surface-to-air missile were prepared before the radomes had even reached the pilot plant evaluation stage.

Perhaps the most serious problem at the beginning of the development program was a lack of broad technical data about the material on which production designs could be based. When the contract was signed, little was known about the operating properties or its melting and forming characteristics. Moving any new glass from laboratory crucible melting to pilot plant tank melting is a lengthy and complex process.

• **Forming**—One of Corning's research-developed processes solved the need for high-speed, close-tolerance forming. It was the centrifugal casting machine, called the spinner, developed in 1949 for forming the funnel of glass television bulbs. The spinner was ideally suited to forming the radome shape.

Manufacture of truly homogenous, bubble-free glass required for optical glassware had been restricted to small batch melts. In 1945, a method was developed for producing flawless glass continuously from a mass production glass tank. This process permits production of glass radome blanks free of imperfections.

One of the difficulties presented by the new material was the need to melt it at high temperatures. In the delivery end of the melting tank, it had to be held at temperatures well above the normal range for glasses. Because of this greater heat, and a lower viscosity than most glasses, the material was extremely fluid at the forming stage. Cooling had to be carefully controlled to prevent runaway crystal growth.

The melting problems were solved through adaptation of the processes developed by the company for high-temperatures and rates of delivery and cooling. This was correlated with control of viscosity of the molten material.

• **Grinding**—Because of the necessity for precise electrical characteristics, the wall thickness of a radome must be held to very close tolerances. This requirement is one of the most difficult obstacles faced by a radome manufacturer, whether his material is fiber glass laminate, alumina ceramic, or Pyroceram.

The spinner machine formed glass to tolerances close enough for most requirements, but the precision finish needed in radomes was on another order of magnitude. It was apparent that the glass-ceramic radomes would have to be machined.

Members of the machine research department at Corning conceived a unique approach to the problem. Using a grinding method probably never before applied to radomes, they tested their theory on small sample cones. The technique achieved tolerances as close as .001 of an inch on wall thickness. Full-scale equipment was designed and built for the prototype radomes.

Even with the new equipment, finishing the radomes was a major operation. The ogive shape proved considerably more difficult to grind than the cone-shaped samples, and the very hardness that gave Pyroceram good radome characteristics made it resistant to machining. Actual tests showed it took about four times as long to remove a sixteenth of an inch from Pyroceram than from glass.

One of the solutions to these difficulties was simply to grind the radome in its glassy state, before it had been ceramed into crystalline material. As a glass, it was considerably easier to finish, and as forming techniques were perfected, it became possible to grind closely enough in the glassy state so that only touch-up finishing was required in the final material.

Later improvements in equipment speeded the finishing action and reduced total grinding time to a fraction of its earlier duration.

• **Production**—To illustrate the volume production potential of Pyroceramic radome, it might be well to briefly review the steps involved.

The Batch: Ingredients for the glass

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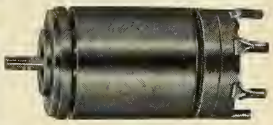
Electrical Characteristics:					
Frequency (cps)	400	400	400	400	400
Torque at Stall (oz. in.)	.15	.30	.63	1.45	2.35
No Load Speed (rpm)	6500	6500	6500	5200	5200
Speed at Half Torque (rpm)	4000	4000	4000	3200	3200
Time Constant (sec.)	0.03	0.015	0.016	0.017	0.013
Reversing Time (sec.)	0.051	0.025	0.028	0.030	0.022
Theo. Acceleration at Stall (rad/sec²)	22500	45000	41500	31000	40000
Operating Temp. Range (°C.)	−54 to +125	−54 to +125	−54 to +125	−54 to +125	−54 to +125
Slot Effect	1.6v/26v	1.0v/36v	1.0v/40v	1.0v/40v	1.0v/40v
Duty Cycle	Cont.	Cont.	Cont.	Cont.	Cont.
Fixed Phase					
Voltage	26	115	115	115	115
R (Stall) Ohms	196	1270	1250	490	280
X (Stall) Ohms	183	1560	1780	890	570
Z (Stall) Ohms	268	2210	2175	1030	640
P.F. (Stall)	0.73	0.57	0.58	0.49	0.45
Effective R (Stall) Ohms	366	3840	3800	2160	1460
Parallel Tuning cond. for unity P.F. (Stall) Mfd.	1.0	0.13	0.15	0.33	0.55
Control Phase					
Voltage	40/20	40/20	40/20	40/20	40/20
*R (Stall) Ohms	480	124	145	58	39
*X (Stall) Ohms	445	215	204	103	77
*Z (Stall) Ohms	660	248	250	118	86
*P.F. (Stall)	0.73	0.50	0.58	0.49	0.45
*Effective R (Stall) Ohms	910	495	430	240	190
*Parallel Tuning cond. for unity P.F. (Stall) Mfd.	0.4	1.4	1.3	2.9	4.1
Mechanical Characteristics:					
Rotor Inertia (gm. cm²)	.47	.47	1.07	3.3	4.0
Weight (oz.)	1.2	2	4.5	8	14
Mounting Type	Synchro	Synchro	Synchro	Synchro	Synchro
Motor Length	.863	.672	1.703	1.625	2.03
Type Shaft	Pinion	Pinion	Plain	Plain	Plain
Shaft Extension	.375	.218	.437	.540	.540
Outside Diameter	.750	.937	1.062	1.437	1.750
Type Connection	Leads	Terminals	Terminals	Terminals	Terminals

*For 40v connection

Size 8

Size 10



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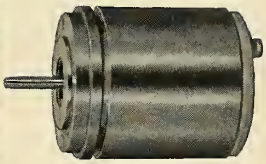

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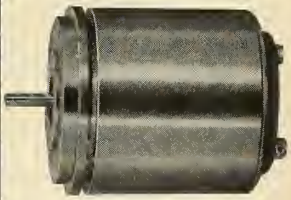

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BURTON BROWNE ADVERTISING

BLOWTORCH demonstration of the heat resistance of a glass-ceramic radome.

batch are selected for purity by chemical analysis. The raw materials are carefully weighed and proportioned to assure the uniformity of the parent glass, and ultimately of the crystalline product. Thoroughly blended in huge mizers, the batch materials are fed into the melting tank at a carefully controlled rate.

Melting: Melting the parent glass is done in a continuous glass tank. Specially compounded refractory lingings are used to minimize contamination of the molten glass, assuring chemical purity. In the pre-melt section of the tank, heat reduces the batch to viscous liquid. Then it flows into a fining chamber where bubbles are removed from the molten glass. Finally, the glass flows into forehearth or delivery end of the tank.

Forming: The glass is delivered in predetermined amounts from the tank into a steel female mold. Then the radome is formed in seconds by spinning the mold at high speed, creating centrifugal force which spreads the glass upward against the inside surface of the mold.

Annealing: The glass cools rapidly during the forming operation. The radome blank can be taken immediately from the mold and transferred to an annealing oven, where internal stresses caused by the sudden cooling are removed by temperature cycling.

Preliminary Inspection: The radome blank is removed from the annealing oven and inspected visually. The material is transparent in its glassy state and internal defects are easily detected. Faulty blanks are rejected.

Preliminary Machining: The inspected blank is taken to the finishing facility where it is rough ground to required dimensions. At this stage, the inside surface is contour ground to the approximate size required, and any excessive stock on the external surface is also removed.

Ceraming: The semi-machined radome blank is placed in a ceraming kiln and heat treated in accordance with a carefully prescribed schedule. During the heat treatment, nucleating agents in the glass cause a controlled crystallization of the material, transforming it from glass into the opaque white state.

Final Machining: The ceramed radome blank is returned to the grinding department for final finishing. During this final grinding, the inside surface is touched up and finish-ground to the prescribed internal contour. Since dimensional changes are minor in the conversion to the crystalline phase from glass, extensive grinding is not necessary. Finally, the outside of the radome is ground to contour and specified wall thickness, finishing to the required length.

Mounting: Last step in the preparation of the radome is to join it to metal ring which can be bolted, revited, or attached by latch couplings to the body of the missile. The base of the radome is permanently bonded to the metal ring with a suitable adhesive. The mounting ring acts as a graded seal between the frangible radome and the ductile metal body, and normally matches the expansion coefficient of the radome. If a perfect match is not possible, a flexible joint is used in the mounting. After mounting, the radome is given a final inspection and then shipped.

• **Advantages**—Fabrication of Pyroceram radomes offers a substantial advantage over alumina or fiber glass laminates in ease and speed of manufacture. Perhaps more important, the manner in which the radomes are produced guarantees precise reproducibility of properties from one radome to another. After being machined to specified dimensions, the glass-ceramic radomes are alike in every respect, including electrical properties.

• **Properties**—The glass-ceramic radome has extremely dielectric properties over a broad temperature range. For example, at a frequency of 10^{10} cps., dielectric constant is 5.45 at 77 degrees F, 5.51 at 572 F, and 5.53 at 932 F. Over the same temperature range, dissipation factor goes from 0.00033 to 0.00075 to 0.00152. These electrical properties remain almost unchanged up to the material's top operating temperature of 1,800 F.

The radomes will withstand 2,200 degrees F. for short terms without deforming, and its thermal expansion coefficient of 32 x 10^{-7} per degree F gives it excellent resistance to thermal shock.

Thermal emissivity is also high. At an altitude of 100,000 feet, and a speed of Mach 6, the glass-ceramic will have a mean temperature of 1300 F; while under the same conditions alumina will be operating at 1800 F. The variance is broader at higher speeds, cancelling most of the 900° advantage of alumina's higher deformation temperature. Pyroceram radomes can also stand thermal gradients nearly 50% greater than the limit for high alumina.

The mechanical properties of Pyroceram fall well within radome requirements. The modulus of elasticity at 77 degrees F is 17.3 x 10^6 psi, Poisson's ratio is 0.245 and flexural strength is 26,000 psi. Using the Vicker's Diamond Pyramid test at 500 grams load, hardness is 618. Using a specific gravity of 2.60 at 77 degrees, it falls between the two other radome materials for weight. Although glass-ceramic flexural strength is lower, a strength-to-weight comparison between alumina and glass-ceramic radomes favors Pyroceram.

• **Future uses**—It is obvious that applications of the new glass-ceramics will not be restricted to radomes. Potential uses in missiles and aircraft may include skin panels, leading edges.

Some of these applications will hinge on the fundamental research at Corning that is still broadening the range of compositions and properties that can be achieved with the glass-ceramics. Higher temperature melting facilities are being prepared for the development of glass-ceramic materials that may extend the operating limits well above the present temperature range. Work on physical properties makes flexural strengths of 100,000 psi a foreseeable achievement, and crystal-clear, high-strength materials are already being developed.★

High Energy Liquid Fuels Promising

But extensive hardware testing is needed for boranes, which are in short supply

By Donald E. Perry

High-energy fuels hold great promise for the missile industry. But they are in short supply and their properties not yet well defined.

Many of the fuels, particularly the boranes, will have to await extensive hardware development programs.

This is the opinion expressed by one researcher for a major petroleum industry. Robert A. Wells, staff engineer, Gulf Oil Research Center, said that "Actually, more can be done by improving oxidizers than the fuels."

The nation's much publicized high-energy fuel program started with the Navy's project "Zip" in 1952, which the Air Force joined in 1955. This multi-million dollar program, based on diborane, resulted in a major fuel technology breakthrough. A new series of boron-carbon-hydrogen compounds were developed that retain much of the high energy of the boranes but are more stable, less toxic and of higher density.

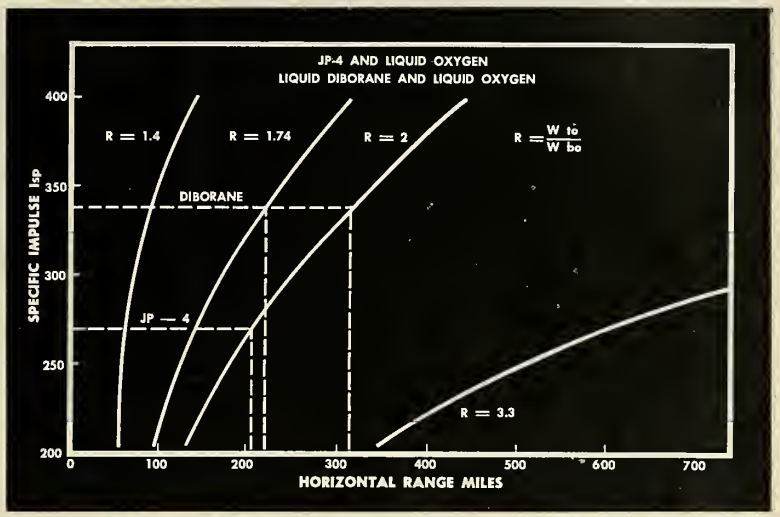
Olin-Mathieson Chemical Corp. has completed and started operation of a production plant to produce boron fuels for solid propellant rockets. Callery Chemical Co., of which Gulf is 25% owner, also is in the boron picture (see m/r April, 1958, p. 85). Both plants are multi-million dollar ventures.

• **Much to be done**—With boron fuels now in production, although probably limited, Wells' statement is particularly significant. While much literature today quotes current I_{sp} as 250, based on a chamber pressure of 300 psi, Wells concludes that a more realistic value for present ICBM-type rockets would be in the 500-600 psi range.

He considers high-energy fuels for rockets as those having theoretical I_{sp} ratings above the 272 rating of JP-4 and liquid oxygen at 600 psi chamber pressure. While security does not permit giving the specific properties of the several HEF (high-energy) fuels, Wells did compare available information on several boron hydrides which closely resemble these boron-carbon-hydrogen fuels. Essentially, the fuels differ from the boranes by the substitution of alkyl groups for some of the hydrogen. The engineer believes that the Air Force's HEF-3 is ethyl alkylated decaborane, a liquid, although decaborane is a solid.

"The smallest alkyl group practical is probably desired in order to substitute as little carbon as possible for some of the hydrogen and prevent drastic reductions in the heat content from the basic boranes," Wells adds.

Boron hydrides have been extensively investigated in small and full-size burners at NACA's Lewis Propulsion Laboratory. The Btu-lb rating of these fuels, along with a performance rating



RANGE PERFORMANCE of a hypothetical rocket vehicle with JP-4 and liquid diborane compared. Diborane would require larger tank.

COMPARING PERFORMANCE OF BORON HYDRIDES

	Form	A Btu/lb.	B Density	A x B	A x B (for JP-4)	State
Hydrogen	H_2	51,500	.000089	5	.00004	Gas
Beryllium	Be	29,100	1.8	52,500	3.64	Solid
Boron	B	25,400	2.0	50,000	3.47	Solid
Diborane	B_2H_6	31,300	.0012	36	.00025	Gas
		31,100	.46 (−92.4°C.)	14,300	.99	Liquid
Pentaborane	B_5H_9	29,100	.631	18,300	1.27	Liquid
Decaborane	$B_{10}H_{14}$	27,900	.94	26,200	1.82	Solid
		28,200	.72	20,300	1.41	Liquid
Alkylborane	B-C-H	25,000	.82 (13)	21,600±	1.5	Liquid
Jet Fuel	JP-4	18,700	.77	14,400	1.00	Liquid
Rocket Fuel	RP-1	18,580	.81	15,100	1.05	Liquid
Jet Fuel	JP-6	18,447	.80	14,800	1.03	Liquid

—a product of their Btu/lb multiplied by their density, divided by the same product for JP-4—is shown in the accompanying table.

• **Hydrocarbons still important**—Wells points out that HE fuels, even with a fuel production price of $1 per pound, will be 50 times more expensive than hydrocarbon fuels. One notable feature, however, is that modification of the boranes into HEF has apparently reduced vapor pressure. This, in turn, has reduced the likelihood of explosive or toxic vapor concentration. One fuel producer has reported an accident level substantially lower than the chemical industry average.

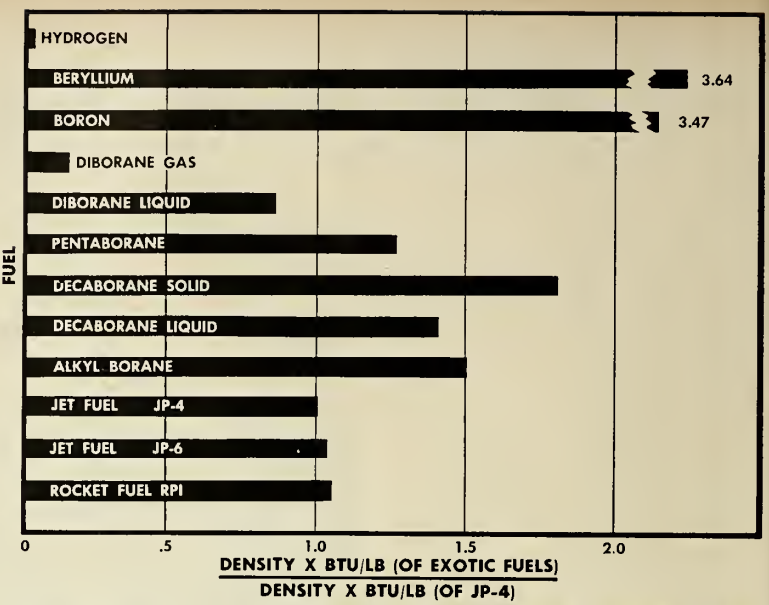
Meanwhile, hydrocarbon fuels are part of the propellants in many rockets now being designed, produced fired to obtain development data. Much effort is being made to improve their reliability and accuracy by more closely defining the characteristics of hydrocarbon fuels, and refining the definitions still further by considering specific hydrocarbon chemicals.

RP-1 fuel, JP-6H and the alkylated polycyclic materials evolved from this type of approach. I_{sp} for these fuels in rocket engines would show good values due to the low molecular weight of the exhaust gases, as compared to nonhydrocarbon fuels, according to Wells. Of interest is that these hydrocarbons can be made available from coal tar distillation at a presumably reasonable price, but the price could be greater than hydrocarbons from petroleum.

• **Trouble in specs**—One of the problems inherent in extension of the present types of specifications to include chemicals for rockets is the specification requirements themselves, Wells said. Fuels derived from petroleum have always been used for aircraft, and specifications have been written to include items such as distillation range, smoke point, aniline point, etc.

But in at least one area something is being done. A modified RP-1 fuel specification is now being written which will attempt to define properties in terms of qualities known to be critical to rocket engine performance. These items may include density/temperature relationship; viscosity/temperature relationships; vapor pressure; C:H ratio/ and heat of combustion. Additional requirements probably will attempt to insure against corrosion, contamination, storage and thermal instability.

• **Comparison**—Wells has compared JP-4 and liquid diborane for a hypothetical rocket vehicle with fixed hardware. The only variables considered are the changes in I_{sp} and W_{to} (weight on takeoff) due to the density of liquid diborane at 0.46 as compared to JP-4 at 0.77.



CHARACTERISTICS of the borane fuels show that low density of diborane adversely affects its mass ratio and offsets the theoretical increase in I_{sp}.

Diborane is combustible over a wider fuel/oxidizer range than are hydrocarbons, so the rocket fuel tank is filled for the same weight as JP-4 with the same number of gallons for the comparison.

Conclusion is that the low density of diborane adversely affects its mass ratio and offsets the theoretical increase in I_{sp} when these values are applied to rocket range and velocity at burnout. Wells parameter predicts that there will be no significant difference in performance between JP-4 and liquid diborane.

According to Wells,

"If we assume $\frac{W_{to}}{W_{bo}} = 2$ for our rocket with JP-4, and JP-4 = 32% by wt. of total propellant, then the diborane fueled rocket would have a

$$\Delta W_{to} = 2 \left[.68 + .32 \times \frac{\text{Density of Diborane}}{\text{Density of JP-4}} \right]$$

$$\Delta W_{to} = 2 \left[.68 + .32 \left(\frac{.46}{.77} \right) \right]$$

$$\frac{W_{to}}{W_{bo}} = 1.74$$

"This calculation indicates that, for a single stage rocket of given configuration, the velocity at burnout would be the same for both JP-4 and liquid diborane in LOX. But, if the hardware could be adjusted to keep the same mass ratio of 2 for the liquid diborane, then the velocity would be increased by 26%.

"The same process, using the range formula, results in an increase of 20% with liquid diborane in a fixed hypothetical vehicle, compared with an increase of 57% where the hardware was designed to a mass ratio of 2.

"Diborane is probably not being considered for such applications due to this low density. The molecular weight of combustion gases affects the values of I_{sp} as do the temperatures of the gases. The heavy exhaust products from the alkyl borane fuels, which reduces theoretical I_{sp}, coupled with the high-flame temperatures—which increase theoretical I_{sp} but may destroy hardware—pose additional problems for the rocket designer.

"Liquid alkylated decaborane fuels have much higher density although their I_{sp} may be appreciably lower. The value of alkyl borane fuels in liquid propellant rockets must await an extensive hardware evaluation program."

Pyrophoric fuels (liquids which ignite spontaneously in air), if used in concentrations of 15 to 30%, can improve burning and reduce screech in rockets. According to Wells, this gives more reliable operation at higher altitudes and leaner fuel/air ratios.

These fuels now available for testing are organo-metallic compounds. Three materials have been prominent in this field—TEA (triethyl aluminum), TEB (triethyl borane), and TMA (trimethyl aluminum). Recently a new material, TNN (tributyl borane), has been synthesized which has very high flame speeds and blow-out velocity. It has the unusual safety feature in that it does not burn when exposed to air, but must be sprayed before it exhibits its pyrophoric characteristics.★

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space age

by Norman L. Baker

Dyna-Soar—The first phase of the Air Force *Dyna-Soar* space glide-bomber development will be devoted largely to organization of the two groups of contractors, headed by Martin and Boeing, into working teams. The meager $7-million-letter-contract giving Martin and Boeing the go-ahead is expected to involve a six to eighteen month period of heated competition. During this time, the contractors will be expected to finance development and organizational expenses from their own capital. It is further expected that only one team will be awarded the much sought-after production contract.

The major subcontractors in the Boeing team are Ramo-Wooldridge Corp., General Electric of Syracuse, N.Y.; North American's Autonetics and Missile Development divisions; Aerojet-General; and Chance Vought. In the Martin team are Bell Aircraft, Goodyear, American Machine and Foundry, Bendix and Minneapolis-Honeywell.

The Martin team will draw heavily on Bell's pioneering work on the *Bomi* boost-glide bomber project. Although it has been reported the *Dyna-Soar* vehicle will be designed as an entirely new system, both teams will rely heavily on the *Navaho, Titan,* and X-15 development programs. Bell, North American and Boeing have spent several years studying the boost-glide bomber concept.

The last stage of the *Dyna-Soar* system, if based upon previous Bell and Boeing studies, will be a delta-wing vehicle with one to three liquid rocket engines as sustainer power plants. Undersurface of the bomber will be flat for more positive control of attitude during re-entry and dissipation of the high heat of aerodynamic friction.

The Dyna-Soar vehicle, essentially a short duration satellite, if in the ten to fifteen-ton gross weight category, will require a first stage propulsion system developing approximately one-million pounds of thrust. Unless propulsion systems now in development are clustered to achieve the one-million figure, the final development of *Dyna-Soar* may be at least five years away.

Dr. Herbert York, chief scientist of ARPA, estimates that it will take five years before the one-million pound engine will be flying and several more years of flight testing. DOD released $450,000 for the project in 1958, with an additional $15-million slated to come out of 1959 funds.

The *Vanguard* **program,** with five remaining vehicles for 20-in. satellite launch attempts, will receive an additional $9.8-million for fiscal 1959. SLV-2, the third failure to launch the full size satellites, was instrumented for further investigation of the radiation belt discovered by *Explorer* III. The *Explorer* program, with a $3.5-million budget for 1958, has no programmed obligations for 1959.

when and where

JULY

Computers and Data Processing Fifth Annual Symposium, Albany Hotel, Denver, Colo., July 24-25.

Society of Photographic Instrumentation Engineers, Third Annual Exhiborama, Second Annual Symposium, Statler Hotel, Los Angeles, Calif., July 29-31.

AUGUST

ARS, IAS, Regional Technical Meeting, "Space Exploration", San Diego, Calif., Aug. 5-6.

AIEE, IRE, NBS, Conference on Electronic Standards and Measurements, National Bureau of Standards Boulder Laboratories, Boulder, Colo., Aug. 13-15.

Missiles Operations Research, Engineering Seminar, Pennsylvania State University, University Park, Pa., Aug. 17-23.

AAS Annual Western Regional Meeting, Stanford University, Dinkelspeil Auditorium, Palo Alto, Calif., Aug. 18-19.

ASME, A. I. Ch. E. Conference, Northwestern University, Evanston, Ill., Aug. 18-21.

Western Electronic Show & Convention, Institute of Radio Engineers, Ambassador Hotel, Los Angeles, Calif., Aug. 19-22.

Ninth Annual Congress, International Astronautical Federation, Amsterdam, Holland, Aug. 25-30.

SEPTEMBER

First International Congress of the Aeronautical Sciences, Palace Hotel, Madrid, Spain, Sept. 8-13.

American Rocket Society, Fall Meeting, Hotel Statler, N.Y., N.Y., Sept. 14-18.

Professional Group on Telemetry and Remote Control, 1958 meeting, Americana Hotel, Bal Harbor, Miami Beach, Fla., Sept. 22-24.

Air Force Association, Airpower Showcase, Dallas, Texas, Sept. 25-27.

ASME Power Conference, Statler Hotel, Boston, Mass., Sept. 28-Oct. 1.

National Aeronautic Meeting, Society of Automotive Engineers, Inc., The Ambassador, Los Angeles, Calif., Sept. 29-Oct. 3.

OCTOBER

Association of the United States Army 1958 annual meeting, Sheraton-Park Hotel, Washington, D.C., Oct. 20-22.

Institute of Radio Engineers East Coast Conference, Aeronautical & Navigational Electronics, Lord Baltimore Hotel, Baltimore, Md., Oct. 27-28.

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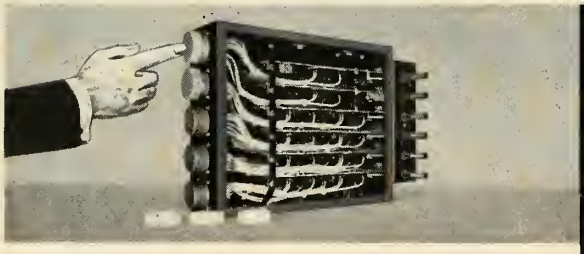
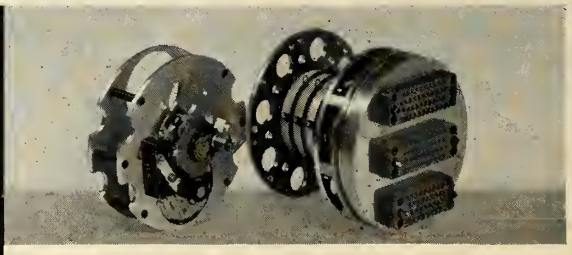


Emergency Fire Control—Used in the Flight Engineer's console of the Douglas Globemaster, plunger actuation allows instant emergency operation of any or several of the following: prop feathering, closing cowl and oil cooler doors, stop fuel and electrical service, fire extinguishing system actuation. Unit illustrated handles six distinct areas with instant cancellation of command feature for error correction.



Ground Power Changeover Control—This assembly (airborne) provides remote control of the transfer from external to internal bird power. Of compact and efficient design, its multiple-contact circuit breaking design allows more than 2 amp and 500 VDC capacity with ample margin. Partial assembly only, shown.

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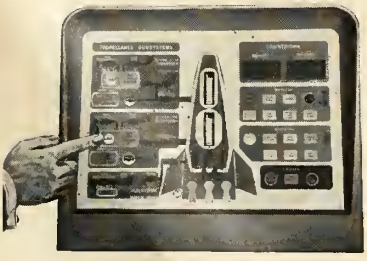

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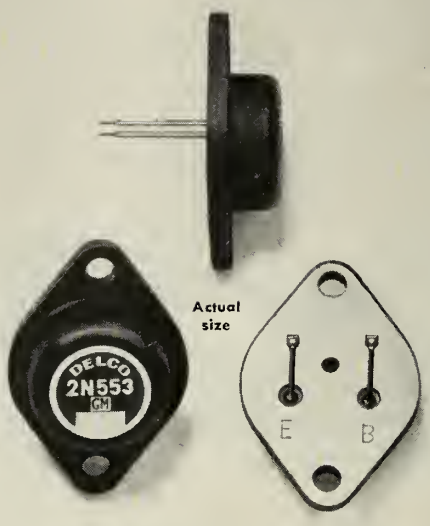

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Collector diode voltage V_{CB} (V_{EB} = −1.5 volts)	80 volts maximum
Emitter diode voltage V_{EB} (V_{CB} = −1.5 volts)	40 volts maximum
Collector current	4 amps. maximum
Base Current	1 amp. maximum
Maximum junction temperature	95°C
Minimum junction temperature	−65°C
Collector diode current I_{CO} (V_{CB} = 2 volts)	12 μa
Collector diode current I_{CO} (V_{CB} = −60 volts)	0.5 ma
Collector diode current I_{CO} (V_{CB} = −30 volts, 75°C)	0.5 ma
Current gain (V_{CE} = −2 volts, I_C = 0.5 amp.)	55
Current gain (V_{CE} = 2 volts, I_C = 2 amps.)	25
Saturation voltage V_{EC} (I_B = 220 ma, I_C = 3 amps.)	0.3
Common emitter current amplification cutoff frequency (I_C = 2 amps. V_{EC} = 12 volts)	25 kc
Thermal resistance (junction to mounting base)	1° C/watt

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west coast industry

by Fred S. Hunter

Pop-up-pops—Reports from the San Clemente Sea Test Range indicate that the Navy's "pop-up" system for launching the *Polaris* IRBM for submerged submarines is working out all to the good. The missile is launched from vertical tubes by compressed air or gas. But the real test will come when they light the fuse. No hint yet how soon this may take place.

Ground handling—Launchers for the *Nike Hercules* possess the dual capability of firing both the old *Nike Ajax* and its atomic-capable successor. The *Hercules* missile structure, four times larger than the *Ajax,* was required to fit into existing elevators and storage areas at established *Ajax* launching sites.

This imposed severe design limitations, which were solved jointly by Douglas Aircraft Co. and Consolidated Western Steel division of U.S. Steel Corp. The Army is installing the initial *Hercules* launchers at permanent locations near metropolitan areas. However, the missiles are also designed as field weapons, thus the equipment can be quickly disassembled for removal to a new site.

Skin divers—Aerojet-General's underwater engine division is working hard these days. It is testing a high-speed propulsion system, described as radically new in design, in the ring channel at Azusa. (This is where feasibility of underwater launch of the *Polaris* was proved). A free-running test missile has been developed, which was fired with accuracies approaching those of aircraft rockets.

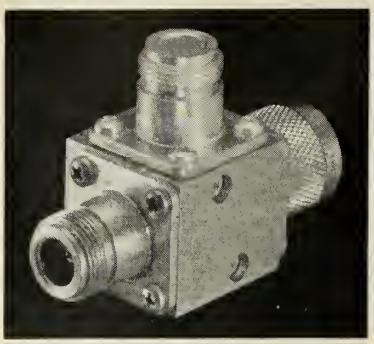
Aerojet is now working on a $36,320 R & D contract from the Federal Maritime Board to explore the feasibility of a submerged cargo ship to be driven at high speeds by water-jet propulsion.

Computer pilots—From W. J. Cecka, Jr., Rocketdyne's test manager, comes news that mathematicians at North American's rocket engine division have worked out a trip to Mars on computers, using ion rocket engines. The trip totaled 46.6 million miles, and required 323 days. That's a speed of about 6,000 mph. Cecka says that had the computer jockeys been a little more certain of their course, three weeks might have been clipped off the trip's time.

New test site?—Appearance of numerous automobiles carrying Jet Propulsion Laboratory identification at Camp Irwin has led to speculation that the Army plans to use the big tank training ground northeast of Barstow for rocket research and development—and possibly some space work. That's wide-open country!

High style—Latest thing in computers and data processing devices seems to be gay color schemes. One manufacturer offers five or six different hues. Reason is that expensive data rooms, we're told, cost something over $18 per square foot. This shouldn't be cheapened by plain old black or gray boxes!

Diplexer by Microphase Isolates S-Band



A diplexer designed to isolate the S-band from the X-band has been introduced by Microphase Corp. In the S-band, the insertion loss is less than 1.0 db, while in the X-band it is under 1.5 db. The isolation is a minimum of 30 db.

The filter weighs 4½ oz. and is constructed to meet rigid environmental conditions. On special request, 60 db isolation between bands is available with detracting from pass-band performance.

Although the filter has a 500 mc buffer zone, this can be reduced if necessary.

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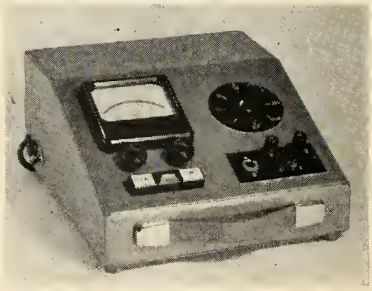
Interval Meter Has 2% Accuracy

Presin Co. has developed a short-time interval meter, model KM-1, with a measuring range in eight steps from 5 microseconds to 1 second, and an accuracy within 2%.

The unit is a portable one, suitable for either field or laboratory use, and is designed for such measurements as



closing and opening times of relays, circuit breakers and snap switches.

The device is also applicable to measuring exposure times of photographic shutters, determining the velocities of levers, missiles, the duration of explosion processes, and the checking of electro-mechanical lags through a system.

Simplicity of the meter enables its use by untrained personnel. Operating from a 110 vac line, the measuring process is controlled by a gate which opens during the measuring interval, charging a capacitor. The increase in the voltage drop across this capacitor is displayed by a vacuum tube voltmeter whose face is calibrated in time divisions. Size of the unit is 5" x 10¼" x 11⅞". Total weight is 13 lbs.

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Bellows Expansion Joint Handles Liquid Oxygen

Skinner Seal Division of Hydrodyne Corp. has announced the production and availability of a machined bellows expansion joint for liquid oxygen and other fuel and oxidizer systems.

The product, which may be made of a variety of metal alloys and in a wide range of sizes, utilizes a spring

seal machined on each end, permitting high pressures. The joint also permits extremely high and low temperatures—the latter to −320°F.

According to the company, both environmental tests and actual applications show that the joint, with controlled wall thicknesses, has a long fatigue life.

Circle No. 227 on Subscriber Service Card.

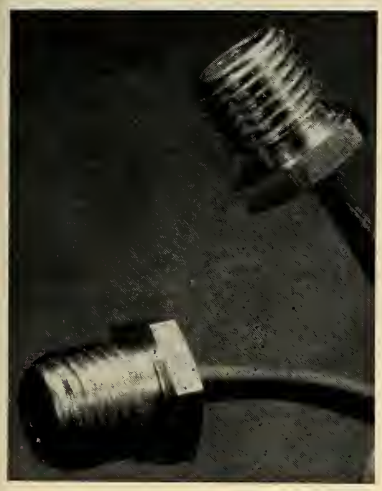
Ignition Primer Operates Above 100,000 Feet

Holex Inc. has added model 1029A high-altitude ignition primer to its line of explosive products. The unit is hermetically sealed and designed specifically for ignition of propellants and powders at altitudes in excess of 100,000 feet. The primer is of standard screw-in construction having a ⅜-24 class 2A thread and a 7/16" hex. It is

normally supplied with integral No. 20 leads, 4½" long.

The basic load is a metallic-oxide priming mixture which has been extensively tested at altitudes over 100,000 feet for the ignition of boron and similar-type boosters and propellants, according to Holex.

The cartridge is bridge-wired with a nominal resistance of 0.25 ohms, and will withstand the application of ½ ampere for an indefinite time without firing. When fired with a current of 5 amperes dc, the unit will ignite



in approximately 13 milliseconds. Similar units are available with shorter ignition times down to 1 millisecond or less.

The cartridge has been designed to minimize static sensitivity and will withstand 1,000 volts ac between either pin and case without ignition. The primer is also designed to withstand all environmental tests called out by MIL-E-5272A. Modifications of the unit are available with different firing times and no-fire characteristics.

Circle No. 228 on Subscriber Service Card.

Transducer Measures Conducting Fluid Pressure

A new line of variable inductance pressure transducers has been developed by Datran Electronics Division of Mid-Continent Manufacturing, Inc., to measure the pressures of conducting fluids such as salt water.

It is possible to obtain these transducers, which have inner components and connections "potted", in differential, gage or absolute ranges from 0 to 10 psi up to 0 to 3,500 psi.

Electrical output from these transducers is in variable frequency, AC or DC voltage.

Circle No. 229 on Subscriber Service Card.

Test Stations Proud

To the Editor:

Congratulations on your special mid-April issue of m/r entitled "Missile Market Guide and Directory Edition." It will be a welcome addition and of great assistance to those engaged in all facets of rocket propulsion and missile development.

The article, "How to Do Business with the Air Force" was read with great interest; however, no mention was made of the Air Force Flight Test Center in the description of test Centers under the jurisdiction of the Air Research and Development Command. In light of the recent altitude and speed records recently achieved, and the ever-increasing amount of missile system static testing being accomplished at the Air Force Flight Test Center on the present family of IRBM and ICBM missile systems, it is felt that the Air Force Flight Test Center's important role and contribution to the Air Research and Development Command's mission was overlooked.

The personnel at the Air Force Flight Test Center, and the Directorate of Missile Captive Test in particular, are proud of their test facilities and overall contribution to the missile development programs and are of the opinion that this oversight should be brought to your attention.

Philip F. Fahey, Jr.
Deputy Chief, Missile Test Division
Air Force Flight Test Center
Edwards Air Force Base, Calif.

All Americans can be proud of the work of the Flight Test Center at Edwards and elsewhere—Ed.

Hard to place

To the Editor:

Air Force and contractor people at the Air Force Flight Test Center were thrilled by the May 1958 cover picture of Test Stand 1-A at the Rocket Engine Test Laboratory here at the Air Force Flight Test Center. But the written description of the picture on page 7 stated the test stand was located at Convair-Astronautics' Sycamore Canyon facility near San Diego.

Donald L. Dynes, Deputy Chief
Missiles Facilities Division
Director of Missile Captive Test
Edwards Air Force Base, Calif.

The test stand is one three such units that are so close in outward appearance that even Mr. Dyne's crew had to identify the number of the yellow trailer in the foreground before they could be sure the stand was the one at Edwards—Ed.

Missilonics?

To the Editor:

I greatly enjoy your fine publication, but am floored everytime I read the expression, "Missile Electronics". How about shortening this unwieldy title to "Missilonics"?

Emercon W. Case
Supervisor of Data Reduction
General Electric Flight Test Lab
Schenectady, N.Y.

We have already coined the word "astrionics"—your suggestion is duly noted—Ed.

Welcomes weekly

To the Editor:

I have your letter of 14 May telling of the plans to convert m/r to a weekly magazine beginning with the issue of July 7.

Please accept my congratulations.

I offer you my encouragement with this new venture and I sincerely hope and believe that it will prove successful. I believe that your feeling that the industry is growing so rapidly that it demands a weekly coverage of events is a sound assumption. The only way to find out "what the traffic will bear" is to seize the bull bodily by the horns. I also feel as you do that you can be of greatest service by bringing current events quickly to the attention of your subscribers.

Wernher Von Braun
Director
Development Operations Division
Redstone Arsenal, Ala.

Thank you! We will continue to grow and expand our service—Ed.

Mature Engineers Not Used?

To the Editor:

I was quite interested, and I might add amused, by the article "Top Personnel Shortage Worries Industry". (m/r, May, p. 49.)

Interested, in that I appreciate the detailed story that it tells; and amused by the one great detail that it fails to mention entirely.

As a reputedly able and experienced mechanical-industrial engineer and a capable administrator, but of mature years, I have not been engaged in any capacity for over seven months. Many of my former friends and associates are in the same category, some for longer periods of time.

For over 25 years, many of us have been engaged in the field of precision mechanical and electro-mechanical instrumentations for government as well as industrial projects: materials and processes, component development, manufacture, and fire control systems.

Most of us agree, whole-heartedly, that there is a shortage of various types of engineering personnel. But, we cannot agree that the available engineering personnel, is and has been, utilized for the best interests of the individual or our country. The engineer, over 45 years of age and under 60 years of age, represents a wealth of experience that will take years for the younger man to acquire—and we all received our experience the hard way.

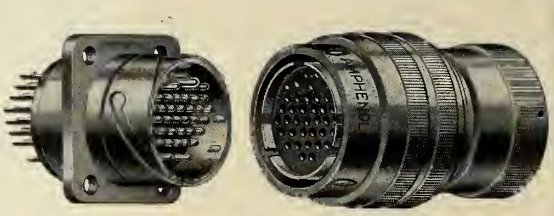
James E. Hill
1300 Steuben St.
Utica, N.Y.

We agree that there is an untapped reservoir of experienced engineering personnel that has not been properly utilized—Ed.

MINNIE CONNECTORS

AMPHENOL

pass tough, new ALTITUDE-MOISTURE RESISTANCE TEST salt water immersion, 65,000 feet altitude



Designers and manufacturers of aircraft and missiles, as well as the military, have long recognized the need for a connector altitude-moisture test which would accurately simulate actual performance conditions. Such a test has been developed by manufacturers and the military and applied as standard procedure on the 67 Series *MINNIE* connectors in the AMPHENOL Laboratories. It consists of the following:

A plastic tank is filled with distilled water and salt added to obtain a solution of 1.050 specific gravity. Marker dye is added for tracing leakage paths. The connectors are given a dry insulation resistance (IR) reading with a 500 volt megohm bridge. All coupling rings are then securely hand-tightened and grommet clamps rechecked for tightness. The connectors are then completely submerged in the salt solution so that all cable bundle ends are out of the solution. The ends of the cable bundle from one side of each connector are taped. The tank and connectors are placed in an altitude chamber and another IR reading is made.

The pressure inside the chamber is then reduced to 0.82 inch of mercury (80,000 feet altitude) and held for one minute, then increased to approximately 2 inches of mercury (65,000 feet altitude). After maintaining 2 inches of mercury for ½ hour, the chamber is returned to room ambient pressure for ½ hour. This is considered one complete cycle. Connectors are subjected to a total of 10 cycles.

At the conclusion of the tenth cycle, connectors remain completely submerged in the salt solution container at room-temperature and pressure for an over-week-end soak (65 hours). Final insulation resistance reading is then taken. Immediately after last IR measurement, specific gravity of salt solution is taken.

The "E"-type construction of AMPHENOL 67 Series *MINNIE* connectors was originally designed to meet the moisture resistance requirements of MIL-C-5015C, Paragraph 4.5.21. Since the development of the new and far more stringent altitude-moisture test, *MINNIE'S* construction design has been modified and all AMPHENOL *MINNIE* "E"-type connectors pass this test.

Following the altitude-moisture resistance test, insulation resistance measurements (in megohms) on production *MINNIE* "E" connectors were as follows:

Cycle	Insulation Resistance	
	Contact to Contact	Contact to Shell
0 (Initial)	6000	7000
1	7500	4000
2	5500	3200
3	5500	3000
4 (overnight 17 hour soak)	3000	1100
5	2800	1100
6	3000	1100
7	3000	1100
8	3000	1100
9	3000	1050
10	3000	1050
11 (overnight 17 hour soak)	2800	1000
12 (weekend 65 hour soak)	3000	1050

AMPHENOL *MINNIE* "E" connectors not only meet but surpass the requirements of this tough new test. 100 megohms is the minimum insulation resistance required by MIL-C-5015C after moisture; *MINNIE'S* minimum insulation resistance after immersion and altitude cycling is 1000 megohms.

67 Series *MINNIE* "E" Connectors

DESCRIPTION Miniature, multi-contact electrical connectors of the quick-disconnect bayonet lock type. Available as Plugs, Cable and Panel Receptacles, and Single Hole Mounting Receptacles. Shell design classes include:

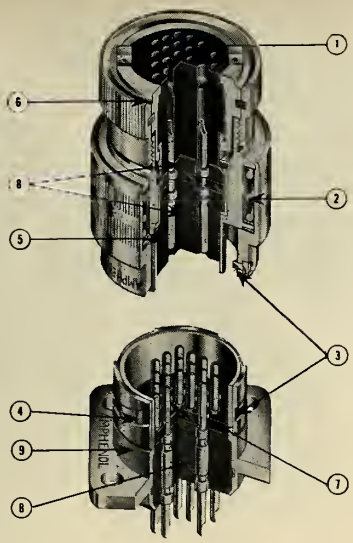
CLASS E—Environmentally resistant—individual wire seal
CLASS P—For potting
CLASS H—Hermetically sealed
CLASS J—For jacketed cable
CLASS C—Standard cable clamp

There are five shell sizes, and 17 insert arrangements—ranging from 3 contacts in the smallest to 48 contacts in the largest.

PART NUMBERING Descriptive part numbering of *MINNIE* connectors follows that used with AN (MS) connectors.

NOMINAL CURRENT RATING #20 contact is rated at 7.5 amperes and #16 contact at 17.0 amperes.

OPERATING TEMPERATURE −67°F. (−55°C.) to +257°F. (+125°C.).



HOODED SOCKET CONTACTS

Both #16 and #20 socket (female) contacts of AMPHENOL *MINNIE* connectors are resistant to test prod damage. The entering end of the socket has a one-piece hood that excludes the entrance of a pin 0.005" larger than the diameter of the mating pin. AMPHENOL Specification 340-43-2108, paragraph 4.5.14, gives this test to be used to determine resistance to test prod damage:

> *"A test prod of hardened steel having a diameter equal to a nominal mating pin shall be inserted into each socket contact to (a) .200 inch; (b) .255 inch; and (c) .310 inch depth. At each of these depths, measured from the face of the insert, a bending moment of 2 inch lbs. ±10 percent shall be applied to the 16 size contact prod and a bending moment of 0.8 inch lbs. ±10 percent shall be applied to the 20 size contact prod about the inserted ends of the prod. The connector shall be rotated in one direction through 360 degrees in order that a uniform force is applied to the inside surface of the socket contact. This test shall be performed with the socket contacts in the inserts and the contacts locked, if necessary, to prevent rotation in the inserts during the test."*

After withdrawal of the fixture at the completion of the above precedure, the force needed to engage or separate the socket contact shall not exceed the following values:

Contact	Max. Force Ounces	Min. Force Ounces
#20	12	2
#16	26	3

FEATURES OF AMPHENOL *MINNIE* CONNECTORS

(1) Environmentally sealed with unitized back end grommet. (Also available with provision for potting.) Grommet seal (type "E") meets altitude-moisture resistance requirements. Either grommet seal or potted seal meets moisture resistance requirements of MIL-C-5015C, Paragraph 4.5.21.

(2) Spring-loaded coupling ring provides a positive locking action in the bayonet slot, and a constant compensating force which eliminates the effects of resilient face seal compression set.

(3) Stainless steel bayonet slots and pins reduce wear and frictional characteristics and eliminate wear encountered with "hard-coat" and similar surface treatments of softer base metals. The three pin bayonet coupling minimizes the rocking action of the mated plug and receptacle.

(4) Flattened incline angle of bayonet slots reduces mating force requirement.

(5) Hooded contacts resist test prod damage as defined in Paragraph 4.5.14 of AMPHENOL Specification 340-43-2108.

(6) Unitized grommet seal; clamp and grommet form a single unit for ease of assembly and maintenance.

(7) Face seal gasket with individual barriers to isolate each contact.

(8) Hard insert dielectric (plus resilient face seal) positively retains contacts with no possibility of contacts being pushed out of the insert.

(9) A visual full engagement indicator is included in the design to insure the user that he has fully engaged the connectors. The indicator is an orange line around the receptacle shell.

- Insulation resistance of "E" type following altitude-moisture resistance test is a minimum 1000 megohms. MIL-C-5015C minimum following type "E" test is 100 megohms.
- When using mated sealed connectors, no derating for altitude is necessary at 70,000 feet.
- Test voltage 1,500 volts RMS 70,000 feet on sealed connectors.
- Vibration per Method 204 of MIL-Std-202A. 10 to 2,000 cps at 20 g's.
- Temperature cycling range per MIL-C-5015C, Paragraph 4.5.3 increased to 257°F. maximum and −67°F. minimum.

VOLTAGE RATING

	Rating	Mechanical Spacing (Nominal)	Flashover V-Rms	Test V-Rms	Recommended Working Voltage DC	Recommended Working Voltage AC
Sea level (unsealed)	A	.034	2,000	1,500	700	500
	B	.046	2,300	1,800	840	600
Sea level (sealed)	A	.034	2,500	2,000	700	500
	B	.046	3,000	2,500	840	600
70,000 ft. (unsealed)	A	.034	500	375	175	125
	B	.046	600	450	210	250
70,000 ft. (sealed)	A	.034	2,500	1,500	700	500
	B	.046	3,000	1,800	840	600

book reviews

SMITHSONIAN CONTRIBUTIONS TO ASTROPHYSICS, Vol. 2, No. 10, compiled by F. L. Whipple, L. G. Boyd, J. A. Hynek and G. F. Schilling, 347 pp., $1.00, Smithsonian Institution, Washington, D.C.

This collection of data, entitled "Orbital Data and Preliminary Analyses of Satellites 1957 a and 1957 b," consists of material (in edited form) which first appeared in Special Reports No. 1 through No. 10 of the Smithsonian Astrophysical Observatory.

Since Oct. 4, 1957, when the first satellite was launched by the USSR, the Smithsonian Institution has compiled and distributed data related to basic research projects. This report includes data on orbits, atmosphere, Moon Watch observations, Soviet predictions and information, and a glossary of astronomical terms.

Many diagrams, charts and photographs are included. The report may be obtained by writing to the Superintendent of Documents, Government Printing Office, Washington 25, D.C.

THE GYROSCOPE APPLIED, by K. I. T. Richardson, M.A. 384 pp., $15, Philosophical Library, N.Y., N.Y.

This book, the first to be published on gyroscopic application since 1946, presents the many technical advances that have been made and embraces as many of the different types of application as possible—ranging from small intricate aircraft instruments to large engineering projects, such as the roll-stabilizers for 40,000-ton liners.

SPACE FLIGHT by Carsbie C. Adams, 392 pp., 50 illustrations, $6.50, McGraw-Hill, N.Y.

The layman, as well as the scientist, will find this survey of the past, present and future of space travel readable and informative. Topics cover the history and background of astronautical sciences and the fields that compose these sciences, including contributions made by the associated fields of astrophysics, communications, geophysics, materials and space medicine.

Mr. Adams discusses many important recent advances, and gives the reader details on new proposals that he feels are worth considerations. These include useful data on space stations, small satellites, moon bases, ion and atomic rocket engines, and advanced research missiles.

The author is president of the National Research and Development Corp., which, at the present, is engaged in astronautical research and development projects.

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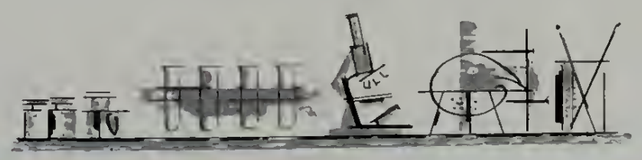

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MIL-J-5624D	JP-4 Wide Cut
MIL-J-5624D	JP-5 Kerosene
MIL-F-25656	JP-6 Supersonic Fuel

Referee and Test Fuels

MIL-F-25524A	Thermally Stable Jet Fuel
MIL-F-5161C	Referee (JP-4)
MIL-F-005161D(Aer)	Type I High Volatility Navy Proposed Referee Jet Fuel
MIL-F-005161D (Aer)	Type II Low Volatility Navy Proposed Referee Jet Fuel
MIL-J-5161E	Referee Grade I (JP-4)
MIL-J-5161E	Referee Grade II (JP-5) and (JP-6)

Missile Fuels

MIL-F-25558B	RJ-1 Ramjet
MIL-F-25576A	RP-1 Rocket
MIL-F-19605	BM-1 Rocket

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Pratt and Whitney	522B
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General Electric	CJ805 Kerosene
Wright Aero. Div. of C. W.	Kerosene
Lockheed Aircraft Corp.	LAC 1-348-1 Kerosene

Consumer Specifications

Trans-Canada Air Lines	Sp. 481 Kerosene
Trans-Canada Air Lines	Sp. 481 Wide-Cut
ASTM	Type A Kerosene
ASTM	Type B Wide-Cut

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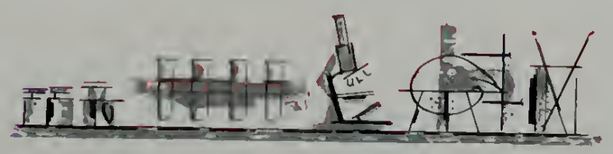

ORDER-BLENDED TO YOUR SPECIFICATIONS

Ashland PROPELLANTS

missile business

by Seabrook Hull

Look for some major changes in Air Force's approach to the weapons system concept. Even as Army has modified its operations under the so-called "Arsenal concept" of doing business, so will the Air Force back off somewhat from its former approach to research, development and production of major rocket and missile-based weapons systems.

It is common rumor in Washington (has been for several weeks) that the Air Force is coming to the conclusion that its administrative approach to development of *Atlas, Thor* and *Titan* has been neither the most efficient nor the most economical. And, importantly, AF, like the other two military services, realizes that no matter how efficient procedures become, there will never be enough money "to do all the jobs that need doing."

Indications are that AF, in the future, will rely more and more on individual company capabilities (with certain specific emphasis on small, highly-specialized companies) and less upon "for-hire" systems monitoring.

As proof of this trend, ARDC just last week held a special briefing for selected small business representatives, outlining the problems and requesting original suggestions for "more elegant" *Dyna-soar* follow-on.

This is a new year, just in case you'd overlooked the fact. Even though fiscal 1959's budget has not yet won formal congressional approval, its size and structure is generally known. And, the new year's programs, extensions, and expansions are now beginning to be negotiated. If you've tended to let up a bit during the last few weeks of selling, it's now time to renew the pace in order to get your point across early with government procurement offices, prime contractors, subcontractors. For, even if they haven't gotten their new bundles of money, they soon will, and are already planning how to spend it.

The shake-out in missile and rocket weapons systems forecast by m/r many months ago is far from complete. Look for some shockers. Reports are increasingly persistent, for example, that the most *Titan* will ever be used for is space flight research; that emphasis instead will be switched to the solid propellant *Minuteman*. Point is: Don't tie all your corporate planning to one big project, lest you find yourself suddenly with all those facilities and little else but contract termination proceedings.

The day of the political or "mobilization base" bailout obviously isn't ended yet, but its hours are numbered. You've only to note rumblings in the Pentagon and on Capital Hill that we can afford less and less to grant contracts to this or that company primarily "because it needs business," or "because we (the taxpayer) have a big investment there."

contract awards

NAVY

By Office of Naval Research:

Carnegie Institute of Technology received $46,362 for research in inorganic solids.

Columbia University received $33,839 for research to develop the theory of probability and its applications.

New Mexico College of Agriculture and mechanical Arts received $42,671 for mid-atmosphere rocket research.

Northwestern University received $256,660 for research on physical changes resulting from imperfections in solids.

Radio Corp. of America received $148,632 for research leading to the development of a microwave amplifier tube.

Harvard College received $35,000 for research dealing with an investigation of crystal imperfections by X-ray diffraction.

University of California received $519,800 for research in marine physics.

Wayne State University received $27,000 for research in the statistical theory of life and fatigue testing aspects of reliability.

Leland Standford, Jr. University received $26,000 for research on radiation induced free radicals of short lifetime.

University of Michigan received $51,682 for research in the field of high energy physics.

University of California received $36,900 for research in differential equations.

Leland Standford, Jr. University received $35,000 for research on new methods for the computation of eigen values.

University of California received $27,500 for research in differential equations occurring in wave propagation and coupled oscillations.

By Puget Sound Naval Shipyard:

Sargent Engineering Co. received $42,276 for spare parts for missile launching system.

By District Public Works Office, 11th Naval District:

L. F. Stilwell & Co. Inc. received $1,413,989 for construction of *Regulus* II facilities, Naval Air Missile Test Center.

By District Public Works Office, 1st Naval District:

Boston Bldg. & Construction Corp. received $209,990 for guided missile support facility.

AIR FORCE

By Cambridge Research Center, ARDC:

Burroughs Corp. received $69,383 for design and construction of a feasibility model of a remote electronic alphanumeric display.

New York University received $39,598 for research of radio wave propagation in variable media.

University of Illinois received $37,500 for studies in dectromagnetic wave interaction technique.

Transistor Applications, Inc. received $39,999 for research directed toward the study, analysis and design of transistor circuits.

High Altitude Observatory of the University of Colorado received $38,400 for study of ionospheric effects on radio signals from satellites and extra-terrestrial sources.

Baird-Atomic, Inc. received $34,977 for research concerning an optical coordinate conversion system.

Philco Corp. received $78,983 for research directed toward growth of silicon crystals.

Massachusetts Institute of Technology received $60,000 for procurement of neutron activation facilities, equipment and consultation services.

General Dynamics Corp., General Atomics Div., received $66,019 for research in radiation damage in semiconductors.

Victory Engineering Corp. received $55,665 for research and development of pressure measuring devices for high altitude

. . . contracts

balloon-borne systems.

By Cmdr., HQ AMC, Wright-Patterson:

AVCO Mfg. Corp., Crosley Div., received $101,724 for accelerated flight tests of radio beacon.

Missile Development Div., North American Aviation Inc., received $541,591 for completion of the development and refinement of the steel "plymetal" sandwich production type machinery.

Syracuse University Research Institute received $27,581 for services and materials necessary to establish the chemical mechanism of scale removal from titanium alloys.

Goodyear Aircraft Corp. received $6,354,348 for nose sections, spare parts and data for the TM-76A missile.

Lockheed Aircraft Corp. received $480,000 for modification of C-130A airplanes to *Drone* missile launcher.

International Business Machines Corp., Military Products Division, received $238,907 for advanced bombing navigational missile guidance system surveillance program.

Thiokol Chemical Corp. received $749,944 for product and engineering improvement of the GAR falcon rocket engine.

David Clark Co., Inc. received $150,000 for full pressure altitude suits.

Perkin-Elmer Corp. received $97,950 for development of a flight type radiation pyrometer for exhaust gas temperature measurement.

Cincinnati Milling & Grinding Machines, Inc. received $105,004 for dealers' services covering five skin mills.

By HQ, AFOSR, ARDC:

California Institute of Technology received $42,000 for research on "the physical properties of metals and alloys at elevated temperatures."

Fordham University received $39,992 for research on "chemistry and phototrophy of sydnones".

Carnegie Institute of Technology received $103,937 for research on "conformal and variational methods".

University of Wisconsin received $29,838 for research in the general field of properties of metal-ion complexes.

Tufts University received $28,290 for research on "initial reaction intermediate in the ozonation of alkenes".

Polytechnic Institute of Brooklyn received $30,530 for continuation of photochemical reactions in plastics.

Cornell University received $58,000 for X-ray spectroscopic studies of the solid state.

Johns Hopkins University received $91,766 for study of plastic wave propagation in metals at elevated temperatures.

Ohio State University received $84,504 for research on "electrical properties of high-purity boron".

Alfred University received $59,836 for research on "correlation between the defect solid state and catalysis".

Aerojet-General Corp. received $66,155 for "investigation of atomic oxygen recombination rates".

Indiana University received $51,800 for quantum mechanical studies of the nature and interactions of simple atoms and molecules.

Massachusetts Institute of Technology received $78,750 for research on "neutron diffraction studies of solids".

American Mathematical Society received $53,414 for "reports on current mathematical developments and their application to related sciences".

University of Rochester received $56,000 for research concerning "phenomena surrounding high speed flight".

Leland Standford, Jr. University received $180,000 for research on whistlers and related low frequency radio wave phenomena; $146,329 for research in paramagnetic resonance.

Cornell University received $54,135 for investigation of atomic phenomena occurring on or near the surface of solids.

The William M. Rice Inst. received $33,850 for research on "effects of vibrations on lattice imperfections movements in metals".

Massachusetts Institute of Technology received $50,000 for continuation of "research on some unsteady aerodynamic and non-linear structural problems of aircraft".

Leland Standford, Jr. University received $175,000 for research on "nuclear photoeffects, meson field, and electron scattering".

Columbia University received $29,190 for investigation of the nature of fracture in metals.

Leland Standford, Jr. University received $1,245,000 for interaction of microwaves with matter.

University of North Carolina received $43,616 for "research in non-parametric statistical inference"; $69,742 for research on "design of experiments".

George Washington University received $32,477 for a study of the reactions between alkali metals and carbon monoxide.

North American Aviation, Inc., Rocketdyne Div., received $95,490 for experimental studies of electrical propulsion.

Yale University received $70,000 for research in "functional equations and spectral theory".

Ohio State University Research Foundation received $28,710 for research and reports concerning "compounds containing trihalomethyl groups".

Phillips Petroleum Co. received $149,388 for continuation of studies leading to production, stabilization, concentration and storage of highly reactive chemical species.

University of Illinois received $45,032 for research on "investigation into the laws underlying human behavior in complex tasks having multiple stimulus, multiple response demands".

ARMY

By Cincinnati Ordnance District:

Purdue Research Foundation, Purdue University, received $30,418 for basic research program on the variational approach to the re-entry problem.

By Orduance District, Los Angeles:

Firestone Tire & Rubber Co. received $68,270 for replenishment repair parts for guided missile, artillery M2 and related ground handling equipment; $34,972 for spare parts for the *Corporal* missile system.

North American Aviation, Inc. received $25,500 for rocket engines.

Sandberg-Serrell Corp. received $26,661 for design of hypersonic wind tunnel.

California Institute of Technology received two contracts totaling $3,801,000 for engineering research and development relating to guided missiles, free rockets materials and wind tunnel operation.

Wallace O. Leonard received $49,875 for lox tank computer.

Gilfillan Bros. Inc. received six contracts totaling $704,626 for repair parts for the *Corporal* missile system.

Firestone Tire & Rubber Co. received $54,000 for guided missile surface-to-surface systems.

Douglas Aircraft Co., Inc. received $79,203 for *Honest John* improvement program; $73,176 for repair parts for *Nike* system; $46,949 for pump, vacuum, lox tank, equipment installation.

Redel Inc. received $39,905 for igniter study.

Rheem Manufacturing Co. received $288,185 for work regarding Zebra III.

Firestone Tire & Rubber Co. received two contracts totaling $241,555 for replenishment repair parts for guided missile, artillery M2 and related ground handling equipment.

Gilfillan Bros. Inc. received two contracts totaling $184,504 for furnishing of depot replenishment repair parts for the *Corporal* missile system.

Grand Central Rocket Corp. received $60,514 for dart, rocket motors and igniters.

Ralph M. Parsons Co., Electronics Div., received $36,286 for decommutation stations.

Reed-Curtis Nuclear Div., American Electronics, Inc., received $26,583 for detector.

North American Aviation, Inc. received $30,000 for rocket engines.

Aerojet-General Corp. received $33,472 for study and design of a new missile systems test facilities for solid propellants.

California Institute of Technology received $732,868 for engineering research and development.

Firestone Tire & Rubber Co. received $689,683 for *Corporal* handling and launching equipment.

Douglas Aircraft Co. Inc. received $181,873 for repair parts for *Nike* system.

Telemetering Corp. of America received $188,317 for telemetry system.

Radioplane Co. received $47,154 for supplies and services relative to missile targets.

Rheem Mfg. Co. received $816,862 for *Nike* warhead and fuze.

California Institute of Technology received $80,000 for hypersonic research. Gilfillan Bros. Inc. received $63,609 for emergency and Blue Streak.

North American Aviation, Inc. received

. . . contracts

two contracts totaling $311,454 for rocket engines.

Giannini Research Corp. received $158,575 for material testing relative plasma jets; $88,446 for facilities.

California Institute of Technology received $812,448 for engineering research and development.

By Signal Supply Agency:

University of Illinois received $39,936 for research work to study measurement of intensity of surface precipitation by means of analysis of radar returns.

Ramo-Wooldridge Corp. received $157,436 for research work to study and investigate automation techniques for electrical and electronic equipment testing.

TRG, Inc. received $64,820 for missile-air and submarine-borne cesium beam frequency standard type A.

Chatham Electronics Div., Tung-Sol Electrical Instrument Co., received $27,344 for research of electron tube glasses resistant to radiation damage.

Aeronutronic Systems, Inc. received $482,050 for additional research in the guided missile instrumentation field.

Stanford Research Institute received $65,518 for research work on missile tracking antenna systems.

Cooper Development Corp. received $27,003 for rocket motors.

Western Electric Co. received $49,566 for experimental, development and research work.

General Electric Co. received $62,738 for research investigation to continue development of super power thyratron tubes.

Melpar Inc. received $75,000 for transponder set; $84,825 for research work to conduct a study of input-output equipment.

United Research Inc. received $34,121 for research to conduct a study of wind shear measurements.

Hallomore Electronics Co. received $90,000 for complete microlock receiving station.

Haller, Raymond & Brown received $102,873 for ground infrared image scanner.

Admiral Corp. received $61,095 for engineering services on television systems for tracking guided missiles.

Polytechnic Institute of Brooklyn received $193,160 for fabricating mm wave guides components.

Armour Research Foundation of Illinois Institute of Technology received $88,391 for research study and investigation on wave propagation under anomalous conditions.

Polytechnic Institute of Brooklyn received $59,540 for research on X-band high power ferrite type duplexer.

Linden Laboratories received $46,198 for high K-ceramic materials.

Grand Central Rocket Co. received $67,500 for rockets, solid propellants.

University of Minnesota received $87,022 for study of noise in semi-conductors and semi-conductor devices.

Collins Radio Co. received $98,114 for research covering study and investigation of radio interference and field intensity instrumentation techniques.

Bendix Aviation Corp. received $561,574 for high speed data terminal.

Lansdale Tube Co., Div. of Philco Corp., received $73,811 for research directed toward germanium PNP or NPN junction transistor.

University of Michigan received $240,000 for a ground station capable of tracking rockets.

Autonetics, Div. of North American Aviation Inc., received $94,550 for recomp II computer.

Advanced Electronics Mfg. Corp. received $31,400 for twelve self-checking digital data transmitters.

Western Electric Co., Inc. received $542,560 for a study of industrial preparedness measures covering solid state devices.

International Resistance Co. received $261,483 for industrial preparedness measure for metal film potentiometers.

By Defense Supply Service:

Ivel Construction Corp. received $28,411 for 253 full size "*Explorer* I" mock ups.

By U.S. Atomic Energy Commission:

Watkins Construction Co. received $316,019 for initial engine test modifications, aircraft nuclear propulsion project at the national reactor testing station in Idaho.

By Military Clothing and Textile Supply Agency:

Seymour Wallas & Co. received $126,666 for hood, rocket fuel handler's vinyl coated cloth.

astrionics

by Raymond M. Nolan

The recent switching around of various guidance assignments has many observers wondering if there isn't some sort of master juggling plan going on. First GE was awarded the *Polaris* guidance contract and then dropped from the *Atlas* program. Kearfott was to have supplied the gyros for the GE-*Atlas* guidance, but now they are listed as a guidance sub-contractor on the *Subroc* program.

Arma is the guidance supplier for both the *Atlas* and later *Titans,* with Bell Labs supplying the back-up radio-inertial sets for use in the first dozen or so *Titans.*

Ramo-Wooldridge has received a contract from the Army. Amount was $13.5 million for the installation and operation of an automatic data processing system at the Army Electronic Proving Ground in Arizona.

RCA has announced a basic improvement in parametric microwave amplifiers. In the new device, a germanium diode is used to detect the incoming signal, and either a transistor or a "pencil-type" tube oscillates at a lower frequency to provide a pumping action for amplification. Previous parametric microwave amplifiers have been hampered because they required a pumping frequency higher than that of the signal to be amplified.

Since the new amplifier does not require the low temperatures or strong magnetic fields of MASER, and can operate on a power input of a fraction of a watt, RCA people see definite future missile uses for the four cubic inch device.

The first all-overwater microwave installation has been completed on the missile range at Cape Canaveral. Motorola, the contractor, stated that the system operates in the 7125-8000 mc band, and covers a total of 80 miles in the Bahama Islands, connecting three missile tracking sites. The installation consists of two microwave links which tie into a pair of terminals at Bassett Cove on the submarine cable to the mainland.

Union story of the week—The largest local of the Teamsters Union is located in the Aero Division of Minneapolis-Honeywell, Inc. However, company union officials are quick to point out that there is very little "contact" between the local and the parent organization.

Next step in the art of inertial guidance will probably be the gimballess stabilized platform. This is not a platform at all, but rather three gyros oriented to three stabilizing axes, and fixed to the frame of the missile. The gyros would sense missile deviation and send correction signals to the control system.

The big problem is orientation of accelerometers. Without a stable platform to provide a fixed measuring reference, the problem becomes one of monitoring the gyro signals to the control system and computing changes in orientation of the accelerometers, so that measurements of accelerations are correct.

missile miscellany

Dyna-Soar's like the weather: Everyone talks about it but very little is being done about it—except, of course, to study it. With both the Boeing and Bell-Martin teams ordered back for another "6-to-12 months" of study (see p. 34), it's a good bet that the Russians will be flying a skip-bomber before we've got the blueprints finalized. A top-level Bell engineer bitterly comments: "We've done all the studying. We're ready to build hardware." And, from a Boeing excutive: "We've got this one sewed up!"—the contract, he means. Still another remark (this column has been traveling) about Martin-Bell group: "It was a shotgun wedding . . . AF thinks Martin has management; Bell, technical knowhow." Other Dynasoaric odds and ends: Four Minuteman first stages being considered as possible initial booster for the glide bomber, whose leading edges may be made of Norton Company's Crystolon-R, a recrystalized silicon carbide taking prolonged 3,000°F exposure.

And while we're on materials, ablation is the word for reentry, and one of the best ablating materials yet is a phenolic resin developed by Cincinnati Testing and Research Laboratory—paired with asbestos, it is the outer coat for Jupiter's nose cone; is slated for Polaris and is being considered for Titan, Atlas and Thor by GE and AVCO.

Two smaller versions of the $185,000. Monarch "Missile Master" lathes (90-inch facing plate; 25 feet between centers; air gage tracer plus Keller), specified and first ordered by Diversey Engineering, have now been ordered by Aerojet-General as part of its facilities program for establishing complete in-the-house missile-metal machining capability . . . Ingersoll-Kalamazoo div., Borg-Warner, is now hydrospinning nozzle and 110-inch-long Nike booster casing from a single cylindrical blank.

And plastics: This column learns that Allegany Ballistics Laboratory's third-stage Vanguard rocket (with all plastic casing) not only gives higher performance than Grand Central's metal-encased motor, but is also reliable. The motor is scheduled to supply third stage power for AF's Thor-Able moon shot; designed to send 32-pound payload around moon. Incidentally, this page wonders why AF is wedding Vanguard second stage motor to costly Thor, when it's never really had a chance to prove itself in flight; also, why AF doesn't mount an X-17 on Thor instead—since X-17's proved itself 92% reliable in flight.

Conflicting reports abound on Thiokol: With RMI, Hunter-Bristol and National Electronics Laboratories under its belt (or wing), Thiokol's well set to bid on, and get, a major prime systems contract. Now all-of-a-sudden, this bit of scuttlebutt: Thiokol top management is looking for a merger or somesuch with a BIG chemical firm in order to expand its working capital . . . Further word: That Northrop may buy out American-Bosch-Arma.

And via the underground railway, opinion by top Soviet IGY scientists that space-pooch Laika, in fact, baked to death. Also, this significant reply to a query about how many Russians would attend next month's IAF Congress in Amsterdam: "Only four. We've got too much work to do here" . . . And, in closing, this page hears it's now powder horns and flintlocks for the Green Mountain Boys . . .

S.H.

EIA Elects Electronics Executive President

David R. Hull, an electronics industry executive for the last ten years, was recently elected president of the Electronic Industries Association.

A vice president of defense programs of the Raytheon Manufacturing Co., Mr. Hull was formerly with IT&T as vice president and director of the Federal Telecommunication Laboratories, and executive vice president and director of Capehart-Farnsworth Corp. He now is also a director of Technical Operations, Inc., and of Raytheon Canada, Ltd.

Cutler-Hammer Acquires Airborne Instruments Lab

The acquisition last month of Airborne Instruments Laboratory, Inc., Mineola, N.Y. electronics company by Cutler-Hammer Inc., combines the research, engineering, production, and marketing talents of a 66-year-old blue chip electrical control firm with those of a 13-year-old blue yonder electronics firm.

Under the terms of the agreement, AIL will operate as the Electronics Division of Cutler-Hammer, retaining its name, officers, management, personnel, and line of business.

Cutler-Hammer, a leading manufacturer of electrical control equipment, has 6,000 employees and is headquartered in Milwaukee. Airborne, presently employing 1,500, is a leader in research and development, specializing in the application of electronics to radar, microwave, and data-processing equipment.

The first AIL plant will be located at Melville, Long Island, N.Y. The new plant will house the Research and Engineering Division and general administrative offices of AIL. Plans for AIL's Engineering and Production Division are to continue in their present facilities located in Long Island, N.Y.

Future ICBM Guidance To Be All-Inertial

Pentagon sources have revealed that the *Titan* guidance system will be used on the *Atlas* missile. The system, almost ready for operational use, is being manufactured by Arma division of American Bosch Arma and Minneapolis-Honeywell.

First units off the production line will go into the *Atlas*. The *Titan* will use the Bell Laboratories back-up radio-inertial system. The *Titan* system (described in m/r, May 1958) uses a frame-fixed platform and gyros manufactured by Minneapolis-Honeywell for the first 300 seconds of flight, and then switches to the Arma pure inertial system.

The radio-inertial system, similar to that planned for use on the *Thor* and later cancelled when AC Spark Plug's Achiever system proved adequate, will satisfy all requirements of the *Titan* during the test phase. However, present plans call for the straight inertial system when *Titan* becomes operational.

No mention was made of the role General Electric and Burroughs Company will play in future ICBM

high-energy fuel briefs from Callery

Two new plants for the production of HiCal,® High Energy Fuel, are under construction at Lawrence, Kansas and Muskogee, Oklahoma. The first shipment of HiCal 3 will be made from our Lawrence, Kansas plant about August 1. Two of the units for the production of HiCal intermediates were put into operation in April. Virtually all the fuel from the Lawrence plant is committed now. There may, however, be quantities of HiCal available in the future for authorized users.

Construction of the Navy HiCal facility at Muskogee, Oklahoma is on schedule and the plant should be finished by the end of 1958. Callery will operate this plant and the Navy will distribute the fuel.

Triethylborane: new pyrophoric fuel — TEB is spontaneously flammable in air, but stable in water. Density at 25°C is 0.68. Melting point is −92.5°C. Boiling point is 95°C. Heat of combustion is 20,200 B.t.u./lb. It is miscible with hydrocarbons, so it can be used as an additive to conventional fuels.

Triethylborane in weapons systems — TEB burns at much lower atmospheric pressures than hydrocarbon fuels. Thus, weapons systems, with TEB as a fuel, can fly faster, at higher altitudes, with leaner mixtures, and therefore with better fuel economy and increased reliability. High altitude flameout can virtually be eliminated. Expenditures for airframe can be greatly reduced — power plants can be built smaller, more simply. In concentrations of 15%, or even up to 30% in JP fuels for small-size units, the additive approach improves burning and reduces screech in rockets.

Other fuel possibilities — Callery can also produce Decaborane, Pentaborane, and Diborane, but these materials are in limited supply at present.

The Amine-Boranes, R_3NBH_3, should also be considered as liquid or solid fuels or as additives to hydrocarbon systems in missile and rocket propulsion.

Samples and specific data available — Specific data on HiCal is classified and "need to know" must be shown. We will be glad to talk with you about the technical aspects of any of the other compounds mentioned above. And we can provide test quantities for specific end-use evaluations. Just write or call.

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Albert J. Taering, Manager
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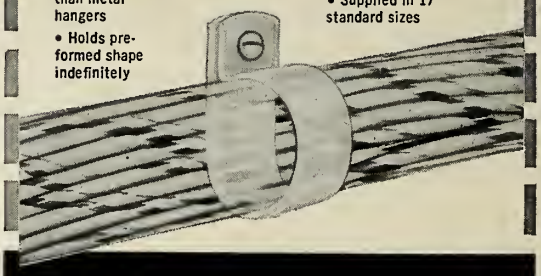

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guidance manufacture, but it is understood that these developers of the present *Atlas* radio-inertial system still have active contracts on which no termination action has begun.

Litton Industries Purchases Airtron

Negotiations have been completed and an agreement signed for the purchase of Airtron, Inc., by Litton Industries, Inc., it was recently announced. The transaction involves the exchange of an undisclosed amount of both common and preferred Litton stock for 100% of Airtron stock. Consummation of the exchange agreement is expected to take place by August 1, 1958.

Airtron's current annual sales rate has been approximately $10 million. The acquisition will add to the Litton organization Airtron plants in Linden, N.J. and Cambridge, Mass., where Airtron employs over 800 people in the development and manufacture of radar and other microwave communication components and equipment.

According to Litton, Airtron management will remain with the operation as it becomes a Division of Litton. David Ingalls will continue as president of Airtron and will become a vice-president of Litton.

Air Force Awards SAGE Contract to Burroughs

U.S. Air Force has announced a $17 million contract award to Burroughs Corp. for the construction of 24 coordinate data processing systems to be used in the SAGE system of continental air defense.

SAGE (Semi-Automatic Ground Environment) is a nation-wide system that combines radar, electronic digital processing systems and highspeed communications to detect the approach of hostile aircraft or missiles and direct a counterattack.

The first completed system will be installed at McGuire AFB, N.J.

AF Electronic Scoreboard Contract Awarded to IT&T

A 300-mile electronic "scoreboard" for testing anti-aircraft missiles will be built on the gulf coast of Florida under a $5.6 million Air Force contract awarded to International Telephone & Telegraph Corp.

The installation will be made at Eglin Air Force Base, Air Proving Ground Center, near Fort Walton Beach, Fla. The range will stretch

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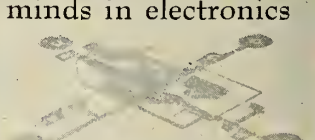

The command radio-radar guidance system under development at General Electric offers an unprecedented challenge to electronic engineers highly qualified in these areas:

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southward into the Gulf of Mexico, parallel to major tracking sites at the Florida shore points of Cape San Blas and Anclote. Known as Eglin Gulf Test Range, the three stations will provide complete missile control and safety.

The installation will include radar equipment for instrumentation and safety tracking, telemetry systems for obtaining data from missiles and aircraft, optical systems, drone tracking and control systems, data transmission equipment and countdown systems.

"Dick Tracy" Radio Aids Missile Work

A transistorized radio, smaller than a cigarette pack, is being used by Chance Vought technicians and movie cameramen to keep tab on guided missile flight preparations.

The set, which is operated by two pencil flashlight batteries and has a flexible cat-tail antenna, is mounted on an ear-protector headset used to cut the effect of pre-launch noise. The receiver is tuned to the primary frequency used for missile launching countdowns.

Space Technology Courses Offered at U. of Calif.

Two new intensive courses on space technology will be given in August at the University of California at Los Angeles by the engineering and physical sciences extension. A course in Astrodynamics and Rocket Navigation will take place August 4 through 15, and will consider the development of acceleration equations for gravity, thrust and drag in inertial and rotating systems applicable to the study of satellites and other space vehicles.

Fundamentals of Rocket Propulsion will be analyzed August 18 through 29. Both courses will meet daily from 8 a.m. to 5 p.m. Participants must have a bachelor's degree in a physical science or in engineering. Applications may be obtained from University of California Extension, Los Angeles 24, Calif.

Stanford Accelerator Power Raised to Billion Volts

The Mark Three linear electron accelerator at Stanford University will be lengthened from 220 ft. to 310 ft., and the power increased to over one billion electron volts. The project, which was scheduled to begin last month (June) will cost $850,000. It is sponsored by the Air Force office of Scientific Research, the Office of Naval Research and the Atomic Energy Commission.

Plans for a bigger multibillion-volt linear accelerator are now awaiting approval of interested government agencies, according to the university's top officials.

Canadian Navy To Use *Sidewinder* Missile

Guided missiles will be fitted to the Royal Canadian Navy's Banshee jet fighter aircraft, the Royal Canadian Navy has announced. The Navy has adopted the *Sidewinder*, the U.S. Navy's newest air-to-air guided missile as armament for its two fighter aircraft squadrons.

The Navy said that the *Sidewinder* was selected because of its suitability for the Banshee and its early availability. Only slight modification of the aircraft will be needed to accommodate this new weapon.

industry countdown

• **The $38 Billion FY 1959 Defense Budget** will probably be hiked by Senate, but only part of "extras" requested will be okayed . . . Meanwhile, USAF spending for missiles, at 30% of total AF procurement budget in 1959, is up 3% from 1958, while aircraft, at 47% is off 1%. AF ballistic missile funds for 1959 total $891.7 million, while $1.010 billion is slated for non-ballistic missiles including *Snark, Bomarc, Falcon, Sidewinder, Hound Dog, Goose, Quail, Falcon* and *Mace*. . . . **Also in USAF Budget** is $130 million for facilities; $728 million for R&D, plus another $15 million for *Minuteman*.

• **On Capitol Hill,** a bill (S. 4105) has been introduced to force Pentagon to give 60% of military aircraft and missile repair work to private industry; will result in a long study, no action this year . . . **Hearings have begun** on H. R. 8002 to put government on an accrued expenditures basis . . . **Congressional Record for June 30** gives Rep. C. King's (D-Calif.) idea of how his bill (H. R. 13092) would update renegotiation from a wartime measure to present-day conditions; you can order a copy from Superintendent of Documents, Government Printing Office, Washington 25, D.C. . . . **Same outfit will sell** you ($1.00) an unclassified "Register of Planned Mobilization Producers", listing 18,000 plants. . . . **Before Senate Armed Services Committee, Defense Secretary McElroy** commented missile program has been wasteful because "we have produced more missiles than were needed and we've duplicated in a way that was wasteful . . ."

• **First Operational Snark** was fired June 19 from Cape Canaveral. . . **Boeing Airplane Co. will deliver** the first Bomarc for the Air Proving Ground Center missile test range at Eglin AFB this month . . . **AF's 865th Strategic Missile Squadron (IRBM-Jupiter)** will start training at Huntsville, Ala., this fall, about the time the 864th completes training at Army Ordnance Guided Missile School . . . **Army apparently has awarded study contracts** for two new missiles: a *Little John* successor; a missile to replace 40 mm antiaircraft gun and called *Mauler*. A third Army missile project is being held up due to possibility that a British design may do the job . . . **ARDC will launch** *Manhigh III* **this summer at Crosby, Minn.,** for follow-on studies resulting from the 102,000-fcet, 32-hour flight last year . . . **ARPA has place a study contract** with GD's Atomic Division for study of a "bomb-powered rocket" which would rely on series of nuclear explosions for its propulsion . . . **Bell Aircraft Corp. has received a WADC contract** to develop flight instrumentation for space vehicles.

• **A million-dollar recently completed expansion** in countdown consoles now permits three long-range missiles to be counted down simultaneously to minus one hour at Cape Canaveral, where before only one could be handled at a time. . . **USAF Air Materiel Command has reorganized** its Inglewood, Calif. Ballistic Missiles Office as a result of accelerated production of big birds.

• **The 93.4% of Grand Central Rocket Co. stock** purchased by Tennessee Gas Transmission has been transferred to Petro-Tex Chemical Corp. which is jointly owned by TGT and Food Machinery and Chemical Corp. . . . **United States Chemical Milling Corp. has purchased** all outstanding stock of Paul Omhundro Co.—follows earlier purchases of Missile-Air and Hydro Metal Spinning, Foto-Etch Circuits. . . **Diversey Engineering Co. has purchased** assets of Warrior Tool & Engineering and leased an additional 40,000 square feet of Lincoln Mills as part of establishment of operations in Huntsville, Ala. . . . **Rocketdyne** is installing a numerically controlled missiling machine at Neosho . . . **Hofman Laboratories has acquired** a new 22,000-square-foot plant in Hillside, N.J. as part of general expansion . . . **Cornell Aeronautical has leased** a new 60 x 80-foot hangar at Las Cruces, N.M. municipal airport for Lacross testing. . . **Beckman Instruments, Inc., has sold** its Helipot Div plant at Newport Beach, Calif.; its activities transferred to Fullerton, Calif.; will do same with Liston-Becker Div. at Stamford, Conn.

• **GE has bought** 135 acres of land, 14 buildings and 3 million square feet of space from Electric Autolite at Evansdale, O., part of which facilities it had been leasing . . . **GE has bought** 45-acre site near Santa Barbara where it plans $4-million research plant for its Technical Military Planning Operation . . . **AF's $400,000 rocket engine test facility** for backing up X-15 development is nearing completion; X-15 will initially be equipped with two XLR-II RMI engines such as those in X-1, with regular power plant due for installation later.

advertiser's index

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EFLON STANDOFF. Subminiature tefn standoff terminal, designated ST-SM--TUR-L2, developed for use in large ounting hole in a thin chassis of .048" ickness. Provides voltage rating of 750 ms, and flashover at 3000 vrms at sea vel, or 1,300 vrms at 50,000 feet—at temperature range of —55°C to 200°. Available in white or eight her RETMA code colors. Sealectro orp.

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LEXIBLE MAGNET WIRE. Ready-toe, flexible magnet wire with a conserative duty rating of 1,000°F for conuous operation. Will withstand temeratures to 1,700°F for a limited time d requires no heat treatment or curg prior to use. Hitemp Wires, Inc.

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AGNETIC AMPLIFIER. Highly sensive proportional magnetic amplifier to ovide reliable temperature control for evices such as hermetic integrating roscopes. Designated the PA4A-1, the it is capable of proportional control up to 150 watts output power with put power of a few milli-microwatts. aing a combination of proportional d integral control, an input signal of less than 1 microampere will produce full power output. Magnetic Controls Co.

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NICKEL CADMIUM STORAGE BATTERIES. Reliability and long-life are featured in a series of improved sintered plate nickel cadmium storage batteries. Low internal resistance (0.001 ohms for 10 AH type cell) permits high discharge current. Nicad Div., Gould-National Batteries, Inc.

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REED GAGE. Multiple recording accelerometer developed specifically for obtaining the response spectrum (peak acceleration versus frequency) of structures subjected to high acceleration loads. Unit is self-contained and has eight sensing elements, each with a single degree of freedom along the same axis. Each element also has a different natural frequency, and is capable of sensing and recording the acceleration to which it is subjected. Frequency range of model #440 is 950-2000 cps. Unit can record from 100 to 10,000 g. Size is 2½" diameter by 7/16" thick. Weight is 3 oz. Engdahl Enterprises.

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MICROMINIATURE POTENTIOMETER. Addition or 50 ohm, 15K, 50K and 100K resistance values for Aceset microminiature, precision, wirewound potentiometers has been undertaken, increasing available values to thirteen, between 50 and 100,000 ohms. Electrical specifications are heat dissipation, 2 watts at 60°C; voltage breakdown, 1000 vdc; electrical angle, 325° nominal; resistance tolerance, ±10%; linearity ±5%. Ace Electronics Associates.

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HYDRAULIC PUMP. High temperature hydraulic pump, model 69W030, is a 3 gpm, 450°F, stainless steel and special alloy pump designed to operate in ambient temperatures as high as 700°F. New York Air Brake Co.

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

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225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
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MISSILE LITERATURE

SIZE 8 SERVOMOTOR. Design information on the smallest size 8 servomotor on the market is contained in data sheet #1366 issued by the Helipot Corporation.
Circle No. 200 on Subscriber Service Card.

INTEGRATING MAGNETIC AMPLIFIER. Two-page bulletin describing new #430 integrating magnetic amplifier for use in missile guidance and precision-control equipment. Amplifier operates from standard 115 v, 400 cps power supply and requires less than 3 watts. Completely self-contained, plug-in unit weighing less than nine ounces. Acromag, Inc.
Circle No. 201 on Subscriber Service Card.

PRECISION-ROLLED METAL STRIP. Designed to aid engineers' selection of proper metal strip for specific applications, booklet is an alphabetically-arranged catalog of electronic parts and components showing precision-rolled metals now being used. Precision-rolled strip comprises all metals rolled to thicknesses as thin as 0.0005" and/or high tolerances as close as ±0.0001". American Silver Co.
Circle No. 202 on Subscriber Service Card.

HIGH-TEMPERATURE EQUIPMENT. Product bulletin, MPB-32 has been issued by General Electric Co., describing successful operation of electronic equipment at ambient temperatures of –67°F to 750°F without the use of refrigerants.
Circle No. 203 on Subscriber Service Card.

HYDRAULIC SERVO DRIVES. Bulletin features precision response to a small signal characteristic of servo hydraulics and electro-hydraulic systems. Based on theme "On yesterday's experience Vickers builds today and develops for tomorrow." Vickers, Inc.
Circle No. 204 on Subscriber Service Card.

MYLAR CAPACITOR. Bulletin contains engineering data and electrical characteristics for this type of non-hygroscopic polyester film capacitor. Pyramid Electric Co.
Circle No. 205 on Subscriber Service Card.

AUTOMATIC VOLTAGE REGULATORS. Bulletin S358-E describes line of instantaneous electronic automatic voltage regulators. Products feature all electronic operation, no moving parts, instantaneous correction, excellent regulation and stabilization and minimum waveform distortion. Twelve-page bulletin gives complete ratings, outline dimensions, features, and prices. Superior Electric Co.
Circle No. 206 on Subscriber Service Card.

THERMISTOR CIRCUITS. Fifteen different circuits are covered in this booklet, which gives specifications for nearly 400 different thermistors, including assemblies, matched pairs, beads, discs, washers, rods and probes. Includes description of basic thermistor properties and characteristics, with diagrams of typical applications. Catalog EMC-2 is available from Fenwal Electronics, Inc.
Circle No. 207 on Subscriber Service Card.

TACHOMETER TEST EQUIPMENT. Twelve-page engineering report describes test procedures and equipment used in determining stability, linearity and other characteristics of d.c. tachometer generators. Servo-Tek Product Co.
Circle No. 208 on Subscriber Service Card.

FREQUENCY ASSIGNMENT LISTS. Prepared semi-annually by the Federal Communications Commission, this list is now available to the communications industry through subscription. Electronic Industries Association.
Circle No. 209 on Subscriber Service Card.

MICROWAVE FILTERS. Two catalogs on microwave filters have been published, one listing a number of standard low-pass/high-pass filters of the block, tubular and shell types operating in ranges from 10 mc to 12,000 mc; and the other illustrating typical waveguide rf filters with very sharp cutoff and low insertion loss in the passband. Microphase Corp.
Circle No. 210 on Subscriber Service Card.

DECADE COUNTER TUBES. Technical booklet prompted by growing significance of cold cathode counter tubes in data processing, machine controls, nuclear and radiation measuring equipment, and X-ray controls. Eight-page brochure covers electrical characteristics and application data on the most popular types of counter tubes. Sylvania Electric Products, Inc.
Circle No. 211 on Subscriber Service Card.

PARTICLE ACCELERATORS. Two-color Brochure (Bulletin B) gives many known and potential applications of both Van de Graaff and linear accelerators, utilizing photos and line drawings to point up significant design and performance features. High Voltage Engineering Corp.
Circle No. 212 on Subscriber Service Card.

ULTRASONIC CLEANING. Illustrated booklet explains practical applications and basic principles of ultrasonic cleaning and also covers design of equipment. Discusses general system considerations, batch immersion, conveyor and multi-stage systems, and various transducer arrangements. Branson Ultrasonic Corp.
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CONNECTORS. Forty-page catalog, completely revised, gives specifications, drawings, illustrations on miniature connectors. De-Jur-Amsco Corp.
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101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
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151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

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250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
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Today's increasingly stringent design requirements for low weight, maximum strength, high temperature components mean every ounce of material must efficiently perform its designed task. The uniform success of Narmco products in applications like these explains why more and more engineers are turning to Narmco when faced with a tough component design problem. They are finding that Narmco products help put ALL the material to work, by spreading the load and increasing rigidity... which means more strength... less weight... longer fatigue life... and greater economy...

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WHEN DOUGLAS AIRCRAFT CO. engineers faced the problem of attaching hardware to sandwich access doors of the C-133A transport, they solved it by using Narmco Formula 3119 Putty plugs This easy-to-use, room-temperature-setting putty was cast in place and drilled for bolts and blind fasteners. In shear tests, both skins and core failed before the putty-supported attachments.

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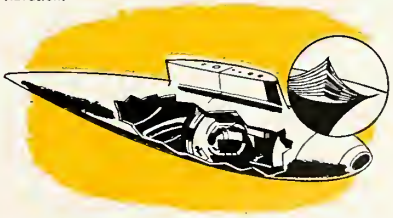
THIS "RUDDEVATOR"—a bonded sandwich structure—for the Boeing KC-135 jet tanker's flying boom required a structural adhesive capable of withstanding severe loads as well as enormous operational punishment. The solution: Narmtape® 102 system, a supported adhesive formulated with non-brittle constituents to provide unmatched fatigue resistance under highest stress and vibration.



SOLAR AIRCRAFT COMPANY'S gas turbine A.P.U. pod had to take oven-hot temperatures up to 400 F... contact with oil and gas fumes... rough ground abuse... aerodynamic loads... severe runway abrasion from its underslung position. So Solar engineers designed a laminated pod of tough, lightweight Conolon® 506. The extra-tough pods, assembled on inexpensive molds, have demonstrated their ability to "take it" after hundreds of hours of flying time.

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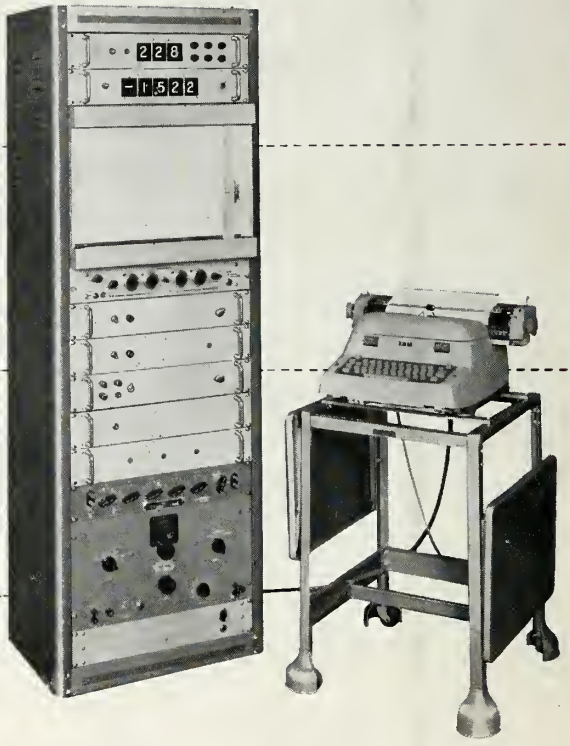

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Standard, off-the-shelf modules never become obsolete—provide maximum versatility. As needs change, simply regroup old modules or add new ones. Your system is always current at minimum cost and engineering. Internal construction is also modularized for ease of maintenance.

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