m/r FEBRUARY, 1957

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION

In This Issue:

SOVIET MISSILES AND ASTRONAUTICS BEHIND THE IRON CURTAIN

"CUSTOMER SERVICE"

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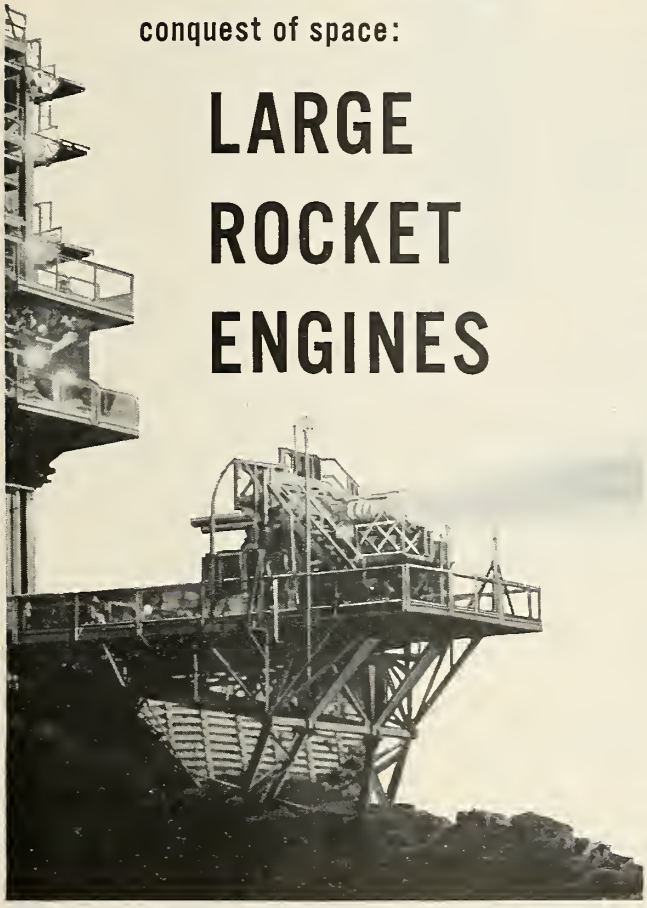

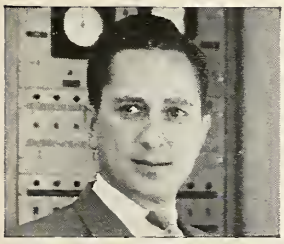

WILLIAM J. CECKA, JR., 35, aeronautical engineer, (Univ. of Minn. '43), was called from North American by the Air Force for experimental rocket work in 1944. On his return, he progressed rapidly: 1948, supervisory test job; 1950, group engineer, operations; 1953 engineering group leader; 1955, section chief of engineering test. Using our refund plan, he has his M.Sc. in sight.

GEORGE P. SUTTON, in the 13 brilliant years since receiving his MSME, Cal Tech, has made rocketry a way of life. His reputation is world wide. His book *Rocket Propulsion Elements* is recognized as the standard text on the subject. Still active academically, but no bookworm, he takes time off occasionally to study the laws of motion at some of the world's better ski resorts.

Tomorrow's count down already fills the air at ROCKETDYNE's 1,600-acre Field Test Laboratory in the Santa Susana Mountains near Los Angeles. For this is the free world's largest workshop for rocket engineering—the great new industry that is now attracting many of the finest scientific and engineering minds in the country.

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A Division of North American Aviation, Inc.

BUILDERS OF POWER FOR OUTER SPACE

missiles and rockets
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February, 1957 Volume II, No. 2

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Notable Achievements at JPL

REALISM IN VIBRATION... Recognizing that it was necessary to provide a simulated missile-flight vibration environment far more realistic than heretofore available the Laboratory developed high power, wide-band, complex waveshape vibration testing equipment.

This has made possible the development of components and packages of greatly improved reliability.

New Techniques for Component Reliability

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INERTIAL GUIDANCE
TELEMETERING
PACKAGING
MECHANICAL ENGINEERING

Wide-band, complex waveshape vibration testing using electromagnetic shakers driven by large audio amplifiers, is a valuable new tool for evaluating guided missile components. Input information can be in-flight vibration data which has been obtained via telemetering or it can be artificial vibration records sythensized from noise, pulses, sine waves, etc., to suit specialized needs.

Design and test for survival in adverse environment is fundamental in producing guided missile components with reliability adequate for modern weapons system requirements. At JPL, a constant search is being conducted for better design and packaging techniques, and for more significant laboratory test methods. Development of the "complex wave" vibration test philosophy, and of apparatus to exploit it, are but two results of this program. In the area of component design, new packaging techniques have been developed, involving control of local internal resonances and nonlinearities, which permit electronic circuits to withstand many times the vibration level which would destroy a conventional package.

Engineers and scientists are working at JPL in nearly all of the physical sciences. Here they are supported not only by outstanding laboratory facilities, but by a continuing series of experimental rocket firings which provide an invaluable tool for research and development.

The combination of a broad base of fundamental research, active development effort, and strong test and flight program has made the Lab a place of achievement. Perhaps you would like to participate in the many new, exciting programs now under way here. Your inquiry is invited.

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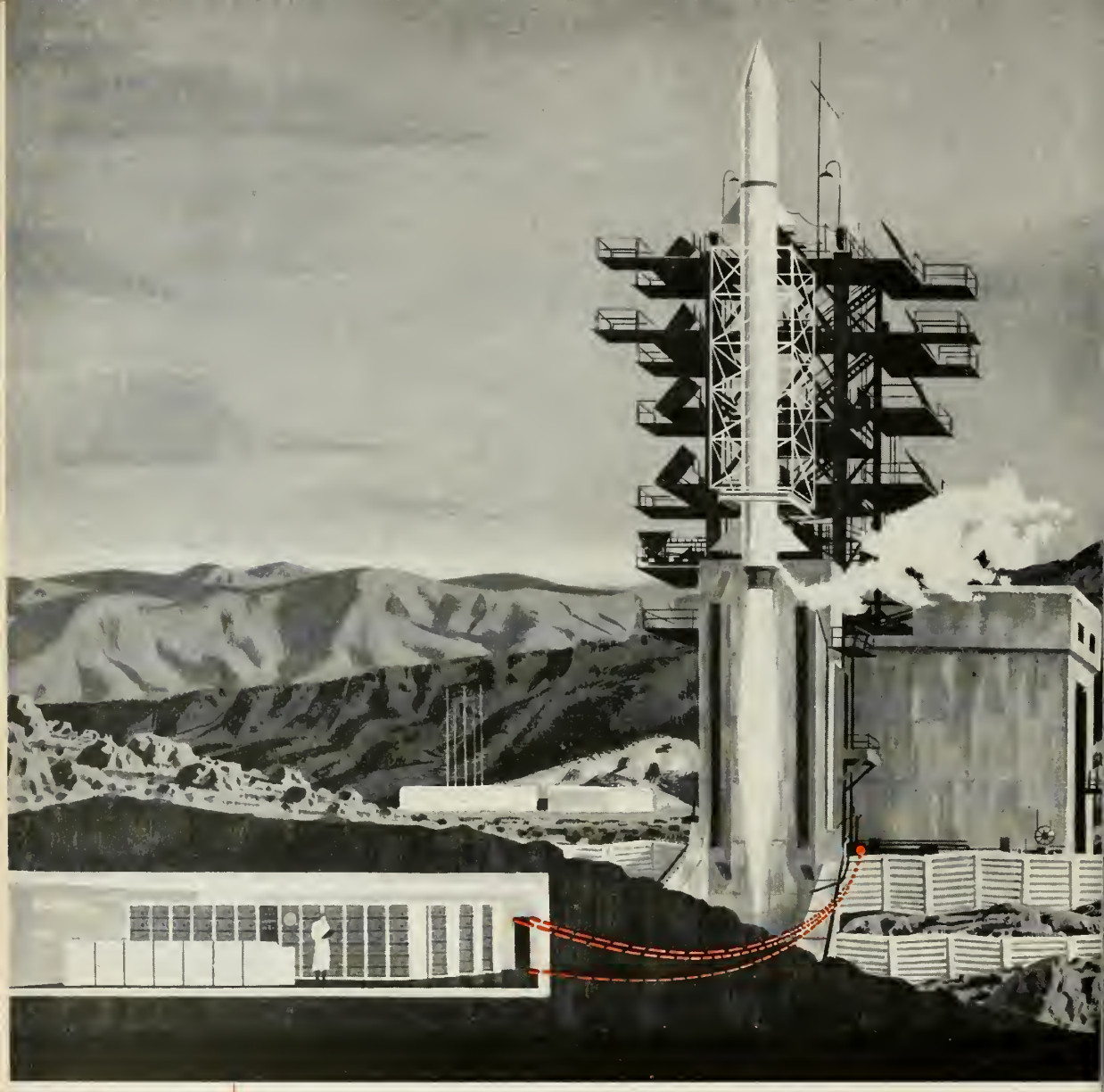

taming the big ones

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How Good the Russians?

The editors of this magazine have assembled in this issue more information and data about the Soviet Union's missile activities than have ever been collected in one public place before.

There are many pieces missing as is the case of every enterprise in Russia, especially military. Yet a fair amount is known.

What does it all add up to?

There is no evidence whatever that the Soviet Union has attained (as of now) an over-all superiority or even a measure of equality.

But the evidence is powerful that Russia is striving with all-out effort—and top priority—in the missile field. This is sufficient warning in itself from the greatest imperialist nation in the history of the world.

Three of this country's top military leaders have spoken out recently on the subject of the Red war machine.

Army Secretary Wilber N. Brucker quoted with telling effect Khruschev's pickled comment at a Moscow embassy party, "History is on our side. We will bury you."

Navy Assistant Secretary Garrison Norton urged strongly the continued modernizing of the Navy with missiles if this service is to keep pace with Russian development.

But it was left to General Bernard A. Schriever, Chief of the USAF Western Development Division, to add a reasoned appraisal to his warning of Soviet progress.

General Schriever said the question of whether the U.S. or the U.S.S.R. has the biggest and best ballistic missiles is somewhat like weighing the chances of the participants in an automobile race solely on the basis of their cars instead of considering the training and experience of the drivers, the reliability of their equipment, the support they receive in the pits, and similar factors.

We like that appraisal. The quality of the missile alone is not the decisive factor. As General Schriever said, there must also be know-how and organization for major strategic operations in order to create a real long-range missile capability.

Once ICBMs and IRBMs are added to the inventory of the Strategic Air Command—whose capability and record is unquestioned—"There will be no over-all ballistic missile capability like it in the world."

Such confidence is heartening. But it is warranted just so long as this country keeps missile development in high gear.

WAYNE W. PARRISH

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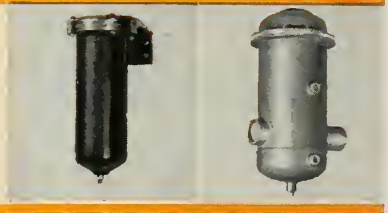

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Their inspection records showed the average inspection-rejection rate was 45 to 47% for the eleven months from January to November 1953; during February and March 1954, all paper filter elements were replaced with Permanent Filter Sintered Bronze units; from February to September 1954 the average inspection-rejection rate was 5 to 7%; and from January to April 1955, the average inspection-rejection rate was only 2 to 4%.

This is one of many case histories in which Permanent Filter installations have drastically reduced costly rejections and delays. As a result, Permanent Filter Sintered Bronze units are standard equipment on such missiles as the Nike, the Navajo, the Falcon, and on such combat aircraft as the F-100, F-104, F-7-U, F-8-U, and the RB-66.

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letters

Radiation Pressure

To the editor:

. . . In a letter "Radiation Pressure" in your December issue, Mr. Norman Blubaugh obviously refers to the Crooke's Radiometer as the revolving element actuated by "light pressure."

It is astonishing that this fallacy of "light pressure" is still fostered; one wonders about the efficacy of physics teaching in this country which does not more clearly demonstrate the absurdity of this premise.

The Crooke's Radiometer is based on the principle of a differential pressure across each vane. The shiny side of each vane is cooler than the black side. Therefore the pressure (in the *partial* vacuum of the bulb) adjacent to the black side is lower than that next to the cool side.

Thus a net force results and pushes the vanes in the direction of the black side. As the radiometer bulb is exhausted to a harder vacuum, the vanes now turn in the opposite direction, with the shiny side turning toward the light. This is caused by the, by now imperfect gas, behaving as discreet particles; these particles when heated by the black side increase their motion and impinge on the black side and transfer their momentum to the black side thus pushing the vanes away from them, that is, i. e., with the shiny side leading.

If the vacuum is reduced to a very low level of pressure then the vanes do not turn at all, no matter how much light impinges upon them. The actual light pressure in micro-micro dynes is immensely less than that required to move the vanes. It is true that a powerful enough light source could produce a motion of the vanes but such a light beam would vaporize the entire radiometer.

As for "sunlight pressure" navigation in space, reflective "sales" of hundreds and thousands of square miles of surface area should be required to propel a vehicle of even a low mass. Furthermore, the light's pressure falling off as the inverse of the distant-squared from the sun further complicates the picture . . .

Kurt R. Stehling
Propulsion Head
Naval Research Laboratory
Washington 25, D. C.

Satellite Camera

To the editor:

. . . After reading Henry Steier's article in the January issue on the satellite tracking cameras, I thought you might be interested to know that the optical systems for the cameras will be one of the most difficult optical production jobs ever attempted. I don't think anything quite like it has been tried before on a production basis.

As you know, the optical design calls for a 31-inch mirror, and three aspheric corrector plates. Until Perkin-Elmer developed economic production methods for aspherics, making such elements of this order were pretty much a hand-made proposition. Generating the aspheric surfaces for these systems will be all the more difficult because of the thickness of the glass, which is so small in proportion to its diameter.

Aspheric surfaces, as you may know, take the form of paraboloids, ellipsoids, hyperboloids or other geometric forms that can only be defined by complex equations. Their advantage to lens design is twofold. First, since an aspheric surface often replaces one or more classical surfaces (spheres or flats), it means lighter weight and smaller lenses. Secondly, aspherics will sometimes correct for aberrations not otherwise correctable, resulting in faster and more precise lens systems . . .

Charles C. Dayton
Public Relations
The Perkin-Elmer Corporation
Norwalk, Conn.

To the editor:

. . . We were very pleased to see from the January issue, on page 64, the description of the Vanguard satellite tracking camera.

You will be interested to learn that the three element Schmidt type objective, consisting of two KzFS-2 and one SK-14 discs of 22" diameter, was supplied by us and produced by the world-renowned Jena Glass Works of Schott & Gen. in Mainz, West Germany, whom we represent. The optical design was, as noted by you, prepared by Dr. James G. Baker. This glass was found to produce an image with very much reduced secondary spectrum.

We trust that you can make mention of this in your magazine . . .

Murray Yawitz, President
Fish-Schurman Corporation
70 Portman Road
New Rochelle, New York

Name-Change

To the editor:

. . . I should like to call your attention to a mistake in the listing of Subcontractors Guide: "Missile Electronics and Astrionics" which appears in your January issue. On page 79 the name Raymond and Rosen Engineering Products appears. This should be listed as Tele-Dynamics Inc. so as to reflect the name change of our organization which took place on August 1, 1956 . . .

J. M. Millet for
C. W. Kropp
Eastern Regional Manager
Tele-Dynamics Inc.
32nd and Walnut Streets
Philadelphia 4, Pa.

Rocket Producers

To the editor:

I was most interested in your article on the "Mighty Mouse" in the November issue and noticed that two of the Rocket Head manufacturers had been omitted from your list of "Well Done" manufacturing facilities.

Since the current issue has not corrected the situation, I'll have to wave the flag for two of the finest cooperating military producers in the business; namely, Hubeny Brothers, Inc., Roselle, New Jersey, and John E. Mitchell Company, Dallas, Texas . . .

Charles M. Featherstone, Jr.
District Manager
Baldwin-Lima-Hamilton Corporation
Philadelphia 42, Pa.

Giannini Trim-servo System
specified for Convair F-102A...
wide range...high altitude...sensitive

The Interceptor champion has a midget manager

The development of Century Series Aircraft has greatly intensified the need for Giannini precision instruments and systems to simplify the increasing complexities of high speed, high altitude flight. An outstanding example is the Giannini functional Mach computer for the elevon trim-servo system which enables the Convair F-102A all-weather interceptor to maintain subsonic trim characteristics at supersonic speeds.

The trim-servo system, a highly accurate Mach number and altitude sensing-computing system which reacts to speed changes as small as 0.0005 Mach, is one version of the servoed bridge network computing systems previously designed and developed by Giannini avionic engineers. The basic design has such capability and flexibility that a prototype computing system was produced for Convair in less than three weeks. Delivery of the first production model was made in less than two weeks from date of purchase order.

This rapid design and development is one more instance of Giannini's superior performance in the engineering and production of quality airborne equipment.

Engineering positions are open at several Giannini locations for career-minded young men—write for details.

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RESEARCH ROCKETS AND MISSILE RELIABILITY

cover picture:

Russia's scientists work intensively toward the goal outlined for them by their military leaders. The Russian scientist has many peculiarities; he or she works long hours, accuracy in their jobs is almost pathetic (see m/r's personal report, page 61). At long last the hero scientific worker might get a medal. This month's cover shows president of USSR Academy of Sciences, Academician Alexander Nesmeyanov, pay visit to rocket lab at the Institute of Chemical Technology, Moscow.

columns

departments

photo credits:

U.S. Army, pp. 22, 50, 54, 55, 87; U.S. Air Force, p. 42; Sovphoto, pp. 17, 38, 49, 71; E. Hull, pp. 43, 61, 62 65, 66, 67, 116; Northrop, p. 21; NAA, p. 23; Temco, p. 23; Lockheed, p. 24; AP, p. 24; Bell. p, 27; Department of Defense, p. 42; W. Geisler, pp. 74, 75; Societe d'Etude, pp. 82, 83; Aerojet, p. 116; ACF, p. 116.

when and where

FEBRUARY

AFA Jet Age Conference, Sheraton-Park Hotel, Wash., D. C., Feb. 14-15.

Conference on Transistor Circuits, sponsored by IRE, AIEE, Phila., Pa., Feb. 14-15.

Astronautics Symposium, sponsored by Air Force Office of Scientific Research and Convair Division of General Dynamics Corporation, El Cortez Hotel, San Diego, Calif., Feb. 18-20.

Western Joint Computer Conference, sponsored by IRE, AIEE and ACM, Hotel Statler, Los Angeles, Feb. 26-28.

Joint Military-Industrial Guided Missile Electronic Test Instrument Symposium, Redstone Arsenal, Huntsville, Ala., Feb. 26-28.

Nuclear Radiation Effects on Semiconductor Devices and Materials Symposium, sponsored by Department of Defense-R&D, Western Union Bldg., New York City, Feb. 27-28.

MARCH

Nat'l Conference on Aviation Education, Mayflower Hotel, Wash., D. C., Mar. 7-9.

Nuclear Congress & Int'l Atomic Exposition, Convention Hall, Phila., Pa., Mar. 11-15.

IAS Flight Propulsion Mtg. (classified), Cleveland, Ohio, Mar. 14-15.

First Military Automation Exposition, New York Trade Show Bldg., (Richard Rimbach Associates), New York City, Mar. 18-21.

IRE National Convention, Waldorf Astoria Hotel and New York Coliseum, New York City, Mar. 18-21.

151st National Meeting of the American Meteorological Society, University of Chicago, Mar. 19-21.

American Society of Tool Engineers, Silver Anniversary annual meeting, Shamrock Hilton Hotel, Houston, Tex., Mar. 25-27.

10th Western Metal Exposition & Congress, American Society for Metals and others, Ambassador Hotel and Pan-Pacific Auditorium, Los Angeles, Mar. 25-29.

Educational Colloquium on Radiation Effects on Materials, sponsored by ONR and Glenn L. Martin Co., Johns-Hopkins University, Baltimore, Md., Mar. 27-29.

APRIL

SAE Aeronautic Meeting and Production Forum, New York City, Apr. 2-5.

Spring meeting, American Rocket Society, Sheraton-Park Hotel, Wash., D. C., Apr. 3-6.

British Radio and Electronic Component Show, Grosvenor House and Park Lane House, London, England, Apr. 8-11.

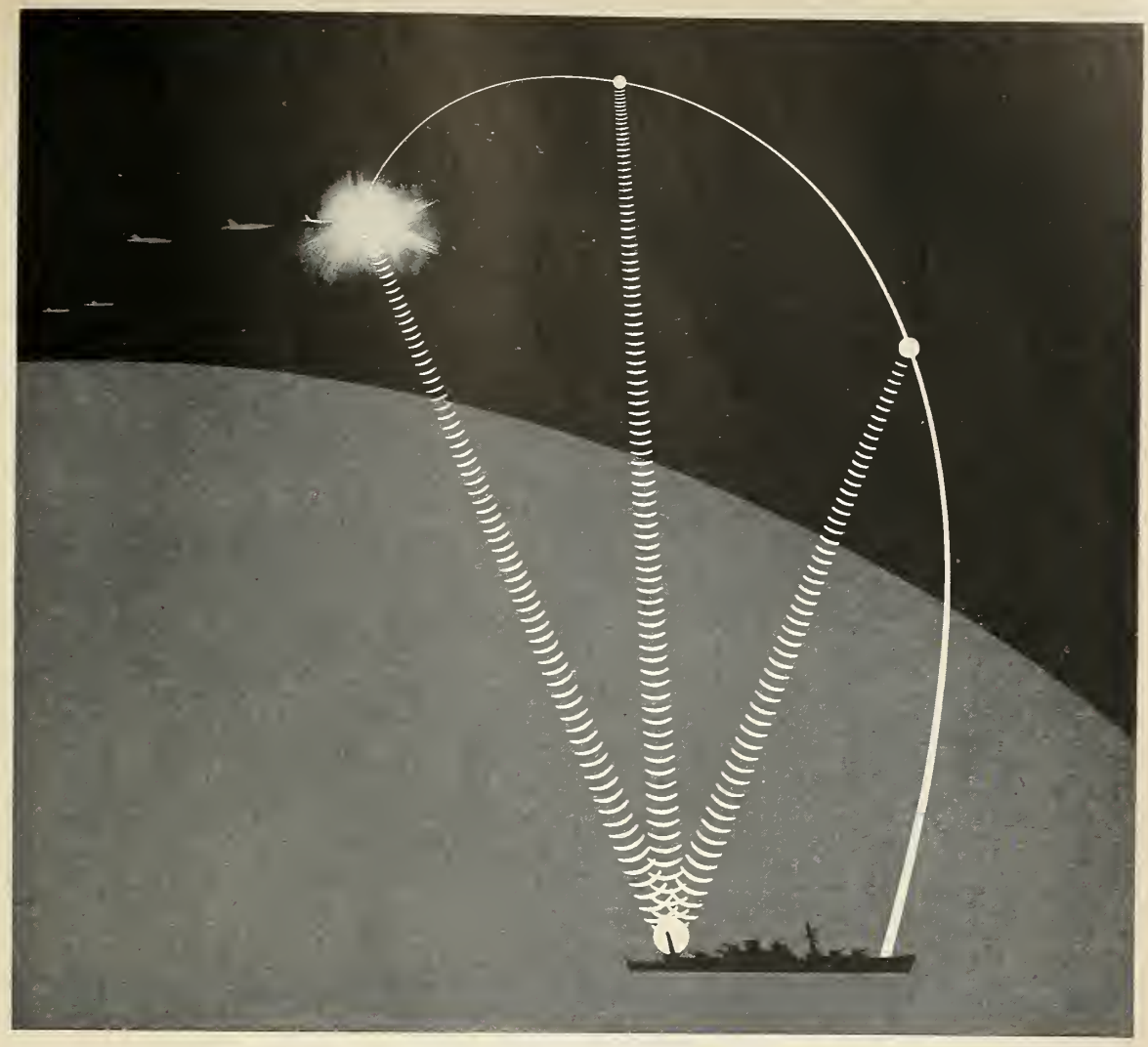
Annual Industrial Electronics Educational Conference, sponsored by IRE, Armour Research Foundation, Ill. Institute of Technology, Chicago, Ill., Apr. 9-10.

Southwestern IRE Conference and Electronics Show & National Simulation Conference, sponsored by IRE, Shamrock-Hilton Hotel, Houston, Texas, Apr. 11-13.

IRE PGTRC National Symposium on Telemetering, Phila., Pa., Apr. 14-16.

IRE Professional Group on Telemetry and Remote Control, national symposium, Phila., Pa., Apr. 15-17.

Symposium on Nondestructive Tests in the Field of Nuclear Energy, Morrison Hotel, Chicago, Ill., Apr. 16-18.



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Manned Rocket Bombers Underway

Soviet and U. S. Enter Race For Space Craft Of 10,000 Mile Range

By Erik. Bergaust

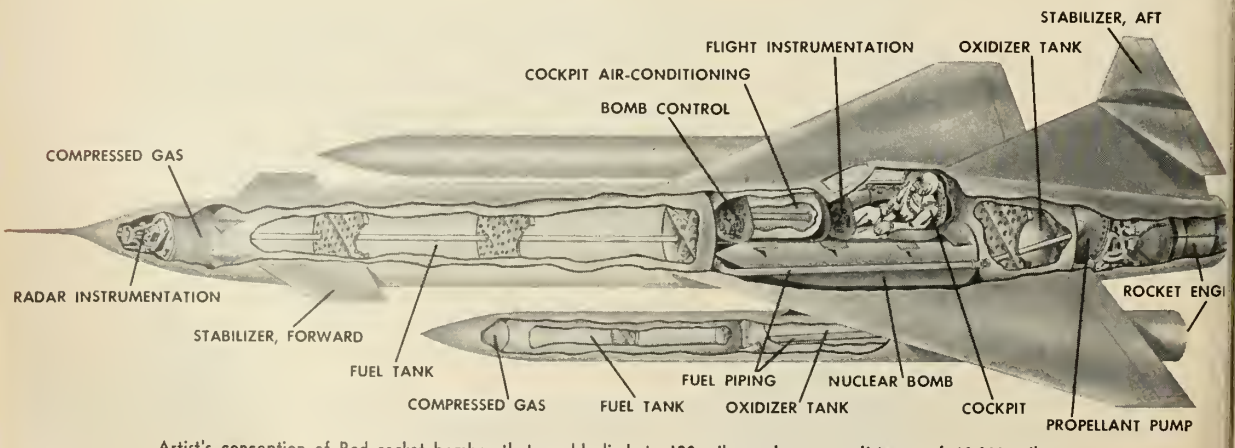
The Soviet and US now are believed to be entering a red-hot race for the next step in ultra-modern warfare. What comes after the ICBM? The answer, according to several experts, is the manned space-rocket bomber, an entirely different concept in weaponry and the greatest technological challenge yet. This supercraft supposedly is a missile with a man it, designed to cover distances up to 10,000 miles. Several US companies have expressed interest in the project, and it is safe to assume that study contracts have been awarded. Among the companies mentioned in this connection are Convair and Bell.

The Soviets have shown great interest in manned space bombers ever since the end of World War II. In fact, the reds tried to pursuade Dr. Eugen Sanger, designer of the antipodal bomber, or skip bomber, to go to work for them. Dr. Sanger, turned down the offer, whereupon the Soviets tried to kidnap him. However, Dr. Sanger is safe in Stuttgart, where he heads up a jet propulsion institute and is working on such advanced projects as ion rockets.

The antipodal bomber concept was conceived by Dr. Sanger during the last war as a possible solution to direct bombardment of targets on the United States mainland from launching sites in Europe. The manned missile would be launched into areopause altitude, approximately 120 miles up, and then behave like a ballistic missile, i.e. it would decend back toward earth in a ballistic path. However, hitting the denser layers of the atmosphere the missile's wings would provide "lift" and bounce the vehicle up into thinner atmosphere layers again, aided by bursts from the rocket engine. It has been calculated that only three of these bounces would be necessary for the bomber to cover the distance from Europe to the United States.

When Dr. Sanger's glide-and-rocket bomber was revealed after the war, many experts could not help being skeptical about the concept. But these same experts seem to think differently today. Although the forthcoming space bombers may or may not be skip-or antipodal vehicles, the feasibility of sending a manned space rocket craft over a distance of 10,000 miles is obvious. It seems, however, that it will take at least two or three years to develop a rocket bomber prototype, if work on it got underway today. And, in all probability, both the Air Force and Navy would want to gather some experience with the high-altitude research aircraft now being built before attempting to design the bomber.

Reports gathered for this issue of m/r indicate the Russians have been working on an advanced version of the Sanger craft, and that its designation is T-4A. A manned as well as an unmanned version are believed to have been attempted. Some of the reports



Artist's conception of Red rocket bomber that would climb to 120 miles and cover a distance of 10,000 miles.

indicate the manned version will be track-launched and that it could cover the distance between Leningrad and New York in 89 minutes.

We are rather skeptical about any statement to the effect that the Russians have advanced to the hardware stage in manned rocket bomber development, but, as has often been proven, it is quite probable that they are on a par with us in this field as well.

Adding up the information we have obtained on the Red rocket bomber, it appears their super craft would be between 60 and 70 feet long. It would be fitted with three liquid rocket engines, all burning kerosene and liquid oxygen. The two smaller, wing-mounted engines and their tanks and turbine gear will be jettisoned after burnout during the initial climb to 120 miles. The vehicle also will employ a large-size booster for the run along the rails or tracks that supposedly will be used for takeoff.

The ship have a delta-wing and T-tail stabilizer. Fuel tank is located in the main fuselage section forward of the cockpit, oxidizer tank is directly behind pilot. Bomb compartment is directly underneath the cockpit.

US Air Force planners—naturally —have no comments to offer on our own efforts in the field of manned space-rocket bombers, but many industry officials believe the Air Force is about to undertake "something big" and "real sophisticated" in this field. Funds for whatever work is being done now probably come from R&D grants.

According to the Italian aviation publication "Alata" this is the way the Russians contemplate to launch their rocket bomber. Bomb is to be dropped on New York. Pilot will be picked up by sub in the Pacific.

IRBM, ICBM Get Super-Priority

HUNTSVILLE, Ala.—Officials of the Army Ballistic Missile Agency and Redstone Arsenal have received notification that the U.S. Department of Commerce has assigned top priority to the IRBM and ICBM research and development programs. The order will specifically affect work on the *Jupiter*, the Army's intermediate range ballistic missile. Supposedly, the *Jupiter* prototype is being readied at Patrick AFB for firing. The order also applies to USAF and Navy programs in the same fields.

The top priority will be helpful to contractors in the procurement and purchase of scarce materials and components. It applies to them and to all others engaged in research, development and production of the weapons.

This is the first time that the super-priority has been applied to programs of the IRBM and ICBM scope.

Russians Hold IRBM Lead?

Moscow now seeks to confirm what some American scientists have been saying privately for some time—that Russia is leading the United States in some significant categories of guided missile development.

Pravda, the official Communist party newspaper, had this to say the other day:

"It is common knowledge that the United States is far from being a monopolist e i t h e r in the sphere of nuclear weapons or, even less so, in the sphere of long-range missiles.

"Here it would be more appropriate to talk of America's lag."

The jibe at American missile technology was contained in a lengthy Soviet warning to o t h e r countries against p e r m i t t i n g establishment of U.S. atomic military contingents on their territory.

The warning included the threat of nuclear retaliation by the Soviet Union, possibly by missile delivery, in the event of war.

Pravda said that the U.S. Defense Department "intends to station atomic groups armed with the latest types of guided missiles in troubled areas."

And it quoted from President Eisenhower's budget message references to increasing the number and variety of nuclear weapons and a 35 per cent increase in guided missile expenditures.

"How can these aggressive plans be reconciled with the dulcet speeches of (Henry Cabot Lodge) U.S. representative to the United Nations, who urged the world the other day to abandon the tendency of stockpiling atomic weapons, to reduce the atomic threat in the future, to bring about a situation where scientific research in the sphere of jet-propelled missiles would be devoted to peaceful scientific purposes," *Pravda* asked.

State Department officials refused to take too seriously the Soviet threats against our allies.

But they, together with Pentagon planners, wondered precisely what the Reds have under development to back up the boast that the U.S. is lagging in long-range missile development.

While the Russians claim they have plenty IRBMs and while reports say they are equally advanced in the field of ICBM development, the United States is in position to show off an actual piece of ICM hardware—and a production model at that: Northrops SNARK.

$533 Million More for Guided Missiles

Six Billions to be Spent in Next Two Years . . . Research and Development Grants Cut

Army has released photographs of its field weapon Lacrosse. Development of this weapon has highlighted accuracy and mobility, according to the Army. These pictures also indicate striking power. "The Lacrosse is a deadly accurate guided missile for close tactical support of ground troops in the field," Redstone spokesmen said. It is mounted on a mobile launcher. First pictures show several of the missiles mounted on the launchers which was taken to indicate that Lacrosse is in at least small quantity production and that field units are being trained in its use.

The Defense Department will spend more money for guided missiles in the 12 months beginning July 1 than ever before in history. New orders for missiles will be second only to the current fiscal year.

According to Wilfred J. McNeil, Assistant Defense Secretary (Comptroller), the Army, Navy and Air Force will spend $2,039,000,000 for missiles of all categories during fiscal 1958 and will have an additional $2,563,000,000 available for missile procurement during the same period.

President Eisenhower's budget for 1958, which calls for $38 billion in new money and $38.5 billion in expenditures for the Defense Department, indicates that "expenditures for guided missiles will be up 35 per cent" during the coming year while procurement of manned aircraft will remain at about the same level and ship construction will be up 12 per cent over fiscal 1957.

The Pentagon comptroller provided the following comparisons of missile expenditures and money available for missile obligations over an eight-year period. The figures include all of the military services.

Defense Department Guided Missiles

			Expenditures	Available for Obligation
Fiscal	1951	.....	$21,000,000	$424,000,000
Fiscal	1952	.....	169,000,000	468,000,000
Fiscal	1953	.....	295,000,000	896,000,000
Fiscal	1954	.....	504,000,000	748,000,000
Fiscal	1955	.....	718,000,000	345,000,000
Fiscal	1956	.....	1,168,000,000	938,000,000
Fiscal	1957	(est.)..	1,506,000,000	2,300,000,000
Fiscal	1958	(est.)..	2,039,000,000	2,563,000,000

McNeil indicated the new money being requested would enable the Air Force to finance either the Chrysler *Jupiter* or the Douglas *Thor* 1500-mile-range ballistic missiles but not both. The same, he added, is true of the Army, which will have to decide between the Douglas-Western Electric *Nike Hercules* and the Bendix *Talos* surface-to-air weapons to replace *Nike Ajax*.

The Defense Department's budgetary expert gave the following indications of missile expenditures and available money for each of the services during the 1951-58 period.

Army Guided Missiles

			Expenditures	Available for Obligation
Fiscal	1951	.....	.....	$173,000,000
Fiscal	1952	.....	$46,000,000	253,000,000
Fiscal	1953	.....	119,000,000	301,000,000
Fiscal	1954	.....	187,000,000	225,000,000
Fiscal	1955	.....	238,000,000	.....
Fiscal	1956	.....	333,000,000	.....
Fiscal	1957	(est.)..	425,000,000	.....
Fiscal	1958	(est.)..	562,000,000	425,000,000

Navy Guided Missiles

			Expenditures	Available for Obligation
Fiscal	1951	.....	$5,000,000	$130,000,000
Fiscal	1952	.....	56,000,000	119,000,000
Fiscal	1953	.....	95,000,000	181,000,000
Fiscal	1954	.....	141,000,000	159,000,000
Fiscal	1955	.....	176,000,000	126,000,000
Fiscal	1956	.....	195,000,000	238,000,000
Fiscal	1957	(est.)..	221,000,000	352,000,000
Fiscal	1958	(est.)..	264,000,000	428,000,000

Air Force Guided Missiles

			Expenditures	Available for Obligation
Fiscal	1951	.....	$16,000,000	$121,000,000
Fiscal	1952	.....	66,000,000	95,000,000
Fiscal	1953	.....	81,000,000	414,000,000
Fiscal	1954	.....	176,000,000	364,000,000
Fiscal	1955	.....	305,000,000	219,000,000
Fiscal	1956	.....	641,000,000	700,000,000
Fiscal	1957	(est.)..	860,000,000	1,948,000,000
Fiscal	1958	(est.)..	1,213,000,000	1,710,000,000

President Eisenhower's budget message shows that the total new money request for missiles in fiscal 1958 is $2,646,000,000. This sum includes $425 million for the Army, $428 million for the Navy and $1,793,000,000 for the USAF.

McNeil reports that if this new obligational authority is voted by Congress, the sum will be coupled with carryover and other funds and will result in new direct obligations during fiscal 1958 of $2,828,000,000 for missiles. The $2,828,000,000 will include direct orders by the Army for $673 million, by the Navy for $465 million and by the Air Force for $1,690,000,000.

Direct obligations figure, compares this way for the 1956-1958 period.

Direct Obligations for Missiles

	FY 1958	FY 1957	FY 1956
*DD	$2,828,000,000	$3,071,000,000	$1,630,000,000
*A ..	673,000,000	743,000,000	439,000,000
*N ..	465,000,000	440,000,000	222,000,000
*AF	1,690,000,000	1,888,000,000	969,000,000

*DD—Defense Dept.
*A—Army
*N—Navy
*AF—US Air Force

McNeil declares that there will actually be an increase in obligations for missiles between fiscal 1957 and 1958, if the ballistic program is discounted. Across the board, he says, more missiles are to be ordered in the coming year. The more than $3 billion scheduled to be obligated during the current fiscal year includes much of the initial groundwork for the IRBM (*Jupiter* and *Thor*) and the ICBM (Convair *Atlas* and Martin *Titan*) program, and will inevitably drop off in 1958, McNeil states.

On the research and development side, the Presidential budget message indicates a total of $331,800,000 is to be obligated in fiscal 1958 by the three services for "guided missile and related equipment" R&D. The respective figures for 1957 and 1956 are $346,500,000 and $280,400,000.

Isolation of the R&D activities in the guided missile field by the Army, Navy and Air Force shows the following comparison:

Research and Development (Guided Missiles and Related Equipment) Program and Financing

	Army	Navy	USAF
Fiscal 1956	$111,953,992	$95,226,874	$73,279,983
Fiscal 1957 (est.)..	108,985,000	146,219,035	91,327,081
Fiscal 1958 (est.)..	87,380,000	167,963,000	76,412,000

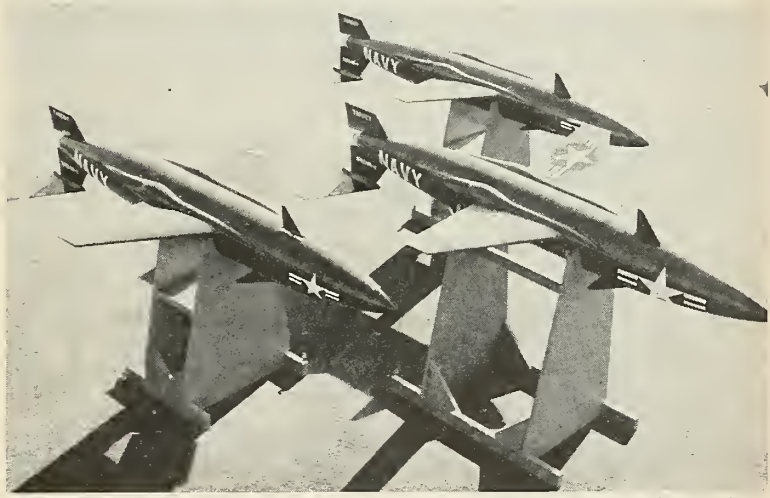
It becomes readily apparent that some guided missiles in the research and development stage in 1956 and 1957 are to be funded out of procurement money for 1958.

- The Army's missile R&D money shows a $21.6 million drop between 1957 and 1958. Its direct obligations for missiles also will decrease $70 million during the period. Spending will climb by $137 million.
- Navy R&D activities in the missile field rise by $21.7 million (presumably to cover the ship-based *Jupiter* IRBM and the sub-based *Polaris*, among others) and its direct obligations will climb by $25 million between 1957 and 1958. Spending will rise by $43 million.
- USAF missile research will fall off by $14.9 million and its direct obligations also will be down by $198 million. Spending will be up by $353 million.

Summarizing the 1958 Defense Department figures as a whole:

- Missile R&D will be down $24.8 million from 1957.
- Direct obligations for missiles will decrease by $243 million.
- Spending for missiles will rise by $533 million.

Sleek X-10 NAVAHO test missile built by North American. This is our second intercontinental missile, Northrop's SNARK being the first one—and closer to production.



Radioplane XKD4R-1 target drones have been produced and delivered to the Naval Air Missile Test Center at Point Mugu, California. The missiles are built under a Navy contract.

Biological Research In Satellites?

A committee of the Space Medicine Association has been formed to plan for biological and medical experiments in the U.S. earth satellite program. The committee, chaired by the Association's President, Dr. Fred A. Hitchcock of Ohio State University, has as members, four leading space medical investigators: Dr. Hubertus Strughold (USAF Department of Space Medicine, Randolph Field), Dr. Heinz Haber (University of California), Dr. (Major, USAF) David G. Simons (Holloman AFB), and Dr. Hermann Schaefer (NAS, Pensacola).

None of the physical experiments contemplated for the U.S.-IGY satellite program are in the fields of biology or medicine. The function of the Association's committee will be to plan a "definite and worthwhile" research program so that space medical researchers will be ready when space and weight are allotted for such experimentation aboard future satellites.

Queried as to Russian interest in such matters, one member of the Association commented that he "wouldn't be surprised" to see such experimentation "early" in the Russian satellite program. "We all know we'll be experimenting in that medium eventually, and I think the Russians would like to be first," he stated.

The Space Medicine Association is a subsidiary organization of the Aero Medical Association, the professional society of aviation physicians and flight surgeons.

Guided missiles gave the finishing touch to the Inauguration Parade in Washington last month. The Army managed to raise the Corporal—in salute—as the launching van passed the presidential stand.

Lockheed proudly displays its X-17 re-entry test missile. Vehicle is said to have made numerous successful flights. Note bulky spin stabilizer rockets mounted on first stage.

Big ARS Meeting In Washington This Spring

The Nation's capital will be the scene of the National Annual Spring Meeting of the American Rocket Society. Illustrated lectures on space flight, earth circling objects, and rocket vehicles will be presented.

The national meeting will be held at the Sheraton Park Hotel, Washington, D. C. April 3 to 6, 1957. More than a thousand experts are expected to be on hand.

One of the principal features of the Spring Meeting will be the exhibition of physical objects and displays staged by the American Rocket Society on rockets, guided missiles, satellites and concepts of space ships—including their components, materials and accessories.

Expected to be included in the exhibit are actual guided missiles, full scale rocket and ramjet engines, a prototype of the *Vanguard* satellite, instrumentation and guidance equipment for missiles, telemetering apparatus, tracking systems, data reduction equipment, and many accessory and component items. Companies interested in booth space should contact ARS in N.Y.

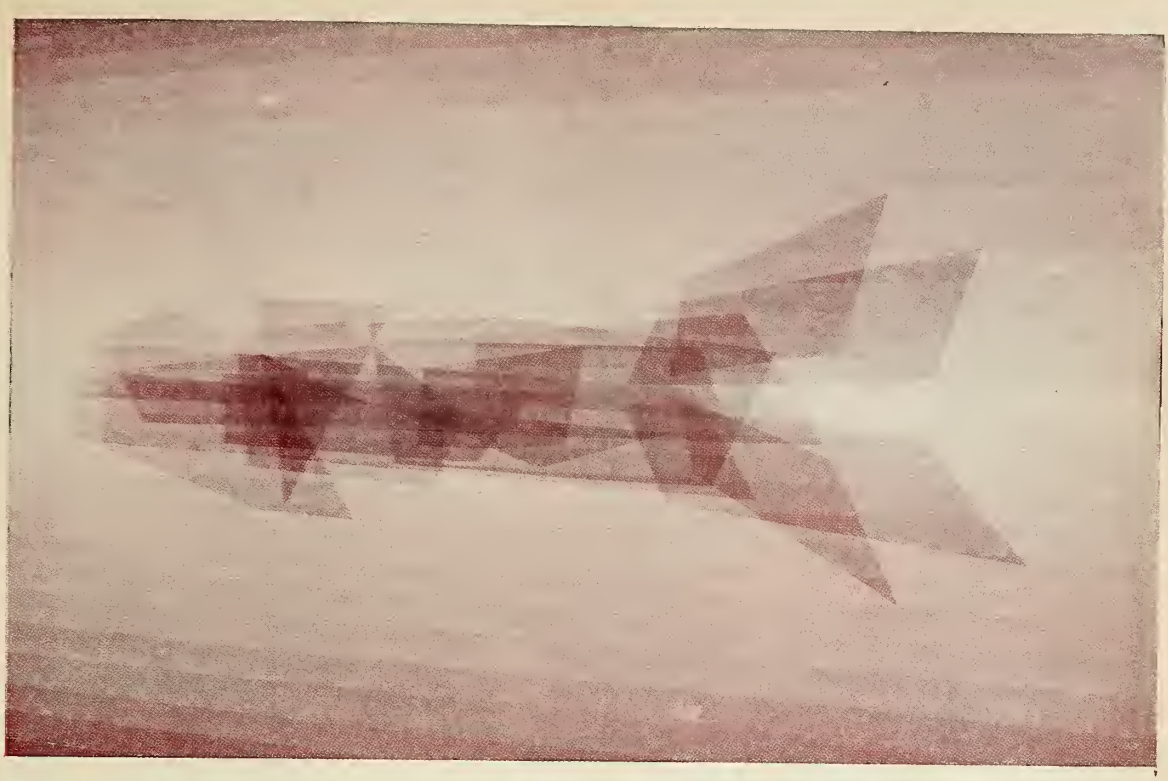
The Spring Meeting was originated by Erik Bergaust, President of the National Capital section of the American Rocket Society and Managing Editor of MISSILES & ROCKETS. Meeting Chairman is Andrew G. Haley, formerly National President of the American Rocket Society and for several years Vice-President of the International Astronautical Federation. Chairman of the National Program Committee is Kurt R. Stehling.

Luncheon speaker and the chairman of the April 4 afternoon session is Doctor Theodore von Karman.

Throughout the sessions, similar renowned experts will give papers, conduct illustrated lectures, and present breakfast and luncheon talks. Extensive program for ARS members' wives is planned.

The meeting will center around four principal themes, namely, Space Sociology, including Medicine, Law, Education and Economics; High Speed Rocket Test Tracks; Propulsive Systems; and the *Vanguard* project, including discussion of the progress of the International Geophysical Year.

More than 300 members of the International Society of Aviation Writers will meet in Washington at the same time. The writers will be invited to attend the ARS sessions. (See "People" page 118).



"ROCKETS", one of a series of paintings by Simpson-Middleman, a team of artists with the rare ability to translate scientific fact into creative imagery. Here, the rocket's blast and its guiding beam are thought of as a single stream of light through the center. Darks and lights of definite shape in a weak visual vector field are relied on to suggest the "wobble" caused by the acts of the servo-mechanisms in making their adjustments. Painting courtesy John Heller Gallery, Inc.

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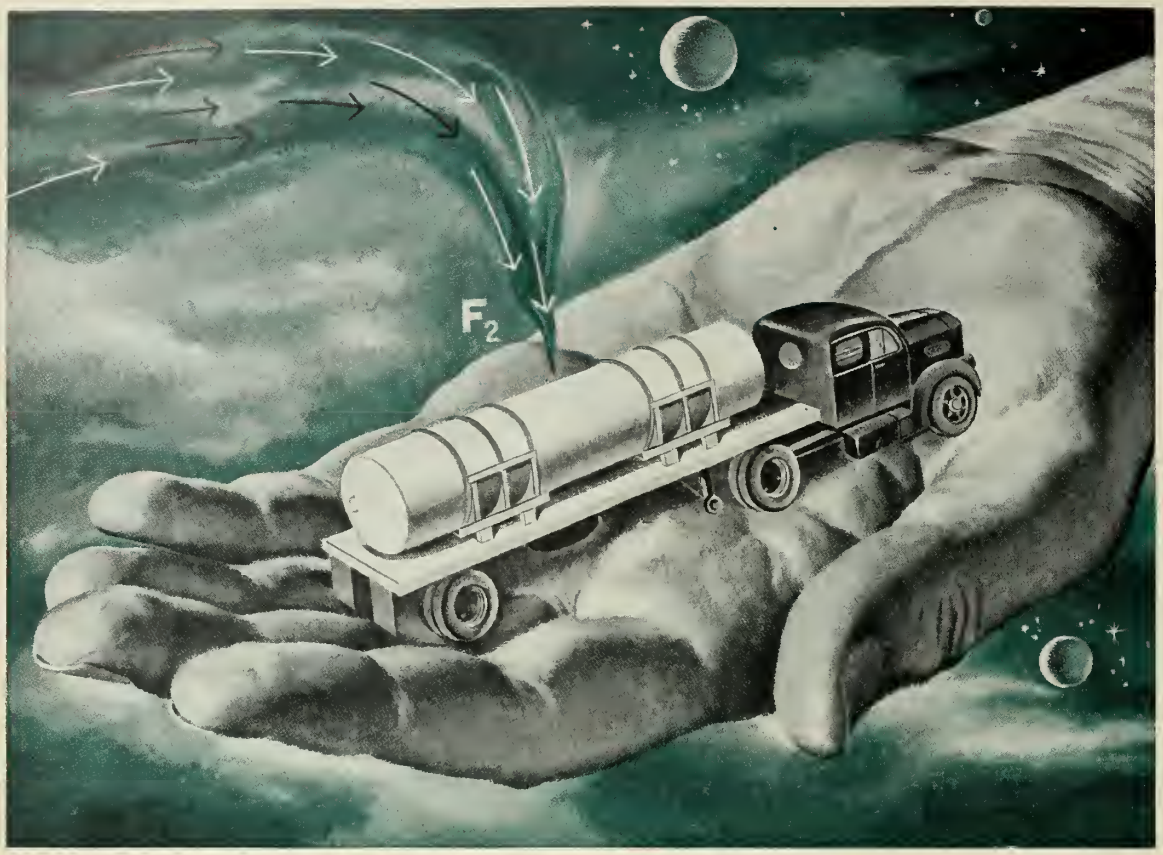

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Huntsville Braces for ABMA Expansion Program

HUNTSVILLE, ALA.—The reported misfiring of the USAF *Thor* ballistic missile in its first tests at Patrick Air Force Base, Fla., had immediate repercussions in this city, home of Redstone Arsenal and the Army Ballistic Missile Agency where the *Jupiter* IRBM was developed.

Only a few hours before the report of the *Thor* fizzle was published, Maj. Gen. John B. Medaris, ABMA commander, made a strongly worded appeal to the annual dinner of the Chamber of Commerce for a broad program of civic expansion. His words acquired special significance in the light of the next day's announcement.

"There is more work to be accomplished in the missile field than there are people to handle it. Consequently, I see nothing but increased activity here for some time to come. We will have even greater responsibilities than ever before," he declared.

The Medaris speech came as a bracing tonic to the city which, under the impetus of Redstone and ABMA, has expanded from 16,000 people in 1950 to almost 60,000 today. The area had been fearful of cutbacks and wholesale transfers of missile and rocket personnel and equipment since Secretary of Defense Wilson issued his memorandum late in November giving the Air Force jurisdiction over all missiles with a range of more than 200 miles. Even the m/r story of November, giving first details of the highly successful first flight of the *Jupiter* and pointing out that full development of *Thor* would require another two years of intensive work did little to lift the gloom that had settled over the area.

Planning for expansion of the city's school, water, sewage and gas systems, which had been delayed when the Wilson memorandum was made public, has now been resumed. A program for some 750 new low-cost houses which also had slowed was stepped up. New tax rates are going into effect in both city and county to finance the expansion of services.

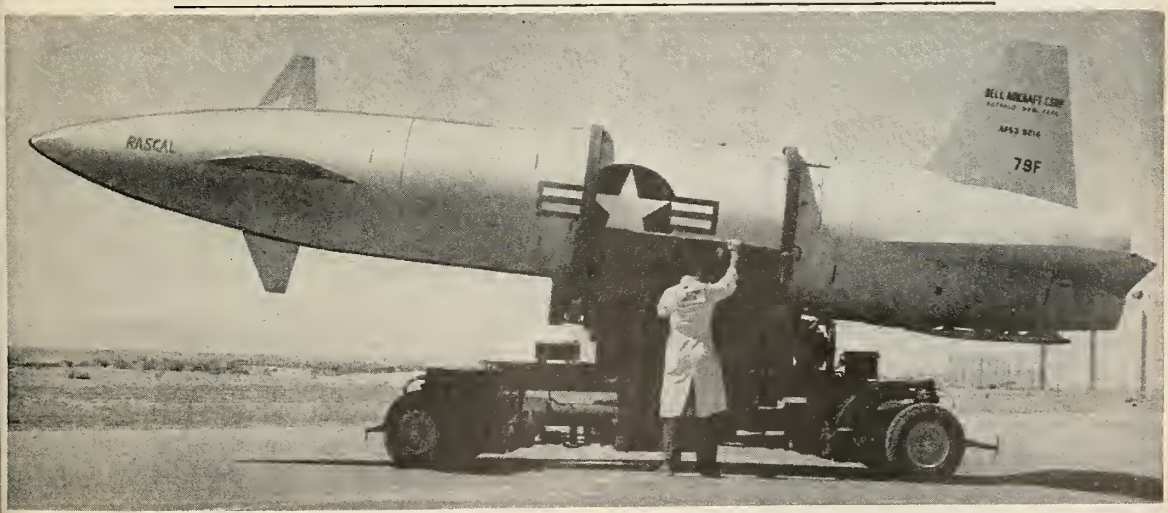
Medaris is repeating his prediction of a year ago that Huntsville will be a city of 100,000 persons by 1960, and the city believes this can only mean that there will be a huge expansion of work at the Arsenal and ABMA, with the Air Force coming in, even reluctantly, to benefit from the work of the famous von Braun group.

The impact of Arsenal and ABMA personnel upon the city was aptly illustrated recently when Hannes Luehrsen, a member of the group, proposed an ambitious plan for remodeling of the city's 150-year-old court house square to provide a magnificent two-mile mall and civic center through the very heart of the city, with parks and lagoons. Luehrsen once prepared similar plans for the city of Berlin. He was also a prime mover in planning of the new four-lane Memorial Parkway which now traverses the city and has sparked a new wave of commercial construction that is actually shifting the business center of the city to the super-highway. The new proposal was made public on one-half of the front page of the local daily.

Underlining the Medaris plea for adequate civic facilities is the fact that the Army since the Wilson memorandum has quietly been transferring large numbers of skilled personnel from other arsenals across the country to Huntsville. A group of 75 new people came in during one week in January from an Eastern arsenal, and applications for employment at the Arsenal have risen from the normal average of 1,250 per month to 2,000. Personnel directors say they expect no slackening of this tempo during 1957.

Indicative of the community's optimism is its reaction to the closing of one of its largest industries, a cotton mill that had functioned here for more than half a century. Only five years ago such a closing would have been a calamity. Now, however, the Huntsville Industrial Expansion Committee regards it as an opportunity for further growth. A group of local leaders now plans to purchase the mill and make its five buildings and 800,000 square feet available to new industries, with heavy emphasis upon those participating in the ballistic missile program. Most of the 700 textile workers made idle are being rapidly absorbed into other jobs.

Informed opinion seems to be that the Army, within the scope of the Wilson memorandum, is now concentrating more of its effort at Redstone and ABMA and will continue to do so; that there is now the chance that the Air Force will not be so reluctant to begin financing ABMA when the new fiscal year begins on July 1st; and that these developments foreshadow the buildup of a real missile and rocket production industrial complex that may make this one-time sleepy little Southern town truly "Rocket City, U.S.A."



Air Force has permitted Bell to release picture of the Rascal—after skilled artist eliminated sonar-type radome and reshaped the nose.

Sharp Criticism by Symington on U.S. Missiles

After a million words of testimony, Senator Stuart Symington's Air Force Subcommittee last month issued its report. Here follow excerpts from the conclusions of that report having to do with missiles and the Soviet threat.

"The vulnerability of the United States to sudden attack has increased greatly during the past decade and this vulnerability will continue to increase in the foreseeable future.

"The Department of Defense has failed to develop an adequate defense warning system.

"The direction and planning of naval strength again leaves the United States vulnerable to submarine attack against our shipping, and particularly vulnerable to submarine missile attack on military and civilian targets within our heartland.

"The Soviets are rapidly closing the qualitative gap. Yet, our qualitative lead is now being given as justification for our having passed over to the Soviets quantitative superiority in military airpower.

"The duplicating approach characteristic of many research and development programs in the Department of Defense, along with the dollar limitations established for such programs, has retarded needed modernization of weapons systems.

"These policies have retarded important scientific breakthroughs. They contrast with Soviet policies which have produced extraordinary Soviet progress in the research and development field.

"The Soviets exceed the United States in rate of technological development, in training facilities, in speed and quantity of prototype development, in the training of scientists and engineers, and in many other phases of airpower development.

"The Department of Defense has permitted duplication, even triplication, among the three services in the development and production of missiles; and has permitted comparable waste in the allocation to the three services of responsibility in the missile field.

"The Department of Defense also delayed in giving overriding priority to the ballistic-missile program. As a result, there has been a serious loss of time as compared with the rapid progress of the Soviets in this field.

"Financial considerations have often been placed ahead of defense requirements, to the serious damage of our airpower strength relative to that of Russia; and hence to our national security.

"The United States has the capacity to produce and maintain airpower which is relatively stronger than that of the Soviets; but the Department of Defense has not utilized this capacity.

"With proper programing and administration in the Department of Defense, it would be possible to maintain air supremacy over the Soviets without jeopardizing a sound economy and without imposing additional tax burdens upon the people.

"Under our form of government, the American people have not only the right, but also the need, to receive all information about our national defense which would not help a possible enemy. Nevertheless the public is neither adequately nor accurately informed about our military strength as against the great and growing military strength of the Communists.

"The public has failed to receive from official sources complete, accurate and timely information which it has the right to know.

"The subcommittee recommends that the deficiencies in military strength, as pointed out . . . be corrected as promptly as possible.

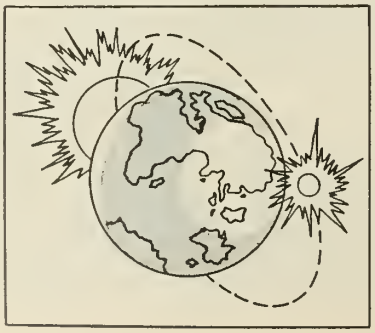
Russian Space Satellite Propaganda

The January issue of USSR, the Soviet propaganda magazine published in the U. S., skips lightly over such warmongering projects as ICBM and IRBM and paints a rosey picture of tomorrow—a day that, "relatively speaking is around the corner," USSR says, when man will send fission-powered suns into space to light and warm the Arctic icelands into verdent lands of Eden.

Also, as you read this issue of USSR, you're told of intercontinental ballistics passenger liners serving contented passengers vodka and sturgeon roe, while the hot little hazard to space navigation mentioned above speeds brightly across the rocket's bow.

In one article entitled "Excursion Into the Future", Soviet writer Vasili Zakharchenko suggests an artificial satellite "shot up into cosmic space" that will orbit the earth at an altitude of hundreds of thousands of miles. This "helio-satellite" would be powered by controlled fusion and would glow brightly over the cold polar regions. But by preset controls—in the middle of this 100,000,000° hot spot presumably—it would switch to low power and glimmer only dimly, conserving its fissile fuel, when passing over the earth's more temporate zones.

Writer Zakharchenko, doubtlessly only because he didn't wish to bore his non-technical readers, decided not to even suggest how all this might be done. In the same article, there's a glowing account of the relative simplicity and immense benefits of daming the Bearing Strait and pumping warm pacific currents into the Arctic with the aid of a two million killowatt system of atomic power stations.

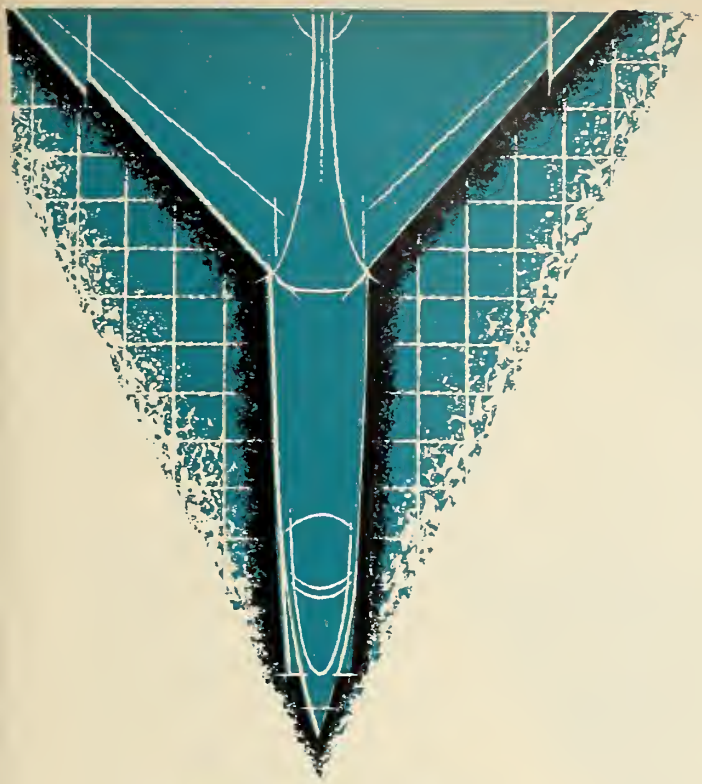


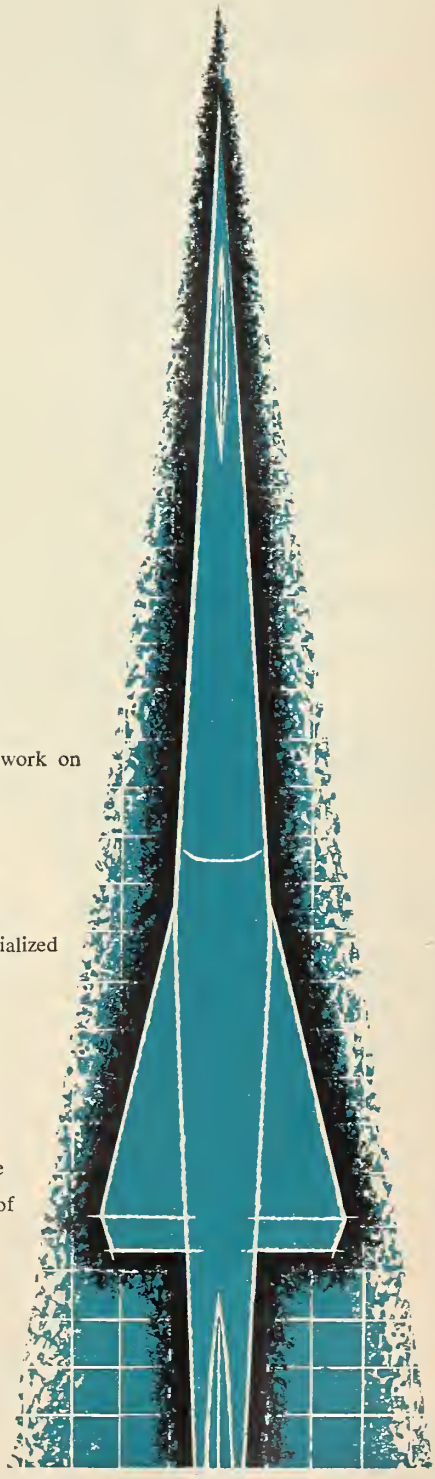
Soviet Rocket Launcher Revealed

When the British entered Port Said in Egypt, they found a large cache of Soviet arms. Among the captured items was a Russian rocket launcher. The anti-tank weapon is surprisingly similar to our old 2.36-inch rocket launcher, the "Bazooka." Indeed, dimensions appear to be highly copied. However, there are some differences, since the Russians have had over ten years to make changes. These modifications are:

1). New fuze.
2). Driving bands on the rocket body (the rocket may be spin stabilized).
3). Blast holes visible on the rocket tube motor (prehaps to vent combustion gases forward to increase muzzle velocity and/or to imprint spin).
4). Large rear cannister (for use either as a barrel wing or for loading into launcher tube only).
5). Shorter launching tube (by about ½-ft) than our old "Bazooka."

Each round is about 17-18 inches long and has a diameter of 60-70 mm. Weight is 3-4 lb. The launcher is about 4 feet long. Construction is extremely rugged and of good quality. Performance characteristics are unknown.





DESIGN ENGINEERS

Perhaps you are wondering which way to turn for real pioneering work on a complete aerial weapon. The missile field offers you a role in advancing our newest family of weapons. Fighter aircraft offer an increasing challenge in human engineering as we equip pilots for new speed and space conquests. In both fields, unique attractions for imaginative designers abound. Yet seldom in today's ultraspecialized organizations is the designer privileged to contribute to *both* fighter and missile development. An exception is Chance Vought's integrated missile and fighter design organization. Here's a rare opportunity to experience the varied career advantages of piloted and pilotless weapons, and to apply applicable design lessons of one field to the other. There may be a place for you with the developers of the Regulus missile and Crusader fighter. Send a resume of your background to:

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Rocket Trends

By Erik Bergaust

Russia's missile arsenal is vast. In fact, as our editors put together the bits and pieces of information for this issue, and as we finally arrived at some kind of analysis, we had before us a pretty complete picture of a nation that truly has become a mass producer of rockets. We learned that Red missilry and rocketry for the first five post-war years were based solely on German hardware and know-how. But since 1950 the Russian military machine has produced weapons of communist designs. We also learned that the Soviets do not tend to build up complex arsenals consisting of a variety of missiles, rather they concentrate on a few standard weapons—probably because they can achieve weapon system reliability and simplicity in this manner.

Furthermore, we have learned that two of the Soviet's operational missiles—counterparts to our *Honest John* and *Redstone*—namely the T-7A and the *Comet* are being produced by the thousands. As a matter of fact, the Russians gladly donated a T-7A to the Polish astronautical exhibition that is currently touring satellite countries *(see page 74)*. The *Comet*—which intrigues us immensely—is Russia's 650-mile rocket (thus it exceeds the *Redstone* in range); this is the Korolov rocket, or M-102, which has been confirmed to us by several reliable sources. These sources also say the Russians have produced at least 20,000 of the M-103, an IRBM-type vehicle which is said to have a range of 1,800 miles. Now, a stockpile of 20,000 IRBMs is indeed frightening—when you know that we haven't yet started production on the *Thor* or the *Jupiter*.

Speaking of our own IRBMs, it is interesting to note that while the powerplant for the *Jupiter* has been referred to as a 150,000 pound thrust engine, the Russian IRBM, in spite of the fact that its range is said to be 1,800 miles, uses a 250,000 pound first-stage rocket and a 77,000 pound second-stage unit. This leads us to believe Russian hardware is bulkier and heavier with more dead-weight, and, designwise, we therefore are ahead of them. Our missiles might be more compact, and if you will, more "streamlined"—nevertheless, such comparisons do not serve much purpose. What counts is the fact the Russians are on a par with us, and capable of employing long-range missiles today.

We often ask oursleves how the Russians possibly could have obtained the know-how and skills that are required to build up the missile and rocket potency which they now possess. Certainly, these results do not stem from German or other foreign aid, although such assistance might have been helpful in the early years. It seems, however, that Senator Symington has a good point when he stresses that the Reds are capable of gaining rapidly in the technological race between our two countries, because their war industry doesn't suffer from the bureaucracies that are so unavoidable in a democracy. Another point: the communists know only too well how dangerously they are surrounded by our "threatening, imperialist" bases, and the answer—in the communist mind—might be a great amount of launching sites and an equally vast amount of missiles.

Finally, let us mention that it took quite a bit of doing to get this issue out. And we are grateful to all our editors, correspondents and contributors and to our special sources overseas. This issue, with some 40 pages of editorial material on Russian missiles, rockets and astronautics, is the result of compiling and sorting and checking hundreds of reports, articles and books. Particularly, we wish to emphasize the tables on Russian missiles on pages 36 and 37—to the best of our knowledge, this tabulated presentation is the first ever attempted in this country. These tables, mapping the Red missile arsenal, give a good picture of the trends behind the Soviet's missile goal. Indeed, we hope we shall never experience the activation of this arsenal.

ABMA Has First Birthday Party

Huntsville, Ala.—The Army Ballistic Missile Agency observed its first anniversary on Feb. 1st with a celebration as close to an "open house" as that closed post will permit.

Several hundred civic leaders of Huntsville and the surrounding areas were special guests and were escorted on a limited tour of the facility, shown recently completed movies that are being used for recruiting purposes and were treated to a brief demonstration of a missile being fired from a test stand.

In its first year, the ABMA has expanded from a handful of military and civilian employes to an organization of some 4,300 persons and, judging from stepped-up employment in recent weeks, may well double its personnel during the coming year.

The dollar value of the physical facilities has jumped by some $10 million from $46 million a year ago.

Nearly $26 million in construction is under way at present, and an additional $20 million is being planned.

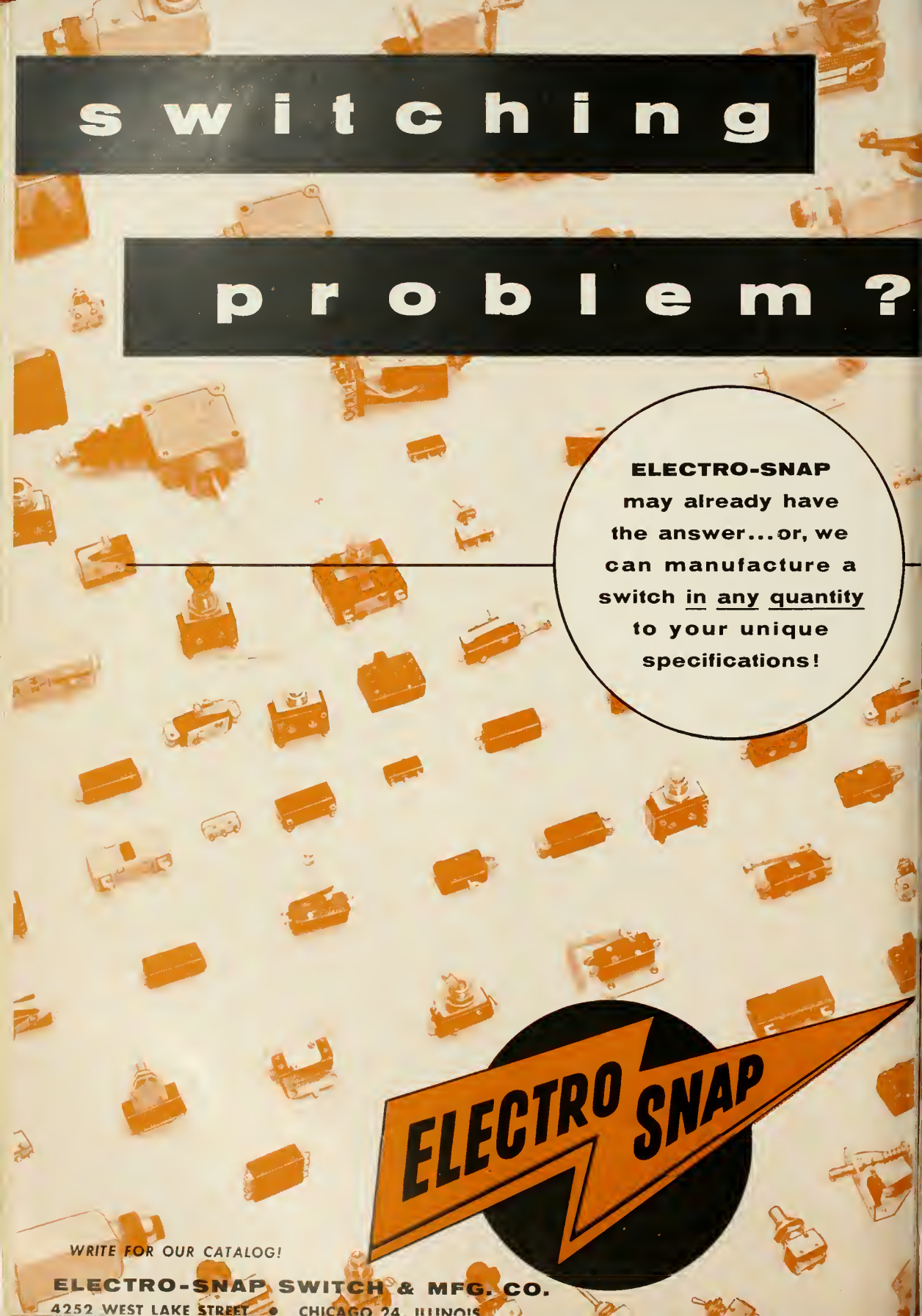
The Army's first *Redstone* missile battalion, the 217th Field Artillery, has been formed and is now being trained at ABMA.

NATO Delegations Visit at Redstone

Huntsville, Ala.—Six officials representing the Federal Republic of Germany (West Germany) received an orientation course in missile and rocket development and use at Redstone Arsenal and Army Ballistic Missile Agency recently.

The German delegation included four retired military officers: Lieut. Gen. Wolfgang Vorwald and Cols. Joachim Luetzow, Maximilian Bohland and Kurt Braennig; and Dr. Walter Hofmeir and Mr. Otto Baier. Their visit was under auspices of the U.S. Departments of State and Defense.

The concern of the NATO defense forces with missiles and rockets has been mounting steadily, observers note, since the announcement in 1954 that the jet fighter-bombers supplied to them under the Mutual Defense Assistance Program were capable of using missiles and rockets with nuclear warheads, and the subsequent stationing abroad of U.S. Army and Air Force units equipped to fire such weapons. The first school for NATO forces dealing in atomic weapons is said to have been held at Oberammergau in the Bavarian Alps some time ago.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VOL. 2 NO. 2
FEBRUARY, 1957

missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

m/r exclusive:

Russia's Guided Missile Program

By the editors of m/r

THE SOVIET UNION'S arsenal is today bristling with missiles and many of them are in just as an advanced stage of development as their U.S. counterparts. In all phases of missile activity the Russians are making tremendous headway and at the present time have a formidable array of guided weapons in operational status. Of particular significance is the crash program on ICBMs. Present indications are that an ICBM will be available for operational use within two to three years. This is the 5,000 mile range T-3.

While Russia's ICBM is being rushed through the development stage, test firings of an IRBM are in full swing. Several test firings of the T-2, a two stage IRBM with a range of 1,800 miles, take place each week. In operational status is the T-1, an MRBM with a range of 400 miles.

There is a developmental connection between the T-1, the T-2 and the T-3. The T-1 is actually an improved German V-2 (the Russians built about 1,000 V-2s to acquire production know how and for training, and aerodynamic and upper atmosphere research). The T-1 had a powerplant with improved performance, thanks to the use of hotter-burning kerosene in place of alcohol, increasing the chamber pressure, and some weight shaving. The result was that the thrust went up to 77,000 lbs. and the range to 400 miles.

The next stage in Russia's ballistic missile program was to take over the drawing board A4/A9 project and to develop an engine with a thrust of some 254,000 lbs. for a two-stage IRBM, the T-2. From the T-2 came the T-3 ICBM which is being given top priority by the Russians.

Because of the Soviet Unon's insistance that the IRBM and ICBM programs be rushed through, the status of the winged A4 (T-4) is not known. Also unclear is the position of the T-4A, a development of the Saenger antipodal glide bomber.

In the low-range ballistic missile category, the T-7A is still one of the main weapons of the Red Army. This is a solid propellant rocket with nuclear capabilities for tactical use. The T-7A may in fact be approaching obsolescense since versions of it have been made available to the Polish and East German armies for some long time.

In the field of anti-aircraft missiles the Russians are in good shape. Long aware of the threat implied by the existence of large USAF B-29 and B-36 bomber forces, they placed into operation several years ago the M-1 AA missile (Table 2). A higher performance missile in this category is the T-7 which was designed to defend Russian targets against attack from B-47 and B-52 bombers. The T-7 has been in operation for some time and U.S. authorities have confirmed AA missile sites around most large centers. Furthermore, a well-developed radar tracking and warning network stretches all along the Soviet perimeter, from Eastern Europe along the Siberian coasts to the Pacific Ocean.

For low altitude targets the Russians use the T-8 barrage flak rocket system. Two other flak rockets are the T-6 and the GVAI. Both of these probably use double-base solid propellants.

Vast Naval Missile Arsenal

The Soviet Navy is well supplied with missiles. The growing Russian submarine fleet (about 100 under construction and 400-800 in operation) could isolate Europe and allow most of the U.S. and Canada to be hit with existing ballistic rockets. In addition vigorous development of cruise weapons has taken place (Table 3). Another Naval weapon under construction in the Soviet Union is the *Comet* underwater-launched ballistic missile (Table 4) which is likely to have a range of 500-700 miles.

The Soviet Navy is being equipped now with missile ships as well as fast and modern destroyers. Several anti-aircraft missile ships have been sighted in the Baltic and the Pacific together with short and medium range missile-armed attack ships. Naval intelligence now admits that the Soviet fleet is second only to the U.S. in numbers and is growing fast. Russian shipyards are so tied up with naval construction, that all merchant vessels are being built in foreign countries.

In the air-to-air missile field, the standard item is the 3.2-in. rocket which like the U.S. 2.75-in. folding fin aircraft rocket (*Mighty Mouse*) is patented after the German WWII R4M. The M-100 guided aircraft rocket has been radically streamlined and cut in weight. It appears that the new M-100A is about 6-10 feet long with a maximum diameter of 8-10 inches. Equipped with four swept wings aft, the unit is small enough (100-200 lbs.) so that several can be carried by a jet interceptor in addition to a compliment of 3.2-in. aircraft rockets. It is no secret that the USAF is worried enough about these Russian aircraft rockets to give top priority to the development of bomber defense missile systems.

It is not believed that the Russians are relying on manned rocket aircraft to any large extent for the defense of key targets. It is known however, that a VTOL rocket interceptor, the I-2 has been developed. Paper specifications for this aircraft called for an endurance of 7-10 minutes and top

speed well over Mach 1. Armaments specified were 37-mm cannon or 3.2-inch aircraft rockets. The I-2 is a distant relative of Germany's Messerschmitt 163 rocket plane. Impressed with the high performance of the rocket-powered interceptor the Russians tried rocket power to boost the standard power plant of the Yak-21 and the LA-17. This lead in time to the I-1 research rocket aircraft from which the I-2 seems to be a derivative

No Doubt About ICBM

Without stating their sources, several American leaders have revealed details of Russian missiles from time to time. Senator Stuart Symington, on July 21, 1954, told of the Russian attempt to build an intercontinental ballistic missile with a hydrogen warhead of 4,000 to 5,000 mile range. And on May 18, 1955, Rep. Overton Brooks, member of the House Armed Services Committee said "dozens of points in Europe and Asia . . . in a pattern allowing an arc of fire to cover, for instance, the Baltic Sea, are being built for guided missile launching sites."

Senator Symington said: "I don't believe the Soviets are ahead of us in ballistic missiles. I state that they *are* ahead of us in ballistic missiles."

It seems the Russians are at least on a par with us in ICBM rocket engine development. As a matter of fact, it sometimes looks as if the Russians tend to overpower their missiles. Their IRBM, for instance, is powered by a 250,000 pound first-stage rocket plus a 77,000 pound thrust second unit.

On the other hand, their ballistic missiles might lack the accuracy that we claim for our guided weapons; many experts that we have talked with lately are inclined to think the Russians are somewhat behind in guidance and control. Then, again, US engineers who have attended international electronics conferences and seen Russian electronics gear, praise the communists for their advanced all-quality equipment.

Since the Russians took over Germany's Peenemünde with all its gear and hardware, they could resume production of a fabulous weapons system; submersible ballistic missile launchers. With her 600 submarines and this new concept in IRBM warfare Russia has a striking power that will be difficult to match.

Dr. Walter R. Dornberger, former Peenemünde Commandant, brought this concept to the attention of Defense Department officials several years ago, reporting that submersible missile launching platforms to be towed by submarines had been developed by the Germans at Peenemünde. Despite the fact technical reports on these developments were brought to this country a long time ago, no United States project of similar character is known to have been attempted.

The Russians, in fact, are capable of towing huge ballistic rockets 50 feet high in submersible containers to areas hundreds of miles off our coasts. The containers are about 115 feet long with a volume of 14,000 cubic feet. From different locations their missiles could be launched simultaneously against targets on the mainlands. With a range of 1,500 miles—or less—the Red missiles literally could be used against any significant target on the American continent.

Furthermore, this potentiality exists today; the Russians do not necessarily have to wait for completion of their ICBMs to obtain the equivalent firepower. Dr. Dornberger has said he believes the Russians "emphasis on underwater vessels indicates a plan to use submarines offensively, in American waters, quite possibly as tow vessels for missile launchers."

Three slightly different missile-launchers were built by the Germans, and they were all taken over by the Russians, who have had 12 years to complete this weapons system—which, incidently, was almost perfected by the Peenemünde engineers at the end of the war. The launchers, now believed to be mass-produced by the Russians, were first suggested in early 1944 by Dr. Dickmann of the famous Vulkan Werft (Vulcan Works) in Stettin.

Developed in the greatest of se-

Comparison of some typical USSR and USA ballistic missiles

crecy under the code names *Project Swim Vest* and *Project Test Stand 12*. Peenemünde's top scientists, led by Dr. Wernher von Braun, were working on the missile launchers.

Designed for V-2 missiles, the submersible launching platforms were fitted with a control station, tanks for liquid oxygen and alcohol, water ballast tanks and a gyro system to counteract yaw and roll under towing as well as when the launcher was in upright position for firing the missile from its inside. The net weight of the launcher was 70 tons; the missile, its propellants and accessories represented 35 tons. Ballast amounted to 300 tons.

Three launching containers could be towed in submersed position by one submarine at 15 mph. One launcher could be towed at 20 mph. The range was limited only by the fuel supply of the submarine. With specially designed vacuum-insulated tanks the loss of liquid oxygen during transportation was kept as low as 1%.

A series of problems and difficulties were experienced by the Peenemünde engineers during the first tests. In particular, the greatest problem was to keep the launcher stable under transport as well as under firing of the missile. Large rudders activated by the gyro-servo system were used to obtain stability during horizontal operations. Certain hazards were connected with the excessive amount of hot steam that was formed during firing.

The rocket exhaust escaped through funnels, but the terrific heat from the gases caused the water in some of the ballast tanks to boil, forming steam which had to be vented to the asmosphere. Vent systems propellant fumes also were incorporated to minimize the explosion hazards.

It took the Germans—on a wartime crash program basis—only two years to develop the missile launchers, and it seems obvious that the Russians, who took over the equipment, have been able to solve whatever problems the Germans did not have time to solve.

Design criteria for the submarine launchers include an intricate pumping system for the water ballast, as well as a complex electrical system for operation of instrumentation, gyros, pumps,

USA
Redstone
300-500 mi

USSR
T-2 (M-103)
1,500 mi plus

USA
Jupiter?
1,650 mi plus

USA
Titan?
5,000 mi

USSR
T-3 (M-104)
5,000 mi

Model	Mission	Type	Length (ft)	Diameter, Max (ft)	Thrust (lb)	Range (mi)	Status	Notes
T-1 (M-101)	SS	MRBM	50	5.5	77,000	400	P;O	Single-stage, improved A4 (V-2) Lox-kerosene motor Impulse: 4.6 million lb sec
T-2 (M-103)	SS	IRBM	100-125	15	Stage 1: 254,000 Stage 2: 77,000	1,800	P;Q	Two-stage, improved A-4-A9 Stage 2 is T-1 Impulse: 20.4 million lb sec Wt.: 75-85 tons
T-3 (M-104)	SS	ICBM	100-160			5,000	D;T	Two or three stages May use T-1 or T-2 components Wt.: 100-150 tons
T-4 (M-102)	SS	IRGBM	50	5.5	77,000	500-1,000	P	Winged T-1
T-4A		RB				4,000-10,000	D	Two-stage, improved Saenger antipodal bomber Track launched by rocket sled Bomber wt.: 100 tons Impulse: 60.74 million lb sec
T-7A	SS	SRBM	25	2.5	17,600 for 30-60 sec	30-60	P;O	Total launch wt.: about 8,800 lb Truck launched (vertical) HE or nuclear warhead Solid composite propellant

SS: Surface-to-surface
MRBM: Medium-range ballistic missile
IRBM: Intermediate-range ballistic missile
IRGBM: Intermediate-range glide-ballistic missile
ICBM: Intercontinental ballistic missile
RB: Rocket bomber
SRBM: Short-range ballistic missile
P: In production
O: Operational
Q: In qualification tests
T: Test
D: Development

Table I. Russia's ballistic and long-range aerodynamic missiles and rocket weapons, with comments.

lighting inside the launcher and for testing prior to firing. Three technicians can handle the launching of a liquid-propellant ballistic missile.

A conservative estimate indicates it will take less than half an hour to launch a missile after the tow submarine has reached its destination. By remote control from the sub some of the water in the upper ballast tanks will be pumped out, the launcher slowly tilts into vertical position, and only the nose is above the surface.

The technicians, entering from a rubber boat, will open the clam-shaped doors and plug in the electrical connection. A ladder leads down to working platforms and the control room. Gas fumes will be vented to the atmosphere, electrical motors started, and the missile activated and pressurized for fueling and launching.

The technicians will leave the launcher after proper testing of instrumentation and setting of the warhead fuse and guidance. The fire control is handled from inside the submarine. The launcher may be abandoned, or, if circumstances permit, it may be towed back to base or a mother ship and be made ready for use again.

The range of a V-2 missile, when launched from a submersible launcher, was considerably reduced because of the back pressure caused by reversing the rocket exhaust 180° through funnels.

However, with improved rocket engines and lighter components, it is permissible to assume that Russia's T-1 or the *Comet* will be capable of covering hundreds of miles, when fired from a submarine launcher. Significance of this launching method is that the missile may be transported undetected.

Table II. Basic data on Russian research missiles and flight test vehicles.

Model	M-1	T-7	T-8
Length (ft)	14.7	20-25	6-8
Diameter (In)	22	25	4-5
Thrust (lb)	—	17,600	1,000-2,000
Max. Alt. (ft)	50,000	50,000-70,000	25,000
Status	Ob; O	P; O	D; T
Notes	Solid booster Peroxide sustainer Guided Speed: over Mach 1	Solid or liquid booster Acid-amine Sustainer Modified *"Wasserfall"* Wt.: 3-4 tons Guided	Solid propellant Barrage flak

Ob: Obsolete
O: Operational
D: Development
T: Test
P: Production

this launching method is that the missile may be transported undetected.

Inter-service Rivalry?

It appears Chief Marshal of Aviation, N. F. Zhigarev, is Russia's missile czar. Furthermore, it seems obvious the communists have decided to give the Red Air Force the responsibility for all ICBM development. Strangely enough, however, long-range missile launching sites are manned by personnel from both the Army and the Air Force. As a matter of fact, there is more Army personnel involved than Air Force people. One of the reasons behind this concept stems from the fact the Red Army is still "more important" to Russian defense than the Air Force or the Navy. And there could possibly be a question of whether the Air Force —which normally requires skillful personnel—has enough trained field operators for the launching sites. In other words, this situation might change.

While there's no doubt inter-service rivalry is dominant in Russia—as it was in Germany, and as it is this country—all three services have been included IRBMs in their arsenals. The bombardment threat Bulganin referred to last fall—when he stressed that Russia had missiles that could bomb England from East Europe installations—is understood to have been based on Red Army missiles, rather than Navy or Air Force weapons. However, this should not be construed to mean that the Red Air Force and Navy are not capable of attacking Great Britain from far-away launching sites.

All production of missiles in Russia, of course, is under direct Government supervision and sponsorship. There is no private enterprise involved whatever, and even the design competitions among universities and scientific institutions are 'all-government' handled. Yet, there is keen competition between factories and between design outfits. High awards are offered for efficiency, high-production schedules and for all-quality end results. The individual "hero awards" that we hear of so often apply to the missile business as well. Numerous "scientific workers"—which is the Red term for scientists—have struck it rich. Thousands of rubles have been given away each year to individuals working in basic sciences—in particular in the fields of mathematics, physics and chemistry.

The Russians put an enormous emphasis on chemistry, partly because the country has been way behind the rest of the civilized world in this field until recently. Very few synthetic materials had been employed in Russia previously, but thanks to a modern chemical industry, and an advanced one, the communists now are begin-

Model	J-1	J-2	J-3
Powerplant	Pulsejet	Turbojet	Turbojet or Ramjet
Speed	Subsonic	Sonic	Supersonic
Range (Mi)	300	700	1,500-1,800
Status	P;Ob	P;O	P;Q
Notes	Modified V-1 Sub or Ramp Launch Target Use	Ground or Sub Launch	Ground or Sub Launch

P: Production **O:** Operational
Ob: Obsolete **Q:** Qualification testing

Table III. Russian research and flight test vehicles.

Table IV. Russian intermediate-range missiles and upper-air vehicles.

	Model	Type	Length (ft)	Dia. (in)	Range (Mi)	Status	Notes
	T-5	BR				P;O	Artillery & anti-tank. Composite solid propellant rocket.
	ME	G	1.5-2	3.35	1-2	P;O	Recoilless, gun-launched rocket for anti-tank use. May be obsolete: large numbers in satellite nations & middle east.
	T-6	BR		5.2	3-5	P;O	Artillery barrage rocket; projector launched.
Missiles	Comet-1	SS			90-100	P;Q	Sub-launched (undersea) solid propellant rocket.
	Comet-2	SS			500-700	P;D	Sub-launched (undersea) solid propellant rocket.
	M-100A	GAR	6-8	6-10	5	P;Q	Guided air-to-air missile; solid propellant rocket.
	T-3A	Satellite				P;D	3-4 stages. 1 ton payload. Pole-to-pole orbit, 125-1,000 mile. May use T-2 or T-3 hardware.
Research	POL-1		10-15	10		T	Mach 4 test vehicle, two-stages. Stage 1: cluster of 4 solid propellant rockets; stage 2:M-100A type.
	POL-2		20-25	25		T	Single stage rocket similar to T-7A. Geophysical studies from 50-100 miles. Four triangular aft fins, short nose cone; payload 50-100 lb.

BR: Ballistic Rocket **GAR:** Guided aircraft rocket **Q:** Qualification testing
G: Gun **P:** Production **D:** Development
SS: Surface-to-surface **O:** Operational **T:** Testing

ning to benefit from and apply more and more plastics and resin materials. In turn, the growing chemical industries are yielding more and more to the armed services in terms of useful by-products and know-how for the rocket propulsion industries.

Atomic rockets also are being worked on in the Soviet. There is no report however, on whether they have as yet attempted to construct any nuclear rocket hardware. But since the Russians know we are doing so, one can rest assured that it won't take them long to follow in our footsteps. A report on Red nuclear rocket trends was given in m/r October 1956, and a further analysis will be given in a special issue this spring. Reports on Russian "scientific workers" and Red capabilities in the basic sciences appear in m/r's *special report* appearing on page 61 of this issue.

Dr. Sedov has confirmed that Russian atomic rocket research is progressing at various nuclear research centers throughout the Soviet Union.

A short time ago Russian research engineer G. Nesterenko said that "engines performing on nuclear fuel are of great importance in our contemporary aviation and rocket engineering. Powerful and highly efficient atomic engines will enable us to build rockets that will overcome the gravitational pull of the earth."

Rocket engines with atomic reactors mounted directly in the combustion chambers have been discussed openly in Russia. Active U235 and U238 reactor mass and a graphite neutron inhibitor have been suggested.

This early Russian missile was powered by a liquid rocket engine. Its launching weight was 3,300 lbs. and its top speed was Mach 1.3. It was 15 ft. long and 24 in. in diameter.

Liquid hydrogen will flow through the porous mass, cool the reactor and at the same time acquire tremendous energy. Nesterenko has calculated the exhaust velocity to be in the neighborhood of 22,000 feet per second.

Extensive Research

In the research field the Russians have done considerable work. Animals have been fired to altitudes of 250 miles. A large amount of supersonic and hypersonic aerodynamic and other research work is being carried on both within the Soviet Union and in Russian satellite countries. Poland recently displayed several and multiple stage rockets with Mach 4 capabilities at its Technical Museum. However, the pride and joy of rocket research is the Red satellite effort (See "Soviet Astronautics" in this issue). Even before the Russians announced their satellite intentions, the U.S. was concerned about the implications of the satellite detection centers established in the Soviet Union. Latest word is that the Soviet Union desires to establish a satellite of about one ton in weight.

The whole Russian missile and satellite program is being conducted with the full support of Red Air Force Chief Marshal Zhigarev who believes implicitly in the value of the ICBM. Special Weapons Chief, General A. S. Yakolov is believed to be the missile hardware man in the Soviet Union. Russian rocket efforts appear to be centered in the ZIAM's institute in Moscow. Another important missile development center, particularly for ballistic weapons, is at Khimki near Moscow. Under recent dispersal programs subsidiary development centers have been set up in various points throughout the Soviet Union including some in the Ural Mountain area. Kuibyshev is probably the main center for missile powerplants. Colonel Andrei Kostikov, well known inventor of the Katyusha Salvo guns, has his headquarters in Kuibyshev. The Frunze engine plant in Kuibyshev is producing rocket motors in quantity.

Production of ballistic missiles is scattered over the entire Soviet Union. It is estimated that Russia has the capacity to build some 2,000 monthly. One of the original ballistic missile plants was factory no. 456 in Moscow. Another important ballistic missile plant is in Tomsk. A subsidiary plant of the ZIS automobile concern also is

Chief Marshal of Aviation N. F. Zhigarev, head of the Red Air Force, is an implicit believer in the missile and was largely responsible for convincing the Soviet government of the need to put the ICBM on a "Crash" basis. He is also reported to be encouraging top priority development of space weapons. These top Soviet missile planners were grouped together during the aviation day show at Moscow's Tushino airfield last June. Marshal Zhigarev, Red Air Force chief is speaking. At the left is Marshal Zhukov, Soviet defense minister while Marshal Sokolovski is at the right.

working in the ballistic missile field. One of the more recent developments in the Russian missile production program has been the establishment of plants in the Far East of the country. There was virtually no missile activity east of Lake Baikal until the beginning of this decade. Now, however, there are modern plants at various points in eastern Russia including a big assembly plant at Komsomolsk on the Amur River. The map that accompanies this article indicates the extent of Soviet missile plants and development centers. This map also shows the location of the principle Russian missile bases. The existence of most of the launching bases shown on the map has been confirmed. It also is thought anti-aircraft missile batteries ring all of the most important Russian centers. The ballistic weapon launching bases are located on the Russian perimeter including many points in the far north.

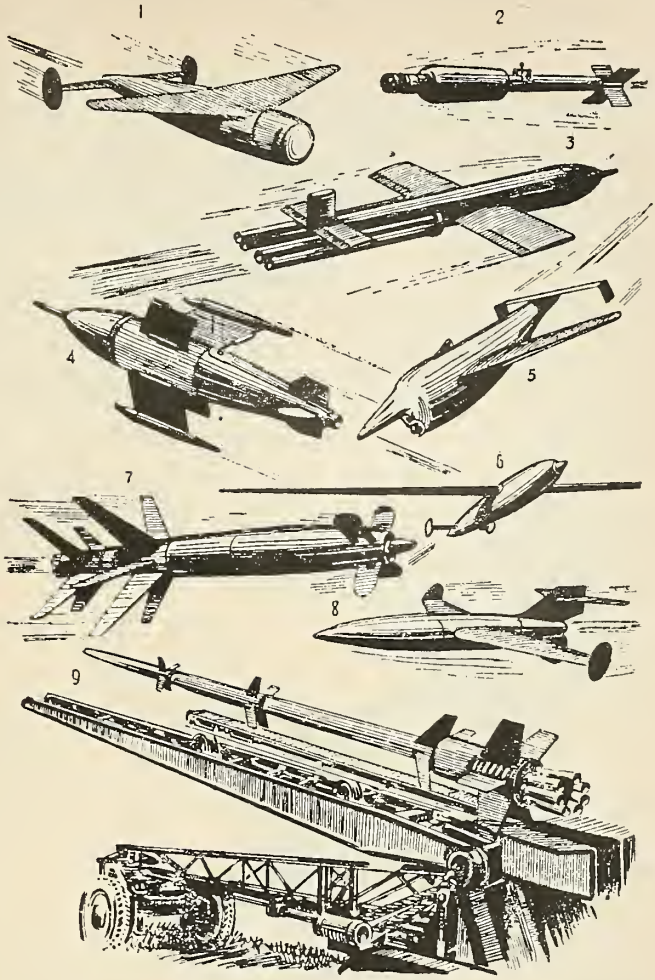
There are also strong indications that Russian missiles have been supplied to the satellite nations. None of these nations have any missile programs of their own although several of them are known to be large scale contractors to the Russian missile industry. East Germany for example, is still an important source of material for missile guide systems although the Russians are rapidly becoming independent in the electronics field.

The Russian dependence on Germany for missile design is long past history. From 1945 to 1950 the Russian effort was almost 100% based on the wartime work in Germany and was carried on by German engineers who were enlisted for duty in missile development in the Soviet Union. From 1950 to 1955 there was a transition with most of the Germans going back to their home land and independent Russian designs taking the place of the German missiles, powerplants and guidance systems. Since 1955 the Russians have been completely independent of German brain power, although most of the current missiles reflect the German thinking that conceived them in their early stages of development. There is some evidence that the Russians are still using Peenemünde missile base in East Germany for certain research projects.

Nonetheless, all evidence indicates that Russia is now on its own in the missile field and is doing well. Missiles enthusiasm abounds among the entire Russian executive class. The apparent attitude of Russia's leaders is to have large quantities of reliable missiles available as quickly as possible. As is the case with most Soviet weapons, the emphasis is on simplicity and reliability.

Although there has been much talk of automation in the Soviet Union —Russia has its own Ministry of Automation in industry—little is known of the current status of many projects. However, it has been reported that some 200 automatic production lines are to be introduced in the course of the current 5 year plan and undoubtedly many of these will be applied to aircraft and missile plants.

Although production methods and techniques are very old fashioned by western standards there is no doubt that the Russians are turning out missiles in quantity. The stock pile of anti-aircraft missiles and IRBMs should certainly be regarded with respect while the imminence of the Russian ICBM is a threat of the first magnitude. The ability of the U.S. to surpass the Russian effort is a key factor in determining the future cost of mankind. ★



Ракетные управляемые снаряды и ракеты на твердом топливе.

1 — управляемый снаряд для поражения наземных целей, запускаемый с самолета; *2* — зенитный ракетный снаряд с радиолокационным взрывателем; *3* — зенитный снаряд, управляемый по радио; *4* и *5* — управляемые снаряды для поражения воздушных целей, запускаемые с самолетов; *6* — управляемый снаряд для действий с самолетов по морским целям; *7* — управляемый зенитный снаряд (с ускорителем); *8* — управляемый снаряд для аэродинамических исследований; *9* — многоступенчатая дальнобойная ракета, установленная на пусковом станке.

Familiar missiles (mostly German) that made up early USSR arsenal. Translation of Russian caption: "Guided rocket missiles and solid-fuel rockets. 1. A guided missile to strike at ground targets, launched from a plane. 2. An anti-aircraft rocket missile with a radiolocating exploder. 3. An anti-aircraft missile guided by radio. 4 and 5. Guided missiles to strike at targets in the air, launched from airplanes. 6. A guided missile launched from airplanes to strike at targets on the sea. 7. A guided anti-aircraft missile (with an accelerator). 8. A guided missile for aerodynamic researches. 9. A many-phased long-range-hitting rocket, set on a launcher."


PEENEMUENDE
RIGA
KOLSKI AREA
NAREV/BUG AREA
KRONSTADT
LENINGRAD
ILMEN AREA
MINSK
KOLGUEV
SMOLENSK
KALININ
KIEV
MOSCOW
RYBINSK
PODBERESYE/KIMRY AREA
KALUGA
KHIMKI
KHARKOV
RAMENSKOYE-ILINSKAYA
KAZAN
SARATOV
STALINGRAD-EAST
KUIBYSHEV
SVERDLOVSK
UFA
URALSKOYE
MAGNITOGORSK
TOMSK
OMSK
NOVOSIBIRSK
UST URT DESERT
KARA KUMY DESERT
TASHKENT


SEVERNAYA ZEMIYA
NEW SIBERIAN ISLANDS
ANADYR AREA
CAPE CHEIYUSKIN AREA
TAIMYR AREA
CAPE NORVIK
KHATANGA
MILKOVO
LEGEND
LAUNCHING BASES
MISSILE PLANTS
MISSILE SCHOOLS
MISSILE TEST CENTERS
ANTI-AIRCRAFT ROCKET PLANTS
MISSILE DEVELOPMENT CENTERS
MISSILE ENGINE DEVELOPMENT CENTERS
NORTH SAKHALIN AREA
NIKOLAEVSK
TOROKO
KOMSOMOLSK
OTOMARI
IRKUTSK

U.S. Military Leaders Warn of Red Danger

Reds Put Emphasis on Rocket Power, Long-Range Missiles, Subs

It was a coincidence that while the editors of m/r were winding up their research for this issue, three U.S. military leaders, Army Secretary Wilber M. Brucker, Assistant Secretary of the Navy for Air Garrison Norton, and Western Development Division Chief General Bernard A. Schriever presented significant speeches on the subject of the increasing danger of the Red war machine.

Not Just Plain Talk

Such speeches frequently have been given by military and political leaders in this country during the last few years. On rare occasions only have any such leaders stood up and told the American public what we have achieved in terms of actual hardware and in terms of the technical advancements that you can put your finger on. It was gratifying, therefore, to hear General Ben Schriever present his speech recently before the Institute of Aeronautical Sciences on guided missile research and development in the United States Air Force, for the WDD Chief plainly stated we now have a broad foundation for United States leadership in ballistic missiles. This is based on the fact, according to the General, that all major milestones for the *Thor*, *Atlas* and *Titan* development program have to date been passed on schedule.

One factor that has often been overlooked in the missle race was stated by General Schriever:

"There has been much speculation as to whether we or the Soviets will have bigger and better ballistic missiles. This is somewhat like weighing the chances of the participants in an automobile race solely on the basis of their cars instead of also considering the training and experience of the drivers, the reliability of their equipment, the support which they receive in the pits, and similar factors.

"A broad foundation has been created for U.S. leadership in ballistic missiles—a foundation which may also serve to assure U.S. leadership in future space technology.

The Ultimate Respect

"However, the data which would serve best to prove these points convincingly cannot be told for security reasons because those are the very data on which our leadership rests. Suffice it to say that the broad breath and great depth of the ballistic missile program assure ultimate achievement of our goal, without depending on one success or facing defeat on account of one failure.

"There is one final question—what will we have achieved when we reach our goal—when ICBM's and IRBM's have become reliable, operational weapon systems produced in quantity? Paradoxically, the best we can hope for is that we will never have to use these weapons; that our ballistic missile capability will be so highly respected by all potential aggressors as to indefinitely deter them from attacking us.

"This should not imply that the ICBM or IRBM are "ultimate weapons" as they are frequently called. Nor will the ballistic missile replace the manned intercontinental bomber. But it will undoubtedly become one of the most potent and convincing arms in our arsenal of strategic weapon systems."

Air Force WDD Chief
General Bernard Schriever

Army's Brucker: Soviet Leaders Fool Themselves

"America can hope to lead the world to a just and honorable peace only if we all remain staunchly true in every sphere of activity to the great moral concepts upon which this Nation was founded—the lofty ideals which have been the driving force behind its advancement through the years to a

Secretary of the Army,
The Honorable Wilber M. Brucker

position of preeminent power and prestige. Uncompromising Americanism is the only solid foundation upon which we can stand to do battle with the communist monster.

"We have had ample warning of of the danger we now face. For a short time not many months ago. numerous people throughout the world, including some in our own land,—imagined they saw reason to believe that the leaders of the communist conspiracy had experienced a change of heart—that they had abandoned armed aggression as a means to attain their ends, and honestly sought peaceful resolution of the world's differences. Dead Stalin was denounced by his confederates. Sweet words and disarming smiles briefly replaced his intransigent hostility to the Free World.

"How utterly this phantasy of Soviet 'reformation' has been shattered. The merciless butchery of liberty in Hungary, the open efforts of the Soviet Union to obtain a military foothold in the vital Middle East, which Russia has coveted for centuries, and the increasingly brazen attempts of the leaders of the Kremlin to stir up dissention wherever possible. and exploit unrest in order to extend their power have served notice on all free nations that freedom everywhere is in greater jeopardy today than it has been for many years.

"In addition to the testimony of evil deeds, we have Khrushchev's strident boast to the West: 'History is on our side. We will bury you!' Only a week ago,—in virtually reconsecrating Stalin as the patron saint of militant communist imperialism—Khrushchev reiterated his warning that the Soviet Union will contribute in every way it can to the death of the Free World. How could any threat be more plain?"

"Soviet leaders are fooling no one but themselves when they call upon history to justify their trust in the ultimate triumph of the ideologically bankrupt communist tyranny. If Khrushchev and his fellow conspirators read the record straight, they must realize that no despot can take comfort in history. The verdict of time has always vindicated the leaders who have served the cause of freedom and human justice—not the Caesars and Hitlers who have ridden the chariots of oppression over the broken bodies of millions."

(These are direct quotes from a speech given by the Honorable Wilber M. Brucker before the Sertoma Club of Washington January 25.)

Navy's Norton Stresses Red Sub Threat

Assistant Secretary Norton

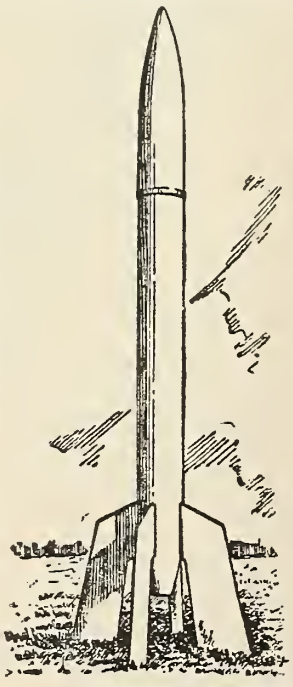
"As the opposing major powers round out their stockpiles of atomic weapons. I believe it has become increasingly clear to people throughout the world that all-out nuclear war is wholly irrational. We know there can be no winner of such a war. At the so-called Summit Conference the leaders of the Soviet Union gave evidence that they too had come to this conclusion. In so doing they must have discounted. or at least degraded, what hitherto has been considered to be a dangerous military advantage of totalitarian nations over free nations, namely the willingness to make a surprise nuclear attack.

"Now this is not to suggest that we should lower our guard against surprise attack. Well dispersed bomber and missile forces, both land and sea-launched, will continue to be the major deterrent against such attack. What I do suggest is that any Nation seeking to achieve its objectives by military action must develop and employ *alternatives* to all-out nuclear warfare. We know from painful experience that the Soviets have demonstrated great ingenuity and long-range purpose in doing just that, from the construction of by far the largest submarine fleet the world has ever known, to the development of new techniques for armed subversion and infiltration.

"Faced as we are with the Soviet strategy, there is no doubt whatever that we, the leading free nation, must speedily develop alternatives to the nuclear capability upon which we have concentrated so much of our manpower, time, and money. We must place some limitation on it to maintain a sound economy, and at the same time have enough in the budget to provide the flexible, versatile forces that can readily respond to the more likely types of limited aggression and hostilities. If we fail to do this, we shall immobilize ourselves in an era of renewed Soviet aggression.

"Indeed, we must develop alternatives on the political and economic, as well as on the military fronts. Immediately after World War II, I stepped from the Navy into the Department of State, and did a tour of duty as an Assistant Secretary of State. No one is more keenly aware than I, that these other two fronts share equal importance with the military, in the development of our foreign policy. I am not going to discuss political and economic alternatives today. But when it comes to military alternatives, I suggest that you keep your eyes on our new Navy."

(These are direct quotes from a speech given by the Honorable Garrison Norton, Assistant Secretary of the Navy for Air, at an Aviation Writers Association meeting in Washington January 25.)



Первая советская ракета с жидкостно-реактивным двигателем, сконструированная М. К. Тихонравовым.

This Russian rocket was tested in 1933, according to the Russian publication from which the drawing is taken. It was designed and built by engineer M. K. Tikhonravov. According to the Russians it "ascended to a great altitude, changed its direction and flew horizontally for some time before descending to earth." Liquid oxygen was used.

MISSILES & RUBLES

If the Red missile arsenal doesn't match that of the U.S., it's not because of a lack of rubles and what they represent. In terms of economic capacity, the Union of Soviet Socialist Republics has what it takes. The only real doubt is in the level of her applied technology.

Setting aside politics for a minute and a top talent as a global trouble-maker, after one of the most astounding economic growths in history, the U.S.S.R. stands second only to the U.S. in basic industrial capacity.

Add the dictatorship's known ability to concentrate effort where it does the most good, and Russia becomes an adversary of note.

And vital is the fact that Russia could not survive a long, old-fashioned World War II kind of scrap either politically or economically. Her people, like the Satellite populations, are restive. Economically, she can handle the current state of semi-war. But with virtually no consumer goods industry, she's got no give for expansion to all-out effort.

Short-War Concept

Not only does Russia have an interest in missiles as the lastest in weaponry, but the long-range nuclear ballistic missile is the weapon of the short war, or so it's said. And a short war is the only kind of war Russia could hope to win.

Last summer, for the first time in 17 years, the Central Statistical Administration of the Council of Ministers USSR—Red equivalent of the U.S. Census Bureau—published some hard figures on the Soviet economy. The *New York Times*' Dr. Harry Schwartz has compiled an analysis of these figures into a "Statistical Handbook of the USSR ($3, National Industrial Conference Board, 460 Park Ave., N. Y. 22, N.Y.). Careful checking indicates they are at least in the same ball park with reality. They form this basis for this m/r appraisal.

Prior to the 1913 revolution, Russia was a feudal power, with only 17.6% of the population being urban; 82.4%, rural. Today the break is 43.4% to 56.6% respectively. With this shift from the farms to the cities has come massive industrialization — industrialization with gays, true, but not where they hinder Red munitions output. As in the days of the Czars, the mass of the people still come last, the state first.

Since 1913, consumer goods output has gone up 1,000%. So, the average Russian is, in fact, a little better off. But the output of goods for production is up 5,200%.

Spurred on by World War II and open Cold War with the West, the greatest expansion of the Soviet economy has occurred since 1940. The population has risen only 5%, 191.7 million to 200.2 million as of April, 1956. But by 1955 basic industrial output had jumped in most cases over 200% in 15 years. The sixth and current five-year plan calls for 1960 totals to be 50%-to-150% up again. Table on this page gives some actual figures.

Notably, nothing on defense related industries, such as non-ferrous metals, aircraft, electronics, etc., has been released. However, it's known that munitions come only after basic industry in the concentration of Red effort.

With basic production now in hand, Russia is turning her attention to standards of technological research and development. In the missile business, this is significant. For the pounds of actual hardware in a missile are few. It's how they're arranged that counts.

In this connection, the number of "specialists with higher education" has jumped from 908,000 in 1941 to 2,340,000 in 1956. Of these, engineers are up from 290,000 to 586,000.

While shortcomings of Red technology are still apparent in many fields, they are least obvious in heavy industry and munitions. The heaviest presses and largest milling machines are still claimed by Russia. And while her claim to operational IRBM's has yet to be proved, her abilities in the demanding arts of jet aircraft and atomic power are evident.

Additional figures quoted support this appraisal. For example, industrial production workers have increased from 8-million in 1932 to 17.4 mililon in 1955. The availability (not output) of metal-cutting machine tools has increased from 710,000 at the end of 1940 to 1,760,000 a year ago; press and forging equipment, from 119,000 to 365,000. And while are not truly quantitative, since they don't say what kinds of tools, U.S. technicians who have seen Soviet equipment respect it.

And in the strange ways of the Communist statistician, this for what it's worth: In 1950, 555,000 people offered 1,241,000 of which 655,000 were adopted in production. In 1955 the figures were 1,138,000, 2,080,000 and 1,160,000 respectively.

Reds Have Capability

Though none of this adds up specifically to "missiles in production," even in exaggeration the figures leave no doubts as to Russia's basic economic capacity to make missiles. Aided by a lot of stealing, borrowing and extrapolating from the West, plus a growing volume of new development on their own, Red technical ability is moving up on the West in more and more fields. In a few words, if the Soviet theoretician knows how to make an ICBM, Soviet industry can carry his paperwork to the operational stage. There are persistant reports that this is being done.

Soviet Basic Industrial Production
(in units unless otherwise stated)

	1913	1940	1955	1960
Pig Iron (1000 tons)	4,200	14,900	33,300	53,000
Steel (1000 tons)	4,200	18,300	45,300	68,300
Rolled Metal (1000 tons) ..	3,500	13,100	35,300	52,700
Coal (1000 tons)	29,100	165,900	391,000	593,000
Petroleum (1000 tons)	9,200	31,100	70,800	135,000
Elec. Power (million kwh) .	1,900	48,300	170,100	320,000
Metal-cutting				
Machine Tolls	1,500	58,400	117,800	200,000
Large, heavy & unique ...	....	212	3,541	not said
Press & Forging Machines ..	....	4,700	15,900	25,800
Motor vehicles*	....	145,400	445,300	650,000

* This includes both trucks and passenger cars and was included as typical of the low proportion of effort going into consumer durables.

Soviet Astronautics

Red IGY Satellite to be Launched by Help of ICBM Hardware

By Alfred J. Zaehringer

Though the Russians admit they are still far from launching a manned space vehicle, they will almost certainly launch an artificial satellite durin the International Geophysical Year. The best conclusion that can be reached on the basis of the sparse amount of information available to the West is that they are not bluffing. Though it may not get "up there" as soon as the *Vanguard,* when the Red Satellite does settle into its orbit, it may well be heavier—and more exclusive.

The satellite the Russians talk about will probably have recording and fast play-back equipment (see m/r's personal report, this issue) and may thus transmit its measurement only while passing over the Soviet receiving station.

In more detail, this much seems apparent:

——the Russian satellite will be quite similar to Dr. S. Fred Singer's *Mouse* vehicle, making magnetic as well as more conventional measurements.

——It will have a polar orbit, thus enabling it to cover all latitudes and longitudes "while the earth rotates beneath it."

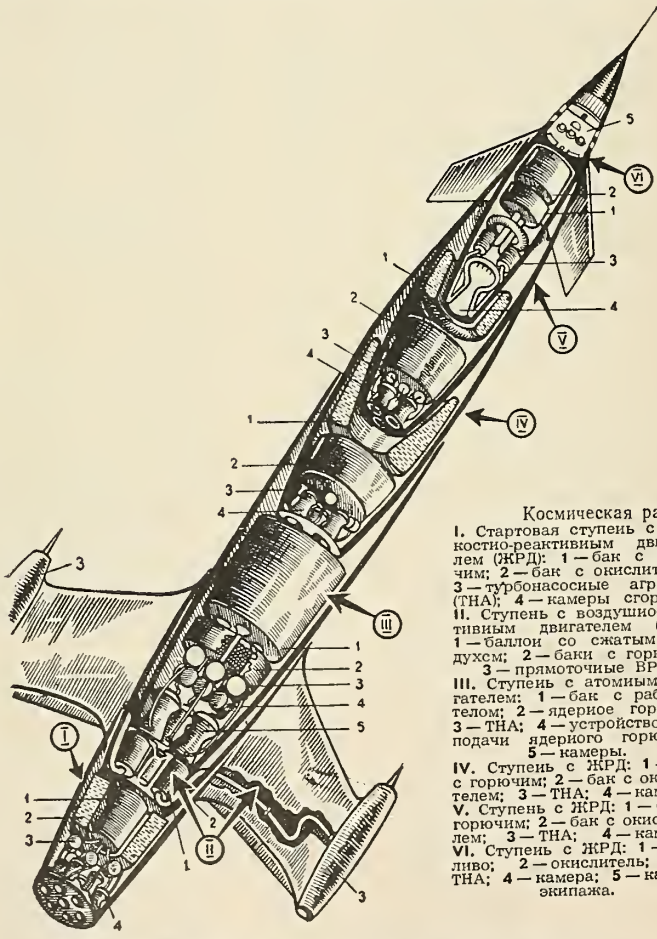
——It will weigh a minimum of 50 pounds, perhaps as much as 100.

——It will be placed in its orbit by a rocket system that is basically the Soviet Intercontinental Ballistic Missile.

Professor K. Stanyukovich, Doctor of Technical Sciences, in Krasnaya Zvezda, August 7, 1955 (as translated by the Rand Corp. for the USAF) wrote as follows:

"The satellite can attain the necessary velocity with the aid of a two-stage rocket . . . if launched at an angle of 45°. When the rocket attains an altitude of 300-to-500 kilometers . . . at the highest point of the trajectory, there must be an explosion which will cast off the sphere to the side of the circumference of the earth with a velocity of eight kilometers per second and thereby convert it into a satellite. Calculations of Soviet scientists, and in particular of Professor G. I. Pokrovski, show that in order to impart the necessary velocity to the sphere, the weight of the explosive charge must be ten times as great as the weight of the satellite itself. Between the satellite and the explosive there must be some inert mass which protects the satellite from the action of the explosion. This mass can be a compressed gas. Undoubtedly, there also can be another, better version of launching the satellite."

That was in 1955. Since then "better versions of launching the satellite" apparently have been developed. This earlier concept estimated that the satellite would revolve around the earth for "several days" before being "retarded



Космическая ракета.
I. Стартовая ступень с жидкостно-реактивным двигателем (ЖРД): 1 — бак с горючим; 2 — бак с окислителем; 3 — турбонасосные агрегаты (ТНА); 4 — камеры сгорания.
II. Ступень с воздушно-реактивным двигателем (ВРД): 1 — баллон со сжатым воздухом; 2 — баки с горючим; 3 — прямоточные ВРД.
III. Ступень с атомным двигателем: 1 — бак с рабочим телом; 2 — ядерное горючее; 3 — ТНА; 4 — устройство для подачи ядерного горючего; 5 — камеры.
IV. Ступень с ЖРД: 1 — бак с горючим; 2 — бак с окислителем; 3 — ТНА; 4 — камеры.
V. Ступень с ЖРД: 1 — бак с горючим; 2 — бак с окислителем; 3 — ТНА; 4 — камеры.
VI. Ступень с ЖРД: 1 — топливо; 2 — окислитель; 3 — ТНА; 4 — камера; 5 — кабина экипажа.

Russian sketch of six-stage atomic cosmic rocket showing:
I. Starting stage with liquid jet engine: 1) fuel tank; 2) oxidizer tank; 3) turbine pump unit; 4) combustion chamber. II. Stage with air-jet engine: 1) compressed air cylinder; 2) fuel tank; 3) direct-flow air-jet engine. III. Stage with atomic engine: 1) tank with working substance; 2) nuclear fuel; 3) turbine pump unit; 4) device for feeding nuclear fuel; 5) chamber. IV. Stage with liquid rocket engine: 1) fuel tank; 2) oxidizer tank; 3) turbine pump unit; 4) chamber. V. Stage with liquid rocket engine: 1) fuel tank; 2) oxidizer tank; 3) turbine pump unit; 4) chamber. VI. Stage with liquid rocket engine: 1) fuel; 2) oxidizer; 3) turbine pump unit; 4) chamber; 5) crew cabin.

Soviet Astronaut Sedov

by the small amount of atmosphere which still exists at this altitude, (when) it will begin to move in a spiral. At an altitude on the order of 100 km. it will begin to shine and gradually evaporate."

The history of Soviet astronautics extends back before the turn of the 20th Century and first took coherent formalized form in 1903 with the publication of a paper by K. E. Tsiolkovskii entitled "Investigation of World Spaces by Reactive Instruments." Since then the study and contemplation of astronautics has been a respectable occupation. He worked on a concept of "cosmic" rocket planes. Another Soviet pioneer in this field, F. A. Tsauder, suggested that step rockets should be so constructed that the actual structure of each stage itself could be processed and consumed as fuel, thus putting dead weight to practical use.

Though it seems pretty obvious that the Russians do not yet have any substantial hardware ready on the firing mat for launching a manned satellite or moon-circling vehicle, the Russians have been thinking about this sort of thing for a long time; one of their forte's appears to be the ability to design and construct massive thrust engines; and in the race for weapons supremacy now being waged between East and West, the advantages of operational space vehicles is obvious.

Furthermore, the Soviet ability to concentrate massive technological and industrial effort without having to answer to the electorate or to consider the needs and wishes of the general consuming public, make the Soviet a place to watch in this connection.

Russian astronautical efforts are now vested in three main groups. There is the purely scientific USSR Academy of Sciences which recently formed the Commission on Interplanetary Communications (Space Flight). The Soviet satellite project operates under this commission. Thus, the project, and its organization, has official government sanction and is on a high level. The respectability of astronautics has been increased by the Tsiolkovskii Gold Medal for Astronautics to be awarded to outstanding scientists.

In the middle is the Chkalov Central Aero Club. With headquarters in Moscow, this group is composed of scientists and engineers. The Austronautics Section, recently formed, also belies the official credulence being given to space flight. Presumably, like its analog, the American Rocket Society, Chkalov is a professional society. However, in all probability, it is a buffer group between official sanction and the hardware groups.

Representing hardware are the armed forces of the USSR. It is here that implementation of astronautical efforts becomes less evident. The Reds employ such heavy security here that all references to rockets, for example, are either: very general, foreign developments, or ancient history. Penetrating this veil has been difficult but not impossible. Authoritative sources have outlined a vast rocket and missile effort comparable in magnitude to American developments. Firing an 1,800-mile range IRBM and work on an ICBM are only two indications that the Soviets are near satellite vehicle hardware.

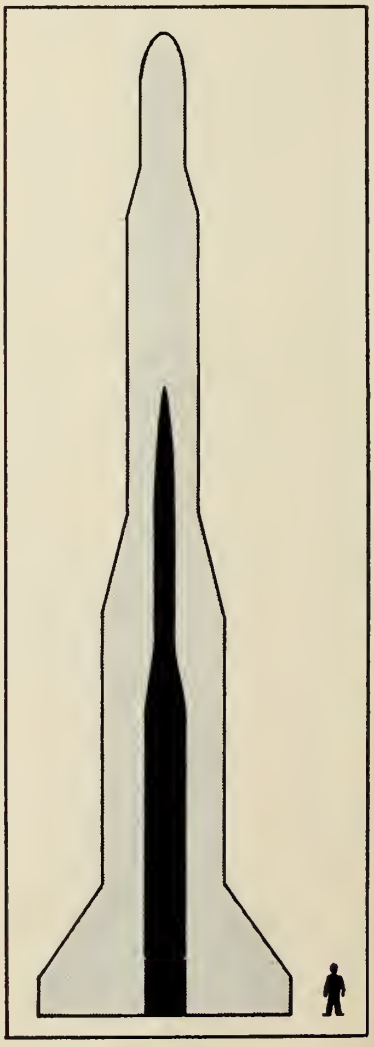
Even more nebulous are references to a Soviet moon project. One version was described in *Pionerskaya Pravda* in 1951. M. K. Tikhonravov of the Academy of Artillery Sciences mentions a 1000-ton circumlunar rocket. The newspaper *Krasnii Flor* (Red Fleet) was later to have said that this rocket was designed to develop 350 million hp and would be 196 feet long, with a diameter of 49 ft. Probably more in keeping with rocket hardware is the description of a one-way moon rocket by Yu. S. Khlebtsevich. The interesting feature of this proposal (first described in *Nauk i Zhizn*) is a "tankette" robot laboratory for exploring the lunar surface.

In checking through Soviet references to space flight, though they sometimes give credit when they quote foreign data and ideas—which is often—it is not always easy to determine just when they are citing or claiming to cite original Russian thinking. However, a quick rundown of some of the propositions they espouse, whether their own or borrowed, gives a pretty good idea of the way they think.

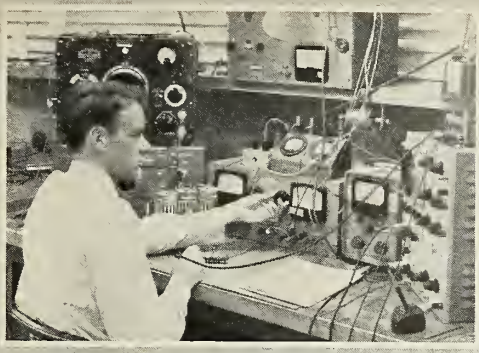
A. G. Karpenko and G. A. Skuridin, writing on the "Contemporary Problems of Cosmic Flights," quote E. Stuhlinger's electrical propulsion system utilizing cesium and rubidium as fuel. He also says that "The problem of utilizing gravitational fields created by the Earth, the Sun, and the planets is absolutely essential for cosmonautics. The fact is that the correct choice of the direction of flight, taking gravitational forces into account, can ensure the ship's motion in space along complex trajectories without significant expenditure of fuel.

Elsewhere in the Rand Corporations "Casebook on Soviet Astronautics" the statement is made that while radar will be useful in measuring distances to and speed by nearby bodies, the space vehicle's velocity relative to more distant bodies may be bettered measured by means of "a special interferometer, which determines the Doppler shift of individual spectral lines.

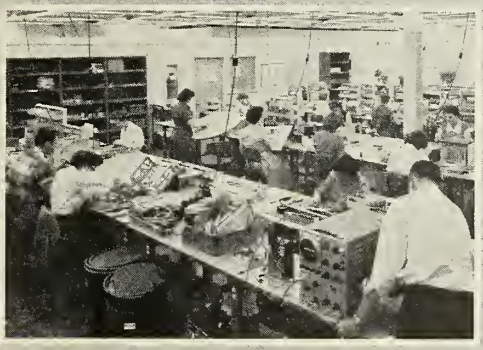
Soviet writers also suggest that a space ship on returning to earth will begin atmospheric braking of its speed at an altitude of less than 200 km. "The ship will describe around the earth a number of decreasing ellipses whose perigrees are submerged in the earth's atmosphere."



Soviet's IGY satellite is a gigantic project, as seen in view of the superimposed Vanguard.

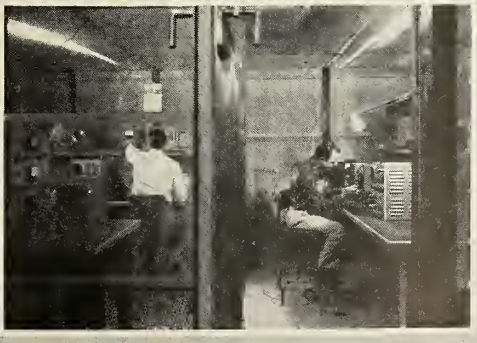


RESEARCH AND DEVELOPMENT



PILOT LINE PRODUCTION

FINAL ASSEMBLY



TESTING IN SCREEN ROOM

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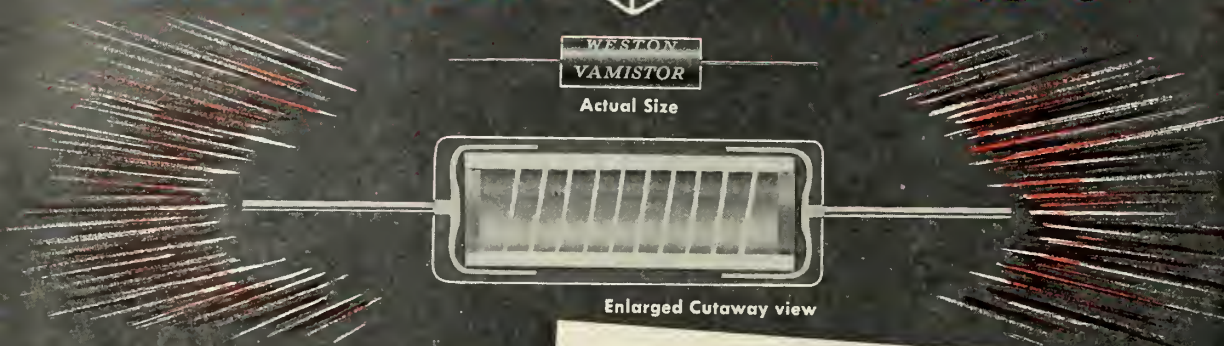

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Load Life 1000 hr—85 C	Average + .15% Low + .10% High + .20%	.5% max.	.5% max.	1.0% max.**
Low Temperature −65 C—24 hours	Average .00% Low .00% High + .02%	.5% max.	(no test)	1.0% max.
Moisture Resistance MIL-STD-202, Method 106	Average + .23% Low + .15% High + .36%	.5% max.	1.0% max.	3.0% max.
Salt Water Immersion 0 to 85 C—5 cycles	Average − .04% Low + .02% High − .10%	.5% max.	.5% max.***	(no test)
Temperature Cycle −55 to 85 C—5 cycles	Average + .04% Low + .02% High + .07%	.2% max.	.2% max.	1.0% max.
Insulation Resistance 100 v d-c	Greater than 10,000 megohms	100 megohms min.	50 megohms min.	10,000 megohms min.
Dielectric Strength 900 v rms—1 minute	Below measurable value—all samples	.05% max.	.05% max.	.5% max.
Terminal Strength		.5% max.	(no limit)	.5% max.
Effect of Solder		.5% max.	(no test)	.5% max.

*MIL-R-10509B test 2.5 times—5 seconds **MIL-R-10509B test at 70 C ambient
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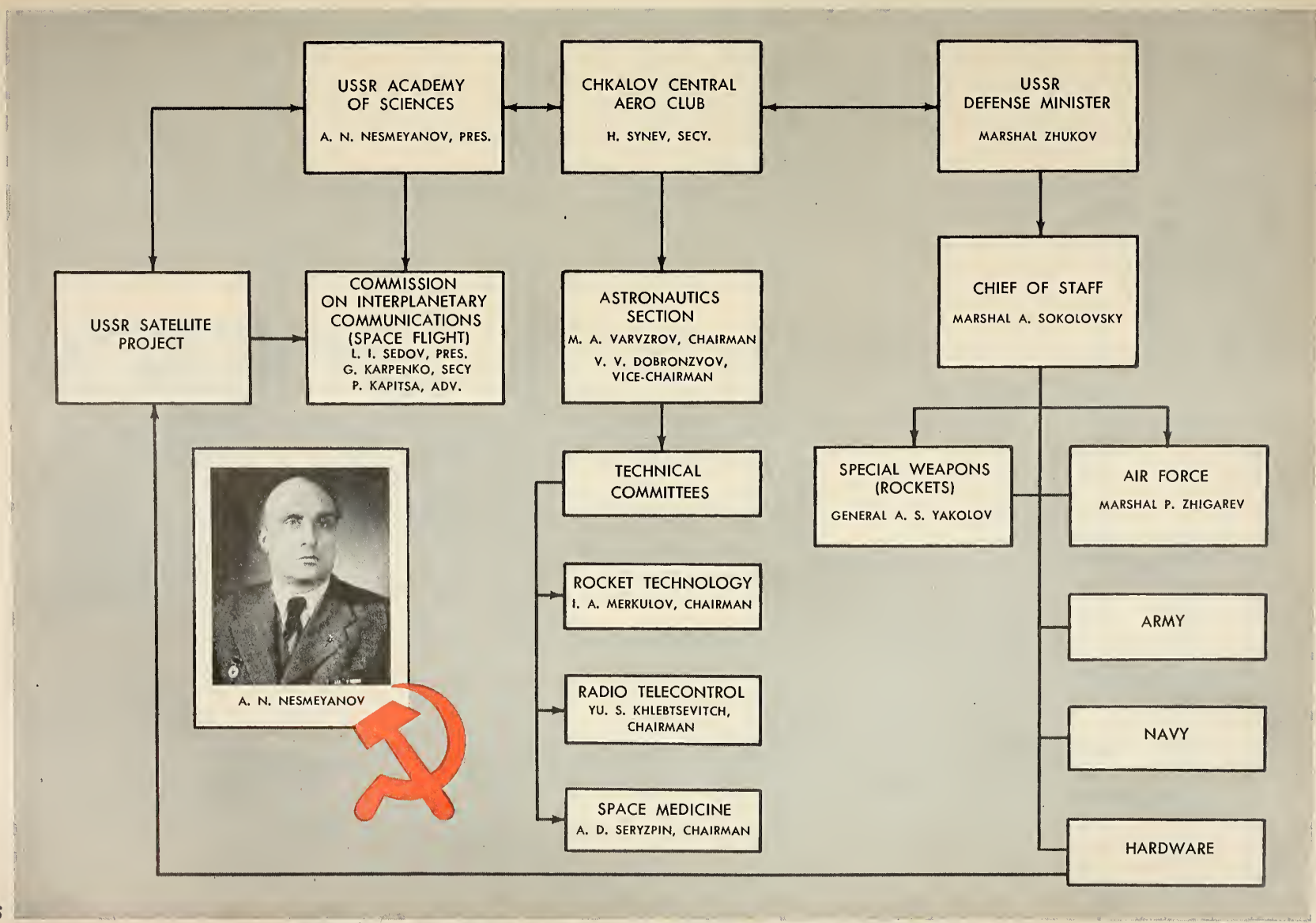

Presented for the first time in the U. S.: organizational chart of USSR's IGY satellite program.

Rockets Change Modern Army Doctrine

. . . and the Soviets know it

By Major General J. B. Medaris

Commanding General, Army Ballistic Missile Agency

ARMY tatical doctrines are being rewritten as rockets and guided missiles expand the range and increase the lethality of Army striking power. Other nations, including the Soviet Union. have added rockets to their military arsenals and are exploring the potentialities of long-range guided missiles.

Full impact of the revolutionary rocket weapons systems cannot be evaluated at this juncture. But some of the immediate potentialities may be appraised. To do so requires an understanding of Army field organization. Relating this to Korean terrain, which has become so familiar to so many Americans, may be helpful.

Military operations conducted on a large scale normally involve three distinctly separate but mutually inter-dependent commands. In Korea, a Base Command was developed around Pusan on the southern tip of the peninsula. From its boundary north to the combat zone, and spread across the waist of Korea, was the Communications Zone. The Eighth US Army Combat Area extended northward from Inchon and Suwon to the Demilitarized Zone.

Within the Base Command the Army accumulated substantial quantities of supplies: food, clothing, housing materials, automotive equipment and parts, tracked vehicles and all the other paraphernalia required by troops in the field. Smaller reserves of these stocks were maintained in depots in the Communications Zone closer to the using units. In the Eighth Army area to the north, centered on Seoul, were the corps and divisions—the Army's fighting arms.

As operations proceeded, supplies were moved in successive stages; first from the Zone of the Interior or from bases in Japan to Pusan; thence in smaller quantities from Base Command into the Communications Zone, known to thousands of service personnel as KCOMZ; thence to the combat area.

Ground commanders in Eighth Army were responsible to protect their sources of supplies in the rear areas and to defend the Republic of Korea from enemy invasion. To defend their positions they depended upon organic firepower such as the light Infantry weapons, heavy mortars, howitzers and artillery. For far-reaching firepower they called upon the Air Force, occupying fighter and bomber strips to their rear, or the Navy operating planes from carriers off the Korean coast. This type of unified striking power is familiar to any World War II veteran who saw active service in Europe or the Far East.

General J. B. Medaris and Chief of Staff Admiral Arthur Radford at Redstone Arsenal.

While it effectively checked the enemy in Korea, and contributed to the victory of World War II, certain disadvantages inherent in the weaponry involved have long been recognized within the Army. The ground commander was restricted in maneuver within rather narrow limits. His heaviest guns could hit targets less than 25 miles away. Thus he was compelled to keep his artillery well forward. If the enemy's artillery possessed equal range, as must be anticipated, it meant that artillery emplacements were well within striking distance of the foe's counter fire.

We have not yet witnessed the atomic battlefield and hope that we shall never experience it. But the shape of things which might come can be pretty well determined. It would mean vastly greater depth in the combat area, avoiding concentrations of men and materiel, and requiring maximum maneuverability. One can well appreciate, therefore, that if forced to depend upon conventional artillery, the ground commander would present inviting targets to an enemy with atomic capability.

Problems of maneuver and exposure have long since pressed for solution. Exposure, that is, not only of materiel such as weapons and ammunition, armor and transport, but of the troops which serve them and the supporting units which repair, replace and maintain weapons, communications, and satisfy the human needs of the combat units.

Any Army commander well knows that the efficiency of the individual

soldier under stress of combat will inevitably suffer from prolonged exposure to enemy guns.

The role of aircraft in our Army's attempts to resolve these problems is well understood. Organic Army aviation reached new highs in performance during the Korean fighting by spotting targets, checking fire, evacuating wounded, and supplying hard-to-reach points. The bomber and fighter planes rewrote history in World War II and rendered yeoman service in Korea.

But the plane, as a delivery system, has admitted shortcomings. It cannot yet operate in adverse weather, its effectiveness at night is somewhat limited. It is a highly expensive fighting machine to build and maintain. Its crew is normally exposed for relatively long periods of time over hostile territory. What's more, at the higher speeds required to provide more protection to plane and crew, it becomes a less dependable bombing platform under such terrain conditions as were encountered in Korea.

It was to overcome these limitations that the rocket and the guided missile were brought to their present state of effectiveness by the Army with the constant assistance of industry and research agencies. What the guided missile is capable of may be gauged if we again relate it to the Korean situation.

Our ground commanders of the future may call upon such weapons as the *Dart, Corporal, Little John* and *Honest John* for tactical purposes, for greater range and lethality. (Instead of measuring his organic firepower in terms of conventional artillery, he now possesses the means to strike at targets three times as far away.)

Given such a weapon as the medium range *Redstone* ballistic guided missile, soon to become operational, the ground commander can locate much greater firepower at distances many miles behind his lines. From Taegu, let us say, he could launch *Redstone* missiles under any weather conditions, at any time, against targets along and behind the enemy's lines. These missiles would carry warheads with lethality equal to the heavier bombs. They would travel at supersonic speed, subject only to automatic control and guidance carried on board, and could not be intercepted by any known counter measures.

Within the realm of possibility, based upon firm achievements in the art, missiles of greater range will also be available. With these, firepower equal to the Redstone's payload could be directed at hostile targets from deep inside the Base Command.

Still more distant bases may be utilized when our intermediate range ballistic missiles, now under development, join the national arsenal. These missiles, capable of being launched from land or sea, will transport their payloads approximately 1500 miles. Reportedly, the Russians are working on similar weapons.

Thus the modern Army can provide its field commanders with a range of weaponry in rockets and missiles that permits him to apply the scalpel, not the executioner's axe, to borrow a phrase from Dr. Edward Teller, the noted hydrogen bomb scientist. Following our own traditional Army policy, measured force can be used selectively —the right amount, the right time, and right place. The Russians have not ignored rocket and guided missile development in the modernization of their military forces. It can be assumed the Russian Army has put great emphasis on rocket weapons.

Progress in the related fields of rockets and guided missiles will by no means eliminate the ground forces. The Infantryman and his fellow soldier traveling in tanks and armored carriers will be needed to occupy, hold, and possibly fortify terrain. Even in missile warfare, we cannot rule out the possibility of localized skirmishes and engagements with guerrillas or small, roving enemy forces. The ground commander will require troops and planes to locate and identify targets, to determine enemy intentions, and to essay his capabilities.

Korea and European experience of World War II taught us that there will continue to be a need for fighting men to reestablished demoralized civilian populations, to apply friendly controls, to maintain communications, to throw up bridges, to build airstrips and road nets over which to move men, materiel and supplies.

Land warfare revolves around the possession of key terrain points such as road junctions, rail marshalling yards, border strongpoints, and control and command centers. The Army must have the capability to seize and hold these points. It must have, everpresent, the capability of exerting its will upon hostile forces. The new Army makes use of airborne troops and equipment for the rapid exploitation of havoc wrought by long-range firepower.

In the immediate future units of the mobile Army can be transported by organic aircraft. Perhaps in the not-too-distant future, the guided missile may serve another purpose by replacing the freight-carrying plane. For it is my firm conviction that we have entered a new era in transportation. In the giant missile we have a means of utilizing the most efficient and effective delivery system man has yet developed. Within the Army our forward looking planners are considering the guided missile as a potential of great promise with which to deliver all the resources they require for control of the land.

With rocket power as their propulsive system, future guided missiles will rise far above any intervening obstacle, follow a trajectory directly to the target, and put down the forces required to seize and hold such an area within a time span so brief as to defy attempts to prevent their arrival.

This is the era upon which your Army is now entering and which it will aggressively exploit as rapidly as its resources permit to strengthen the national defense.*

[*The views expressed in this article are those of the author and do not necessarily represent Dept. of the Army policy.*]

Shame on the West—practically all "the modern work in rocket technology" outside the Soviet Union represents "purely military effort" and no other. So charges Professor A. A. Kosmodemiansky in his biography of Constantin Tsiolkovsky, the famed Russian pioneer of rockets. This book, issued in 1954 in the same Soldier and Sailor Library series by the Soviet War Ministry, tells Russian troops that "reactive missiles can be hurled any distance," that guided missiles indeed make conventional guns wholly obsolete. Firing from such artillery "over distances of more than 100 kilometers will soon be economically unprofitable." For the walls of such guns have to be "extraordinarily thick and these guns quickly wear out due to the great pressures and temperatures" caused by the tremendous quantities of conventional explosives used in these guns. "How much simpler and more advantageous the modern use of rocket missiles, this very latest artillery!"

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Washington Spotlight

By Henry T. Simmons

A look at the Air Force's new budget readily illustrates the financial bind confronting the airmen. Despite insistence of top USAF witnesses last spring that fiscal 1958 appropriations would have to be substantially increased over those voted for the current year to maintain the current development programs, the new budget embodies reductions rather than increases in two key accounts. For R&D, the Administration asked Congress for $661 million in new money, compared with $712 million voted for the present year. And $1,712 million was requested for procurement of missiles and test vehicles in fiscal 1958, against $1,948 million voted for this year.

•

If the new money wont be sufficient for all USAF development programs, at least it will assure continued high-pressure work on the *Atlas, Titan* and *Thor* ballistic missiles. Further evidence of the amount of beef behind this program was supplied last month by Maj. Gen. Bernard Schriever when he disclosed that the Western Development Division, in addition to perfecting the hardware, will also assume the initial operational capability for the weapon systems within the USAF. This unprecedented step is deemed necessary for the proper development of the weapon's operational environment and will give WDD control over training facilities and techniques, operational installations, logistic support and other details normally left to the using command.

•

The Northrop *Snark* intercontinental missile appears to have weathered the budget storm in good shape. The weapon is scheduled to go to the Strategic Air Command of the USAF for training and operational purposes, perhaps before the end of fiscal 1958. Though the turbojet-powered *Snark* lacks the speed and altitude of the more glamorous *Navaho,* it has one incomparable advantage: it is here and the *Navaho* is not.

•

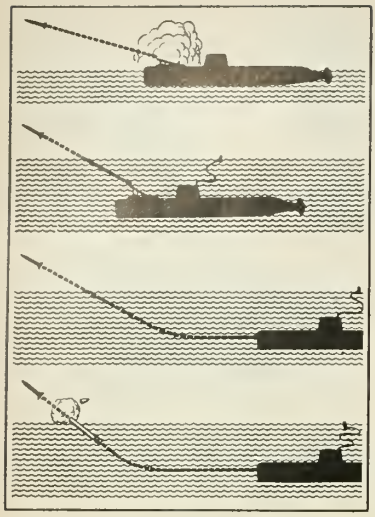
The Air Force will support development of the *Jupiter* IRBM project for at least another year as a hedge against the utter collapse of the *Thor* program, according to Pentagon insiders. Still a mystery is where the money will come from. Most likely source: Defense Secretary Wilson's emergency kitty for R&D projects. It contained $68 million at last count, and all three services are in hopes of getting a slice of it.

•

"It looked like an atom bomb going off," commented one official after viewing a film of last month's spectacular *Thor* misfire at Patrick AFB, Fla. The big missile hardly cleared the ground before it exploded and drenched the area in a lake of fire. One report blamed the engine for the failure; another said the trouble was up-system from the engine and looked like a valve malfunction. First firing of the vehicle had been delayed for weeks because of leaks and hung valves encountered in static tests.

•

Most parties agreed that the *Thor* mishap stemmed from a minor flaw and that the program would not be set back. Nevertheless, there was a disturbing note to the situation. The *Thor* embodies most of the components designed for the *Atlas* and *Titan;* its powerplant is one of the Atlas boosters. Thus any difficulty with the mid-range *Thor* is bound to have ominous implications for the more ambitious weapons which follow it.



Submarine Missiles: Reds Move Ahead

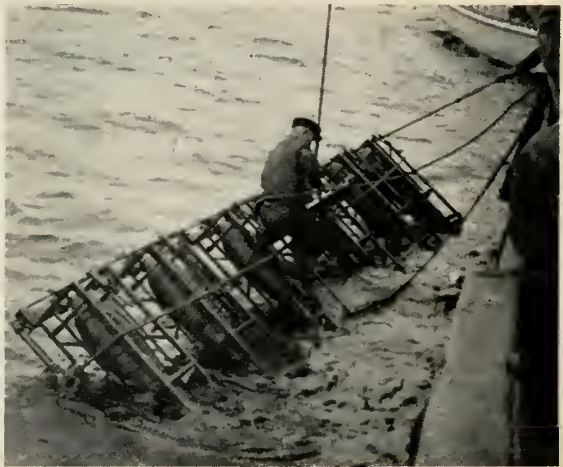
Ready-to-go solid missile in its launching rack on deck of submarine.

Top U.S. Navy officials have told the House Armed Services Committee that the Russians now have a total of 600 submarines, over a third of the way to their goal of 1,200. This compares to a total at latest official count of 400 for the U.S.

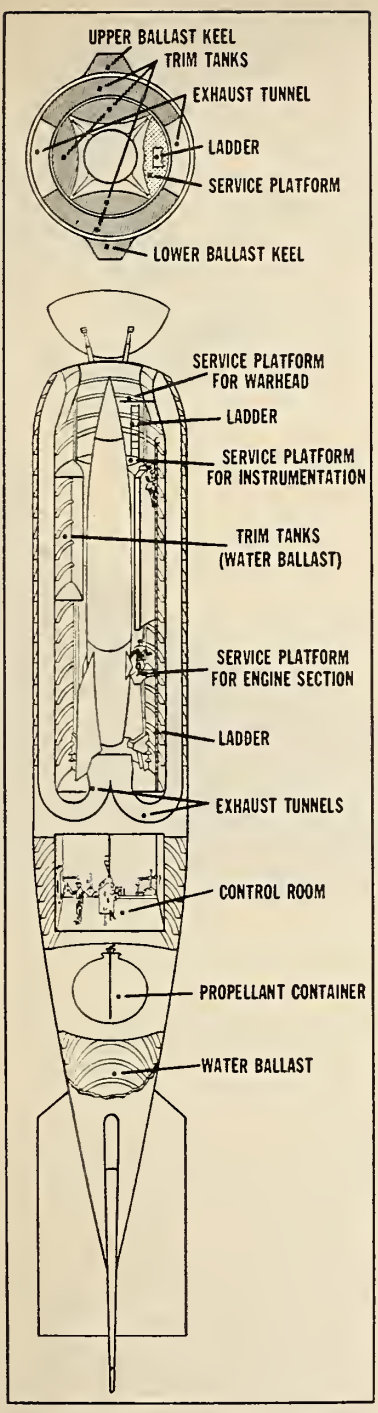
Add to this the *Comet*, Russia's Fleet Ballistic Missile, and the total works out to a considerable threat to the U.S. and it's over 5,000 miles of coastline. Admiral Burke has pointed out that any significant deployment of Russian submarines could well be the tip-off for an attack.

Russian submarines, currently being built at a rate of two-to-three a month, are direct descendents of the World War II German long-range W-class vessels with snorkels for submerged operation and combination diesel-electric powerplants. There are no reports that the Reds have either nuclear-powered submersibles or have gone to the high-speed underwater *Albacore* type of hull. Even with improvements since 1945 it's doubtful if Russian submarines now being built are capable of more than 20 knots on the surface or eleven knots at snorkel depth.

Though there's little reliable information as to the state of Russia's submarine missile art, the basis they started from 12 years ago—two methods for underwater launching worked out by the Germans but never put into actual operation. In the one case small solid-propellant 21 cm *Borsig* rockets were mounted in external racks on the submarine's deck. These could be fired from under water by controls mounted within the submarine. This weapon system now has



Collapsible launching gear for solid rockets being installed on W-class long-range sub. Rack holds six missiles.



Peenemünde left three of these submersible missile launchers to the Russians. Container is 100 feet long, holds V-2-type rocket with propellant supply, control room and water-ballast tanks. Russians also have subs capable of direct launching of fleet ballistic missiles. Russians could tow these containers to undetected sites in the Atlantic or Pacific oceans. Disadvantage of this weapons system lies in the fact towing speed is slow (15-20 knots); sub could easily be detected and attacked by missiles such as our Rascal.

been developed to perfection by the Soviets.

The other method involved the surface firing by a submerged submarine of what basically was a V-2 rocket with a one ton warhead and a range of several hundred miles. There seems little doubt that the Soviet Union must have made considerable improvement in these devices and is now approaching a concept similar to that the Navy envisages for the *Polaris*, namely a 1,000-to-1,500 ballistic missile carried internally in submarines and launched from a fully submerged position. As to whether these are in operation now or not, U.S. Navy Assistant Secretary for Air Garrison Norton says they are not.

U.S. defense against this kind of attack aims first at destroying the submarines before they can launch their missiles. To this end, the Navy has the *Rascal* and, in advanced state of development, the *Lulu*. Development of nuclear warheads in anti-submarine warfare has been a major U.S. project for some time. Later anti-ICBM weapons like the *Nike Hercules* may be able to intercept and destroy these missiles before they reach detonation altitudes.

Meanwhile, the Red submarine fleet and its probable missile potential form the greatest single threat to United States military security. Even though U.S. anti-submarine warfare has reached a high state of effectiveness, it's still far from 100%. And with small-but-powerful nuclear warheads a reality, even 20% of Russia's submarine fleet launching even primitive missiles against our coastal cities could cause severe damage.

It is interesting to note that the Russians have put great emphasis and faith in any weapon system developed by the Germans. In terms of missile systems, all major German concepts seem to have been adopted and accepted fully by the communists, such as the V-2, the *Reintochter*, the *Borsig* solid-propellant sub missiles, as well as the container-hauled V-2s.

Obviously, the Russians had great faith in the Germans and their missile technology and capability; several German scientists have enjoyed high privileges in the Soviet since the last World War. But indications are the Russians are getting tired of playing with German post-war hardware; they have activated several all-Russian missile programs. There is no reason to doubt that an all-out submarine-missile program is heading the list.

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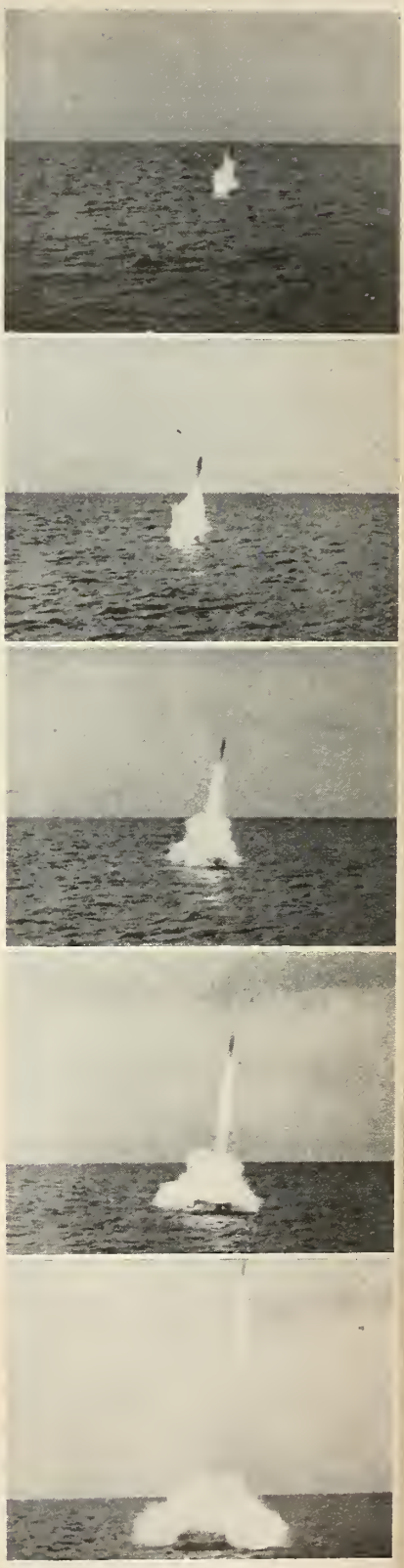
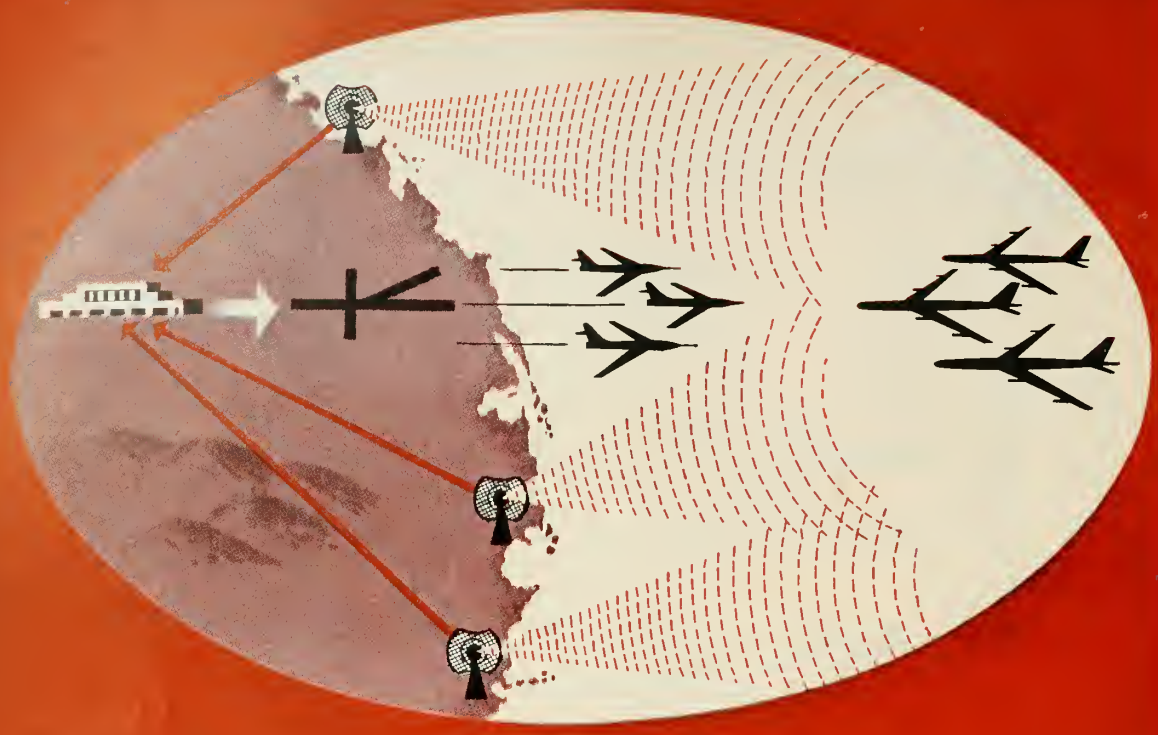


Solid rocket zooms out of the Baltic Sea and into the blue skies over Peenemünde.



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Proposal from behind the iron curtain:

SATELLITES

for checking Einstein's relativity theory

By M. Subotowicz
Physics Department,
University of M. Curie-Sklodowska
Lublin, Poland

As the science of earth satellites develops it may well be possible to experimentally check Dr. Albert Einstein's General Theory of Relativity. In recent years this revolutionary physical concept has come under closer and closer scrutiny by mathematicians and physicists the world over. As more and more empirical evidence of the innermost structure of matter is brought to light, more and more does Einstein's theory seem to fit. Or does it? That is the question.

In using it to explain newly suspected phenomena, the theory continues to provide a great many logical answers. But, there is an increasing suspicion that it may not be the full answer in itself; that parts of it may be wrong or that it simply may be incomplete. Recently, for example, experimental results of work with matter at temperatures close to zero degrees Kelvin raise doubts as to Einsteinian time hypotheses.

If the doubts about some phases of Relativity could be proved or disproved conclusively in controlled man-made experiments it would greatly facilitate the analysis and evaluation of work in the study of matter and the solution of science's basic mysteries, such as the true nature of gravity.

While the early satellites to be launched by the U.S. and the Soviet Union during the International Geophysical Year may not be sufficiently perfected to help in the resolution of these problems, later models may well be capable of providing us with specific answers. These would be satellites able to remain stable in their orbits for periods of a year or more. Some would have to circle the earth at an altitude, say, of 2,000 kilometers with a period of under two hours. They would not necessarily have to be either manned or recoverable. But the means of very precise continuous measurements would have to be provided. And they would be rather larger than presently planned early vehicles.

The General Theory of Relativity is the theory of gravity, time and space as formulated by Einstein. It is the theory of the relationship of the properties of space and time with matter and its motion. The experimental verification of the results of the Special Theory of Relativity is generally not so difficult and has been performed with great accuracy. But experimental verification of the General Theory of Relativity is very difficult.

Einstein suggested three effects to prove the General Theory experimentally. According to Einstein these three effects could be measured:

1—the gravitational shift of the spectral lines.

2—the gravitational deflection of light.

3—the advance of the perihelion of the planet Mercury.

M. Subotowicz is "a scientific worker" at the Physics Department of the University of Madame Curie-Sklodowska in Lublin, Poland. This article, which he has titled "The Artificial Satellite of the Earth and the Possibility of the New Experimental Verification of the General Theory of Relativity," was written exclusively for MISSILES & ROCKETS.

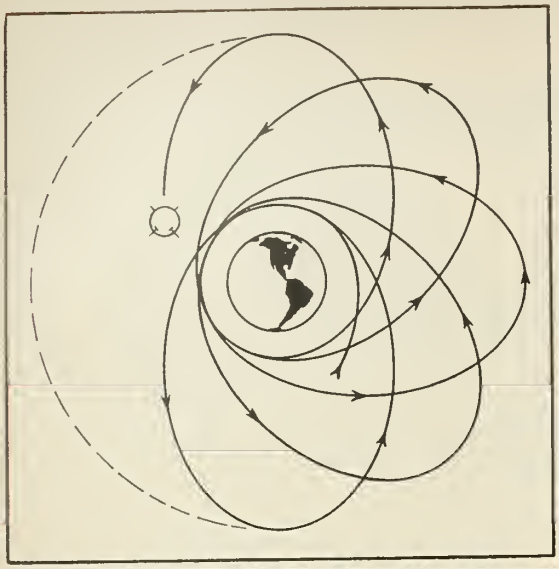
I won't discuss these three effects in detail here. They can be found in special books on the General Theory of Relativity—Tolman, 1949; Moller, 1952; Fock, 1955. I shall give the results of the measurements of the effects proposed by Einstein. Indeed the gravitational shift towards the red of the sun spectral lines and other stars has been observed. The same effect for the massive (companion of) Sirius is about thirty times as large as for the sun.

The gravitational deflection of light was observed in the gravitational field of the sun. The angle of deflection for a ray of light, which grazes the limb of the sun, is 1.75 seconds of arc. This effect has been tested by observations during total eclipses of the sun on the apparent positions of stars. The light of those stars has passed close to the limb of the sun.

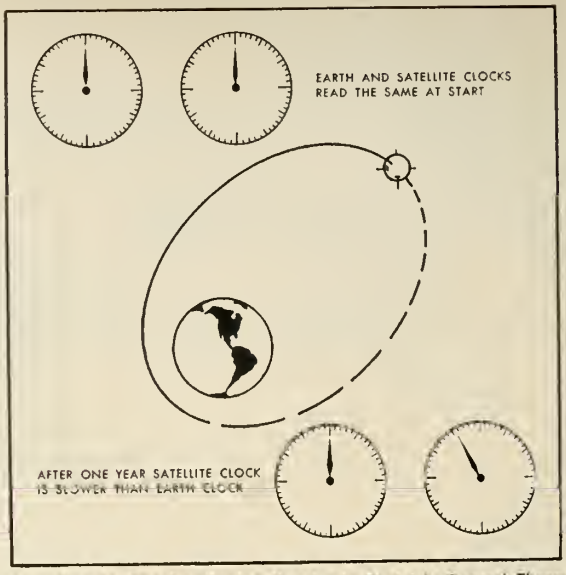
The agreement between predicted deflection and the observations would be accurate, except that the shift is just inside the limits of experimental error. This effect can be treated as having been tested only qualitatively.

As the third effect to verify the General Theory of Relativity Einstein has predicted the advance of the perihelion of Mercury around the sun. This he predicted would be at the rate of 42.9 seconds of arc per century. After subtraction of the effect due to the perturbation by the other planets, the observed advance of the perihelion is 43.5 seconds of arc per century. This is in excellent agreement with the predicted theoretical value. The advance of the Mercury perihelion was known before Einstein's theory. That theory explained this effect.

The existence of only these three effects to prove experimentally the General Theory of Relativity shows



The perigree of a satellite orbiting about the earth for a year would, if Relativity calculations are valid, advance more than the perihelion of the planet Mercury does around the sun in 100 years, and might thus provide another check of Einstein's theories.



According to time lengthening theories in Einstein's General Theory of Relativity, a clock in an earth satellite would run more slowly than one at relative rest on earth. Subotowitz says the difference in a year could be measured with available equipment.

that Newton's theory represents a good approximation for all gravitational phenomena inside the solar system.

Two Out of Three Verifications

In the use of an artificial satellite for verification of the General Theory, only two of these three effects are of importance. They are:

1—the gravitational shift of the frequency of electromagnetic wave radiation (from the satellite) in the gravitational field of the earth.

2—the advance of the perigeum of the satellite orbit in its motion around the earth.

But there are yet two more relativistic effects to prove the General Theory. It is impossible to verify these by observing known celestial bodies. They are:

3—the relativistic "effect of rotation" of the spinning central mass (earth) on the advance of the perigeum (perihelion) of the satellite (planet). The influence of the Lense and Thirring (1918) predicted "effect of rotation" on the advance of the Mercury perihelion is very small—only —0.01 seconds of arc per century.

4—the lengthening of time on the artificial satellite moving in the gravitational field. This effect is connected with the General, not the Special Theory of Relativity.

I shall give here some results of the calculations of all these effects in connection with the problem of artificial satellites (Ginzburg, 1956; La Paz, 1954; Winterberg, 1956).

Suppose that the height of the satellite orbit above the earth is $h = 800\ km$. Then the relative change of the frequency of radiation emitted by the satellite and observed on earth would be

$$(\Delta^{\nu}/_{\nu})_{gravit.} = 7.6\text{x}10^{-11}.$$

Since the source of the radiation, the satellite, has a smaller gravitational potential than the receiving station (the earth's surface), the observed shift of the electro-magnetic radiation should be the violet shift. It would not be a red shift, as in the case of the sun or another star.

But the relative shift of frequency connected with the Doppler effect is of the order

$$(\Delta^{\nu}/_{\nu})_{Doppl.} = -3\text{x}10^{-10}$$

for this same satellite. Thus, the Doppler effect shift is about four times larger than the gravitational shift.

It is, unfortunately, impossible to separate these two effects in one experiment. Thus experimental verification of the General Theory in this way is quite difficult. Life would be considerably simplified, however, if the satellite were circling along a much higher orbit, where h is greater than the radius of the earth.

Advance of Satellite Perigeum

For the above-mentioned satellite, the advance of the perigeum as a consequence of the influence of the gravitational field of the earth is quite large, about 1500 seconds of arc per century. This is about forty times greater than for the Mercury perihelion. According to La Paz (1954), a one-year observation of a satellite would be more efficient than a 100-year observation of Mercury.

According to the theories of Lense-Thirring (1918), there is an effect of the spinning central mass on the perigeum motion of the circling body. For the Sun-Mercury system, this effect is very small, hardly —0.01 seconds per century. For an artificial satellite circling at a height $h = 400\ km$ above the earth with a period $T = 1.54\ hr.$, the advance of the perigeum as a result of the earth's rotation would be about —43 seconds of arc per century. Thus the gravitational effect of the rotation of the earth would be as great for the satellite as relativistic effect on perihelion advance appears to be for Mercury.

The effect here discussed is connected with the General, not the Special Theory of Relativity. It concerns the Doppler effect in the presence of gravitational fields. And with the Doppler effect is connected the analysis of the time on earth and on the satellite.

The General Theory of Relativity treats with both longitudinal and transverse Doppler effects. The transverse Doppler effect is indirectly connected with time-lengthening and is not dependent on the direction of the motion

of the radiating body (the satellite) relative to the observer. As time passes the difference in the readings of two watches, one on earth and the other in the satellite, will grow in accordance with the above-mentioned transverse Doppler effect. In the General Theory of Relativity there are formulas dealing with the ratio of the time intervals of two synchronized watches in the reference systems of emitter and observer.

Neglecting the small influence on the earth's rotation on time lengthening, the following simple expression for the ratio $\Delta t/t$, where Δt is the difference of times measured on earth and in the satellite and t is the time measured on earth.

$\Delta t/t = A/r_2 - 3a/2r_1$; $a = G.M./c^2$

Where r_1 is the radius of the satellite orbit measured from the center of the earth; r_2 is the radius of the earth; G, the gravitational constant; M the mass of the earth; and c, the velocity of light.

According to Winterberg (1956), for a satellite at height $h = 1650$ *km* above the surface of the earth is $\Delta t/t = -1.3 \times 10^{-10}$. This means that in one year, a watch in the artificial satellite should be 4.2×10^{-3} seconds late relative to the watch on earth. A watch with an accuracy of 10^{-11} could be used to verify this effect. The "atomic watch," with an accuracy of 10^{-12} would meet these requirements.

Thus the coming of the artificial satellite offers the possibility of yet additional scientific work of the greatest importance. It should be noted, however, precise measurement of the effects of interest (rotation effect and time lengthening) will require a precise knowledge of all deflections from the stable satellite orbit. Some of these deflections include: the perturbations of the sun, moon and the other planets; the inhomogenity of the earth's mass distribution, the resistance (of the rests) of the atmosphere, tide effects.

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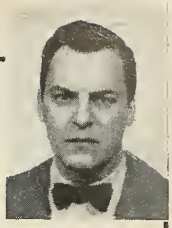

Aerophysics

By Seabrook Hull

The U.S. is well on the way to overcoming Russia's reported lead in high-energy particle accelerators used in the basic study of matter. Prof. Luis W. Alverez (Cal. Tech.) used such equipment in the mu-meson "cold fusion" of light and heavy hydrogen into helium, the first real break in man's efforts to develop a controllable thermo-nuclear rocket motor.

Dr. Tihiro Ohkawa and Dr. Lawrence Jones of Midwestern Universities Research Association reported before the American Physical Society on a "siamese twin" accelerator design to give a useful energy release of 30 billion electron volts. Proposed are a pair of backed-up 15 billion e.v. accelerators whose proton beams intersect. To achieve this power by conventional stationary target machines would require a theoretical capacity of 540 billion e.v. Largest accelerator in the U.S. is the Bevatron at the University of California at Berkeley with a useful power of two billion e.v. A six billion e.v. machine is now under construction at Brookhaven National Laboratory, reportedly to be on a par about with Russia's best.

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The Forty-second Annual Report of the National Advisory Committee for Aeronautics gives a new lease on life to transpiration cooling as a possible answer to aerodynamic heating; seems this kind of cooling tends to move the boundary layer separation point downstream. The NACA report also notes detailed investigation of several of the so-called exotic fuels including octene-1, aluminum, aluminum-octene-1 slurries, magnesium, magnesium-octene-1 slurries, diborane, pentaborane, boron, boron-octene-1 slurries, hydrogen, alpha-methylnapthalene, and graphite. In the field of high temperature lubricants, NACA Technical Note 3657 gives data on graphite and mixtures of graphite with lead oxide, cadmium oxide, sodium sulfate, or cadmium sulfate as solid lubricants. Among the temperature tolerant structural materials covered by NACA during the last year are melamine-resin glass-fabric laminates and silicone-resin glass-fabrics—up to temperatures of 600°F. And what may perhaps be a significant note in the incremental stey-by-step approach to manned space flight, this comment: "Because of the loss of the X-2, the need for earliest possible completion of (the X-15) has become imperative." Manned flight testing of superthermantic flight is now limited to a little over Mach 2.0 in the X-1B and X-1E.

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As man's operational devices depend increasingly on a working knowledge of the basic structure of matter and energy and on clear comprehension of advanced theories such as Einstein's General Theory of Relativity, "major technological break-throughs" are more impressive; their attainment, more difficult. It might help if more people understood the basic theories that have superceded the classical concepts of Newton, Gallileo, Euclid, etc. For the non-physicist, "The Evolution of Physics" by Albert Einstein and Leopold Infeld (1938, Simon & Schuster), covers field, realtively and quanta; is simple, thought-provoking.

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A Russian scientist claims he has studied chemical reactions at pressures up to 500,000 atmospheres in the laboratory; at 100,000 on the pilot plant level—both records, if true. At these pressure levels, classical chemical and physical laws do not necessarily apply, due to resistance of atoms to compression.

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Soviet Missile Science Profile

. . . from Dr. S. Fred Singer, *Physics Professor, Maryland University*
Dr. Leon Trilling, *Fluid Dynamics Research Dept., M.I.T.*
Dr. Hurd Willett, *Professor of Meteorology, M.I.T.*
Michael Michaelis, *Phycisist, Arthur D. Little, Inc.*
Dr. Albert Parry, *Chairman, Russian Studies, Colgate.*
Alex G. Korol, *International Studies Institute, M.I.T.*
Andrew G. Haley, *Director, International Astronautics Fed.*

Catching its interviewees in between on-time airliners, skiing dates, mid-year exams, baby-sitting chores and book deadlines, m/r's editors traveled hundreds of miles with recorder and camera to bring you this intimate profile of the men and methods of Soviet Missile Science. The better we know them, the better our chances of staying ahead in the current race for missile supremacy.

Soviet Satellite Plans Sophisticated; Astrophysics Research Well Advanced

Q. *Dr. Singer, can you tell us something of Russia's plans for launching an artificial earth satellite?*

A. Dr. Leonid Sedov first announced in 1955 at Copenhagen that Russia would launch a satellite during the International Geophysical Year. This was repeated by Bardin at Barcelona. Last year in Rome, Sedov gave some details; said that their satellite would measure pressure, temperature, density and magnetic field. I questioned him rather closely as to whether they were really going to measure temperature, to which he replied, no. To measure temperature under satellite conditions is very difficult.

Q. *Did he indicate the size of their satellite?*

A. No. But when I asked him whether they were going to measure magnetic fields, he said yes. This gets into size because you have to provide storage equipment and you have to play it back in order to transmit it when the satellite is over the receiving station. Play-back must be at a very rapid rate, and therefore with high transmitter power which means several watts. This rules out transistors. It also requires the use of B + batteries. This really adds weight.

Q. *Have you done a rough calculation of what the minimum weight would be?*

A. Yes. I would estimate it's at least 50 pounds, if they want to measure magnetic fields in the proper way. Properly packaged, it could still be fairly small, however. My guess is that the Russians will have a satellite with a near-polar orbit or an orbit which is much more inclined than ours, and with internal recording and playback. It's a more sophisticated satellite than our first ones.

Q. *Did Dr. Sedov make any claims as to how long it would stay in orbit?*

A. No, he didn't, but of course with sufficient propulsion in the rocket assembly, you can make the satellite stay in its orbit indefinitely. In an orbit at about 400-to-500 miles instead of 300 miles, the chances of long life are enhanced quite a bit. And from some indications, particularly in your magazine, it seems like they have the rocket equipment to do such a job. But of course this doesn't mean they can do it immediately. It still takes some work. It takes some thinking, as Bardin said.

Q. *Do you think they're bluffing on the satellite?*

A. In a Western Gear advertisement in the Wall Street Journal, Mr. Bannon, the President of that firm, raised the question of whether they've got a satellite ready for launching or whether they're just bluffing. As you know, they copied the Mouse. The question is: Are they bluffing and just covering up by printing this picture from Popular Science, or was the artist just lazy and looked around for something that looked like a satellite to put in the article. I think it's probably the latter. I don't think we should underestimate the Russian effort.

Q. *Wasn't the Mouse your idea?*

A. Yes. It is a more sophisticated satellite than the Vanguard and I think it would have come first except that the Vanguard propulsion system is fairly limited.

Q. *Can you give any indication of the level of Russian science in the fields with which you're familiar?*

A. In astrophysics and in cosmic rays the Russians have done outstanding work on the theoretical side and fair work on the experimental side. They've made some very important discoveries, particularly in the field of radio astronomy and have done a great deal of theoretical work of some importance on the origin of cosmic rays. You can say they have contributed to the world's supply of knowledge. The reason for such a great amount of activity in theoretical astrophysics is twofold: First, you can learn a lot about the universe, which has great scientific interest. Second, the energy sources in the universe are based on fusion power, and the more we learn about how the universe operates, the better we can understand fundemental physical laws.

Q. *Would their knowledge of astrophysics contribute to their work in nuclear physics?*

A. Not necessarily, but they do have excellent theoretical nuclear physicists. There is great incentive for Rus-

sian young men to go into the natural sciences. I think the incentive is partially financial but most of all a matter of prestige. And, the support they get for their work is just tremendous. Russian cosmic ray physicists may have fifty assistants working on data, reducing results, laying out experiments and so on. This is a tremendous number compared to our average large cosmic ray group of that type which might have, maybe, five assistants. They just don't care how much money they spend and as a result often spend it very uneconomically and wastefully. And, as well as the men, they have some good equipment. Our nuclear physicists who have been over there are very impressed by their large accelerators. They are well engineered. So apparently they're developing a good crossbreed team of pure scientists and engineers, which is of great importance. Their system of technical education is quite excellent and heavily endowed. Some Russion scientists I've talked to have graduate classes with maybe a couple of hundred students where we have only a few.

Q. *In your field of physics do they tend to quote American and other foreign figures rather than their own?*

A. They always cite their own calculations and prolifically. I think this is part of the way they operate. But when it comes to experimental results, they pretty much have to fall back on Western figures. They don't have the experimental data, but they're good interpreters.

Q. *Does this mean that they tend to take their lead from non-communist sources, and then, once they know the basic problem, to tackle it on an all-out basis?*

A. This is not always true. Sometimes they take on experiments themselves which are quite difficult and expensive and not very inspiring. This is because they are not in close touch with the Western world and don't keep up. In some fields they are completely out of fashion. In others they are right at the forefront.

Soviet Scientists Competent, Sociable: Missile Hypersonic Knowhow Up to Date

Q. *Professor Trilling, what is your experience with Russian science and scientists?*

A. I have looked at their education system in aeronautical engineering. Also, as a practicing aerodynamicist I follow their technical papers. I have talked with acousticians who attended the Second International Acoustics Congress here at MIT last June, and to aerodynamicists at the International Congress of Applied Mechanics in Brussels.

Q. *Were they easy to talk to?*

A. Oh, yes. They were trying to contact all the people they had heard of in the U.S., trying to find out what they were up to and quite willing to say a good deal about what they themselves were doing. Whether or not they were telling everything is hard to say. They were quite willing to talk, though this depends a bit on the individual. One senior gentleman who came up the hard way was very skillful at evading questions whereas another one a little bit younger and with a different personality was only too anxious to talk—was going out of his way to find people to talk to on the technical problems he was interested in, what his ideas were and how he was going about it. In fact at times, the older one had his hands full trying to keep the younger one from talking too much.

Q. *Did you get the idea that their level of accomplishment was on a par with ours?*

A. On the average, the answer would be yes. In some areas they're doing possibly better than we; in others we are doing a good deal better.

Q. *Did they describe their research equipment?*

A. No. In fact they were fairly careful not to talk very much of their research equipment. Professor Leonid Sedov said the volume of experimental work in the USSR was a good deal lower than in this country, so that they were attempting to use their facilities as effectively as possible. I have a feeling that they are not too active in fundamental experimental research, but they are extremely strong in analytical research.

Q. *With regard to education, what is the significance of reports that they're graduating increasing numbers of engineers? Do they simply order a promising student to go into, say, aerodynamics?*

A. Well, no. It isn't as crude as all that. The carrot gets you much farther than the stick. There are all sorts of incentives. In the first place there is no equivalent in the Soviet Union to our class of administrators and executives. The technically trained people do that work. They are the socially leading groups. So there is an inducement for them to go into natural and applied sciences. And, a student in aeronautical engineering, for instance, will get a bigger fellowship than a student in history or ancient languages. The number of applicants for the better technical schools is a good deal higher compared to vacancies than the number of applicants for schools which train librarians and such. Students are not told what department they should register for individually. Still, the total number of students in various fields is regulated. It is decided by the Government that 65% of college vacancies will be in the natural sciences. In this country, I think this is correct, about one in eight children eventually go to college. In the USSR it is likely to be one in twelve. A greater proportion of these are in the technical fields.

Q. *In talking with Russian scientists, did you ever get the impression they were trying to pump you?*

A. It depends on the individual. Without quoting names, I would say that some gave me the impression of trying to get the most information at the least cost in contributions by themselves. Others, on the contrary, spoke freely and were apparently quite willing to talk about their own work.

Q. *Can you be specific as to the state of the missile art in Russia?*

A. In theoretical work they are extremely good. It's in experimental work where they are not so good. In the theoretical work I think they are at least as good as we, apparently having spotted some problems a few years ahead of us. Exactly where they are now is difficult to tell because of security and that sort of thing, but they seem to know what they are talking about, and they grasp the fundamental problems involved in hypersonic flow past a missile-like configuration. They know how to go about making reasonable calculations. So far as the boundary layer is concerned in hypersonic flow—the bow shock wave and pressure distribution—they gave a paper about a year-and-a-half ago at a meeting in West Germany that thoroughly indicates they know how to calculate pressure distribution of a sharp-nosed body as well as a blunt body in hypersonic flow. And the comments they make indicate they are not only interested but reasonably well advanced.

As to heat transfer, all I got from them was that there is a group doing experimental work on heat transfer and presumably doing all right. At any rate they know what the heat transfer problem is. Not very long ago, a paper

was published by L. E. Kalikhman, who has been doing high speed boundary layer research in the USSR. He wrote on the reduction of heat transfer through a boundary layer by injection of a cold, light gas through the wall. This is a technique with which we are also playing. It shows that they know what they are about. However, how well they are succeeding is hard to tell because the experiments which Kalikhman quotes to support his calculations are American measurements.

Q. *Why did he quote American measurements?*

A. I think this is standard procedure with people associated with defense establishments. But people in the power stations ministry, for example, who also do gas turbines, publish local data quite freely . . . interferograms of high speed flows past cascades, heat transfer measurements, boundary layer profiles and all sorts of things, because, I suppose, this is a research establishment of a non-sensitive industry. It raises the question of whether people in one industry talk to people in another.

Q. *Could you name some of the outstanding people in Soviet aeronautical engineering?*

A. I think the two leading men in fluid mechanics are Sedov, who is the theoretician, and S. A. Christianovich who did important work in transonic flow in the late 1930's and early '40's and who is now Secretary of the Engineering Section of the Soviet Academy of Sciences. As such, he has much to say about what type of engineering research is done.

Q. *Have you seen any signs that scientific theory is still politically dictated?*

A. Not in any of the aeronautical sciences.

Q. *They are competent competitors, then?*

A. They're quite competent, but they're rather dedicated to the state. They have a measure of national fervor which makes them very intense and hard working. They believe in Soviet science, not science in general—a factor that's just a bit disturbing.

Q. *You mean the advantage it may give them?*

A. Whether this really is an advantage in the long run is a question. It leads to an approach to scientific research which is a little bit too much day-to-day, a matter of concentrating on today's problems today and letting tomorrow's problems get solved tomorrow. A disadvantage is that the right fundamental problem may not be attacked early enough. It does have the advantage of concentration of effort. But it makes them sometimes rather forbidding.

Soviet Theoretical Work Excellent? Engineering Crude; But Results Good

Q. *Mr. Michaelis, you were at the U. N. International Atomic Conference at Geneva in 1955?*

A. Yes, I had submitted a paper and attended as a participant though not a formal delegate.

Q. *Being British, were you in a better position to talk to the Russians than the Americans?*

A. No, I don't think so. Having lived in America for the previous 5 years, I was not regarded as a member of the British contingent anyway. Generally speaking, it was notable—for the first few days anyhow—that quite a few Americans held off from talking with Russians—and vice versa. Europeans seemed to get to them more quickly, one reason possibly being that many of the elder Russians spoke German, having studied in German universities before World War II.

Q. *Well, in talking with them, were they just like any other group of scientists, anxious for information and willing to contribute fully to the discussion?*

A. Curious and interested, but a little hesitant, I think, at least to start with. The first few days were pretty formal. Then things began to loosen up a little. They mixed well, barring the language difficulty. I got the impression they were holding back on information, because on direct questions such as "where do you get your uranium"? you'd get no answer, or you'd be told "Well, it's sent to us."

Q. *Could this have been all they knew?*

A. One would guess they knew a little more. They were obviously working under fairly strict instructions from home on what to say and what not to say.

Q. *Any more strict than ours were, for example?*

A. That is hard for me to tell. I don't precisely know what our delegates' instructions were. One of the interesting aspects of the Conference, in retrospect, was their exhibition of equipment which showed that even though they were scientifically well advanced and knowledgeable, their technical execution was much less elegant than ours. Instruments and equipment they showed had an archaic look. But from experimental results obtained with them and presented at the Conference one must assume they function perfectly well.

Q. *Do you think their technical achievement in the field compares to ours?*

A. You must distinguish clearly, I think, between technical and scientific—applied as against fundamental research. I would think that in fundamental research they matched us quite well. As far as applied engineering goes, their proposed power station, medical radiation equipment, etc., I think they did not match our standards in sophisticated design work. It seemed a little like what in England used to be called the "string and sealing wax" style. As I say, it's only appearance, and it's very hard to judge from looks alone the reliability of a nuclear power station or whether an instrument is better or worse.

Q. *Did you get the impression that, as scientists, they felt a serious lack at having been unable to wander about the see what the rest of the world was up to in nuclear technology except through translated papers?*

A. Yes. Some said that in so many words—in private conversations They seemed to feel this a handicap, but so did delegates from other nations, bearing in mind the tight secrecy prevailing at least up to Geneva.

Q. *Considering the level of know-how required for early nuclear powered aircraft, what do you think of the state of their art?*

A. This, of course, was not discussed in public, nor privately to the best of my knowledge, being a highly classified area. But, knowing their achievements with large aircraft gas turbines and knowing that as far as nuclear electric power plants are concerned they are not very far behind us on the fundamentals, I would think they are capable of achieving nuclear aircraft propulsion. Extrapolating from their past performance, they certainly seem to have the brains and technical capabilities of solving these problems. Western delegates were surprised in Geneva at how far they had got in their fundamental understanding of nuclear technology. And, in the case of the controlled thermonuclear reaction Academician Kurchatov made a speech last April at the Atomic Energy Research Establishment in England that gave more information on the subject than any nation to that time.

Kurchatov said at the time that the "pinch"

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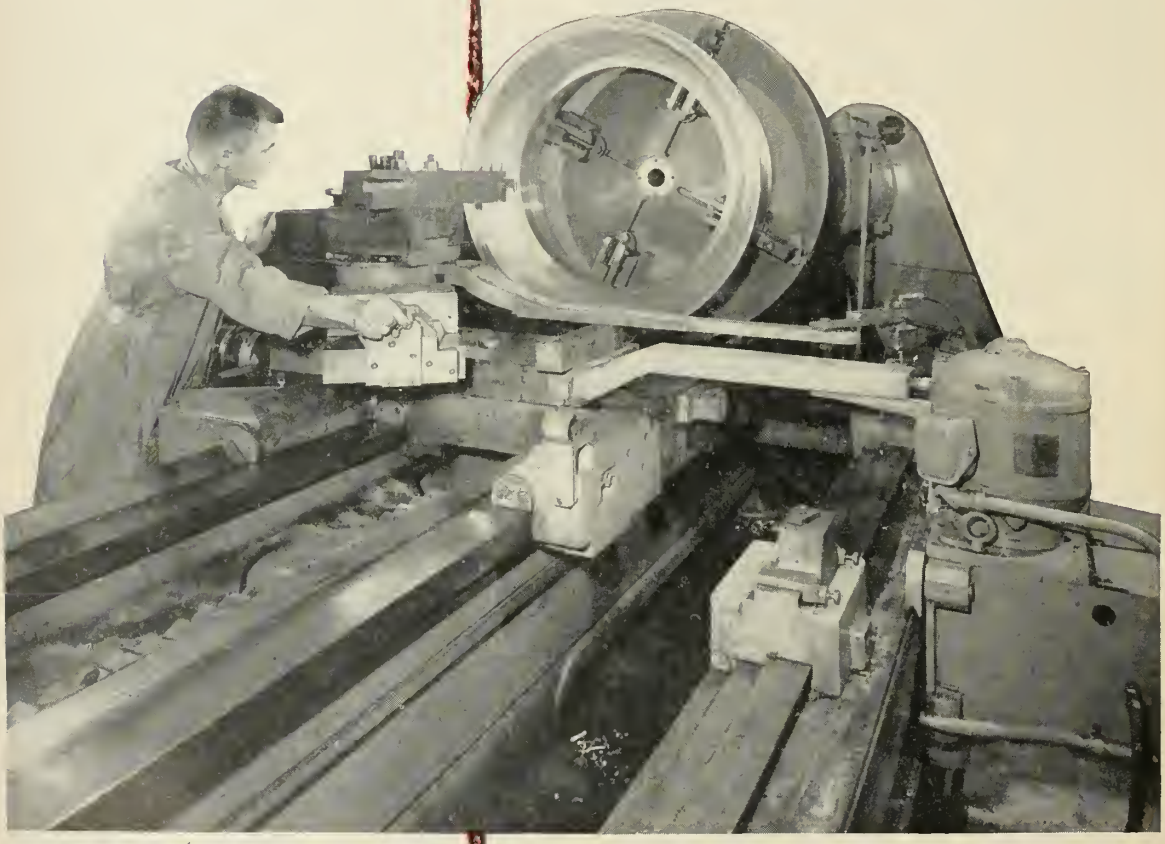

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effect, using electro-magnetic fields, was probably not going to be the ultimate way of achieving controlled mononuclear reactors. He could see limitations. I would think that we've already seen them also. The cold fusion reaction might be a possible alternative approach. At least, Dr. Alvarez of the University of California recently announced the discovery of a low temperature reaction, using a mumeson as a catalyst, to fuse hydrogen and deuterium. It is interesting to note that Dr. Alvarez mentioned that a Russian scientist had predicted the possibility of this reaction some two years ago—another indication that they do not seem to be lagging in ingenuity.

Since particle accelerators are said to be a possibly significant tool in achieving thermo-nuclear reactions, it is interesting to note that, as far as accelerators were concerned, the Russians appeared to be ahead of us in some ways at the time of Geneva. Some visiting U.S. firemen felt that Soviet multi-billion volt accelerators seemed to be further advanced than those in the U.S. So for research in this particular field they may be as well, if not better set than we, for the time being at least. It takes time to build these machines, and they started a bit earlier.

Q. *Did you get the impression that perhaps they lack in experimental ability?*

A. No, I don't think I did. Their experimental work, even though it may sometimes appear crude to our eyes, has certainly produced results which are identical to ours. One of the highlights of the first few days of the conference was the simultaneous release by the U.S., Britain, and Russia of certain so-called neutron cross-section properties of materials. These had been obtained independently and kept secret until then. The three curves fell on top of one another with remarkable agreement.

Q. *Did you feel that they had gained a considerable degree of scientific intellectual freedom?*

A. Well, more than they've had, I think, until recently. Perhaps they don't have as much as they want. I believe that only a few weeks ago scientists formally asked the Soviet Government for more "scientific" freedom.

Q. *Going back to the reticence of American scientists during Geneva's first few days, do you feel we would gain if more U.S. scientists and engineers traveled abroad to international conferences and the like?*

A. Yes, I do, very definitely.

Red Atmospheric Theory of Little Value; Loss in Translating Technical Papers

Q. *Dr. Willett, what is your experience with Russian science and scientists?*

A. I knew Commander Ryzhkov who was liaison man between U.S. and U.S.S.R. meteorologists during and after the war. I also talked quite a lot with the chief Russian long-range forecaster, Col. Pagava, who was over here at the same time. Otherwise, I know Russian scientists only by personal correspondence, exchange of reprints, etc.

Q. *How deeply do they go into the study of the atmosphere? For example, are they knowelgeable on the degree of dissociation at altitude?*

A. The Russians have done something with ozone, but I don't think that's a specialty of theirs. I would say that Soviet meteorological work has not been primarily of basic importance. They do a tremendous amount in observational and applied meteorology, maintaining large systems of observational stations, and particularly in Arctic meteorology. They have developed some forecasting theory, but their contributions, as far as they're generally known, don't rank with British and Scandinavian meteorology.

Q. *Are their professional papers, when translated, technologically thorough, lucid, etc.?*

A. That's hard to answer, for the language presents certain difficulties in translation. It's a question of whether the translated product means as much to one of us as it did to the Russian.

Q. *Why is this?*

A. They have different ways of saying things. In fact, it goes almost back to a different way of thinking sometimes, and it's pretty difficult always to get an exact equivalent . . . whether from Russian to English or vice-versa, some of the finer points may be lost in translation. I think this is something anybody reading translations of Soviet technical papers should keep in mind. I've studied the Russian language sufficiently that I am aware of differences in grammatical structure and different ways of using verbs that sometimes make the exact rendering of the meaning in the other language awkward. However, despite this handicap, they study very thoroughly all the literature of other countries. In fact, a lot of what you might almost call textbooks are taken from German and American meteorologists.

Q. *Though their efforts at developing meteorological theory haven't been too successful, in other than theoretical work have they made any material contribution to the science, such as in measuring and observational techniques?*

A. Though they developed their own radiosonde about the same time as Finland, I don't think there's a great deal that we have that we wouldn't have had if it hadn't been for the Russians. They've given much information, however, particularly in Arctic meteorology.

Krushchev, Bulganin Chide Scientists; Ballistic Rocket Threat is Not a Bluff

Q. *Dr. Parry, considering all the facets that make up a complete and whole scientist, are there any gaps or lacks in the Soviet scientist?*

A. Well, one is the lack of personal communication with the West. Up to and including Stalin's demise, the Iron Curtain did Russian science more harm than it gave Russian science any security from Western prying and spying. Because Soviet scientists were cut away from Western science so completely, they are not as far ahead as they could have been. There is still some fear on the part of Russian scientists apparently of being in touch with the West, and their leaders, Krushchev and Bulganin, have to remind them from time to time, sometimes in rather crude and rude words, that they have the Kremlin's blessing for making contact with the West. Last February during the 20th Congress of the Communist Party, K & B both chided Russian scientists for being so slow in getting in touch with the West. Apparently K & B feel that if intercourse is allowed, we in the West will learn less of value from the Soviets than they will learn from us. Security is desirable, they said, but not so as to isolate Russian science.

K & B also said that Soviet scientists hide too much from one another. Krushchev put it this way: ". . . too much pointless, parallel work because one group of scientists do not know what another group of scientists is doing." Another point of chiding was that there is too little of the very necessary connection between industrial and university research. "Look at the United States," said K & B, "where universities do so much research for in-

dustry, where industry helps universities, gives them grants, establishes laboratories. Such collaboration is very necessary for the advancement of science and should be emulated in the Soviet Union." Another point of criticism K & B advanced to their own scientists and engineers is that there is too much nepotism, too much favoritism to their own families and to friends of friends of friends.

Q. *Haven't they got a slang word for that?*

A. Blat. Blat covers a multitude of sins. Sometimes it's also called left-handed business, meaning that your right hand pretends not to know what your left hand is doing. It also means illegal; and profit for the individual rather than the state. Another point of Soviet criticism of their scientists, one which has been repeated again and again in the Moscow press, is that Russian scientists like comfort too much, that they have established their institutes in Moscow and Leningrad and do not go into the field. The reindeer breeding institute is in Moscow and not in the Arctic; Marine institutes are in Moscow instead of by the sea. More than one third of all institutions and laboratories run by Soviet industry and two thirds of those belonging to the Academy of Soviet Sciences are concentrated in and around Moscow and Leningrad. Why? K & B say because scientists, their assistants and their families like the soft life, bright lights and comforts of big cities. So the order now is to disperse. Of course, this may be a camouflaged desire to disperse the institutions in case of war.

Q. *What is the reason for the lack of communication between scientists in the Soviet Union?*

A. They don't trust one another.

Q. *Don't they have professional societies that meet and hear papers, etc.?*

A. Yes. But ever since the revolution and the seizure of power by the Communist party, these have been founded or taken over by the Government. Only in very recent months have scientists shown some signs of running these societies the way they want, and not the way the ministry of culture wants them to do it.

Q. *Can you comment on the number of scientists and engineers being graduated by the Soviet Union?*

A. Yes. Quite often the number of scientific and technical graduates of all sorts, as published by the Soviet government and alarming us, is misleading. They give diplomas at lower levels of technical competence where we don't. One elementary example: Here in our country, any farm boy can run a tractor. The Russians send them to special schools. This means special diplomas. Quite possibly some such categories are included in the rolls of scientific talent which we see. Also, in our society, though a number of graduating engineers go into selling or other administrative work, the large percentage really work at their trade. In the USSR you will find a much greater percentage employed as administrators. And generally no matter what field you take, you will find the administrative personnel far exceeding similar U.S. operations.

Q. *Have you seen any signs that the Soviet Union is dissatisfied with the number and quality of scientists and engineers it is graduating?*

A. Yes, a Moscow newspaper article on Oct. 4, 1956 quotes V. Stoletov as saying too few are graduated in biophysics, electronics and in the field of computor design and operation. Too many, Stoletov says are graduated in the humanities; also too many degrees are granted for "nothing of theoretical or practical value."

Q. *Have you noted any influence from the German or other European scientists who have been assimilated into the Soviet Union since the end of World War II?*

A. I think the German contribution to Soviet science has been exaggerated in the Western press, particularly here where Americans just won't give the Russians any credit for their originality. Let's put it this way: The Germans have not been the decisive element in Russian successes in recent years. The Russians do have a tradition of science regardless of any borrowing from the West. Look at Dmitri Mendeleyev (Periodic Table); look at Prof. Peter Kapitza, famous physicist and now Nicholas Semyonov, recent Nobel Prize winner in chemistry. Of course, they did profit from Klaus Fuchs, Bruno Pontecorvo and other such traitors. Pontecorvo may have played a more important role than is generally recognized.

Q. *Now, just going to basic Soviet psychology, the nuclear blackmail that's been going on such as the threats to use missiles against Europe and the Middle East—Are they inclined to bluff? Would they threaten the possible use of rockets if they didn't have the rockets to fire?*

A. They would have the rockets. They know the rocket principle; they use rockets in other fields.

Q. *Do you have any idea of how successful they've been in perfecting guidance?*

A. Answering indirectly, I remember in 1945 after we had dropped our Nagasaki and Hiroshima atomic bombs, one American engineer said to me: "We don't have to fear any Russian atomic bomb because they don't have the precision techniques to make a bomb. Tolerances are practically unknown to them." Yet look. They've got it. They got the proximity fuse when we least expected.

Q. *What can you say about their better ability in theoretical work compared to experimental work?*

A. This goes with their interest in paper work and paper calculations. A typical desire of Russian middle and upper class people is not to sully their hands. If you are middle or upper class, why you wear your nice collar, and your hands are clean. The "do-it-yourself" movement just has not come to Russia among these classes. Our tendency to do it yourself is a tremendous source of our technical personnel. There, we overwhelm the Russians. They use basements to shoot people in, not for workshops.

Reports of Red Education Lead False; More U.S. Than U.S.S.R. Postgraduates

Q. *Mr. Korol, I understand that you are preparing for the Center for International Studies at the Massachusetts Institute of Technology a report on Soviet education. What is it and when will it be published?*

A. The Center has recently completed a two-year study of the Soviet educational system. A book tentatively entitled *Soviet Education in Science and Technology* is scheduled for publication in the fall of 1957.

Q. *How many engineering colleges or universities are there in the Soviet Union?*

A. In the Soviet Union a sharp distinction exists between universities and engineering institutes. Universities train scientists; engineering institutes train engineers exclusively. There are thirty-four universities and approximately 200 engineering institutes. Of the latter, about 24. the polytechnic and industrial institutes, offer training in several branches of engineering; the rest are narrowly

specialized for training in a particular field of engineering and, as a rule, for a particular industry. There are, for example, thirteen institutes for training engineers in "Mechanization and Electrification of Agriculture."

Q. *Much of a sensational nature has been printed in the American press on the quantitative dimensions of Soviet education. What are the real facts? Do they train more people than we do?*

A. The Center's study has been less concerned with quantity than with the qualitative aspect of Soviet training.

Both relative to the population and in absolute figures Soviet enrollment in schools of higher education is well below that in the U.S. For instance, in 1955-1956 American college enrollment was nearly three million and in the U.S.S.R. somewhat less than 1,900,000 including 640,000 part-time, extension students. What is important, however, is that in the U.S. most college students take liberal arts whereas in the U.S.S.R., the reverse is true. Thus in some professions, including engineering, the rate of training in the Soviet Union now for several years has been higher than in the United States.

Q. *What about graduate training? I remember reading that the output of graduate students is about twice as large in Russia as in the U.S.*

A. That is not so. In 1955, for example, the number of Ph.D. degrees earned in the U.S. was 8,840, including approximately 4,400 in science. This compares with some 7,700 Soviet graduate degrees most nearly corresponding to the American Ph.D. (*kandidat* of sciences) awarded in the U.S.S.R. in that year. This is like comparing apples and oranges. The Soviet figure includes *kandidat* degrees not only in science but in all fields of training—including education, arts, economics, Marxism-Leninism, etc.

Q. *Is a Soviet trained physicist, chemist, or engineer as well qualified as his counterpart in the U.S.?*

A. In general, comparing scientific training, there are no significant differences between, let us say, an American Ph.D. in physics and his Soviet counterpart. The difference increases, however, as we go down the academic ladder. At the high school level the science and mathematics content of instruction in the Soviet Union is, statistically speaking, very much greater than it is in the U.S.

Q. *What do you mean by "statistically speaking?"*

A. All Soviet "high school" pupils take one and the same course. He is heavily oriented toward science and mathematics. Thus *every* Soviet "high school" graduate—1.3 million of them in 1955—has had the equivalent of more than four years of high school mathematics (through trigonometry) and nearly six years of high school science.

Q. *How many of the "high school" graduates in 1955 went on to higher education? How were they selected —by aptitude tests, scholastic record?*

A. No more than 220,000 of these new graduates were admitted to the institutions of higher education—perhaps considerably fewer. The present admissions policy is to give preference to older "high school" graduates, those with two or three years of work experience.

A Soviet applicant may apply to only one school in any year. Selection is made on the basis of competitive examinations in several subjects, taken orally and graded subjectively by individual examiners. I do not think this system provides the best means for selecting the most able and promising students.

Q. *What happens to those who don't pass?*

A. In practice they may not get another chance to apply for resident study. Going to work is the obvious alternative. They may then enroll in an extension course of higher education. Another alternative is to qualify for admission to a "technicum," a school for sub-professional training in various fields. Engineering and industrial technicums, with their two-year courses of sub-professional training following graduation from "high school," are similar to U.S. institutes which train engineering technicians. Here is one area of training that the Soviets have been strongly promoting. We estimate that by 1958 they may train at the rate of approximately 140,000 engineering and industrial technicum graduates per year. In comparison the present output of engineering technicians in the U.S. is perhaps not more than 20,000 per year.

Soviet Science Academy Voted Into IAF But Must Still Supply List of Members

Q. *Mr. Haley, what has been your association with Soviet scientists?*

A. My first acquaintance with them was at the Copenhagen Congress of the International Astronautical Federation in 1955. Two Russian gentlemen came in an official capacity, namely Professor Ogorodnikov of Leningrad and Professor Sedov. They listened quietly to the Congress proceedings. Then they agreed to a press conference at the Soviet Embassy which I attended. I can't recreate the acute and searching questioning by reporters but my impression was that the answers were adroit and uninformative. I always have been acutely aware of the problem of re-entry to the earth's surface—of an object, flying in outer space; so, rightly or wrongly, I asked Professor Sedov myself if Russian scientists have studied the problem of re-entry of earth circling satellites back to the earth's surface. He seemed a bit perplexed. So did Ogorodnikov. Their answer was that this sort of question was not on the agenda. Socially, the two professors circulated freely among all people. Nothing was said, that I heard anyway, that had any ideological bearing on the problems of rockets. They showed no knowledge of rocket techniques either theoretical or in the field of hardware. On the other hand they showed no lack of knowledge. All they showed was that they were not going to give any information. Then at the IAF Congress in Rome last year, I actively sponsored the membership of the Moscow Academy of Science in the IAF. Prof. Sedov was elected vice president. The purpose of the IAF is essentially civilian and peaceful, and in order to be able to have civilian and peaceful earth circling satellites, we need the common consent of all the nations of the world. Certainly we need the consent of a nation which controls one-sixth of the land surface of the world. Therefore, I though it was my duty to insist that the application of the USSR be acted upon favorably by the IAF so that they not only shared the benefits but also the duties and responsibilities.

There were a few remissions in the information they submitted, however. They didn't have a copy of the constitution of their committee. So we want that. Another was that they didn't have a full list of the membership, which we want, and we'll never get such a list if they don't have an official standing in our organization. ★

B. Ellis (center), head of the Propulsion Department, discusses methods of accurate thrust termination for a ballistic rocket with Dr. Howard M. Kindsvater (left), propulsion staff engineer, and André P. Bignon, propulsion research specialist.

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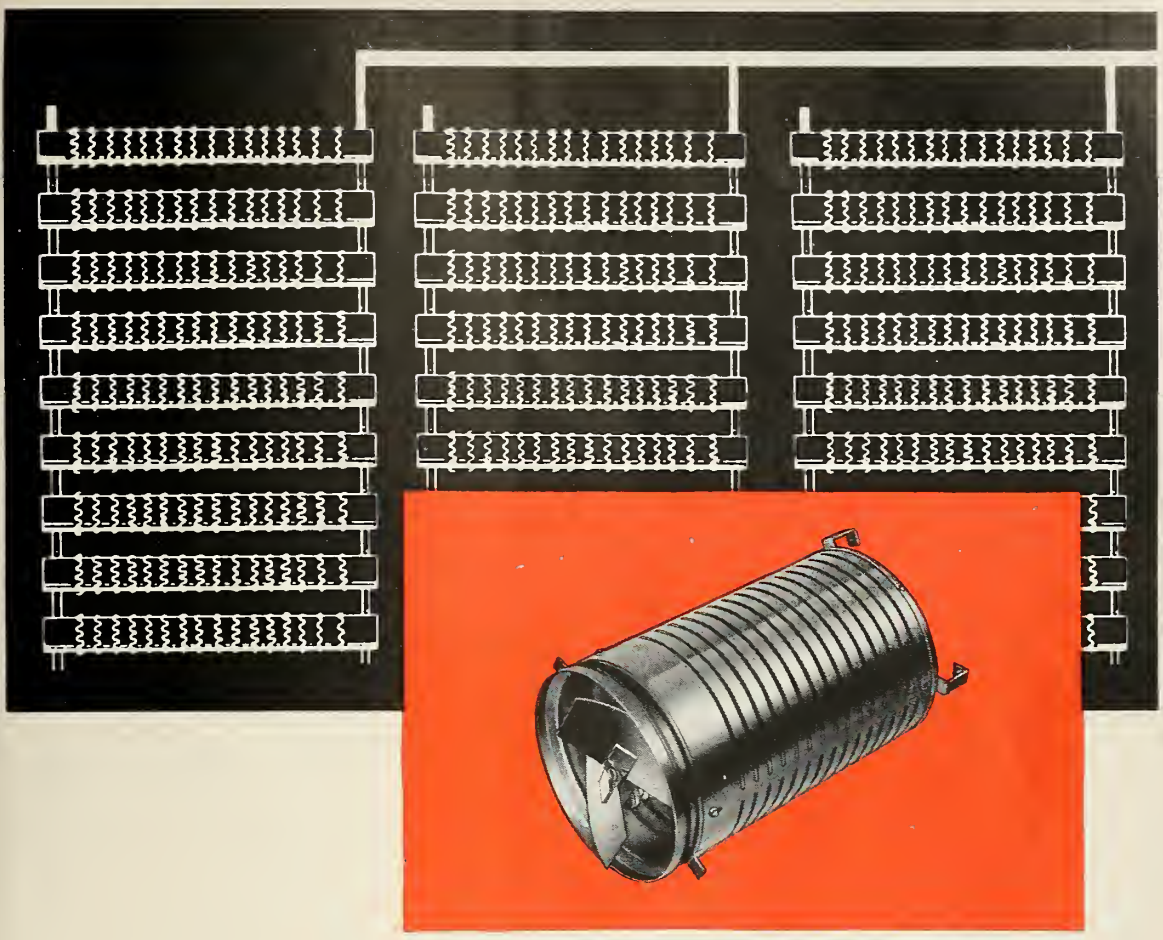

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What the Russians Tell . . . and What They Don't Tell

By Albert Parry
Professor of Russian Civilization and Language, Chairman of the Department of Russian Studies, Colgate University, Hamilton, N. Y.

Exactly one year ago, in February 1956, at the Twentieth Congress of the Communist party in Moscow, the Soviet Defense Minister Marshal Georgi K. Zhukov declared that Russia already possessed "diverse atomic and hydrogen weapons, powerful rocket and jet armament of various kinds, including long-range rockets."

Two months later, on April 23, during his (and Bulganin's) state visit to England, Nikita S. Khrushchev, first secretary of the USSR's Communist party, boasted even more boldly of Red progress in guided missile development. Soon, he said in his speech to the Birmingham Chamber of Commerce, the Soviet Union would have a missile armed with a hydrogen bomb warhead able to hit any spot in the world—meaning, of course, any spot in America first of all.

How soon?

Apparently not yet by the end of 1956. But other, nearer Western countries could by then be reached. "If rocket weapons had been used against Britain and France . . ." warned Premier Nicholas A. Bulganin ominously in his message to Prime Minister Anthony Eden of Britain and Premier Guy Mollet of France on November 5 in connection with the Suez crisis. He threatened to use against England and France, not the Soviet "naval or air forces," but "rocket equipment."

This, by Moscow's official announcement, meant that already three months ago the Soviet Union had means of rocket attack spanning whole nations—if not entire oceans and great continents as yet.

But beyond these statements, threatening or triumphant though they may seem, neither the Soviet people nor the outside world is told by the Moscow leaders precisely what has been achieved in Russian warhead-rocket research and production—exactly how far the guided-missile experimentation of the military type has progressed in the Soviet domains.

Our side tries, naturally enough, to "guestimate" the very latest state of Soviet accomplishments in this crucial field. But the Soviet leaders are no fools. They do not rise to the bait. They make no statements either to foreigners or in their own Moscow press either denying or confirming our intelligence.

In May 1954 George P. Sutton, chief of the Aerophysics Department of North American Aviation, Inc., stated that according to his information the Soviet Model 103, a liquid-propelled rocket engine, weighed very little, yet had the thrust of 53 conventional turbojet engines or more than five times the thrust of the German V-2 rocket. The Red goal, he said, was to evolve a 5,000-mile-per hour guided missile.

Any Soviet reaction to this American revelation? None whatever. Hard as we searched the Moscow press for any comment on Mr. Sutton's statement, there was nary a word.

Symington Reveals Red ICBM

On July 21, 1954, Senator Stuart Symington of Missouri, former Secretary of the Air Force, spoke of the Soviet attempt to produce an intercontinental missile with a hydrogen warhead of 4,000 to 5,000 mile range. Did Moscow acknowledge this declaration with any further clarification of its own? Not at all.

That the Soviet Russians had built long-range guided-missile launching platforms "at dozens of points in Europe and Asia . . . in a pattern allowing an arc of fire to cover, for instance, the Baltic Sea," was disclosed on May 18, 1955, by Representative Overton Brooks, a member of the House Armed Services Committee. Barely a month later, in mid-June 1955, our own Erik Bergaust reported after a trip to Europe that the Soviets had a liquid fuel rocket engine capable of developing a quarter-million pounds' thrust and a missile arsenal "as advanced as it is substantial." But again Moscow's response was, in effect, "No comment."

On February 5, 1956, Senator Symington returned to the theme by pointing out that the Soviet Union had tested an intercontinental ballistic missile which went "hundreds of miles further" than any such weapon then tested by the United States. The Russians, he added, were "well ahead of us." Insisted the Senator:

"I don't 'believe' the Soviets are ahead of us in ballistic missiles. I *state* that they are ahead of us in ballistic missiles."

Any significant echo from Moscow? Mum was still the Red word.

Similarly there was neither "yes" nor "no" from the Reds to other American statements that, late in 1955, the Soviets had missiles with ranges up to 1,500 miles; that by late 1956 these ranges surely increased; that Soviet submarines could fire ballistic missiles over distances of 650 miles when submerged and nearly 1,500 miles on surfacing.

But if not all such things, then just what are the Soviets saying about their rocket research and experimentation?

Mostly they tell their people of *our* guided-missile work and in the process call us nasty names because, the Moscow propagandists repeat again and again, in our rocket experimenta-

tion we mean war only, never peace—and aggressive war, at that, not merely defense.

On March 3, 1956, *Sovetsky Flot* (Soviet Navy), the official Russian navy organ, denounced the latest American development of guided missiles as being "for offensive purposes" and "aggressive plans." The Russian article carried as its illustrations detailed sketches of three American missiles (*Terrier, Regulus,* and *Petrel*) along with data as to their range, speed, weight, warheads, and guidance systems, also the types and names of United States warships being re-equipped for missile operations. Significantly the Soviet navy journal remarked that, of course, such "weapons can be used by both sides"; in other words, that the Soviet Union had such missiles, too.

Lists US Peace Rockets

It is true that the article on *Raketa* (Rocket), in Volume 35 of the Great Soviet Encyclopedia (July 1956), lists two peaceful American missiles along with three military ones, but the general tone of Soviet writers is "Be on guard against that warmongering America, fellow citizens!"

"We must not forget," warns Boris V. Liapunov, a Soviet engineer specializing in writing about missiles and rockets for the layman, "that guided missiles can carry not only scientific-research equipment, but also explosives; not only mice and monkeys, but also atomic warheads." He makes this statement in his article *"Samoliot-Raketa-Snariad"* (Plane-Rocket-Missile) published in the Moscow *Ogoniok* (Little Fire) on May 1, 1955. He does not say anything clear or definite about the Soviet investment and accomplishments in guided missiles. Instead he cautions the Russian reader that "the aggressive circles of the imperialist countries devote considerable attention to guided missiles as a weapon of mass destruction."

In such countries (meaning the United States first and foremost), "guided missiles of most varied types are being planned and tried out for the army, the navy, and the air force." What can or will or do the Soviets undertake to counter this danger from the West? Plenty, hints Liapunov. "Like atomic weapons or any other weapons, pilotless arms have two edges. Rockets and pilotless missiles are in themselves a target for our means of defense."

But will the Soviets attack first? Comrade Liapunov hedges on this a bit: "Soviet people demand prohibition of the weapons designed for the mass annihilation of humans. Science should serve peace and prosperity of mankind. With their pilotless aviation Soviet people will conquer the ocean of air, will study the world's space." His implication is that this Russian conquest will be wholly peaceful, but should any foreign power stand in its way—look out!

Earlier, in 1954, and speaking this time directly to Soviet soldiers, the very same Boris V. Liapunov charged "the imperialists" with the evil intention of "using rocket technology to wipe out people en masse." He issued this warning toward the end of his book *Raketa* (Rocket) published in Moscow in the series "Scientific-Popular Library for Soldiers and Sailors" by the Soviet Defense Ministry. "Modern technology," he wrote, "permits the utilization of rocket weapons over distances of thousands of kilometers, without employing airplanes." But, continued Liapunov, the Soviet armed forces have such weapons, too—strictly for defense purposes, "to give a smashing repulse to the foe in case he dares to aggress." We, the Soviets, also have "scientists, engineers, designers, and industrial specialists" in this newest field!

Explaining to the Soviet soldier and sailor the scientific principle of Soviet "defensive" guided missiles, Professor Kosmodemiansky closes his recent book with this eloquent appeal:

"Warriors of the Soviet army, navy, and air force! Remember that these days science stands beside you in defending the frontiers of the Socialist Power. Think as you create and improve your fighting technology. Daydream, indulge in fantasies; then check your daydreams and fantasies by mathematical calculations and practical experiments. Always bear in mind the proud motto of Constantin Eduardovich Tsiolkovsky: *That which is impossible today will become possible tomorrow!*"

In many such Soviet books and articles the "glorious" tradition of the use of rocket weapons by the Russian armed forces is continually stressed.

Soviet Guided Missile Czar—
Air Marshal Zhigarev

By text and picture it is recalled that Russian military commanders and engineers first introduced rocket artillery in their wars of the early 19th century; that Russian inventors constantly perfected such weapons; and that under the Soviets, in World War II, the celebrated "Little Kitty" (*Katiush*) or modern rocket artillery truly distinguished itself.

In their discussions of rockets and missiles of other than military nature, Soviet writers like to dwell again and again on the pioneering work of Tsiolkovsky and other Russian professors of the first 30 years of this century. They also boost the "boomerang-to-the-Moon" project of our contemporary Professor G. Chebotarev. They revel in detailed descriptions of the artificial satellite of the Earth soon to be launched by the Soviets; also in the blueprints of Soviet mail-service by rocket, and in other such peaceful accomplishments or plans.

In their book *Samoliot-Raketa* (Rocket Plane) published in Moscow in 1953, L. K. Bayev and I. A. Merkulov praise not alone Tsiolkovsky but also such pioneers as F. A. Tsander and Yu V. Kondratiuk. These Russian researcher-inventors are lauded in the little volume for their suggestion "to utilize as fuel for rocket engines such metals as magnesium and aluminum . . . by burning them in oxygen or by combining these metals with the chemical element of fluorine, this leading to a great yield of heat energy." The authors point out that "this enhances the energy of the fuel and, besides, allows to burn, toward the flight's end, those parts of the flying apparatus which by then would become unnecessary anyway." Soviet readers are informed that here lies the solution of the problem of how to increase sharply the range of flight.

No Manned Satellites

Lucid explanations of Professor Chebotarev's project of sending a rocket to the Moon and back have been appearing in the Soviet press quite frequently, the best of these having been presented in *Literaturnaya Gazeta* (Literary Gazette) of October 20, 1956, and *Trud* (Labor) of September 30.

In effect cautioning the Soviet reader against too much optimism, G. B. Kozhevnikov (an engineer) wrote in his treatment of radioelectronics and the artificial satellite in *Radiotekhnika i Elektronika i Ikh Tekhnicheskoye Primeneniye* (Radiotechnology and Electronics and Their Technical Application, Academy of Sciences, Moscow, 1956) that it was far too premature to expect the actual manning of the satellite with human beings. "Mod-

ern rocket means now available," he remarked, "do not yet permit us to launch a satellite large enough to lift into space one or more men."

On the other hand, Yu. Khlebtsevich (a candidate of technical sciences) showed considerable confidence in the prospects of rocket work in Russia when in his article on the artifical satellite, published in *Literaturnaya Gazeta* on July 10, 1956, he maintained: "We must note that from the viewpoint of modern technology the launching of an artificial satellite does not present any particular complexity. In the future, satellites will set out on their flights by the score—to various heights, along different orbits."

Speaking of what may prove actually practical in the very near future, Liapunov in his already quoted *Ogoniok* article discourses on Soviet postal-service rockets. He makes a point of insisting that such mail-rockets are "no idle fantasy." The Red project of such mail service, he says, is based on "the entire experience of rocket technology, in cooperation with radiolocation and automatics already creating remarkable pilotless machines flying faster than sound." Postal rockets are planned to connect Moscow with the farthest cities "of the European part of the country." Soviet Asia will evidently have to wait for such boons. No more than one-half hour will be needed to reach, by postal rocket, the farthest European Russian city from the Soviet capital. "The sending of a letter will most likely cost not more but less than it does now, yet think of the tremendous time gain!" exclaims Liapunov. To his text he appends a drawing by N. Grishin, a Soviet artist, showing the landing of a mail-rocket of the future.

In another of his numerous texts —in his 1954 book *Raketa*—Liapunov predicts an equally early use of rockets for shipping freight "from one end of the country to another in a matter of just a few hours." Here Soviet Asia is included—else the time lapse would have surely been stated in minutes.

And in his 1955 volume entitled *Rassakzy o Raketakh* (Tales of Rockets) the same author become eloquent about Soviet peaceful progress to the point where he proclaims that "we have never had and could not have rockets that would serve as means of destroying of a mail-rocket of the future.

Here the Red signals have certainly become crossed. How this peaceful use of warlike rockets could be possible, in view of all the statements by Khrushchev, Bulganin and Zhukov about Soviet possession of warhead-carrying guided missiles, only the main Moscow propaganda office in charge of Liapunov's writings can figure out. ★

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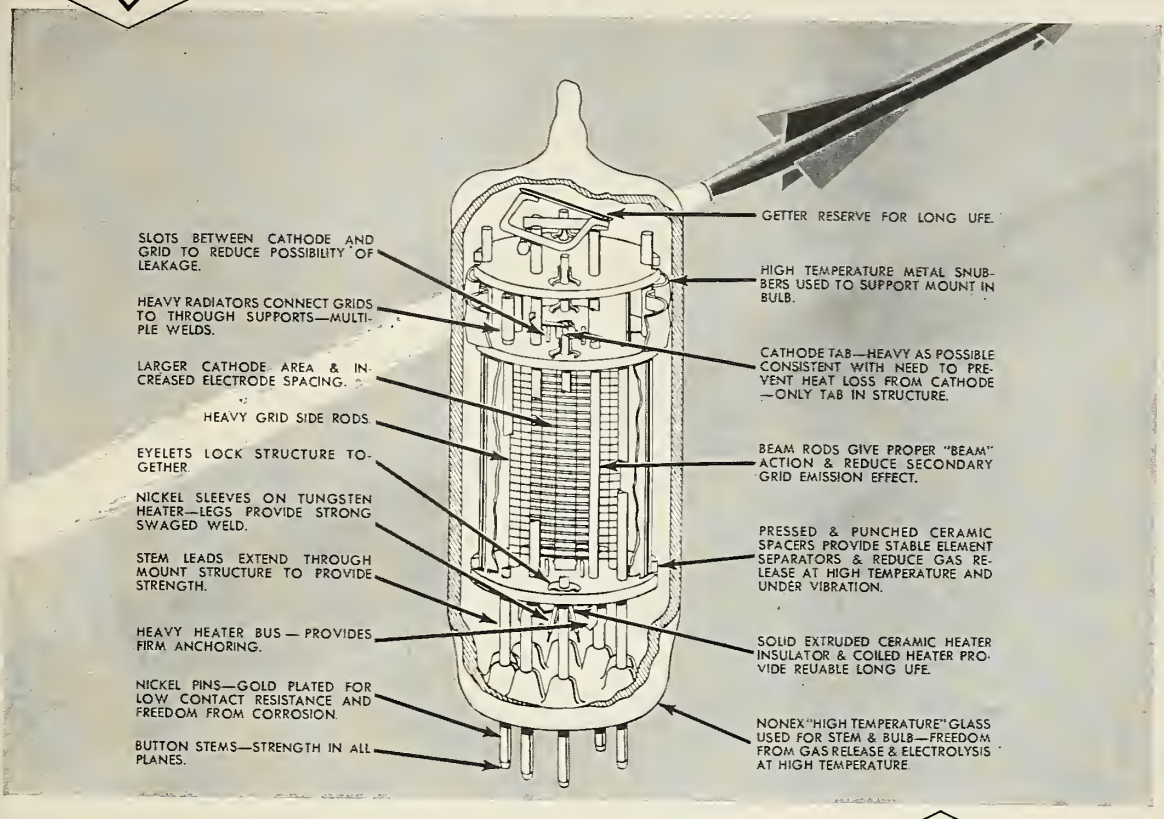

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T-9	—	—	—	6853	—	—
T-6½	6851 6854 6900	6582A	6486A	6754	6094	6877 6900

Retma Type No.	Retrofit For	Generic Type	E_f	I_f	Bulb	Bendix Type No.
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6094	—	6AQ5-6005	6.3	0.6	T-6½	TE-18
6853	6106 5Y3	5Y3	5.0	1.7	T-9	TE-45
6384	6AR6 6098	6AR6	6.3	0.9	T-11	TE-27
6854	6385	2C51 5670	6.3	0.5	T-6½	TE-47
6486A	6486	6AS6	6.3	0.25	T-6½	TE-43
6582A	6582	6AK5	6.3	0.25	T-6½	TE-44
6754	412A	—	6.3	1.0	T-6½	TE-36
6851	5751	—	6.3	0.5	T-6½	TE-42
6877	—	Half of 6080	6.3	0.8	T-6½	TE-48
6900	5687	5687	6.3	0.9	T-6½	TE-54
6889	—	—	6.3	0.9	T-11	TE-52
6082A	6082	6082	26.5	0.6	T-12	TE-55

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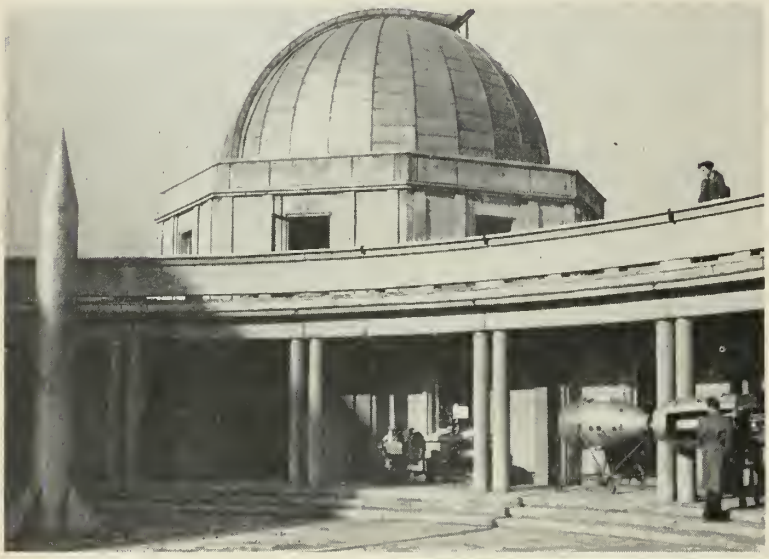
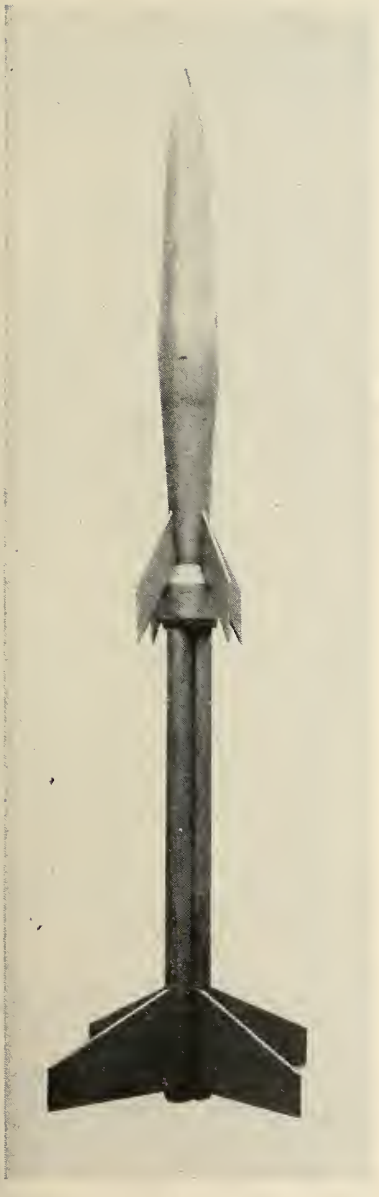
Behind-Iron-Curtain Rocket Show

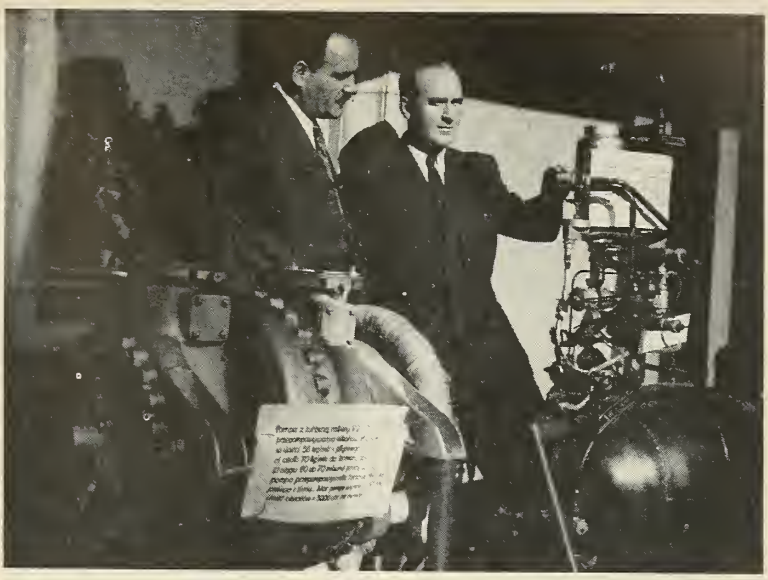


The Silesian Planetarium and Astronomical Observatory in Katowice in Poland has been the home of a recent rocket and space flight exhibit sponsored by the Polish Astronautics Society in cooperation with the Museum of Technique of the Chief Technical Organization NOT. Several German and Russian items were displayed. Of particular interest was a modified Russian T-7A research rocket (left) which is believed to be of the size and have the performance of our Honest John.

Director of the Silesian Planetarium, Professor Satabun, right, is posing in front of picture of space man with Wladislaw Geisler, physics engineer and president of the Silesian Section of the Polish Astronautics Society. Geisler was a delegate to last year's International Astronautics Federation Congress in Rome, Italy.

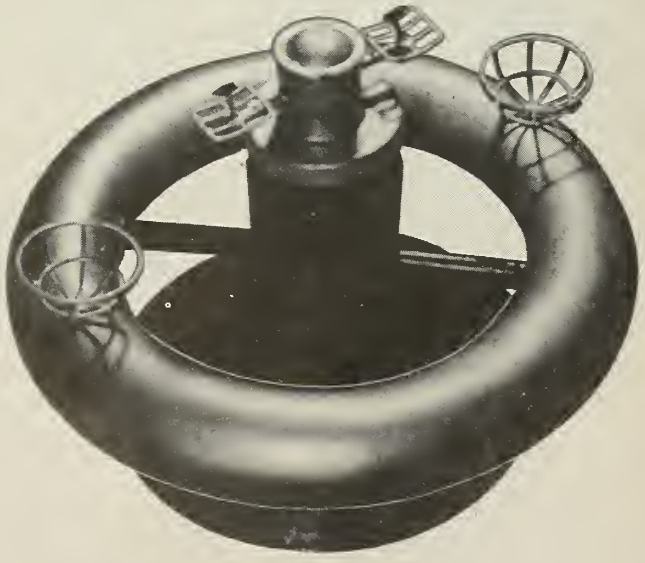


Russian Mach 4 sounding rocket. Notice crude first-stage booster and fixed stabilizer fins. Booster consists of four solid-propellant chambers believed to be modified aircraft rockets. Odd-size second stage contains instrumentation and small parachute. Reports say Russian research rocketry is extensive. Large rockets have carried animals to 300 miles, Reds say.



Satabun and Geisler looking over V-2 components. Main pump and turbine unit (left), and gas generator are displayed. Undamaged, well-maintained equipment and components were contributed by the Russian Army. They were shipped from Soviet missile schools. Numerous research rockets also were provided by Reds.

Model of Russian space station, similar to Wernher von Braun's famous "pinwheel." Interest in astronautics is overwhelming, according to Geisler. He told m/r the exhibit has been visited by more than 20,000 in less than four weeks. Exhibit is now touring Poland and might also go to other satellite countries.



international briefs

USSR Aviation Minister Honored

P. V. Dementyev, minister of the aviation industry in the U.S.S.R. has received one of the highest awards of the Presidium of the USSR's Supreme Court. Dementyev received the Order of Lenin on his 50th birthday "for his services in aviation industry development."

Supersonic Atom Plane Design Shown by British Firm

The British company, Hawker-Siddeley Nuclear Power Co. has published general details of its version of a supersonic nuclear powered aircraft in the Hawker Siddeley Review, a company house organ. Though, the general design is too heavy for missile application, it is a first step in the direction of a nuclear rocket. Noting that low weight and space are essential, the article says:

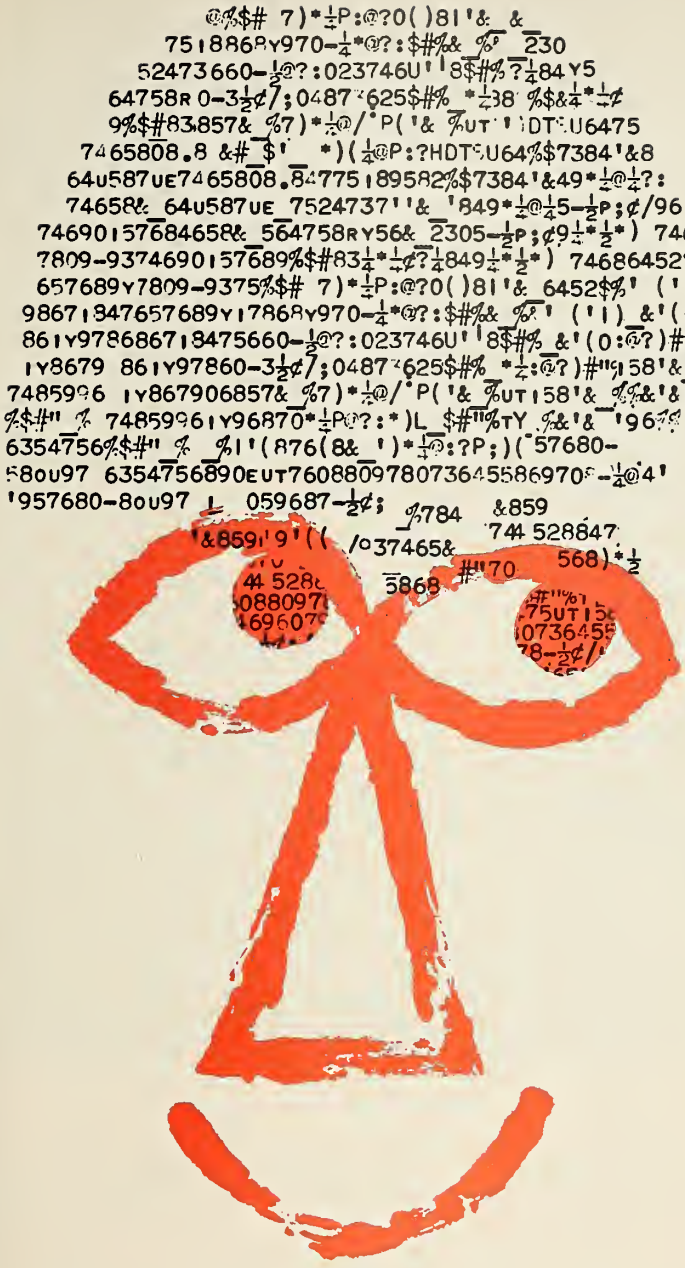
"At present a fast reactor with highly efficient liquid-metal heat extraction would seem the most suitable system, although there are strong arguments in favor of a gas-cooled system even at the expense of some increase in size. The crux of the aircraft problem is a successful evolution of the concept of partial shielding but, even so, such aircraft will be large with all-up weights probably greater than 100,000 pounds."

The Hawker-Siddeley configuration shows two wing-tip turbines driven by a reactor situated about amidships in the fuselage.

Britain Schedules Testing Of Skylark Rocket

Test firings of Great Britain's upper atmosphere research rocket is scheduled soon at Woomera. The *Skylark* is 25 ft. long, 17½ in. diameter and is stabilized by three swept fins. It is powered by a Bristol Aircraft Raven dry rocket, which has a maximum thrust of 11,500 lbs. for a nominal 30-sec. period.

The initial design ceiling is 70 miles with 120 miles foreseen for later variants. The launching tower at Woomera will be 80 ft. high and once a predictable trajectory has been proved, firings will continue from a similar tower at the MoS missile center of Aberporth, Wales.



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International Scene

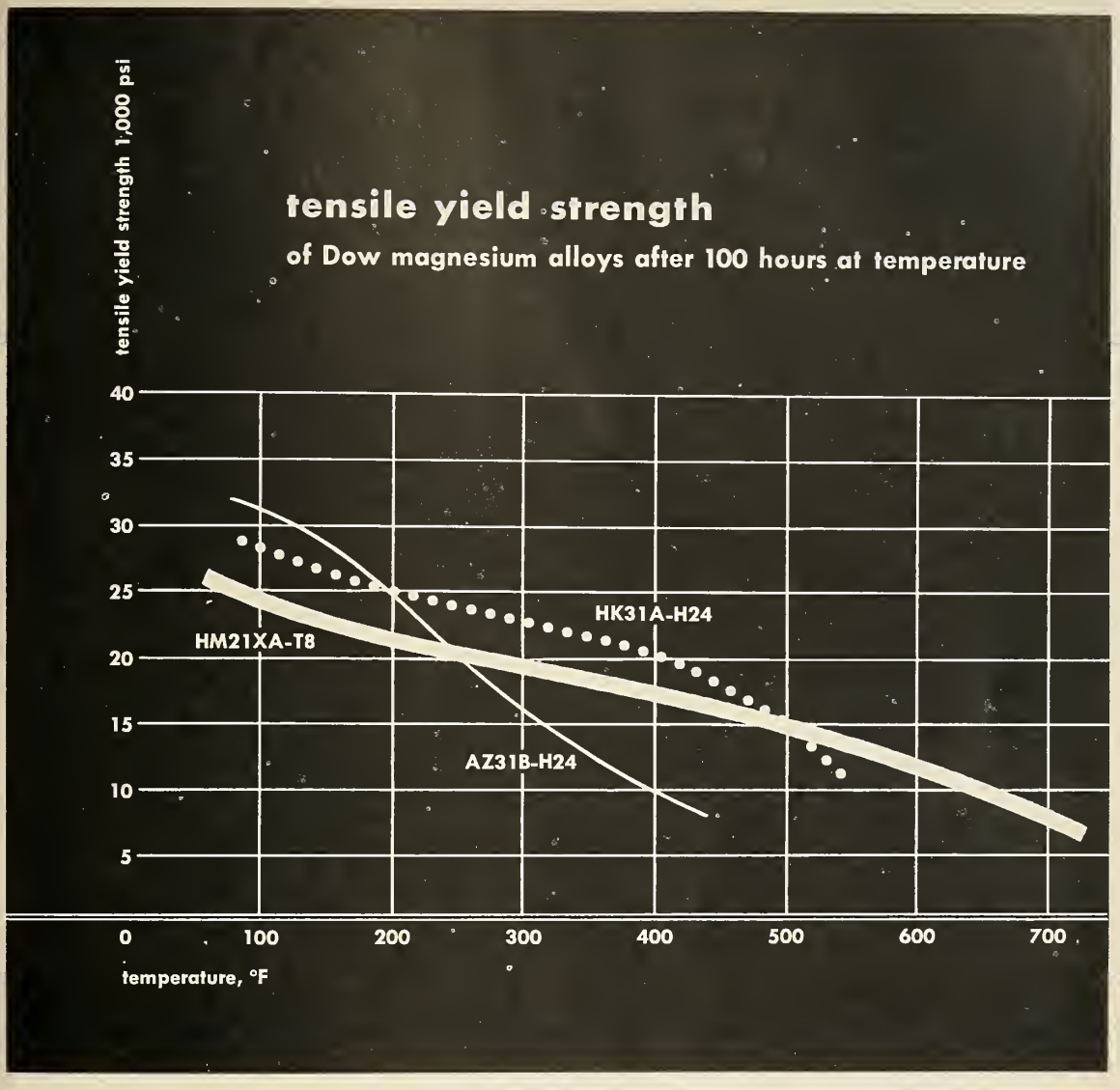
By Anthony Vandyk

None of the group of reporters, including this writer, who visited Russia last year saw any trace of Soviet missile activities. It was some consolation to learn that General Twining did no better. "We met a blank wall," he said. Nonetheless, Sovict aircraft production methods can give a clue to missile production techniques. Three things about Soviet aircraft production methods impressed the Twining group. First, the assembly jigs were light and simple; in contrast with the American practice of employing forgings or extrusions, welded sections were used for landing gear and similar structures. Second, curved sections were fabricated from sheet aluminum on simple hand-operated light hammers, while more difficult sections were formed by air-activated, hydraulic stretch processes managed by simple hand control. Third, the wing and fuselage sections in the plant visited by the Twining group were built up by the riveting together of smaller parts.

The two plants to which the Twining group was permitted were among the oldest in the Soviet aircraft industry and are not representative of the modern production facilities that exist elsewhere in Russia. Nonetheless, says Twining, there is good reason to believe, even on the basis of these two examples, that the Soviet Union possesses "in high degree the ability to apply mass production processes and techniques to the manufacture of airframes and jet engines." In research facilities the Russians seemed to Twining to be doing well. At the Zhukovski Air Engineering Academy the Twining group was given a demonstration of a Mach 3 wind tunnel. The aircraft model used was a true delta design. From the shock waves produced when it was subjected to the ultrasonic air stream, "it was clear that this tunnel was a bona fide Mach 3 testing device," Twining reports. There was another wind tunnel at the academy which the Russians said should produce Mach 5 conditions but this was not put into operation for the American group.

During a visit to the Air Force Academy at Monino the Twining group noticed several models of U.S. aircraft in a classroom devoted to the study of fighter tactics. Among the models represented were the B-52, F-100, F-101 and the B-66—but no missiles. This writer saw photographs of the Matador and the Regulus in the Air Museum in Moscow but there was no material whatsoever on Russian missiles. During the fairly extensive travels of the group of reporters accompanying General Twining no missiles or apparent launching sites were observed. The reporters were allowed to travel freely in the Moscow area and many numerous flights on commercial aircraft to and from the Soviet capital. It is probably that the aircraft use air corridors that avoid areas of special military interest. Nonetheless, it is amazing that not a single missile or launching sight has ever been detected by a Western reporter, particularly since many reporters and other observers have seen Russian radar installations.

The Russians' missile potential is of vital interest to the Western world at a time when Britain is planning to cut its defense expenditure and concentrate most defense production on a long-term missile program which is unlikely to show any results before the end of this decade. At this writing it seems that the U.S. will have to defend the western world with missiles for several years to come, either directly with missile-equipped units based in foreign nations or indirectly by supplying the armed forces of NATO allies with U.S.-built missiles. The possibility of extending the off-shore procurement to the missile field exists but it does not seem to offer a satisfactory solution to the problem of bolstering the overall missile defense of the western world in that many of Europe's present missiles are inferior to their U.S. counterparts.



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World Astronautics

By Frederick C. Durant III

During the past few years the press has reported the conflicting claims of the U.S. and the U.S.S.R. as to which nation fathered certain major inventions, e.g. the airplane and the electric light bulb. With respect to the science of astronautics, however, there appears to be no argument: Russian K. E. Tsiolkovski was the founder.

It was Konstantin Eduardovitch Tsiolkovski who, in retrospect, most completely realized the relationship between rocket propulsion, mass, and the distances from the earth to other heavenly bodies. Tsiolkovski, a school teacher, published in 1895 his first article on space flight. He was then 38 years old. Until his death 40 years later he dedicated his life to the careful study of the problems he prophetically realized would have to be solved before man could venture into space. Striving for the highest possible specific impulse he sketched in 1903 a rocket ship showing space for liquid oxygen and liquid hydrogen tanks and a sealed, pressurized crew compartment.

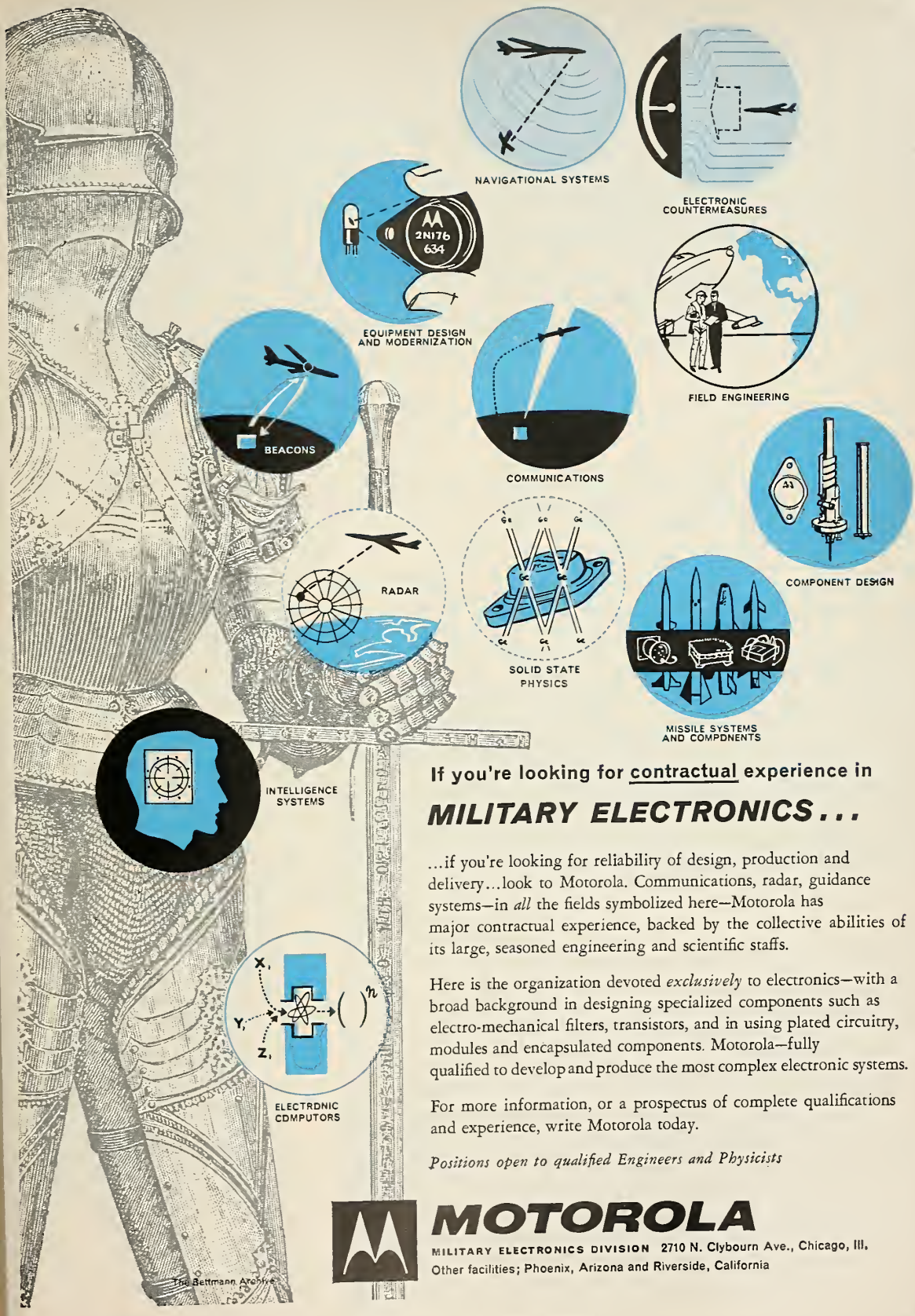
In 1929 Tsiolkovski's disciples Fortikov, Rynin and Perleman founded a competent scientific organization for investigating and systematically developing rocket devices. Called the "Group for the Study of Reactive Motion" (GIRD), chapters were formed in Moscow and Leningrad. In 1934 the Soviet Government organized a military rocket research program which paid off in World War II in rocket bombardment weapons, notably the Katyusha. Since the War there has been increasing reference to rockets and space flight in the official press.

The U.S.S.R. was the first major nation to give official scientific recognition to astronautics establishing in 1954 the Tsiolkovski Gold Medal Award for the "best papers by Soviet scientists working in the field of astronautics." A permanent Commission on Astronautics of The Academy of Sciences, Moscow, was announced in 1955. The Academy is the top scientific body of the U.S.S.R. The Commission on Astronautics was the first governmental organization to apply for membership to the International Astronautical Federation which has as members the rocket and space flight societies of twenty other nations.

The Commission on Astronautics is headed by well-known Academician L. I. Sedov and the membership includes the names of outstanding physicists such as Peter L. Kapitsa as well as engineers and astrophysicists. This public and professional recognition of the respectability of astronautics by the U.S.S.R. predated such recognition by the governments of all other major nations.

At the Barcelona meeting of the IGY national committees last September, Professor Bardin, speaking for The Academy of Sciences officially announced the existence of a Russian satellite vehicle project for the IGY and a desire for cooperation in the U.S. satellite program.

Many rocket engineers fired by the realization that manned space flight could occur in their lifetime even hope for a friendly rivalry and "space race" between the U.S. and the U.S.S.R. Based upon the technology of long range ballistic missiles such research in the upper atmosphere and beyond could result in major breakthroughs in science. Many kinds of data obtainable from rocket research in space can be obtained in no other way. The possibility of military-developed hardware of both countries being eventually used for such peaceful and productive endeavors is an exciting premise.



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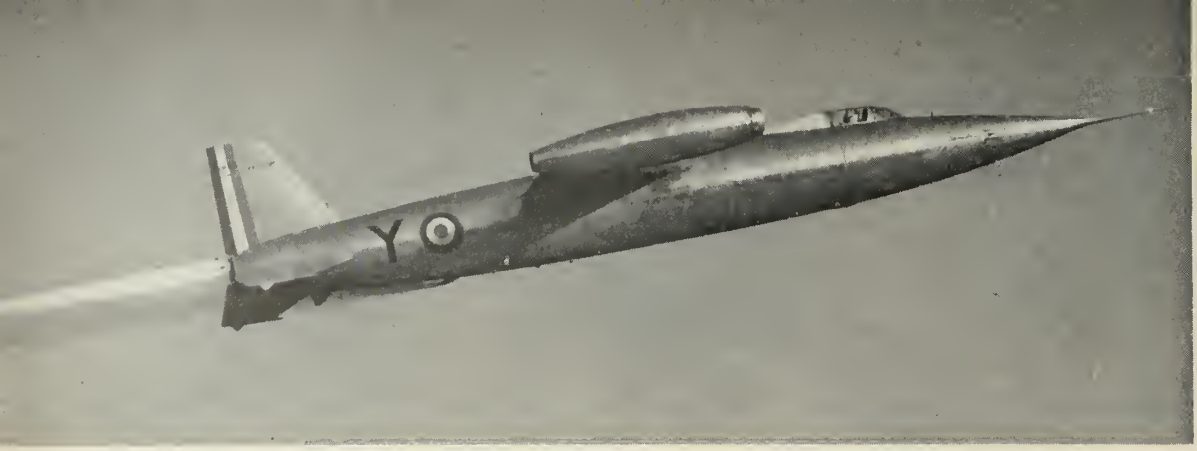
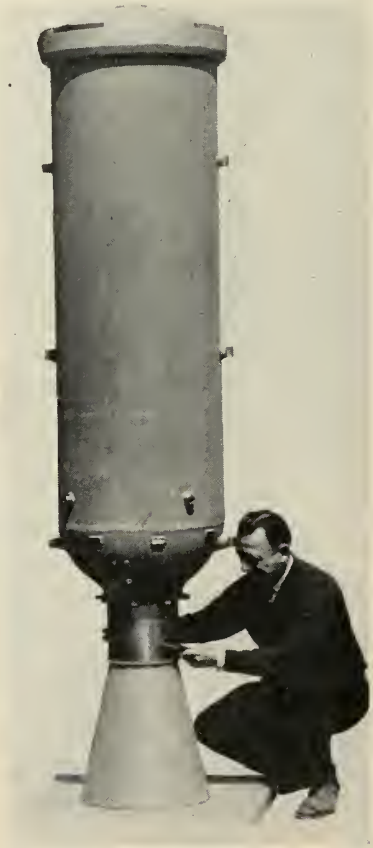


Ouest-Aviation's TRIDENT I is capable of Mach 1.6 at 53,000 ft. Its SEPR rocket motors provide a total thrust of 9,900 lbs. The wing-tip mounted turbojets are used principally for take-off. The rocket units are manufactured by Societe d'Etude pour la Propulsion a Reaction.

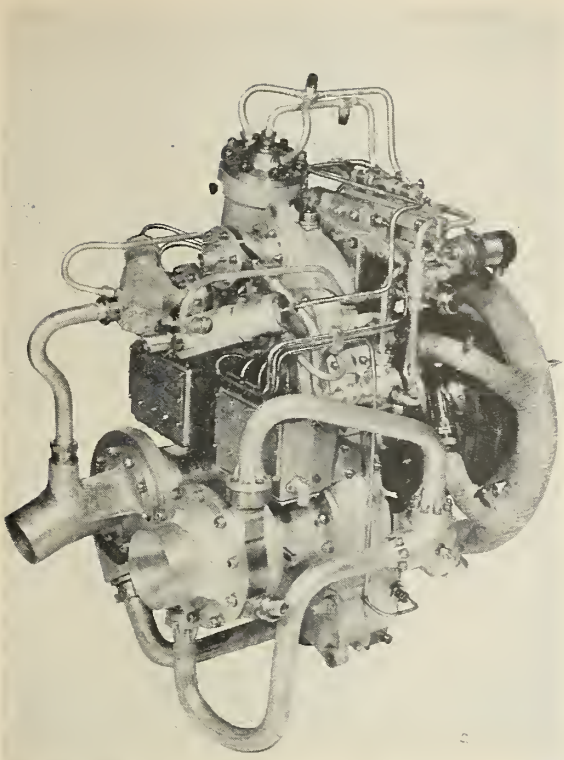
French Solid and Liquid Rockets

One of the TRIDENT I's three rocket motors is in operation as the aircraft taxies into position for take-off. Overall aircraft configuration is clean, fast.

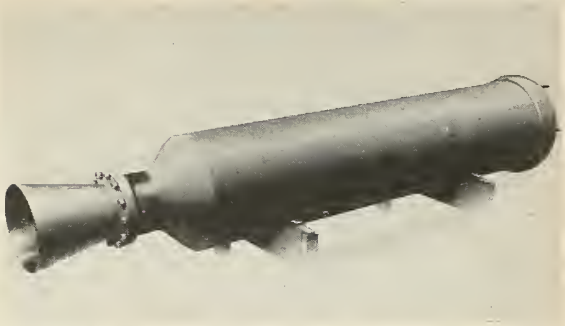
Tail view of the TRIDENT II shows two rocket chambers. TRIDENT I had three chambers.



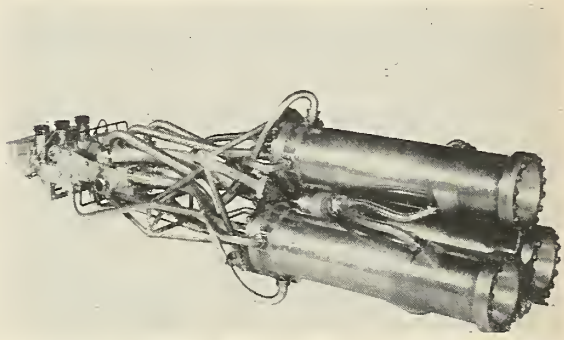
The SEPR-73 solid propellant booster rocket develops a thrust of 45,100 lbs. for four seconds. Loaded weight is 1,528 lbs. Combustion chamber pressure is 995 lbs. per sq. in.



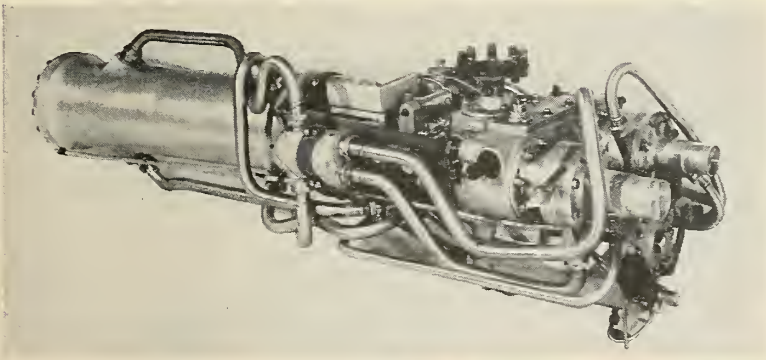
This turbopump unit is used in the TRIDENT I's SEPR-481 rocket engine. Unit operates on rocket engine propellants (nitric acid and furaline). Turbine cooling is achieved by separate water supply.



The SEPR-505 solid propellant booster rocket has a thrust of 22,000 lbs. for 4.5 seconds. Weight loaded is 884 lbs. and overall length is 7.9 ft. Chamber pressure is 780 lbs. per sq. in.



This cluster of three SEPR-481 rocket motors is used in the TRIDENT I. Each chamber develops 3,300 lbs. thrust. The 9,900 lbs. total thrust is about 40% greater power than the 6,000-lb. thrust Reaction Motors engine used in the Bell X-1 and the D-588 research planes.



This is one of SEPR's early rocket engines, the SEPR-25 Guepe used for the Ouest Aviation 6025 Espadon experimental aircraft. Developing 3,300 lbs. thrust, the SEPR-25 uses nitric acid and furaline as propellants which are forced into the combustion chamber by a pumping system mechanically driven from the main powerplant of the Espadon, a Rolls-Royce Nene turbojet. Power take-off arbor is located on top (note attachment plate with eight bolts).

Ouest-Aviation's 6025 Espadon was the first French aircraft with rocket power. The SEPR-25 rocket engine of 3,300 lbs. thrust enabled the aircraft to achieve Mach 3 and an altitude of 50,000 ft. Slung under the fuselage is a Rolls-Royce Nene.

Case For Jelly-Propellants

A jellied propellant has the advantage over a liquid since, with proper pumping and feed design, it can be flow-regulated. At the same time, by this regulation of flow mixture-ratio can be changed and throttling rocket chambers can be built. How can a jellied propellant be obtained?

Various organic substances such as the butyl rubbers, various stearates and such gellatinous substances as the saturate amines which have the property of becoming a quasi-solid under the proper conditions of temperature and pressure may be considered. Various metallic additives, such as metallic soaps, have been added to gasoline and have resulted in the jellification of gasoline.

The cresyl and butyl and buna rubbers again have this property and if the rubber producing reaction is not carried to completion but allowed to stop before full polymerization occurs, a jelly rather than a liquid or solid results.

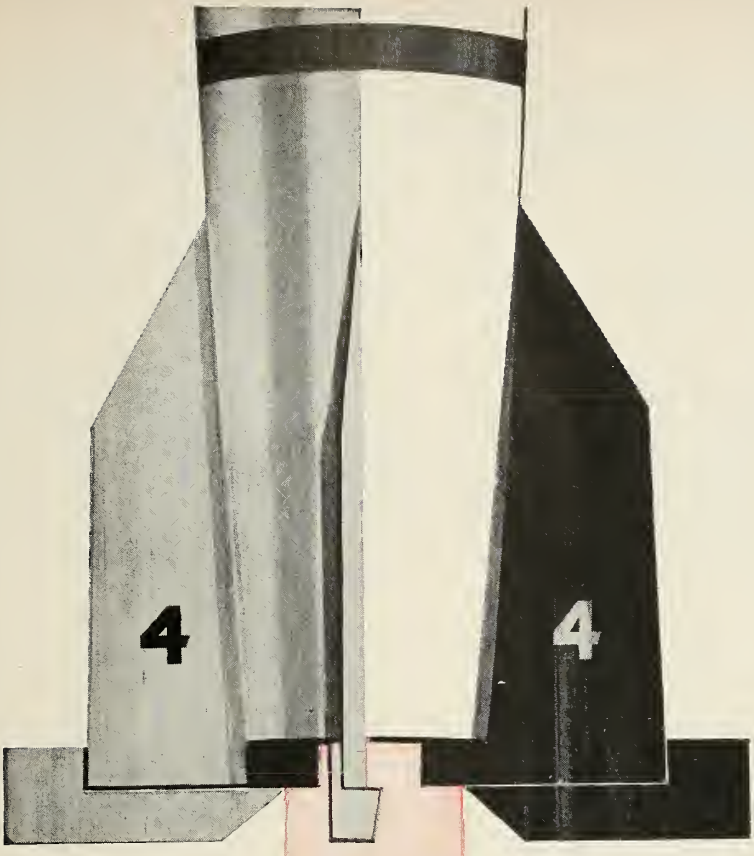
These jellies could be used as fuels but the problem is to produce an oxidizer which is also a jelly. This is much more difficult since ithe chemically active nature of oxidizers is an inherent block to jellification. One approach out of this dilemma is to combine the oxidizer and the jellied fuel in some way without reacting. This seems difficult since the oxidizer naturally wants to react with the jellied fuel.

The way out of this is to put a third additive into the system, i.e. make a three component system and the third additive will then insulate, so to speak, the fuel from the oxidizer, or as the globule of fuel is surrounded by a layer of liquid polyethylene or some saturate fluorinated liquid elastimer, which prevents the oxidization of the fuel. If this mixture is forced into the rocket thrust chamber, and ignition is applied by a spark or igniter, the insulating wall momentarily breaks down and allows the reaction to proceed. Since the jelly is very temperature sensitive and will readily become a liquid, the reaction proceeds in a liquid phase, and goes to completion. Once the proper temperature gradient is established, all the jellied "mono-propellants" continue to react as fast as the fuel can be injected.

The feed systems for jellies, perforce, are more complicated than for liquids since the "fluid" flow friction is so much higher. Many systems using jellies tend to have, therefore, a somewhat more powerful gas generator and thrust chamber machiners to pump an equivalent mass flow of propellant. Special chamber design would have to be employed and conventional valve pintles and seats would be necessary.

However, an interesting benefit of jellies is the greater unit volume density which is obtained, i.e., more propellant can be packed in a given space. Another advantage is that the absorption of a pressurized gas, such as nitrogen, is reduced again because of the greater density of this jelly. Also, as stated before, since it would be almost mandatory to include the oxidizer in the jelly suspensoid, a form of mono-propellant is obtained. This would more than overcome the extra pumping and piping complexity needed for the jellies since the flow system itself is naturally simpler for a mono-propellant. Boron or berrylium or aluminum as metallic additives would greatly increase the combustion volume temperature.

A drawback of the jelly propellant is its temperature sensitivity. If the temperature were raised beyond the critical point, the jelly might become liquid and create a serious hazard. Therefore, some means would have to be found either by chemical additive or temperature conditions to prevent this recurrence.



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Critical Temperature	158°C
Critical Pressure	99 atm
Specific Heat of Liquid	0.36 cal/gm −10 to 200°C
Density of Liquid	1.45 at 20°C
Density of Gas	3.3 gm/liter 21°C, 1 atm
Vapor Pressure	2 atm at 35°C
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Aeroballistic Forecasting at Redstone

for High-Punch Missiles

Predicting the influence of natural farces upon giant guided missiles is the difficult job performed by the Aeroballistics Laboratory of the Army Ballistic Missile Agency.

These 20th Century seers would put to shame the Merlins of the past. Instead of crystal ball or occult lore, they employ mathematical equations, meteorology, physics and other sciences to come up with estimates and not guesses.

Heading up this enterprise is Dr. Ernst D. Geissler, whose closely knit team of specialists at this Army Ordnance activity includes 110 civilians and 22 military personnel. Six of them have doctor's degrees in one of the sciences, 20 have master's degrees and 44 are bachelors of science.

Their unique assignment is to forecast the behavior of such missiles as the 60-foot *Redstone* as it roars through the earth's atmosphere and coasts through outer space, then falls upon the target.

"Our predications have so far been quite successful," Dr. Geissler admits. "No change was necessary in the configuration of the *Redstone* due to unexpected aerodynamic characteristics."

Having brought the medium range *Redstone* guided missile to the production stage, the Army Ballistic Missile Agency is now pursuing development of the intermediate range ballistic missile, or IRBM, dubbed the *Jupiter*. This will travel approximately 1,500 nautical miles and can be launched from land or sea.

The Laboratory's success has saved time, materials, and countless dollars. Because of the information developed by Dr. Geissler's group, the Army can hold down the production of test missiles and models to relatively modest numbers. It was for lack of dependable information that the Peenemüende group in Germany was able to launch successfully only 40 per cent of the V-2 rockets developed in the closing phase of World War II.

Dr. Geissler was a member of the Peenemüende group. He was engaged in missile activity since 1940. The year before that he received a master's degree from the University of Dresden and immediately became assistant professor of the Institute for Physics. At Peenemüende he studied the theory of control and stability of guided missiles. When the anti-aircraft missile *Wasserfall* was under development he directed the study of flight mechanics, theory of control and homing.

With his associates he worked out a new method of automatic, three-dimensional homing still in use in ground-to-air missiles. This project won him a doctorate in engineering in 1951.

Dr. Geissler came to the United States in 1945 with Dr. Wernher von Braun and others of the Peenemüende scientists. For the last six years he has concentrated on the *Redstone* missile. He recently became an American citizen.

It takes a well-seasoned mixture of theory and test data to produce reliable predictions of missile behavior. In Dr. Geissler's words, it involves:

"The prediction of aerodynamic lift, drag, stability, pressure distribution, controllability, and forces acting upon missile control vanes for new models is usually based upon a judicious mixture of direct theoretical calculations and extrapolation from existing test data for similar configurations when this information is available."

He added that so far, in the progress of the *Jupiter* program, there has been substantial agreement between the estimates of his Laboratory and results of actual test firings.

ABMA employs the services of many other mathematicians and physicists in the aeroballistic phase of its effort by contracting projects. Thus it derives data from wind and blowdown tunnels, and ballistic ranges, located at Aberdeen Proving Ground, Md., an Army Ordnance installation; the Naval Ordnance Laboratory at White Oak, Md., the Arnold Engineering Development Center at Tullahoma, Ala.; Langley and Wright Fields and Lewis Flight Laboratory of the Air Force; Cornell Aeronautical Laboratory, the University of Alabama and California Institute of Technology.

In many cases Dr. Geissler's personnel provide the models and model balances required for tests conducted elsewhere. Usually his representatives participate in the actual testing.

At the Army Ballistic Missile Agency Dr. Geissler has facilities available far superior to those used at Peenemüende. There is a supersonic wind tunnel, for example, and a high pressure jet facility with ranges from Mach 1.5 to Mach 4.5. He considers this wind tunnel a most efficient tool for obtaining aerodynamic data quickly. Installed in the tunnel are strain gage balances and pressure pickups which flash their information during testing through an analog-digital conversion device to an electric typewriter, or through other circuits which punch IBM cards for interpretation later by a massive computer.

Shortly the Laboratory will begin preliminary tests on a transonic and supersonic test section, double the size of the present tunnel, which will be capable of Mach numbers corresponding to speeds of more than 4,000 mph.

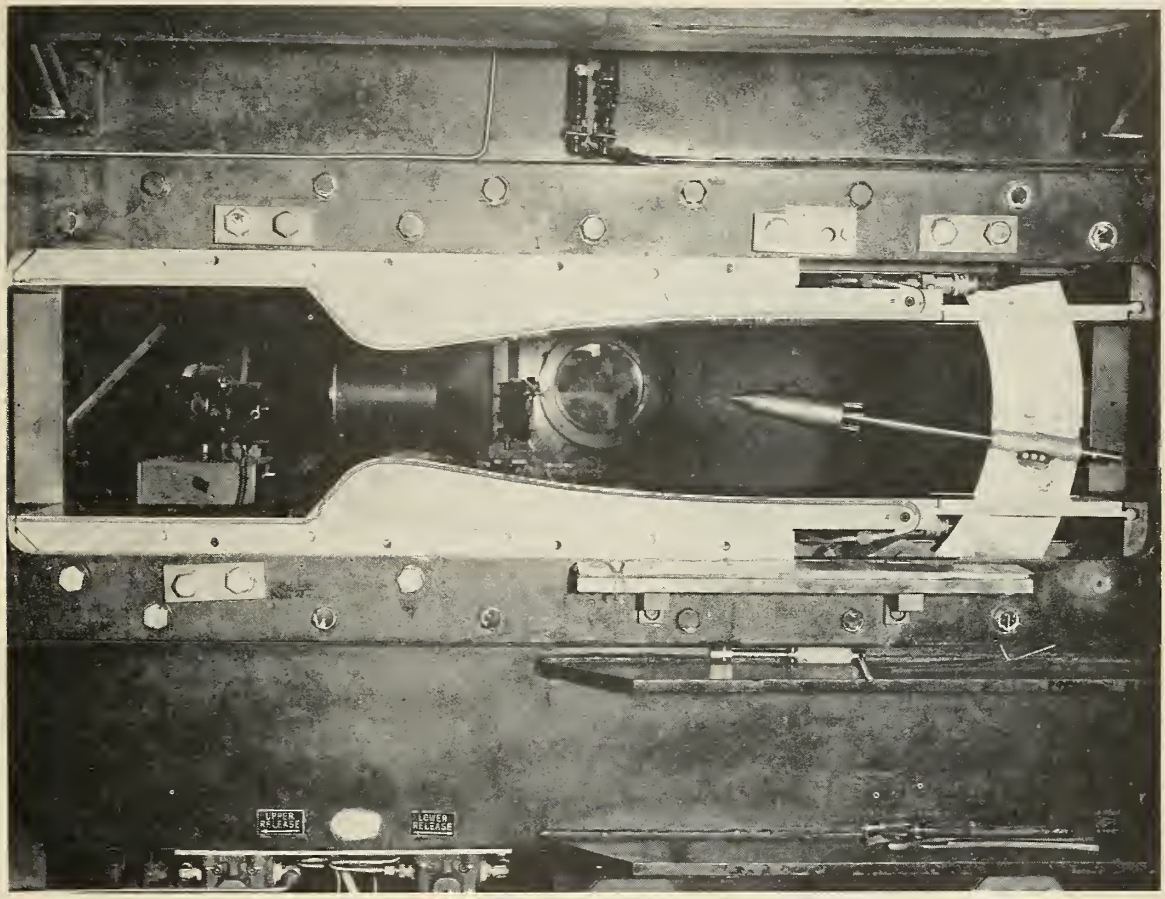
Some of the mathematical problems are so involved that Dr. Geissler pointed out the matter of programming the equations takes considerable time, although the electronic computers which deal with the programmed data can produce results quickly.

"One wonders," he observed, "if in the development of high speed computers there has been too much emphasis on speed rather than ease of programming. There are cases where much simpler procedures, even desk calculators, are competitive in view of their higher flexibility."

One of the current problems under investigation is the effect of wind upon large missiles. At the so-called "jet stream" level, 30,000 to 40,000 feet up, missiles encounter very high winds. Alabama's Polytechnic Institute is compiling a statistical evaluation of wind measurements for the Army Ordnance Agency as a part of this study.

One of the Laboratory's sections conducts studies of such factors as meteorological effects, wind, density, pressure, temperature variations, altitude, geographical locations, and the season of the year—which also has a bearing on missile performance.

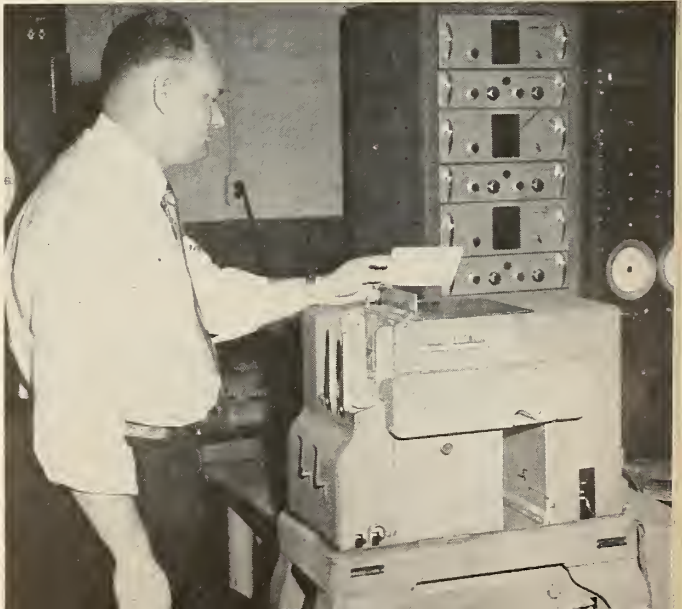
Another section pre-calculates test flight trajectories with the assistance of the Navy's Dahlgren Computation Laboratory. Firing tables for the *Redstone* missile are being prepared by the Aberdeen Computation Lab. These tables will be employed by future Army missile men in the field such as the 217th Field Artillery Missile Battalion—the first unit organized to fire the *Redstone* —which is now in training at the Agency.



Missile model is pictured in position for aerodynamic testing in the Aeroballistics Laboratory wind tunnel chamber. High-pressure jet facilities are capable of testing within ranges from Mach 1.5 to Mach 4.5.

DR. ERNST GEISSLER, Director of the Army Ballistic Missile Agency's Aeroballistic Laboratory, is shown inspecting various models of missile warheads used in wind tunnel tests. This lab is assigned the mission of forcasting the behavior of Ballistic Missiles on the path of their flight from the firing base to the target.

Cards are automatically punched for later interpretation when information from wind tunnel tests is picked up by strain gage balances and pressure pickups and flashed to the electronic computing machines.



Aerojet Expands Architect Engineer Services Division

Aerojet-General Corp. keeps expanding scope of its Architect-Engineer Services division.

Located at Covina, next door to the company's headquarters at Azusa, this division now has more than 600 architects and engineers. It provides such specialized services as static test instrumentation, flight-test range instrumentation, high-speed test tracks, rocket test stands and launching facilities, and complete propellant-handling systems.

One of its present major projects is the construction of facilities at Fort Churchill, Canada, for the launching of upper-air research vehicles during the International Geophysical Year.

Zip Fuel Sources For Ramjets

A U.S. Geological team is conducting a study of Southern California's unique dry lakes, seeking new reservoirs of boron, lithium and other non-metallic minerals. These elements have many uses, but high-energy fuel developments now add greatly to their value.

The so-called zip fuels for which these materials are required are just on the verge of coming into their own. Any problems that existed as regards their use in ramjet engines have been surmounted. At the same time, progress has been made with respect to turbojets.

For many years, the dry lakes and desert areas of Southern California have produced 95% of the world supply of borates. More than $25,000,000 worth of chemical products were mined from one of these dry lakes, Searles, in 1956. Hundreds of these lake beds dot the Mojave desert, but probably less than a score have ever been worked commercially. Only about six are being mined now.

Marquardt Named In Nuclear Propulsion

Marquardt Aircraft Co., producer of the ramjet engines for the Boeing *Bomarc* missile, has been named a prime contractor in the Air Force aircraft nuclear propulsion program.

President Roy Marquardt said the company is now engaged in studies directed at development of advanced nuclear propulsion systems.

Propulsion Notes

By Alfred J. Zaehringer

According to Bulganin, Soviet chemical production is to be stepped up. Pravda claims the new 1960 capacity is to be 91% over the 1955 mark. Among others, this reflects the expanding missile propulsion demands. Also, all satellite chemical industry will be integrated to form a huge Soviet centered chemical cartel.

The big guns in Soviet ballistic missiles are all of the lox-hydrocarbon type. Most widely used fuels are heavy gasolines, kerosenes, or fuel-oil grades. Apparently the difficulties associating the hot and heavy fuels have been solved indicating solution of combustion instabilities, hot spots, burnouts in large motors. All the big Red rocket motors operate at high pressures (viz., 500-1,000 psi).

•

Russia is increasing its output of nitric acids and ammonia. However, nitric acid engines have only been used for smaller rockets (such as manned aircraft or AA). However, the USSR appears to be better sold on peroxide than the US in that they have at least one operational peroxide-propelled surface-to-air missile. Production of peroxide was recently doubled in Russia and also may be in for another increase under the new five-year plan.

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Increased amounts of ammonia will be going into ammonium nitrate for solid propellants. The Reds invested heavily in basic ammonium nitrate research and the payoff is coming in the form of increased use of these low cost materials for RATO, boosters, and long duration sustainers. The 1960 production goal of about 1 million metric tons of rubber and related synthetic resins implies trends toward increased use of new composite propellants.

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The M-100 guided aircraft rocket has been drastically redesigned along with a rough halving of package size. The powerplant thus may be using ammonium perchlorate or some other high-energy solid in place of the old potassium perchlorate type propellant. Scale-up of solid propellant powerplants has been successful and operational units are operating at the ½-1 million lb-sec level. Further increases are anticipated. Most of USSR solid propellant development seems to be riding on composite propellants. Double-base propellants, however, are still being used for boosters, unguided aircraft rockets, infantry and artillery weapons. Big blank is new solid monopropellant work.

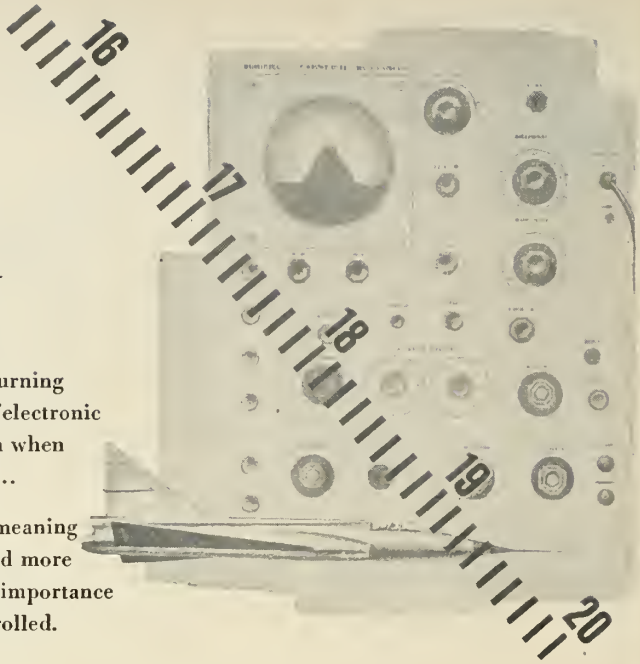
•

Status of exotic fuel production is unknown. However, turbojets and ramjets are well trenched in the USSR aircraft and missile line. Most ramjet efforts are currently going into long-range, cruise-type, attack weapons. Work also appears to be in progress on nuclear propulsion (See m/r Oct., 1956). Present Russian thinking is quite conventional—the use of a working fluid (such as hydrogen or water) in conjunction with an atomic pile. Studies also have been reported on the direct utilization of high-speed nuclear particles, ion, and photon-type systems.

•

Rocket powerplant development and production centers are located at Leningrad, Kasan, Kuibyschev, and Irkutssk. The entire system has its headquarters at ZIAM Institute in Moscow. Important test stands and ranges are at peenemünde, Kalinin, Uralskaje, Tomsk, and Kara-Kum.

How to get reliability



Got the automation jitters?...worried about turning complex manufacturing operations over to an "electronic brain"?...worried about what can happen when one component in the control system fails?...

Reliability takes on a new and different meaning as American industry becomes more and more automated. Here are a few thoughts on the importance of reliability and how it can be controlled.

All of us are going to have to pay more attention to "reliability."

We'll have to pay more attention to individual "devices" within a system.

We'll have to guard ourselves carefully when we design the entire system.

The industrial pendulum is swinging more and more toward automatic controls, servo-mechanisms, computers, and automatic "watchers." As it does, the reliability factor becomes more and more important. Let's see why. For example, you probably have three radios at home. If one fails because a soldered joint comes apart, your home life is probably not disrupted to any alarming degree. But... consider the automatically controlled steel mill. One soldered joint failing, unless all controls are installed in duplicate (which is expensive) could tie up the entire production process for valuable minutes, if the maintenance crew has second sight. For hours, if automatic trouble-indicating and locating systems are not installed (and these are expensive, too). Last, but not least, lend a thought to the dependence of guided missiles and man-made satellites upon the reliability of electronic circuits and components. So... let's start to examine "reliability." Let's begin by looking at this definition which is currently popular in the technical field:

The reliability of a particular component or system of components is the probability that it will do what it is supposed to do under operating conditions for a specified operating time.

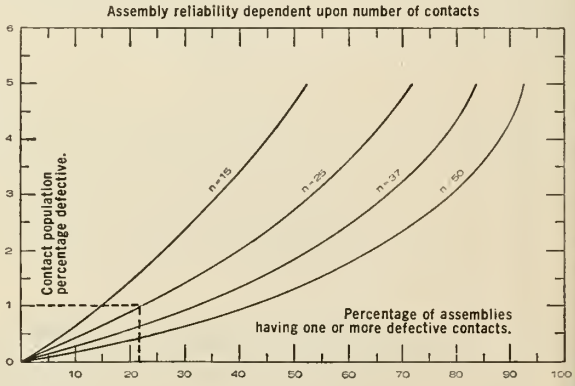
Now...this is a relatively well-accepted definition, and it offers the key to the problem of coping with failure control. Take the word "probability" in this definition. Let's discuss its implication.

Many of today's systems, simple or complex, are a chain of components. So picture a system as a chain with its successive links. In the field of statistics the over-all reliability of the chain is the mathematical product of the reliabilities of the individual links...

Overall Reliability, $R_o = r_1 \times r_2 \times r_3 \ldots r_n$

Now, let's consider a system made up of 100 different components, each of which has a reliability of 99%. In applying the formula, multiplication of .99 by itself 100 times gives an over-all reliability for the system of only 36.5%. Two out of three systems you have put together will probably fail!

Cannon becomes involved with this problem because our main business is making electric connectors. So, let's look at the following chart that covers contact reliabilities and reliability of the assembly in which they are mounted.



This chart illustrates the reliability of four connectors having 15, 25, 37 and 50 contacts respectively. As an example, assume that the contacts have a contact population of 1% defective (1 in 100 defective... this percentage is considered a fairly high standard in most fields). On the 15-contact assembly, we find from our chart that 14% of the connector assemblies would have one or more defective contacts! With 25 contacts, 22% would have one or more defective contacts. With 50 contacts, 41½%... is your hair starting to curl? Obviously, a 99% contact reliability standard for guided missile components is absolutely unacceptable. And, in between the simplest system and that of a guided missile, are hundreds of assemblies and systems whose reliability factors must be analyzed with utmost care.

But all is not lost! There's another side to the picture. With proper care, analysis, and control, our Cannon organization has actually achieved, in special "missile quality" contacts, a known level of only 2.85×10^{-3}% defective... only 1 part in 35,000! Naturally, we don't achieve that with all our contacts... but we do try to design and manufacture the utmost in reliability required for specific applications.

We have pictured this chart to show the direction we must all take, whether we're talking about connectors, other components, or systems. It boils down to two steps...

* The number (n) of components must be kept low ... *simplicity.*
* The level of component reliability must constantly be improved ... *hard work for all of us.*

Now... if we refer to our reliability definition on the previous page we note the phrase "do what it is supposed to do." So be sure *you* define these objectives for your component assembly, or system... failure to do so carefully can cause undue failure or the expenditure of unnecessary dollars for needless, excessively-reliable parts or design.

Further on in the same definition, we note the words "operating conditions." This brings up many new points for consideration. Here we are concerned with such things as temperature, pressure, humidity, corrosive atmosphere, stray electric and magnetic fields, low and high frequency noise, shock and vibration. Do your design standards need upgrading? Are your components designed and then tested to meet the operating conditions you specify... or are they designed to meet "average" conditions? Are you using adequate "safety factors"?

In a simple component, manufacturers have always looked for, recognized, and corrected faults when they occurred. We use component quality control to achieve and maintain Cannon's world famous product quality. But in complex systems such component quality control is not enough. Actually ...

Reliability control over the system is needed. It should be all-encompassing. When you get right down to it, *reliability* is the product of procedures, equipment, and people... in the design, manufacture, testing, control of quality, transportation, and use of products or systems.

Do you have a reliability control system?

Here are a few of the steps that are needed to get a reliability control system operating:

1. Determine Your Requirements. Specify the environment, operating time, performance limits, and the percent of reliability required. Allow an adequate safety factor keeping in mind the end use of the finished product.

2. Collect Reliability Data. Set up facilities for the continuous accumulation of data on component or system failures and their causes.

3. Establish quality control and test procedures which show high degree of correlation with end-use conditions.

4. Analyze. Determine if reliability requirements are being met. Establish the most important causes of failure by analyzing the data you collect.

5. Improve. Take action to eliminate the most important defects or causes of failure. Reduce the failure rate to the required level.

6. Maintain Continuous Vigilance. You have emphasized system design... you have used statistical analysis of failures... now exert continuous and critical control to be sure your "improvements" actually improve reliability. Examine new and unforeseen failure sources. Review and modify your requirements with changing conditions.

*

We at Cannon Electric are proud of our historical emphasis on quality and reliability. Since 1915 we have adhered to a design philosophy embracing the highest quality and reliability in each and every Cannon Plug for the specific application for which it is to be used. *If we can't design to that principle, we don't make it!* In manufacture, we are proud of our know-how in depth, proud of our fine quality control systems, proud of our personnel and proud of our reliability control group.

Whenever *you* have an electric connector reliability problem... in design, engineering, production, or prototype phases... we would appreciate the opportunity of discussing it with you.

Cordially,

Robert J. Cannon *President*

CANNON ELECTRIC COMPANY
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Eight plants around the seven seas!

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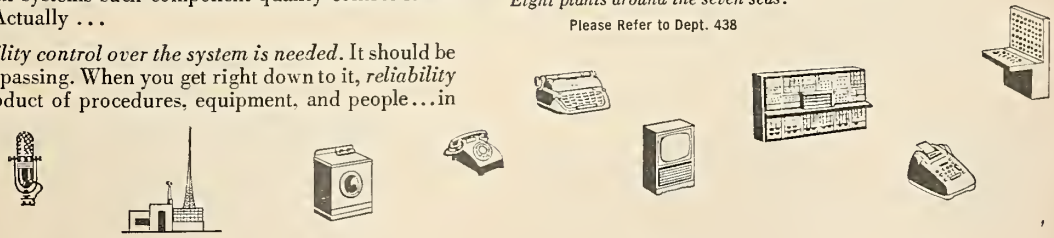

Approach to Solid Propellants

The key to the future growth of solid systems may well lie in processing techniques. We already have seen that we may be nearing the limits of chemical energy release in working systems.

In developing solid propellant systems cognizance must be taken of the present state of the art and projected developments. Due to present exigencies, we cannot be too specific about current systems. However, there is enough available data to give us a view of orders of magnitude.

Although homogeneous solids (viz., single and double base and colloidal propellants) released us from the shackles of the once standard gunpowder, they have somewhat restrained growth. Certain innate properties as high cost, low stability, and high sensitivity previously had given us a false view of the entire solid field. However, because of such factors as high burning rates and a large technological background, they are likely to remain in the picture for some time.

The advent of modern composites has, to a certain extent, released us from many of the shortcomings of homogeneous propellants. However, although we have tremendous possibilities with composites, our limiting factors are likely to rest on choice of oxidant. With large number of available fuel-binders, the composite field probably will be the most flexible in offering custom propellants.

The composite solid system is likely to be a stopgap field until we can synthesize a true, ideal solid monopropellant. Unfortunately, our knowledge of progress in the solid monopropellant field will be obscure for some time to come.

The gap between solid and liquid systems has been bridged by recent work, in hybrid systems. Performances greater than existing pure systems have been revealed at only slightly greater complexity.

Competing with Liquids

Designers now will be interested in a comparison of solid and liquid systems. Despite the fact that data may be restricted, a comparison is very favorable. Other factors such as handling, storage, reliability, etc. should be considered also.

Two Avenues of Approach

For the present and future, solid propellants have two avenues of approach in competing with liquids. For one, we can limit the field (by such factors as cost, applications, etc.). Or, we can take the unconventional approach. One technique to lower costs, for example, would be to design a system which yields a valuable by-product. That is, we would wind up with a propellant which can sell for less than that of its raw ingredient costs.

The general field of solid propellants has experienced a tremendous growth in a short period of time. Solids now compare very favorably with liquids. Hybrid systems now offer the possibility of bridging the gap between solids and liquids and make wider use of existing technology. Motor designers thus will have an extremely wide choice of high performance propellant systems. Designers of both active and inert systems should strive to maintain and better the present high degree of reliability in solid propellant systems.

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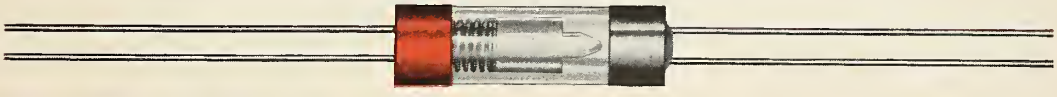

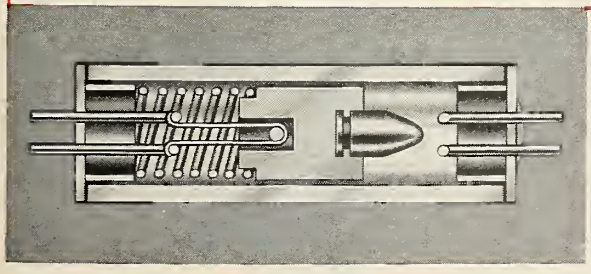

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ORIGINAL DESIGNS FOR HIGHER RELIABILITY IN GLASS-HOUSED RESISTORS AND MINIATURE RELAYS FOR ALL PURPOSES

Astrionics

By Henry P. Steier

Russian and other IGY delegates meeting in Barcelona last fall agreed to the resolution that both U.S. and U.S.S.R. satellite programs operate on the U.S. chosen 108 megacycle radio tracking frequency. At that time, Russian delegates announced they would "provide further data when ready" on their planned instrumentation load and satellite diameter.

Nothing further on Soviet astrionics has been heard officially from U.S.S.R. Oddly, latest news indicates the Soviets are maintaining their previously disclosed line in satellite thinking. It has come from Russian broadcasts beamed to Far Eastern countries. Members of the U.S. IGY Committee have been studying transcripts of the intercepted broadcasts with great interest—particularly in the inconsistencies with our program. Broadcasts are quoted as saying the U.S.S.R. satellites "ought to be" the size of ours but with a higher payload. Despite this rocket motor figures given are copied after ours.

If and when our "competing" satellites get up there first, the competition should not be felt in Russian scientific circles. Full data on what we find was promised the Russians through the International Council of Scientific Unions in Brussels. This ought to allay the fears of those who fear "pirating" of data stored in the U.S. satellites during each revolution.

As things stand now it's the high school kids and other potentially over-zealous amateur experimenters that worry U.S. satellite scientists about pirating. Since the stored information must be "dumped" by a signal from the ground at the right time, both deliberate and unintentional signals could wreak havoc with experiments. Naval Research Laboratories' John T. Mengel, who is the brains behind the satellite transmitter design, informs us the satellites will have their own "security system" designed to foil unauthorized dumping. He says it's not the utmost in security but is the best we can do with payload available.

Secret is "a couple of audio tones," Mengel says. Satellite astrionics will respond only to an rf signal modulated by this particular combination of tones. This is a hard one to beat. It's been very successful in airline Selcal, selective calling, systems. Specific combinations of audio tones enables airlines to call specific aircraft. Each plane responds only to a particular combination of tones to which it is tuned.

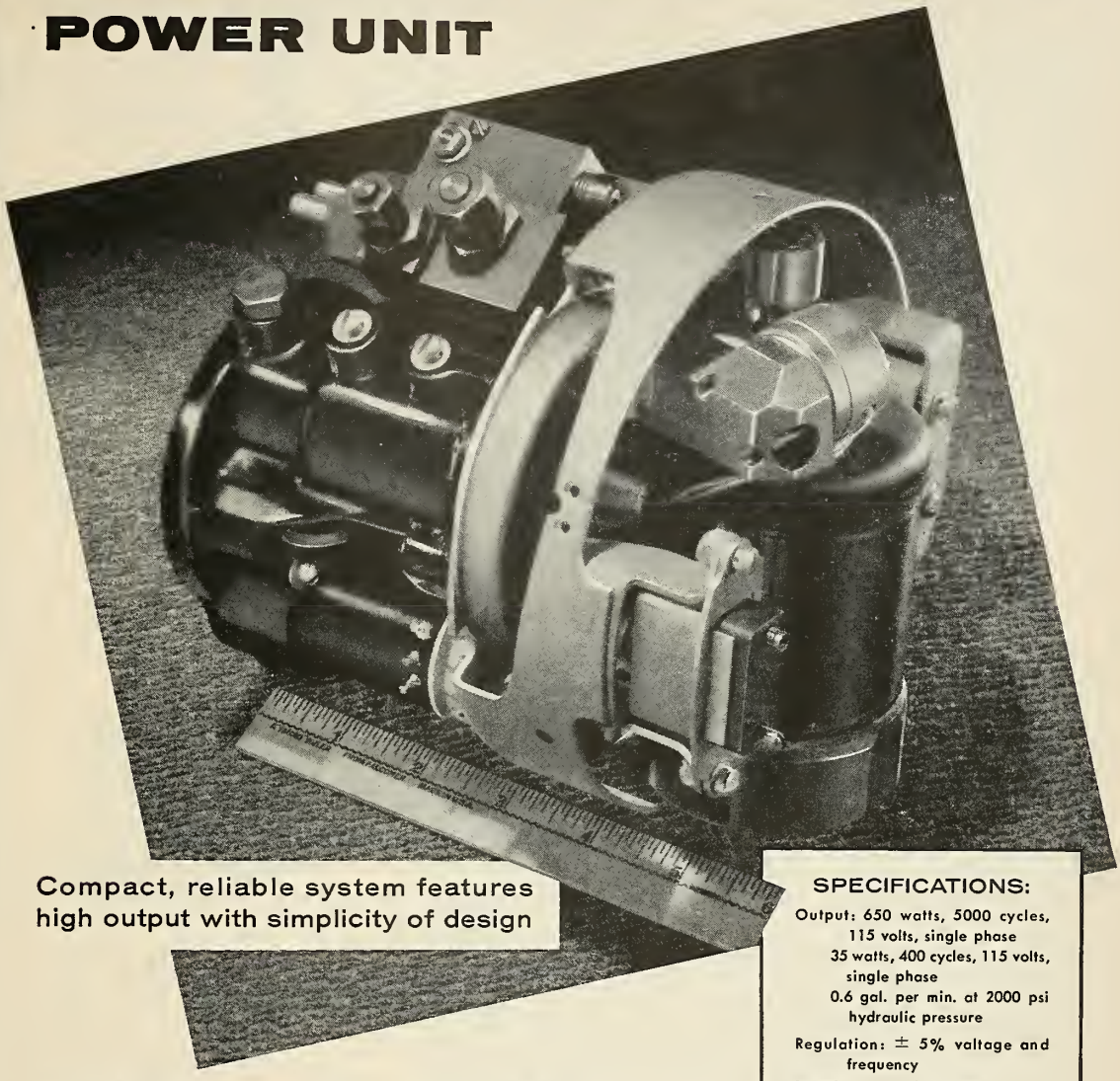
•

It's the little things that count. Among these in the Vanguard program are the gyroscopes being built by Minneapolis-Honeywell to control the vehicle's orientation to within 2.9 degrees. Outside that limit anything can happen. Observers who have toured Free Europe's laboratories say work there on producing super-accurate gyros is nil. What the Russians have in the way of inertial guidance is not known. Despite importance of propulsion, these "little things" could make or break the success of a scientific or military rocket vehicle design.

•

Another "little thing" is transistor technology. The Russians are now beginning to talk about transistor developments. These will be of first importance in our satellite astrionics gear. Russian talk of transistors is mainly in the computer field. They appear to have built very fast and large capacity data processing machines which they are beginning to transistorize. As with our IGY program, Russian satellite experiments would depend heavily on rapid and powerful computing machinery.

AiResearch MISSILE AUXILIARY POWER UNIT



Compact, reliable system features high output with simplicity of design

This AiResearch auxiliary power package operates the vital electrical and hydraulic systems in a missile.

Gases from a solid propellant spin the unit's turbine wheel at 50,000 rpm. The turbine's shaft drives the following: a 650 watt generator which supplies electrical power to run the missile's guidance system; a 35 watt generator which runs the missile's gyros; a hydraulic pump which in turn powers the servos that control the movable flight surfaces of the missile's airframe.

The hydraulic system features drilled passages which eliminate the need for potentially troublesome plumbing. It includes reservoir, filters, temperature compensator, relief valve, check valve, and squib valve within a single housing.

This auxiliary power system is an example of AiResearch capability in the missile field. Inquiries are invited regarding missile components and sub-systems relating to air data, heat transfer, electro-mechanical, auxiliary power, valves, controls and instruments.

SPECIFICATIONS:

Output: 650 watts, 5000 cycles, 115 volts, single phase
35 watts, 400 cycles, 115 volts, single phase
0.6 gal. per min. at 2000 psi hydraulic pressure

Regulation: ± 5% voltage and frequency

Duration:	27 secands
Weight:	9.5 pounds
Size:	6.14 in. diam., 6.74 in. lang

Ground power: campressed air

Outstanding opportunities for qualified engineers

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AiResearch Manufacturing Divisions

Los Angeles 45, California . . . Phoenix, Arizona

Designers and manufacturers of aircraft and missile systems and components: REFRIGERATION SYSTEMS • PNEUMATIC VALVES AND CONTROLS • TEMPERATURE CONTROLS CABIN AIR COMPRESSORS • TORBINE MOTORS • GAS TURBINE ENGINES • CABIN PRESSURE CONTROLS • HEAT TRANSFER EQUIPMENT • ELECTRO-MECHANICAL EQUIPMENT • ELECTRONIC COMPUTERS AND CONTROLS

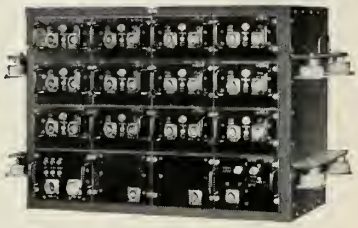
VERSATILITY

TDI MINIATURE TELEMETRIC RECEIVING SYSTEMS

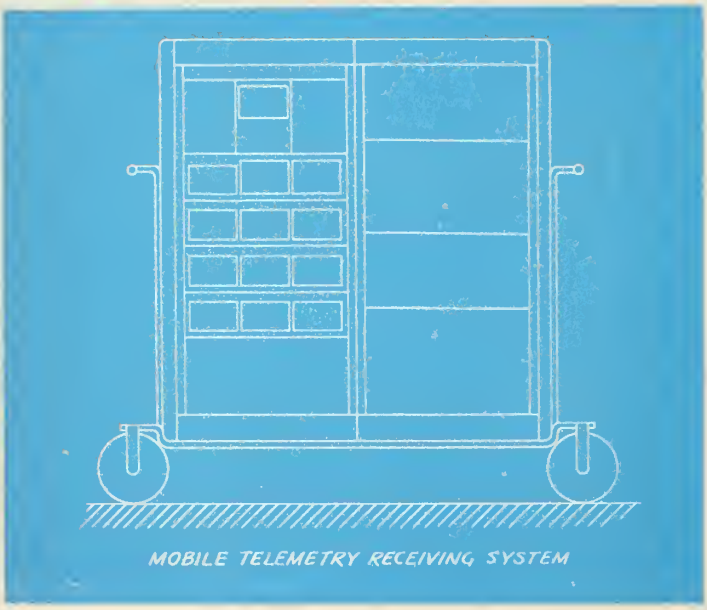
Miniature and mobile, here's a telemetric receiving system designed for a host of military and civilian applications . . . airborne, ground or marine!

For missile checkout, flight tracking experimental aircraft and missiles, the TDI systems are highly effective, even under the most severe field service conditions. They operate ideally with tape recording, oscillographic, photographic and similar types of recording equipment . . . and this rugged equipment can be installed in jeeps, autos and trailers.

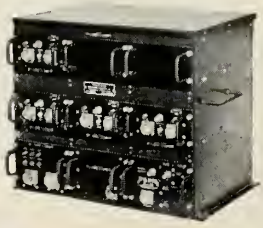
Design-wise, these systems achieve substantial reductions in weight, size and power consumption—yet a high degree of accuracy, exceptional stability and simplicity of operation are maintained.



TDI 12-Channel Receiver. Modular construction permits wide flexibility of arrangement and actual form factor of receiving equipment. Packages or combinations in any number from one to eighteen units can be arranged in various mounting styles.



MOBILE TELEMETRY RECEIVING SYSTEM



TDI Type 2701A 4-Channel Receiver. Use as flexibly as 12-channel unit—split up in combinations to suit your particular receiving requirements. Ideal for flight line checkout.

← Telemetering on wheels! New portable test cart enables users to perform wide variety of telemetering functions in previously inaccessible locations, with greater efficiency and accuracy than ever before.

Technical bulletins on miniature receiving systems and other TDI products available on request.

TDI's newest office is now located at 305 Washington Avenue SE, Albuquerque, New Mexico

- TELEMETERING
- MISSILE GUIDANCE
- GROUND ELECTRONICS SYSTEMS
- AIRBORNE ELECTRONICS SYSTEMS

TELE-DYNAMICS INC.

A Raymond Rosen Corporation

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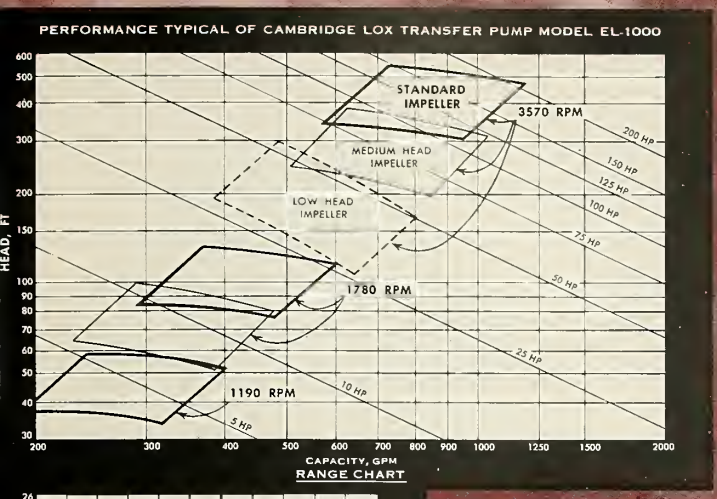

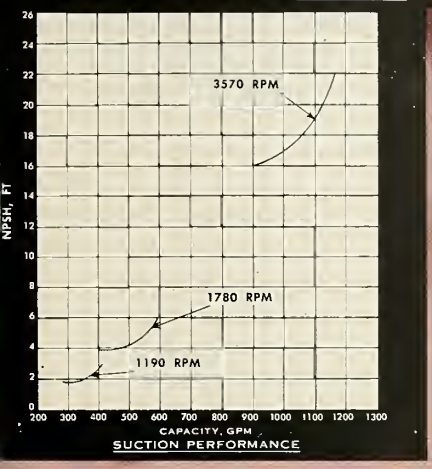

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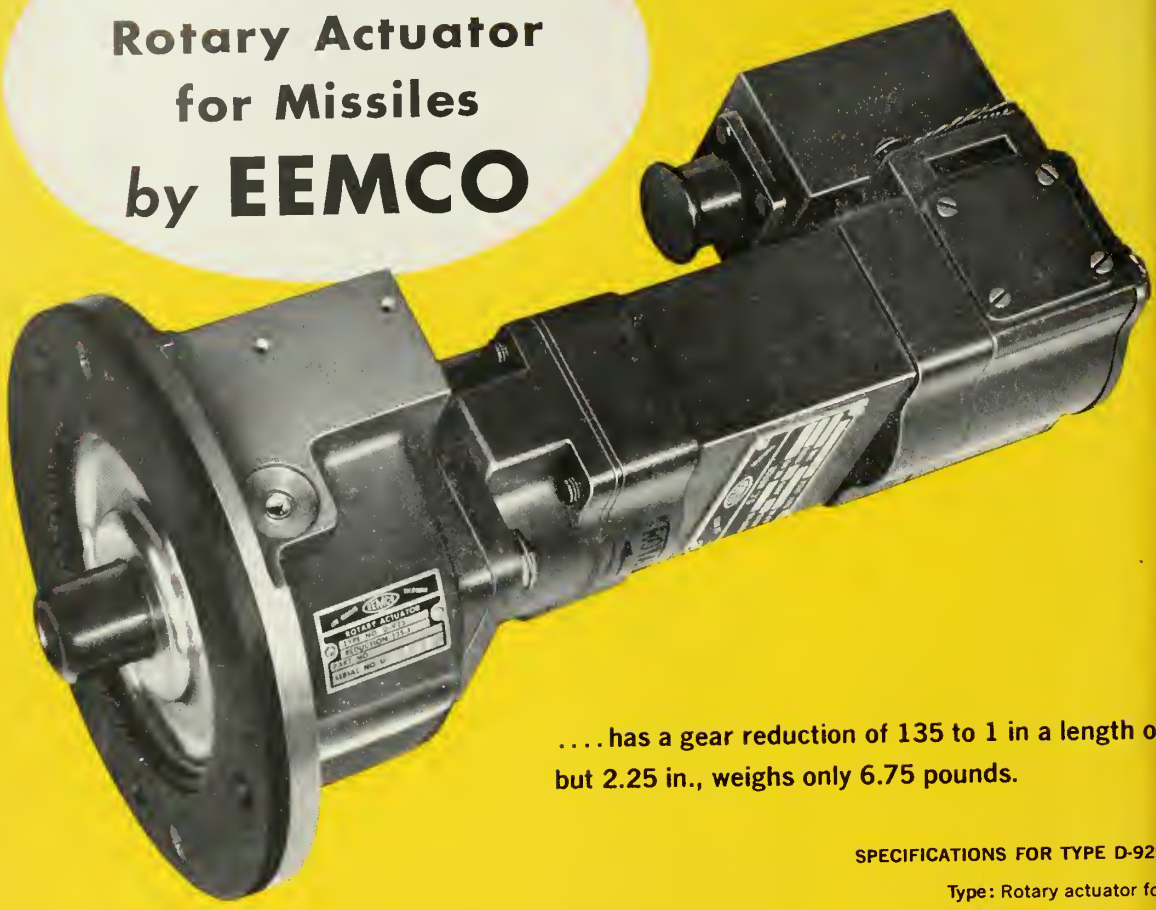
Creators in Cryogenics • Leaders in Liquid Logistics

* with head capacities to 300 feet

NEW
Rotary Actuator for Missiles by EEMCO



. . . . has a gear reduction of 135 to 1 in a length of but 2.25 in., weighs only 6.75 pounds.

SPECIFICATIONS FOR TYPE D-925

Type: Rotary actuator for missile fin actuation
Output: 400 inch-pounds @ 64 RPM, 24 volts, 27 amps
Duty Cycle: 1 minute on, 10 minutes off
Gear reduction: 135 to 1 in 2.25" length
Weight: 6.75 pounds

This new light-weight, compact rotary actuator by **EEMCO, Type D-925,** was designed for fin actuation in one of the nation's latest missiles. Here, as in all other applications of **EEMCO** actuators and motors, it must operate unfailingly under the extreme environmental conditions that are encountered at ultrasonic speeds in stratospheric altitudes.

Type D-925 rotary actuator has a self-contained 28 volt DC motor with clutch, and 400 inch-pounds of output at 64 RPM on 24 volts, 27 amperes. Duty cycle is 1 minute on, 10 minutes off.

✳ **EEMCO** is a specialist in the design and manufacture of precision actuators, both linear and rotary, and special motors. **EEMCO** products are on the majority of the latest supersonic military aircraft and missiles. Therefore **EEMCO**'s many years of experience in this field, exclusively, is aiding materially in the delivery of the latest aerial weapon systems for the national defense in which reliability of performance must be unerring.

Electrical Engineering and Manufacturing Corp.

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Designers and producers of Motors, Linear and Rotary Actuators . . . Exclusively!

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Missile Miscellany

Where do you get your ideas? Try these: A rocket company with contracts and profits is making a missile in the shape of a sphere to operate in either air or outer space . . . At Hialeah last month, the Hibiscus Stakes, the favorite, Missile, lost to Honest Man . . . At a bar the other night, an AF officer declared that the Thor that goofed was "a production model" . . . same bar, same night this page heard odds quoted one-to-one the Vanguard would not be the first man-made vehicle to orbit the earth, or escape.

* * *

Has anyone ever used modern theory to explain why the silicate, Lintz basalt, spontaneously generates heat at a rate of 2.36×10^{-4} calories per hour per gram; why in free fall it won't accelerate at 980 centimeters per second^2? It's not radio-activity, for uranium is 1500 times as active as Lintz basalt, generates only 7.2×10^{-5} cal/hr/gm.

* * *

Lunch with this page's NACA structures engineer brought the observation that up to ICBM man had always been able to borrow from nature. Now reentry temperatures were known only at the sun's surface, the earth's center or in the stratosphere when meteors burn up. But what about meteors that make it down? What's the aero- or thermodynamics behind the myriads of spherical holes that pock their surface? And by mail, a missile valve and piping man wonders if anyone's tested the metal from Arizona's big meteor in missile applications.

* * *

A reporter member of ISAW, commenting on Pentagon policy of misleading the American public by letting them think the 3300-mile Jupiter-C missile is a Jupiter IRBM, suddenly asked: "Say, I wonder if Wilson's gone to Florida really to see the first full Jupiter fire?"

* * *

At home one night discussing the many and the varied with a working physicist, this page was asked: "Why not take the obsolescence out of education, start teaching the thinking of Field Relativity Theory in grade school when it's new and logical, instead of later when it's contradictory and disturbing; let it grow with the young, inquiring mind and perhaps, like that mind, expand?"

* * *

Then, in New York at the recent Institute of Aeronautical Sciences meeting, an Admiral unofficially insisted that the missile-equipped Navy of the future will have to go 100% underwater, and that once it does, its missile ability will top Army's and AF's.

* * *

With cracks like "Snark-infested waters" and the "Thor Myth" going about, it's no surprise a recent failure of another missile to make it farther than the adjacent launching pad leads to the AF quip: "Have you heard about Army's latest Inter-Pad Ballistic Missile?" . . . with the progress being made in jellied propellants, why can't later models of the Polaris be "liquid" after all . . . AF now forbids its civilian scientists to voice impressions of Soviet scientists on the grounds of military security "in the international political field" . . . from a manufacturer of high temperature materials like brake linings, an offer of a laminated reentry nose cone that will take 6000 degree boundary layer temperatures for 18-20 seconds . . . and just in case you thought the reaction motor was something new, Heron's steam driven Aeolipile amused the Greeks in 300 B.C. . . .

* * *

INDUSTRY SPOTLIGHT

By Joseph S. Murphy

Civil Application of Missile Know-how

Some missile principles and techniques are being applied to consumer industries with surprising success. The fact that missiles are of a highly technical nature and that the military have top priority in their research, are not valid reasons for holding up consumer industrial progress in any way. Rather, research men are "squeezing" every drop of helpful information possible from their pool of guided missile information and data.

Guided missile work has already proven useful in these consumer fields in the design of propulsion systems, airborne navigational aids, and machine tools. Research on upper air phenomena, miniaturized electronics and precise automatic computers are of more recent vintage.

Future aircraft fire control systems are in advanced stages and are of a classified nature. They include the design and development of systems to meet the tactical and strategic requirements of new bombers, fighter-bombers, and interceptor aircraft.

Other improvements for the future are new techniques in integrating flight control computer and radar functions of fire control systems that will make present-day computing gunsights obsolete.

Impact on Industry

Needless to say, fire control systems, missiles, and their components have had a tremendous impact on industry as a whole. They have undoubtedly had a great deal to do with the estimate of a leading firm that today one out of every eight workers in the company is a technical employe. In 1943 the ratio was one out of every one hundred.

One of the chief industries to be influenced by this surge in technical employment is the electronics field. This is especially true of military aircraft fire control systems where more tubes are being required.

Already the U.S. Air Force for 1957 has allotted 17.3% of its aircraft procurement budget for electronics. In 1952 less than 10% was spent. Airborne radar requirements, for example, have increased from $11.4 million in fiscal 1955 to $35.6 million in 1957. Electronic countermeasure equipment requirements call for $195.5 million in fiscal 1957.

Within these figures lie jobs—many jobs—technical as well as semi-technical and even non-technical. More jobs, of course, mean less unemployment, more buying power.

Right now the guided missile and weapons field is literally begging for engineers and technically trained personnel for careers in aerodynamics, electronics, propulsion, optics. Hundreds of ads appear in magazines and newspapers daily, seeking engineers and scientists with creative skills in aircraft and missile systems.

The job of developing missiles and weapons systems has been dropped in the lap of industry and, in come cases, almost abruptly. At no time in history, however, has there been closer cooperation between industry and the Armed Forces of our Government for the development of these defense weapons. Never has industry held such crucial and great responsibility. Industry's performance in utilizing its facilities and talents to the utmost is the key factor in the keen competition shown and is largely responsible for the progress we have made to date.

In the past there were grumblings about industry being shouldered with responsibility but hampered by (1) ignorance of long-range Armed Forces needs (2) by the state of the development art and (3) by inability to get a decision out of a "complex uniformed bureaucracy." In many instances these grumblings were justified. This should not be the case now. Industry must now "carry the ball"—all the way.

Fortunately, the discoveries coming from today and tomorrow's fire control and missile developments by American industry have not been for war alone. Many great possibilities exist for the future and a world of peace.

Today's automatic pilots and remote control devices in missiles can be put to work to control the flight of aircraft when human ability is not adequate because of high speeds or atmospheric conditions.

Automatic instruments inside a missile can steer an explosive warhead directly to a ground target. These systems can be geared to a compass for direction, to an altimeter for height of climb, to a propeller that acts as a odometer for distance, to a telescope that navigates by watching the stars, or even to a television set that looks for a spot on the ground.

Why can't similar systems be devised to land high-speed aircraft on the runway in any weather or visibility? In fact, why can't such a robot craft be used to deliver important documents or much-needed serums or drugs in emergencies to distant places in short time, regardless of weather—a sort of "missile-mail" service?

New and greatly improved automatic computers are beginning to run offices and factories.

Because of the need for sending technical information to the ground from a test missile, telemetering has appeared. This is nothing more than measuring conditions on a vehicle in flight and radioing the information back. The telemetering principle is already being followed in earthbound machines. Information is sent automatically from one part of a machine to another, used (again automatically) to direct the whole machine's operation. This, the feed-back mechanism, is leading us toward "automation."

Such a missile guidance system would have to be modified to land a plane. It could be redesigned to control the flaps at a certain time, level out, and stop engines. Information obtained by radar could be fed into a computer which could calculate exactly when and how much to begin braking.

It is not inconceivable that directional forward firing rockets, automatically controlled by instrumentation originally developed for missiles, could gradually bring a plane about to crash to almost zero velocity before impact.

These are but a few of the peacetime possibilities that exist for missiles and rockets in the future.

Industry Highlights

By Fred S. Hunter

A well-known household remedy, milk of magnesia, is being used successfully by North American Aviation as an inexpensive thread lube. Before milk of magnesia was tried, North American had been experiencing a high breakage rate on bolts and clamps on stress relieving and welding fixtures placed in ovens for post-forming operations. Application and removal of milk of magnesia is easy, says Ed Cane, conservation committeeman in the missile detail department at Downey. It is daubed on threads with a brush; after removal from the oven it is in powder form and is easily dusted off.

Lockheed's Missile System division has installed a new Baldwin 440,000-pound hydraulic universal testing machine in its engineering laboratory for its structures test group and it would, of course, be dubbed *Big Bertha.* It is able to test components up to 65 inches wide, 11 feet long (in tension) and 12 feet long (in compression) in its vice-like arms. The $36,000 machine's four load ranges read to an accuracy of plus or minus ½%.

At this writing, all Boeing has announced is that it has options on land in the San Ramon Valley in California for possible construction of a *Bomarc* production plant and on the Ford Motor Co. plant at Richmond, Calif. But word is being freely passed around that the joint plants of the Seattle manufacturer and the Air Forces will involve a total investment of $100,000,000 for plant, equipment, etc. Seems like a pretty large sum even though *Bomarc* is a pretty large program.

A U.S. Geological team is conducting a study of Southern California's unique dry lakes, seeking new reservoirs of boron, lithium and other non-metallic minerals. These elements have many uses, but high-energy fuel developments now add greatly to their value. For many years, the dry lakes and desert areas of Southern California have produced 95% of the world supply of borates. More than $25,000,000 worth of chemical products were mined from one of these dry lakes, Searles, in 1956. Hundreds of these lake beds dot the Mojave desert, but probably less than a score have ever been worked commercially. Only about six are being mined now.

Rocketdyne has installed a new emergency telephone system that makes good sense. Employes at the main plant in Canoga Park dial 333 and those at the Santa Susana test facility dial 555. This puts 'em through to the central control operator. A new-type of number disk is being placed on all Rocketdyne telephones. In addition to telephone and extension number usually found on these disks, the correct emergency number will be listed and the telephone location, such as Room 27 or Column 00.

Raytheon's new laboratory opposite the Santa Barbara airport for the design of electronic and infrared equipment for the government is scheduled to be ready for occupancy by mid-summer . . . More than 40 of Aerojet-General's Aerobee sounding rockets will be launched during the International Geophysical Year program at the launching facility installed at Fort Churchill, Manitoba . . . North American's transplanted Californians were treated (?) to a brand new type of weather at Rocketdyne's Neosho, Mo. plant when 1.48 inches of rain, snow and sleet broke power lines, knocked out telephones and completely stopped work at the plant . . . Art L. Hubbard, recently named to head the newly established systems test facility department of Lockheed's Missile Systems Division, was the first employe selected by the division to attend UCLA's two-year engineering executive program begun last year.

New Missile Contracts Announced

Commerce Department's synopsis of new Defense contracts at presstime listed four new awards to missile and rocket firms.

Douglas Aircraft Co.-Santa Monica received three contracts totaling $2,340,083 covering facilities for *Thor* WS-315A medium range ballistic missile production.

Thiokol Chemical Corp. of Elkton, Md. won a $1,520,527 award to produce M-58 rocket engines for *Falcon* missiles and Phillips Petroleum Co. of McGregor, Tex. a $442,000 contract for JATO development and production facilities.

Hycon Manufacturing Co. was awarded a $404,000 contract to produce missile test sets.

Interstate Gets $½ Million Order

Interstate Engineering Corp. has received an order valued at approximately $500,000 from Consolidated Western Steel Corp. for production of rocket launcher cylinders for the *Nike-Hercules.*

The company also produced similar cylinders for the original *Nike.*

Sperry Sets Up Air, Surface Armament Divisions

Sperry Gyroscope Co., Div. of Sperry Rand Corp. has established two new divisions—an Air Armament Division and Surface Armament Division.

The Surface Armament Div., under Myron D. Lockwood, has been assigned responsibility for original development, design, manufacture and sales of ground, shipboard and submarine armament products.

The Air Armament Div. headed by Samuel Agabian, will have similar responsibilities in the fields of air armament, missile guidance systems and navigational equipment.

Cornell Developing New Test Facility

A new hypersonic test facility capable of testing aircraft and missile designs at simulated speeds of 10,000 mph and 9,000°F temperatures is being developed by Cornell Aeronautical Laboratory, Inc.

Feature of the new installation will be its test endurance. It is said to be capable of maintaining the high-velocity, high temperature airflows for peri-

ods up to 15 seconds, far longer than before possible.

The $2 million facility is an Air Force funded project that uses a new wave superheater described as a unique arrangement of tubes capable of producing a continuous flow of high-speed hot air.

Lockheed Missile Division Forms Two New Units

Two new weapons system organizational units have been formed under Lockheed Aircraft Corp.'s Missile Systems Division in its new Palo Alto and Sunnyvale, Calif. facilities.

Heads of the new groups will be John H. Carter, MSD associate research director and Stanley W. Burriss, former division engineer in charge of flight test activities. New groups will have the responsibility of developing and interpreting MSD obligations under specific contracts as they are assigned.

NAA Consolidates Purchasing Office of Rocketdyne Division

Purchasing activities of North American Aviation's Rocketdyne Division have been consolidated under one roof with the recent shift of 600 employes into a new materials building in Canoga Park, Calif.

Division purchasing, which involves a $60 million annual volume, supports local production of the Rocketdyne Division and involves more than 3,000 suppliers in 34 states.

NAA Nets $9.8 Million For First Quarter

North American Aviation, Inc. reports a net income of $9,898,999 for its first quarter ended December 31, a $2.7 million increase over the same period in 1955. Sales and income for the period amounted to $330,526,940 compared to $195,935,978 a year ago.

NAA's net represented $1.23 as share against $0.89 in the first quarter of 1955. Federal income taxes were estimated at $10,722,000 for the three months based on preliminary figures.

Advances in Digital Telemetry Reported

A new system of handling information in direct digital form is opening a serious bottleneck in telemetry and said to be saving up to six months time

in the analysis of rocket and missile flight data.

A system developed by Radiation, Inc. for digital data computing receives information in direct digital form at a speed of 24,000 samples per second with an accuracy of one part in 256.

Two of the systems have been built and are in use by Wright Patterson AFB and Convair. Other systems are under development for AC Sparkplug, AVCO, Holloman ADC, Kirkland AFB and project *Vanguard*.

R-W Center Takes Shape

Ramo-Wooldridge Corp. has completed the first unit of a nine-building research and development center being built on a 41-acre site south of Los Angeles International Airport.

First building is assigned to the company's control system division, electronic instrumentation division, and two laboratories—one for aeronautical research and the other for electronics research.

Office and laboratory space in the first unit will accommodate about 500.

Douglas Investing $3 Million In New *Thor* Facilities

Douglas Aircraft Co. plans to spend up to $3 million over and above the $1,305,500 in funds supplied by the Air Force for construction of a guided missile facility in the Sacramento area this year.

F. W. Conant, senior vice president, said more than $2 million in contracts already have been let for land clearance at the 1,700 acre site, construction of roads, missile test stands, assembly and modification hangars.

Outstanding contracts also provide for a cafeteria, fire and plant protection building and control building.

The new Douglas facility will be used initially for development and test work on the Air Force's *Thor* IRBM.

Lockheed Talks Terms On Four New Missile Deals

Lockheed Missile Systems Division is negotiating four additional contracts, according to general manager L. Eugene Root. In a year-end review, Root said the division started 1956 with a dozen major contracts and a number of minor ones and added two very important new jobs and eight minor ones during the year.

Lockheed recently was named major contractor in the Navy's new *Polaris* fleet ballistic missile program;

missile division sales are running at about $60 million annually compared to $24 million a year ago and backlog has doubled in the last six months.

Missile Spending Reaches $1.5 Billion Annual Rate

Total Defense spending by Army, Navy and Air Force for the first four months of fiscal 1957 reached $506,249,000 for an annual rate exceeding $1.5 billion. The unexpended balance as of October 30 stood at $3,828,245,000 with individual services reporting these accumulated spending figures for the four months:

Army	$116,977,000
Navy	67,851,000
USAF	321,421,000

New missile obligations for the period totaled $699,217,000 with this breakdown by service: Army—$86,289,000; Navy $134,029,000; and USAF—$478,899,000. Unobligated balance on October 30 for the three services was $1.98 billion.

RMI Income, Backlog Increase Sharply in '56

Preliminary 1956 year-end figures for Reaction Motors, Inc. show sales in excess of $15,500,000, an increase of nearly 50% over 1955. Company officials expect the final 1956 report to show a substantially higher net profit after taxes of at least $330,000.

RMI backlog on December 31 stood at $22 million, up about 150% over the same time in 1955. Employment was 1,350 compared to 669 at the beginning of 1956.

AF Awards 3 Contracts For Ballistic Missiles

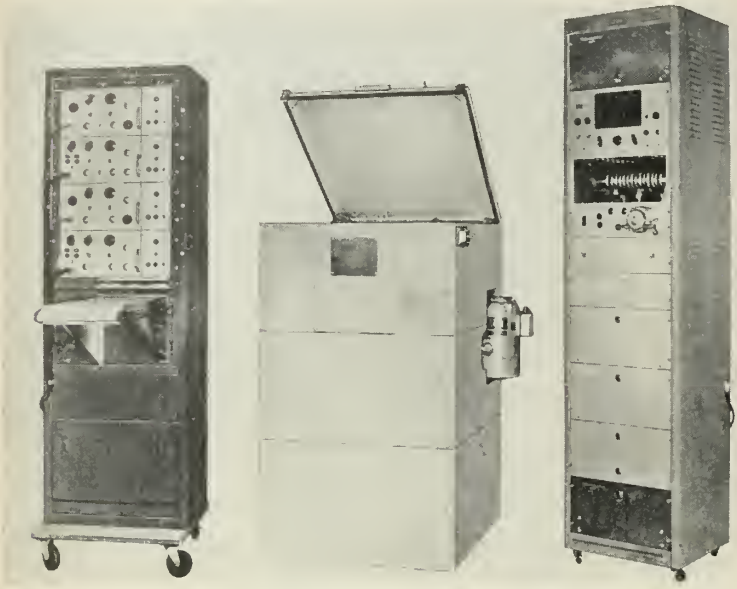
Air Force has negotiated cost-plus fixed fee contracts totaling nearly $600 million with Douglas, Convair and Martin—prime contractors in the *Thor*, *Atlas* and *Titan* ballistic missile programs respectively.

Largest of the three, amounting to $358,000,000 went to Martin for design, fabrication and testing of the *Titan*. Award to Convair for similar activity on the *Atlas* was valued at $145,000,000. Douglas' contract for the *Thor* totaled $67,500,000.

Dollar values of the contracts, however, were labeled "rough estimates," not to be used as an index of the size of the three projects. The Martin contract, for example, covers a substantially longer period than that awarded Convair or Douglas.

NEW MISSILE PRODUCTS

ROCKET FLIGHT SIMULATOR



A simulator for acceleration-sensitive devices used in rockets and missiles permits testing for acceleration and deceleration effects. A vector seeking specimen mount is used which eliminates nearly all undesirable side accelerations. An acoustic specimen cavity and special microphone permits audio data sensing of hermetically sealed units.

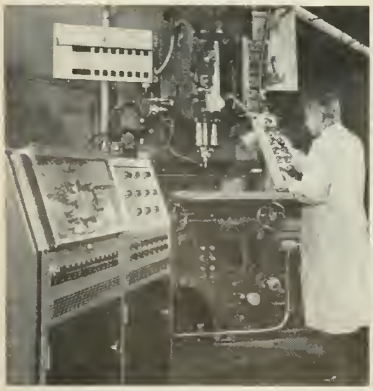
Two energy storing flywheels are used which can accelerate a device from 2 to 125 g in 200 milliseconds. Minimum braking time is 100 milliseconds. Maximum flight time is 55 seconds. A program unit controls acceleration-deceleration cycling through adjustable cam operated switches which control magnetic clutches and brakes. The Magnavox Co.

Circle No. 205 on Subscriber Service Cord.

MACHINE CONTROL SYSTEM

North American Aviation's Autonetics Division has developed Numill, a tape control system designed big-machine automation to small lot and single part production of aircraft and missile tools and parts.

The system is adaptable to lathes, boring mills, contour mills and grinders



and permits finished tools or parts to be produced without use of blueprints. Sole guidance for machine operation is provided by instructions recorded by a standard electronic brain on magnetic tape and continuously monitored by automatic electronic gauges.

Basically, its operation hinges on the transfer of recorded instructions from the tape into electrical signals to direct the movement of the machine. An instruction panel specifies the materials and tools to be used.

Within a few years, North American officials predict, control systems like Numill will be in widescale use in by firms engaged in small lot production. Further, their use will provide the competitive advantages of improved parts uniformity, reduced costs and greatly shortened lead times.

North American Aviation, Inc., Autonetics Div., International Airport, Los Angeles 45, Calif.

Circle No. 207 on Subscriber Service Cord

TEMPERATURE PROBE

A temperature probe for missiles and aircraft features very high recovery and negligible radiation and conduction errors for operation to temperatures of 1000° and 2800°F. For either boom or strut mounting, the T-1305 aircraft total temperature probe can be obtained with a choice of resistance or thermocouple elements. Resistance elements of wire wound type go to 1000°F and thermocouple types to 2800°F.

The units use the double stagnation principle and are said to have rapid response to temperature changes and complete insensitivity to 20 degree angle of attack. Aero Research Co.

Circle No. 204 on Subscriber Service Cord.

PRESSURE TRANSMITTER

New Synchrotel pressure transmitters designed for use in high performance aircraft and guided missiles weigh about one pound, about one-third that of previous models, according to the manufacturer.

The Synchrotel transmitter are used for transducing pressure values as electrical signals. They are used with air and navigation data computers as well as flight and engine control systems where accurate measurement of pressure functions is a must and where space and weight are at a premium. Kollsman Instrument Corp.

Circle No. 208 on Subscriber Service Cord

GYRO ROTOR ALLOY

New high-strength, high density alloy introduced by P. R. Mallory & Co. for use in gyro rotors is said to withstand rotor speeds about 25% higher than allowable with other materials.

A sintered alloy of tungsten, nickel, copper and other elements, Mallory 1000 Gyromet has a density of 16.70-17.05 grams per cubic centimeter. Proportional elastic limit is 62,000 psi and endurance limit 55,000 psi.

According to its producer, the new alloy has considerably higher stability and strength than previously obtainable, an indication of its potential use in inertial guidance systems where exceptional precision and uniformity are in demand. P. R. Mallory & Co.

Circle No. 212 on Subscriber Service Card

PRESSURE REDUCER

New series of lightweight pressure reducers designed to meet Spec. MIL-R-8572 range in weight from 0.4 to 0.6 lbs. and are intended for 3,000 psi aircraft and missile pneumatic systems. Units are available for ¼-in. and ⅜-in. tube sizes with larger models supplied on request.

Valve design includes built-in relief provisions, but reducer is available without this feature for special pneumatic or hydraulic system installations. Unit is balanced for straight-line regulation, leak-tight shut-off and small initial pressure drop. Operating temperature range is from —65°F to 225°F. Pneu-Hydro Valve Corp.

Circle No. 210 on Subscriber Service Card

TEMPERATURE SENSING RESISTORS

A new line of "Tape-On" surface temperature resistors that can be applied to any surface with a small piece of Mylar tape have been announced. Designed for temperature telemetering, the sensing elements have an output up to 5 volts and can be used directly in a commutation circuit to modulate standard telemetering transmitters.

Resistance change over the temperature range is 100 ohms. The resistors are available in various ranges from —300°F to +400°F. They have two 6" long fibreglass covered constantan leads.

Size is ¼" x 5/16". Accuracy is rated at ±2% of full scale range. Precision is ±0.5% of full scale range. Maximum continuous current is 20 ma rms (averaged over 1 second). Trans-Sonics, Inc.

Circle No. 216 on Subscriber Service Card

SEALED SWITCHES

New hermetically-sealed, potted switches for aircraft and missile use feature a threaded actuator plunger guide for versatility of mounting. This arrangement permits location of switch actuator button flush with mounting board or at any extended distance up to ⅞ in.

Model No. 9129, when mounted on actuator, has ⅛ in. overtravel with equal pretravel along the plunger. Tests by manufacturer indicate units conform to MIL Spec. 50-g shock limits.

Actuator button is compounded from special elastomers said to flex satisfactorily at —90°F and at 285°F. Switch is bonded to switchover and is rated to withstand 100 psi pressure differential inside to outside without rupture or leakage. Literature available. Haydon Switch, Inc.

Circle No. 211 on Subscriber Service Card

METAL LAMINATES

A new series of metal laminates employing a true metallurgical bond in combinations of two or three metals have been unveiled by Bridgeport Brass Co. Combinations include stainless and mild steels, Monel, copper, brass and titanium plus some precious metals bonded to form laminates or sandwich structure of varying thicknesses.

Advanced research is being continued on the use of the laminates in nuclear power and missile applications. Bridgeport Brass Co.

Circle No. 213 on Subscriber Service Card

PRESSURE SWITCH

High temperature pressure switch rated for operation at 650°F in airframe, missile and rocket systems weighs only 11 oz. Unit uses all-welded stainless steel

construction, an advanced type of snap-action switch element and a precision stacked-capsule sensing element, according to its producer.

The pressure switch is usable in standard aircraft fluid systems, air and hydraulic systems. Absolute-pressure version provides an adjustment range of 20 to 75 psia with a reset value, or difference between make and break, of 2 psi.

The Type 6576 switch adjustment is externally accessible through the inlet port. Rated proof pressure is 100 psi and burst pressure 150 psi. Contacts are SPST or SPDT rated at 1 amp. inductive. Overall dimensions are 1 1/ in. diameter by 3¼ in. long. Manning, Maxwell & Moore, Inc.

Circle No. 209 on Subscriber Service Card

INSTRUMENT SIGNAL CONVERTER

A three-channel system converts signals from 400 cps transducers to 0-5 volts dc for telemetering inputs. Conversion is by a crystal diode demodulator that eliminates all amplifiers from the signal circuits. Model 4-1103 provides a demodulated signal output with rated linearity of 0.5%. Dynalysis Development Laboratories, Inc.

Circle No. 206 on Subscriber Service Card.

⅔ actual size

Honeywell Aero's MIG (Miniature Integrating Gyro) represents a scientific breakthrough in floated gyro design. Only 1.75 inches in diameter, and weighing less than 0.5 lb., its performance compares to hermetic integrating gyros three times larger. Primarily used in stable platforms, the MIG excels in short-time inertial and aided-inertial applications. Such miniaturized components typify Honeywell Aero's anticipation of advanced flight control system needs.

AERONAUTICAL DIVISION, MINNEAPOLIS-HONEYWELL

POTENTIOMETER

A high performance potentiometer for severe environmental applications has a resistance of 30,000 ohms ±10% and withstands temperatures from —65°F to —275°F, 10g vibration from 10 to 1500 cps, and shock to 60g.

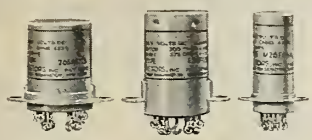
Model RP04-0101 weighs 2.5 oz. Distance travel is 4.13 in. Service life is 1,000,000 cycles. For mechanical positioning, the case and actuator have a vernier scale reading to 0.010 inch increments. Humphrey, Inc.

Circle No. 202 on Subscriber Service Card.

FREQUENCY DETECTOR

Narrow band frequency detector for telemetry and instrumentation applications provides an output current linearly proportional to frequency within a band width of 375 to 425 cycles. Units can also be provided to cover 10% bandwidth at any center frequency from 30 cps to 5 kc.

Output is suitable for operating a d'Arsonval instrument, servo-type recorder or a control curcuit. Linearity is within ¼% of midband frequency. Detector is hermetically sealed; operates from —55°C to 72°C; withstands 10g vibrations to 2000 cps and shocks of 30g in any direc-



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NO STAMPED PARTS IN THE MOTOR. MACHINED PARTS—ONLY ONE OF THE ADDITIONAL QUALITY CONTROL STEPS TAKEN BY FILTORS IN THE MANUFACTURE OF HERMETICALLY SEALED SUB-MINIATURE RELAYS . . . YOUR ASSURANCE OF GREATEST RELIABILITY.

WRITE FOR CATALOG, FILTORS, INC., PORT WASHINGTON, LONG ISLAND, NEW YORK, PORT WASHINGTON 7-3850

tion. Octal or other sockets can be provided. Units are 1½ in. diameter, 2 inches in seated height and weigh 6 oz. Airpax Products Co.

Circle No. 200 on Subscriber Service Card.

INPUT-OUTPUT TYPEWRITER

A new electric IBM typewriter designed for use as an input and output unit for the data processing field has been announced. It can be used in conjunction with measuring and recording instruments, scales and meters for engine resting, liquid flow measurement and wind tunnel research to provide a visual record.

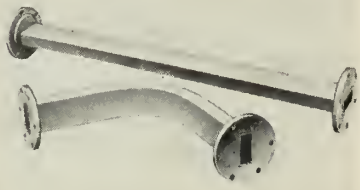
Electro magnets and solenoids act as receivers of signals from a controlling device or computer to actuate the keyboard. Typing is done at the rate of 120 words per minute. Actuated functions include carriage return, spacing, tabulation, ribbon color control and others.

As an input device electrical impulses are transmitted by depressing the typewriter keys. International Business Machines Corp.

Circle No. 215 on Subscriber Service Card

HIGH-CONDUCTIVITY WAVEGUIDE

Oxygen-free high/conductivity copper is used in Airtron's waveguide components to minimize losses in long transmission lines. Now available are components such as straight sections, circular bends and adapters in the new material for WR-137 waveguide size.



For microwave relay systems operating in the 6000 mc region, the waveguide components of the new material have general application in indoor and outdoor cabinet applications since the high conductivity gives a lower insertion transmission loss for extended waveguide runs in these applications. Attenuation is between 2.0 and 2.4 db/100 ft. Airtron, Inc.

Circle No. 203 on Subscriber Service Card.

HIGH OUTPUT TRANSDUCERS

Resistance-type temperature transducers that give outputs up to 5 volts in telemetering and other applications are available in a variety of configurations for measurement of surface, fluid, and air temperatures.

Units cover temperature ranges of —320°F to 500°F with linearity rated at ±2%. Special units are available that cover up to 1600°F. Resistance values are 100 to 20,000 ohms. Either ac or dc bridge circuits may be used.

Each probe is supplied with a serialized calibration curve. Units are stated to meet MIL-5272 specification. Arnoux Corp.

Circle No. 214 on Subscriber Service Card

AMPLIFIER KLYSTRON

An amplifier klystron for use as the final amplifier of a high power microwave transmitter permits amplification of frequency, amplitude or phase modulated signals at power gains of about 50db. Featuring all-ceramic and metal construction, the VA-806 provides 2000 watts of continuous power in the 7125 to 8500 mc range.

The tube is water cooled and has a four cavity amplifier section tunable ±25 mc from specified center frequency. It features matched waveguide input and output, and low FM and AM noise. Varian Associates.

Circle No. 201 on Subscriber Service Card.

MISSILE MATERIAL

The Russell Manufacturing Co. has developed a new high temperature resistant Rusco woven material for rocket and missile parts insulation that is said to have stable performance characteristics under temperatures ranging up to 2,000°F.

Company reports it has developed techniques for weaving a ceramic fibre into tapes, sleeves, tubes and almost any other shape that might be required to meet particular applications.

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SENIOR TELEMETRY ENGINEER

Capable of planning and monitoring requirements of telemetering problems associated with missiles programs.

SENIOR ENGINEER

Analog Computers

Should be thoroughly familiar with up-to-date analog equipment and methods; capable of planning simulated programs involving electronic analog methods and equipment.

ENGINEER and SENIOR ENGINEER

Operations Research

Should be experienced in applied methods, either military requirements or market analysis.

SENIOR DESIGN ENGINEER

Guidance Systems Design

Capable of designing and evaluating for complex guidance systems and techniques as used in advanced missiles systems. Experience in electronics, inertia, radio command, infra-red forms of guidance equipment desirable.

ENGINEER and SENIOR ENGINEER

RH and Antenna Design

Experienced in UHF and microwave techniques and antenna design.

TEMCO

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Please send me complete details of the Temco story of unusual opportunities for creative engineers. I am especially interested in_____

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HOLSCHUH

Carl G. Holschuh has been appointed president and gen. mgr. of Sperry Gyroscope Div., Sperry Rand Corp., succeeding **Charles M. Green**, retiring. **Mr. Holschuh** steps up from exec. vice president and gen. mgr.

Elmore P. Pillsbury, formerly chief of aeromechanical engineering for Fairchild Guided Missiles Division, Fairchild Engine and Airplane Corp., has been appointed chief engineer for the division.

Raymond J. Condon, mgr. of military sales for Minneapolis-Honeywell Regulator Co.'s Aeronautical Div., has been appointed vice president-government projects for the division.

Charles H. Godschall, manager of tooling and tooling engineering for the Government and Industrial Division of Philco Corp., was presented the Distinguished Service Award, the Navy's highest civilian award, "for outstanding work in the development of a new underwater weapon."

Capt. F. D. Pfotenhauer (USN, ret.) was appointed vice president of production and **D. C. Eaton** was promoted to vice president of program management for Reaction Motors, Inc.

James D. McLean succeeds **John B. Moss** as president of Hoffman Laboratories, Inc. Moss becomes chairman of the executive committee and remains a director of Hoffman Electronics Corp.

Glenn D. Maxwell was appointed asst. director of Consolidated Electrodynamics Corp.'s advanced electronic data laboratory, and **Lenard Johnson** was named supervisor, laboratory services.

William R. Whittaker, president of Wm. R. Whittaker Co., Ltd., has been elected chairman of the board of Telecomputing Corp.

Max M. Tall was appointed head of the reliability program for missile control projects at Radio Corporation of America's Missile and Surface Radar Dept.

PEARSON

John E. Lowe, formerly personnel manager for American Machine & Foundry Co.'s electronics division, has been appointed director of personnel and public relations of the new guided missile launching system plant in Rochester. **Robert W. Pearson**, manager of reliability control in the Missile and Surface Radar Dept., Moorestown, N.J., has been appointed deputy general manager for operations of the electronics div. in Boston.

Dr. Clarence Zener has been named director of Westinghouse Research Laboratories, after five years as associate director and a year as acting director.

Henry M. Haase was elected president and chief executive officer of the York Division of Borg-Warner Corp. at York, Pa. **Stewart E. Lauer** became chairman of the Board.

Bell Aircraft Corporation's Research Division announced the following appointments: **John F. Hawkins**, administrative mgr.; **Robert E. Hannel**, services mgr.; **William Shultz**, sales mgr.; and **Ronald E. Shainin**, contract administration mgr. The Avionics Division made these appointments: **Frank H. Andrix**, director of engineering; **Joseph D. Schantz**, assistant to division mgr.; **Robert C. Sellers**, sales mgr.; **Howard H. Herod**, contract administrator.

Maj. Gen. Francis H. Lanahan (USA, ret.) has been elected president of the Federal Electric Corp., subsidiary of International Telephone and Telegraph Corp.

Dr. C. B. Jolliffe, vice president and technical director of Radio Corp. of America, will head the new Special Systems and Development Dept. Other appointees are: **A. W. Vance**, chief systems engineer; **G. L. Dimmick**, chief development engineer; **A. C. Gay**, mgr., projects engineering; and **Dr. E. W. Pritchard**, administrative engineer.

Lewis F. Millett has been named to head radar development department of Bendix Aviation Corp.'s Research Laboratories division.

E. L. Rucks, principal engineer for Aerojet-General Corp., will head the new structural plastics group of its Solid Engine Division, whose principal activities are in the field of pressure vessels, thermal insulation and components for rockets and missiles.

LOWE

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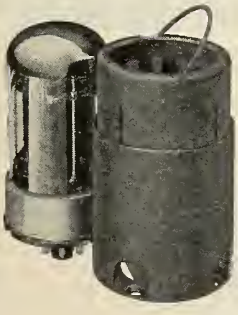
A principle is at work, too! The same one by which a spoon creates a "silent cycle" of conduction, radiation and convection that cools the coffee—now, effectively applied, increases electronic equipment reliability.

Electronic reliability engineers are learning how to beat *heat* (the most frequent cause of electron tube failures and resultant equipment unreliability) with the "silent cycle" effectiveness of IERC Heat-dissipating tube shields. IERC's extensive research has resulted in the *only* Heat-dissipating tube shield that gives you maximum effectiveness in *all* three phases of the "silent cycle"—conduction, radiation and convection! Service in severe environmental conditions in many military and industrial equipments proves IERC shields reduce tube operating temperatures as much as 150° C—extend tube life up to *12 times longer! Excellent retention and shock and vibration protection is also provided.

IERC tube shields are available for miniature, sub-miniature, octal and power electron tubes.



IERC literature and latest Octal and Power tube shield Technical Bulletin available now — FREE!

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people

Navy Secretary Charles S. Thomas at Aerojet's Azusa plant discussing rocket power in general and the Polaris FBM engine in particular (?) with Dan A. Kimball, Aerojet president (right) and Assistant General Manager William L. Rogers (left).

Atoms-for peace visitors from Sweden. Representatives from the Swedish Atomic Energy Co. nuclear experts B. Nelsson, B. Swenson and R. Vestergaard. ACF Manager of Nuclear Energy Products Division, George Anderson (on right).

International Society of Aviation Writers plan First Congress to be held in Washington, D. C. April 3-6. Two hundred reporters, many from Europe and Latin America will learn about IGY and the Vanguard satellite program. Top left to right: Paddy Kavanagh, CANADIAN AIR REVIEW; Ed Kirschner, free lance, U.S.; Erik Bergaust, MISSILES & ROCKETS; James Cunningham, United Press. Bottom, left to right: Sydney Cooper, International Civil Aviation Organization, Montreal; Anthony Vandyk, AMERICAN AVIATION and MISSILES & ROCKETS; Ross Willmot, Executive Secretary, ISAW, Toronto. International aviation writers will set up headquarters at the Roosevelt Hotel in Washington. They will attend the American Rocket Society sessions to take place April 3-6. President of ISAW is Arthur Riley, Aviation Editor of the BOSTON GLOBE. ISAW was formed in San Francisco last year. It now has more than 300 members; more than 100 accredited US aviation reporters have joined.

•

Wanted!

Engineers to sign on for one of the most exciting scientific expeditions of our time:

The SM-64 Navaho Missile

The men behind this invitation are pioneers in missile development. Ten years ago they started from scratch. There were no texts to consult, no rules to follow. Today their technological achievements are so great ... their jobs so broad ... there is room at every level of engineering for additional mindpower.

Accept this challenge and you can travel faster and farther than you ever thought possible on one of the most important programs in the free world today—North American's complete weapons system responsibility for the Air Force SM-64 Navaho Intercontinental Strategic Guided Missile.

DOUGLAS K. BAILEY received his BS degree from the University of California. He joined North American ten years ago as a senior design engineer. Today he is chief, Missile Design Section—responsible for missile design engineering and analysis. Doug and his family live in Long Beach where he participates in golf, bowling and sports car activities. He is currently organizing road races in Southern California for the Long Beach MG Club.

Unprecedented programs have been completed and more are to come. Others are being developed, modified and perfected as we enter another exciting phase following a successful flight test program at Patrick Air Force Base using a test vehicle known as the X-10.

The fascinating nature of this work has already attracted the world's best informed missile men. Top-tier men have opportunities in almost every field of engineering—including some of the most advanced work being done today in aerodynamics, thermodynamics, high temperature materials and aero-elasticity.

Solving these problems is bringing forth new formulae and new production techniques. One example is Chem Mill, the process of shaping metals—including titanium and newest alloys—to previously unattainable designs by chemical etching. This method reduces weight ... increases strength. The idea came from a North American Missile engineer.

Navy vet **GEORGE W. JEFFS** earned both his BSAE and MSAE from the University of Washington. About 9 years ago he started his professional career with North American as a junior aerodynamics engineer. Now, 5 promotions later, this 30-year old veteran of missile work is chief, Advanced Design Section. He lives in Downey, California with his wife and 3 children. His hobbies include fresh-water fishing and hunting for quail and pheasant.

This is the kind of opportunity open to you. You can share our knowledge and add to it.

Recent graduate engineers can step into established groups. Experienced men will find even greater opportunities in the new groups that are being formed. And you'll do this in a management climate that stimulates personal growth and rewards it with responsibility, professional recognition and material benefits. Further, you can continue your studies with the aid of North American's Educational Refund Plan ... live and work in Southern California ... in near-ideal climate.

Let us know what kind of creative engineering interests you. (Please include highlights of your education and experience.)

Write today to: Mr. R. L. Cunningham, Engineering Personnel Manager, Dept. 91-2-MAR
Missile Development Division, 12214 Lakewood Blvd., Downey, California.

NORTH AMERICAN AVIATION, INC.

Photo courtesy of Northrop Aircraft, Inc.

High-speed control for high-speed missiles

Nowadays, target, aircraft, and missile speeds are too fast for human reactions. Automatic equipment makes ready, radar eyes take aim and a computer pulls the trigger.

Replacing men with machines on the firing line gives us a better chance for an interceptor kill or successful missile shot. And, today, we can't afford to miss. That's why reliability of every component is so important in modern fire control gear. And reliability is the main reason engineers—like those designing Northrop Aircraft's Snark missile (above)—so often pick Bristol's® Syncroverter® High-Speed relays (or the very similar Syncroverter chopper).

These high-speed relays have a normal life of billions of operations in dry circuit applications. They're available in SPDT and DPDT models with the typical characteristics listed below and in many variations.

And, of course, many critical applications other than fire control—such as air-to-ground telemetering, analog and digital computers, aircraft or missile navigation equipment, carrier current switching—can benefit from the outstanding reliability of Bristol's Syncroverter line. Write for complete technical data today. The Bristol Company, 173 Bristol Road, Waterbury 20, Conn. 6.61

TYPICAL CHARACTERISTICS

Temperature range: —55°C to 100°C
Operating shock: 30G; 11 milliseconds duration
Vibration: 10-55 cps (see below, Mounting); 10 G
Contact ratings: up to 35v, 45 microamperes
Stray contact capacitance: less than 15 mmfd
Pull-in time (including bounce):
os low as 200 microseconds
Drop-out time: 300 microseconds
Life: Billions of operations
Mounting: Octal tube socket; others available, including types for vibration to 2000 cps.

BRISTOL FINE PRECISION INSTRUMENTS FOR OVER 67 YEARS

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missile literature

ACID RESISTANT COATINGS. The Development of a Protective Coating Resistant to Nitric Acid and Hydrocarbons; by D. F. Siddall, E. Hillier, R. Garling and M. Gunther of U. S. Stoneware Co. for WADC; 116 pages; $3.00. Order Ref. No. PB 121217S. Review of research program to prove out X-200 resin or Kel-F 800 as a fluorinated material resistant to white fuming nitric acid encountered in acid tanks and assisted takeoff compartments of jet aircraft.

EXPLOSIVE VAPOR DETECTION. Study of Explosive Vapor Detection; by T. M. Shaw, F. K. Truby and W. R. Wood, Southwest Research Institute for WADC; 277 pages; $6.00. Order Ref. No. PB 121517. Report reviews results of survey of vapor detection methods and instrumentation with conclusion that no completely satisfactory principle of operation or sufficiently compact instrumentation exists for vapor detection in rocket-propelled aircraft. Recommendations are offered on possible methods of detecting fuel and oxidizer vapors, optimum detection methods and use of tracers.

HIGH TEMPERATURE MATERIALS. Cemented Borides; by American Electro Metal Corp. for Office of Naval Research; 140 pages; $3.50. Order Ref. No. PB 121346. A summary of experiments with Barolite IV, a promising high temperature material comprising several compositions of a chromium boride, Cr_2B and a Cr-Mo alloy. It is said to possess outstanding heat shock resistance, oxidation resistance and stress-to-rupture strength through 2,000°F.

TITANIUM CARBIDE. Iron Bonded Titanium Carbide, by R. E. Wilson, New York State College of Ceramics; for WADC; 39 pages; $1.00. Order Ref. No. PB 121323. Report describes techniques developed for hot pressing iron bonded titanium carbide into various shapes to enable determination of its physical properties. Although material was found inferior to nickel-bonded titanium carbide for use in aircraft power plants, extensive work with hot pressing is reported to have advanced that art. Iron-titanium carbide was effectively hot pressed with either the carbide or the metal as the continuous phase, depending on temperature used in the process. Also, molybdenum disulfide suspended in ethylene was found effective as a parting medium in hot pressing.

TITAIUM CLADDING. Roll cladding of base metals with Titanium, by P. T. Mataich and F. C. Wagner, Horizons, Inc.; for WADC; 36 pages; $1.00. Order Ref. No. PB 121479. Describes experiments with roll cladding of titanium to steel using a number of different metals as bonding agents. Best bond was obtained with a chromium plated layer on steel which was pressure-welded to titanium, but good bonds were also obtained by plating successive layers of silver and nickel on the titanium before cladding. Elements such as cobalt or nickel formed strong bonds to titanium—but in a very limited temperature range—a restriction which would make commercial work difficult, the report states. Although study indicated roll cladding is possible on a laboratory basis, the use of alloys as bonding agents is believed a possible means of producing higher strength bonds and further research is recommended.

DATA REDUCTION. Automatic Data Reduction—Part II, by R. S. Hollitch and A. K. Hawkes, Armour Research Foundation; for WADC; 80 pages; $2.00. Order Ref. No. PB 111928. A catalog of devices useful in automatic data reduction listing five categories of such devices commercially available or under development. Scope of listing is limited to equipment that is digital in nature. Categories include analog voltage to digital converters; shaft position to digital converters; digital plotters and digital to analog converters; miscellaneous digital devices; and, special tape recorders. An appendix lists producers of the devices.

DATA STORAGE: Superimposed Coding for Data Storage; by M. Taube, Documentation, Inc. for Office of Naval Research; 27 pages; $0.75. Order Ref. No. PB 121345. Report discusses methods of superimposing coding, or the recording of two or more codes in the same field, to facilitate information searching on machine sorted index cards.

ENVIRONMENTAL TESTING. Correlation of Natural Weathering and Sheltered Storage Exposure Tests with Simulated Environmental Laboratory Tests, by W. E. Laesch and W. W. Smith, South Florida Test Service; for WADC; 60 pages; $1.50. Order Ref. No. PB 121321. Report of investigation of the possible correlation between natural and laboratory-simulated weathering and storage tests on degradation of metals and plastics. Results showed no significant correlation between the simulated environmental tests and data obtained from natural weathering tests of the metals, or of lucite and laminated phenolics.

The Defense that Research Built

Working closely with various government agencies and aviation companies*, The M. W. Kellogg Company has participated in many important research and development phases of the rocket program. This has covered a wide range of missiles and rocket propulsion systems for Terrier, Talos, Snark, Sparrow, and Nike. Kellogg has also produced booster rocket cases and other components.

M. W. Kellogg's long rocket experience, supplemented by this organization's 50-year background of engineering and fabricating high temperature-high pressure industrial products, continues to provide valuable assistance to National Defense.

*Including the Navy, Army, Air Force, Allegany Ballistics Laboratory, The Johns Hopkins University Applied Physics Laboratory, and such well-known aviation names as Bell, Boeing, Convair, Douglas, Grumman, Lockheed, McDonnell, Northrop, Republic.

M.W. Kellogg

ENGINEERING FOR TOMORROW

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Kellogg Pan American Corporation, New York • Societe Kellogg, Paris

industry briefs

THIOKOL CHEMICAL CORP. has received six new rocket engine development contracts from Army's Redstone Arsenal. Largest is valued at $442,743 for continued development of propulsion system for Raytheon *Hawk* I. Others involve XM19, XM19E1 and XM20 rocket engines ($329,180); *Lacrosse* rocket engine ($325,328); M58-E4 engine for Hughes *Falcon* ($41,-482); and continued R&D on large propellant type engines ($386,935).

BELL AIRCRAFT CORP. has been awarded two additional Air Force contracts totaling $22,040,047 for further R&D work on *Rascal* air-to-ground missiles.

BOEING AIRPLANE CO. has abandoned plans for a separate, fully-integrated guided missile division it hoped to establish near Richmond, Calif. Option on Ford Motor Co. plant there has been allowed to lapse and two additional options on local acreage will not be exercised. Reason: Air Force refused to support Boeing's plan for new division, hence *Bomarc* missile production will revert to company's Seattle plant with support from Wichita division and subcontracting firms.

McDONNELL AIRCRAFT CORP. reports earnings of $3,862,453 for first half of its fiscal year ended December

31 compared to $2,663,902 a year ago. December 31 backlog stood at $831,-171,849 compared with $607,468,294 last year. Company is a key producer in *Talos* and *Green Quail* missile programs.

THREAT OF PROLONGED WORK STOPPAGE at Patrick AFB Missile Test Center ended abruptly February 1 when some 600 of 900 non-union workers striking against Pan American World Airways returned to work after one-day walkout. Their demand for vote on union affiliation remained unsettled at presstime.

AEROPHYSICS DEVELOPMENT CORP., Curtiss-Wright Corp. subsidiary which developed the *Dart* missile and HTV (hpersonic test vehicle), expects to occupy the first two of five proposed new buildings on February 15.

HUGHES AIRCRAFT CO. plans construction of a new $6-million plant for production of ground radar system components on a 475-acre plot near Fullerton, Calif. Hughes expects to employ about 2,000 workers there by 1958.

HALLAMORE ELECTRONICS division of Siegler Corp. has received an addition to an earlier contract with Convair's Astronautics division for system design, fabrication and assembly of equipment used in Convair's missile program.

Bomarc Test Personnel Get Pay Increase

Boeing Airplane Co. and International Association of Machinists-Local 2061 have agreed on hourly wage increases from 14½¢ to 20¢ for employes assigned to *Bomarc* missile test facilities at Cocoa, Fla.

The agreement covers workers who service and test missiles built in Seattle. The increases raise the rates of employes in Labor Grade A to $2.80 an hour.

NAA Missile Workers Get New Recreation Center

A new 6700-sq. ft. recreation center at North American Aviation's Downey, Calif. plant was opened recently for use by personnel of company's Autonetics and Missile Development divisions.

New Center includes a 375-person capacity auditorium, two club meeting rooms, office, kitchen, lobby and rest rooms.

Douglas Plans Conferences To Aid Engineering Force

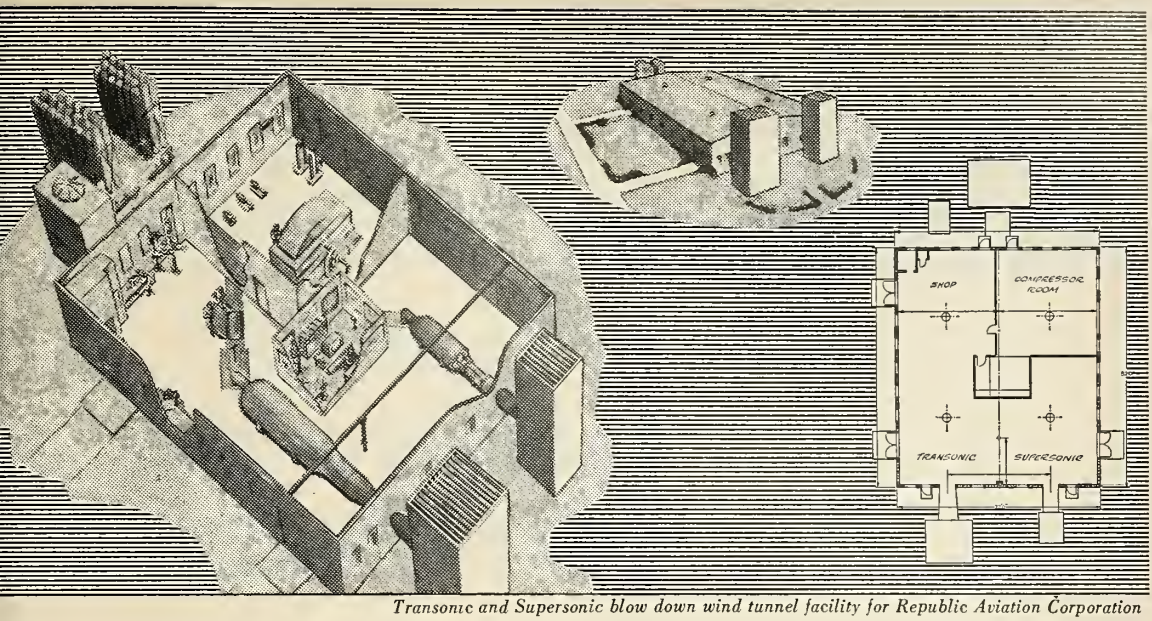
Douglas Aircraft Co. has held the first of a series of periodic inter-division conferences of design engineers —a meeting of chief aerodynamicists from five Douglas divisions.

The sessions, spearheaded by v.-p. engineering Arthur E. Raymond, are intended to take full advantage, throughout the Douglas engineering organization, of the diversified experiences at each of its divisions. In this way, Raymond feels, the overall Douglas engineering organization will be strengthened and improved.

On hand for the first session held recently in Tulsa, Okla. were O. E. Bottorff, asst. to Raymond, and these head aerodynamicists from Douglas divisions: W. B. Oswald—Santa Monica; K. E. Van Every—El Segundo; A. S. Church—Long Beach; H. F. Klecker—Tulsa and H. J. Gunkel—Missiles division.

GE Forms New Lab For Missile Research

General Electric Co. has formed a new Aerosciences Laboratory within its Missile and Ordnance Systems Department in Philadelphia. Its purpose: to conduct or direct applied research in specific fields of technology so that major improvements in missile weapons systems may be developed.



Transonic and Supersonic blow down wind tunnel facility for Republic Aviation Corporation

a special message to wind tunnel engineers and scientists

ANNOUNCING UNUSUAL OPPORTUNITIES WITH REPUBLIC'S NEW WIND TUNNELS SECTION OF THE R & D DIVISION

A new wind tunnel installation doesn't open every day!

Yet, that's exactly what's happening at Republic Aviation. A brand-new installation is being planned for Farmingdale, Long Island, dedicated to the study of all the complex, interrelated aspects of passage through the upper atmosphere.

What can this mean to you?

If you're presently a Director or Assistant Director of a wind tunnel installation, it means an opportunity to change pace —to express your ideas—and then implement them—in brand new facilities. And at the same time, to broaden your professional horizons.

Or perhaps you're a member of the operating staff at a wind tunnel. You've got experience, ability, intelligence. But you'd like a chance to get in on the ground floor of a new operation, with the most modern facilities at your command...and increase your opportunities from the very start.

If you're in any of these categories, you owe it to yourself—and your family—to check the following requirements and then contact us.

DIRECTOR: Should have 10 to 15 years' experience in the design, construction and operation of wind tunnels and related facilities, as well as complete staff administration.

STAFF: Preference will be given to people with direct or related experience, at all levels, in wind tunnel

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ANALYSIS • INSTRUMENTATION

Republic engineers and scientists enjoy top-of-industry pay scales plus added financial and professional recognition for individual contributions. Benefits include our famous 2-Fold Retirement Income Plan. Educational Aid, and broad Life, Accident and Health Insurance Program. Unequalled Long Island Living, with all the cultural, educational and entertainment facilities of New York just minutes away.

Please send complete resume, in strictest confidence, to:
Mr. George Hickman, Engineering Employment Manager

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CHEMISTS, PHYSICISTS,
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- ☐ "If I'd taken that automotive job in the 20's I'd be a top executive today."
- ☐ "If I'd gone into aviation in the 30's I'd be in a key spot now."
- ☐ "If I hadn't turned down that TV opportunity in the 40's."

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1957 YEAR OF OPPORTUNITY IN ROCKETS

The BIG careers in America's next BIG industry now being launched at Reaction Motors

The *time* to get into rockets is now. This young industry is becoming a giant overnight, thanks to developments that are pushing the field ahead faster than any other open to engineers and scientists today. 1957 will see significant advances that will bring the conquest of outer space closer to reality. Scientists and engineers who get into rockets this year with Reaction Motors will be strategically placed to rise to prominence in the industry...for RMI is the oldest company in the field, a leader for 15 years, now embarking on a new, major expansion program involving every area of activity.

Whether or not you hove worked in the rocket field before, there are high-calibre openings for you with Reaction Motors. Practically all basic professional knowledge and training is employed in rocket engine development and RMI's experts will help you acquire the specific know-how you need for an accelerating career in this burgeoning field.

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Instrumentation recorders
Braking systems
Stress analysis
Air conditioning
Numerical analysis
Heat transfer equipment
Fuel injection systems
Metallurgy (high alloys, temp.)
Jet or reciprocating engine design, test
Pressure equipment, vessels, high vacuum
Controls (hydraulic, pneumatic, electrical)
Regulators (valves, hydraulic, pneumatic)
Physics – solid state, atomic, etc.
Chemistry – fuel, rubber
Ignition systems

Experience in any of these areas...

... is your passport to important assignments in one or more of these areas

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Chemical kinetics
Combustion phenomena
Servo mechanisms
Project engineering
Controls (hydraulic, pneumatic, electrical)
Instrumentation
Applications engineering
Analog simulation
Proposals
Test
Aerodynamics
Fluid Flow
Nuclear applications
Data reduction
High temperature
Alloys
Thermostress and vibration
Technical planning (advanced design)
Tool design

You will be working in the forefront of one or more of our 6 main Project Areas: Missiles • Piloted Aircraft • Launching Devices • Ground Support Equipment • Liquid and Solid Propellant Chemistry • Nuclear Rockets.

For further details drop a line or send complete resume – including address and phone number – in strict confidence to: Supervisor of Technical Placement, Reaction Motors, Inc., 50 Ford Road, Denville, N. J.

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A MEMBER OF THE OMAR TEAM

50 FORD ROAD, DENVILLE, N. J.

More C/L Wage Hikes Paid Aircraft/Missile Workers

Cost of living wage increases totaling 6¢ an hour are being paid to aircraft and missile production workers in two west coast plants as the result of the BLS 118.0 index for December 15.

At Douglas, hourly workers will get a 2¢ increase added to the 4¢ received in past C/L allowances. Northrop Aircraft, Inc., producer of the *Snark*, reinstituted the cost-of-living allowance in December and is paying 6¢ in a single raise.

North American Aviation paid an additional 2¢ C/L adjustment late last month based on the November 15 index bringing its total C/L allowance to 5¢ an hour.

In addition to these immediate changes, deferred wage hikes negotiated in a number of two-year labor contracts will soon go into effect. At Lockheed, which recently received the Navy's *Polaris* missile prime contract, a 7¢ increase starts February 18. A 6¢ jump goes into effect at Chance Vought (*Regulus*) on March 12 and a 7¢ hike begins at Convair Pomona and San Diego (*Atlas, Terrier* and *Tartar*) on April 1.

Douglas will pay 7¢ effective March 18 at plants represented by United Auto Workers and on April 1 at those involving International Assn. of Machinists. Rohr Aircraft also pays 7¢ starting April 15 and Boeing a similar amount on May 22 at its Seattle plants. Ryan Aeronautical will pay a 7¢ increase on July 8.

Computers—and the Engineer Shortage

Electronic computers, properly used, could produce a "new look" engineer and may be the answer to the current shortage of scientists and engineers, a computer symposium jointly sponsored by New York University and International Business Machines was told recently.

Daniel O. Dommasch, president of Dodco, Inc., predicted that the mechanical brains could achieve this end via their creative power of more than 30 present-day engineers.

The Dodco executive said computers would free engineers and scientists from making the physical and mathematical approximations that are necessary and would replace today's educated guesses with accurate numerical solutions. This abandonment of approximation would bring industry into the age of true science, he added.

Are You Looking For A Job... Or A Career?

For A Real Career Position... Read About These 12 Outstanding Openings At

WESTINGHOUSE-BALTIMORE

The 12 positions listed below are not just job opportunities — they are permanent career positions with an established leader in the electronics field. Westinghouse-Baltimore is an engineer's company — one that respects the engineer and rewards him for his contributions. The company's two new plants offer the very finest modern facilities and equipment for advanced work on vital projects that challenge the imagination and assure steady professional growth. These 12 opportunities may be the chance for which you've been waiting. Investigate them—and get in on the ground floor of tomorrow's electronic developments — at the rapidly expanding Baltimore Divisions of Westinghouse.

CURRENT OPENINGS EXIST FOR:

AIRBORNE RADAR SYSTEMS ENGINEERS
Overseas assignments on a research and development type project. An E.E. degree from an accredited college or university with additional training or experience on airborne radar systems is desirable. Applicants should be single, or willing to spend periods of six months to one year away from their families.

TROPOSPHERIC SCATTER SURVEY ENGINEERS
To work with the Air Force. Those selected would travel considerahly here and overseas. The company would provide living allowances and salary bonuses for overseas service. Applicants should have an E.E. degree from an accredited university and two to four years experience with microwave communications systems. Additional experience in surveying and laying out microwave systems would be helpful.

ELECTRIC WAVE FILTERS ENGINEERS
To assist in the design and development of audio, i-f and r-f filters, to meet the increasingly difficult requirements of modern SSB receivers and transmitters, both high and low power, at frequencies up to and including UHF.

MISSILE RADAR SYSTEMS ENGINEERS
To do analysis of over-all systems requirements. Must be able to translate to hlock diagram requirements.

MATHEMATICIANS
Some radar systems experience is desired, or experience in the following related fields: Noise analysis, Anti-jamming or Electrical Counter Measures, Communications systems.

MICROWAVE DEVELOPMENT ENGINEERS
To do development for the functional block diagram state to a complete hread board model. Theoretical and practical knowledge in the field is desired.

MECHANICAL DESIGN ENGINEERS
For the mechanical design of X-ray equipment, and for the designing of equipment to permit use of isotopes for medical treatment while protecting hospital personnel. An M.E. degree is required.

SALES ENGINEERS
To work with regional sales force on preparation of diagrams of the customers' organization, knowledge of the functions of the various elements, definition of procurement cycles, indication of important people and recommendations on over-all relations; detailed planning and coordination of sales strategy and proposal preparation; direction of contact efforts; liaison with Product Planner; and dissemination of product information.

DIGITAL COMPUTER ENGINEERS
For the extensive application of present and future digital techniques to military problems. Applicants with background and interest in digital coding, digital programming, and in the necessary hardware to implement such systems would find immediate application in our present digital work and would be expected to originate future digital programs.

ELECTRONIC TRANSFORMER ENGINEERS
To assist in the design and development of audio, i-f and r-f coils, flea-power to 600 x 10^6 v-a, frequencies up to 1000 MC, hoth linear and saturable, involving prohlems of halance, shielding, handwidth, insulation, heat transfer, wave shape, efficiency and regulation.

COMPONENTS ENGINEERS
For testing, evaluation and developing reliability programs for Electrical Components such as: switches, diodes, triodes, tubes, meters, resistors, capacitors, chokes, etc. Applicants must he qualified for standardization of components and interpretation of military specs.

MISSILES RADAR TEST ENGINEERS
To design intricate test equipment and assist in the testing and evaluation of developmental missiles target seeker systems.

TO APPLY:

For a confidential interview, send a resume af yaur educatian and experience ta:

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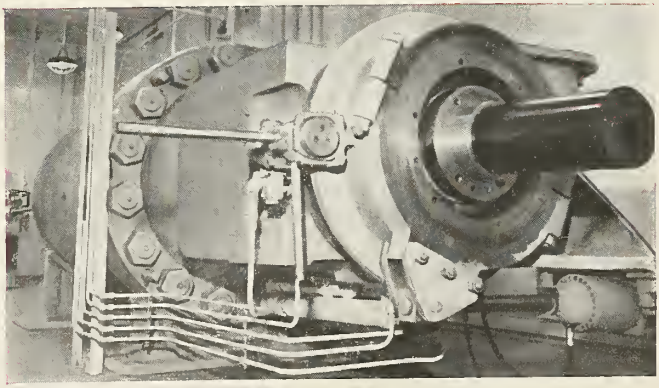

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Open ears lead to the open thinking that made possible today's rocket powerplants. They are alert ears—ears acutely sensitive to the unsolved problems that must be conquered in designing powerplants for the vehicles of the future.

RMI puts a premium on just such thinking. Its engineers and scientists form a talented, alert team, efficiently and effectively meeting the rocket power needs of tomorrow.

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Power for Progress

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