PLASMA ARC TORCH—
New Missile Production Tool

DECEMBER 22, 1958

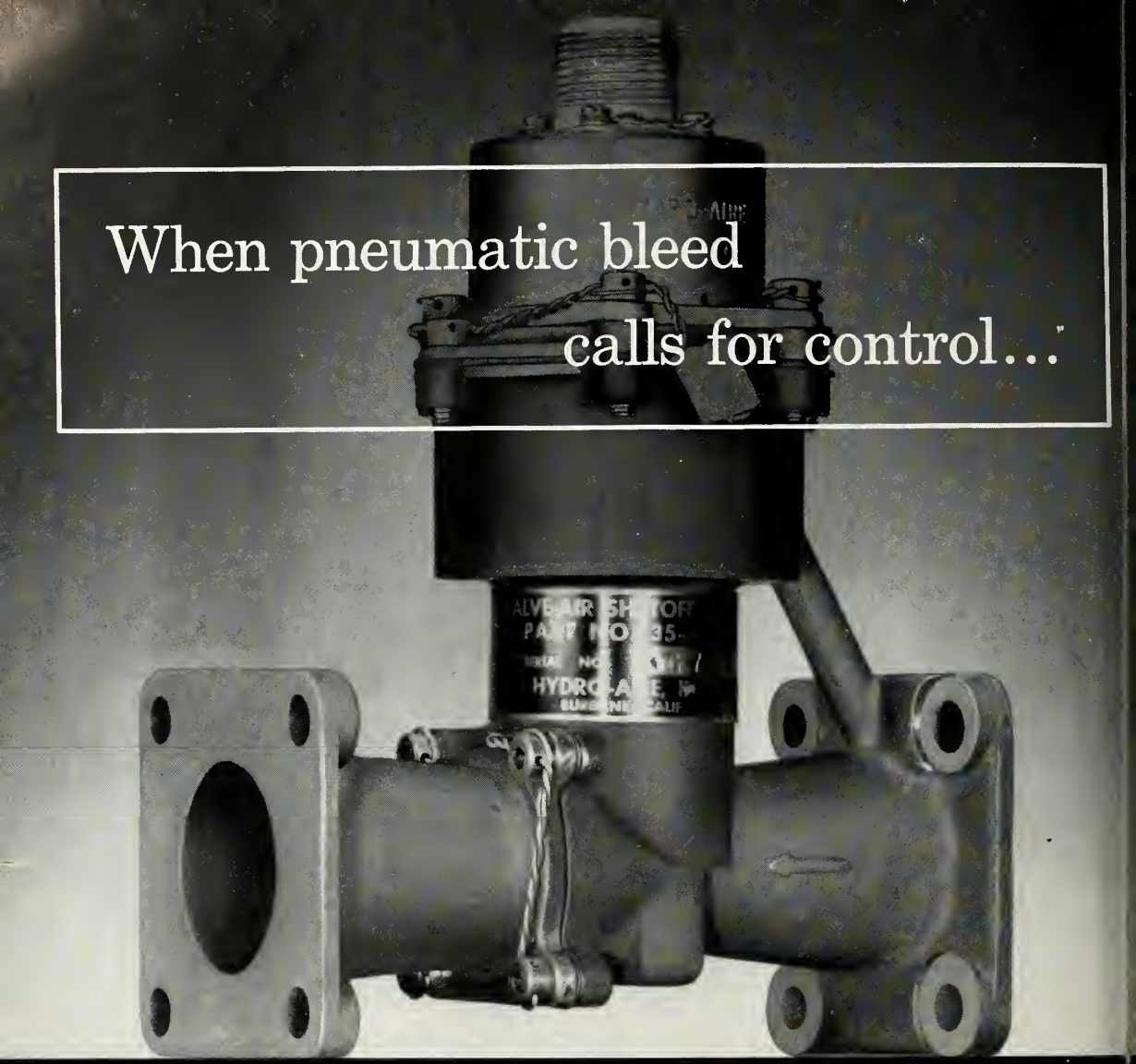
missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

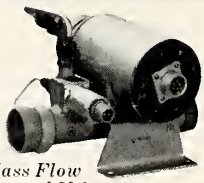
News and Business Edition

AN AMERICAN AVIATION PUBLICATION

When pneumatic bleed calls for control...



Motor operated Hot Air Butterfly Valves



Mass Flow Control Valve

Pressure Regulator & Anti-Icing Valve

the answer is right in this family

The featured player on this page is one of the latest additions to Hydro-Aire's family of pneumatic controls: a fast acting (less than a second) D.C. solenoid operated hot air shutoff valve. All dressed up in a precision casting (for low weight), it is ready to handle 250 psig at operating temperatures up to 900 degrees F. Because it is pilot operated, it's easy on current drain, and it can be supplied to fail safe open or closed. Below... some of its distinguished colleagues. If you don't see the one for your requirement, let us know. We're always happy to add to this family.

HYDRO-AIRE

BURBANK, CALIFORNIA

Anti-Skid Braking Systems • Fuel System Controls • Pneumatic Controls • Actuation Systems Electronic Devices

Producing Controls for Every Basic Airborne System

What's new in TITANIUM alloys:

Advances in aviation technology have happened so swiftly that engineering materials can no longer be selected for their broad use, but rather for the specific tasks they perform.

Today, in the face of tight budgets, the *right* material is the only sound solution to any given problem. Patch-work design, engendered by second-best materials, can only result in second-best aircraft and missiles in uniquely critical times.

To meet the constant tightening of design requirements, Titanium Metals Corporation of America has opened wide new areas of alloy development. This means: heat-treatable bar stock with *guaranteed* capabilities; higher temperature ceilings; broad new strength ranges.

Q. Are the guaranteed heat-treat alloys new?

A. The alloys are not. They have a production history of four years and a wealth of technical data to support them. Recent development of their full heat-treat capabilities has produced such dramatic results that they are considered new.

Q. What are the heat-treat alloys?

A. Ti-155A (5.5% aluminum; 1.5% iron; 1.5% chromium; 1.1% molybdenum) the highest strength bar and forging stock commercially available; and Ti-6A1-4V (6% aluminum; 4% vanadium), which in the annealed condition has already won wide designer confidence. Samples of *guaranteed* minimum heat-treat capabilities show:

	Ti-155A	Ti-6Al-4V
Section size: Up to 1"		
Ultimate Tensile Strength (psi)	170,000	160,000
0.2% Yield Strength (psi)	155,000	150,000
Elongation, % in 4D (Long)	10	10
(Trans)	8	8
Reduction in Area, % (Long)	20	25
(Trans)	15	20

Detailed information on Ti-155A is presented in a 20-page TMCA Engineering Bulletin. Additional data on Ti-6A1-4V, such as fatigue characteristics and guaranteed heat-treat capability are also available.

Q. Are there other new alloys?

A. The leading alloys nearing commercial volume are Ti-8A1-1Mo-1V, a bar stock offering excellent elevated-temperature creep strength to 1000°F, and Ti-4A1-3Mo-1V. The latter, now being produced and evaluated by the Department of Defense sheet rolling program, is designed to fill the need for high strength sheet alloy which can be formed in solution-treated condition and aged to strengths of 175,000 psi. When compared to other high-strength titanium alloys, Ti-4Al-3Mo-1V combines improved formability with outstanding elevated-temperature strength and stability.

Typical Properties — Ti-4Al-3Mo-1V

Condition	Temp. °F	0.2% YS psi	TS psi	Elong. % in 2"
Solution treated	Room	94,000	135,000	14
Solution treated and aged	Room	163,000	175,000	5
	200	142,000	169,000	8
	400	126,000	152,000	8
	600	111,000	140,000	7
	800	98,000	127,000	9

Q. How will these alloys raise temperature limits?

A. Ti-8Al-1Mo-1V is a good example. Although its short-time elevated temperature tensile properties are similar to Ti-6A1-4V, this new alloy offers as much as a tenfold increase in creep strength between 600°F and 1000°F, as shown:

Creep Comporison Between Ti-8Al-1Mo-1V ond Ti-6Al-4V

Alloy	Anneoling Treotment	Temp (°F)	Stress (psi)	Time (Hrs.)	Def. (%)
Ti-8Al-1Mo-1V	1400°F (24 hrs) AC	850	50,000	300	0.42
Ti-6Al-4V	1300°F (2 hrs) AC	850	50,000	300	3.6
Ti-8Al-1Mo-1V	1400°F (24 hrs) AC	950	15,000	300	0.16
Ti-6Al-4V	1300°F (2 hrs) AC	950	15,000	300	4.3

Now being evaluated by engine manufacturers, Ti-8A1-1Mo-1V appears to answer the need for light-weight strength at steadily higher temperatures. Data on both Ti-4A1-3Mo-1V and Ti-8A1-1Mo-1V alloy are available from TMCA.

All these excellent new alloys have boosted still higher titanium's major advantages of light weight, great strength, superior temperature characteristics, and outstanding corrosion resistance.

To guarantee ready availability of this important engineering metal, TMCA has opened in Toronto, Ohio, the world's first plant designed and instrumented solely for rolling and forging titanium to aircraft quality standards.

This plant guarantees more titanium at better delivery dates than ever recorded in the history of titanium metal.

A series of outstanding technical bulletins is available from TMCA, 233 Broadway, New York 7, N. Y. This literature is yours for the asking.

TMCA hopes to serve you.

TIMET

TITANIUM METALS CORPORATION OF AMERICA

233 Broadway, New York 7, N. Y.

Clip out and mail coupon for helpful Engineering Data on TITANIUM

- ☐ Bulletin 1 Properties of Ti-6Al-4V
- ☐ Bulletin 2 Heat-Treatability of Ti-6Al-4V
- ☐ Bulletin 3 Analytical Chemistry of Titanium
- ☐ Bulletin 4 Mechanical Testing of Titanium
- ☐ Bulletin 5 Properties of Ti-155A
- ☐ Other .....

NAME TITLE

ADDRESS

CITY ZONE STATE

These engineers are checking data as it is being acquired from a dynamic test. The results are being recorded on an oscillograph equipped with CEC's rapid-access DATARITE Magazine... DATARITE produces a flash-processed, dried, fully visible and permanent oscillogram in less than a second!

Use **DATARITE** *to monitor high-frequency, dynamic data visually*

...as it happens!

To record, see, and analyze high-frequency data—instantly and simultaneously—CEC's 5-119 Recording Oscillograph and DATARITE Magazine provide the most efficient direct route to immediate access to test results.

In the test set up above, a DATARITE oscillograph and magnetic-tape recorder/reproducer are being operated in a time-parallel circuit. Input data fed to the tape unit are simultaneously recorded and processed by the DATARITE Magazine. Therefore, test results may be monitored continuously. Notations pertinent to the test, or references to later data-processing operations of the tape may be made directly on the DATARITE record as it emerges.

Sensitive galvanometers used in the oscillograph combined with DATARITE's high writing speed permit visual, instant monitoring of high-frequency data not possible with conventional pen-type recorders.

The 5-119/DATARITE combination provides a 50-channel capacity, greatly reducing the cost and bulk of equipment for application where immediate read-out is required.

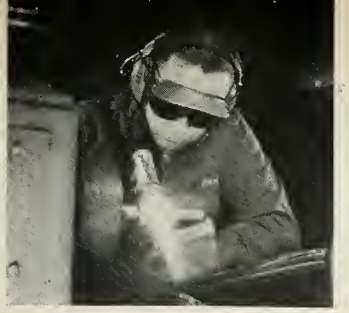
For detailed technical information on the DATARITE Magazine and the 5-119 Recording Oscillograph, contact your nearest CEC sales and service office, or write for Bulletins CEC 1598-X26 and 1536-X31.

Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

FOR EMPLOYMENT OPPORTUNITIES WITH THIS PROGRESSIVE COMPANY, WRITE DIRECTOR OF PERSONNEL



COVER: *Use of plasma torches for fabricating shapes and applying coats capable of withstanding temperatures above 5,000 degrees F, is gaining momentum. Here, a nozzle liner for a rocket engine is formed from tungsten with a Linde Co. plasma torch. (See page 26).*

missiles and rockets Vol. 4, No. 25, Dec. 22, 1958

Published every week by American Aviation Publications, Inc., 1001 Vermont Ave., N.W., Washington 5, D.C. Printed at the Telegraph Press, Harrisburg, Pa. Second class postage paid at Harrisburg, Pa., and at additional mailing offices. Copyright 1958, American Aviation Publications, Inc.

Subscription rates: U.S., Canada and Postal Union Nations—1 year, $8.00; 2 years, $12.00; 3 years, $14.00. Foreign—1 year, $20.00; 2 years, $30.00; 3 years, $40.00. Single copy rate—$.75. Subscriptions are solicited only from persons with identifiable commercial or professional interests in missiles and rockets. All subscription orders and changes of address should be referred to: the circulation fulfillment department.

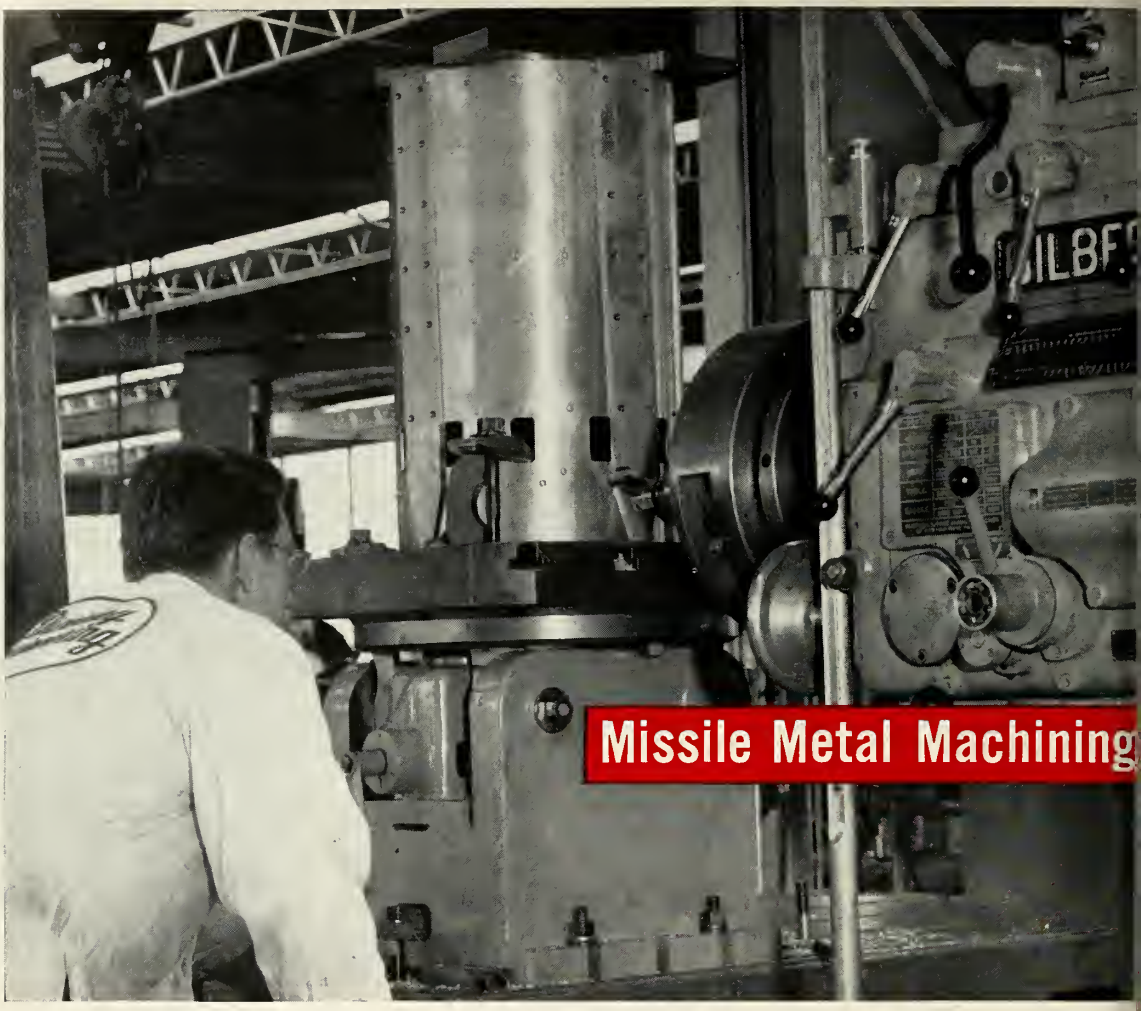
in this issue

DECEMBER 22 HEADLINES

ASTRONAUTICS ENGINEERING

MISSILE ELECTRONICS

DEPARTMENTS



Another Tough Job

Above you see an extremely complex body section of a missile being finish machined on a horizontal boring mill. You are looking at another intricate example of Diversey skill and craftsmanship. A visit to our plants would show you many comparable jobs that would astonish you.

At Diversey you have the LARGEST FACILITIES exclusively devoted to your missile metal machining problems. You work with fast, precise, and progressive technical people who know what works and what won't. Bring your tough jobs to Diversey.

HYDROSPINNIN NOW AVAILABL

A new Hydrospinning Division h been formed at Diversey which us the latest and largest equipment produce intricate missile parts.

SEND FOR FREE BOOKLET

Diversey

LEADERS IN CONTOUR MACHININ

ENGINEERING COMPAN

10550 WEST ANDERSON PLACE
FRANKLIN PARK, ILLINOIS • *A Suburb of Chicago*

FROM NOSE TO NOZZLE, FROM FIN TO FIN, CONTOUR TURNED PARTS—WITH PRECISION BUILT I

In My Opinion . . .

. . . the United States and the Soviet Union are now quietly waging an atomic rocket battle behind heavy security that may well shape the future of the free world (see story on page 13). But once again the U.S. is falling behind, and even extra funds and personnel probably will not speed the program.

The truth: Both nations' programs are startlingly similar in design, but it is in details that vast differences are noted. Present status: The Reds are believed to have tested a nuclear rocket engine of about 50,000 pounds of thrust, while the U.S. *Kiwi-A*—slated for a first test next month—will generate a maximum of 5,000 pounds thrust. Furthermore, in the third *Kiwi* model, total thrust will be 100,000 pounds, while the Soviets are striving for a 2,200,000 pound thrust nuclear engine by 1962.

The United States now—in the belief of many scientists—is taking an ultra-conservative approach on a fairly small scale. This despite the fact that the U.S. and the USSR both began active experimental atomic rocket propulsion programs about the same time—1955.

While the atomic Energy Commission is only now readying its first static test reactor, *Kiwi-A,* the USSR—many U.S. nuclear scientists believe—have already passed this stage.

Worse, the Russians are taking an experimental approach that might readily be translated into a piece of missile or space hardware.

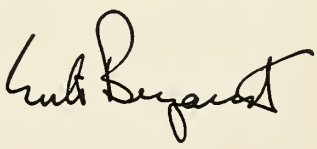
The United States is moving slowly—apparently geared to grinding out data rather than flyable hardware. First U.S. step is a "dry" reactor—that is, a reactor from which heat output, radiation, and control characteristics can be gleaned. This is the much heralded "static" test.

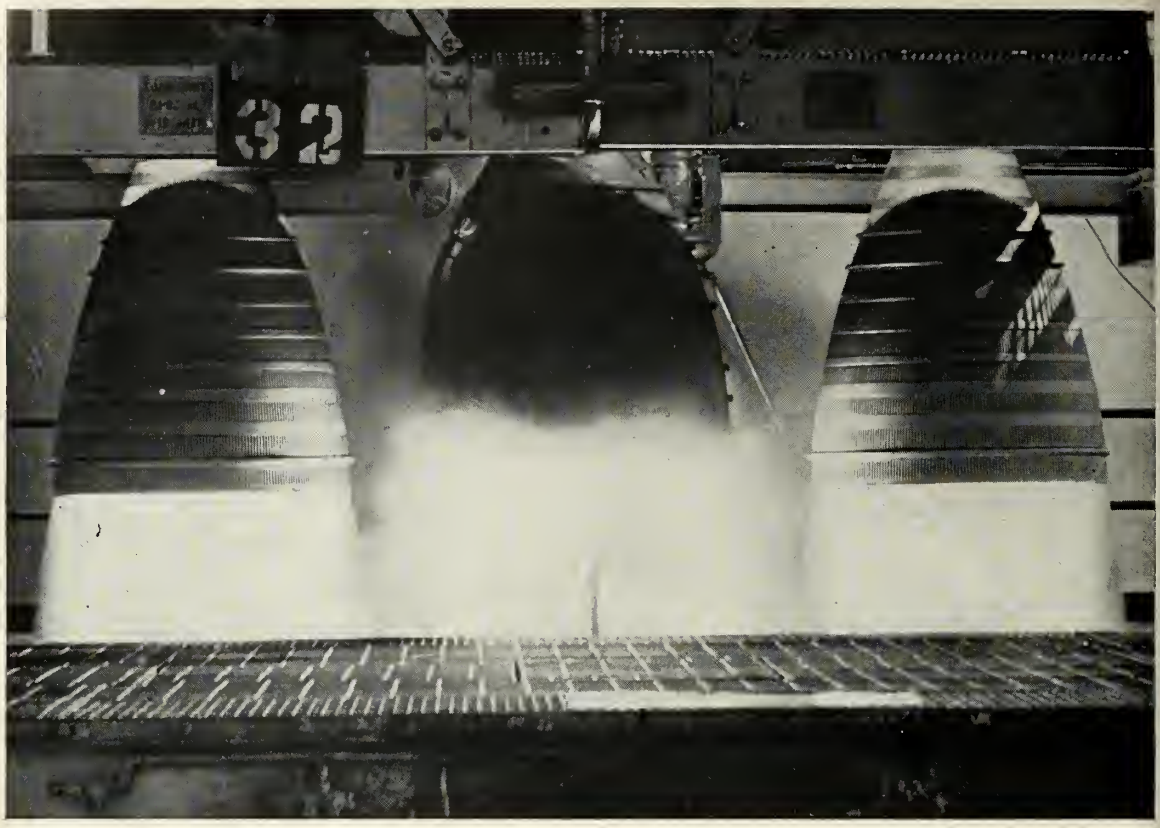
Provided AEC can get the pile to stay together—and this will be most difficult because it will attempt operation at about 3,000°F, or about twice that of present nuclear reactors, AEC will then start tests by forcing gaseous working fluids through it, with hydrogen or helium considered as the best bets.

But these gaseous flow tests, conducted by AEC's Los Alamos Scientific Laboratory on the Nevada test site, will be limited in operating time—now pegged at about five minutes.

The USSR program—to the contrary—apparently is sufficiently advanced to be geared directly to work with liquids first. Obviously, the Reds are aware that this country is trying hard to close the gap. So the Russian nuclear rocket crash program is proof the Communists won't permit their scientists to rest on *Sputnik* laurels.

This is a clear warning to this nation that we must continue pushing—and from the top—our own atomic rocket program with energy and consistency. The free world still has not recovered from Soviet gains in conventional chemical rocket propulsion. A victory in the atomic rocket race could well be the bridge for intended Soviet plans of world dominations.





Special Solar skills for advanced missile systems

Powerful Rocketdyne booster engine chambers—designed to withstand combustion temperatures of 5500 F—are being fabricated by Solar. The chambers are an outstanding example of Solar's advanced technology in the missile systems field. Made from hundreds of spaghetti-like nickel or stainless steel tubes, they are precision fabricated and brazed together to form nozzles. A large sustainer engine plus the twin-chambered booster engine make up the liquid propellant power system for the giant Atlas ICBM.

Solar's leadership in high-temperature technology—*plus advanced facilities*—is one part of the company's outstanding missile and weapon systems capability.

Complete engineering, research and test facilities—staffed by a team of systems engineers participating in America's most challenging missile and space programs—are available to help solve your difficult design, development and production problems. Write for details to Dept. F-103, Solar Aircraft Company, San Diego 12, California.

SOLAR
AIRCRAFT COMPANY
SAN DIEGO
DES MOINES

ENGINEERS WANTED! CHALLENGING PROJECTS, UNLIMITED OPPORTUNITIES, GOOD LIVING WITH SOLAR. WRITE TODAY!

washington countdown

A severe economic dip . . .

is feared by Brevard County, Fla. residents living near Cape Canaveral, if new Pacific Missile Range facilities take over some Cape functions and draw federal money away. DOD, however, says Vandenberg will compete with no other installations, and will complement them.

***Polaris* firings are good . . .**

says Rear Admiral W. F. Raborn. Some 21 out of 24 were successful. One failure preceded 21 successes, followed by two more failures. Seven shots were made this year. Raborn says the last failure was caused by the premature activation of a minor destruct system which would not be incorporated in the operational missile.

Dollar scarcity . . .

competition battle is looming between the Air Force and Navy over each service's major war deterrent capabilities. The Navy wants SAC funds passed to the *Polaris*. It is a battle that will increase in intensity as the advocates of the forces in being compete with the forces of the future.

***Bullpup* may go to Italy . . .**

according to reports from Rome where studies are underway. The Fiat G-91, may be equipped with the air-to-surface missile.

British satellite . . .

launching and re-entry techniques leading to a possible manned satellite are being studied by Britain's Armstrong-Whitworth.

Defense department is concerned . . .

with the failure to find a country which is willing to install *Jupiter*. Defense Secretary Neil McElroy is conferring with Italian officials in the hope of installing 45 *Jupiters*.

Army is moving ahead . . .

with its big solid propellant *Pershing* with the letting of a $2 million contract for construction of test facilities at Cape Canaveral.

Breakthrough in photographic . . .

detection and recording satellites in space has been achieved by NOTS at China Lake. Known as a "synchronized smear camera," the device is capable of obtaining exposure as long as 10 minutes on a satellite. A network of nine of these cameras reportedly can cover the sky from horizon to horizon maintaining "photographic watch" for as long as three hours at a time.

U.S. military thinkers . . .

doubt reported 8,700 mile range ICBM gives the Soviet any new advantage. DOD points out a 5,000-mile missile fired over the pole can hit any point in U.S. but increased range would permit Russia to locate bases further south, which would be an advantage. But increased range carries with it increased guidance problems and greater CPE.

High-altitude launch sites . . .

are reported being built by Russia in Tibet. This could provide advantage in missile and satellite firings as half the weight of the earth's atmosphere is below 15,000 feet. Such bases would indicate distinct Russian advances in solid propellant rockets.

New Congress . . .

should be liberal minded when it comes to spending, with its majority of Democrats. However, in preparing briefings for the lawmakers, military planners are not forgetting there will be many newcomers to the Hill and many probably will bring with them a "show me" attitude. In the House there will be 63 new faces, three of whom have served previous terms. In the Senate there will be 18 new Senators including two from Alaska.

Eisenhower wrote the ticket . . .

which sent the first Western primate into space. The decision to send aloft in a tactical *Jupiter*, the squirrel monkey, "Gordo," was made the afternoon before the early morning launch.

ROUNDUPS COMING: *Next week, m/r will feature missile and astronautics progress during the past calendar year. The January 5 edition will be a preview of what the new Congress can be expected to do in legislation affecting the industry. Watch for these articles.*

industry countdown

Redstone Arsenal . . .

will undergo extensive research and development expansion as the result of contract awards from the Corps of Engineers. Pearce and Gresham Co. of Decatur, Alabama received contracts totalling $2,103,199 for Redstone Arsenal construction. One contract provides for a preflight evaluation laboratory at a cost of $1,060,947 and the other for $1,042,252 calls for construction of propellant development facilities.

High energy liquid engines . . .

are being sought for second stage systems in ARPA's ICBM research rocket test vehicles, according to the agency's chief scientist, Dr. Herbert York. Reference was apparently made to the Project *Discoverer* and Project *Midas* satellites planned for late 1959 or early 1960, recently disclosed by agency head Roy Johnson. Two firms have been mentioned as potential suppliers of such systems. Bell Aircraft has developed a HEF rocket engine for the second stage of the first *Discoverer* shots (m/r, Dec. 15, p. 18) using fluorine as propellant while Pratt and Whitney holds a development contract for a high energy rocket engine for the second stage of a later system.

Boron trichloride . . .

may soon reach manufacturing feasibility status. A joint venture to perfect an economic process for the manufacture of the boron compound, an intermediate from which most of the newer and more exotic compounds are made, has been initiated by the Dow Chemical Co. and U.S. Borax Research Corp. Both companies have conducted individual research in this field for several years. Boron compounds have potential and actual uses as catalysts, high temperature polymers, high energy fuels for rocket (solid and liquid) and jet engines, gasoline additives, metal refiners, and fluxes.

Unobserved observer . . .

device has been patented by an arm of the Singer Manufacturing Company's Military Products Division. The system employing infrared radiation to make the original detection and determine the direction of the object observed, permits the searcher to operate unobserved during this phase of the search. Once the object is discovered and its direction is determined, a series of radar pulses obtain the range. Electronic countermeasures of the enemy are given minimum opportunity to detect the observer because of the slight duration of the radar operation.

Controlling interest . . .

of Research Communications, Inc., consultants to the astronautics industry, has been acquired by the Turbo Dynamics Corp. research and development firm of Los Angeles.

Washington trade-association . . .

executives, recently polled on the treatment they think business will get as a result of the election of so many liberal new lawmakers, were quite calm about legislative prospects for 1959 and 1960. Those polled don't anticipate persecution of business by the New Deal-Fair Deal Democrats on Capitol Hill. Labor may in fact be able to secure an increase in the minimum wage to $1.25 an hour and Congress will probably pass the Kennedy-Ives bill with revisions in the Taft Act more likely than at any time since its passage.

AVCO's latest division . . .

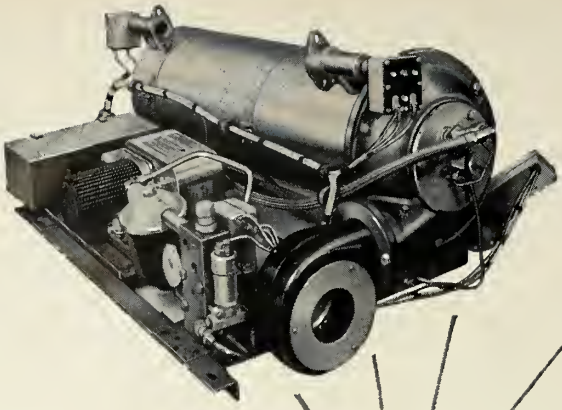
located at Nashville, Tenn., will be engaged in engineering and production of aircraft and missile structures and assemblies, stainless steel honeycomb panels, and components for radar systems.

***Atlas* guidance computer . . .**

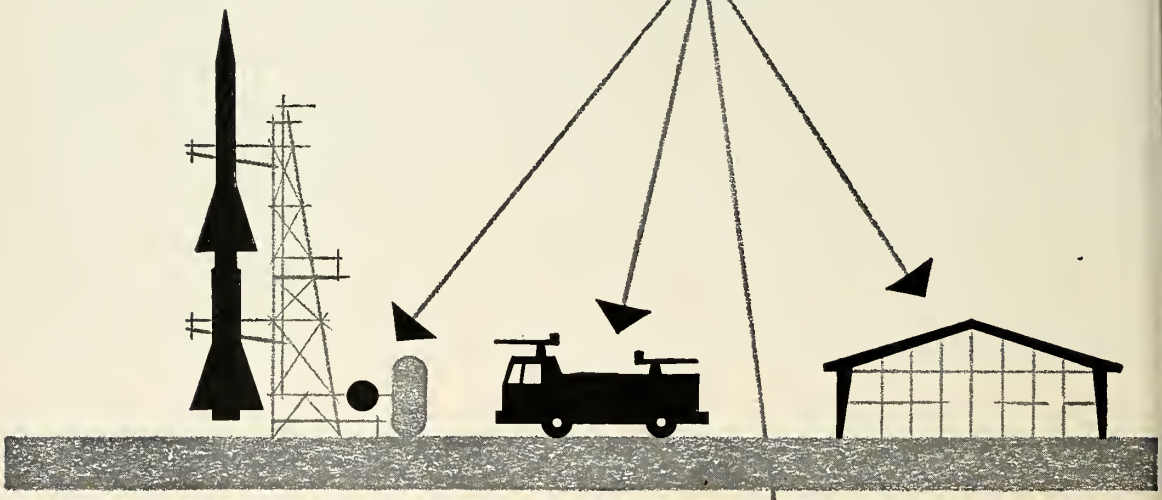
delivery to the Air Force from Burroughs Corp. was followed by two additional contract awards totaling $22,448,568 for more equipment. Latest computer is more sophisticated than previous models, is easier to maintain and has higher reliability capabilities. The two awards brought Burroughs total backlog for *Atlas* computers to $68 million.

Vandenberg's three-pad *Atlas* . . .

complex has an estimated construction cost of about $15 million, according to Army Corps of Engineers. With $50 million for the base construction already contracted, it is estimated that $120 million will be spent in the next three years. Packard-Bell Electronics Corp. has installed 110 items at Vandenberg at a cost of $1 million. Ultimately, $400 to $500 million will be spent on electronic gear by various missile sites in the Pacific Missile Range, according to information received by Packard-Bell.



reliable heat for ground support



The Janitrol line of liquid heaters provides versatile packages ranging in capacity from 90,000 to 1,000,000 Btu per hour. They provide reliable heat—at specified temperature—for vaporizing or maintaining temperatures of missile fuels, for instant engine starts in any weather, windshield defrosting, comfort for personnel, cargo and equipment protection.

Liquid heater reliability is a result of refinement and design simplification over a period of ten years of production. Proved in Arctic and Antarctic use, they are already serving in fire crash trucks, prime movers, ice removal units, and in heating decontamination and cleaning fluids.

We'd like to discuss with you any heat requirements you have for missile handling and ground support equipment or vehicles—for fuel processing or for protection of equipment and personnel. Call in your Janitrol representative.

Janitrol Aircraft Division, Surface Combustion Corp., Columbus 16, Ohio.

JANITROL®

pneumatic controls • duct couplings & supports • heat exchangers
combustion equipment for aircraft, missiles, ground support

DECEMBER 22, 1958—VOL. 4, NO. 25

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

USSR May Have Tested Atom Rocket

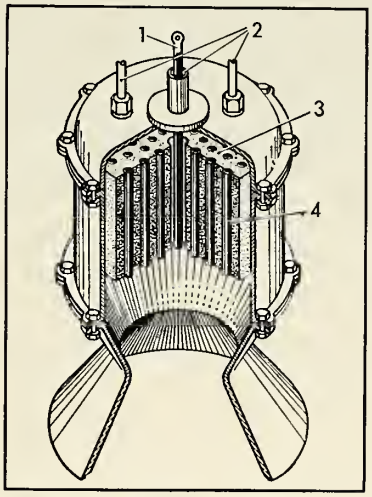
by Alfred J. Zaehringer

DETROIT—The Soviet Union—m/r has learned from usually reliable sources—has reportedly tested an ultimate flyable prototype of a nuclear rocket engine of 50,000 pounds thrust, and has set a development goal of a 2,200,000 thrust nuclear rocket engine by 1962.

In contrast, the United States will make the first so-called "static" test next month of *Kiwi-A*, which is not designed to be the prototype of a flyable reactor, and ultimately will generate only 5,000 pounds of thrust in the first version. *Kiwi-C*, the third version, again not flyable, will generate 100,000 pounds of thrust.

M/r is unable to determine with any degree of certainty where the USSR is conducting its nuclear rocket tests, but they have to be bifurcated from conventional test complexes because of the inherent radiation hazards. Probable regions are Arctic Siberia or the extreme Southern desert regions.

• **100 ton goal**—The Soviet goal is an atomic rocket weighing close to 100 tons and having sizeable payload characteristics. The USSR program is geared directly to the use of liquids from the start—probably liquid hydrogen. Thus when they finish their current test program they will have a scalable prototype.



PROBABLE RUSSIAN atomic rocket. 1. Control shaft, 2. Hydrogen pipeline, 3. Graphite, 4. Rods of U235.

The United States, on the other hand, is moving first with a "dry" reactor—that is a reactor from which heat output, radiation, and control characteristics can be gathered. This is the heralded *Kiwi-A* "static" test, which poses at least one almost insurmountable problem: getting the pile to stay together. This is because attempted operation will be at about 3,000°F—or about twice that of present nuclear reactors.

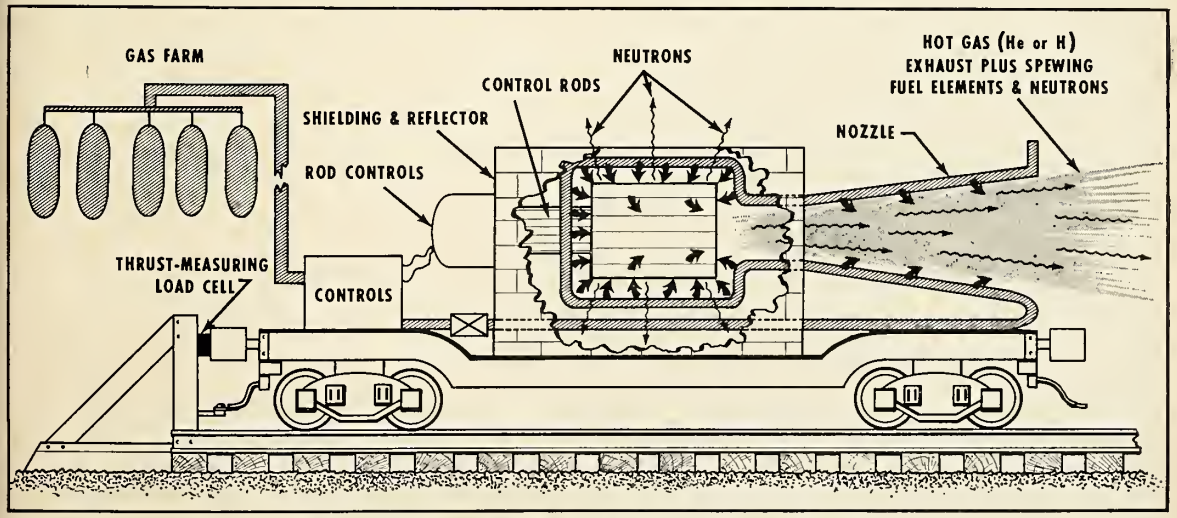
If this problem can be overcome, the next step will be to force gaseous working fluids—as the Russians are currently doing—through the reactor. Hydrogen or helium are considered the best bets.

• **Limited operating time**—But these gaseous flow tests, conducted by the Los Alamos Scientific Laboratory at AEC's Nevada test site, will be severely limited in operating time—about five minutes.

The USSR nuclear rocket program is directly geared to its astronautical aspirations. The Astronautical Commission and the USSR Academy of Sciences, has representatives from the nuclear field. Noted among these is the Soviet atomic expert, Peter L. Kapitsa.

According to Fred C. Durant, noted astronautics worker, the role of Kapitsa is to advise the Commission on low temperature propellants (such as liquid hydrogen) and the use of atomic rockets.

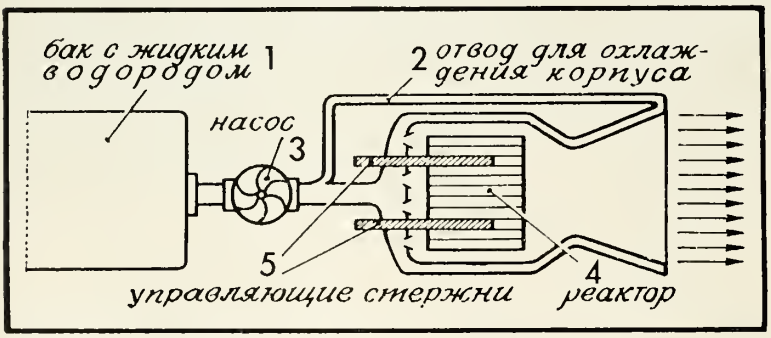
It is significant to note that Academician Kapitsa, aside from his nuclear talents, runs a cryogenic lab and has done much work on the prop-



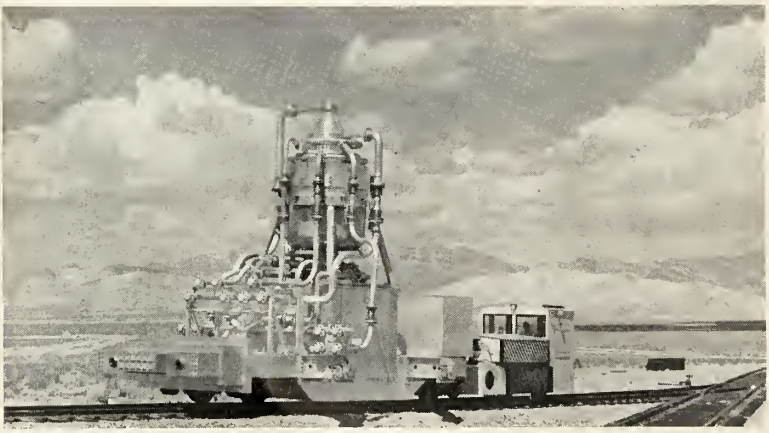
SCHEMATIC DRAWING of AEC's *Kiwi-A* nuclear rocket.

The Atomic Rocket Engine
US versus USSR
(Estimated)

PARAMETER	USA			USSR		
	KIWI-A	KIWI-B	KIWI-C	TEST	PROTOTYPE	PRODUCTION
Fuel Element	90% U-235	Enriched U-235		U-235/ U-238	90% U-235	enriched U-235
Cladding	Metal?	Ceramic?		Metal?	Ceramic?	
Neutron Moderator	Graphite?	?		Graphite	Other	
Coolant	He or H gas	liquid H or hydrocarbon		Liquid H		
Reactor Temp. (F)	3000	3600		3600	7200?	
Operating Time (minutes)	5			6	6-10	
Thrust (lb)	5000	50,000	100,000	50,000	100,000	2,200,000
Reactor Wt. (lb)	10,000-15,000		15,000	30,000	20,000	20,000
Diameter (ft)	5					
Length (ft)	10		6.0			7.7
Isp (sec)	300	550	790			710
Date	1959	1962	1965	1959	1961	1962



'FLUID REACTIVE' Russian engine probably works like this. 1. Hydrogen tank, 2. Regenerative cooling line, 3. Pump, 4. Reactor, 5. Control rods.



READY FOR tests on the Nevada proving ground of AEC, is *Kiwi-A*, shown on its railroad car. *Kiwi* is part of the *Rover* program.

erties and handling of liquid hydrogen. The USSR Academy of Sciences also has a firm grasp on nuclear efforts since it runs the USSR Institute for Atomic Energy. The IAE may be similar to our own AEC in operation. However, the IAE is governed by scientists.

Thus, the Soviet atomic rocket program is seen to be in an extremely strong position when compared with America's atomic rocket project.

• **Here is comparison**—America's weak start is likely to be reflected in its technological pattern. It is now, for the first time, possible to compare both technical programs (see accompanying table).

The startling fact is that both programs are very similar in outline. It is in detail that vast differences are noted.

First, both countries will use the pile to replace the chemical combustion process by using heat released during fission to expand a working fluid.

From this point onward, there is a wide disparity in hardware attempts. The Soviets are clearly thinking big. Assuming equal talent, it would be possible for the Soviets to beat us to the punch since they are thinking toward the hardware of large rockets.

Two American aircraft firms have taken a look at the need for an atomic rocket. Rocketdyne, now building the nozzle for *Kiwi-A*, estimates that a compact liquid atomic rocket engine delivering, say, 100,000 pounds of thrust, could be put together readily. Convair-Astronautics' Krafft Ehricke has advocated the use of a nuclear rocket using liquid hydrogen working fluid for various space missions.

Another potent problem concerned with the atomic rocket is takeoff. The atomic rocket engine may never be able to come up to full thrust and temperature like the milliseconds of conventional chemical engines. Therefore, most U.S. thought seems to be to boost the atomic rocket with chemical rockets. This also solves some of the radiation problems.

However, the USSR has been doing much design work with mixed powerplants for the atomic powerplant. Goal: to combine the nuclear power plant with chemical systems to give returnable, manned satellites and space probes.

The next Soviet satellites might conceivably be heavier by use of the megapound chemical engines now under development. However, large manned satellites and moon expeditions will probably come hard on the heels of the megapound thrust atomic engine now being aimed for in the Soviet Union.

Budget Outlook: Program Stretch-outs

Missiles and space hardware and R&D could reach $6.8 billion of $41 billion-plus defense budget. ARPA's budget should approximate half billion. High emphasis will continue on *Polaris, Titan, Atlas, Minuteman.*

by William O. Miller

WASHINGTON—Continuing the upward trend of the last few years, it is more than likely that the U.S. military budget for missiles and space equipment for Fiscal Year 1960 will well exceed the $6.8 billion mark.

As the largest spender of the three services, the Air Force has shown a steady trend toward missiles and away from manned aircraft. So have the other services. These are comparative Defense Department figures for procurement and production:

	Fiscal 1958	Fiscal 1959
Aircraft	$8.4 billion	$7.2 billion
Missiles	$2.7 billion	$3.4 billion
R&D	$1.7 billion	$2.4 billion

Funds for missiles and space projects this fiscal year should approach $4.3 billion for production and procurement; $1 billion for construction, and $1.5 billion for research and development.

Not included is the $420 million budget of the Advanced Research Projects Agency for 1958 (its first year) of which, ARPA's officials estimate, probably two-thirds or some $300 million went for missilry. ARPA's 1960 budget should approximate $500 million. NASA's non-military budget may approximate $500 million.

• **$41 plus billion budget**—Last year's overall defense budget, not including foreign aid, was $40.9 billion. Estimates for this year—taking into account the Russian threat and the temper of an overwhelmingly Democratic Congress—range from $42 billion to a more likely $41-plus billion. Under any trend it is highly unlikely the increase in missile procurement will be under the 25% increase of 1959 over 1958.

Individually, the services, rate their missile programs about as follows:

Air Force

The Air Force budget for Fiscal Year 1959 was $18,662 billion plus $785 million construction funds. It is expected to be about the same this year. Added to this will be a carryover of several billions from last year. Of these two figures, the Bureau of the Budget and Department of the Defense will tell the Air Force how much it can obligate in contracts and also how much it can actually spend. Working under the assumption that both obligating authority and spending cash will be about the same in Fiscal 1960 as in Fiscal 1959, the USAF missile program shapes up in this fashion:

Dyna-Soar: Limited funding for this boost-glide man-in-space concept. Design competition is between Martin and Boeing with systems management contract due in late Spring. Development progress will be slow because the system requirement exceeds present and near future state-of-the art.

Minuteman: Firm funding with stepped up development. Boeing is assembly and test company for this advanced solid propellant, hard-base ICBM. System still faces problem on whether adequate guidance and propellant can be wrapped in the projected small package. *Minuteman* is intended for mass production, wide dispersal, medium warhead and is not at the moment considered competitive or supplanting the *Titan*.

1000-mile air-to-surface missile (WS-199B): Limited funding. Lockheed and Martin are working in design competition. Early tests have gone well, although a number of stability problems have cropped up unexpectedly. Test hardware near final configuration expected in about one year. Good bet for more volume production.

Discoverer: Money is in the bag on this Lockheed outgrowth of the old reconnaissance satellite project. It is now intended to investigate many scientific space problems, including those necessary for recon capability. *Thor* and later *Atlas* will be used as boosters.

Atlas: Well funded although far from Convair's possible production capacity. Latest tests of this ICBM have gone well and missile has many potentials although still not yet completely proven.

Titan: Money is firm for this Martin ICBM and it is on schedule. *Titan*, while a year or more behind *Atlas*, is designed for hardened bases and AF believes *Titan* will be operational before *Atlas* could be converted to hardened launch capability. Also *Titan's* two stages give it greater potentials over stage and half *Atlas*.

Thor (Douglas) and *Jupiter* (Chrysler): Production on both these IRBMs will probably be cut off within a year, at end of present limited schedule. DOD feels there is no use for them. England is getting up to four squadrons of *Thors*. Other foreign commitments are solely up to NATO with only one country under serious negotiation for the *Jupiter*.

Falcon: Limited funding for this air-to-air missile. *Falcon* does not adapt well to nuclear warhead, now deemed essential. Worthwhile features may, however, be mated with *Eagle*.

White Lance: Limited funding also for this nuclear warhead air-to-surface tactical missile. AF is having trouble converting it from Navy version *Bullpup*.

Genie: An interim nuclear weapon but the air-to-air weapon will be well funded until something better comes along with atomic warhead.

Bomarc: Strong funding for this ground-to-air interceptor. The Boeing *Bomarc A* (250 mile range) scored eight out of eight on latest tests. *Bomarc B* (400 mile range) is due in about a year.

Hound Dog: Well funded and doing well. Will definitely continue as strategic air-to-ground missile until it is succeeded by a longer range version. Continued production at North American scheduled.

Snark: Funding probably limited to one announced squadron of this air-breathing ICBM. After looking well proven, has been having troubles lately.

Goose: This air-breathing ICBM decoy has just been cancelled.

Army

The Army asked for and received $8.9 billion dollars in the Fiscal 1959 budget. Indications are that this year's budget will be about the same. Chief of Staff Maxwell Taylor has estimated that modernization of the Army will cost about $3 billion a year for the next five years.

While no definite figures as to numbers or amounts are available, Army thinking as to emphasis or deemphasis in the event of a cut looks like this:

Corporal: Probably will be in for

some cut. It's an older missile system and Army looks to *Sergeant* to replace it. No development money in *Corporal* but spares and replacements are required in some equipment, especially radar.

SS-10: Has high priority as replacement for *Dart*. Most important weapon in anti-tank area, not only to Army but also Marine Corps. Would not be touched if cuts come.

Honest John: Possible but not probable reduction. Now operational and well integrated into all divisions. Improvement program now underway. Troops in field are familiar with and know how to use. Most future expenditures for improvement of range and efficiency which Army knows how to attain.

Little John: Possibly could be cut back, but is important weapon to Army's STRAC forces. Needs very little more development money. Definitely will receive emphasis in form of improvement program.

Lacrosse: A very accurate close support weapon but may be considered for cut back in numbers produced.

Redstone: Further production and procurement of extensive spares and improvement unlikely. Army looks to forthcoming *Pershing* to do the same job a lot better and easier.

Nike-Zeus: Has one of the highest priorities and would not be cut. Not only an anti-ballistic missile but could be used against aircraft targets.

Nike-Hercules: Out of development stage and would not be involved in cuts. Overall cost has been less than might be expected because of previous work on *Ajax*.

Pershing: Will receive emphasis and cuts should not involve it. Solid motor and mobility capability makes this highly desirable from Army viewpoint.

Hawk: Definitely will receive emphasis in any budget. High degree of mobility appeals to Army.

Redeye, Mauler, Missile Able: All in feasibility study stage. While Army does not want funds cut, admits feasibility area good hunting place for budget cutters who feel work can proceed with less money. Army fears cuts will dangerously delay availability.

• **Guide line**—Army planners readily admit the one guide line for any reduction or emphasis is how the weapon fits into plan for support of the land battle. Basic mission is for utilization in the field and rapid development of the battlefield mobility concept. Army, like other services, would implement cutbacks in numbers of various missiles rather than elimination of complete systems.

Navy

Navy missilemen are putting up a hard fight for more money, suggesting that some of these funds can come from SAC funds which they believe is being outdated by *Polaris*. Not only would Navy like some of the AF money, but within Navy itself, there is a hot controversy between the airmen and the missilemen as to relative importance of the two. Missilemen say they want to give the airmen better weapons for their aircraft, while the airmen want more aircraft. Missilemen say that if their viewpoint doesn't win out, equipping of present and additional Navy aircraft could deplete back-up supply and empty magazines.

Again, actual numbers are not available, but emphasis would be placed on certain systems in the event of a cut. Navy also would try not to eliminate any specific system, but would cut back in numbers ordered and slow up on feasibility and development and research.

Polaris: Has highest of priorities and would not be bothered by a cut. Funds for four FBM subs still being held up by DOD.

Bullpup: Expected to be operational in fleet by next year. Actual numbers ordered might be curtailed, but Navy is worried about a back-up supply.

Sparrow III: Now operational in fleet. Production quantities might be reduced as number of squadrons increase. But it will receive definite emphasis in view of its all-weather capability.

Sidewinder: Navy wants to put it in all fighters. Many aircraft utilize *Sidewinder*, but can't use *Sparrow III*. Again, total production numbers might be cut.

Regulus I: Definite phase out.

Regulus II: Will receive emphasis in view of nuclear submarines use. Plans are that boats originally slated to use either *Regulus I* or *II* will now use only *Regulus II*. Cruisers, including new construction, can employ missile.

Terrier: Operational, and only way a cut could be effected would be in stretching out production numbers.

Tartar: Has high priority and will receive emphasis. Undergoing developmental evaluation. This semi-active guidance missile provides new construction destroyers with important low-altitude capability.

Talos: Now operational, but total production numbers may be cut in view of anticipated improvements. Size presently permits use only on cruisers.

Rat: Cancelled in favor of *Asroc* which will receive emphasis.

Subroc: Has one of highest priorities. Still undergoing development. Contract went to Goodyear about six months ago. Some of money which was cut during present year has been reprogrammed into the project.

Sparrow I: Being phased out.

Eagle: Navy's latest air-to-air long range defense. Has one of highest priorities. Emphasis will be on missile rather than aircraft used to launch. Would not be affected by cut.

Corvus: Air-to-surface-being developed by Temco. Undergoing development with availability anticipated in 1962. Receiving emphasis.

Feasibility and development studies could be slowed by, but no eliminations can be expected on various follow-up programs.

Astronautics Tests

This is the week's summary of missile and space experiments:

1) Dec. 10—*Regulus II* launched from LST. Mission completed.

2) Dec. 11—*Snark* made round-trip flight from Cape Canaveral. Mission completed.

3) Dec. 11—*Regulus II* launched from Mojave Desert on inland range for 750-mile flight. Mission completed.

4) Dec. 13—*Jupiter* fired over 1500-mile with "Gordo" squirrel monkey in the nose cone. Payload impacted within the target area but neither cone nor monkey was recovered.

5) Dec. 13—*Bomarc* sent 250 miles against F-80 target drone. Mission completed.

6) Dec. 16—Air Force was to have fired first *Thor* from Vandenberg at 12:20 p.m. (PST).

Here is a summary of space animal experiments.

1) 1953—Air Force fired two monkeys to an altitude of 200,000 feet in *Aerobee* rocket.

2) November 3, 1958—Laika orbited the earth aboard *Sputnik II*. Lived for seven days.

3) April 23, 1958—*Thor-Able I* with mouse aboard traveled at least 1500 miles. No recovery.

4) July 9, 1958—*Thor-Able II* traveled 6000 miles. Mouse aboard. No recovery.

5) July 23, 1958—*Thor-Able III* traveled 6000 miles. Mouse Wickie aboard. No recovery.

6) August 27, 1958—Soviets sent two dogs 281 miles above the earth and returned them safely.

7) Dec. 13, 1958—*Jupiter* went 1500 mile range with peak 300 mile altitude with monkey aboard. No recovery.

Maruca, **ship-to-air, is formidable addition to French Navy.**

Masurca **is another addition to the French naval arsenal.**

New Warships Planned for French Missiles

by Jean Marie Riche

PARIS—When the French Defense Minister, Pierre Guillaumat, went to Toulon at the end of October to visit top secret facilities of the French Navy, the veil was lifted for the first time on the plans and activities of the Marine Nationale in the missiles field.

Since 1950, the French Navy has been engaged in a program whose fruits were to grow and ripen in a period of about 10 years. A "Groupe Technique des Engins Speciaux" (Technical Group for Missiles) was created at the Arsenal of Toulon, the main base of the French Navy. Purpose: to back a test-range installed on the nearby Ile du Levant, a five-mile-long island whose shooting range extends about 30 miles over the Mediterranean to the southeast. This range is called "Centre d'Essais et de Recherches d'Engins Speciaux" (C.E.R.E.S., Test and Research Center for Missiles).

In 1952, personnel at the center began training with ARS 5501 target missiles which have now been replaced by CT 20 missiles produced by SNCA du Nord. In the version delivered to the Navy, these missiles are especially equipped to float after being shot down.

In 1957, the first subsonic training ship-to-air missiles *Maruca* became operational and regular firings began. It was from those missiles that the Arsenal of Ruelle developed, in liaison with the Direction des Etudes et des Constructions d'Armes Navales, a supersonic ship-to-air weapon, the *Masurca,* which the French Navy compares with the *Terrier* and which is guided by a semi-active homing system. Further, a pilotless interceptor—the *Masalca*—also equipped with a semi-active homing

(Continued on page 32)

Missiles in the French Naval Arsenal

DESIGNATION	SS 11	MALAFACE	MASALCA	MASURCA	MARUCA
TYPE	Ship-to-Ship	Ship-to-Ship	Ship-to-Air	Ship-to-Air	Ship-to-Air
MANUFACTURER	Nord-Aviation		Latecoere	Ruelle Naval Arsenal	Ruelle Naval Arsenal
LENGTH	4′ 0″	20′ 8″		18′ 8″	15′ 1″
SPAN		8′ 6″		3′ 3″	5′ 3″
WEIGHT				2205 lbs.	1015 lbs.
ENGINES	SPR			SPR	LPR
RANGE		25 miles	60 miles	Approx. 15 miles	11 miles 10 mile altitude
SPEED	430 mph			Supersonic	Mach 0.85
PAYLOAD		1545 lb. warhead			132 lb. warhead
GUIDANCE	Wire	Radar	Semiactive radar	Semiactive radar	Radar
REMARKS	Naval version of antitank missile, to be used against small craft and in support of landings.	May also be used against shore installations. Guidance is integrated with Maruca system. Antisubmarine version is known as Malafon.	Small missile intended for small warships.		Also used as experimental and training missile.

U.S. Lags i
Propagandize

CZECHOSLOVAKIA ISSUED *Sputnik II* **stamp for IGY, left. First rocket on a U.S. stamp commemorated the Fort Bliss Centennial, right.**

PENQUIN WATCHES orbiting satellite for another IGY issue, this time by Japan, left. Italy commemorated IAF meeting in Rome during 1956, in this first stamp to picture a satellite, center. Netherlands Antilles issue locates a U.S. satellite tracking station in Curacao, right.

by Alfred J. Zaehringer

DETROIT—Using stamps as parameters to indicate its international feelings, the United States is seen to lag badly in this vital area of ideological and propaganda warfare.

But the Soviet Union is using the time honored stamp to get across to other nations that it is a leader in peaceful rocketry and satellites. As the accompanying table indicates, the U.S. has only once in 10 years chosen to put a rocket on a stamp. This was the 3¢ Fort Bliss Centennial which showed, of all things, a rocket very greatly resembling a German *V-2*! On the other hand, Russia during the IGY issued eight stamps showing all three *Sputniki*, IGY rockets, plus a Ziolkowsky commemorative.

The USSR, however, was not the first to show a rocket on a regular stamp issue. During World War II, Germany issued a special stamp showing the employment of barrage artillery rockets. In addition to the stamps shown in the table, there have been other private stamps to commemorate rocket firings, rocket mail, and astronautical meetings. However, only stamps issued by the various world governments have been used in this comparison.

In 1955, Monaco issued a Jules Verne commemorative showing a moon rocket.

COMMUNIST ROMANIA pictures USSR satellite activities with *Sputnik I* **orbiting Kremlin, left.** *Sputniki* **orbit world, center. Laika, the dog passenger in** *Sputnik II*, **right.**

GERMAN WORLD WAR II printing shows artillery rockets in action, marking the first time rockets were illustrated on stamps, left. East Germany issue shows *Sputnik I*, **right.**

• **Italy first**—The first satellite stamp was issued by Italy in 1956 in honor of the International Astronautical Federation which held its meeting in Rome.

One of the most recent satellites on a postage stamp is the 1957 IGY issue by Japan which shows a penguin watching an orbiting vehicle. One of the most unusual rocket stamps recently issued illustrates the Japanese

ANOTHER RUSSIAN satellite issue is this *Sputnik II* **allegory, left. Carrier rocket of** *Sputnik III*, **right.**

g Stamps To onautics Work

Only once in 10 years has the nation put a rocket on a stamp, but Soviet uses stamps to extoll USSR as 'Peaceful'

pencil rockets (Ryukya Islands). Even the Netherlands Antilles has gotten into the stamp satellite business by issuing a map of the American satellite tracking station at Curacao.

The Republic of Haiti has even beaten the U.S. to the punch by issuing the first U.S. satellite to be shown on a stamp—the *Vanguard* "grapefruit."

Of course, various eastern European satellite nations have decided to ride on the merits and accomplishments of the Soviets. Romania has four issues—one extolls Laika as the first living orbiter. East Germany illustrates *Sputnik I* as an IGY accomplishment. Czechoslovakia not only shows *Sputnik II* but shows a large carrier rocket—which accurately corresponds to the 50-70 foot long rocket which has been theorized as a result of optical tracking data.

• **Eight Soviet issues**—To be sure, the Reds are not to be outdone for they have eight official issues. The first shows an IGY sounding rocket (resembling a worked over *V-2*). The second, celebrated the anniversary of Ziolkowsky. As a matter of fact, the first *Sputnik* came so close to the issue of the Ziolkowsky event that one may conclude that it was so planned. Anyway, the Russians merely overprinted the Ziolkowsky stamp with the launching date of *Sputnik I*. *Sputnik I* was heavily glamorized by the use of an allegorical female form—something unusual for the Russians. *Sputnik III* was pictured in fairly accurate detail in the last Russian stamp issue.

It is clear that the Soviets will use stamps for all they are worth in order to propagandize to the world that they are the new aggressive—and peaceful—world force. For example, the Soviets have recently issued a rocket-atom disarmament stamp. The U.S. occupies a back place in the satellite stamp field while the world knows it is spending billions on military missiles.

The Soviets never fail to blast this forth to the "neutral" nations—while the U.S. neglects to give proper credit to the personnel and accomplishments in peaceful research, particularly the IGY.

The U.S. now produces many new commemoratives each year—anywhere from five to 15—which usually conservatively extoll some dull fact out of the dim past.

From the standpoint of the present world struggle, the U.S. still apparently does not realize that you have to display democracy as a dynamic, relentless thing, not a portrait of the past.

It is certain that what the U.S. is now doing in missiles, rockets, and astronautics will certainly hold the key to the future. Stamps are only a small cog in the ideological battle now raging, and many observers feel strongly the U.S. is very deficient.

DATE	SCOTT CATALOG NO.	DENOM.	TITLE	COUNTRY
1944	B268SP221	25+15 pf	Artillery rockets	Germany
1948	976A423	3¢	Ft. Bliss Centennial	U.S.
1955	C45APZ1	200 fr	Verne's Earth-Moon Rocket	Monaco
1956	717A393	25 l	IAF-Satellite	Italy
1957	241A55	15	Curacao Tracking Station	Netherland Antilles
1957	637A386	10 y	IGY-Penguin-Satellite	Japan
1957	370A113	10 pf	Sputnik I-IGY	E. Germany
1957	41A20	4.00	Pencil Rocket	Ryukya Is.
1957	1959A1034	40 k	IGY Rocket	USSR
1957	1991A1055	40 k	Ziolkowsky Anniv.	USSR
1957		40 k	Ziolkowsky and Sputnik overprint	USSR
1957	1992A1056	40 k	Sputnik I	USSR
1957	1993A1056	40 k	Sputnik I	USSR
1957	838A337	75 h	Sputnik II	Czech.
1957	C51AP23	3.75+25	Sputnik I & II	Romania
1957	C52AB23	3.75+25	Sputnik I & II	Romania
1957	1200A446	1.20 l	Laika-Sputnik II	Romania
1957	1201A446	1.20 l	Laika-Sputnik II	Romania
1958	2032A1072	20 k	Sputnik II	USSR
1958	2035A1072	1 r	Sputnik II	USSR
1958	2083A1099	40 k	Sputnik III	USSR
1958	2077A1094	60k	Rocket-Atom Disarmament	USSR
1958		10¢	Vanguard "Grapefruit"	Haiti
1958		50¢	Vanguard "Grapefruit"	Haiti

Astronautics Course Begins at AF Academy

COLORADO SPRINGS—Keeping in close step with the air-space age, the U.S. Air Force Academy has added a course in Astronautics to an already busy curriculum.

First Class cadets, members of the Academy's first graduating class of June, 1959, are now taking the course which covers the fundamental physics of manned and unmanned flight through space. The new Department of Astronautics got underway shortly after the Cadet Wing moved this fall from its temporary home at Lowry Air Force Base in Denver.

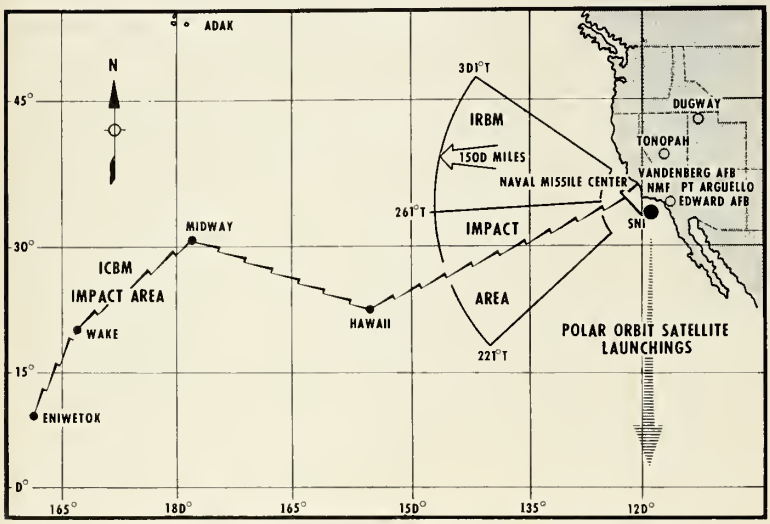
The department is headed by Colonel Benjamin P. Blasingame, who holds a Doctor of Science degree in Aeronautical Engineering from Massachusetts Institute of Technology and who, two years previous to his assignment to the academy, was director of the Air Force program to develop the *Titan* ICBM.

Colonel Blasingame served for more than three years with the Air Force Ballistic Missile Division at Inglewood, Calif.

Astronautics at the Academy includes ballistic missiles, satellites and space vehicles. The cadets study trajectory characteristics, rocket power plants, terminal trajectories, stabilization, control and guidance. The students make a survey of test techniques and weapons systems case studies on airborne and rocket vehicles.

U.S. Planning Manus for Equator Launch Site

Multi-billion dollar expansion of PMR facilities is proposed. First priority is extension of Sea Test Range for IRBM



PACIFIC MISSILE Range will encompass this area of island tracking sites.

POINT MUGU, CALIF.—Manus, largest island of the Admiralty group, and a forward base during World War II, may become the United States' equatorial launching site for space vehicles.

The island, under United Nations mandate through an Austrian trust, reportedly is under consideration in U.S. multi-billion dollar development plans for the Pacific Missile Range over the next 15 years. The Navy will operate the range.

PMR is seven ranges in one—each with specific functions. Ballistic Missile Range performs dual functions for IRBM and ICBM tests. The ICBM portion is an extension of the IRBM range centerline. Other ranges are Polar Orbit, Equatorial Orbit, Sea Test, Inland, Anti-Missile-Missile and Nuclear—six designations, but seven operational activities.

• **Here are plans**—First expansion will be of the Sea Test Range until it spreads 1,600 miles between Seattle and Baja, Calif. and a distance of 5,000 miles out to sea.

The IRBM range will extend 1,500 miles from Vandenberg AFB and Point Arguello, being centered on a medium bearing of 261 degrees. Maximum launch courses will be between 301 and 221 degrees True. Basic launch course for ICBM's probably will be 261 degrees True, with impact 75 miles NE of Wake Island.

ICBM's of greater range would travel across New Guinea, northern Australia and North Africa, with impact in the Atlantic.

The Anti-Missile-Missile and Nuclear Range pass through the general area of Midway, Wake, Bikini and Eniwetok, and should offer excellent possibilities for testing AMM systems against nuclear systems in inter-island intercepts.

Second on priorty for PMR is the Polar Orbit Range for the *Discoverer* program (m/r, Dec. 15, p. 18). Launch course will be close to 180 degrees True, and tracking will be by ship at the junction of the equator at 123 degrees West Longitude. Satellites probably will pass over the British-owned Ducie Island, where additional instrumentation may be located. A second range ship will be stationed south of Adak Island in the Aleutians.

• **Recovery zones**—Combined recovery zones for both the Polar and Equatorial Orbits extend from the equator north to 17 degrees North latitude on a line between 157 degrees West and 172 East longitude. Largest land masses in the area are Tarawa, Howland, Baker, Palmyra and the Marshall Islands.

Phase II of the *Discoverer* program, which involves use of the *Atlas* means a change of sites from Vandenberg to special facilities about four miles inland from Point Arguello. However, Air Force will perform the work.

Some of the projects the Navy anticipates will be underway and assigned to PMR by 1961 are; *Nike-Zeus, Pershing, Polaris,* and *Minuteman.* While these plans are not firm, they are, however, under consideration in Washington.

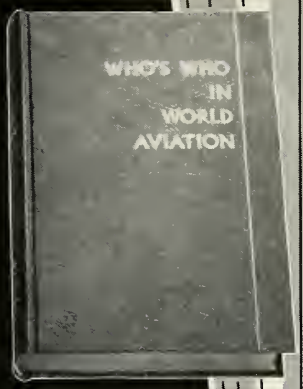
Firm site selections have been made at the Navy facility. Included are *Terrier* and *Hawk* launch pads; range operations building, telemetry building, surveillance, radar tracking, radar, radio receiver building, UHF and HF-VHF transmitter building, and a public works building.

A limited amount of construction is now in progress. Sites have been proposed but not firmly selected for a central launch control in Spring Canyon; a 150,000 pound thrust launch complex, and a 1.5 to 3 million pound thrust launch complex in La Honda Canyon; and volume fuel storage facilities in Bear Creek Canyon.

Instrumentation facilities on Oahu, Midway and Wake Islands, reportedly is near completion. Plans are still being developed for Eniwetok, Bikini and Manus.

The Manus-Christmas Island complex, which could be tied in with Australia's Woomera Range, offers the possibility that it could be used for *Dyna-Soar* tracking in cooperation with other Pacific stations.

A NEW DIMENSION



has been incorporated into the all-new, Second Edition of *Who's Who in World Aviation.* This new dimension is space.

Reflecting this extension of scope is the new title—*Who's Who in World Aviation and Astronautics.* Extended too, is the scope of its international coverage. Over all there has been a 40% increase in the number of biographical entries over the well acclaimed First Edition issued just three years ago, raising the total to 3,390.

What leaders are included in *Who's Who in World Aviation and Astronautics?* Officials and key personnel of aircraft and engine companies; airlines and associated industries; scientists in aeronautics and astronautics; officers of the air services of all countries who merit recognition due to rank or service; distinguished members of pilot organizations; government officials, who work with the industry; legislators who take a significant interest in aviation; and those who have contributed to the science, industry, commerce, literature and development of aviation, astronautics and allied fields.

No library, no reference shelf, no reading room can be without this useful, comprehensive volume. It will make a welcome addition to the personal bookshelf of anyone associated with the aviation and astronautics fields by vocation or interest.

Because of the perennial popularity of *Who's Who in World Aviation and Astronautics* and because there will be only one printing of this edition, please order your copy early to avoid disappointment.

AMERICAN AVIATION PUBLICATIONS

1001 Vermont Avenue, N.W.,
Washington 5, D.C.

Please send.....copies,
at $12.50 each
of Who's Who in World Aviation
and Astronautics

NAME_____

JOB TITLE_____

COMPANY_____

ADDRESS_____ ☐ BUSINESS ☐ HOME

CITY, ZONE, STATE_____

☐ Check enclosed ☐ Bill later.

m/r personal profile

Dr. James R. Killian: Science 'Mystery Man'

by Erica Cromley

As we prepare to penetrate outer space, we have the exciting opportunity to open a new window on the universe.
—James R. Killian, Jr.

WASHINGTON—Dr. James R. Killian, Jr., is one of the most influential men in Washington but one of the least known. In his double-hat role as Special Assistant to the President for Science and Technology and Chairman of the President's Science Advisory Committee, Killian counsels the Chief Executive in such vital areas as the nation's space and missile programs, atomic energy projects, and the exchange of scientific information with other countries. Involved are the nation's defense, its technological superiority, its economic growth. Yet to most Americans and even to some of Washington's "inner circle," Killian is a man of mystery.

It is no easy task to dodge the spotlight in the news capitol of the world, thoroughly probed by more than 1,000 press correspondents. Except for a quick publicity once-over when he was named to the White House post a year ago, newsmen have been unable to dig up much on the man himself, or to comprehensively analyze the extent of his power. His immediate staff is also in the dark about many of his activities, including his appointments with Eisenhower.

Reason given by his office for press-interview turndowns: "His heavy schedule won't permit it." Even invitations to appear before Congressional hearings, considered by many as "command performances," are refused because "this is inconsistent with his position as Presidential advisor." The Senate space committee, which wanted him as leadoff witness during hearings on the bill to set up the new space agency, had to settle for James Doolittle.

Although there is much that is secret about the job, there is strong feeling that much of the mystery could be unveiled in the public interest. Said one scientist, active on the Washington scene: "He may be doing great things but how would we know?" Aside from the security aspects of the science advisor's work, Killian is kept in the shadows, it is said, to insulate him from "non-political pressures"—industrial contacts who would want to push their pet projects.

• **Frequent visitor**—One index of his influence on the national scene is the frequency of his visits to the Presidential office. During one recent month, the White House appointment book lists 10 Killian visits with Eisenhower personally, and six sessions with the National Security Council and the President's Cabinet. One day that month he saw the President four times. In addition to the recorded appointments are impromptu informal consultations from time to time.

To keep the President up-to-date on top scientific developments and their significance, Killian has the help of about 100 experts—10 full time staffers, about 70 consultants and the 18 members of the Science Advisory Committee. The committee's work is broken down into 15 areas, each of which is tackled by a panel of from five to 15 experts, not necessarily members of the committee itself.

While some of the panel names have not been revealed for security reasons, seven identified by Killian's office are: education, scientific information, space and science technology, research, science and foreign relations, disarmament (nuclear test cessation), missiles. These committees meet whenever a particular problem arises in their area, and report their conclusions to Killian. If there is disagreement, Killian is called in to hear both sides. Usually he ties together a conclusion acceptable to the majority. If necessary, he will call in outside experts to help shake down a problem.

Although his reliance on the group brain-storming sessions would tend to belie the "Czar" tag given him by the press at the time of appointment, how closely he follows these group views when he has the President's ear is known only to Killian.

Keeping the commander-in-chief informed on scientific matters of grave import keeps Killian nimble-footed. A typical day looks like this: A.M.: staff conference, meeting with a panel chairman, session with Undersecretary of State Christian Herter, National Security Council meeting. P.M.: luncheon meeting with panel members, speech-writing session, ironing out a panel disagreement, confab with Ike, meeting with top foreign scientists. Hours covered: 8 A.M. to 7 P.M.

• **An appraisal**—Opinion on Killian runs from warmly in favor to mildly against with the pros ahead. The top strata of nation's scientific community on the whole seemed gratified when Eisenhower announced the appointment November 1957, a month after *Sputnik I.* The President said at the time: "Dr. Killian will see to it that those projects which experts judge have the highest potential shall advance with the utmost possible speed. He will make sure that our best talent and the full necessary resources are applied on certain high-priority top-secret items . . ."

Killian's year in office has seen creation of three new agencies dealing with space. The Defense Department's Advanced Research Projects Agency, the National Space Council and the civilian National Aeronautics and Space Administration. Among the non hush-hush achievements in which

the science advisor played a key role was passage of the National Defense Education Act, expanded funds for research and development, reorganization of the Pentagon and publication of the "space primer," *Introduction to Outer Space,* which was read countrywide after a printing that ran into the millions.

One political hot potato that cooked in the Killian office was whether or not to transfer the Army Ballistic Missile Agency's team of crack scientists to the civilian space agency. Although Killian did not publicly express his views on the issue, he undoubtedly gave advice to the President, possibly toward the benefit of NASA. Because he has been quoted as saying: "The use of science for defense is necessary and we cannot be strong without it. But such use of science and technology is not a natural or satisfying use and in the end can only thwart and distort their true spirit."

Although details of the Killian operation are obscure, the government's top research and development people are well aware, sometimes painfully, of his "go, no-go" authority.

Said one high Navy R&D official: "To say that James Killian wields tremendous power is an understatement. If he approves a program, it's on its way.

"A lot of people don't like him because he won't approve their pet ideas," he added. "I like him and if I can't justify an idea to him, I'm satisfied there's a good reason. Biggest disadvantage about Killian is that while he has a lot of authority, he has no responsibility—he doesn't have to live with his sins. If this man were of Cabinet stature and had responsibility it would be better for the United States."

This criticism of the nature of Killian's role is echoed periodically in scientific and space-industry circles. Said one missile industry official recently; "If anybody has authority they should also have the responsibility. He tells ARPA and NASA what to do but if something goes wrong they get blamed."

Strong criticism of the job he is doing, however, is hard to come by. Biggest specific gripe is that he is not paying enough attention to the scientific manpower problem. One member of the panel concerned with that problem, complains that he has yet to call a meeting on the subject.

Killian supporters point out that his position is formidable—"an almost impossible one"—and that he is doing an extremely competent job under tremendously difficult conditions.

Although not strictly a scientist, Killian's standing in the world of scientists stems from several sources: his success as president of the Massachusetts Institute of Technology, the competence with which he has handled past government-scientific assignments, his quick grasp and analysis of technological problems, and his abilities as an administrator which includes keen judgment in evaluating the men he selects to help him.

Said a Capitol Hill space committee staffer: "Although Killian is not a figure in the space world, he is one in the science world. He may not be competent in any one field, but he does know who is. He can reach down in the scientific community and pull out just the man he needs. He is an excellent people-dealer."

He is described by those closest to him as determined, strong-willed, reasonably selfless, perceptive, somewhat complex, serious, reticent about pushing himself, dispassionate but warm.

His immediate staff says he is easy to work with and shows concern about the well-being of those who work for him.

The Killian office is a rather austere green-painted, high-ceilinged room approximately 22 x 18 feet with a picture of Eisenhower hanging on the wall behind his desk, and a view of the White House, directly across the street from the Executive Office Building. Except for the fireplace, it resembles the staid Congressional offices in the old Senate and House Office buildings.

It is here that he writes most of his speeches. Killian, who will have nothing to do with ghost writers or staff-written speeches, gained his fluency with words when he was editor of MIT's technical review.

Killian's approach to his job and his basic philosophy is perhaps best revealed through his speeches. The following are excerpts:

• **On research**—"We need to stabilize the support of research by both public and private agencies. Starts and stops, ad hoc commitments, and modification of research programs have at times kept the national effort off balance and have occasionally served to dissipate our efforts rather than to augment them . . .

In stressing the "importance of maintaining and increasing research and development in a time of recession," Killian declared: "Advancing technological knowledge provides a company with the agility to react rapidly to changing economic conditions . . . It helps in planning future goals by the systematic, planned discovery of new products and methods of making them. This is true no less for the nation as a whole, than it is for an individual firm."

". . . more than ten billion dollars are being spent annually by industry, government, universities and other non-profit institutions on research and development . . . By far the major total of the ten billion dollars is expended for development, and over the past decade there has not been a comparable increase in basic research [*which*] drives to the heart of the qualitative problem we face."

• **On his job**—"The [*Science Advisory*] Committee serves as a board of directors or consultants to me as Special Assistant to the President . . . We have no operational responsibility . . . My function and that of the committee is to provide answers to questions raised by the President . . . to mobilize the best scientific advice of the country and to make recommendations to him in regard to ways by which United States science and technology can be advanced.

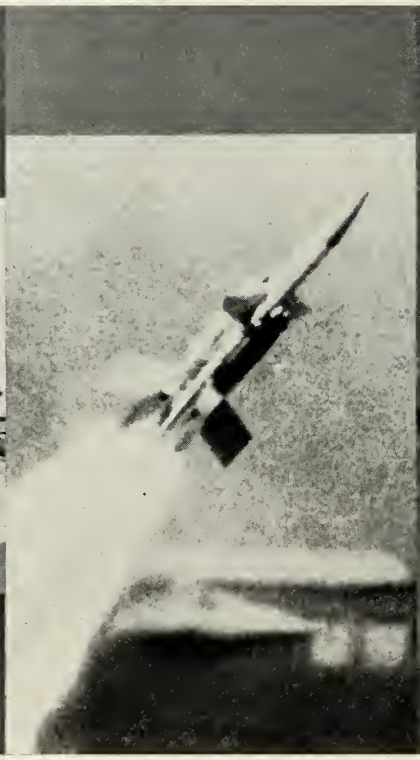
• **On education**—"We should not engage in an academic numbers race with the Soviets. We must not throw quality out the window in order to handle numbers . . . Our colleges and universities should raise their entrance requirements in order to set a higher standard for the secondary schools . . . particularly should admission requirements be increased in English and mathematics . . . There is the need for earlier identification and cultivation of high talent, as early as the seventh or eighth grades . . . [The four-year undergraduate engineering program] must be supplemented by expanded graduate study in engineering. Many industries have been ahead of the colleges in recognizing this need . . . it would be more appropriate and advantageous in the long run for them to receive their advanced training in the university, rather than in industry . . .

• **On the space race**—"We continue to be outstandingly strong in nuclear physics, in solid-state physics, in polymer chemistry and in high-speed calculating machines. In high-energy nuclear physics the Soviets are developing fast and may indeed grow to excel. But in low-energy nuclear physics, which is directly related to applications, the outstanding position of the United States is beyond dispute . . .

"The problem before us is not our leadership in technological strength today; the challenge we face is maintenance of this position tomorrow.

FOR BRITA

Missiles and launchers readily transported on light limbers; rapid installation on site



Launching, assisted by rockets; main ramjets burn safe-to-handle kerosene

Rockets jettisoned; ramjets, started from cold, already giving even more spe

Approaching full operational status with the RAF as mai stay of Britain's air defence...

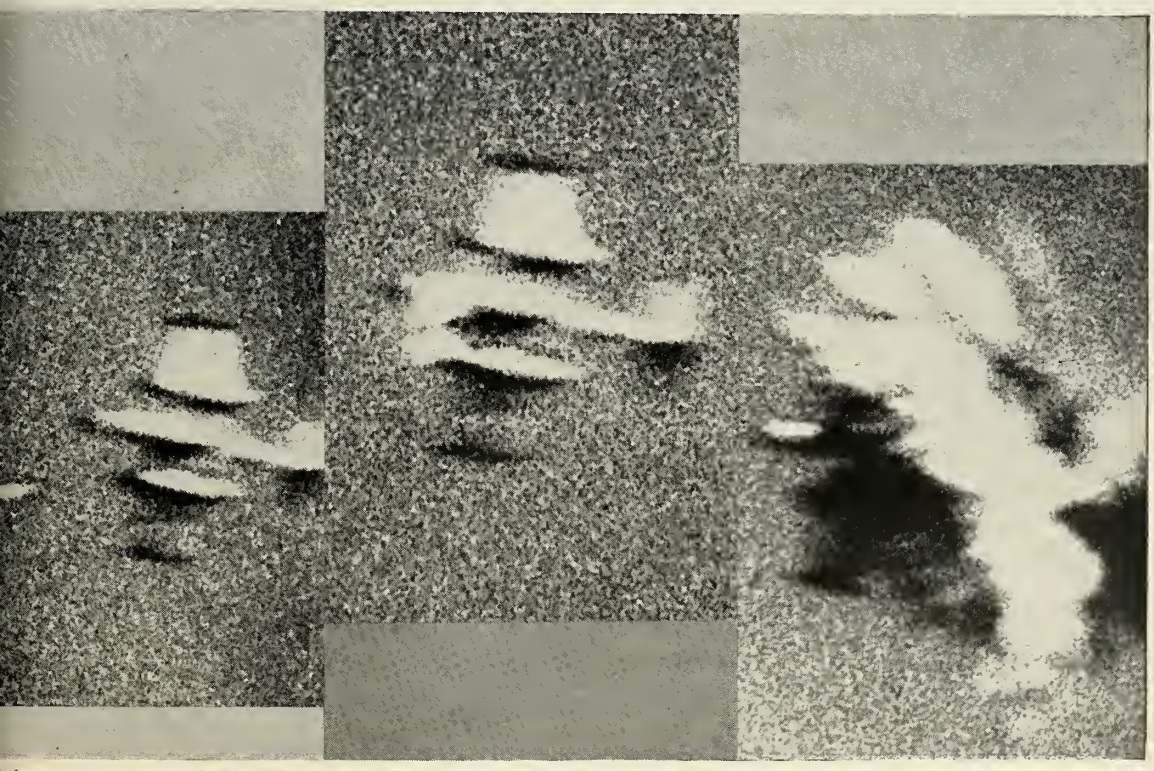
Proved in many hundreds of test firings...

Adopted by Sweden after exaustive consideration of surfac to-air guided missile systems available throughout the world

Bristol/Ferranti Bloodhound forms the world's most effectiv defence system now and for many years to come.

WEAPON DESIGN AND CONSTRUCTION BY BRIST

N'S DEFENCE



e homes on to target; semi-active guid-system ensuring highest accuracy

Missile closes in; moving wing control holds course, whatever evasive action target takes

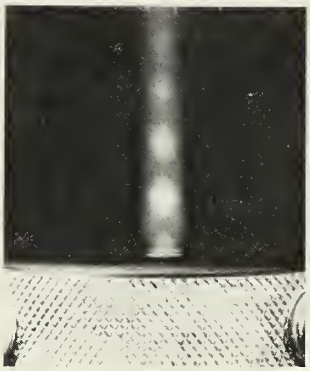
Missile gets within lethal distance; proximity fuse detonates warhead—target destroyed

urity forbids publication of full details, but the follow-facts about Bloodhound can now be given:—

ver. The Bloodhound is powered by two Bristol ram-—jet engines with no moving parts. Ramjets ensure ver and range flexibility, burn kerosene, are simple and e to handle.

ming System. Semi-active: i.e., ground crew directs ar beam on to target, which is reflected to a receiver in odhound, ensures highest accuracy—regardless of ge. Missiles may be fired, singly or in salvoes, using only radar.

rame. Employs unique and advanced monoplane ving wing configuration—two advantages:– quicker and more precise response, as well as greater accuracy of interception; superior at high altitudes. This configuration was selected at initial design stage to embody maximum development potential.



PLASMA TORCH mounted in wind tunnel for missile research.

New Plasma Tools Handle Ultra-Hard Metals

by Peer Fossen

WASHINGTON—The word "plasma" when mentioned in conversations these days, immediately makes one think of space science, and the power that will be used for space travel.

This is only natural, since the publicity given to plasma in the past few months has been focused on the space side of the art as a result of several significant breakthroughs in the field. Programs for plasma in space are being carried out by such organizations as Plasmadyne Corp. (m/r September 29, p. 11), General Electric (m/r October 6, p. 29), Avco Research Republic Aircraft, Vitro Corporation, and Lewis Flight Propulsion Laboratory of NASA. (The basic principles for generating plasma were described in m/r, September 29.)

It is, however, significant to note that while plasma as a power source in space still has to be proven, plasma devices can be used on earth to fabricate metal components for such things as rocket nozzles and nose cones for re-entry purposes.

• **Latest tools**—The latest additions to the line of plasma tools were recently introduced by the Linde Company, a division of Union Carbide Corporation. Considered by the Linde Company as involving a radically new method, the devices are capable of fabricating metal shapes and applying coatings that will withstand temperatures above 5000 degrees Fahrenheit.

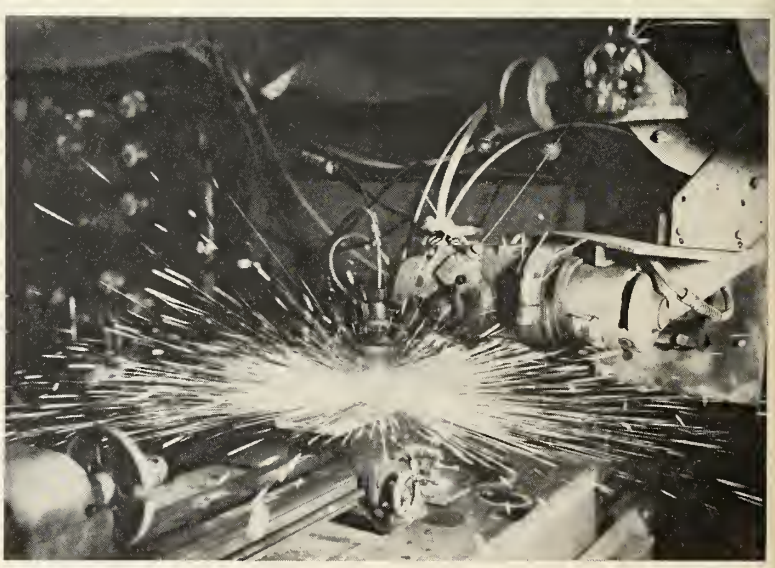
The process, harnessing controlled temperatures up to 30,000 degrees F, makes possible mass production of ultra-hard materials which have been considered practically unworkable by conventional metal-working methods.

In Linde's plasma torches, as these devices are called, the metal or substance to be worked is prepared in either wire or powder form and is then passed through an intense arc that is struck inside the torch. At this point temperatures above 15,000 degrees are reached.

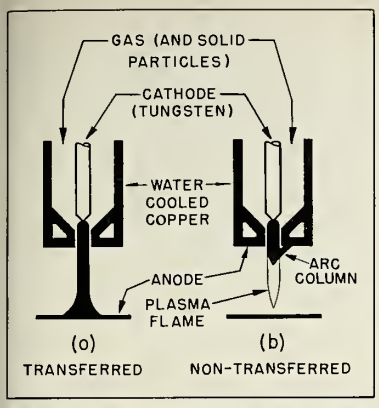
• **Material is converted**—Because of the high heat of the plasma arc, the material passing through is converted into a fluid or plastic state. It is then carried out of the torch by inert gases flowing at high velocity and is finally deposited on the part being made or plated with such force that a firm bond results.

The choice of wire or powder—and there is a separate torch for each—is largely one of convenience or economics. Stainless steel, for instance, is readily available in wire form and would most often be wire-fed.

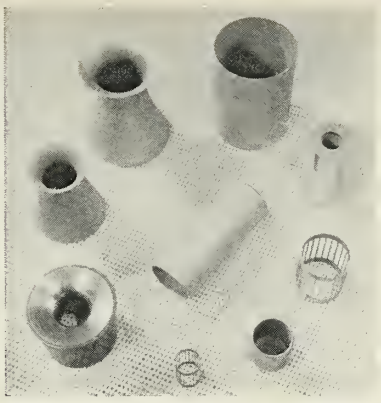
Tungsten and the carbide materials, on the other hand, are more usually found in powder form and are regularly used in this form.



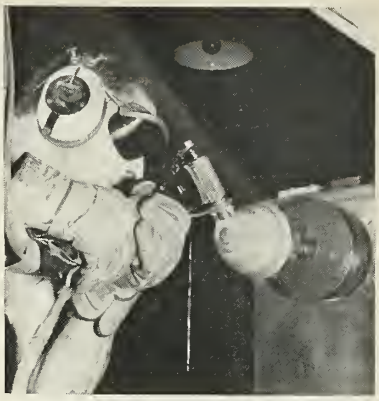
WIRE FED plasma torch coats stainless steel on aluminum plate. Fed from a spool, the wire is preheated before entering the torch's arc chamber.



BASIC TYPES of plasma torches. Transferred arc is used for metal cutting, non-transferred for metal coating.



THESE PARTS have been produced with Linde's torch, making possible handling of critical metals.



TUNGSTEN IS applied to missile nose cone with torch, after being drawn into the arc in powder form.

In a plasma torch, most inorganic materials that melt without decomposing can be used. Some of these materials are:

1) The refractory metals such as tungsten, tantalum, columbium, molybdenum, niobium and rhenium.

2) Some of the refractory metal compounds such as borides of zirconium, tungsten, niobium, tantalum, titanium, chromium.

3) The refractory carbides of niobium, hafnium, tantalum, zirconium, titanium, tungsten, vanadium.

4) The refractory oxides of thorium, hafnium, magnesium, zirconium, cerium, aluminum.

5) The noble metals—platinum, palladium and others in that group plus their alloys.

Of particular interest is the use of the plasma torch for formed metal shapes, such as a tungsten part. This is accomplished by depositing a coating to the required thickness over a precisely made brass mandrel.

At this stage the tungsten has a density of 94 to 95%, a modulus of rupture of 44,000 psi and a Young's modulus of 22 x 10^6 psi. The mandrel is removed in acid bath which attacks the brass only. The shape is then fired in an inert atmosphere furnace for two hours at 1400 degrees C.

After firing, the density is increased to 97-98%, the modulus of rupture to 57,000 psi, and Young's modulus to 34 x 10^6 psi. The volumetric and linear shrinkage upon firing are 2.2% and 0.7% respectively.

• **Other uses**—In addition to experimental rocket and missile parts of pure tungsten or tungsten-coated graphite, the metal forming method has been used to produce high density tungsten crucibles for metallurgical purposes, special parts for nuclear work, sensitive electrical contacts, and electronic components and x-ray targets of superior density.

Coatings made with the plasma method, using the powder type torch, will bond good to most any base material including some re-inforced plastics, graphites, and carbons. These bonds are generally chemical and mechanical in character and exceed those obtained by electroplating, vapor deposit, or metal spray.

The coatings are very dense, usually laminar in structure and may be finished to below 10 microinches.

The areas of application of plasma torch coatings are manifold and cover practically every industry.

Typical work is the application of plasma coatings in the production of refractory parts—such as crucibles for melting high melting point materials, for example, silica. Several distinct advantages are claimed in forming these parts with the plasma torch.

They can be made structurally sound without resorting to heavy walls. They are dense and can be made with high surface finishes. The thinnest practical crucible wall understood to be made by other processes is 0.125″, more commonly, however, this thickness ranges in 0.250″ area.

Plasma arc formed crucible wall thickness are generally .040″ to .060″. Consequently they should, under full production pricing conditions, be more economical.

• **Permanent molds**—Another refractory application is special permanent molds for high temperature service. These may be coated with suitable refractory materials. An example of this is a section of a molybdenum base metal mold coated with tungsten, that can be used to cast a highly radioactive metal rod. Other parts used to process radioactive materials have been coated with both tungsten and tantalum and are under test, according to the Linde Co.

The company does not plan to market any of the patented plasma torch devices at this time, but is prepared to accept orders for parts coating or parts fabrication, either in production or in experimental quantities.

• **Other companies**—Leading companies in the production of plasma jets or plasma torches, in addition to Linde, are Plasmadyne Corporation, a division of G. M. Giannini & Co., Inc., and Thermal Dynamics Corp.

Plasmadyne has for some time been developing tools for coating large metal surfaces, including the inner surfaces of liquid fuel tanks for rockets. This company has also been developing tools for fabrication of redomes and domes for infrared devices. Plasmadyne torches, which have been offered for sale for more than a year, are substantially different from other torches on the market, according to a company spokesman.

Thermal Dynamics has equipment for sale which has been designed particularly for research and development purposes. Straight commercial use is controlled through licensing. The company has three standard torch sizes available—24, 50, and 100 DC KW, with various special attachments for modification. One modification of the torch design permits generation of temperatures over 60,000 degrees Fahrenheit at heat transfer rates 5 to 10 times that of the standard torch.

Thus, the problem still stands: Plasma as power in space still must be proven. But there are multiple uses—especially in metals today. Research is paying dividends, as the Linde Company has found out.

Computer Component Has Reliable Inert Materials

Transient permanent magnistor can be placed into data processing circuits

by Raymond M. Nolan

NEW YORK—A new computer component—called a transient permanent magnistor—is so rugged and reliable that it can be incorporated directly into data processing computer equipment circuits without replacement according to the manufacturer, the Potter Instrument Company located in Plainview, New York.

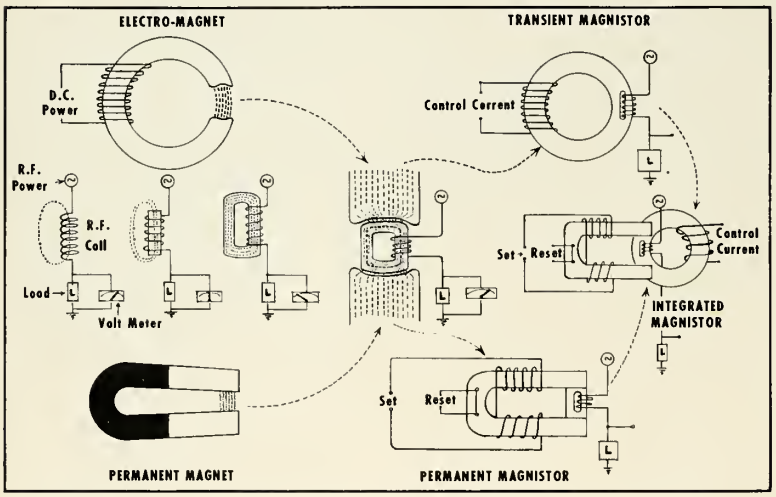
Sealed in epoxy plastic, the dime-size component will also make possible high speed printer systems two-thirds smaller than those now in use by the Armed Forces in space experiments.

The Potter MPT-1 magnistor is a solid state magnetic component composed of inert materials in an apparently reliable and versatile arrangement. High retentive ferrite combined with a high permeability low retentive ferrite is employed in the configuration to achieve characteristics not now attainable in one component, the Potter Company said.

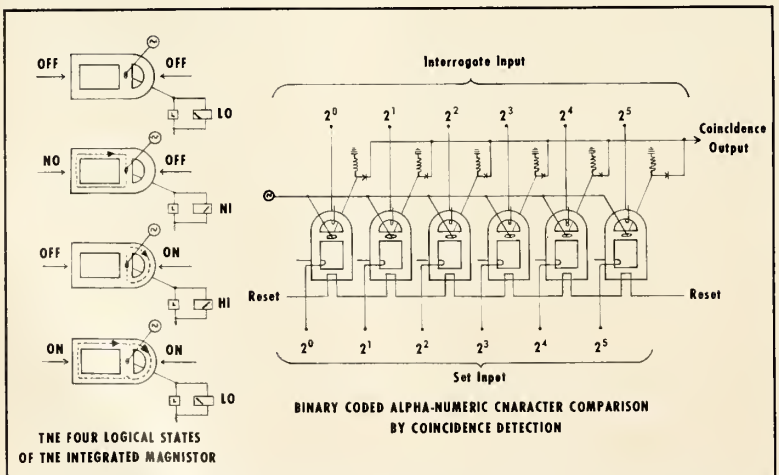
The MPT-1 is an eight-terminal device. SET input terminals provide access to the high retentive ferrite for data storage in the same manner as with conventional ferrite cores. The RESET winding, when actuated, dissipates the stored magnetism. The resulting alternate states of magnetism are indicated by a two-state change of inductance of an RF signal winding.

The INT (interrogate) winding is associated with the high permeability ferrite and effects an identical change of the RF signal winding inductance. However, with the lack of magnetic retentivity, the response is proportional to the applications of current to the INT winding. When both magnetic circuits are considered in combination, the effects of each with respect to the other is of a complementary nature. This result reveals an identity to the half adder (less carry) that is used in digital computers.

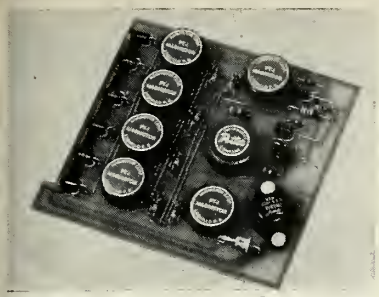
• **Magnetic states**—The four possible magnetic states within the MPT-1 and the corresponding relative values of the signal winding inductance are shown in the accompanying illustration. For the upper left figure, with no magnetic flux from either the permanent or transient sections, the signal winding will show a high inductive value. With saturating flux from either of these two sections, as in the second and third figures, the signal winding inductance will be



EVOLUTION of the integrated magnistor from standard magnetic sources.



FOUR POSSIBLE magnetic states within the MPT-1 transient permanent magnistor, left. Six-bit combination for coincidence comparison, right.



COMBINATION of six MPT-1 transient permanent magnistors and Q-1Y 10 Mcs signal source.

RELATIVE SIZE of the Potter magnistor. Unit is so rugged that no replacements are necessary.

considerably reduced. With both sections energized as in lower figure, the saturating flux through the signal winding core is removed by the proper polarization and coercive effect of the energized interrogate winding. A six bit combination to satisfy the requirements of a coincidence comparison is shown on the right side of the diagram.

For equal input states, that is "off-off" and "on-on," a high inductance will be displayed, whereas for unequal inputs such as "on-off" and "off-on" a low inductance will result. This takes the form of a differentiating detector between equal and unequal states combined with storage for one state. Possible digital applications for this are: sorting and collation, coincidence detection, parity checking and digital servo follow-up.

An RF signal source is part of magnistor technology and Potter uses a Q-1Y 10 mcs source. This unit is a complete oscillator package, fully encapsulated, and designed for printed circuit applications. A minus 20-volt DC input will produce an output signal of approximately 2-volts RMS of sufficient power to accommodate more than 10 magnistors. The size of the Q-1Y makes is possible to group several magnistors for a specific logical function as shown in the photograph.

The magnistors are to be produced in Puerto Rico. John T. Potter, company president, said a key reason for producing the new type units in Puerto Rico was the high manual dexterity and productivity of Puerto Ricans in delicate coil-winding and assembly done under magnifying lenses. He also said that the parent plant in Plainview has already received the first shipment of magnistors from its island affiliate, Magnistor Corporation, Luquillo. In connection with this, Hector E. Pineiro, U.S. Industrial Promotion Director for Puerto Rico's Economic Development Administration, noted that Magnistor Corporation is among 50 electronics affiliates established in Puerto Rico since 1950 under the "Operation Bootstrap" industrialization program.

Potter noted that "three years of testing by our engineers have shown the magnistor to be extremely reliable. The magnistor stores energy indefinitely. It avoids in part electronic connections which are subject to loosening and deterioration. Sealed in epoxy resin, the magnistor can withstand operating temperatures beyond 220 degrees F."

Tentative specifications for the MPT-1 magnistor and the Q-1Y 10 mcs source are:

MPT-1 MAGNISTOR at 100 DEGREES C

	Resistance (ohms)	Inductance	Current (±20 %)
SET	5	*95 uh at 1 mc	100 ma
RESET	3	*35 uh at 1 mc	120 ma
INTER-ROGATE	6½	700 uh at 1 mc	120 ma
RF SIGNAL	1	Set: 18 uh at 10 mc Reset: 90 uh at 10 mc	

Typical RF signal voltage: 2-volts RMS

* This value is for initial and final inductance; during the transition period the inductance may rise by a factor of ten.
Height from case top to bottom of pins: .75-inch Diameter: 1-inch (overall).

Q-1Y 10 MCS SOURCE

Input voltage	minus 20-volts DC (max.)
Input current	10 milliamps
Output voltage (loaded)	2 volts RMS
Frequency	10 mcs plus or minus 5%
Temperature	55 degrees C (max.)
Height (to base of pins)	9/16-inch
Diameter (overall)	13/32-inch

BMEWS Are Reported Solidly on Schedule

WASHINGTON—In a joint progress report made public by Brig. Gen. Charles B. Root, chief of the USAF Electronic Defense Systems Division, and William L. Richardson, Administrator of the BMEWS project for RCA, it has been announced that construction of BMEWS (Ballistic Missile Early Warning System) is solidly on schedule as winter sets in and brings the long night to the arctic.

One base where several hundred workers are leveling ground, building roads and constructing facilities was cited in the report as an example.

One part of the program in the summer—when temperatures were steadily above freezing—was erection of rubber shells about the size of circus tents. In the warmer months, the shells were moved from place to place as concrete footings and foundations were finished. This will allow outside superstructure work to proceed through the winter.

Port facilities are normally free of ice for three summer months of the year. But this year, the Military Sea Transportation Service devised a method of keeping them open another month. Three 1,000-foot long tubes were lowered into the water at the sides of the docks, with compressors attached at the top. The compressors pumped air down to the tubes, sending air bubbles constantly up from the bottom to keep the water churning and prevent the formation of ice. The exercise was dubbed "Operation Polynya," using an arctic word that describes a phenomenon of the region—a pool of open water that forms seasonally in areas otherwise completely frozen over.

BMEWS is managed by Air Materiel Command with the assistance of Air Research and Development Command and the Air Defense Command. RCA is the prime contractor with offices at its Missile and Surface Radar Department at Moorestown, N. J.

Bell System Used for *Regulus II* Tests

BUFFALO, N.Y.—An automatic all-weather landing system, developed for use aboard Navy aircraft carriers, has landed the *Regulus II* surface-to-surface guided missile twice as part of an evaluation program.

The landings were made at Edwards Air Force Base, Calif., on October 8 and October 15, Bell Aircraft manufacturer of the landing system, disclosed.

Purpose of the test program was to determine whether the automatic system could be used to recover the *Regulus* missile after test flights at the California base.

The Bell system which uses a combination of radio and radar, locked on the missile's autopilot several miles from a selected point of touchdown and guided it to a safe landing.

Another type of automatic control system has been credited with saving more than $100 million during the *Regulus I* program by landing missiles more than 600 times after evaluation flights.

Synthetic Crystals Produced

CINCINNATI—Details of pilot plant production of synthetic quartz crystals were given in a paper presented at the American Institute of Chemical Engineers meeting here. The paper described the production facilities that are now growing large crystals by the hydrothermal process in limited quantities at Western Electric's Merrimack Valley Works in North Andover, Mass.

In addition to its availability in any quantity and size, synthetic quartz provides other advantages. Seeds can be cut to provide grown crystals which can be sawed efficiently. The material also has natural faces which allow easier orientation of the stock for cutting into units. It contains none of the foreign inclusions which usually occur in natural quartz, and it can be produced without either optical or electrical twinning.

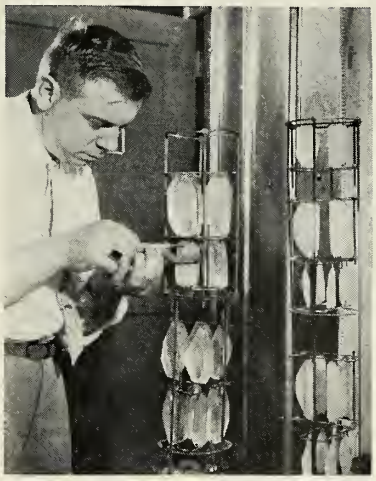
In the pilot plant, quartz crystals up to two to three inches in each cross section and five to six inches long have been grown by the hydrothermal process.

• **Autoclave used**—In the hydrothermal process, a long, narrow autoclave mounted vertically is filled with an alkaline solution, usually solium hydroxide. Small pieces of natural quartz are placed in the bottom of the container to provide the nutrient. Western Electric plans to use high quality sand as the future nutrient.

Seed plates cut from either natural or previously-grown synthetic crystals are hung from a rack in the upper section of the autoclave. After sealing, the vessel is heated and maintained under a constant temperature differential from bottom to top for the desired time, which varies from one to several weeks depending on the experiment.

Economical growth rate in excess of 60 thousandths of an inch per day has been achieved. Since growth occurs primarily in one dimension, flat seed plates are used which effectively become thicker but change little in other dimensions. The rate of growth varies with temperature differential, alkilinity, temperature and pressure of the vessel.

Operation of the hydrothermal process depends on the maintenance of a temperature differential between the nutrient area and the seed plate area. The nutrient dissolves in the hotter lower region and is carried by convection currents to the cooler upper region. The lower temperature here leads to a supersaturated condition in the nutrient solution, which causes the dissolved quartz to redeposit into the seed plates in single crystal form.



QUARTZ CRYSTALS are measured.

Main problem that faced Western Electric was closure for the autoclaves. Laboratory units were welded tubes supported by capped, high pressure piping. A repetitive closure was required for the larger autoclaves and a satisfactory closure was developed which gives a tighter seal as the pressure inside builds up.

Martin's IBDL System Now Operating In N.Y.

ORLANDO—A new system, called the Interim Battery Data Link (IBDL), manufactured by Martin's Orlando Division is being used for electronic coordination of Army air defense installations in the New York City area. The IBDL was accepted by the Army September 26 and became operational in October.

IBDL is installed at each *Nike* battery in the New York air defense system. The system is used as an interim measure which permits electronic coordination of missile batteries, and functions as a target data link between firing batteries of an air defense installation. Developed in conjunction with the Signal Corps, IBDL indicates to battery commanders, on their scopes, which targets are engaged by other batteries in the area. Possible targets, picked up by radar, appear on the screen of a scope. Each battery commander in the system sees the same information to assure that all targets will be engaged.

IBDL is intended as an interim system to be replaced by the Martin *Missile Master* system when accessory buildings and other preparations are complete. The only operating *Missile Master* system is at Fort Meade and works with the Washington-Baltimore air defense system.

Plans are to install the IBDL in every air defense area where *Missile Master* is to be installed and then to integrate IBDL into the *Missile Master* when it becomes operational.

Transistor Sales Hit Another Record High

WASHINGTON—Factory sales of transistors in October established another new high with a 10% increase over September, according to the Electronics Industries Association. Unit sales during the first 10 months of 1958 exceeded total sales for 1957. Sales in October were 36% greater than in October, 1957.

Transistor sales in October totaled 5,594,856 with a dollar value of $13,461,857, compared with 5,076,443 transistors valued at $10,811,412 sold in September and 3,544,000 units valued at $7,075,000 sold in October a year ago.

Cumulative sales of transistors during the first 10 months of this year, January-October, totaled 36,072,133 transistors valued at $83,692,052 compared with 21,396,300 valued at $56,131,000 sold during the corresponding 10-month period last year, EIA said.

Factory sales of transistors during calendar year 1957 totaled 28,738,000 units with a dollar value of $69,739,000, according to EIA's compilation.

Soviet Scientist Gives Peace Symbol to Johnson

SAN ANTONIO—Senate Space Committee Chairman Lyndon B. Johnson, one of the key men in the nation's space race with the Russians, has received a symbol of peace from a top USSR scientist.

Johnson, Senate Majority Leader, was presented a leaf of the ancient Ginkgo tree, from Prof. Gabriel A. Tikhov, founder of Russia's Institute of Astrobiology and renowned for his studies of possible plant life on Mars.

The Ginkgo, one of a species surviving from a remote geological era, grows in the institute's botanical garden at Alma Ata, Soviet Asia.

(Continued from page 7)

system, was developed in cooperation with Latecoere. This type has a longer range than the *Masurca*. Solid propellant rocket engines are used.

• **Ship-to-ship missile**—Finally, the French Navy has developed a ship-to-ship missile, the *Malaface* from which a ship-to-submarine version, the *Malafon* has been developed and will be installed on the escorter "T56—La Galissoniere" presently being built. The *Malafon* uses acoustic guidance underwater.

After having been successfully tried, at either the Ile du Levant naval test range or at the Defense Department test range of Colomb-Bechar, in the Sahara, these miscellaneous missiles will soon see their first sea trials next month, when the "Ile d'Oléron" test ship will take to sea. This ship is a former German transport which has been revamped by the Arsenal of Toulon.

The "Ile d'Oléron" will carry ship-to-air missiles, ship-to-ship missiles, a platform for a two-ton helicopter, an electronic center (which will be the most sophisticated ever built in a French ship), a platform for an eight-ton helicopter and two launching ramps for target missiles.

Besides having to meet special requirements like those of the U.S. Navy (as compared with those facing the Army or the Air Force), the French Navy also has to take into account the fact that its missiles have to be developed to operate from ships as small as 1,800/2,500-ton escort vessels.

In the future, however, the plans are to reconvert anti-aircraft cruisers like the recent "de Grasse" and "Colbert" with missiles replacing artillery and, from 1960 forward, to build a new generation of warships, especially designed for missiles and which will be in the 2,500/5,000 ton category.

The work completed already pays returns—one-third of the activity at the Ile du Levant test range is undertaken by operators other than the French Navy. The British and Swedish Navies have availed themselves of the facilities existing on the now well-organized Riviera test-range.

Are Changes Needed in IAF?

by Andrew G. Haley
President, International Astronautical Federation

WASHINGTON—Are the rocket and astronautics societies of the world, because of their membership in the International Astronautical Federation, losing the opportunity for preeminence in the communities of the natural and social sciences?

Based upon the events at the ICSU (International Conference of Scientific Unions) general assembly in October; United Nations proceedings in November; and actions taken at UNESCO (United Nations Educational, Scientific and Cultural Organizations) this month, there are several affirmative and highly favorable answers to this question. This despite the fact that the organizational complex of the IAF itself furnishes some negative replies.

The favorable developments are:

1) The unanimous adoption by the general assembly of ICSU in October, of the committee report of Professor K. F. Ogorodnikov (Academy of Sciences of the USSR, Moscow), Professor John T. Wilson (President of the Geodesy and Geophysics Union, University of Toronto, Canada), and Dr. Alan Shapley (U.S. Bureau of Standards). In this report, ICSU expressed its awareness of the useful activities of the IAF in furthering the science and technology of astronautics, and said it looks to the future possibility of arranging a more formal affiliation in matters of common concern.

2) The encouraging response from the Permanent Missions and the Secretariat of the United Nations when the services of three committees were offered on a consulting basis. The committees are: the UN Ad Hoc Committee on the Peaceful Use of Outer Space, the IAF Permanent Legal Committee, and the newly-constituted IAF Committee on International Cooperation.

3) The action of the general assembly of UNESCO in voting unanimously to give to the IAF full consultative status, and the action of the program committee of UNESCO in approving the recommendation of the UNESCO Natural Sciences Working Party that "exploration of extra-terrestrial space be added to the fields of research on which the Director General may be active."

• **Scientific help**—To say the least, these affirmative achievements were the results of never-relenting vigilance and of the unstinting help of many great scientists—Ogorodnikov, Wilson, Shapley, von Karman, Berkner, Malina, Singer and Kaplan, to mention only a few.

The negative factors, such as failure to change the constitution of the IAF to make the IAF eligible for membership in ICSU, flow directly from the conservative attitude of certain very strong IAF member societies which ordinarily would be fully justified in their attitudes. But they are not now because of dynamic changes resulting in the creation of such bodies as COSPAR (Committee on Space Research).

If the IAF had long since amended its constitution to provide for three divisions, namely, the Division for Space Sciences, the Division for Space Technology, and the Division of Social Sciences Related to Space Problems, the IAF would not only have accomplished the perpetuation of its existence as a great world nongovernmental organization in all fields of astronautics, but it also would have available for affiliation with ICSU a Science Division concerned with the broad spectrum of physical, mathematical, astrophysical and like sciences related to the study of space.

If such a division had been in existence, ICSU at the October meeting would have proffered affiliation to the IAF Science Division. Because the IAF as presently constituted cannot qualify as an astronautic science union under the statutes of ICSU, the latter had no alternative but to set up a special committee within its own organization.

• **COSPAR committee**—This committee is COSPAR and its existence is discouraging in a sense to the IAF. But under the circumstances, the creation of the committee was essential.

• **Changes needed**—ICSU has already demonstrated unprecedented recognition and friendship for the IAF. The IAF needs only to make the appropriate changes in its statutes to conform with the requirements of ICSU, and to provide qualified and recognized scientists from among the ranks of its member societies to become the ICSU affiliate.

A special meeting of the officers of the IAF and of the representatives of all of the member societies will be held in Geneva, or any other centrally located city, in May to agree upon positive statutory and other necessary changes. An obvious defect in the IAF Constitution is apparent because such interim meetings have no statutory sanction.

At this meeting perhaps majority decisions may be made which can be presented immediately on the convening of the London Congress for ratification on the basis of prior agreement.

when and where

DECEMBER

American Astronautical Society, Fifth Annual Meeting, Hotel Statler, Washington. Meeting will be held in conjunction with the 125th Annual Meeting of the American Association for the Advancement of Science, Dec. 27-30.

JANUARY

Fifth National Symposium on Reliability and Quality Control in Electronics, Bellevue-Stratford Hotel, Philadelphia, Jan. 12-14.

Southwest Electronic Exhibit, Arizona State Fairgrounds, Phoenix, Jan. 21-23.

Fifth Annual Radar Symposium (classified), Rackham Bldg., University of Michigan, Ann Arbor, Jan. 27-29.

Society of Plastics Engineers, 15th Annual Technical Conference, Hotel Commodore, New York, Jan. 27-30.

Armour Research Foundation, Fifth Annual Midwest Welding Conference, Illinois Institute of Technology, Chicago, Jan. 28-29.

FEBRUARY

14th Annual Technical and Management Conference, Reinforced Plastics Division, Society of the Plastics Industry, Inc., Edgewater Beach Hotel, Chicago, Feb. 3-5.

IRE, AIEE 1959 Solid State Circuits Conference, University of Pennsylvania, Philadelphia, Feb. 12-13.

1959 Engineering Exposition, Balboa Park, San Diego, Feb. 26-March 1.

MARCH

IRE, AIEE and Association for Computing Machinery, 1959 Western Joint Computer Conference, Fairmont Hotel, San Francisco, March 3-5.

Institute of the Aeronautical Sciences, Flight Propulsion Meeting (classified), Hotel Carter, Cleveland, March 5-6.

Western Space Age Conference and Exhibit. For information: Domestic Trade Dept., Los Angeles Chamber of Commerce, 404 South Bixel St., Los Angeles, March 5-7.

Gas Turbine Division of the American Society of Mechanical Engineers, turbine in action, Cincinnati, March 8-11.

American Society for Metals, 11th Western Metal Exposition and Congress, Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles, March 16-20.

propulsion engineering

by Alfred J. Zaehringer

Electric ramjet? Novel Soviet claim is the generation of ball lightning within a ramjet engine as a heat source. Distance and intensity of the discharge would be varied according to air flow. According to reports, this engine has been tested on the ground but development of high-power, light-weight power source may delay flight tests.

Ion rocket engine test lab is operational at Rocketdyne's propulsion field lab. The 40x40 foot lab can handle electric power rated at two amps and 40,000 volts. An ion engine—developing ounces of thrust—necessary to propel a vehicle to Mars might be small (nine inches in diameter and about two feet long) but it would use about 2,200 pounds of cesium propellant. Current price of this easily ionized, heavy metal is about $750 per pound.

U-235 fuel for an atomic rocket is expensive. AEC figures about $8,000 per pound for the highly enriched material. At the present state of the art, some 1,000 pounds of U-235 (in a gaseous thermal reactor) would only give an impulse of 1/10th that of the *V-2*. A separation factor of 100-1,000 better than current methods is required to retain unfissioned fuel in the core.

Ignition of metals in fluorine has been studied at Fenn College. Tests indicated that there is an ignition delay-temperature relationship for the fluorine-metal reaction. Nickel has a high ignition temperature while tungsten and molybdenum had the lowest among the metals run. The results point to the use of nickel and stainless steels as combustion chambers for fluorine propellants.

High temperature propellant systems have been evaluated by the Research Institute of Temple University. Hydrogen cyanide (HCN) when oxidized by oxygen and fluorine at 300 psi gives a c* of 6250 ft/sec and a flame temperature of 4,410°K. Cyanogen (NC:CN) burning with oxygen at the same pressure yields a c* of 6,100 ft/sec at 4,860°K. Tests were run in a rocket motor of two-inch exit diameter at the High Temperature Test Area, Elverson, Pa. Personnel wear gas masks using a self-contained oxygen source because of the toxic nature of the propellants.

Undue attention may have been lavished on combustion and flame research since the real physical situation in flames is so complex that a good theory may be unwieldy and cumbersome. This is apparently the feeling of Project Squid which has been monitoring US combustion research for years. Combustion researchers are not feeding enough vital data of concern to engine designers. As a result there is too much shuffling around.

Gaseous detonation with an eye to a propulsion device is being reviewed for the Air Force by the University of California and Fairchild Engine Division. Others are also studying the problem. A ramjet employing a standing detonation wave might be made to work at Mach 7. Fairchild is working on the release of chemical energy in supersonic flow in a new supersonic "combustion" tunnel.

Lithium perchlorate can be produced at the HEF (Hooker-Foote) plant at Columbus, Ga. Claim is that the plant is the only one capable of producing the new oxidizer. However, the present production of the plant will be for ammonium perchlorate—standard composite oxidizer. AP production capacity at this plant will be about four million pounds a year.

Advertising correspondence should be addressed to Advertising Sales Manager, Missiles and Rockets, 17 East 48th Street, New York 17, N.Y.

REGIONAL OFFICES:

New York City: 17 E. 48th St., New York 17. Edward D. Muhlfeld, Advertising Sales Manager; P. B. Kinney and G. T. O'Mara, regional adv. mgrs. Phone: PLaza 3-1100.

West Coast: 8929 Wilshire Blvd., Beverly Hills, Calif. Fred S. Hunter, manager; Walton Brown, regional adv. mgr.; James W. Claar, regional adv. mgr. Phones: OLeander 5-9161 or OLeander 7-1555.

Chicago: 139 N. Clark St., Chicago 2, Ill. George E. Yonan, regional adv. mgr. Phone: CEntral 6-5804.

Cleveland: 244 Hanna Bldg., 1422 Euclid Ave., Cleveland 15, Ohio. Douglas H. Boynton, regional advertising manager. Phone: PRospect 1-2420.

Detroit: 201 Stephenson Bldg., Detroit 2, Mich. Kenneth J. Wells, regional advertising manager. Phone: TRinity 5-2555.

Florida: 208 Almeria Ave., Coral Gables, Fla. Richard D. Hager, advertising sales representative. Phone: Highland 4-8326.

Canada: Allin Associates, 12 Richmond Street East, Toronto 1, Ontario. Phone: EMpire 4-2001. Allin Associates, 1487 Mountain St., Suite 4, Montreal, Que.

Geneva: American Aviation Pubs., 10 Rue Grenus, Geneva, Switzerland. Anthony Vandyk, European Director.

London: The AAP Company, 17 Drayton Road, Boreham Wood, Hertfordshire, England. Phone: Elstree 2688. Cable address: STEVAIR, London.

Paris: Jean-Marie Riche, 11 Rue Condorcet, Paris (9e), France. Phone: TRUdaine, 15-39, Cable address: NEWS AIR PARIS.

contract awards

ARMY

By U.S. Army Ordnance District, Pasadena, Calif.:

$112,217—**Gilfillan Bros. Inc.,** Los Angeles, Calif., for repair parts.

$94,899—**Townsend Engineered Products,** Santa Ana, Calif., for design & development.

$51,883—**Electro-Optical Systems, Inc.,** Pasadena, Calif., for investigation of gases.

$35,800—**Firestone Tire & Rubber Co.,** Los Angeles, for modification of guided missile equipment.

$32,966—**Douglas Aircraft Co. Inc.,** Santa Monica, for launching area items.

$66,631—**Douglas Aircraft Co. Inc.,** Santa Monica, for repair parts.

$48,960—**Northrop Aircraft, Inc.,** Hawthorne, for design studies.

$195,404—**Gilfillan Bros. Inc.,** Los Angeles, for repair parts.

$104,302—**Gilfillan Bros. Inc.,** Los Angeles, for engineering services.

$500,000—**California Institute of Technology,** Pasadena, for engineering research & development.

Army Ordnance Corps and Hercules Powder Co.:

$1.3 million—**National Electric Products Corp.** for production of metal part assemblies for use in the *Nike-Hercules* missile.

By U.S. Army Ordnance District, St. Louis, Mo.:

$25,284—**Benson Mfg. Co.,** Kansas City, Mo. for drum, aluminum shipping hydrogen peroxide 86 gallon 43 ID-492 and 495-59.

$37,786—**Heiland Div., Minneapolis Honeywell Regulator Co.,** Denver, Colo. for event recorder.

By District Engineer, U.S. Army Engineer District, Fort Worth, Texas:

$3,030,196—**Lawless and Alford, Inc.,** Austin, Texas for ICBM/IRBM training facilities, Sheppard Air Force Base, Wichita Falls, Texas.

By Purchasing and Contracting Division, White Sands Missile Range, N.M.:

$27,342—**Parabam, Inc.,** El Segundo, Calif., for reader, film cinetheodolite, angle dial.

By U.S. Army Signal Supply Agency, Philadelphia, Pa.:

$57,940—**Elgin National Watch Co.,** Burbank, Calif., for research and development work for 12 months leading to the establishment of miniaturized sensitive microminiature relays.

$39,720—**Hycon-Eastern, Inc.,** Cambridge, Mass. for research work for 12 months on overtone mode, thickness sheer filter crystals.

AIR FORCE

By Commander, Headquarters AMC, Wright-Patterson AFB, Ohio:

$55,287—**Westinghouse Electric Corp.,** Dayton, for power supplies for SM-62A missile.

$59,846—**Ladish Co.,** Cudahy, Wis., for systematic study to determine what factors caused fluctuation in the mechanical properties of large steel forgings.

$36,929—**Tube Division, Radio Corporation of America,** Harrison, N.J. for procurement of research and development of methods and techniques for manufacturing high sensitivity photomultiplier tubes.

$269,286—**Crucible Steel Co. of America,** Midland, Pa., for development of methods and machinery for cold rolling titanium and titanium alloy.

$120,205—**North American Aviation, Inc.,** Los Angeles, for structural analysis and flutter analysis reports.

$46,776—**Doehler-Parvis Division, National Lead Co.,** Toledo, for investigation of the effect of ultra-high pressure exerted on castings during and prior to solidification.

$39,866—**Pioneer Parachute Company Inc.,** Manchester, Conn. for canopies and accessory hardware for experimental parachute systems for use with classified end items.

$51,335—**Systems Research Laboratories, Inc.,** Dayton, Ohio for development of high temperature, radiation resistant thermometers.

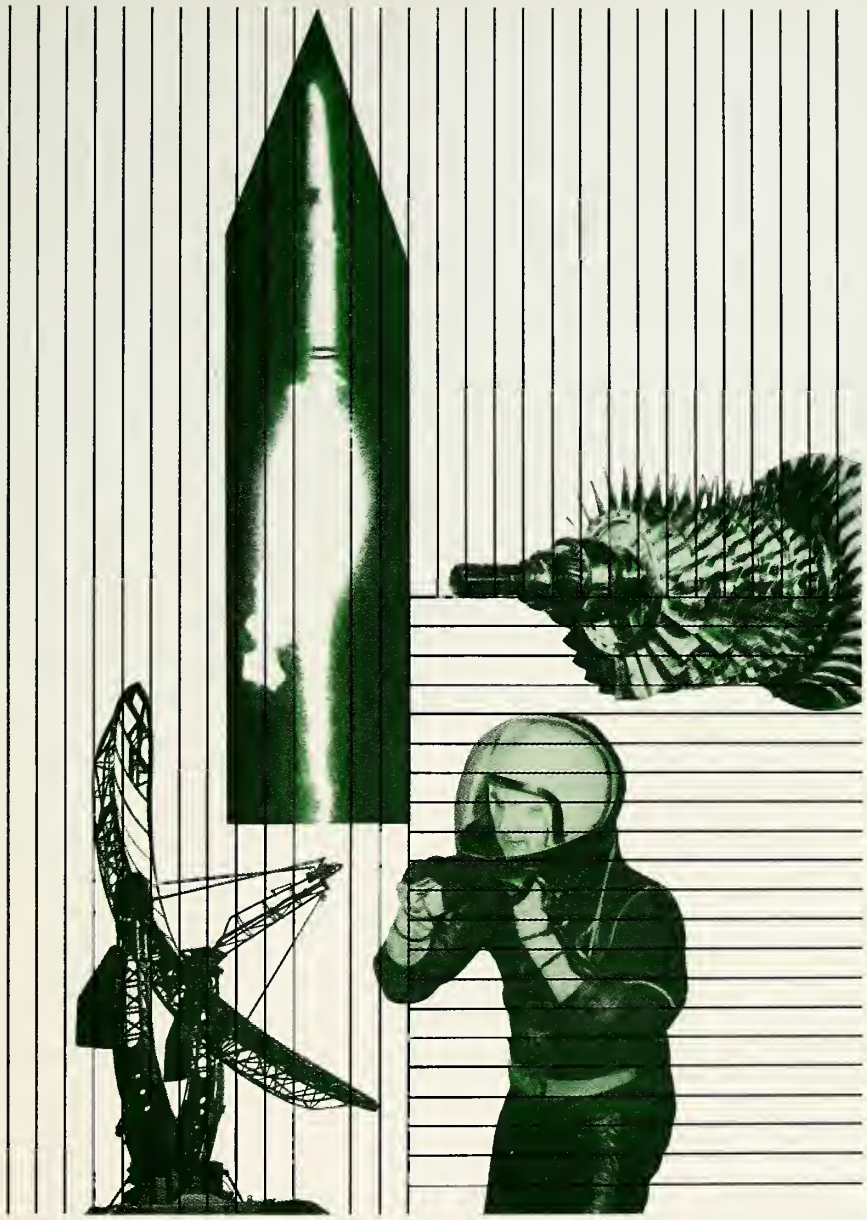
$86,439—**Dynamic Research, Inc.,** Los Angeles, for development, fabrication, and evaluation of a service test quantity of two recharging units, liquid nitrogen or oxygen, including supporting spare parts for three months operation.

$50,343—**International Electronics Engineering, Inc.,** Washington, for maintenance services for data reduction and specialized intelligence equipment.

$91,723—**Astrodyne Inc.,** McGregor, Texas for igniters for M15A1 jato units.

By San Antonio R&D Procurement Office, Wright Air Development Command, Lackland AFB, Texas:

$96,352—**Institute of Andean Biology,** Lima, Peru for research & reports on mechanisms of natural accliization.



Avco: Men and Machines for Defense. No amount of lost motion can be endured in America's space-age defense programs. Progress must be swift and continuous. Avco, alert to its needs, helps to maintain America's strength: Avco Research Laboratory—investigating problems in gas dynamics and space technology; Crosley—weapons systems, radar, communications, aircraft and missile structures; Lycoming—aircraft, marine, industrial power plants; missile subsystems; Research and Advanced Development Division—basic and applied research in electronics, physical sciences, and advanced engineering.

UNUSUAL CAREER OPPORTUNITIES FOR QUALIFIED SCIENTISTS AND ENGINEERS . . . WRITE AVCO TODAY

Avco

AVCO MAKES THINGS BETTER FOR AMERICA / AVCO MANUFACTURING CORPORATION / 750 THIRD AVENUE, NEW YORK, N. Y.

When your project calls for

SMALLEST PACKAGING

LIGHTEST WEIGHT

TIGHTEST COUPLING

LOWEST PHASE SHIFT

LOWEST NULLS

HIGHEST ACCURACY

IN

SYNCHROS

Look to CPPC Size 8's

ACTUAL SIZE

SYNCHRO FUNCTION	CPPC TYPE	PRIMARY: Input Voltage (400~)	Input Current (Amps.)	Input Power (Watts)	Output Voltage (Volts)	Sensitivity (MV/deg.)	Phase Shift (deg. lead)	D.C. RESISTANCE: Rotor (Ohms)	Stator (Ohms)	IMPEDENCE: Zro (Ohms)	Zso (Ohms)	Zrsa (Ohms)	Max. Null Voltage (MV)	ACCURACY Max. Error (Min.)
Torque Transmitter	CGC-8-A-7	26	.100	.54	11.8	206	8.5	37	12	54 + j260	12 + j45	80 + j20	30	7
Control Transformer	CTC-8-A-1	11.8	.087	.21	23.5	411	9	143	24	210 + j690	28 + j114	250 + j73	30	7
Control Transformer	CTC-8-A-4	11.8	.030	.073	22.5	393	8.5	365	64	470 + j1770	81 + j330	590 + j190	30	7
Torque Receiver	CRC-8-A-1	26	.100	.54	11.8	206	8.5	37	12	54 + j260	12 + j45	80 + j20	30	30 sp.
Electrical Resolver	CSC-8-A-1	26	.038	.39	10.8	189	20	230	27	270 + j630	39 + j142	340 + j67	30	7
Electrical Resolver	CSC-8-A-4	26	.038	.39	26	454	20	230	170	270 + j630	250 + j830	340 + j67	30	7
Control Differential	COC-8-A-1	11.8	.087	.21	11.5	204	9	36	24	38 + j122	28 + j114	47 + j13	30	7
Vector Resolver	CVC-8-A-1	26	.100	.54	11.8	206	8.5	37	16.5	54 + j260	19 + j60	80 + j20	30	7

CLIFTON PRECISION PRODUCTS CO., INC. cppc **Clifton Heights, Pa.**