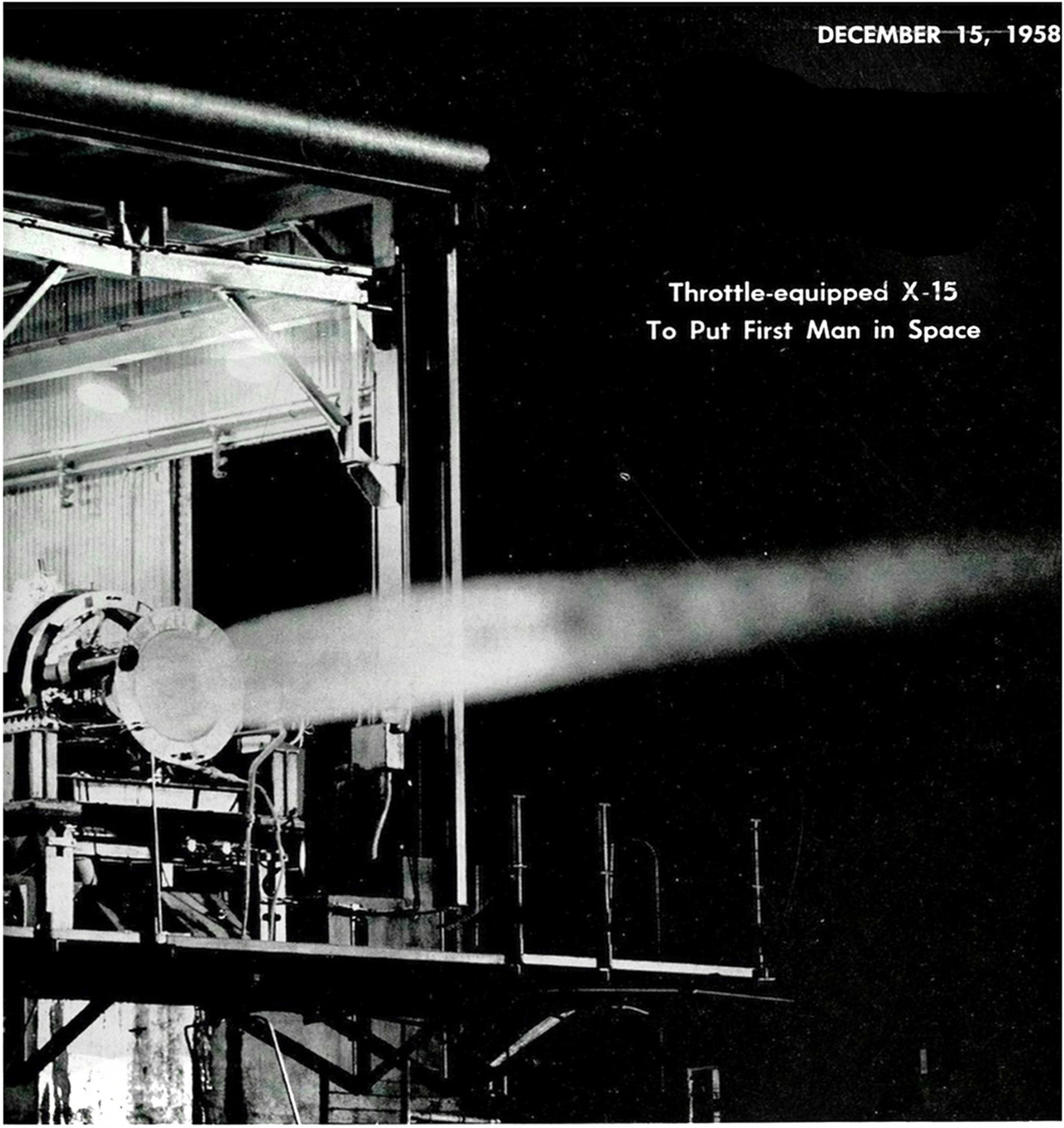
DECEMBER 15, 1958



Throttle-equipped X-15
To Put First Man in Space

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Engineering and Electronics Edition

AN AMERICAN AVIATION PUBLICATION

SPACE AGE ALCHEMY

New materials, capable of withstanding extremely high temperatures and encompassing properties that meet specific requirements are now being created at Servomechanisms' Research Laboratory. SMI's research has been in the field of solid state physics, wherein the study of basic atomic and molecular properties of matter has resulted in materials that can actually be designed to accomplish specific tasks. The challenging space age will depend heavily upon such techniques.

Major scientific break-throughs in the "State of the Art" have already resulted in new materials capable of operating at 500°C and new investigations indicate that this upper limit may be extended to 1000°C.

The above illustration pictures an experimental hot press, developed by SMI, for basic investigations into these new materials. The press subjects various compounds to 3,600°C and 6,000 PSI in a vacuum or inert gas.

These new advances are providing positive support to the ever-increasing requirements of the Department of Defense. The expanding Research Laboratory facilities are ready to assist you in your advanced scientific programs.

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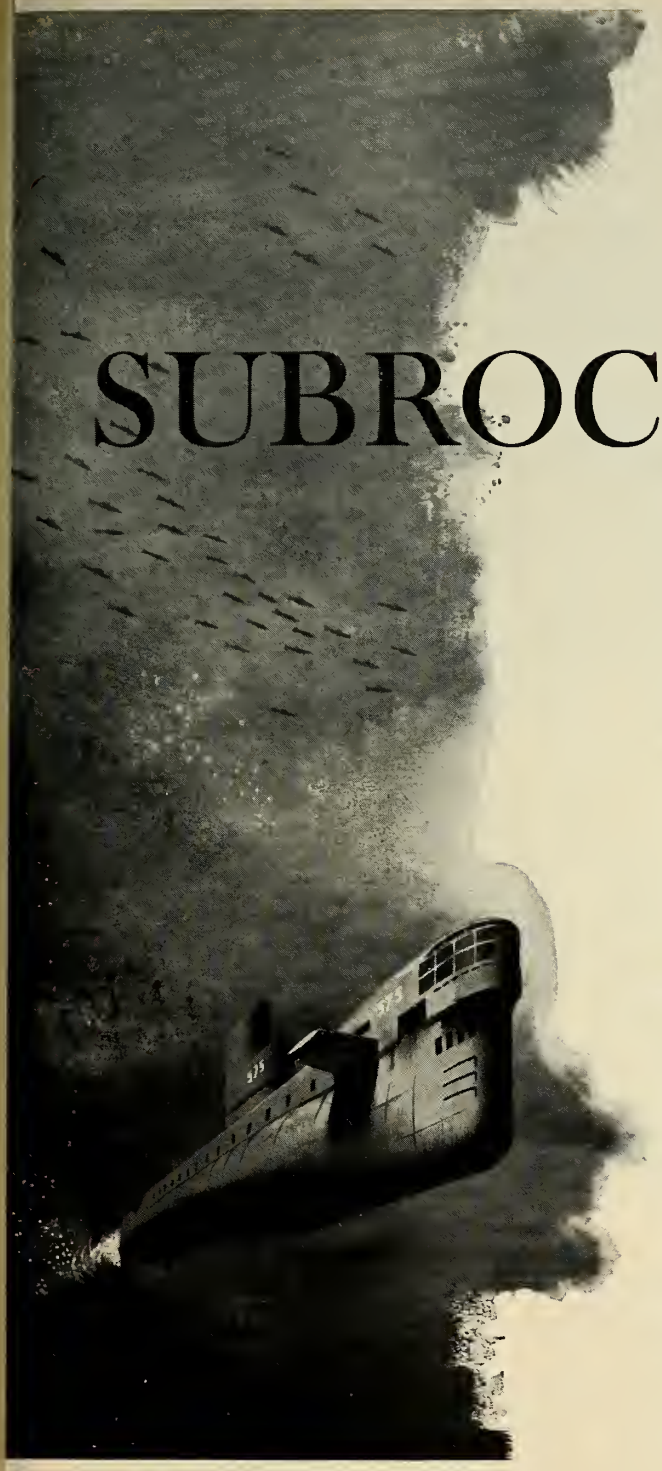
The products of SMI are available in Canada and throughout the world through Servomechanisms (Canada) Limited, Toronto 15, Ontario.



SUBROC

— new antisubmarine weapon system—will seek, strike and destroy lurking submarines at long range. Spearheaded by an underwater guided missile which can be fired from below the surface, this vital system — now being developed for the Navy's Bureau of Ordnance, under the technical direction of the Naval Ordnance Laboratory in Silver Spring, Md. — will use our existing underwater fleet as launching platforms.

Development of Subroc is the responsibility of Goodyear Aircraft Corporation, producer of Pinpoint* Guidance, nose cones, rocket engine cases and major components in virtually every area of the nation's most advanced weapon systems.

WEAPON SYSTEMS—a prime capability of

GOODYEAR AIRCRAFT

Plants in Akron, Ohio, and Litchfield Park, Arizona.

*T. M. Goodyear Aircraft Corp., Akron, Ohio

STEPS IN THE RACE TO OUTER SPACE

Assembling a station in space

This imaginative but technically accurate illustration shows a permanent satellite (center) being constructed in orbit around the earth. It generates its own heat and electricity from solar rays. Basic vegetation (such as algae) for oxygen as well as protein-rich foods are grown in hydroponic tubes in upper level "greenhouses."

New vistas in astronomy will be opened up by such a space station, because of perfect conditions for photography and spectroscopy. It will also provide unique conditions for advanced research in physics, electronics, weather prediction, etc. Three such stations, properly placed, could blanket the entire world with nearly perfect TV transmission.

Atomic rocket vehicles with prefabricated skin layers (lower center) provide building materials for the station, then return (bottom) to earth. Similar craft will service an established station (lower right), docking by electromagnetic pull in lower section of station's axis.

WIDE RANGE HETERODYNE FREQUENCY METER

Divco-Wayne Electronics Model 1021 Heterodyne Frequency Meter Advantages

Broadest RF Spectrum:
125KC to 1000MC . . . a range normally requiring three separate meters.

Accuracy:
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RF output:
100 microvolts on all calibrated fundamentals.
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The Divco-Wayne Electronics 1021 frequency meter works equally well in the laboratory or out in the field. It's the only wide range meter covering the entire range of 125KC to 1000MC. Widely used in missile work, radar, communications, or for any laboratory work in frequency determination or as a signal source. Fully illustrated and described in new bulletin DW-102. For your free copy, write Divco-Wayne Electronics, 9701 Reading Road, Cincinnati 15, Ohio.

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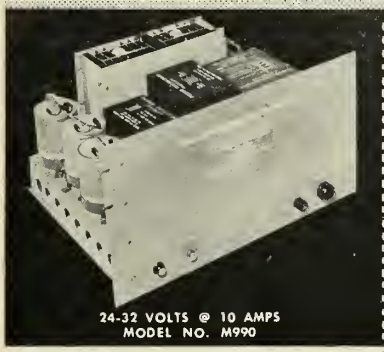
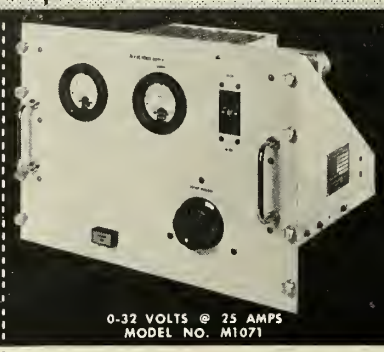


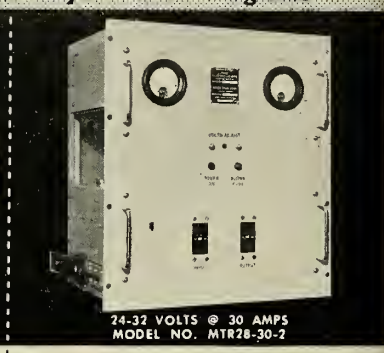
24-32 VOLTS @ 10 AMPS
MODEL NO. M990

Transistor—Mag amp power supply
DC Output: 24-32V @ 10 amps
AC Input: 105-125V, 1 phase, 60 cps.
Static Regulation: ±0.1% line & load
Dynamic Regulation: ±0.1% line; ±1% load
Ripple: 1 MV R.M.S. maximum
Output Impedance: 0.05 ohms, 0-20 KC
Protection: Short circuit proof; unit has automatic current limiting at 125% of rated load
Dimensions: 19"W x 10½"H x 15"D
rack panel maunt
Meets Spec. MIL-T-4860



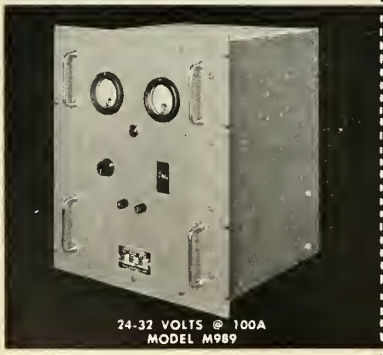
0-32 VOLTS @ 25 AMPS
MODEL NO. M1071

Mag-amp power supply
D.C. Output: 0-32V @ 25 amps
(Surge loads to 35A for 30 min. or less)
A.C. Input: 115V, 1 phase, 60 cps.
Regulation: ±1% 28 volts—
Not stabilized for A.C. line voltage changes.
Ripple: 1% RMS @ 32V and full load
Response Time: 0.1 to 0.2 seconds
Dimensions: 19"W x 14' H x 15"D
Rock panel maunt
Meets Spec. MIL-E-4158A



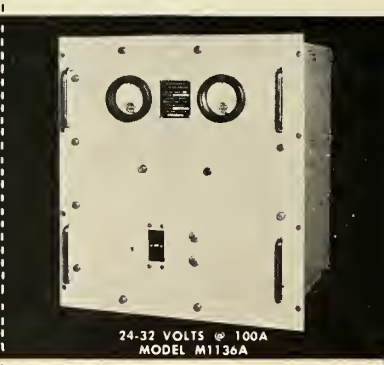
24-32 VOLTS @ 30 AMPS
MODEL NO. MTR28-30-2

Transistor—Mag amp power supply.
D.C. Output: 24-32V @ 30 amps
A.C. Input: 105-125V, 1 phase, 60 cps
Static Regulation: ±0.1% line and laad
Dynamic Regulation: ±0.1% line
±1% for full load changes
Ripple: 7 MV RMS mox.
Output Impedance: 0.05 ohms 0 to 20 KC
Protection: Short circuit proof; unit has automatic current limiting at 125% rated load
Dimensions: 19"W x 21¼"H x 14"D
Rock panel maunt
Meets Spec. MIL-E-4970



24-32 VOLTS @ 100A
MODEL M989

Mag-amp power supply
D.C. Output: 24-32V @ 100 amps
A.C. Input: 208/230 or 460V ±10%
3 phase, 60 cps
Regulation: ±½% for line & load
Ripple: 1% RMS
Response Time: 100 milliseconds
Dimensians: 19"W x 21"H x 16"D
Rock panel mount
Unit incorparates remote sensing.
Meets Spec. MIL-E-4970



24-32 VOLTS @ 100A
MODEL M1136A

Transistor—Mag amp power supply.
D.C. Output: 24-32V @ 100 amps
A.C. Input: 208V ±10%, 3 phase, 60 cps.
Static Regulation: ±0.1% line, ±0.2%
for laad
Dynomic Regulation: ±0.5% line,
±2V. for full load changes
Ripple: 10 MV RMS mox.
Dimensions: 19"W x 21"H x 18"D
Rock panel mount
Meets Spec. MIL-E-4970

24-32 VOLTS @ 500 Amps
MODEL NO. M1134B

Transistor—Mag amp power supply
D.C. Output: 24-32V @ 500 amps
A.C. Input: 208/230/460 V ±10%
3 phase, 60 cps
Static Regulatian: 0.1% line; 0.1% load
Dynomic Load Regulation: ±15% for full
laad changes
Ripple: ½% RMS mox.
Response Time: Adjustable 20-200 MS
Dimensions: 26"W x 68"H x 32"D
Meets Spec. MIL-P-6457A

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COVER: *In an evaluation captive test firing the United States' first throttleable-thrust rocket engine for the Air Force X-15 is put through its paces at Reaction Motors' Lake Denmark captive test facilities. Engine, which will be used to place the first man in space is now in final test (story page 24).*

missiles and rockets Vol. 4, No. 24, Dec. 15, 1958

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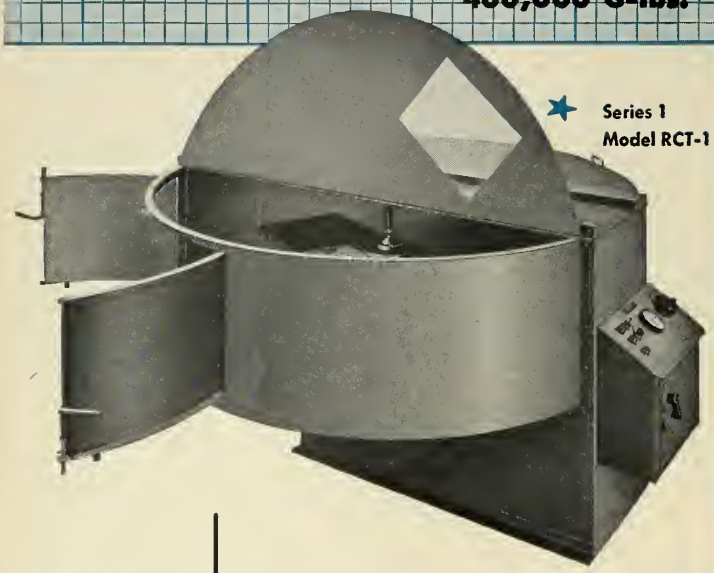
in this issue

Environmental
TEST LOADINGS OF MISSILE COMPONENTS and ASSEMBLIES

...up to: 150 G
8,000 lbs.
400,000 G-lbs.

other RUCKER PRECISION EQUIPMENT



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Model RCT-1

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G-rating: 1 to 150
Test radius: 18" to 46"
Specimen: 30-100 lbs.

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Test radius: 96" to 240"
Specimen: 300-600 lbs.

SERIES 20
G-rating: 1 to 100
Test radius: 264" to 420"
Specimen: 2000-8000 lbs.

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Rucker Centrifuge Acceleration Test Machines in a full range of sizes are precision-engineered for accurate pre-testing of components, instruments and assemblies employed in aircraft, missiles and rockets under simulated operational acceleration loadings in the 1 to 150 G-range. They are ideally suited both for exacting laboratory testing and mass production-line testing procedures.

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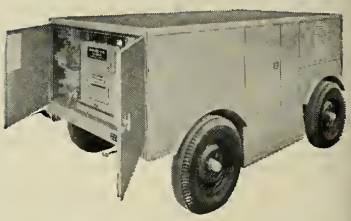

Stationary or portable high pressure gas boosters for compressing helium or nitrogen up to 6000-10,000 p.s.i. for missile development and production testing or flight line checkout.

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Standard or custom designed stationary or portable test benches for precision testing of all types of hydraulic or pneumatic components and systems.

★ Series 20 Model RCT-21

View of 22' radius arm and powerhead installed in test pit. This large Series 20 unit is designed for testing 4,000 lb. specimen at 100 G-rating.

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Also working under the direction of the Special Projects Office, U.S. Navy, on various phases of the POLARIS weapon system are: U.S. NAVY BUREAU OF SHIPS, SPERRY GYROSCOPE CO., WESTINGHOUSE, and over 200 sub-contractors—a team composed of America's topmost scientific talent with vast technological resources, working together on one of the Navy's top-priority defense projects.

Every military target on earth ultimately will be within range of Polaris, the Lockheed space-age missile, now under development for the U.S. Navy—to be launched from Navy submarines hidden in ocean depths that cover three-fourths of the world's surface.

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EXPERIENCE

when it comes to producing motors for the aircraft and missile field

Type D-1066

For supersonic aircraft applications. .71 HP DC motor, 7600 rpm continuous duty, 24 volt. For pump drive. Weight: 6.5 lbs. Meets MIL-SPEC M-8609.

Type D-1086

For missile applications. 9 HP DC motor, 12,000 rpm intermittent duty, 56 volt, explosion proof. Weight: 14.75 lbs. Meets MIL-SPEC M-8609.

Type D-978

For missile applications. Tested successfully at over 200,000 ft. altitude, this ⅓ HP, 27 volt DC motor (ranges 24 to 32 volts) delivers 12,000 rpm, weighs 2.75 lbs, has radio noise filter, is explosion proof. Built for high shock and vibration loading. Meets MIL-SPEC M-8609.

Type D-632

For fan, blower, pump applications. Only 6½" x 2¼", weight 23½ ounces, delivers 50 watts continuous duty at 7500 rpm. Long life. Small motor wound for 28 volt DC, or 110 volt AC or DC. Meets MIL-SPEC M-8609.

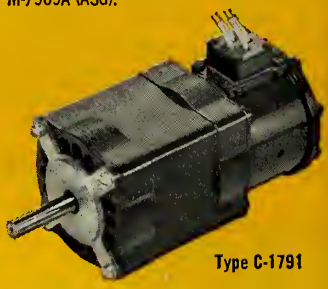
Here are eight special motors for eight different applications designed and produced by EEMCO for eight manufacturers of aircraft and missiles, and for related applications. Note the performance details for each: ratio of high output to size and weight.

EEMCO has designed and produced special motors for **thousands** of various applications in aircraft and missiles during the past 17 years. This is proof of EEMCO's unparalleled capabilities as a **specialist** in the production of high precision motors.

No matter what your problem may be in powering components for aircraft and missiles EEMCO has had experience that can help you. Your inquiry is invited.

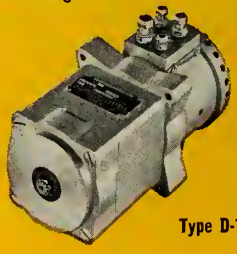
Type D-1068

For missile applications. 2.75 HP AC motor, 3140 rpm at gear box, continuous duty, 200 volt, 400 cycle, 3 phase. Power factor: 83%. Overall efficiency: 76%. Weight: 11.25 lbs. Meets MIL-SPEC M-7969A (ASG).



Type C-1791

For ultracentrifuge application. 1½ HP AC motor, 12,000 rpm continuous duty, 115 volt, 60 cycle, single phase, fan cooled. Weight: 12 lbs.



Type D-1025

For motor truck turbine engine applications. Starter-generator, weight 14.5 lbs. As starter: breakaway torque 220 in-lbs, terminal voltage of 20 volts. As generator: 40 amps continuously with intermittent peaks up to 80 amps at 28 volts.

Type C-1874

For actuator applications. 400 cycle, 3 phase AC motor and clutch. Intermittent duty, 12,000 rpm on 200 volts, 650 watts output. Weight: 4.5 lbs. Meets MIL-SPEC M-7969A (ASG).

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the missile week

washington countdown

No air-launched IRBM . . .

program has been approved, according to DOD's missile office. However, other sources indicate that Martin, Lockheed and Convair are busy on WS-199B, of which one version is called *Bold Orion*.

The *Eagle* concept . . .

represents a new trend because the launching aircraft may be relatively slow since high performance is built into the missile, according to Rear Adm. Robert Dixon, in announcing award of the air-to-air missile design competition. Bendix Aviation Corp. will have prime weapon system responsibility and Grumman will provide the frame. Nine firms entered the competition.

First *Polaris* squadron . . .

designed by the Navy will be Squadron 14. It will consist of two divisions for a total of eight to 12 boats. The first boat, the George Washington, is to be launched next spring at Electric Boat's Groton yard. Others will be the Patrick Henry, the Theodore Roosevelt, the Robert E. Lee and the Abraham Lincoln. Meanwhile, *Polaris* is on schedule, according to Rear Adm. W. F. Raborn, and the Navy has commissioned the USS Observation Island. It incorporates the first shipboard launcher for *Polaris*, plus equipment to test the control systems. Submarine launches will be made next summer.

Faith in the *Titan* . . .

was reaffirmed by BMD's Maj. Gen. Bernard Schriever at an AMF meeting in New York. Although behind *Atlas* by perhaps 18 months, *Titan* will have the advantage of the underground sites (which AMF is building). Later Schriever inspected this work at AMF's Greenwich, Conn., plant.

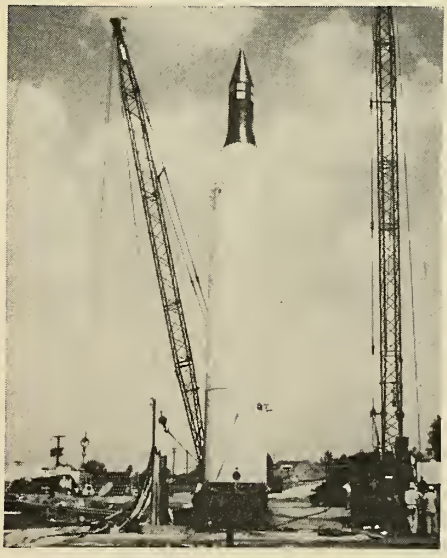
Classes in space technology . . .

will be held to educate the House Space Committee into the mysteries of the Space Age. Lecturers will be military, government agency and scientific technicians in every segment of the missile field.

Second *Juno* Due in February

For the lack of three seconds burning time and a firing angle error, *Juno II*, shown at right on its checkout pad, failed to reach or pass the moon in the NASA-Army try December 6. Maximum altitude was 63,000-plus miles, about 175,000 miles short. Next try probably will be in February.

Exact cause of the failure was faulty valve adjustment resulting in improper fuel mixture and short burning by 3.7 seconds, plus an aiming error of about three degrees low. Result: *Juno* reached only about 24,000 mph instead of the planned 24,995. In mitigation of her failure, *Juno's* payload (*Pioneer III*) provided high priority information on radiation. *Juno's* 60-plus tons (fueled) consisted of an elongated *Jupiter* first stage; 11 clustered *Sergeants* in the second; three in the third, and one in the fourth. The gold-plated conical payload weighed 12.95 pounds.



Something to see...

for the pilot who's flying blind

Autonetics' new Pilot Display Projector is another milestone in the elimination of blind-flying problems. It projects onto a special transparent screen, in the pilot's normal forward view, a bright replica of any instrument display, or combination of displays, that can be put on a cathode ray tube. The pilot is not distracted, as with other systems, by having to look down repeatedly at an indicator. And—since the display is transparent—his normal view through the windshield is unobstructed. Autonetics' Pilot Display Projector was originally developed for the Army-Navy Helicopter Instrumentation Program, but is adaptable to fixed-wing aircraft.

A DIVISION OF NORTH AMERICAN AVIATION, INC. · Downey, California **Autonetics**

industry countdown

RAT project . . .
has reportedly been terminated by the Navy, replacing the rocket assisted torpedo with the *ASROC* (anti-submarine rocket) weapon. *ASROC* is an atomic-warhead equipped missile produced by Minneapolis-Honeywell. M-H now produces atomic warheads for eight missiles: *Honest John, Little John, Lacrosse, Talos, Tartar, Terrier, Corporal* and *ASROC*. The Sandia Corporation has systems control on nuclear warheads, with M-H handling production.

Jupiter and Thor . . .
missiles, which have become "less interesting" with the development of ICBMs demonstrating encouraging strides, are expected to continue in production for at least another year. Army commitments for the *Jupiter* total $185 million while contract figures for the *Thor* are still on the secret list. U.S. is committed to supply 60 *Thors* to Britain and probably about 45 *Jupiters* to Italy. Deliveries of these missiles to France and Turkey—if and when—are expected to come from current production.

Future of IRBMs . . .
is likely to be extremely limited. Increased demands for the missiles from the NATO nations will probably not materialize, with Britain and France developing their own IRBMs. Except for space projects and training purposes, for which a few will probably be stockpiled, *Jupiter* and *Thor* will fade out of the weapon systems arsenal within two years. Even in the role of space vehicles, their utility will be limited by the rate of development and stockpiling of the ICBMs slated for this usage by 1960.

Goose decoy missile . . .
is another weapon with an uncertain future. This missile, designed to divert enemy air defenses during an attack by SAC bombers and missiles, is now being reviewed to determine whether the development of the weapon will continue. The Air Force has suspended construction of launching facilities for the intercontinental missile at Ethan AFB in Vermont and at the Duluth airport in Minn. The *Goose*, a surface-to-surface missile developed by Fairchild, could be replaced by the McDonnell *Green Quail*, an air-launched decoy designed for launch from SAC bombers.

Bomarc base construction . . .
will be on the upswing for 1959 with one site well underway, contracts let on three and 10 planned with no contracts let. An estimated 50 sites will be dispersed through-out the United States if program is fully realized. Each site with 56 launching positions costs $13.5 million.

Minuteman motor production . . .
may have to be carried out in newly constructed facilities. Air Force Secretary Dudley Sharp said that the size and weight of the solid propellant grain for the *Minuteman* is beyond the capability of current solid facilities. Sharp added however, that components for the missile will be mainly produced in existing plants.

New Minuteman facilities . . .
could result in "great waste," according to a statement by Rep. Robert A. Everett (D-Tenn) before the House Military Investigating Subcommittee. Everett said the Air Force should look into the possibility of using Army arsenals to load the *Minuteman* and other solid propellant missiles. Sharp emphasized there was no prohibition against using the facilities of a sister service when they fill requirements and explained that the Air Force program was "aimed at obtaining an industrial base which is adjusted to firm weapon program needs, and is privately capitalized to the maximum degree."

Mobile handling equipment . . .
for the new generation of solid propellant missiles is under development by the Hufford Corp. with a $225,000 subcontract from Thiokol Chemical Corp. The mobile rocket motor handling device, known as a "Transrector" will have a capacity for handling missile units up to 35 feet long, 85 inches in diameter and weighing 80,000 pounds.

Future Project Rover tests . . .
may be run on duct-type test stand in order to solve the problem of radiation and combustion of the heated hydrogen with the surrounding atmosphere after it has been discharged from the nozzle—phenomena that is common in testing the nuclear rocket. The test facility would hold the engine in a vertical position with exhaust gases carried through a water-cooled aluminum duct away from the nozzle.

50,000 rocket engine tests . . .
is the record for Rocketdyne's propulsion field laboratory since it began operations ten years ago.

BRUNSWICK'S SBP HELPS TAME PRODIGIOUS PRESSURES

Brunswick's unique Strickland "B" Process (SBP) cures a multitude of headaches in the pressure vessel field because of its unique combination of features. From rocket motor cases to helium-nitrogen bottles, SBP filament-wound laminates give the highest strength-to-weight ratios possible, plus resistance to extremely high temperatures (up to 600° F). Tough SBP laminates are also ideal for pressure vessels that undergo many operating cycles.

Not just another filament-winding process, Brunswick SBP is an exclusive machine method for precise placement of fiberglas filaments. Each roving is nested and packed for the highest glass-to-resin ratio, and hence highest strength. Strength can be further increased by stress designing bodies to meet special types and areas of pressure. And the system permits mass production of shapes to meet the most exacting space-age specifications.

Continuing, extensive research and development projects have given Brunswick a special knack for solving strength and leakage problems, in existing fields as well as new and more difficult areas of design, development and fabrication. Talk to Brunswick about the multitude of advantages SBP laminates offer. Write or call: Brunswick-Balke-Collender Company, Defense Products Division Sales Manager, 1700 Messler St., Muskegon, Michigan.

BRUNSWICK

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DECEMBER 15, 1958—VOL. 4, NO. 24

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

USSR Plan: *Sputniki* for Sputniki

by Alfred J. Zaehringer

WASHINGTON—Having already reaped benefits by establishing the first earth satellite, the Soviet Union is expected to assist her own satellite nations in establishing orbiting satellites of their own, m/r has learned.

Directly designed to embarrass the West, orbiting satellites are expected to give tremendous prestige to such nations as East Germany, Poland, Czechoslovakia, and Red China.

Not only would the new satellites place these countries—in the eyes of the "neutrals"—on a par with the U.S., but they would orbit them ahead of Britain and France. These satellites can be expected as early as mid-1959. In addition, the large Soviet stockpile of missiles would enable these countries to orbit substantially larger satellites than the *Vanguard* or *Explorer*. Payload capabilities are expected to be on the order of 50-100 lb.

• ***T-1* would be used**—First stage rocket for such a satellite system would probably be the now obsolete *T-1* missile. It resembles the U.S. *Redstone* and has a higher thrust capability than its early 78,000 lb LOX-jet fuel engine. Second stage would be a lash-up of from three to five *T-5*, *T-6*, or *T-7A* solid propellant artillery rockets.

Last stage would consist of a single solid propellant engine (probably the same as the second stage type), plus a total satellite package of around 45 kg (about 100 pounds). All solid stages would probably have to require considerable weight saving to effect good mass ratios. Possibly higher propellant performance also would be required.

If the total satellite weight could be kept to 50 pounds, then the total vehicle weight at launch would approximate 100,000 pounds—indicating marginal performance for the standard *T-1* engine. More probably the *T-2* 220,000 lb thrust LOX-hydrocarbon engine would have to be used. However, if a satellite of about 25 pounds can be tolerated, then the standard *T-1* engine could be employed with thrust up-grading.

It is possible, however, that by weight saving and the use of high energy propellants, a satellite of about 100 pounds can be orbited by use of a lash-up vehicle. It is more than likely, therefore, that 2000:1 (vehicle weight to satellite weight) would be the Soviet technique rather than the 1000:1 ultra-performance technique. The launching vehicle with a height of about 110-feet would have a long "bean-pole" effect because the Soviets would rather throw considerable thrust into a launch than employ a complexity of stabilization techniques.

• ***T-1* to be used for training**—The Soviet *T-1* missile (range on the order of several hundred miles) is now obsolete and will be used for training and test vehicle purposes. The solid upper stages are becoming increasingly available due to shelf life characteristics.

This means the USSR will have several hundred potential satellite capabilities within the next 1-5 years. It is indeed possible that such a satellite has already been tested. The Soviets would be extremely reluctant to release information about such a satellite: 1) because of its small weight, 2) because it would be in a crude-relatively unstable orbit, and 3) because it would yield data directly applicable to the military IRBM and ICBM program. Many satellites, for example, would be needed to get data concerning the upper atmosphere (100-500 miles) on a statistical basis.

Use of East European launching sites would establish a north-south or polar orbit. Use of sites in Red China would be attractive for utilizing some of the earth's equatorial velocity. China may launch a satellite sometime in 1959, and the home of the rocket, will again shine in national glory.

Total Satellite Wt., Lb.	Total Vehicle Wt., Lb.	First Stage Thrust, Lb.	Notes
25	50,000	78,000	Standard *T-1* Engine
50	100,000	220,000	Standard *T-2* Engine
50	75,000	80,000	Up Graded *T-1* Engine
50	50,000	80,000	Up Graded *T-1* Engine plus Better Mass Ratio
100	100,000	220,000	*T-2* Engine plus Better Mass Ratio

'Runaway' Sputnik tracked past moon

WASHINGTON—m/r Editor Erik Bergaust, revealed recently that a Russian vehicle had been tracked to the vicinity of the moon and beyond.

Since Bergaust's disclosure, reports from tracking installations in the United States and England have corroborated the announcement although there has been no official confirmation.

The Russian space probe attempt, launched on/about September 24, is generally believed to be a lunar probe that failed to orbit.

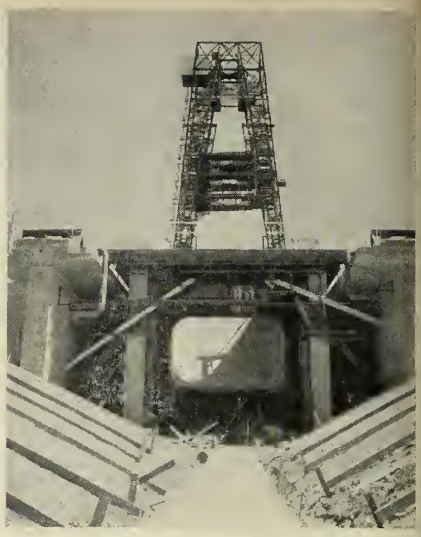
The Soviet space venture has apparently been tracked not only by radio—at 40.007 mcs and 20.003 mcs—but also by radio telescope. A capsule summary of the tracking reports in chronological order follows:

1) A report, supposedly originating from various intelligence sources, refers to three separate tracks made since the launching of *Sputnik* III. Objects were tracked by the ionized gases produced by the exhaust paths through space. One was tracked for a distance of 10,000 miles—another to the vicinity of the moon and beyond.

2) Radio signals were received on 40.007 mcs at Cape Canaveral for three hours.

3) Radio signals were intercepted by Lockheed's Missile Tracking Station on 20.003 mcs on November 26. Absence of the doppler effect indicated travel away from earth.

Thor **PAD has been completed at Vandenberg AFB, for first** *Discoverer* **shot into space.**



BEFORE 1960, 5-ton satellites will leave *Atlas* **pads at Southern California base.**

Discoverer Has Recon Capability if Needed

by Norman L. Baker

WASHINGTON—First vehicle of the Air Force's Project *Discoverer*, once the WS-117L satellite program, was being readied for launch as m/r went to press. Although the aims and intent of the program have been drastically "changed" (m/r, Dec. 8, p. 21), the satellites have been designed to eventually provide the United States with a world-wide surveillance capability, if and when we feel justified in sending them aloft.

The top-level policy switch will involve only a slight alteration of payload instrumentation—specifically the elimination of the camera. Basic booster vehicle and satellite design will remain essentially the same.

New designation of *Discoverer* for the Air Force satellite program was announced by ARPA's Roy Johnson, who said it is "the largest single item" in the agency's 1959 budget. The main purpose of the program is to develop "useful information" for putting a manned vehicle into orbit around the earth by first putting animals into orbit and returning them safely to earth. Animals being prepared include mice and monkeys. They probably will not go aloft, Johnson says, until the fifth or sixth launching. No attempt will be made to put man in orbit during 1959, Johnson adds.

Earlier names for the WS-117L project were *Big Brother*, *Pied Piper*, and *Sentry*. Later the project had the unofficial title of *Baby Sentry*.

Discoverer test vehicles will be sent aloft from a recently completed pad at Vandenberg AFB (m/r, Dec. 8, p. 21) in the nose of a two stage rocket. Original plans called for *Thor* as booster with an extremely high total impulse solid propellant second stage. Current program will use a modified *Pioneer* system, a *Thor* first stage with a high energy Bell Aircraft liquid second. The basic *Pioneer* system has a capability (with optimum performance) of orbiting up to 400 lbs. Added thrust, supplied by the Bell rocket, will also place the second stage in orbit boosting total satellite weight to 1300 pounds.

First nine shots probably will be boosted into orbit with the *Thor* configuration while awaiting the availability of the *Atlas*. The *Atlas* is expected to reach a sufficient level of reliability before the end of next year, Johnson said.

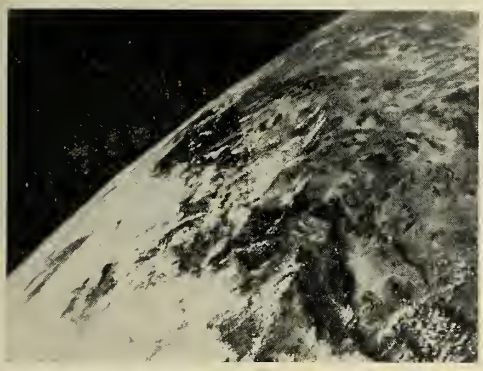
• **Boosters**—*Atlas* C or D eventually will be used for the first stage booster with a Bell Aircraft high energy liquid propellant second stage, reportedly using the high impulse fluorine. Twelve of the *Atlas* configurations, having a 10,000-lb. total satellite capability, have been planned for the advanced program. Any hopes for utilizing the *Atlas* before then are diminished by the current limited financial support and minor technical difficulties encountered throughout the system.

The instrumentated packages scheduled to be launched with the *Thor* vehicles will be low orbiting short-life packages. Launch will be due south passing over the polar regions and the entire earth's surface in about five orbits, or eight hours. First satellites will make only about two complete passes over the entire earth's surface (about 10 orbits) before burning in the upper regions of the atmosphere.

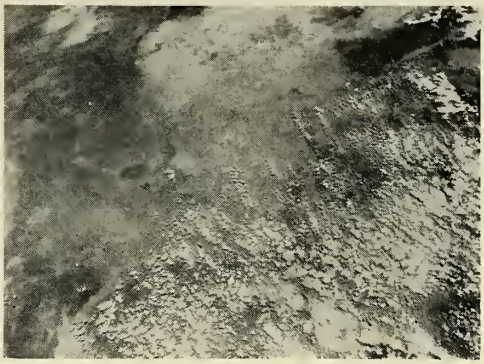
The program is being initiated without waiting for the completion of eight additional tracking stations needed for the large satellites scheduled for the program next year. Initial tracking will be handled by a ship stationed down-range from Vandenberg and stations in Hawaii and Alaska. The station in Alaska is expected to be capable of monitoring the satellites during each orbit. A near circular orbit ranging in altitude from 175 to 200 miles will be attempted.

When the series graduate into a reconnaissance project, the position of the orbit is of considerable importance. This establishes the attitude of observation, the amount of the earth's surface covered at each pass, and the time of appearance of a certain region, according to a report on satellite recon studies by the DuMont Laboratories.

• **Scanning capabilities**—The vision area from the satellite is very great even from minimum altitude orbits. For example, at the altitudes programmed for the first test satellites, the vision area would extend almost completely across the United States.



FUTURE RECON satellites will make large scanning sweeps of a large section of the earth's surface.



VIEW FROM orbit will be similar to this 158-mile shot taken from a *Viking* research rocket.

Vision angle would be about 145 degrees and vision arc would extend approximately 2400 miles with 15% of the earth's surface falling within the cone of observation.

In any reconnaissance orbit, not all of the observed area will be useful since the line-of-sight is near grazing incidence at maximum distances from the satellite. If 45 degrees is considered to be the minimum useful vision angle, the useful coverage is reduced to about 1/3 in distance and about 1/9 in area. Distortion errors induced by the curvature of the earth and the refraction of the atmosphere will reduce the vision angles considerably when earth surface position determination is of prime importance.

• **Test investigations**—Initial tests must be made to determine the perturbations in the orbit caused by error in launching, oblateness of the earth, atmospheric drag, and possibly the gravity field of other heavenly bodies. Orientation of the payload package in orbit in order that the optical system is always pointed toward the center of the earth will, of necessity, be a major field of investigation.

Orientation of the satellite may be accomplished by circuiting an electromagnet with a stable platform. The electromagnet would always point toward the center of the earth. Sensors would detect any change in attitude of the satellite, transmitting the variation to a servo-system tied to a gyro stable platform. This was the system used for the orientation of *Sputnik* III, a satellite designed for controlled orientation in space.

Payload weight limitations for the first shots would severely limit the number of data pickup instruments and the associated equipment necessary for processing, storage, and transmission of acquired data.

Later, more advanced satellites may be able to transmit many different types of information to the command stations, including such data, as pressure, temperature, radiation and television pictures.

• **Data storage**—As long as a recon satellite program involves the launching and operation of only one satellite at a time, long-term storage becomes almost mandatory, since the recording and transmitting functions must be accomplished on opposite sides of the globe. Two methods of data storage are available: magnetic tape or wire recording, and film recording.

At least one satellite in the Lockheed program, as stipulated in the original project, was designed for infrared detection capabilities. This type of detection is highly desirable for the interval of the satellite's orbit when the earth's surface is not in the sun's illumination. Under these conditions the only radiant energy available to the detector is the self-emission from the earth.

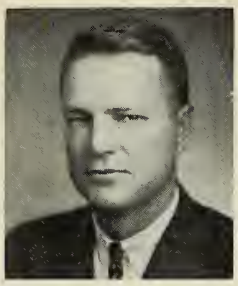
• **Missile detection**—An outstanding application for reconnaissance from a satellite is the detection of missile firings, especially of the ICBM size. The main difficulty arises from the fact that for reliable detection within the short burning time of the rocket an extremely large area must be surveyed. This is in contrast to the mapping technique where the earth's surface is examined point-by-point in time sequence using a very narrow elemental field of view. Photomultiplier detectors would be used for increasing the contrast by comparing the ICBM firing signal with the general background illumination.

Infra-red detectors, incorporated within the instrument package, would further increase the contrast of the missile against the earth surface background and allow detection of smaller missiles of the IRBM class.

• **Maximum coverage**—At 200-400 miles altitude, at least eight satellites would be needed to cover instantaneously the periphery of the observation orbit. Launched at intervals of about 20 minutes, as many as 24 satellites would be needed to cover the entire earth's surface at any instant. By precise timing this number could be reduced considerably and still have continuous transmitted data from "enemy" territory.

• **Contractors** — The test vehicle series is almost exclusively a Lockheed Missile Systems Division product. The more advanced versions scheduled for late 1959 and 1960 will incorporate highly sophisticated systems developed by the following contractors: Engineered Magnetics Co., transducers and converters; Telechrome, telemetry transmitters; Lockheed, satellite frame; Mallory, rechargeable batteries (recharged by solar cells); Remington-Rand, Univac computer system; Philco, receivers and associated tracking equipment; Ampex, magnetic tape recording system; and Sperry-Gyro, orientation gyro system and Eastman Kodak for future camera systems.

David R. Hull



William L. Reynolds

Joseph H. Baylis

Robert Canan

Wage Battle Could Mean $1 Billion Cost

by Raymond M. Nolan

WASHINGTON—A wage-labor battle now in progress in Washington has many of the basic elements of good musical comedy. Unions involved have joined with traditional enemies to argue one side. Some of the contestants belong to each of the two trade organizations joined in the struggle.

The point of contention is the Walsh-Healy definition of the aircraft industry. The protagonists are Aircraft Industries Association, the United Automobile Workers and the International Association of Machinists on one side, and the Electronics Industries Association on the other.

• **Wage structure issue . . .** The basic problem is this: Under the terms of the 1937 Walsh-Healy act, all firms which bid for one particular phase of government business must incorporate the same wage structure so that unfair competition will not exist. The determination of a fair wage is the responsibility of the Labor Department's Wage and Hour and Public Contracts Division.

Under the Walsh-Healy act, if several manufacturers are bidding to furnish items to the government, then each of these must pay substantially the same wage rates.

This rule has operated with a minimum of trouble for years. However, demands of the space age and the rising dependence on electronics within the aircraft industry have presented new problems.

• **$1 Billion Issue . . .** At stake are these vital points: If the Unions and aircraft industry win the battle, $1 billion will be added to our defense bill, EIA estimates, and many electrical appliances would take a six or eight percent jump in price.

If AIA and the unions lose, the aircraft industry is faced with the most serious, industry-wide labor troubles in its history.

The situation is not new; it has been some time in the making. The last definition of the aircraft industry was made by the Department of Labor in 1950. This definition excluded electronics as such and did not consider missiles. However, for the proposed redetermination, AIA feels that any electronics equipment peculiar to the particular airframes is properly part of that airframe and should be considered part of the aircraft manufacturing industry.

This is also the case with missiles. AIA quotes statistics to show that a majority of the missile systems in existence are administered by airframe manufacturers.

There has been a trend for the past few years for airframe manufacturers to establish separate missile and electronics divisions. Some of these are Northrop's Nortronics, Convair's Astronautics, Lockheed's Sunnyvale and North American's Autonetics. When the airframe manufacturers established these divisions, they continued to pay the wage rate determined for aircraft. These rates are approximately 50 cents an hour greater than the prevailing rates in the electronics industry. Herein lies the rub.

Statement of the problem is simple enough: Shall the aircraft industry continue to pay aircraft wage rates to missile and electronics workers?

Shall they adjust these rates to those of the electronics industry?

If the former course is taken, then the electronics industry would be forced to raise wages in order to comply with Walsh-Healy provisions. If either of the latter, it is not difficult to foresee some of the violent labor eruptions which would face the aircraft industry.

Unfortunately, as is common in most broad problems such as this, each side has a good case and each can predict dire results if the decision goes against his interests.

• **EIA's case . . .** EIA waded into the battle after President David R. Hull polled his board of directors on June 23 of this year to determine the policy EIA should follow. The unopposed decision was that EIA should lodge strong objections to any extension of the aircraft wage rates to missile production and the electronics industry and also to any automatic identification of missile production sources as being identical to those of aircraft.

This view, of course, is directly opposite that of AIA. And it is also opposite to that of the UAW/IAM who see in the fight an opportunity for an extension of the relatively high aircraft wage structure into many places where these wages do not now exist.

One interesting facet of the controversy is that many AIA members such as Sperry-Rand, Westinghouse, Minneapolis-Honeywell are also members of EIA. Their views are certain to oppose some of the arguments put forth by either opponent.

The EIA contention is that there is a separate electronics industry and separate missile production sources which are not necessarily identified with the aircraft industry. In comments filed before the Department of Labor on October 31 by William L. Reynolds, general counsel of EIA, two conclu-

ions are put forth:

1) Missile production in itself is not a distinct industry but a combination of products of different industries;

2) At this stage of its development missile manufacturing cannot be catalogued either as a unique industry in itself or as a subdivision of any industry—much less the aircraft industry.

EIA then, touches on its most important point—one which does not necessarily affect all of the missile producers—but does have far-reaching effect on the entire U.S. economy.

This point is that there is no segregation in electronics plants between workers engaged in defense work and those producing consumer equipment. How could you separate a group of employees covered by the same bargaining unit into higher pay-sections for defense work and lower pay-sections for non-defense work? And in the manufacture of sub-assemblies and components, common to both defense and consumer end products, how do you determine a fair price?

One alternative, if the definition should be broadened to include electronics, would be to raise wages throughout the electronics industry. But, as EIA points out, consumer products such as washing machines, television sets and radios produced by workers making some 50 cents an hour more would cost more money.

Actual figures for both wage rate were quoted in the most recent bulletin of the Bureau of Labor Statistics on "Employment and Earnings" (Vol. 5, No. 3, Sept. 1958) which showed that average hourly wages in the aircraft industry were $2.53 during July, the last month for which published figures are available. In contrast, the corresponding wage rate in the electronics industry was $2.07, a difference of forty-six cents, or an aircraft wage rate 22 per cent higher than the electronics rate.

• **Greater budget . . .** For missiles, the argument advanced by EIA is that the increased cost would be in missile production and reflected upward into a greater defense budget.

Reynolds says, "Both the President and DOD have been increasingly concerned with the mounting costs of the new weaponry essential to maintain the position of our nation in the cold war. Because of the great disparity in wage levels between the aircraft industry and the electronics industry, it is clear that any determination which would place a segment of the latter industry in the aircraft classification would vastly increase the labor costs of missile development.

". . . electronic equipment is by far the most expensive item in the production of a finished missile. As the actual cost of the materials in such equipment is comparatively small, a heavy proportion of the cost—perhaps as high as 90 per cent because of the large number of hand operations—is charged to labor. Thus an aircraft determination applicable to missile electronics equipment might well mean an added cost in the neighborhood of 20 percent to the government . . ." Reynolds estimates that the determination could add an annual $1 billion to the budget.

Considering another aspect, Reynolds says that there is a real danger that missile development itself would be retarded. Since missile and consumer products are produced in the same plants and the consumer market in electronics is so fiercely competitive, many companies now participating in missile development would hesitate to continue if faced with a wage scale which would affect the price of everything produced in their plants.

Since the decision of EIA's board to oppose the new definition, two panel meetings have been held at the Labor Department and two briefs filed, October 31 and November 17. Next brief is to be filed in December.

• **AIA's case . . .** Key to AIA's case is the proposed redefinition wherein the 1950 definition is expanded to embrace "manufacturing (including assembling) . . . guided missiles; . . . guided missile propulsion systems; . . . guided missile airframes; . . . and parts and accessories especially designed for use with or on these products; . . . fuel systems, armament and equipment . . ., and specialized . . . guided missile servicing equipment.

AIA cites as precedent other industries such as the iron and steel and the paint, varnish and related products industries where redeterminations to add new classifications were accomplished.

The complete argument by AIA is best stated by quoting from Page 4 of its brief: "The basic elements of the first airplane were the structure, the power plant and the guidance and control systems. The same major elements are present today in both manned and unmanned vehicles, and they will be the basic ingredients of tomorrow's airborne vehicles, manned or unmanned. Despite the revolutionary changes in product performance, the end-product —a guided flying vehicle has remained the same.

"The proportion of effort devoted to each of the basic elements in the airborne vehicle (aircraft, controls, guidance and power plant) has changed from time to time. Today, for example, the control and guidance systems are assuming more and more importance; and as new altitude and speed ranges are achieved, it will be necessary to develop and perfect new propulsion systems. Another far-reaching trend is toward specialization of airborne vehicles and all their elements, to an extent unknown a decade ago.

"Notwithstanding such changes in emphasis, the basic elements of the airborne vehicle remain unchanged; and all are integral, inseparable products of the industry. The burden is surely upon anyone who takes a contrary position to prove otherwise, and no such proof has been adduced."

AIA's spokesmen, led by Robert Canan of Lockheed and Joseph Baylis of Fairchild, contend that they are not concerned with components as such, since items such as transistors, tubes and servo motors are customarily manufactured outside the aircraft industry.

The systems which AIA proposes be included in the redefinition are those especially designed for and having special functions in particular guided missiles and other airborne vehicles.

Each system, according to AIA, embodies a complex subassembly of many units of equipment and their components—not electronic alone, but an appropriate combination of electrical, electronic, mechanical, hydraulic and pneumatic elements—having the relationship to the entire system which the human brain, nervous, sensory and motor systems have to the entire human organism.

AIA is concerned here with what amounts to a de facto situation—divisions of almost every major airframe manufacturer are now building electronic systems and paying aircraft industry wage rates. None of these manufacturers intend to get out of the electronics or missile business and none of them intend to meet the labor force head-on in a wage cutting situation. So, while AIA limits its arguments to the "proper" definitions for systems and for prime contractor, they obviously do not feel that any other points must be developed to win the argument.

In the definition of prime contractor, there is some disparity between the views of EIA and AIA. EIA rightfully states that first tier sub-contractors are predominantly electronics manufacturers, but does not make too strong a case for their contention that this waters down the definition of prime.

So the situation remains awaiting a decision by the Department of Labor, personified by Harry Weiss, assistant administrator for the Wage and Hour and Public Contracts division.

The outcome is squarely dependent on the Department of Labor and in the words of one AIA spokesman, "this situation needs the judgment of a Solomon."

		missile type	Surface-Surface	Air-Surface	Air-Air	Surface-Air	ICBM	IRBM	IGBM	Drone	Tactical	Unknown	service use	Army Ordnance	USAF	NAVY	Army Sig. Corps	Bur. Aeronautics	Unknown	propulsion	Liq. Fuel Rocket	Solid Fuel Rocket	Booster	Ram Jet	Turbo Prop	Gas Turbine	Unknown	guidance	Radar	Inertial	Infra Rad	Radio	Unknown	ground support
cooling systems	Mechanical Refrigeration					■	■							■	■							■	■										
	Expendable Refrigeration	■				■	■							■	■												■						
	Cryogenic					■	■							■	■			■			■						■				■		■
	Heat Transport									■				■	■												■					■	■
	Console Cooling	■		■	■		■				■			■	■			■			■	■							■				
	Evaporative									■				■	■										■								
heat exchangers	Liquid/Air	■				■				■				■	■						■		■						■				
	Ammonia/Glycol	■												■	■												■						
	Liquid/Gas										■							■						■									
	Evaporative		■											■	■								■			■							
	Liquid/Liquid	■				■								■	■												■						■
	Liquid Ammonia/Liq. Oxygen						■														■												
	Hot Gas/Nitrogen Tetroxide					■								■	■												■						
	Ammonia/Air														■									■					■				
	Cold Plate	■		■										■	■			■			■		■										
valves	Rupture		■			■								■	■						■								■				
	Explosive		■			■								■	■						■								■				
	Bleed		■				■							■	■												■						■
	Bypass					■	■			■															■								■
	Temperature Control										■							■															
	Pressure Control										■							■															
	Solenoid		■			■								■	■												■						
	Thermostatic										■							■															
hand pumps																																	
oil tanks	All-Attitude	■	■	■	■	■			■	■				■	■			■			■					■					■		

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Propellant Gases Used for Auxiliary Power

by Alfred J. Zaehringer

DETROIT, MICH.—Vickers, Inc. has successfully employed the hot gases obtained directly from combustion of solid and liquid propellants to drive a positive displacement fluid power motor. The new system uses proven hydraulic components to give an integral package.

Auxiliary power, often called secondary power, is non-propulsive and is used to drive the myriad of pumps, controls, generators, and other equipment that are used on missile and rocket systems. A complicating factor has been that of a completely self-contained power source. Requirements for AP systems are on a steady increase.

Solid propellants show advantage for power levels under 10 horsepower and operating times of several minutes or less. Solids are storable and show high energy content per volume of weight, and are simple.

Much of Vickers development work has been with double base solids. Such homogeneous propellants have relatively clean and stable burning characteristics. However, the big problem has been with the inhibitor used in the end burning charges. These inhibitors decompose and give a carbonaceous residue.

Initially the residue was filtered out but it tended to clog the filter. Running with the residue showed that it caused no difficulty in the running. Gas motors used in experiments have been hydraulic motors with a minimum of re-work—the major change being the valve plate material. Even the hot gas motor is a standard Vickers piston-type hydraulic motor with minor modification. It is Vickers' opinion that the positive displacement motor is superior in many applications to a turbine for the following reasons:

1) Rotational speed closely matches that of either hydraulic pumps or electrical generators.

2) The gear box is eliminated.

3) The motor case is filled with hydraulic fluid assuring good lubrication for bearings, pistons and cylinder blocks, and serves as a heat sink to dissipate heat absorbed from the hot gas by the working parts.

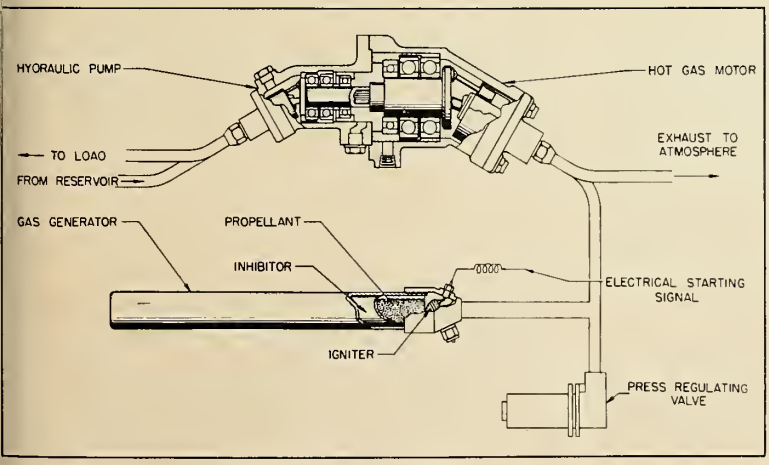
• **More efficient**—Vickers also believes the positive displacement motor is more efficient than the turbine—especially at off-design points. Higher efficiencies are directly translated into lower fuel consumption and overall system weight.

Full admission motors (gas admitted during the entire downstroke of the piston) appear to be promising for short operating times—of 10 to 20 seconds. For longer operating times where fuel economy is required—the partial admission motor (gas admitted during the initial portion of the downstroke only) looks promising.

For longer operating times, Vickers has investigated using the liquid propellants carried aboard the missile for thrust production. One test has used hydrogen and oxygen burning at about 5200 F. It ran for 39 seconds and halted because of rupture of a stainless steel line connecting the combustion chamber and the motor inlet.

A hazardous test area has been erected and placed into operation for development of solid and liquid auxiliary power units. Other power sources are also being evaluated. Battery power to drive an electric motor which in turn drives a hydraulic pump, and energy stored in a flywheel are some of the other auxiliary power sources of interest to Vickers. Studies show, for example, that for extremely short time durations, a flywheel offers extremely high energy storage capacity per unit of space and weight.

The Vickers safety test facility is a self-contained laboratory separated from the main engineering center in Detroit. Six steel-reinforced concrete test cells permit safe handling of hazardous tests. Closed circuit TV permits monitoring all tests with complete safety to the operator. Due to the high temperatures and pressures, most of the gas propellant tests were conducted here.



VICKERS' HOT gas motor system uses hydraulic components.

$1 Billion Budget Planned for ARPA in 1959

WASHINGTON—One enlarged item in the $40 billion-plus defense budget now being finalized is the proposed budget for the Advanced Research Projects Agency. Best estimates are that ARPA will ask for at least $1 billion when the fiscal year 1959 budget goes to Congress.

ARPA's FY 1958 budget is $550 million. Of this, $59 million was transferred, by executive order, to the National Aeronautics and Space Administration when it was formed in October. In addition, another $68 million of Air Force funds was transferred to the space agency.

All of the money has been set aside for "scientific" research. However, some projects which were transferred from ARPA to NASA, are in the "gray area" for both scientific and military application. But it is not felt that these projects violate the "peace charter" of the civilian space agency.

While the ARPA budget is considered one of the closest to an actual performance budget in the Pentagon, observers point out that like most budgets, the requested amount and the appropriated amount represent only the visible costs. In fact, one rule of thumb is that the visible budget indicates about half the total expenditure. The other half of the costs include support and development financing, and other costs borne by budgets of the forces or offices supplying the service.

Rear Admiral John E. Clark, deputy director of ARPA said in a recent speech that additional taxation might be required to finance the mounting defense budget.

'SPAGHETTI' TUBING construction of the *Pioneer X-15* engine is near the exit area of the nozzle. Engine, with infinite throttle capabilities and loaded with safety features has been designed for maximum protection of the pilot.

X-15 Engine Undergoes Tests

LAKE DENMARK, N.J.—The *Pioneer* engine for the Air Force *X-15* air-space vehicle will be a revolutionary first application of infinite-throttle operations for rocket engines in the United States.

The first engines for the research craft have been completed and are undergoing static tests here at Reaction Motors' captive test facilities. As many as 10 firings are made during each 12-hour day as each power plant is run through several evaluation checkouts. Engines are run with complete flight equipment including tanks, pumps and pressurization systems.

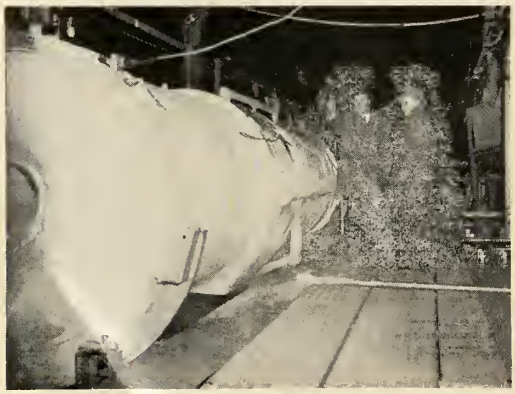
The *Pioneer* XLR99 RM-1 liquid propellant engine system has many safety features. Engineers proudly say that each safety device is backed up with another safety device. Reaction points out that the safety requirements of the system have been the major emphasis throughout the project.

Starting and stopping of the engine and thrust variation will be under full control of the pilot throughout flight. *Pioneer*, with a maximum thrust of more than 50,000 pounds, can be throttled from 100% output to idling condition over a smooth infinite variation of thrust. This contrasts with the *X-2* step thrust principle.

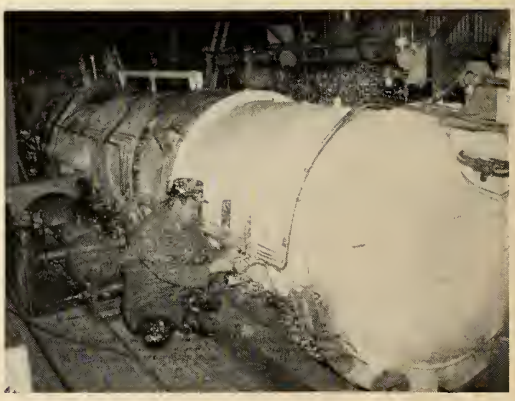
During the testing of the system, every conceivable malfunction is artificially created to insure complete reliability of the basic features of the system.

Reaction entered the *X-15* program with the award of a prime contract in February 1956. Current engine is an outgrowth of a 50 k *Viking* engine. Original *Viking* engine developed slightly over 20 k.

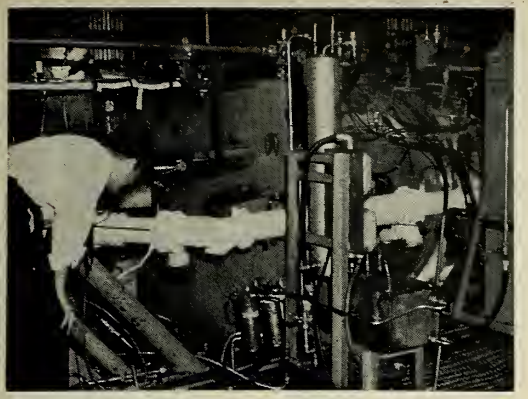
Dcliveries of the first engines will begin next February. Early test flights will use two X-1 engines.



HEAVY FROST builds up on liquid oxygen and ammonia tanks during fueling of the *Pioneer* system prior to a night firing check-out at Lake Denmark.



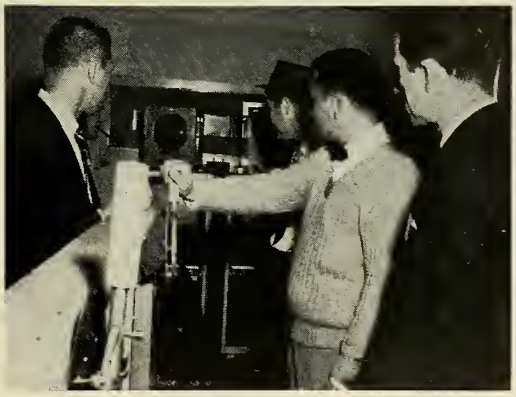
FINAL CHECK is made on instrumentation lines of oxygen tank. LOX is stored in the forward tank just aft of the pilot's cabin with ammonia tank amidship.



LIQUID OXYGEN flow line is examined as propellants are pumped into the system. *Pioneer* engine, pumps and pressurization system is to the left of the engineer.

WHEN MALFUNCTION is induced, engineers check data sheets to detemine results after safety shutdown. From the left: Bernie Saber, Harry Burton and Ted Sjoberg.

TEST OPERATOR Edward Margetson, (l to r) Test Engineer Sjoberg, Technician Raymond Wodell, and Operator William Dunkelberger wait out malfunction fix.



OPERATOR DUNKELBERGER, operates *Pioneer* throttle as (l to r) Bob Mayer, Sjoberg and m/r editor Norman L. Baker watch a captive firing on remote TV.

ROCKET ENGINE lights up the Reaction Motors Lake Denmark test area as it is throttled through a full-cycle.

DESTRUCTIVE TESTING MISSILE MOTOR CASES

These random samples of Falcon motor cases were tested to destruction as proof of product reliability. In addition to extensive Scaife "in-process" quality control procedures—beginning with metallurgical examination of incoming materials and subsequent hardness-testing, harmonic thickness gauging, magnetic particle and dye penetrant inspection, radiographic examination and hydrostatic testing—Scaife "proof-tests" random product samples, where practical, to insure product reliability. In supplying missile motor cases for nearly a decade, Scaife's primary considerations have been to produce cases which meet contract obligations with a maximum of safety, performance, and design. For further information on Scaife "know-how" for application to your missile programs write, or phone EMerson 2-2100.

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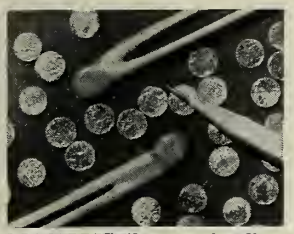


METALLIZED ceramic discs are heart of thermistors.

New Thermal Switches Resist Heat Increases

PITTSBURGH—Solid-state devices that act as tiny contactless thermal switches have been developed by the Westinghouse Electric Corp. The units are thermistors whose resistance increases abruptly when a specified desired temperature is attained.

Westinghouse sees their first practical application for over-temperature protection of hermetic motors. In this type of application, thermistors installed directly in the motor windings will operate a small external relay which de-energizes the motor or gives a signal when overheating occurs. The company expects to market hermetic motors with the new protective system shortly.

Applications such as this are possible because of the thermistor's ability to display an abrupt and substantial increase in resistance when its temperature rises to a specified point and its ability to return to nominal resistance value when cooled below that point or level.

Because of this, when temperatures of thermistors reach the critical point, they become high-resistance circuit elements and, with no moving parts, perform the function of a switch by effectively opening the circuit.

When temperature falls below the critical point, resistance returns to a relatively low value, so that in effect a conductor which closes the switch is inserted into the circuit.

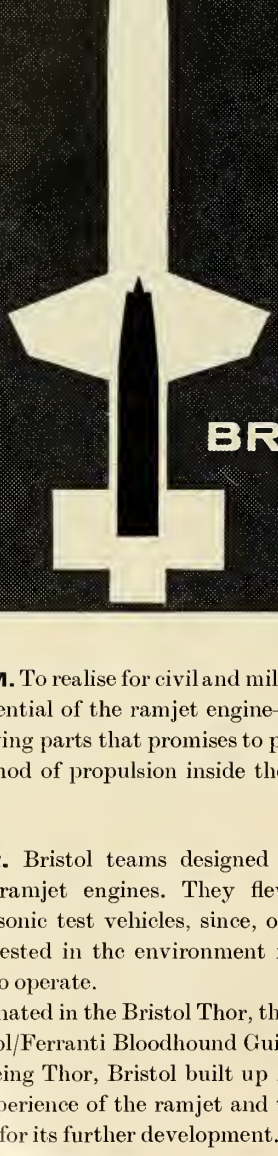
The new devices, termed Positive Temperature Coefficient Thermistors, increase in resistance with temperature in contrast with conventional thermistors whose temperature coefficient of resistance is negative. Another contrast is that within their respective operating ranges, the sensitivity of the units is many times that of conventional thermistors. Temperature ranges in which switching occurs are very sharply defined and are controllable.

By varying the composition of the thermistors, it is possible to precontrol both residual resistance and temperature level at which switching occurs. For example, thermistors for motor over-temperature protection will switch at specific temperatures between 100 and 125 degrees C and will function in control circuits requiring a 17:1 ratio of maximum to residual resistance.

The thermistors are small ceramic discs, roughly the size of aspirin tablets, that are surfaced on opposite faces with a metallic coating. Before use they are fitted with leads and encapsulated in an epoxy resin having proper thermal, electrical, and mechanical characteristics.

IN THIS DEMONSTRATION, thermistor at left displays its normal resistance at temperature of 100 degrees C. Thermistor, right, in boiling solution of ammonium chloride, displays resistance newly-developed roughly 20 times higher at about 112 degrees C.

BRAIN POWER



BRISTOL RAMJETS

THE PROBLEM. To realise for civil and military use the staggering potential of the ramjet engine—the jet engine with no moving parts that promises to prove the most efficient method of propulsion inside the earth's atmosphere.

THE ANSWER. Bristol teams designed and developed efficient ramjet engines. They flew many hundreds of supersonic test vehicles, since, of course, ramjets must be tested in the environment in which they are destined to operate.

This work culminated in the Bristol Thor, the powerplant for the Bristol/Ferranti Bloodhound Guided Missile. But in producing Thor, Bristol built up Europe's most extensive experience of the ramjet and the most complete facilities for its further development.

And developed it will be. For today, the world's designers are beginning to see in ramjet engines the means of making *civil* supersonic travel a practi economic reality.

How well has the b ief been ful:illed?

The Bloodhound can best answer for the military appli tion.

Security forbids publication of the full facts, but t much can be said. The Bloodhound already approac full operational status with the RAF and has been orde by Sweden. With the range and speed imparted by Bristol ramjets, the Bloodhound has greater effectiver than any other surface-to-air guided missile in the west world. And when future defence needs dictate even hig speeds, even longer ranges, even heavier armament, th needs can be met without major alteration or redesigr the ramjet-powered missile and its system.

Ramjet power for manned aircraft is the next stage.

Other famous Bristol Siddeley engines :-

ARMSTRONG SIDDELEY SAPPHIRE—turbojet . . . high subso

FLIGHT POWER

upersonic speeds . . . powerplant of the Handley Page r bomber.

OL PROTEUS—most powerful jet-prop in airline service emarkable mechanical excellence and exceptional relia- . . . in the Bristol Britannia.

TRONG SIDDELEY VIPER—turbojet . . . exceptional hand- qualities . . . powers the Hunting Jet Provost, RAF's jet trainer, and the Jindivik pilotless target aircraft.

OL ORPHEUS—outstanding lightweight medium-thrust jet . . . already specified for 14 different aircraft in ntries.

TRONG SIDDELEY SINGLE MAMBA—jet-prop . . . stressed aval operations such as deck landing and catapulting stalled in the Short Seamew.

OL OLYMPUS—turbojet . . . remarkable for great power gh altitude and very low fuel consumption . . . powerplant e Avro Vulcan bomber.

TRONG SIDDELEY DOUBLE MAMBA—jet-prop . . . virtually twin-engined reliability for long oversea reconnaissance duties . . . powers the Fairey Gannet anti-submarine aircraft.

BRISTOL CENTAURUS AND HERCULES—two radial piston engines, with Bristol-pioneered sleeve-valves . . . renowned for their reliability and long overhaul life.

Bristol Siddeley

ENGINES LIMITED

BRAIN POWER translated into FLIGHT POWER

Metal Joining

Ultrasonic Techniques Used by Aeroprojects

by Peer Fossen

WEST CHESTER, PA.—The problem of joining similar and particularly dissimilar metals has long plagued electronic equipment designers, engineers, and production people, especially those working in the miniature component field.

Many new concepts have been tried out, with varying degrees of success, to achieve better and more reliable joints, with government and industry pouring large amounts of money into research and development. Results of R&D are now becoming evident.

The most fascinating development in the field is the application of ultrasonic techniques for metal joining. Aeroprojects Inc., West Chester, Pa. today is offering on the market production type ultrasonic equipment which will become extremely important tools in the electronics industry before long.

• **Started 10 years ago**—Aeroprojects began its work to develop these metal-joining tools some 10 years ago after laboratory research had proved ultrasonics potential in the field. Before, very little had been done to develop ultrasonic energy into a useful production tool, and the company's basic objective was to bridge the gap between laboratory research and industrial applications.

Most important in Aeroprojects' present line of metal-joining equipment are ultrasonic welding, soldering and brazing tools manufactured and marketed under the tradenames Sonoweld, Sonosolder and Sonobraze. A subsidiary, Sonobond Corp. is responsible for actual manufacturing and marketing.

Besides producing the hardware, Sonobond offers production engineering services, recognizing that "off-the-shelf" ultrasonic equipment is seldom satisfactory and that each production application usually requires special "tailor-made" engineering and tooling. Engineering pilot plants devote substantial effort to each new production requirement, devising special tooling, and establishing the most efficient techniques for utilizing the equipment.

• **Ultrasonic welding**—This can be described as a method for bonding similar or dissimilar metals by introducing vibratory energy into the metals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A unique concept in liquid propellant rocket engines, the pre-packaged powerplant developed and now being produced by Thiokol's Reaction Motors Division stands as one of the most significant recent advances in the field of rocketry. It is high on reliability; can be held in "ready" state for extended periods of time; and in design will lend itself to many missile applications.
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in the areas to be joined. The process produces a solid state metallurgical bond. Two types of equipment are being used for this type of welding—the spot-type welder, and the continuous roller seam welder.

Aeroprojects line of welding equipment includes a variety of sizes and types. The largest spot-welder at present is a 4000-watt unit used for joining medium-heavy gages of materials such as aluminum and copper and the somewhat thinner gage sheet of metals and alloys that are more difficult to weld—titanium, zirconium, molybdenum, Inconel.

The spot-type welding units are also manufactured in sizes all the way down to 100-watt instrument welders for joining fine wires and thin foil materials. The spot-welders can be used for either single spots or over-lapping spots to produce continuous bond.

Ultrasonic welding equipment consists basically of a transducer coupling system for generating vibratory energy and delivering it to the weld zone, a support for the work pieces, a means for applying clamping force to the weldment, and ultrasonic generating equipment for driving the transducer.

• **Wide size range**—Aeroprojects has developed ultrasonic transducer-couplings for applications utilizing both magnetostrictive nickel stacks and electrostrictive barium titanate as transducing materials and couplers of various materials and configurations. Sizes range from jewelry-type equipment that operate on power of less than one watt to massive equipment that require kilowatts of power.

A basic and significant development is the force-insensitive transducer-coupling system that permits the application of high forces of the system without draining great amounts of vibratory energy into supporting members and without shifting the system frequency to destroy resonance.

This mount can be hermetically sealed to a vessel wall so that the ultrasonic energy can be transmitted through a coupler into an atmosphere of high pressure or vacuum at very high or low temperatures or into toxic, corrosive, or radioactive materials without exposing the transducer or other sensitive parts of the equipment to such environment.

A substantial number of ultrasonic generators of Aeroprojects' design have been developed for driving transducers in the frequency range of 5 kilocycles to 3 megacycles per second and having power production application. Increasing emphasis is being placed on

the use of rotating motor-alternator sets for driving transducers.

One of the most important advantages of ultrasonic welding is its ability to join dissimilar metals formerly considered impossible to weld together. And since this type of welding does not involve fusion, combinations of dissimilar metals can be welded to each other without the formation of intermetallic compounds. The following indicates some combinations that have been successfully welded on Aeroprojects equipment:

Material	Bi-Materials
Aluminum	Tin, Nickel, Beryllium, Tantalum, Molybdenum, Silver, Copper, Gold, Magnesium, Titanium, Steel, Germanium, Kovar, Zircaloy
Silicon	Aluminum, Gold
Germanium	Gold, Aluminum, Platinum
Copper	Kovar, Aluminum, Nickel
Nickel	Kovar, Platinum, Molybdenum, Aluminum, Steel, Copper
Molybdenum	Tantalum, Aluminum, Nickel
Zirconium	Aluminum, Copper, Steel
Platinum	Nickel, Aluminum, Gold, Germanium, Kovar
Gold	Platinum, Aluminum, Nickel, Silicon, Kovar, Germanium

Ultrasonic welds of high structural integrity can be made by joining many dissimilar metals. The data shown below has been obtained on Aeroprojects equipment when making bi-metal welds in materials and thicknesses as indicated.

Thickness and Material	Average Spot Strength
0.042″ Low Carbon Steel to 0.050″ 2024-T3 Alclad Aluminum	860±100
0.042″ Copper to 0.061″ 1100-H14 Aluminum	850±30
0.031″ 6061-T6 Aluminum to 0.030″ 321 Stainless Steel	870±30
0.028″ Titanium 5 A1-2.5 Sn to 0.025″ 430 Stainless Steel	940±30

Other important features of ultrasonic welding are low power requirements (in some cases as low as 5% of that required by ordinary resistance welding); low clamping forces resulting in negligible external deformation; precleaning normally limited to degreasing; (postcleaning unnecessary); and ease of operation.

• **Ultrasonic soldering**—The devel-

opment of new metals and alloys created a soldering problem. Many of the new materials proved highly resistant to uniting with solder, and although chemical fluxes used in standard soldering methods ordinarily overcomes this resistance, the flux itself creates new problems, especially where corrosion is a critical factor.

To overcome these problems, Aeroprojects has developed a line of ultrasonic soldering tools for fluxless soldering and metal coating. These tools will solder silicon, germanium, aluminum, copper, silver, magnesium and other unusual materials.

The ultrasonic solder tool can be used for single tip operation, or for multi-point soldering with 5 to 50 tips.

• **Ultrasonic brazing**—Aeroprojects ultrasonic brazing equipment is used for brazing of aluminum and for other low-temperature brazing work. Several models have been developed. Some of these operate with gas heat while others are electrically heated.

Ultrasonic brazing, like ultrasonic soldering, insures joints free of contamination often left by flux in conventional brazing operations. It also eliminates the cleaning operation often required after conventional brazing.

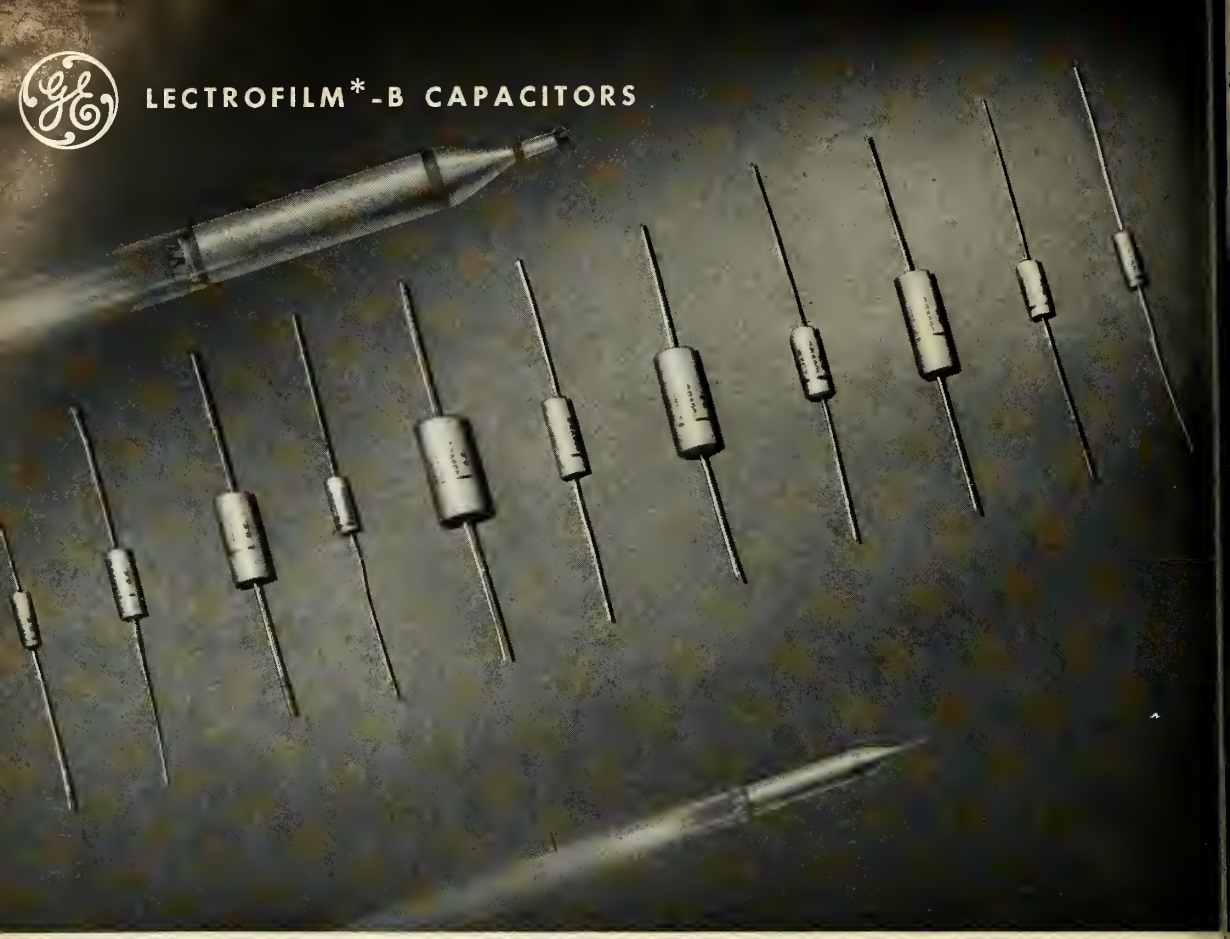
New Measurement Jargon Springing up in Industry

NEW YORK—Measurement accuracy of a tenth of a millionth of an inch will probably be attained in the United States within the next 10 years. This is the prediction of Louis F. Polk, vice-president and group executive of Bendix Aviation Corporation.

Polk pointed out that some plants today are manufacturing grinding, honing and other machine tools and measuring equipment for volume production of precision parts to an accuracy of plus or minus five millionths of an inch (six decimal places).

"But in the aircraft and missile fields, we have practical requirements for seventh-decimal-place accuracy right now," he said. "Projected piloted plane speeds of more than 4500 miles an hour and missile altitudes of up to 240,000 miles with speeds of more than 24,000 miles an hour present incredible precision requirements in making such parts as gyros, control systems, power linkages and various sensing devices," he added.

The Bendix official said advanced research in such fields as nuclear energy is developing new concepts of measurement complete with new jar-



General Electric Announces for Missile Use . . .

New Lectrofilm*-B Capacitors for 44,000 Hours of Reliable Life

New G-E Lectrofilm-B capacitors offer you maximum reliability at lowest possible cost . . . results of over 3,000,000 unit-hours of life test data (per G-E Spec. MTC-3) indicate a probability of survival in excess of 0.99 for 44,000 hour life under rated voltage at 85C. Under rated voltage at 125C, the indicated probability of survival is in excess of 0.98 for 44,000 hour life.

LOW FAILURE RATE AND LONG LIFE of these inexpensive G-E capacitors result from using only the highest quality materials and the closest of process controls . . . units are tightly wound with high-purity aluminum foil and capacitor-grade Mylar† film dielectric. No solder is used, and introduction of contaminants through impregnation is eliminated.

SMALL, LIGHTWEIGHT ENCLOSURE consists of tape wrapped around the compact roll and sealed with epoxy resin, forming a rugged case which resists humidity, vibration and shock.

TO MEET YOUR APPLICATION REQUIREMENTS, 14 case sizes are available in five ratings—100-, 200-, 300-, 400-, and 600-volts. Capacitance range within each rating is: 0.015 to 0.68 uf in 100 volts; 0.010 to 0.47 uf in 200 volts; 0.0047 to 0.22 uf in 300 volts; 0.0033 to 0.15 uf in 400 volts; and 0.0010 to 0.10 uf in 600 volts.

GET A QUOTATION TODAY ON NEW LECTROFILM-B CAPACITORS by contacting your General Electric representative. Ask for your copy of life-test data and G-E Specification MTC-3. Or, write to Section 447–4, General Electric Co., Schenectady, N. Y.

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gon. For example, he cited the estimated weight of an electron as one-thirtieth billion, billion, billion billionths of an ounce. A "jiffy," he said, is the time required for light (going at the speed of 186,000 miles a second) to travel one centimeter. A "barn," which is an area used to measure atom action, is the part of a square centimeter that would be expressed by the fraction 1 over 1 followed by 24 zeros. A "shed" is one-millionth of a "barn."

JPL Utilizing U.M. 'Scope for Probe Tracking

ANN ARBOR—Radio astronomy antennas used by the Army for tracking its first moon satellite will once again show the continuing feedback between basic and applied research, says a University of Michigan astronomer.

Prof. Leo Goldberg, director of the University Observatory, said the Army's Jet Propulsion Laboratory (JPL) at California Institute of Technology has an antenna and receiver ready for the moon probe at Goldstone, Arizona.

JPL, according to Goldberg, studied several antenna designs before going through with a crash program to track the moon probe.

The instrument finally selected by JPL is an exact replica of the university telescope now nearing completion at Peach Mountain near here.

The instrument, however, will have a different receiver and is designed for basic research of gas clouds, galaxies, the sun, and other celestial bodies and phenomena.

"JPL found that our antenna, which was previously to be the first of its kind in the nation, was best for tracking the moon satellite. It ordered an identical antenna from the same company that manufactured ours," Goldberg said.

Why did JPL choose the university design? One reason, according to Goldberg, was because of the large (85-foot) dish-shaped surface and ease of steering.

Perhaps even more importantly, it has a very precise surface. (Precision and sensitivity are needed to pick up high frequency waves and information from great distances in space.)

• **Tracks rapidly**—With such equipment, JPL found it could track a satellite rapidly moving away from earth and learn such things as its speed, direction, and other pertinent data.

Astronomers in Manchester, England, home of the world's largest (250-foot) radio telescope, tracked *Sputnik*

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Below are included just a few of the products which Link-Belt offers on an "off-the-shelf" basis. Literature on all products shown below is available: Please write to the Link-Belt Executive Offices. Address: Dept. MR, Prudential Plaza, Chicago 1, Ill.

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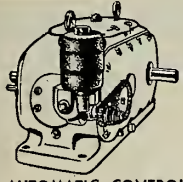

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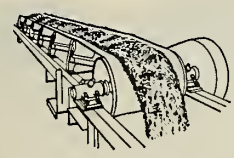
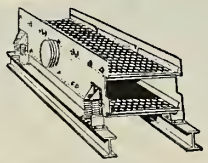
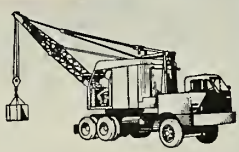


CONVEYORS. Belt, screw, trolley, chain, oscillating and drag types; bucket elevators, haulage machines and component parts.



VIBRATING EQUIPMENT. Link-Belt vibrating screens, Syntron equipment for feeding, conveying, elevating and packing.



LINK-BELT SPEEDER SHOVEL-CRANES — crawler and rubber-tired models in a capacity range from 8 to 75 tons.

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I with their equipment. However, the Manchester instrument is designed to pick up lower frequency radio waves.

Illustrating the recent history of the feedback between applied and basic research, Goldberg says that since the beginning of radio astronomy more than 25 years ago, the relationships between the two seemingly similar methods of research have been strengthened.

"In 1932 the Bell Telephone Co. laboratories in New Jersey put a young electrical engineer named Karl Jansky to work searching for a 'mysterious' interference which was disturbing wireless radio communications," he said.

"Jansky set up an antenna in a field and noted, over a period of days, that in certain directions static causing disturbances was stronger than in others. He measured the static's intensity and found it was always most intense from the direction of the Milky Way. Jansky concluded that the static was cosmic in origin and was coming from the galaxy."

The young scientist published a paper describing his findings but the static couldn't be eliminated and Bell discontinued work on the problem. "This was the beginning of radio astronomy," Goldberg said, "and several years later the problem was taken up by basic researchers. Again the feedback was illustrated."

Then it was found that there are short-lived, small clouds of gas of varying density in the atmosphere, and that when the beam of high frequency radio waves sent out by radio and TV chanced to hit the blobs of gas, they were reflected back downward.

• **Waves fluctuate**—It was noted, too, that the amount of radio waves reflected by these clouds fluctuated depending on the frequency and life of the blobs, Goldberg said.

With large antennas, it was reasoned, much of the sky could be covered and consequently a large number of "blobs." Thus, as one gas cloud faded out, another would be coming into the antenna's range, with the end result a continuing scattering of waves from the area between the troposphere (10 miles above Earth) to the ionosphere (50 miles in height).

With this new knowledge, waves could be sent out in huge quantities of energy by large antennas and received in large quantities, though some, of course, would escape through the electrically-charged ionosphere. An example of the usefulness derived from solving this basic problem is the transmission of high frequency TV waves from Key West, Fla. to Cuba—sending and receiving waves across water.

Entire new industries have been based on new knowledge concerning electronics, much of it through basic research, Goldberg adds. In Massachusetts, near MIT and Harvard, several small industries have sprung up in support of basic information of general importance to electronics. The same goes for California.

With the advent of *Sputnik*, designed by the Soviets for basic research during the International Geophysical year, has come still greater strides in technology and once again a feedback to basic researchers is apparent, Goldberg declares.

"In just a few years, both basic and applied research in radio astronomy has developed tremendously," he says. "Cooperation between government, industry and education in solving the many complex problems in astronomy and space research has helped immensely. But it's only the beginning. Whole new areas in these fields are on the threshold of development."

AERO-THERMODYNAMICISTS EXPLORE HIGH-SPEED RE-ENTRY

A report to Engineers and Scientists from Lockheed Missile Systems — where expanding missile programs insure more promising careers

Advanced weapon system technology has brought to the forefront problem areas requiring attention to interaction between aerodynamic and thermodynamic phenomena. Typical of these is the problem of high-speed atmospheric re-entry.

Expanding research and development activities have coincided with acceleration on top priority programs like our Polaris IRBM. At the same time, positions for qualified engineers and scientists have opened up that are unequalled in responsibility or in opportunities for moving ahead.

Positions in **aero-thermodynamics** include such areas as: aerodynamic characteristics of missiles at high Mach numbers; missile and weapon system design analysis; boundary layer and heat transfer analyses in hypersonic flow fields; and calculation of transient structural and equipment temperatures resulting from aerodynamic heating and radiation.

In addition, openings exist at all levels in **Gas Dynamics, Structures, Propulsion, Test Planning and Analysis, Test Operations, Information Processing, Electronics,** and **Systems Integration.** For these and other positions, qualified engineers and scientists are invited to write Research and Development Staff, Dept. 2912, 962 W. El Camino Real, Sunnyvale, California.

Lockheed / **MISSILE SYSTEMS DIVISION**

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO

Maurice Tucker, Aero-Thermodynamics Department Manager, right, discusses combined aero-thermodynamic re-entry body tests being conducted in Division's new "hot-shot" wind tunnel. Others are Dr. Jerome L. Fox, Assistant Department Manager, Thermodynamics, left, and Robert L. Nelson, Assistant Department Manager, Aerodynamics.

Propulsion by Nuclear Explosions Under Study

LOS ALAMOS—A method of propelling a rocket by a series of small nuclear explosions is being studied by a group of theoretical physicists and mathematicians at the University of California's Los Alamos Scientific Laboratory.

This method was first outlined in 1947 by Dr. Stanislaw Ulam, research advisor at the Laboratory and co-developer of the hydrogen bomb. It was later taken up and extended by T. B. Taylor, former staff member at Los Alamos, who is now with General Atomic Division of General Dynamics Corp.

Studies at Los Alamos will determine how effectively blasts from explosions can be directed to get the maximum push on the rocket from given masses of exploding materials. Each explosion would give the rocket an extra push forward. Care has to be taken to avoid subjecting the rocket structure to excessively high pressures and temperatures, but Dr. Ulam believes this method might give several times more push for each pound of propellant than by the reactor method.

If studies are successful, they will point the way to a possible method of propelling space ships through the solar system.

In development of this concept, the laboratory will share ideas and information with the group at General Atomic, which has a contract to consider the possible structure and operation of such a space ship.

Analog Computer Uses Time Division Multiplier

WASHINGTON — Development of components for an all-electronic analog computer facility described as sufficient to simulate modern guided missile systems is reviewed in a report just released to industry through the Office of Technical Services, U.S. Department of Commerce.

The proposed computer, according to the report, is designed to operate on a 1:1 time scale and utilize a method in which programming could be done off the machine. This method would make it possible to store problems solved in as complete a form as possible.

The computer, called the Dynamic Systems Synthesizer, uses a high precision electronic time division multiplier and an electronic chopper which eliminates the electromechanical vibrators from the DC amplifiers. An electronic function generator using silicon diodes eliminates the need for servo function generation.

Tests were made of one or more of the components and of the proposed programming systems on a model computer. The results, according to the report, indicate the practicability of such a computer.

The report, PB 151137 Dynamic Systems Synthesizer, E. C. Hutter and others, Radio Corporation of America for Wright Air Development Center, U.S. Air Force, Nov. 1956, may be ordered from OTS, U.S. Department of Commerce, Washington, D.C.

Machine Can Test 2,500 Tubes an Hour

HARRISON, N.J.—A new multiple-function tube testing machine which can test up to 2,500 electron tubes per hour has been developed by the RCA Electron Tube Division.

Four of these machines are in use at RCA tube manufacturing centers in Harrison, Cincinnati and Indianapolis. RCA will offer the equipment for sale to other manufacturers of electron tubes.

Each machine can perform up to 15 individual electrical tests on more than 40 miniature receiving tubes per minute. Loading is accomplished by an operator inserting tubes directly into sockets or placing them in an automatic loading device. Unloading is done automatically.

An unusual feature of the factory tube tester is a system of programming that establishes the test criteria for different tube types. Programming boards, containing a maze of spaghetti-like wires, can be plugged into the device in less than a minute. These boards can be pre-set according to the testing schedule and are interchangeable within themselves. A complete change-over from one tube type to another can be made in about 20 minutes.

These testing machines also offer several important advantages for immediate controls in the manufacturing process. For example, mechanical counters register the number of tubes tested, the net of good-tube output, and the quantity and reasons for any rejections. As a result, flaws can be detected promptly and corrective process controls quickly instituted.

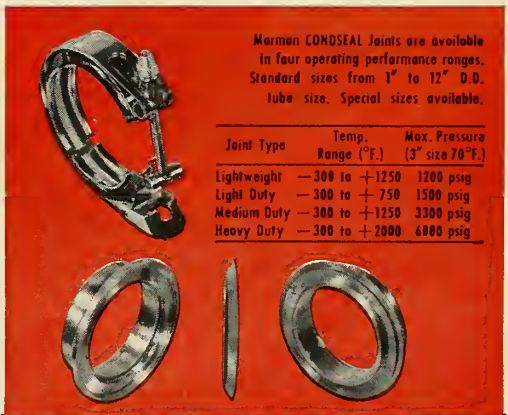
The machines pre-heat and then test miniature tubes used for radio, television, and industrial applications.

MARMAN CONOSEAL Joints Assure Perfect Seal of Dissimilar Metals at Extreme Low Temperatures

Even at extreme cold of —300° F., tubing of dissimilar metals can be joined in a perfect seal by the all-metal CONOSEAL Joint. Seal is maintained through the full temperature range up to red hot 2000° F. (for applicable tubing). Strength and sealing capabilities are also unaffected by distortion, shock or minor linear deflections.

The Marman CONOSEAL Joint assures unlimited shelf life because it is made entirely of metals not subject to deterioration. Its compact design requires minimum envelope clearance; single bolt fastening simplifies installation. Recommended for a wide range of fluids, including liquid metals, the CONOSEAL Joint is available in four weight/strength configurations. Mail coupon below for complete new catalog.

CONOSEAL is an Aeroquip Trademark.



Marman CONOSEAL Joints are available in four operating performance ranges. Standard sizes from 1" to 12" O.D. Tube size. Special sizes available.

Joint Type	Temp. Range (°F.)	Max. Pressure (3" size 70°F.)
Lightweight	—300 to +1250	1200 psig
Light Duty	—300 to +750	1500 psig
Medium Duty	—300 to +1250	3300 psig
Heavy Duty	—300 to +2000	6000 psig

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"100 Million Habitable Planets in Universe"

by George Rhodes
Special m/r Correspondent

BERKELEY, CALIF.—It is within "the realm of possibility that man should be able to change the course of the orbit of the moon" some day, a University of California professor of chemistry, associated with its famed Radiation Laboratory, has written in a biochemical study prepared under sponsorship of the Atomic Energy Commission.

Dr. Melvin Calvin's study is titled "Round Trip From Space." Most likely it will be "must" reading for every scientist connected with the space programs of the United States and other nations. It states most clearly the reasons why man must venture into space. And, of course, it should provide Congress with the answers to the question:

"Why should the government finance a space exploration program on non-military grounds?"

There will be, no doubt, many Congressmen—and millions of citizens—who will scoff at Dr. Calvin's study. But men of science everywhere, their students and those with the ability to think beyond their everyday lives, will recognize the significance of his conclusions, based on biological and chemical formulae.

In his concluding chapter, titled "Man In Space—The Next Step," Dr. Calvin declares that:

"Now that man has the capability of taking his machines and himself off of the surface of the earth and of beginning to explore outer space, there is no reason to suppose that life, and man as its representative, will not transform any planet, or any other astral body upon which he lands, in the same way, and perhaps even in a more profound way, than he has transformed the surface of the earth."

• **Habitable planets**—Dr. Calvin concludes from his studies and those of other eminent scientists that there are, conservatively, 100 million "habitable planets to be found in the universe" roughly one in every thousand of the estimated number of planets "which are the correct size . . . which will have the proper atmosphere containing carbon hydrogen, nitrogen and oxygen" . . . and which most likely will have "cellular life as we know it on earth."

The UC scientist's calculations are limited to those planets which will have conditions within the range compatible with cellular life, based on carbon, as we know it on earth.

"This does not include such systems, which conceivably we can imagine, based on other elements, such as silicon, or nitrogen, or perhaps even anti-matter. Such worlds and such systems may very well exist," Dr. Calvin says, although he does not include these as possibilities in his calculations.

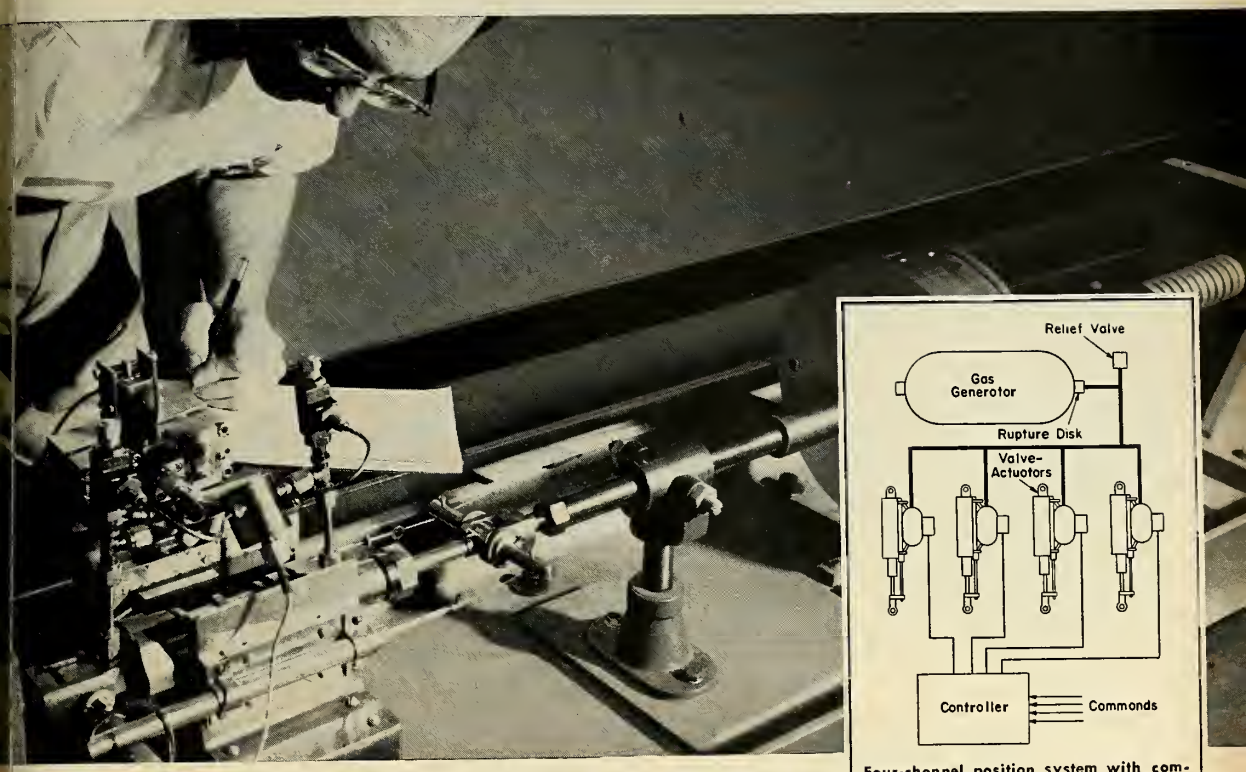
"Since in the course of the chemical and biotic evolution the appearance of man on the surface of the earth has occupied only a very small fragment of time, namely, only one million years of the five billion, it is clear that we may expect to find cellular life, and perhaps precellular life and posthuman life, in many of these other planets."

What better reason can this nation—and preferably every nation on earth in unprecedented cooperation—have for supporting exploration of space?

One can even visualize the time when some eminent editor will say—not "Go West, Young Man" but "Go Out, Young Man."

WHERE HYDRAULICS WON'T PERFORM . . .

GAS SERVO SYSTEM



Four-channel position system with common hot-gas generator, designed for thrust-vector control.

Ideal For High Temperature and Radiation Environments, G-E Gas Servos Are Compact — Give Fast Positioning Response

General Electric has developed a new gas servo device for actuation control systems where hydraulic servomechanisms are undesirable. Basically a force servo with position and velocity feedback, it consists of only three major components—an energy source, a valve-actuator unit, and a feedback and stabilization network.

By using the energy directly, rather than converting it to hydraulic power first, the system can tolerate ambient temperatures of 750F and higher. And, by eliminating this energy-conversion step, the number of components is kept at a minimun, simplifying the design, and thus increasing reliability.

As a hot gas servo, a solid propellant is stored in a gas-generating unit that also acts as an accumulator. When ignited, the gases fill the accumulator before entering the pressure-controlled, two-stage servo valve. The bleed-type first stage regulates the pressure in the second stage. This diverts the gas to either side of the actuator to control output force.

As a cold gas servo, with air or an inert gas as the energy source, the same system reduces contamination problems in high nuclear-radiation areas. In addition, the "closed-center" type valve also offers operating economies in such a system, when using stored gas or a closed cycle in which the gas is reused.

This servo system design offers several advantages over other approaches:

1. High frequency response is possible through pressure-type control. For example: 20 cps at 90-degree phase lag, with a 250-pound load. Higher response is possible with increased control bleed flow.
2. The unit is flexible. Damping, stiffness, and accuracy characteristics are controlled electrically. No change in hardware is needed.
3. Poppet valves minimize leakage. They have no close-fitting sliding parts and are well suited for high-temperature operation.
4. Symmetry of design lessens thermal shock problems, minimizes effects of G-forces, and avoids null shifting.

A dry system, the G-E servo eliminates virtually all the problems resulting from the static storage of liquids—thermal expansion, leakage, evaporation, etc. This reduces maintenance and insures instantaneous readiness.

If you'd like more information about G.E.'s gas servo and how it could help simplify your positioning-control designs, just fill out and mail the attached coupon, or contact your nearest General Electric Aviation and Defense Industries Sales Office.

Manufactured by General Electric's Aircraft Accessory Turbine Department, West Lynn, Massachusetts

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Section B231-22, General Electric Co.
Schenectady 5, New York

Please send me "Gas Servo System" bulletin, GEA-6846.

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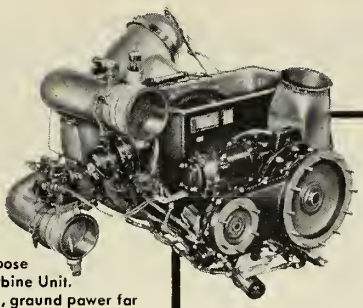
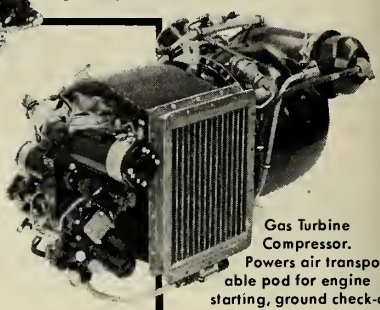


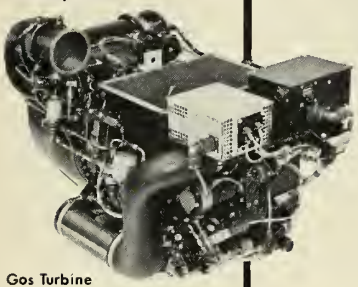
Multipurpose Gos Turbine Unit. Airborne, ground power for heating, cooling, starting, electrical, hydraulics, pressurization of military aircraft.

Gas Turbine Power Unit. Aircraft and missile ground support to drive generators, pumps, compressors. Weighs only 45 lbs.

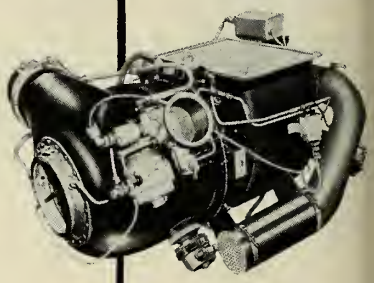


Gas Turbine Compressor. Powers air transportable pod for engine starting, ground check-out, ice and snow removal.

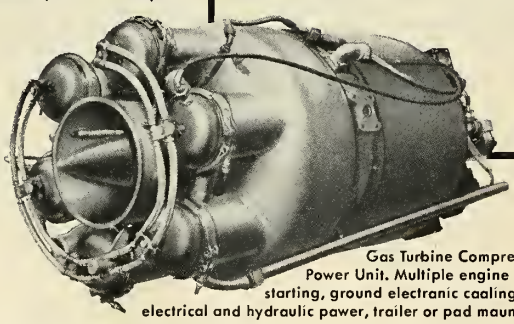
8,000 now in operation



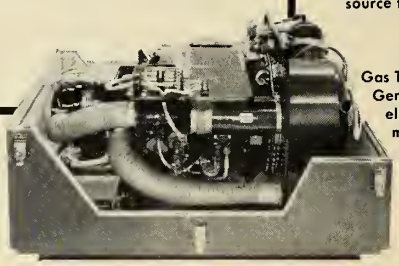
Gos Turbine Compressor. Standby in-flight pneumatic power for turbine-powered transports.



Gas Turbine Compressor Power Unit. Electricol and pneumatic ground power source for jet transports.



Gas Turbine Compressor Power Unit. Multiple engine starting, ground electranic cooling, electrical and hydraulic power, trailer or pad mounted.



Gas Turbine Generatar Set. Primory electricol power for missile launchers, guidance and refrigerotion systems.

AiResearch Gas Turbines are used in hundreds of applications: auxiliary power and ground support for missile systems, military and commercial aircraft; main engine starting, electrical and pneumatic power, air conditioning, pressurization, pre-flight check-out, snow and ice removal; prime power for helicopters; variety of ground applications or aboard aircraft for mobile or stationary use.

Advantages: these lightweight units are air transportable as fixed installations, detachable pods or portable vehicles; supply low pressure air and shaft power from 30 H.P. to 850 H.P.; provide variety of electrical power—9 to 150 KW, 60, 400 and 1200 CPS, AC or DC; have highly refined self-regulating controls and operate in any weather; have instant push-button starting; time between overhauls 1000 hours or 3000 starts.

Your inquiries are invited.

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letters

APS Roundup Enjoyed

To the Editor:

I have just finished reading with great interest the article entitled "Auxiliary Power Systems Challenge Chemicals" by Associate Editor Peer Fossen, which appeared in the November 3 issue of m/r.

My only objection or criticism to your most excellent presentation is the use of the word "Hydrox" in conjunction with fuel cells. "Hydrox Fuel Cells" is a trademark of the Universal Winding Co.

Anthony M. Moos
Vice President and General Manager
Patterson, Moos Div. of Universal Winding Co., Inc.

Dream and Convictions

To the Editor:

When a dream becomes a conviction in the minds of scientists who are dedicated to the evolution of ideas and who possess the perseverance to stick with their convictions, success is imminent. But ultimate success does not come easy for those trodding the rocky road of evolutionary development.

Modern research scientists face heavy demands on their courage and determination—for inaction and delay sprout in every filing cabinet and blossom in every staff conference. If these stumbling blocks are not sufficient deterrents to success there are other detours in the form of bureaucratic red tape, the two year Congressional turnover and re-education job, sudden budgetary cuts and restrictions being placed on programs well underway, and mass media attacks against which there is little recourse.

Every layman has access to the serious lessons of history, but the basic research scientist is not so richly endowed, for he is the pioneer of each decade, each generation, and each century. He must travel the road of totally unknown but assumed probabilities. He must weave the tedious pattern of trial and error to prove or disprove his convictions.

His dedication to progress often forces him into a lonely existence or he may drop over the precipice into oblivion because of his willingness to take the calculated risk.

Massive successes and massive errors make good reading and sell newspapers. But the lonely hours of research, intense pressure from the un-

initiated, and necessary preoccupation with the task at hand are not so well known to the reading public. Nonetheless, the intermediate sucesses and failures, unglamorous though they be, are the stable mates and pacers for the eventual Derby winner.

The indomitable spirit of the research scientists made of "blood, sweat, and tears." When this high courage of the inner human soul takes over, genius is distinguished from mediocrity. The destiny of success is never automatic with any individual or group regardless of the awesome array of talent—the ingredients of courage and determination must be at hand and in use. The scientists who survive through the unwarranted milieu besetting them truly become the scientific giants of the age and should so be recognized.

Robert A. Smith III
Redstone Arsenal
Huntsville, Ala.

Acoustica Included

To the Editor:

We would like to call your attention to an omission in the "Missile Prime Contracts List" on page 12 of your Nov. 17 issue.

Acoustica Associates, Inc. of Mineola, New York and Los Angeles, Calif. is a prime contractor on the *Atlas* missile program. You did not list our company and we hope you can correct this error in your forthcoming issues.

Just under two years ago, Acoustica received a research and development contract approaching $1-million from the U.S. Air Force Ballistic Missile Division, involving a system for controlling the flow of liquid propellants to the engines in the *Atlas*. More recently, the Air Force awarded the company substantial production contracts for airborne equipment and related ground support equipment and services.

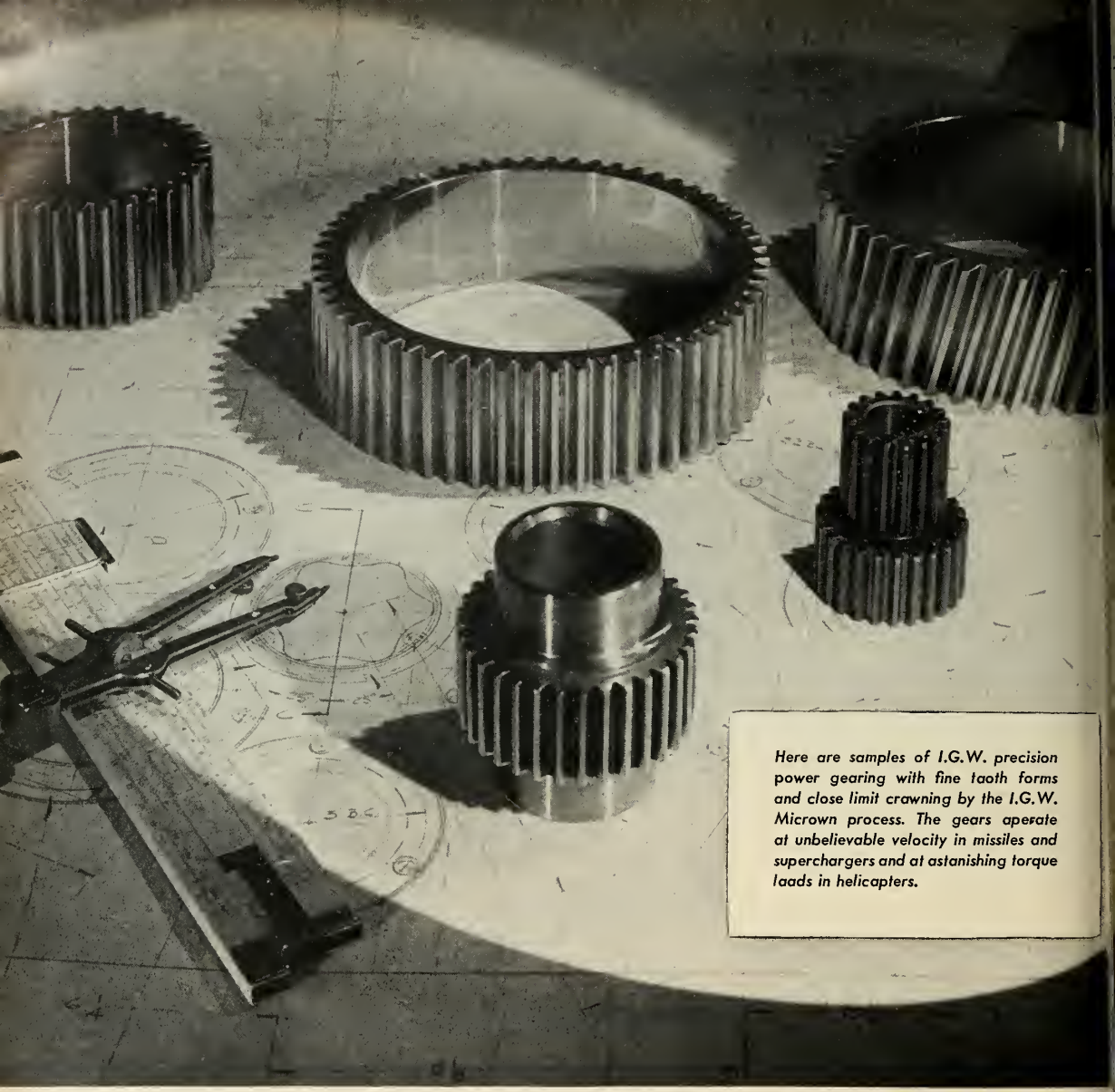
Ralph Reynolds
Vice President,
Acoustica Associates, Inc.
Mineola, NY

No Russian Failures

To the Editor:

Recently I attended a meeting of the Institute of Petroleum in London at which a member of the Soviet Embassy staff read a paper on "Soviet Earth Satellites."

As expected, this contained little that was new to astronautics experts, admirable as it was for the type of audience concerned. However, there was one interesting point made. The Soviet engineer categorically stated



Here are samples of I.G.W. precision power gearing with fine tooth forms and close limit crowning by the I.G.W. Micrown process. The gears operate at unbelievable velocity in missiles and superchargers and at astonishing torque loads in helicopters.

missile precision

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● Exacting tolerances—tight schedules—they're all in a day's work at I.G.W. Day after day, year after year, our experience in the missile and aircraft field enables us to put teeth in the word precision—and precision into teeth.

I G W

INDIANA GEAR WORKS, INC.
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that there were no unsuccessful attemps to launch artificial earth satellites in Russia.

After his lecture, I asked him why, if this was the case, the USSR had not sent up more satellites, since they appeared to have the equipment available and there were many more measurements to be made. He answered by saying that Sputnik III was still in orbit and carrying out its task, so it was not necessary to send up other satellites.

"Does this mean that the next Russian satellite will be yet another design?" is a question that prompts itself to us.

The speaker gave the estimated life of Sputnik III as over 500 days. He said Russia had solved the re-entry problem, and that teams of Soviet scientists were working on advanced propulsion systems such as nuclear engines with liquid hydrogen as a working fluid, ion rockets, and photon rockets.

"These seem fantastic proposals today," he said, "but what would you have thought if I had come here a year ago (before Sputnik I) and given this lecture?"

G. V. E. Thompson
Editor, Journal of the British Interplanetary Society

Space Dictionary

To the Editor:

There are many highly technical terms used in the missile industry today. Often a person will use one of these terms without clearly understanding its meaning. For this reason several such terms are defined below, so that there will be no further confusion when the subject of missiles is under discussion:

Missile: As good as a mile.
Rocket: (1) Precision dancer at a New York theater. (2) a confidence game. (3) Much noise.
Fuel: What you can do to all of the people some of the time.
Solid State: Condition of being real gone.
Semi-conductor: Part-time streetcar jockey.
Reactors: Concerning thespians.
Filter: Touched her.
Anode: Ann knowed!
Address: Ladies' garment (singular).
Armed: Cockney expression meaning "hurt."
Beacon: Meat often served with eggs.
Breeding: Inhaling and exhaling.
Mode: Cut the grass.
Cross modulation: Modulation that is annoyed.

To a man floating weightless around Space Station C, these are perhaps meaningless words—but *solid footing* is highly important to most of us who live and work on the surface of the earth.

Autonetics has established a solid footing in inertial guidance through 12 years of successful development and production of airborne and ocean-going systems, as well as systems for space applications.

The healthy growth of the Autonetics Guidance Engineering department—based on a number of highly diversified contracts—has created new senior-level positions in the fields of electro-mechanical component development and system analysis.

Well qualified, experienced men will find solid footing in this permanent, progressive, and successful organization—plus the chance to create and to grow in one of today's most challenging fields.

But time's a-wasting. *Now* is the time to find out what the future holds for *you* at Autonetics.

Please send your resume to Mr. N. M. Benning, Manager, Employment Services, 9150 E. Imperial Highway, Downey, California.

NERVE CENTER OF THE NEW INDUSTRIAL ERA **Autonetics**
A DIVISION OF NORTH AMERICAN AVIATION, INC.

. . . letters

Element: A pachyderm.
Feed: Pedal extremities.
Fission: Angling, trolling, casting.
Impact: Act of an imp.
Launcher: One who eats a midday meal.
Jam: Precious stone.
Phase: Front of the head.
Wake: Seven days in Ireland.

Harold S. Sharp, Chief Librarian
ITT Laboratories
Fort Wayne 1, Indiana

. . . *Ed.*
These days, a laugh is worth a lot.

Concerning a "Goof"

To the Editor:

Knowing the m/r staff as rocket experts, I was surprised to see in your article, "About *Pioneer*" (m/r, Nov. 3, p. 11) a "goof."

All previous releases on the second stage power plant of the *Vanguard* gave the thrust as 7,500 pounds; however, in your article I see it has been "jazzed up" to 20,000 pounds of thrust.

R. J. Hughes
1476 Dordine Lane
Cincinnati 31, Ohio

When we "goof," we really "goof." . . . *Ed.*

Splitting the Inch

To the Editor:

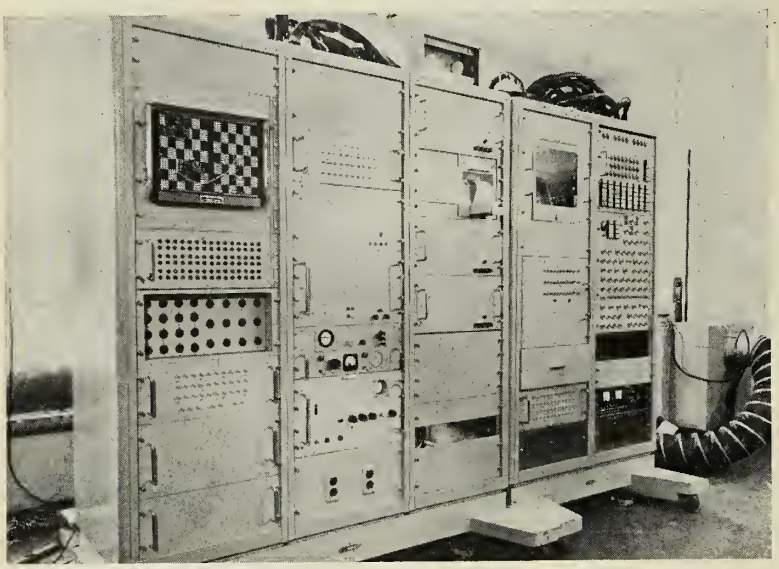
We read with a great deal of interest your fine article "Precise Measurements Sought for Space," which appeared in the October 27 issue, but disagree with your statement that "gyros have become so precise that they are designed to be built with more accuracy than any available laboratory measuring instrument."

Since our business is one of "splitting the inch finer and finer" through design and manufacture of precision measuring instruments, we have commercially available both apparatus and standard measuring facilities, with capabilities well above the tolerances specified on missile guidance components.

On the matter of facilities, we were the first company in the U.S. to establish, with the blessing of the U.S. Bureau of Standards, a measurement laboratory combining the finest features of standards laboratories throughout the world.

Carl J. Linxweiler
Director of Public Relations
The Sheffield Corp. of
Bendix Aviation Corp.
Dayton, Ohio

Missile Automatic Checkout Units Available



Systron Corporation has just completed two automatic checkout units for missiles and now offers as a standard production unit a complete universal automatic tester capable of rapidly evaluating, within assigned limits, dynamic functional capabilities of a weapon system, sub-system, or components without manual surveillance.

The space system provides for automatic IBM card programming and will accept 1000 inputs from any electronic sub-assembly. The unit provides complete printed record, precision limit detection, in-line nixie readout and removable patchboard for control logic and switching of stimuli to the unit under test.

The principal feature of this new equipment is the precision it provides in evaluating such inputs as DC voltages, true RMS of AC voltages, peak-to-peak of AC voltage, resistance, frequency, time interval, or periods from the unit under test. Because of the flexibility provided by the IBM card programming and patchboard, the system can be adapted to any electronic assembly, even though designed specifically for checkout of missile electronic sub-assemblies.

The system was designed to meet many military specifications and provides for internal standards, manual or automatic control, visual monitoring, digital selection of sampling rate, and self-check and verification. The heart of the system is the universal digitizer and limit comparator designed by **Systron Corporation** specifically for this system.

Circle No. 225 on Subscriber Service Card.

RCA Introducing Air-cooled Beam Tubes

Two new, very small and compact, forced-air-cooled beam power tubes (RCA-7203/4CX250B and RCA-7204/4X250F) designed with ceramic-metal seals throughout have been introduced by the **RCA Electron Tube Division.**

Capable of dissipating 250 watts in the plate, each of the new types is useful as an audio-frequency power amplifier and modulator, as a wide-band amplifier in video applications, as a linear radio-frequency power amplifier in single-sideband suppressed-carrier equipment, and as a class C amplifier and oscillator. The tubes can be operated with full ratings at frequencies up to 500 megacycles.

The maximum plate-dissipation rating of 250 watts is made possible without sacrifice in tube reliability by the specially designed, high-efficiency radiator which is brased directly to the plate for better heat transfer.

Both types are identical except for their heater ratings. The 7203/4 CX250B has a 6-volt, 2.6-ampere heater as compared with a 26.5-volt, 0.58-ampere heater in the 7204/4X250F.

Circle No. 229 on Subscriber Service Card.

Transient Filters Eliminate Switching Use

E.R.A. Electric Corp. is producing a new line of transient filters which are intended for switching applications. The "Slim Tran" transient filters are connected to the DC input of the transistor circuitry and eliminate hash and noise transmission to the external circuitry, as well as protecting the switching transistors against line conducted transients. These filter components are designed for all types of transistor inverters, converters, frequency changers, and semi-conducted switching circuits.

Slim Tran units have low loss inductive elements and high Q capacitors. Stock units are available for center keying frequencies of 60, 400, 2,000, and 5,000 cycles. DC ratings extend up to 5 amp. DC resistivity is a few tenths of an ohm and attenuation for unwanted components is in excess of 50 DB. A typical filter size is 1 x 1 x 1½ inches and weight is three ounces.

In addition to stock designs, special designs are also available in modified ratings for both commercial and military applications.

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NOTE: *For additional information about any product mentioned in this section of Missiles and Rockets use the attached prepaid reply cards. Circle numbers shown on the reply card that correspond with numbers appearing beneath items described. If no circle number accompanies the article or advertisement, give page number (and advertiser's name) on line provided at bottom of the card.*

Your requests for information will be forwarded promptly to the companies concerned.

The Editor

A darning needle or grain of sand?

E/C^2?

A singularity in a field?

A ratio of accelerations?

How is it held together?

Is there a region of anti-matter extant in the cosmos?

The nature of matter is important to Allison because energy conversion is our business and matter is convertible to energy. Thus, we have a deep and continuing interest in matter in all its forms.

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Energy conversion is our business

ALLISON
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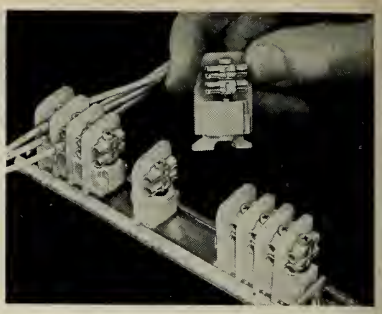
New Terminal Block Marketed by Burndy

Based on the modular principle, Modulok, a new, extremely versatile and reliable terminal block accommodating wire sizes #22-#12, is now available from **the Omaton Division of the Burndy Corporation,** Norwalk, Conn.

Modular construction allows individual modules to be snapped together or apart and then inserted onto a steel track and locked by end locks. The modules are made of Zytel 31, a nylon compound having extremely low water absorption characteristics. The tracks are available in any lengths up to 32 inches and 30 modules may be mounted per foot of track.

Modules have either 2 or 4-tier spring-loaded plated sockets which may be set for quick-disconnect for rapid ring-out, bussing, or circuit changes. A twist of a screwdriver transforms the quick-disconnect into a permanent connection. These unusual spring-loaded sockets exert continuous and uniform pressure in either position.



Solderless crimp-type contact tips installed on wire ends are inserted into the sockets and provide high reliability and speed of assembly as contrasted to the high rejection rate and slow assembly characteristic of solder operations.

Circle No. 231 on Subscriber Service Card.

Ceramic Coil Form Available for Circuitry

Cambridge Thermionic Corporation has added a new ceramic coil form for printed circuitry to its line of Cambion (R) coil forms.

This new ceramic coil form permits primary and secondary windings on a single form with each winding independently tunable. The form is internally threaded to accept threaded powdered iron tuning cores supplied for four different frequency ranges (2-1.5 mc, 1-20 mc, 20-50 mc, and 30-150 mc). Unshielded and designed for horizontal mounting, its overall length is 1.328″. This new coil form is Grade L-5 silicone impregnated ceramic with silver plated brass terminals mounted on fiberglas collars.

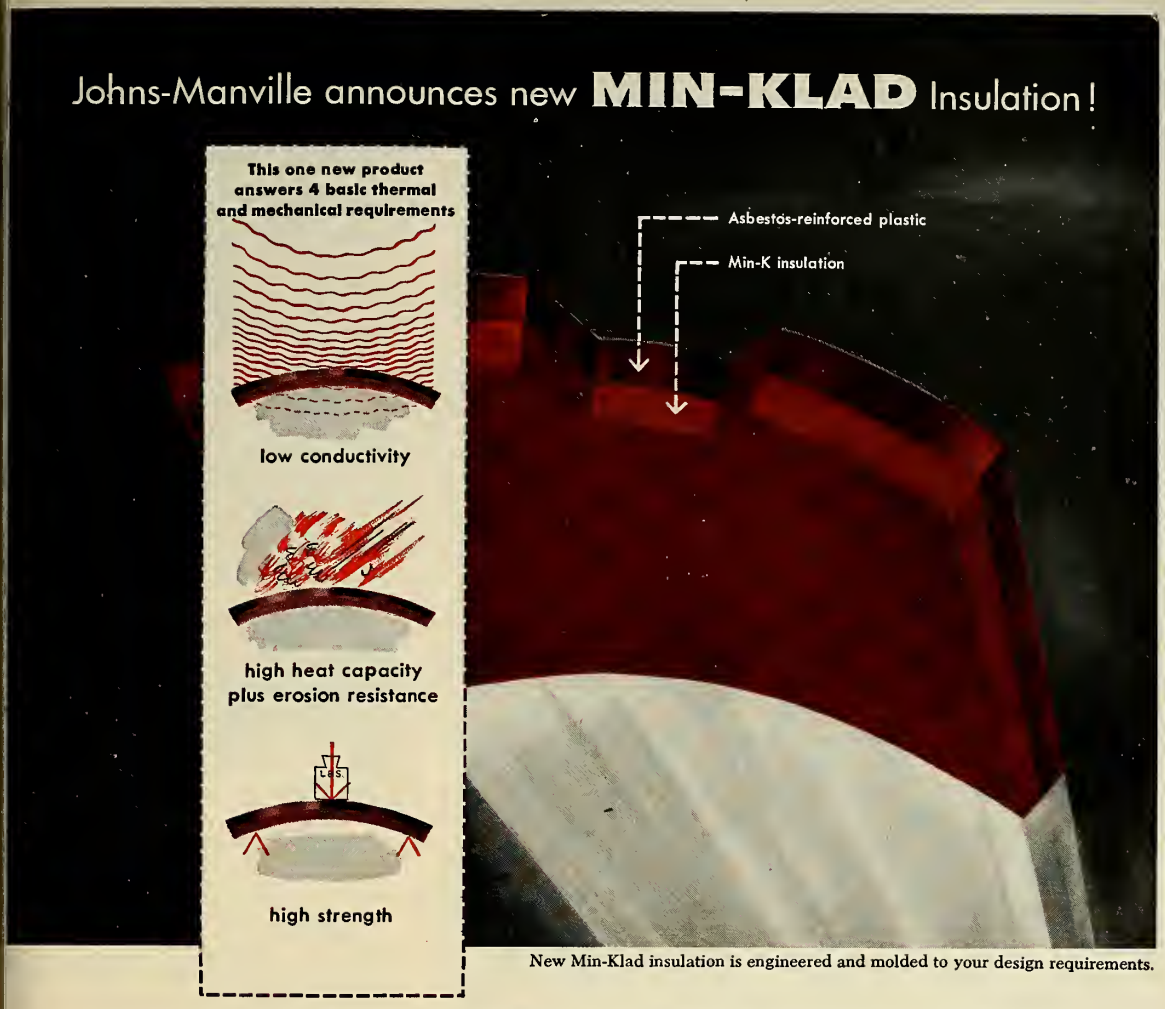
Circle No. 226 on Subscriber Service Card.

2.5 oz. Servomotor Available from Beckman

Four major servo-design requirements are met by the newest Size 8 rotating component introduced by **Helipot Division of Beckman Instruments, Inc.,** the Beckman Inertia-Damped Servomotor Model 8 IM 460.

This new servomotor is small enough (2.5 ounces, 1.680″ long) to be

Johns-Manville announces new **MIN-KLAD** Insulation!



New Min-Klad insulation is engineered and molded to your design requirements.

Combines the capabilities of asbestos-reinforced plastic with the dramatically low conductivity of MIN-K insulation!

New Min-Klad insulation may well be the most significant advance ever made in missile and rocket insulation.

Developed by Johns-Manville research scientists, Min-Klad is the only product of its kind, a permanent lamination of the missile industry's two most effective high-temperature materials: 1) reinforced plastic and 2) J-M's recently developed Min-K insulation.

Does more than plastic alone

Min-Klad gives the missile designer all the advantages of high-temperature plastic: Strength, toughness, rigidity! Erosion resistance! High heat capacity! Yet Min-Klad does more.

It also insulates . . . and with dramatic effectiveness! Its insulating element is J-M's Min-K, an insulation with thermal conductivity that is lower than any other known insulation. Actually lower than the molecular conductivity of still air. And this conductivity (already less than half that of the best fibrous insulations) drops still further with altitude. At 10 miles, for example, it is decreased by as much as 40%, with further decreases at greater altitudes.

Wide range of applications

Min-Klad offers the missile and rocket designer a rich choice of heat-control possibilities. It may be used for a part that must insulate, yet have the structural advantages of plastic. Where requirements call for a scuff- and erosion-resistant insulating surface . . . or for a good adhesive bond between Min-K insulation and other surfaces. Or, it may be used to control high transient temperatures! For high heat capacity of asbestos-reinforced plastic combined with the low conductivity and heat capacity of Min-K result in a product that provides minimum heat transfer under transient conditions.

Min-Klad is now being tested for approximately two dozen missile and rocket designs. Why not investigate this new material for your present thermal requirements? Upon request, we'll be pleased to send you a sample of the material along with detailed technical information. Write Johns-Manville, Box 14, New York 16, New York. (Ask, too, for information on Min-K insulation and the new aviation insulation brochure IN-185A.) In Canada: Port Credit, Ontario.

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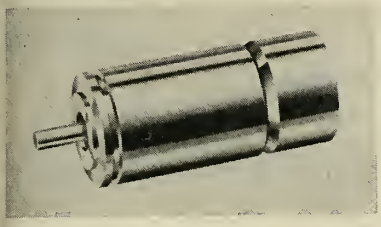


ration from stall insures rapid response to minimum error signals.

Damping is provided by the viscous friction induced by the magnetic coupling of a low inertia drag cup to a freely rotating magnet flywheel.

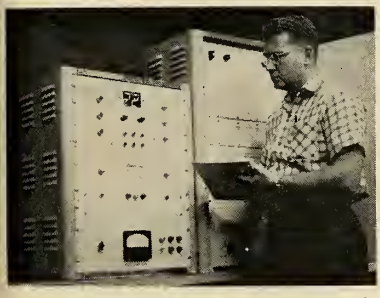
The rotor has an inertia of 0.34 gm.cm.^{2}. Combined with comparatively high stall torque of 0.33 oz. in. this produces acceleration at stall of 68,500 rad/sec^2. Upper corner frequencies approaching 41 cycles per second can be attained.

No-load speed is 6,000 rpm; flywheel inertia is 2 gm.cm.^{2}, and the flywheel damping factor is 52 dyne-cm-sec/rad. Power input is 3.3 watt per phase.

Circle No. 227 on Subscriber Service Card.

Bell Aircraft Ascat Simplifies Missile Testing

An electronic device which automatically tests the electrical, hydraulic and pneumatic systems of guided missiles and airplanes in a fraction of the time normally required has been developed by **Bell Aircraft Corp.**



Designated ASCAT (Analog Self-Checking, Automatic Tester) the device is a compact unit combining high-speed, accurate and reliable performance with flexibility and simplicity of operation and maintenance.

Originally developed for use in a specific Bell missile program it is readily adaptable to other missiles such as the IRBM *Thor*, the ICBM *Atlas*, or any of today's complex high-speed airplanes.

Circle No. 228 on Subscriber Service Card.

space age

by Norman L. Baker

Lest we forget—It has been fourteen months since the Russians launched the world's first satellite, signalling the start of the space age. *Sputnik* I weighed 184 pounds—the weight of the final stage rocket that gave it its final boost is not known. The United States, during the same period, has successfully orbited a maximum satellite weight of 48.5 pounds (200-year *Vanguard* plus final stage). In May of this year the Soviets launched *Sputnik* III—payload weight: 2900 pounds; estimated weight of empty final stage rocket: 7000 pounds; total satellite weight: close to five tons.

Air Force satellites significant stride—Meanwhile, the Air Force is preparing to launch the largest U.S. satellites to date, the Discoverer series with satellite weights of 1300 pounds. NASA has plans for utilizing our largest rocket the *Atlas* for orbiting satellites up to 10,000 pounds, but availability of the vehicle is nearly a year away. Of course, within that same period of time the United States could have available enough rocket power, in the form of the 1.3 mega-pound-thrust *Jupiter* cluster, to overshadow the Russian satellite achievements to a place of insignificance.

Soviet manned satellite predicted—Top experts, such as former Lt. General James Gavin, do not expect the Russians to wait out future U.S. developments before they go on to greater achievements. For instance, Gavin thinks the Soviets will next attempt a manned satellite launching—having proved the feasibility of the program with *Sputnik* III and the animal-carrying high altitude rocket flights. Our manned satellite flights are at least a year away.

ICBMs—United States on par with Russia?—Most of the nation's press recently proclaimed the full-range *Atlas* flight as confirmation that we were now on a par with the Soviet Union in the ICBM missile race. Shortly before *Sputnik* I began orbiting the earth, Russia announced the successful flight of an operational ICBM. That was in August 1957, fifteen months before the United States was in a position to claim a similar achievement. If the Russian announcement is accepted as factual, that country has now had 15 months to carry out operational testing, production, launch site construction, and stockpile buildup, a program we are only now entering.

Water content of Mars—An electronic multiplier phototube, which converts light into an electrical signal, was installed on the instrumentated balloon capsule that was scheduled to be sent aloft last month to study the planet Mars. The tube, developed by IT&T, would have amplified the sunlight reflected from the surface of the planet and filtered by the Martian atmosphere. Through study of this infra-red absorption spectrum, scientists hope to learn whether the amount of water on the planet will sustain life. The flight of the balloon, carrying two men in addition to the instruments and scheduled for November 15, was postponed due to balloon failure.

Radiation protection by extract injection—Scientists of Atomic Energy of Canada, Ltd., report that a parathyroid extract can increase survival following irradiation by more than 50%. Experiments, using rats, are still being conducted to learn if the extract's ability to increase serum calcium is responsible for the protective powers, or if some other factor is at work.

REPORT
On Ground FM/FM Equipment

New standards of performance are being set by Data-Control Systems telemetry ground stations now in use in missile and space research programs. These stations are meeting the needs of all three services — Army, Navy and Air Force.

The stations incorporate the most recent advances in telemetry science and are characteristic of DCS leadership in the development of new techniques and products. All units have been custom designed with the exclusive DCS Data Modules

New Data-Modules

The DCS subcarrier discriminator is of the pulse-averaging type and incorporates the latest circuit techniques and components. Its performance is the best in its field. Among the features are an automatic input limiter, reduced sensitivity to changes in supply voltage and drift, chopper-stabilized output filters, and integral, completely automatic tape speed compensation circuits.

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For use with the discriminator is the DCS switchable tuning unit containing modular switchable tuning units of 8, 16 and 24 channels. The unit gives maximum flexibility and compactness.

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Typical ground station delivered to missile facility recently by Data-Control Systems, Inc

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keeping track

by Peer Fossen

The full-range *Atlas* flight was accomplished at the sacrifice of telemetry gear. According to Patrick spokesmen, the *Atlas* vehicles successfully tested over limited range earlier this year could have gone the full distance had they not been weighted down by heavy instrumentation loads. Except for the telemetry gear, the short and long range vehicles were practically identical, with same fuel loads and burning time.

No additional tracking gear was employed for the 6,000 miles plus flight, the Patrick source said. The vehicle is tracked only up to time of burn-out which occurs approximately 4 to 5 minutes after launch. From there it is a straight ballistic trajectory, and if the impact prediction system at time of burn-out indicates that the vehicle is going to be on target, "then they don't care." Provided it does not break up in the meantime, it is a mathematical certainty where the missile will land, and no special tracking facilities are set up at the other end.

The telescope currently being built by the Russians at Leningrad Sovnarkhoz will be one of the largest in the world when finished. Mirror diameter is 102.5 in. The unit will have the height of a 20-story skyscraper. Once aimed at a star, the scope will "lock on" and follow the star continuously. Circular motion of the scope tube will be regulated by a complex automatic control system. Completion date is unknown.

Our various space travel programs are going ahead full steam, and it is interesting to notice that communications are one of the most highly developed aspects of space technology. This because better understanding of several phenomena is emerging from the data obtained from the U.S. and Soviet satellites. These vehicles have proved that current techniques are sound by successfully telemetering scientific data information from space to stations on earth.

Existing equipment limits operation to vehicles in near space. New and more sophisticated equipment will be needed for communication with space-craft bound for distant interplanetary places such as Mars and Venus. Techniques for development of such new equipment is, however, well understood, and the equipment could probably be engineered within a short period of time. According to leading scientists, no overwhelming problems are likely to prevent development of suitable equipment as rapidly as the vehicles that will require them.

One problem that remains to be solved, is transmission of intelligence beyond our solar system. Even if equipment existed, the round trip transmission time to our nearest star would be approximately nine years. As yet, there appears to be no way of circumventing the fundamental equivalence of space and time.

The U.S. Army's *Juno* II space rocket was given its final azimuth aim by a Perkin-Elmer Corp. precision theodolite. Since the rocket system was entirely free of external sources of guidance after launch, the azimuth command given to it was of utmost importance. Once in the air, the rocket's correctly aligned inertial guidance system produced signals necessary to counter any deviations in the azimuth heading.

The theodolite, so sensitive that it can detect deviations within the angle subtended by a dime a mile away, is an electronic-optical system which peers at a mirror mounted high in a missile on the one hand and at a known reference mark on the other. It continuously monitors the azimuth heading—the angle formed by the mirror in the missile head, the theodolite and the reference mark—up to the moment of launch. When any deviations in this angle occur, the theodolite automatically sends electronic correction signals to the drive elements of the platform which stabilizes the inertial guidance package.


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ICBM Manpower Is Probed

by Erica Cromley

WASHINGTON—Congressional hearings on manpower utilization may boil over into an investigation of alleged waste in the Air Force ICBM program when Congress convenes next month. In the meantime, the Bureau of the Budget has been asked to tighten up on contracting authority.

The manpower subcommittee of the House Post Office and Civil Service Committee is seeking information on the Air Force's multi-million dollar cost-plus contract with the Thompson Ramo-Wooldridge Corp. which has technical direction and systems engineering.

Air Force officials were questioned closely about the 11.9% profit called for in the R-W contract. Salaries came under close scrutiny, and Air Force at the subcommittee's request is now determining how many scientists the service has lost to the company.

Overall profits actually earned by R-W on defense business fell below the figure cited by the subcommittee. The Renegotiation Board lists for the years 1955 and 1956—most recent figures available—profits of 8.1% and 9.7%, respectively. A report submitted by the Air Force to the General Accounting Office shows R-W total net profit of $5,099,000 after taxes from 1953 through 1957.

The company claims salaries are not excessive, and of 360 jobs offered in 1957, 160 were refused. Some 65% of refusals were because of low salaries. Only six corporate officials make over $30,000 a year, according to company records. Of 989 technical employees, 117 with an average of 17½ years experience earn between $15,200 and $25,000. Some 862 technicians and engineers, with an average of 10 years experience earn between $5,900 and $15,000. Only the top 10 of the technical staff—some of whom are also officials of the corporation—average $30,000 a year, according to R-W.

Subcommittee chairman James C. Davis (D-Ga.) said that while the ICBM program was a top-priority subject, the subcommittee wanted to know whether money was being wasted. A committee staff member added: "We're not saying they haven't done a good job, but we are interested in what it costs the taxpayers. We will look into this thing again next year to see if the situation has improved. We maintain these profits are excessive when there is no risk of loss." Davis told Elmer Staatz, assistant director of the Budget Bureau, that the bureau should clamp down on loose contractual practices by government agencies.

NASA Testing Space Capsule Off Wallops

LANGLEY AFB, VA.—A full-scale mock-up of the probable configuration of NASA's first manned space capsule is being air dropped from a C-130 in tests off Wallops Island.

Two drops, both under 10,000 feet, have been made to determine roll, pitch, tension, shock load and water impact characteristics. The configuration for which proposals were to have been received from industry on December 11, utilizes two parachutes. The first opens at 30,000 feet.

After being dropped, the capsule sheds its lid which releases the parachutes, and a dish-like beryllium heat shield.

Total weight of the test capsule is 1,700 pounds with about 500 pounds in the shield.

missile people

William M. Duke has been appointed director of the Systems Engineering Division of Space Technology Laboratories, Inc. Elected a vice president of the Laboratories in April, 1958, Dr. Duke has had 23 years experience in helicopter aerodynamics, structural experiment, analysis and design, powerplant analysis and installation, materials research, aircraft preliminary design, applied mechanics research, and missile systems and component research.

He is the recipient of a Bureau of Aeronautics' Commendation Letter, a Naval Ordnance Development Award and the Centennial Citation from New York University. Prior to his election as a laboratories vice president, he served as director of the ICBM *Titan* Weapon System.

Appointment of **Brig. Gen. H. F. Gregory,** (ret.) as vice president and assistant to president **G. R. Morrow,** of Midwestern Instruments, Inc. has been announced. He recently retired as Commander of Air Force Office of Scientific Research, Air Research and Development Command, USAF. He had been in command of the headquarters office there since 1956 and had been air attache at the American embassy in Paris, France during the four previous years.

Dr. Ernst Stuhlinger, director of the Research Projects Laboratory, of the Army Ordnance Missile Command was elected a Fellow Member by the American Rocket Society at the organization's annual meeting last month, "in recognition of his distinguished contributions in the field of astronautics."

Dr. Malcolm R. Currie, co-head of the electron dynamics department of Hughes Aircraft Company, Culver City, Calif., was named the "outstanding young electrical engineer of 1958" by Eta Kappa Nu, national honor society.

W. R. Clay, formerly director of Engineering of the Research and Development Section of Rheem Manufacturing Co., has been appointed assistant to the vice president of Engineering of Radioplane, a division of Northrop Aircraft, Inc.

The following new appointments have been announced:

John G. Copelin, a vice president and comptroller of International Telephone and Telegraph Corp.; **Col. Henry H. Wishart,** Chief of the Industrial Division of the Army Rocket and Guided Missile Agency; **Harold T. Morris,** Air Force Plant Representative to Northrop Aircraft, Inc.

west coast industry

by Fred S. Hunter

In its third quarter financial report, the Douglas Aircraft Co. noted that missile sales accounted for about half the company's military backlog at the end of the period. This is significant in view of the fact that the ratio of missile sales to total military output in 1957 was 27%. In 1956 it was 16%.

There are other eye-openers in the Douglas figures. The total backlog, military and commercial, as of February 28 was $1.638 billion. As of May 31, it was $1.583 billion. As of August 31, it was $1.584 billion. There was little change in the six months between February 28 and August 31; practically none at all between May 31 and August 31.

What was Douglas selling to maintain so steady a backlog at the same time it was delivering an average of $300 million per quarter in finished products? Few DC-8s were sold in this period, and about the only real big contract Douglas has announced lately was the $75 million Navy order for A4D aircraft and this did not come until after August 31. The only conclusion to be drawn is that the stabilizing effect on the Douglas backlog is coming from missile business, notably the *Thor* IRBM, on which no dollar volumes have been announced.

More light was thrown on the extent of the *Thor* program the other day in Long Beach when Col. Dean E. Hess, Chief of the Air Force Office of Information Services in Los Angeles, appeared on the scene to answer to noise complaints from residents and reported on the flow of material in a big C-124 airlift from the Long Beach Municipal Airport to *Thor* bases in Britain.

Explaining the 15-hour turnarounds which resulted in the heavily loaded C-124 takeoffs from Long Beach at all hours, Col. Hess told the Long Beach people he saw little possibility in the troubled world situation to eliminate the airlift of missiles and missile-support equipment to the NATO defense bases in Britain. Moreover, the 30 to 40 C-124 flights a month is being increased to 70 this month.

It is no secret that Douglas has been in production on the *Thor* for more than a year now. Back in July, the Douglas Company forecast that employment at its Santa Monica Division would decline from a high of 27,000 to 20,000 by November 30, because of the phase-out of DC-6/7 aircraft production. Actually, the decline stopped at around 22,500. The aircraft production workers are gone, but increases are taking place in other areas.

One of these areas is service, growing rapidly in the missile field. Training is another. When it was training Royal Air Force crews in the *Thor* program at Tucson, Douglas was hard put for people to teach the NATO missile airmen. This problem promises to become even more complicated at the new Vandenberg Air Force Base ballistic missile training facility, particularly if *Thors* are the IRBMs selected for other NATO countries, such as France, Germany, Italy and Turkey.

Marquardt Aircraft, which now has to ship its *Bomarc* ramjet engines from its manufacturing plant in Ogden to California for testing, will start putting people on the payroll shortly after the first of the year for its new test facility in Utah and should have it in operation about the middle of the year.

world astronautics

by Frederick C. Durant III

The British Interplanetary Society recently sponsored a highly successful space medical symposium. In addition to the usual survey and "state of the art" types of space medical papers, several human engineering treatises were presented. In "The Physiological Effects of Transient Mechanical Forces: A Review of Their Relevance to Astronautics," Flight Lieut. J. C. Guignard of RAF Institute of Aviation Medicine reviewed possible mechanical stresses which will affect man during ascent, re-entry and certain presumed operations in space. In addition to plus, minus and zero g-loadings, a wide variety of potential combinations of vibration frequencies are possible as well as tumbling or spinning around various axes. J. Billingham in "Heat Exchange Between Man and His Environment on The Surface of The Moon" analyzed the heat exchange between men and a lunar space suit, and the suit and surroundings at different times and places on the moon.

These and other significant papers point clearly to the fact that competent scientists and engineers in any country can contribute to the many, in fact the vast majority, of current problems which face man in contemplating space flight. It has been said (and will probably have to be reiterated many times) that a country which has developed large rocket launching vehicles does not in the course of such experience become magically endowed with superior intellect for the solution of the multifarious problems attendant to space exploration. The reason for the existence of large rocket vehicles is a combination of geopolitical factors based upon national wealth and defense requirements, not a unique national "corner on the brains market." This point becomes obvious when one considers, in addition to the names of Tsiolkowski and Goddard, such names as Oberth, Esnault-Pelterie, Congreve, Siemienowicz, Von Pirquet, Crocco and many others.

Did you recognize the name Siemienowicz above? Almost unknown, Polish Kasimierz Siemienowicz was apparently the first to suggest the step-rocket, clustered rockets and delta-winged rockets in the Seventeenth Century. His monograph on the art of artillery was published in Holland in 1650 and subsequently translated into German, French, Dutch and English. Drawings published in this work show clearly his technical appreciation of all of these concepts. More information on this interesting bit of rocket history is being sought.

The Svensk Interplanetarisk Salskap offers one service to its members not known to be matched by other societies: an abstracting service of astronautics articles appearing in periodicals. Several times a year members receive a stack of mimeographed sheets on significant news items from national trade magazines and publications of other spaceflight societies. In addition, numbered library cards in classical form, printed in Swedish, of technical papers provide each member with his own astronautical library catalog.

Four "student groups" have been organized by the German Deutschen Gesellschaft fur Raketentechnik und Raumfahrt e. V. at the Technischen Hochscule at Karlsruhe and Stuttgart and the Universitat at Tubingen and Marburg/Lahn. Four sections of the DGRR, known as Landesgruppen, are active in addition to the headquarters at Stuttgart: They are located at Baden-Wurttenburg, Hamburg/Schleswig-Holstein, Nordbayern and Rheinland-Pfalz.

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book reviews

APPLICATION OF ATOMIC ENGINES IN AVIATION, Military Press of the Ministry of Defense of the USSR, 180 pp., $3.00, Foreign Technical Information Center, Office of Technical Services, Department of Commerce.

Written by Soviet nuclear and rocket experts in 1957, this book is a good guide to Russian thinking on the subject of nuclear powerplants for aircraft, missiles and spacecraft.

It is concerned with the feasibility and potentialities of nuclear engines and was published "to systematize the scattered data in the literature on the utilization of atomic powerplants in aviation and rocket engines."

General design, specifications, and types of airborne nuclear reactors are also examined. Possible diagrams of atomic powerplants are illustrated and discussed. These include such combinations as ramjet-atomic, turbojet-atomic, turboprop-atomic, and atomic rocket. Radiation shielding and special features of design are covered as well as in-flight operation and ground servicing.

A full chapter is devoted to the use of atomic engines for interplanetary flight. Advantages of nuclear fuels for space flight, projected atomic space rockets, and a proposed program for attaining cosmic speeds is discussed.

RUSSIAN-ENGLISH GLOSSARY OF GUIDED MISSILE, ROCKET, AND SATELLITE TERMS, compiled by Alexander Rosenberg, 352 pp., $2.50, Card Division, Library of Congress, 1958, Washington, D. C.

This work should prove extremely valuable to anyone attempting to use Russian sources in the missile, rocket and satellite field. Containing over 4000 entries, the glossary has been compiled from official Soviet sources published in the period 1955-1958.

It has heretofore been necessary to consult a number of sources for accurate translation of astronautical terms, and extremely few Russian-English dictionaries cover this field.

This volume is printed in large, clear type and gives both abbreviated and full forms of many terms. Listing is made in each of the several ways a term may be encountered. For example, "Newtonian particle reflection" is also found under "particle reflection, Newtonian."

The glossary is highly recommended for those engaged in translating, abstracting or research.

GUIDED MISSILE ENGINEERING: Edited by Allen E. Puckett and Simon Ramo; 512 pages, 213 illustrations, $10; McGraw-Hill, New York.

Two well-known names to misslemen, Allen Puckett, associate director of Hughes Aircraft Co.'s systems development laboratories; and Simon Ramo, president of Space Technology Laboratories, collaborate in an introduction to guided missile engineering.

Seventeen other eminent specialists, each representing a particular field, cover electronics, guidance theory, aerodynamics, airframe performance and other subjects underlying various phases of guided missile engineering.

A combination of theoretical and practical material, the book emphasizes systems engineering aspects of the subject. Topics covered include: missile system and its components; aerodynamics; stability and control; the rocket motor; information theory and missile guidance; principles of missile navigation; random phenomena; gyrocopy; radio propogation; microwaves; radar; analog and digital computers; integration of design.

when and where

DECEMBER

Fourth Convertible Aircraft Congress, The Franklin Institute, Philadelphia, Pa., Dec. 16.

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

JANUARY

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

Society of Automotive Engineers, Annual Meeting and Engineering Display, The Sheraton-Cadillac and Hotel Statler, Detroit, Jan. 12-16.

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

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

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

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

Nuclear Fuel Elements, First International Symposium jointly sponsored by Columbia University and Sylvania-Corning Nuclear Corp., Columbia University, New York City, Jan. 28-29.

FEBRUARY

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

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

MARCH

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

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

contract awards

ARMY

By the Department of the Army:

$3,030,196—**Lawless and Alford, Inc.,** of Austin, Texas for construction of an Air Force missile training facility.

By U.S. Army Engineer District, Jacksonville, Corps of Engineers, Jacksonville, Fla.:

$414,011—**Diversified Builders Inc.,** Patrick Air Force Base, for missil bldg. "Z," ordnance checkou facility, Nezzanne in contractor' storage facility.

By Cleveland Ordnance District, Cleve land, Ohio:

$39,900—**Ohio State University Re search Foundation,** Columbus, fo additional research work for th study of amine perchlorates a ingredients for fast-burning pro pellants.

By Frankford Arsenal:

$76,348—**Hamilton Watch Co.,** Lan caster, Pa. for fuze movemen subassembly for rocket fuze.

By White Sands Missile Range:

$41,950—**Goldberg & Lavis,** El Paso Texas for target for *Lacrosse* mis sile.

By Boston Ordnance District, Army Base, Boston, Mass.:

$34,595—**Olin Mathieson Chemical Corp.,** New Haven, Conn. for investigation of glass flake laminates.

$428,876—**Barnes Engineering Co.,** Stamford, Conn. for optical measurements for project Damp.

By U.S. Army Ordnance Dist., Los Angeles, Calif.:

$690,536—**Motorola's Military Electronics Division,** three separate awards were received: one for production of antennas, the other two for design, development and study programs covering a wide variety of advanced miniaturized electronic equipment.

NAVY

By Navy Department, Bureau of Ordnance, Washington, D.C.:

$352,229—**Baker Industrial Trucks,** a Division of Otis Elevator Co., Cleveland, for launcher loading stands for *Terrier* BW0-BW1 and BT3 missiles and their companion boosters.

By Office of Naval Research, Washington, D.C.:

$35,000—**Harvard University,** Cambridge, Mass. for theoretical and experimental research on properties of non-linear circuit elements.

$37,000—**Indiana University,** Bloomington, Ind. for research on polysilanes and derivatives.

By Navy Purchasing Office, Brooklyn, N.Y.:

$32,379—**Pratt Institute,** Brooklyn, N.Y. for tuition, co-op program engineering and science training.

EMPLOYMENT

Advertiser's Index

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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.

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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.

Give Us A Goal For The Space Race

As of this writing the United States has placed two small satellites in orbit, has failed on several other similar attempts, has attempted four times to place a payload in the vicinity of the moon, has shot several space rockets from a balloon for some reason or other and has half a dozen-odd other projects in view.

We also have three government agencies, three military services and a fair segment of the national industry involved in the almost frantic effort to do something in one way or another regarding our solar system.

In all of this—if there is a planned program as to what we are trying to do on what schedule and for what purpose, that fact is not apparent.

This magazine would like to suggest a few procedures. If they have been considered by those whose job it should have been, the suggestions won't do any harm. Otherwise, they might help. To begin, let us:

Define the national goals in the space race.

Establish a program to achieve those goals.

Develop the organization to carry out the program.

As a beginning and under the impression that no one in the government has realistically done so, m/r would like to define our goal in one simple tough sentence.

The goal:

Until the world is guaranteed that space occupation of our solar system is for peaceful purposes, the United States can take no chance on its being dominated by someone else.

This is based on the premise that he who controls space around it can control the earth. Until we find out differently this is an assumption we must make. Our continued existence depends on it. Achievement of the goal includes, naturally, the exhaustive exploration of space necessary to achieve a preemptive veto power over any other control.

• Establish a program to achieve those goals. There is no doubt that even with the present shotgun approach to the problem we have accomplished some success. There is no doubt also that we are wasting money and what may be very precious time for the lack of reasoned and defined intentions. With a goal established, what are the steps we need to achieve it? They could be these, or some variation thereof:

1) Orbit the moon. 2) Orbit Venus and Mars. 3) Establish a reconnaissance satellite. 4) Man in space. 5) Soft landing on the Moon, Mars and Venus. 6) Establish a space platform. 7) Hard landing on the Moon. 8) Planetary and lunar bases.

There may be other steps and those above probably would not be taken in exactly that order. We'll accept a better plan. In fact, we'll accept almost any coherent plan in lieu of none.

• Develop the organization to carry out the program. At the moment we don't have one organization carrying out our space program, but we do have three government agencies, three services and a lot of industry trying. There is the National Space Council, the National Aeronautics and Space Administration, the Advanced Research Projects Agency, the Army, Navy and Air Force, plus a couple of hundred prime contractors.

The National Space Council, headed by the President and advised by Dr. James R. Killian, has to decide which space projects shall be attempted, and in what priority.

NASA, under Dr. T. Keith Glennan, has the responsibility for non-military space projects. It is destined to get more money and become more powerful, as it must. At the moment, however, NASA has been blocked by the President from getting the scientists it desperately needs from the Army and hasn't even the urgent authority it needs to cut Civil Service red tape to get minor officials.

ARPA, headed by able Roy Johnson who reports directly to Defense Secretary Neil H. McElroy, allocates military space projects among the services. ARPA fears military space projects will be neglected under NASA's growing authority and there is a less than cordial exchange of information between the agencies.

The services, distrusting the practical hardheadness of scientists, reach under the counter for money to finance developments which are kept secret even from ARPA until they are virtually accomplished facts.

U.S. industry is the power and glory behind America's space program. It is the main reason the space program will succeed. For every scientist in the services and civilian agencies, industry has ten. The U.S. will spend $8 billion tax money next year on missile and space projects and, while earning legitimate projects, will pour millions of its own dollars back into research for the future. Industry's peculiar problem is frustrating official indecision and even occasionally mismanagement and favoritism.

With all of these involved in the space race, there is in this country no one agency, department or office through which all space projects clear. There is no one man, group or organization which establishes the goal or lays out the program for the country to follow. We have a team but it is charging off in all directions at once.

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Your requests for information will be forwarded promptly to the companies concerned.

NEW PRODUCT BRIEFS

DELAY LINES. Digitronics Corp. announces several additions to its standard units of model 1R continuously variable delay lines. Each of the lines are completely hermetically sealed and feature infinite resolution. The new delay ranges available are from 0.18usec to 0.22usec, 0.23usec to 0.27usec, 0.28usec to 0.32usec, 0.33usec to 0.37usec, 0.48usec to 0.52usec and 0.58usec to 0.62usec. Characteristic impedance is 250 ohms, with higher impedances are readily available. Other characteristics are a rise time of 0.06usec and a maximum attenuation of 1.0 db according to the manufacturer.

Circle No. 275 on Subscriber Service Card.

CAPACITOR TESTER. Systems Engineering, Division of Paul Hardeman, Inc. recently placed on the market a precision capacitance and temperance coefficient tester for checking the reliability factor of capacitors over a given temperature range. The tester is a self contained unit designed to measure capacitance and temperature coefficient of capacitors over a range of −65° to +175°C.

Circle No. 276 on Subscriber Service Card.

TRANSISTOR TRANSFORMERS. A new line of fully mu-metal shielded miniature transformers explicitly designed for transistor application is available from Amphenol Corp. of America. This series of hermetically sealed transformers are epoxy impregnated for optimum freedom of moisture penetration and are housed in drawn, annealed after stamping, mu-metal shields. Hermetically sealed units are constructed in accordance with MIL-T-27A specifications are also available. Some units use the best type of nickel-alloy core material and are wound up on either bakelite molded coil forms or ceramic bobbins. Bifilar windings and one-piece gapless core construction are utilized in some units. All transformers are color coded in accordance with EIA standards. Thirteen basic types are input, driver, output and interstage transformers are available for use in 90 different impedance matching circuits.

Circle No. 277 on Subscriber Service Card.

HIGH TEMPERATURE WIRE. Ready-to-use, flexible, ceramic-type insulated wire rated for continuous operation at 1000°F is described in this technical bulletin. Applications and handling characteristics are covered, and the bulletin also contains graphs, charts other descriptive data. Hitemp Wires, Inc.

Circle No. 278 on Subscriber Service Card.

GEAR HEADS. Fae Instrument Corp.'s size 11 precision gear heads are designed for use in conjunction with standard BuOrd Mk Mod. 2 (size 11) servo motors and through use of available adapters to other than size 11 motors and systems. All are built for high and low temperature applications and environmental tests covered by MIL-E-5272A.

Circle No. 279 on Subscriber Service Card.

SMALL ROCKET MOTOR. Armstrong Siddeley Motors, British manufacturers of liquid propellant rocket engines, have announced development of a small rocket motor for auxiliary use in missiles. The Armstrong Siddeley PR.23, according to the manufacturer, can be used for trimming the attitude and velocity of long-range ballistic missiles. The unit, weighing 3032 lb., is entirely self-contained and gives a thrust of about 500 lb. with a high specific impulse. Smooth control of thrust can be obtained down to at least one-third full power, with only slight reduction in S.I.

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OPTICAL INSTRUMENT. The "Omniscope," a new optical instrument with a 180° hemispheric field of view, is announced by the Lerma Engineering Corp. Built as a periscope or borescope, it transmits this extremely wide angle field of view from inaccessible, hazardous, or remote regions. The Omniscope can be furnished in lengths up to 40 feet, with offsets and angles to suit the configuration of the installation. Other features, such as underwater design, sectional construction, non-browning optics, shielding, special illumination and photographic attachments available.

Circle No. 281 on Subscriber Service Card.

LINEAR INDUCTION POTENTIOMETERS. Kearfott Co., Inc.'s new series of linear synchro transmitters has been added to standard group of synchros. Dimensionally identical to Kearfott's R900 Series synchros, these components are highly linear induction potentiometers providing accurate linear indication of shaft rotation about a reference position in the form of a polarized voltage whose magnitude is proportional to angular displacement. Phase relationships indicate direction of shaft rotation. Being of the induction type, the potentiometers need no sliders to make electrical contacts. The units are furnished with either terminals or leads, and with special shaft configurations.

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MISSILE LITERATURE

PRESSURE TRANSDUCER. Four-page bulletin on model S-30 unit, a dual-coil, variable reluctance diaphragm type pressure transducer designed for voltage output, bridge type circuits, carrier systems, telemetering systems and servo control applications. Ultradyne, Inc.
Circle No. 215 on Subscriber Service Card.

VOLTAGE REFERENCE SOURCES. Brochure describes "ultra-precision" voltage references sources, and covers three models, the VR-607 portable decade unit, the VR-608 rack mounting decade unit and the VR-607B portable binary model. Epsco Instrument and Equipment Division.
Circle No. 200 on Subscriber Service Card.

CRYOGENIC PUMPS. Four pumps for use with liquified atmosphere gases are described in a four-page folder which includes detailed information on the performance and specifications for two turbine type and two immersed reciprocating pumps. Specially designed for service with liquid oxygen, nitrogen and argon. Linde Co., Division of Union Carbide Corp.
Circle No. 201 on Subscriber Service Card.

SURFACE COATINGS. Brochure, 12 pages, describes Eccocoat Surface Coatings intended for electrical and electronic applications for use in component protection, printed circuit boards, hermetic sealing, etc. Emerson & Cuming, Inc.
Circle No. 202 on Subscriber Service Card.

POWER FOR AUTOMATION. A revised, up-to-date version of the bulletin "A New Approach to Practical Control" is available. The 8-page bulletin, 765A, gives complete engineering data and describes typical applications of Regatron programmable power packs. New models and revised specifications are included. Electronic Measurements, Co. Inc.
Circle No. 203 on Subscriber Service Card.

OPTICAL EQUIPMENT. A 96-page catalogue containing data on essential equipment for visual inspection, comparison, checking or measurement. Hundreds of quality-control aids are listed, as well as more than 1000 optical items. Edmund Scientific Co.
Circle No. 204 on Subscriber Service Card.

ANTENNA SYSTEMS. Catalog covers antennas, systems, and transmission line products in 96 pages. Includes developments in 21-inch waveguide, high-power lines, ground-to-air and telemetry antennas, etc. Contains 16-page section of general antenna systems engineering information. Andrew Corp.
Circle No. 205 on Subscriber Service Card.

LOW-NOISE HF PREAMPLIFIERS. Four-page brochure illustrates and gives detailed electrical and mechanical data on line of low-noise, high frequency preamplifiers. Series "A" models are fixed-tuned preamplifiers available with flat bandwidths in the range 50 to 500 mc. Series "B" units are available for any center frequency in the range 100 to 250 mc., depending on frequency center. Special models are also describ
A. R. & T. Electronics, Inc.
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SERVOS & AMPLIFIERS. Illustrated b
letin covers synchro transmitters, tra
formers, receivers and differential tra
mitters with stainless steel housin
thru-bore construction, accuracies
±7′ and torque gradients of 2400 n
MM/degree. Also includes size 8 se
motors offering high rate of stall torc
to power input (0.025 oz. in. for
watts input). Bulletin describes Size
transistorized amplifiers with a volu
of 0.8 cubic inches and capable of
livering 2 watts of continuous pov
output at 100° without a heat si
Ketay Dept., Norden Division of Unit
Aircraft Corp.
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ENGINEER'S HANDBOOK. A new su
plement to the handbook published
CBS-Hytron has been issued, offeri
revised data for 14 types, as well as
pages of revised curve sheets. CBS-H
tron.
Circle No. 208 on Subscriber Service Ca

SPECIAL CHARTS. A new bullet
#Y1906, describing charts for spec
requirements, including pre-printed phc
charts for oscillograph recording,
been released by the Bristol Compa
Circle No. 209 on Subscriber Service Ca

VERTICAL SCALE INDICATOR. A te
nical report on the ATC vertical sc
indicator used with Atcotran differ
tial transformers to display linear me
urements of such variables as motic
pressure, liquid level, thickness, et
has been published by Automatic Ti
ing and Controls, Inc.
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HYDRAULIC RESEARCH. Latest in
series of publications summing up
ports on hydraulic research in the pa
year in the U.S. and Canada. Serves
a guide in the coordination and pla
ning of work in this field and is a co
tribution to the effort to elimina
duplication of work. Contains 168 pag
$1.25. U.S. Department of Commerce
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MERCURY SWITCH. Low-angle swit
described in one-page data sheet whi
gives photograph, dimensions, specific
tions, and electrical rating. Switch
smallest single-pole, double-throw me
cury switch available. Differential ang
is .15° maximum. MICRO SWITCH D
vision of Minneapolis-Honeywell Reg
lator Co.
Circle No. 212 on Subscriber Service Co

TEST EQUIPMENT. Bulletin 1374,
illustrated folder, covers products, ser
ices and facilities of Nankervis Co.
Circle No. 213 on Subscriber Service Co

DIGITAL TEST EQUIPMENT. Data fold
provides specifications and prices
transistorized equipment, covering
standard building blocks produced
Digital Equipment Corp.
Circle No. 214 on Subscriber Service Co

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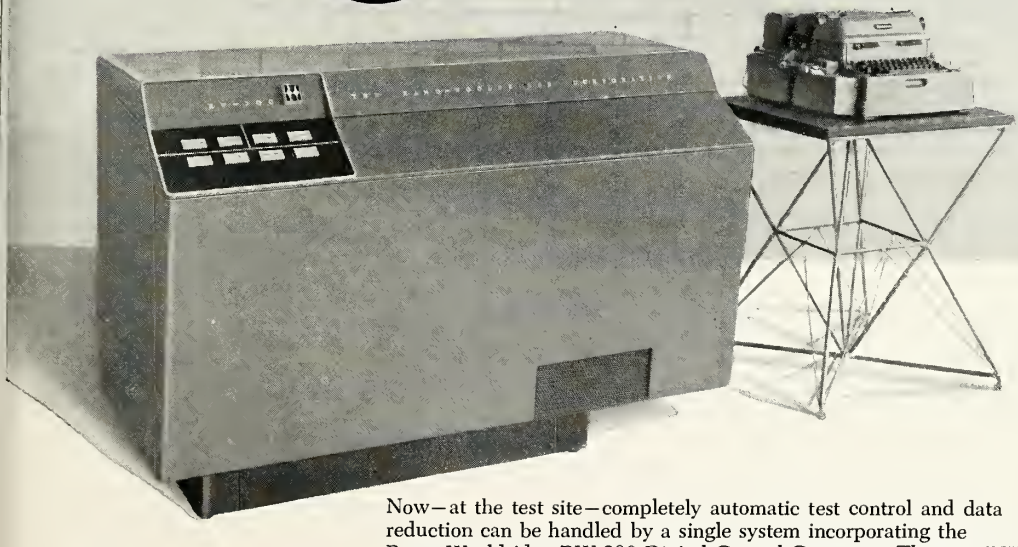
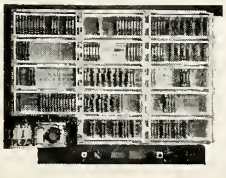
The RW-300 is the first digital computer for test control and data reduction



Now—at the test site—completely automatic test control and data reduction can be handled by a single system incorporating the Ramo-Wooldridge RW-300 Digital Control Computer. The new RW-300 can schedule and closely control test routines, and it can collect, analyze, and record test data.

The versatile RW-300 utilizes input data as feedback to modify control actions, thus substantially shortening many test routines. In addition, the RW-300 directly logs both instrument data and complex relationships among these data. Thus, test results are available immediately. The time-consuming task of processing raw data through a separate computer, often remote from the test facility, usually can be eliminated.



For technical information on automatic test control and data reduction with the RW-300 and with special digital systems which utilize solid-state components exclusively, write: Director of Marketing, The Thompson-Ramo-Wooldridge Products Company, P.O. Box 90067, Airport Station, Los Angeles 45, California, or call OSborne 5-4601.

THE THOMPSON-RAMO-WOOLDRIDGE PRODUCTS COMPANY

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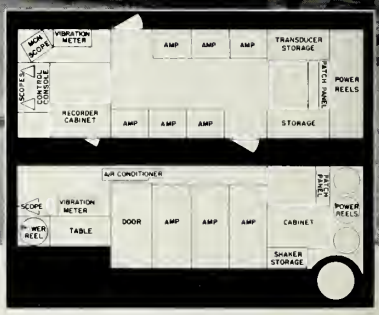


COMPLETE, COMPACT LAB—control center at forward end . . . six amplifers in the center and patching panels with power reels at the rear.

Douglas gives the entire DC-8 a vibration "shake-down" with this new mobile test laboratory

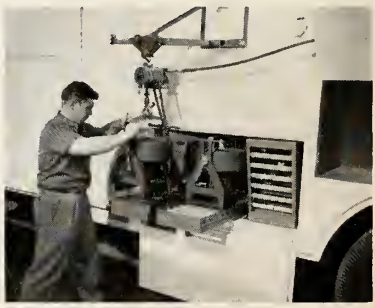
A complete Ling vibration testing laboratory on wheels allows Douglas Aircraft to simulate actual flight vibrations without ever leaving the ground!

This new Ling unit is a self-contained laboratory, with up to 12 shakers integrated into a single system.

For the first time it provides an efficient means of testing the entire aircraft, missile or other large component while fully assembled. Structural vibrational characteristics of the complete airframe can be determined under various dynamic loadings, and the chances of test inaccuracies through mismatched or temporary connections are reduced. Further, important time and money savings are realized with this on-the-job test lab.

A new bulletin giving full information and specification data on this new Ling mobile unit will soon be available. Write for your copy now!

MASTER CONTROL CONSOLE features front panel reading and easily accessible control of all basic system functions.



ACCESSIBILITY OF EQUIPMENT includes roll-out storage of 12 shakers, power reels and equipment check-out.

LING ELECTRONICS INC.

LING-CALIDYNE FACTORY SALES OFFICES

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