

CONRAD LAU

Conrad Albert Lau, aeronautical engineer, inventor, executive, known to his friends and business associates as "Connie", was born on February 8, 1921 in Port of Spain, Trinidad, British West Indies to Mr. and Mrs. Egbert Lau. He was one of a family of four, all boys. His brothers were Neil, Roy and John. He and his wife Nancy Page Lau had three children, Conrad, Jr., Sally and Michael.

Conrad attended school in Trinidad through his sophomore year at Queen's Royal College. He entered Massachusetts Institute of Technology in his junior year. He received his B.S. Degree in 1942 and his Masters Degree in Aeronautical Engineering in 1943. While at MIT he was on the Dean's List for high scholastic achievement, and he was elected to membership in TAU BETA PHI, National Honorary Engineering Fraternity. Also, at MIT, in recognition of his Christian leadership, he was elected Secretary of the Technical Christian Association, a student organization of all Christian denominations dedicated to practicing and encouraging the Christian life.

Conrad joined Chance Vought Aircraft, Division of United Aircraft Corporation, upon graduation from MIT in 1943. He devoted his entire professional career to the Company that had become Ling-Temco-Vought, Inc. at the time of his untimely death, April 18, 1964. Through his initiative, superb intelligence, and human warmth, he had advanced rapidly from the position of Junior Aerodynamics Engineer to Director of the U. S. Navy VAL Light Attack Aircraft program for LTV.

SEPTEMBER 3, 1958



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missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

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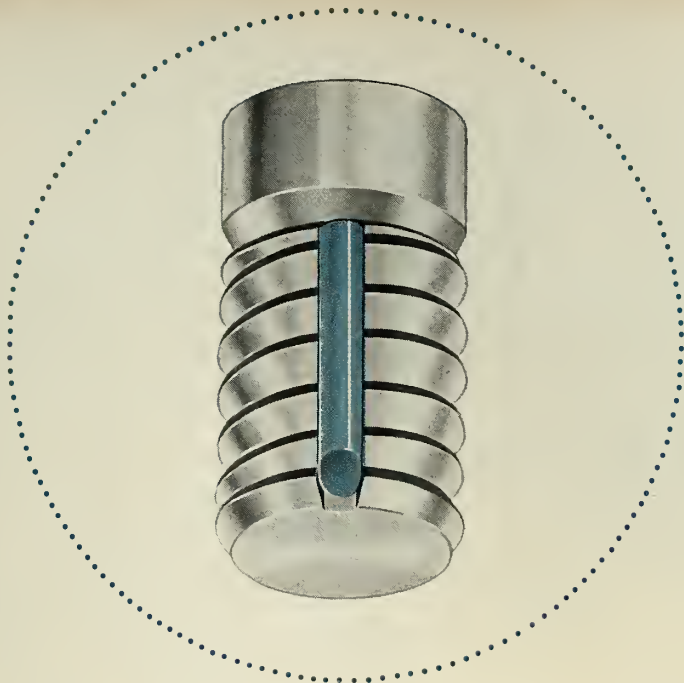
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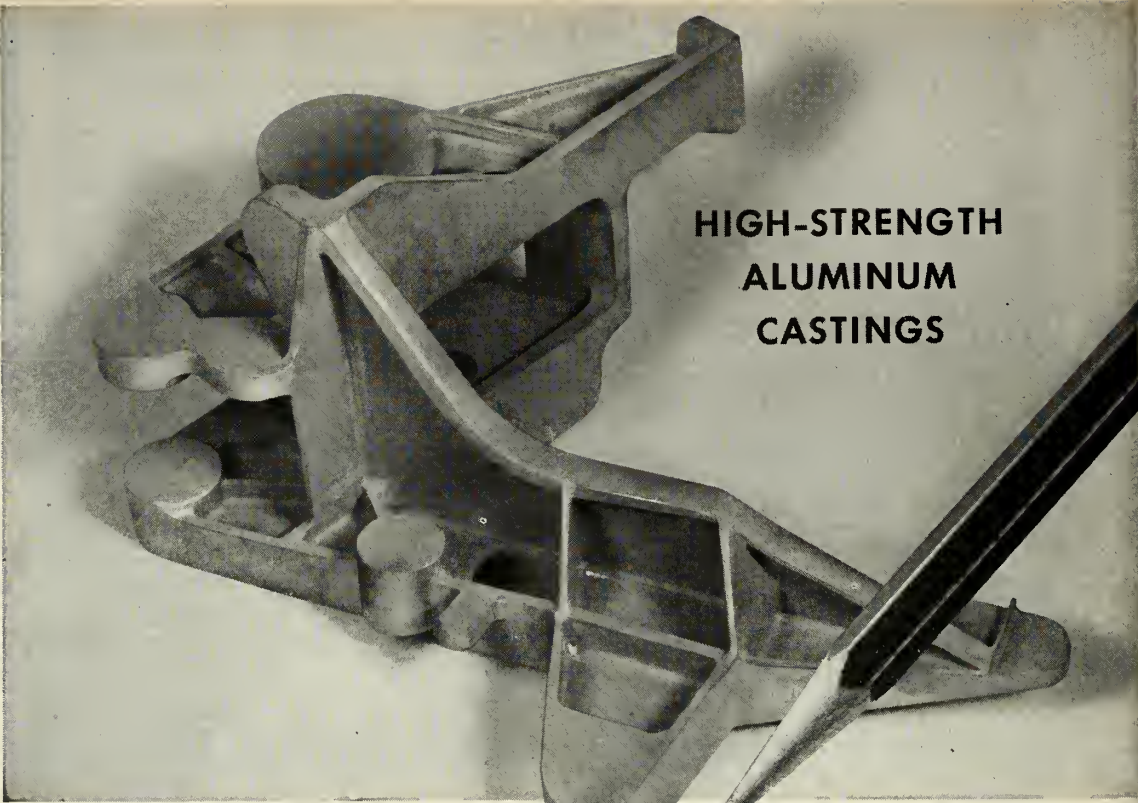
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cover

Dusk firing of the *TERRIER* missile from the battleship "*Mississippi*" three years ago set sea birds a-flutter and pointed the way for present day installations on board the "*Boston*," "*Canberra*" and other cruisers currently being converted to accommodate the air-to-surface bird. Even though previous tests of launching systems, radars and computers had been carried out from the U.S.S. "*Norton Sound*," the system on "*Ole Miss*" was the Navy's first experimental tactical installation. (See page 15 for latest developments.)

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World Astronautics

Astronautics is inherently an international endeavor, according to the delegates of the various IAF member societies.

At the IAF Congress in Amsterdam a week ago, a bold four-point program of international cooperation in spaceflight was adopted: it called for the collection and dissemination of information from one focal point concerning the plans and progress of spaceflight research activities of all nations. Further, the proposal called for international competition for selection of a number of research experiments to be conducted in earth satellites, and the establishment of a significant number of scientific research fellowships in astronomical subjects. An international conference for peaceful application of rocket vehicles, similar to an atoms-for-peace conference, also was proposed.

It may well be that the limitless space beyond the thin shield of the earth's atmosphere has no national boundaries. It may also be that a "dynamic situation exists today wherein a vacuum of knowledge pertains in much of the world with respect to detailed knowledge of the aim, problems, and progress in astronautics" as was pointed out by one American IAF delegate.

Undoubtedly, scientists and engineers in all countries would like to study, work and become identified with the evolution of astronautics on an international basis. We understand and respect this view. We are for World Astronautics.

We believe peaceful international achievement in any area of astronautics looms as the most promising of all man's advances. We also believe that much can be accomplished toward this goal through the formation of an international organization and possibly an international astronautics research academy, but we certainly do not believe that the International Astronautical Federation—with its incomplete organizational and inadequate financial structure—is capable of achieving any of these goals for the time being.

There was a time, not long ago, that the IAF needed the support of big-name scientists. Professor Theodore von Karman, at an informal luncheon in Amsterdam last week, put it this way: "We wanted to make astronautics a respectable science—so we invited respectable scientists to join us." Indeed, the IAF now has many outstanding members and its congresses are attended by more and more important researchers and en-

gineers. Why is it then, that the organization is so weak in action?

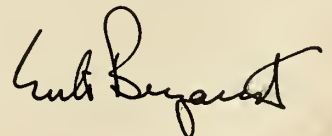
For several years a handful of energetic enthusiasts—we think Americans Andrew G. Haley and Frederick C. Durant III are among the outstanding ones—have tried desperately to obtain international recognition of IAF.

Haley has made fine progress toward a cooperative effort with important international bodies, including the United Nations, The International Council of Scientific Unions, The International Telecommunication Union and others. However, Haley is only one man, and the IAF will never get off the ground until its president has the support of a full-fledged secretariat and an adequate staff that is capable of rendering the kind of service that is always required to operate an international organization successfully.

It seems obvious to us that the IAF must concentrate on building an internal structure that will eventually lead to outstanding progress in the area of world astronautics. Until then, IAF will only be capable of offering proposals and no action. Indeed, the science of astronautics is about to run away from IAF.

As far as international cooperation in astronautics is concerned, we understand that "The lack of the all-important rocket launching vehicles needed to carry instruments into space . . . is causing a natural frustration." A delegate said: "This frustration, because of human nature, can lead to envy and bitterness." This may well be so, but the United States for one, certainly is not among those nations which are prepared to give away their rocket hardware. We are faced with a life and death race to overtake the Communists in this field.

We appreciate the views of IAF and its proposed drive to "open up" space rocketry to everyone. But as long as we are fighting a cold-war struggle for survival, and as long as we hardly are off the ground ourselves, we cannot see how the U.S. could participate in an international rocket hardware exchange. This country should naturally support a world astronautics science program, but we must take care of ourselves first.

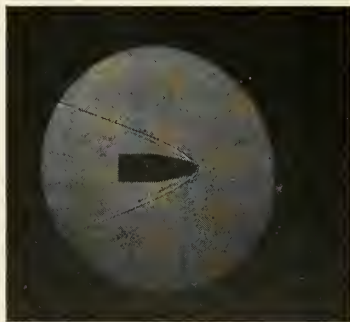




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industry countdown

labor trends

Sylvania Electric Products move to boost pay of non-union hourly workers—while the company continues negotiations with five unions—is being watched. What Sylvania did give to its non-union personnel is the same package it has offered the unions: a two year schedule of pay increases of from 5 to 11 cents an hour this September, a similar boost next August; continuation of cost of living wage and salary formula for hourly and salaried employees through August, 1960; a third week of vacations for employees with 10 years' service, starting in 1959; improvements in hospital insurance, company-paid group medical insurance programs. Currently, about half of the company's hourly employees are union members, and negotiations are being carried on with Machinists, Electrical Workers, Steel Workers, and two other union groups in their behalf. Sylvania added bait for union negotiators: If the company's offer is accepted within a specified period after Sept. 1, increases will be retroactive to that date.

how's business?

Key to the general optimism of electronics manufacturers (and to their generally good earning reports) can be found in expanding government uses of electronics, both for defense (largely missiles) and other purposes. For instance, defense agency outlays for electronics are expected to jump 120% over the next five years; other government expenditures for such items (including airways modernization and computer programs) may rise to a level of \$700 million yearly by 1963. Industrial uses for electronics are also rising fast. You can get an idea of what this has meant to industry out of reports such as that just turned out by **Northrop Aircraft, Inc.**, which showed sales of electronic and related equipment at \$63 million for the fiscal year ended July 31. That's about 25% of the company's total sales, according to W. C. Collins, Northrop president. More evidence: **D. S. Kennedy & Co.**, which designs and manufactures microwave antennas and equipment at Cohasset, Mass., figures its 1958 fiscal year earnings will double the \$6.8 million 1957 figure.

industry view

A sparsely-attended session (on "Project Management-Airframe and Electronic Viewpoint") at the recent WESCON show produced some strong industry opinions on handling of missile work. Said George Stoner, Boeing weapons systems project manager (Dyna-Soar): The difficulty of maintaining the "incredible" pool of skills required makes the contractor wonder (1) how to get paid for his investment (2) whether the prime's position wouldn't be improved considerably if there was an incentive in the contract. Said Richard L. Shelter, General Electric Co.: The decision on who should do systems management should be made on the basis of which technology controls the system. Oscar Simpson, Philco Corp., had some words about electronic firms as system managers: Some can handle the job, but many are too specialized for it. Final word was spoken by Col. Edward N. Hall, USAF's Ballistic Missile Division, who insisted: Systems management is a choice of who can do the best job at lowest cost.

company notes

Acme Precision Products Inc., Dayton, Ohio, "expects to acquire" **Cal-Tronics, Inc.**, Los Angeles electronics firm . . . **Cubic Corp.** has licensed the Italian Firm OTE to produce Cubic's SECOR missile tracking equipment on a royalty basis. The Italian-made equipment will be used on a missile test range planned by Italy on the island of Sardinia . . . **Aerojet-General** has set up a new systems analysis department within its Avionics Division . . . **American Missile Products Co.**, Lawndale, Calif., will supply electronic components to **Hughes Aircraft Co.**, from a newly-opened plant at Fullerton . . . **Mitre Corp.**, a nonprofit group sponsored by Massachusetts Institute of Technology, has been setup at Cambridge, Mass., to provide Air Force with a defense management system. Head will be H. Rowan Gaither of the Ford Foundation.

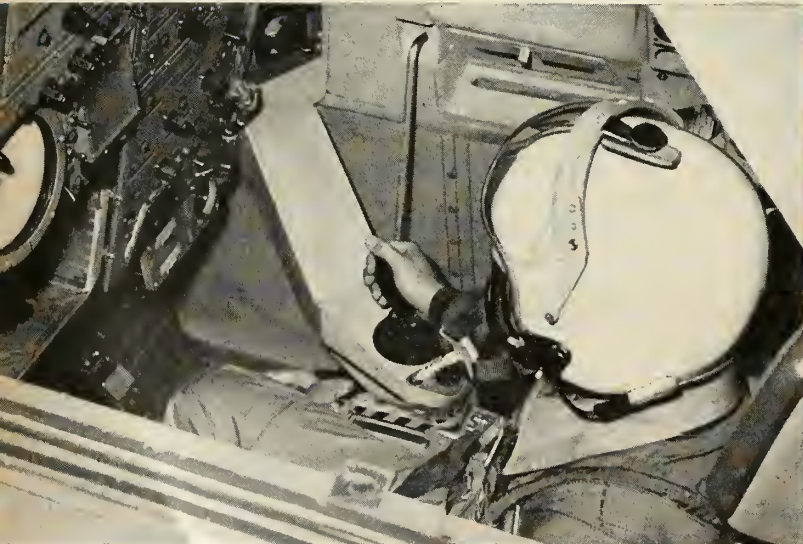
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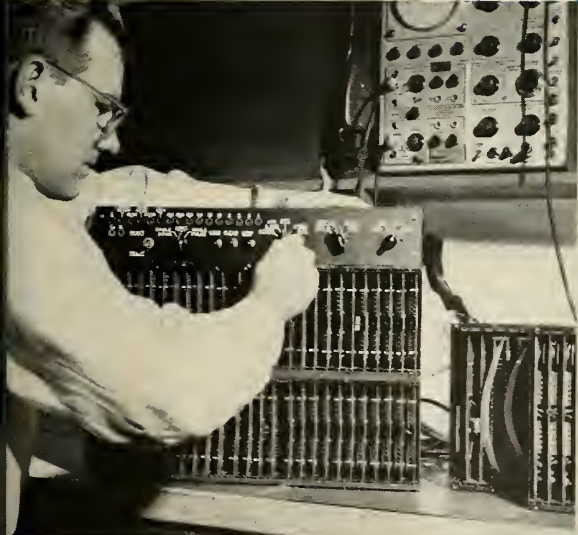


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washington countdown

The wide-open drive to spend money for missile and space programs shows signs of slowing down. Reason: there is a definite point in development of any weapon where additional money will not buy additional performance. The conduct of R&D programs is now dictated by engineering people who, in the words of one defense contractor, "always hope to achieve the ultimate in design by long and arduous series of changes which cause slippages in program time and hardware delivery."

There is some alarm in Administration circles that the successful launching of more sophisticated satellites (such as weather eyes and reconnaissance vehicles) will bring the issue of territorial rights in space to a head. U.S. policy in these matters is expected to be clarified soon. We won't make any space claims, but won't recognize others either.

Policy-makers might listen to Andrew J. Haley, president of the International Astronautical Federation, who told a space-law conference at the IAF Amsterdam meeting that he hopes the U.S. and Russia—the nations most likely to be the first to land men on the moon—will let the United Nations decide whether earth nations should be allowed to claim moon territory.

There is no restriction on the firing date of the first Army lunar probe. However, the failure of *Explorer V* may keep Army efforts channeled into the determination of the limits and intensities of the radiation band. And an ARPA official said that Air Force firing dates would have no effect on Army attempts.

ARPA will use both the Air Force and Army in the development of higher-thrust chemical engines on the order of one million pounds or more. Army Ordnance Missile Command reportedly has been authorized by ARPA to cluster (probably six) of the Rocketdyne 165,000 pound thrust *Jupiter* engines. Thinking is that this arrangement will give "early availability" of a high thrust engine "sufficient for military requirements," particularly in heavier satellites. Air Force has already awarded Rocketdyne a development contract for a single chamber one million pound thrust engine.

Attempts by the Naval Ordnance Test Station to put a satellite in orbit by launching it from an F8U airplane might not prove to be such a major scientific experiment after all. Latest rumors say that the "satellite" will really be on the order of the metal pellets launched in the Farside series last fall, rather than an orbiting, information-transmitting vehicle.

The concept, though, is not to be discounted. Raising a missile or space vehicle to something over 80,000 feet before launch cuts down first stage thrust requirements considerably. General Electric has been proposing (for over six months) to lift IRBM's to about that altitude with clusters of J79 turbojets. The engines and launcher would be recoverable and would inject considerable economy into the liquid-missile field.

- DOD Kills Manned Probe, Because . . .
- Possible X-15 Duplication
- USSR Program May Parallel



FORWARD SECTION of *Redstone* missile, shown here, would have been used in Army's Project *Adam* proposal to rocket a man 150 miles into space. "Man-in-space" portion has been cancelled because of conflict with X-15 program.

Army To Research *Adam's* Transport Potential

by Donald E. Perry

PROJECT *Adam*—The Army's proposal to put a man into space in less than a year—has been turned down by the Defense Department, but a go-ahead has been authorized to research its potentialities as a transport carrier.

Advanced Research Projects Agency confirmed to m/r that Project *Adam* will not be in ARPA's program for the specific use—man in space—for which it was submitted. However, ARPA considers the plan's transport potentialities worthwhile and will permit the Army to research these areas.

DOD feeling is that Air Force's X-15 rocket plane would be available about the same time as Army's modified *Redstone* rocket. And while Army could get a man higher—150 miles compared to less than 100 miles for the X-15—the experiments possibly would duplicate each other.

The belief that the X-15 will be available at the same time as the modified *Redstone*, is in conflict with testimony given to Congress April 15 by Dr. Wernher von Braun, director, Development Operations Division, Army Ballistic Missile Agency.

At that time, Dr. von Braun said "the X-15 cannot possibly be ready to reach 100 miles altitude at the time when we could hit 150. It will be substantially later (later 1959 or 1960) than our schedule (May or June, 1959 if approval had been given then)."

ARPA told m/r that "many components of Project *Adam* are worthwhile," and it does not intend to bypass the technical competence of ABMA to research these areas. But whether ARPA research funds will be available for Project *Adam's* transport features has not been determined.

Army contends there is a very definite need to use large ballistic missiles of several hundred miles range for the transportation of troops and supplies to fighting areas surrounded by the enemy. The service has pointed out that the use of ballistic missiles as accurate delivery system—fully and directly responsive to the will of the ground commander—will provide the firepower and selective force immediately at critical points where concentration is needed.

• **How to do it**—Use of pressurized capsules in the nose sections of ballistic missiles, Army believes, could possibly be more economical than transportation through the atmosphere by slow-moving troop and cargo-carrying aircraft vulnerable to modern fighter planes.

Large ballistic missiles—particularly the *Atlas* and *Titan*—can accommodate a considerable number of individuals in pressurized capsules along the lines of those now used as ejection devices in high-speed aircraft.

Army is researching ways to reverse the attitude of a missile during its pas-

sage through the vacuum portion of the trajectory so that individuals might remain "feet first" throughout. These capsules could be lowered to earth by the combination of parachutes to check velocity and reverse thrust rockets for final stabilization.

In Project *Adam*, the modified *Redstone* (*Jupiter-C*, configuration, minus the upper staging arrangement and Hydne fuel) would have had a 4,500 to 5,000 feet per second velocity at power cutoff when the nose section would have separated (m/r June, 1958, p. 40).

The capsule would have come to a near standstill at the apex of its ballistic trajectory, gaining a speed of about 5,000 feet per second when it re-entered the atmosphere. Two or three automatic drag parachutes would slow the capsule down and a parachute would have been deployed at an altitude of 7,000 feet.

The flight, lasting about 12 minutes and giving over six minutes of weightlessness, would have given an overall distance of 150 miles from launch point. Army said it could have landed within a half-mile from a waiting ship, giving early recoverability of the capsule and its passenger.

Adam was blasted in some quarters as a "publicity stunt," and the project, which first enjoyed Air Force participation, later was withdrawn. It would have investigated four areas of experimentation: safety of launching rocket,

weightlessness, aerodynamic heating, re-entry and recovery techniques. Four flights—costing an estimated \$10-12 million—had been planned. The first two would have utilized instrumented monkeys, the last two manned.

• **Russia ready**—Russia's counterpart to Army's Project *Adam* appears to be in full progress with Radio Moscow announcing last week that two dogs had been returned to earth safely after having been rocket launched to an altitude of about 281 miles.

Radio Moscow said a one-stage rocket with a total payload weight of 3,725 pounds took the dogs past a previous record of 132 miles, and special stabilizers prevented the rocket from rotating during flight. U.S. observers believe the experiment was a prelude to efforts to launch a man into space.

A photograph of a dog emerging from a rocket was made available to the U.S. press. It was the same as one published previously in *m/r*. (April 1958, p. 61).★

AMC Overhaul To Upgrade Weapon System Offices

Under a major reorganization of the Air Materiel Command announced last week, the Ballistic Missile Office, now headed by Brig. Gen. Ben. I. Funk, will report directly to Air Materiel Chief Gen. E. W. Rawlings.

Aim of the AMC overhaul is to make the current decentralization of authority to Air Materiel areas function, and to upgrade the authority of Weapon System Project Offices.

The Directorate of Procurement and Production, will have its staff elements separated from the operational elements.

The new Aeronautics Systems Office will have responsibility for strategic systems, air defense systems, tactical and support systems, equipment and resources. Strategic systems include strategic and guided air missiles, B-52, B-58, B-70 and advanced nuclear bomber weapon system project offices.

Operational elements, such as the weapons system project offices will stay in their present location. They will, in effect, become an order-placing unit handling major procurement items not shifted to the AMA's.

The reorganization shifts will be made over the next six months. Meanwhile, other steps in general reorganization of DOD became effective last week, with a change in the structure of the Joint Chiefs of Staff. Under the new setup, JCS will work through a director and deputy director of a joint staff; this staff, in turn, to be divided into nine major parts. The JCS secretariat will not be affected.

Navy to Simplify Missile Systems

by William O. Miller

The Navy has taken a big step forward in simplification of its surface-to-air missiles systems with an 85% interchangeability of parts for an advanced version of *Terrier* and the forthcoming *Tartar*. Though the *Tartar* is much smaller, the capability involves certain parts of the air frame, servo systems and guidance systems, and is the result of a deliberate effort to make the two missiles as much alike as possible for logistics reasons.

Additional advantages are seen by Naval planners in requirement of fewer production lines, a simplified and dual-purpose training program for personnel, and a general streamlining of the missiles which rapidly are replacing the Navy's five-in. guns.

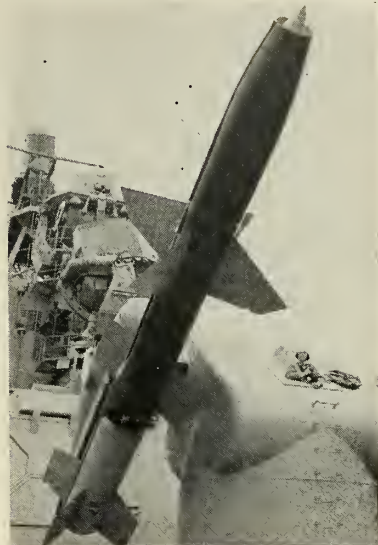
Budgetary limitations and rising cost are a factor, Navy spokesmen admit, but the foregoing points are basic in the philosophy for advanced weapons planning. Simplification and interchangeability, and a reduction in the overall number of missiles, is a strong consideration in any long range planning, they say. By long range planning, the Navy means a project of at least 10 years.

"We'd like to have one missile which we could use for all purposes," one Navy spokesman said, "However, we know this is not practicable. But we do foresee getting along eventually with two—a long and a short range dual purpose missile."

Presently, the Navy has the longer range *Talos*, the *Terrier* and the forthcoming *Tartar*. Navy spokesmen said that the reduction in number is a long range goal, and should not be construed as meaning the elimination of any specific missile from the program. Testimony before congressional committees has indicated that *Tartar* will have the capability of the earlier *Terrier* and it is hoped that eventually *Terrier* will be equal to *Talos*.

Best guess is that there will be a marriage of advanced versions of *Talos* and *Terrier*. The long range capability of *Talos* is good, but its 20-ft. length requires at least a cruiser for a launching platform. Miniaturization of all missiles including both *Talos* and *Talos* (nuclear warhead version) has high priority.

• **Storage life**—Another step forward in the art of making and keeping missiles is an improvement in the "shelf life" the Navy has been getting from some of its missiles. *Terriers* which had been stored aboard an ammunition ship in the Mediterranean for more than eight months recently were



MAIN BATTERY of the Galveston type cruisers will be the long range *Talos*.

tested, with an extremely high percentage of satisfactory checkout. In fact, the Navy recently has cut the number of tests required for *Terriers* in storage to one-third. The same high reliability is anticipated for *Talos* and *Tartar*, a Navy official said.

While not yet in the production stage, the Navy is reported highly pleased with the recent tests of prototype *Tartars*. *Tartar* is expected to be ready for the first of the new construction destroyers scheduled for completion in 1960 (*m/r* July 14).

Simplification, reduction in numbers, interchangeability of parts, extensions of range, increase of payload and development of dual purpose capability are all fruits of the Navy system. As rear Admiral P. D. Stroop, Chief of the Bureau of Ordnance recently told a congressional subcommittee:

"The risk, technologically and economically, of producing an obsolete weapon on quantity is materially reduced by projecting research and development work well into the production of missiles.

"In procurement of missiles, the Bureau of Ordnance has followed a modified approach to what is known as the weapon system concept; the extent of modification being determined by the complexity and ultimate use of the particular weapon in question."

Despite a reduction in the number of different missiles, the scope and speed of Navy missile advances points the way to the eventual exclusion of all other weapons, many observers predict.

UN To Rule On Space Law?

THE HAGUE, NETHERLANDS—A new international convention should be established to settle legal problems involved in the development of international astronautics. This was resolved by a colloquium on space law of the International Astronautical Federation.

(Meanwhile, the National Academy of Sciences at Washington announced the appointment of a four-man committee of scientists, headed by Dr. W. Albert Noyes, Jr. of the University of Rochester, to propose a U.S. program for international control of space exploration.)

Attended by legal experts from 20 countries, the colloquium called for the setting up of a permanent legal committee within the framework of the IAF to study space law problems. It also resolved that the United Nations should be informed of the plans approved by the colloquium. Some delegates felt that the United Nations itself should tackle the question of establishing a special agency to work out legislation for "the fourth dimension of our age."

There was general agreement among delegates that the International Civil Aviation Organization is not the agency that should be entrusted with doing the spade work on this problem. U.S. Congressman K. B. Keating, New York, put it this way: "There is a very real likelihood that ICAO, both by its charter and because of predisposed and specialized ways of thinking, is not the proper agency for the job."

• **Flight plans?**—Keating suggested a number of topics for discussion on



DR. L. E. SEDOV, chief Russian delegate, explains rocket principles.

a code for outer space: the filing of "flight plans" for satellites and missiles; continuing agreements for exchange of technical information on the performance of spacecraft and the accumulation of data; workable schedules for spacecraft broadcasting (use of frequencies, single codes, cooperative triggering of transmissions to permit more accurate reception of information); return-to-earth covenants (surrender of craft downed on foreign soil, and liability for possible trespass and damage); navigational cooperation to facilitate fixes, telemetering and rescue;

possible agreements on safe passage for scientific craft.

Several experts suggested that the IAF should go slowly in its study of the problems of space law.

John Cobb Cooper, for example, believed that before any recommendations are made by IAF it should be decided whether to pursue the objective of an air-space upper boundary, or whether to consider the proposals for new international agreements dealing with flight control irrespective of the sovereign status of different space areas.

• **Terminology?**—Other experts believe that the first task in tackling the problem of space law is to define the terminology involved. They would like to see IAS compile a glossary of terms used in matters relating to space flight. In order that future developments in space flights will not be impaired, some spokesmen caution against making an international convention too restrictive in its wording.

The problems caused when a space vehicle returns to earth were discussed by Dr. I. H. Ph. de Rode-Verschoor of the Netherlands. She stated that nations are responsible for their satellites when they return to earth, and third parties must be protected as much as possible.

George J. Feldman, director and chief counsel for The House of Representatives' Committee on Astronautics and Space Exploration, called for adherence to the twin principles of freedom of outer space for non-exclusive peaceful purposes and the prohibition of military uses, particularly for atomic and nuclear warheads.

• **Officers**—At final sessions, IAF delegates re-elected Andrew G. Haley of Washington as president.

Named as vice-presidents were: T. M. Tabanera of Argentina; E. Saenger of Germany; L. R. Shepherd of the United Kingdom; L. E. Sedov, Soviet Union; K. Zarankiewicz, Poland. J. Stemmer was re-elected secretary. The delegates selected London, in mid-September of 1959, as the site and date for next year's meeting.

Navy to Build \$10 Million Polaris Facility

A \$10 million *Polaris* missile assembly will be built at the Naval Ammunition depot, Charleston, S.C.

Construction work will be begun late this fall and will be completed in about 16 months. The new facility will be built 18 miles North of Charleston on the Cooper River.

missiles and rockets, September 8, 1958



Army

ARMY TECHNICIANS ready Thiokol's new rocket motor for first static firing at Redstone Arsenal. The solid propellant rocket motor achieves a thrust of possibly 450,000 lbs. for a short duration, and probably will be used in the Nike-Zeus air defense missile.

- **Polaris Subs Have Bomber's Striking Power**
- **Separate Funding For These Subs Urged**
- **Bureau System of Management Criticized**

Red Missile Subs Held Threat To U.S.

Frank G. McGuire

A REPORT whose importance is far greater than its size has been released by the Joint Committee on Atomic Energy. The 14-page document on undersea warfare was compiled by the advisory panel of the Military Applications subcommittee and makes a number of serious revelations about our missile-submarine capabilities as compared with those of the USSR.

Two recommended actions which would give the U.S. undersea fleet its biggest boost would be separate funding for the *Polaris* system and a change in our submarine thinking. At the present time, funds for *Polaris* submarines come from the Navy's regular shipbuilding budget. This appropriation covers the building of carriers, cruisers, frigates, destroyers, tenders, and all of our other naval vessels.

"A *Polaris*-launching submarine is thus treated fiscally like any other naval vessel," the report points out. "In terms of its military mission, however, it is radically different from the other ships of our fleet."

"Actually, the *Polaris* system is a part of our national military deterrent against all-out war. It is an instrument of strategic reprisal. It is more analogous to a SAC bomber or a land-based IRBM or ICBM than to other ships of our Navy."

"We recommend that, for funding purposes, the *Polaris* system be entirely removed from the Navy's shipbuilding budget . . . that construction budget requests for the *Polaris* system be determined by the Secretary of Defense and the National Security Council, as part of our overall strategic deterrent budget."

• **Defense Preparations**—The advisory panel lists 17 findings, including:

1. The time is rapidly nearing when the Soviet Union can possess a large fleet of IRBM-launching nuclear-propelled submarines.

2. The Soviets could mount a devastating nuclear-warhead attack from the sea against the U.S. early in the 1960s.

3. Our existing defensive system could not stop such a missile attack.

4. No weapons system now in existence, even on an experimental basis, offers an adequate defense against non-

snorkeling submarines which run quiet and deep.

5. It is very doubtful whether the present scale and scope of research and development in undersea warfare will give us an effective defense against nuclear submarines in time to meet the threat.

6. Although defense against *Polaris*-type submarines may soon equal the problem of air defense in urgency, the funding of R&D in support of operational requirements for ASW (anti-submarine warfare) has been grossly inadequate, when compared with the support given such programs as air defense and missile development.

7. Assuming no modification of our present and planned submarine-construction program, it is believed that the Soviets will have it within their capability to build a larger nuclear submarine fleet than our own by the mid-1960s.

8. The *Polaris*-system possesses unique advantages as a deterrent force, and it is a matter of national importance that a force of *Polaris* submarines be brought into being at the earliest possible date.

9. The bureau system of the Navy has serious shortcomings in the present era of highly integrated and complex weapons systems.

• **Recommendations**—The report, noting that "The sea could be our enemy as never before," holds a warning tone throughout and makes twelve recommendations for correcting the problems cited. It suggests at doubling

the Navy's R&D budget for ASW work in 1959, with substantial increases later.

Great emphasis is also placed on increased basic research, on oceanography, and utilization of private research facilities such as universities. The scale and rate of our attack submarine construction program should be significantly increased, according to the report, and the Navy should immediately proceed with the building of an initial task unit of nine *Polaris* submarines.

The advisory panel recommends that development of underwater atomic weapons be increased and that information be gathered on the nature and effects of underwater atomic explosions. A "limited number" of vertical management organizations, under officers reporting directly to the Chief of Naval Operations, should be established for such projects as ocean surveillance systems and attack submarine systems.

During World War II, the report points out, we confronted a maximum of 440 German U-boats, not equipped with snorkels, and with limited underwater endurance. The speed of these craft did not exceed 12 knots underwater. Facing this menace, we had a total of 950 ocean going escorts and 2,200 ASW aircraft.

The U.S. now has 300 escorts and approximately 700 ASW aircraft, operating against a Soviet undersea force numbering about 475 vessels with much greater range, speed and destructive capability than any of the German fleet.

McElroy "Won't Be Pushed" Into Spending

• **Chicago**—The spending ceiling on long range ballistic missiles has been reached for the present, Secretary of Defense McElroy told the national convention of the American Legion.

"In the business of the defense of America, we are willing to take greater gambles on weapons than the boards of directors of business enterprises would vote to risk on untried products.

There is a point, however, beyond which gambling huge sums on untried weapons would be foolhardy—would, in fact, endanger the economic, and even the military, security of the country," the defense chief said, "In the development of our long-range bal-

listic missile programs, your defense board of directors believes we are at the point where spending of more tax dollars would, at this time, be an unwarranted risk of your money."

Additional production will be warranted largely by additional information from research and development. Otherwise, the Secretary said, "We might very well find our shelves cluttered up with unuseable duds—a drug on the weapons market and a drag on our defense resources."

Secretary McElroy repeated that he did not intend to be pressured into spending tax dollars on unproved programs.

SAC Crews Start Atlas Training

Phase One or "factory" training began last month for Air Force crews to be assigned to *Atlas* ICBM stations of the Strategic Air Command. Some of the military personnel will man operational bases—others will be assigned as instructors to aid in crew training.

The program is being conducted by Convair Astronautics, through customer training section of the product support department. Also lending a hand is the Air Training Command and SAC.

Phase One is the first of two major training steps. Phase Two, also called "integrated weapons system training," will be offered at Vandenberg AFB, Calif., new SAC ballistic missile training center (m/r., Aug. 25, p. 20).

Personnel for the first classes at Convair-Astronautics have been drawn from Air Force Supervisors and planners for an overall course in the weapons systems. Each course will run three weeks and additional courses are scheduled into 1960.

When the major training effort begins later this year, students will be

selected from Air Force specialists in hydraulics, fuel systems, instrumentation and about two dozen other categories. All classes will be small with a maximum of about 10 students. Most of these groups will study for a period of three to six months in San Diego.

Study will be divided between the classroom, "on the job" training at the Astronautics plant, and work at the Sycamore Canyon *Atlas* tests site.

Instruction will include actual work with hardware, components and systems. A complete missile with all its checkout equipment will be made available to the classes. Detailed training aids will be used, including "bug" systems which create malfunctions for trouble-shooting experience.

When the initial courses are completed, students will be skilled in specialized tasks and capable of acting as operators in the blockhouses during a launch operation.

During Phase Two training, in which Astronautics will also play a major part, individual specialists will be grouped into crews for additional training until ready for operational assignments.

Curtiss-Wright Starts Solar Energy Program

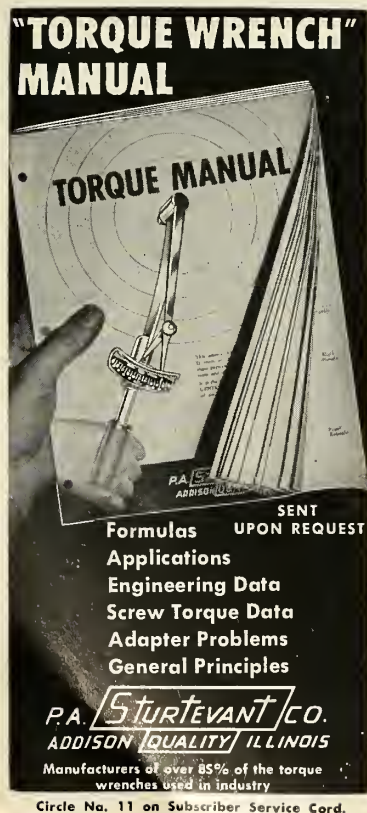
A solar energy program, with emphasis on development and production of commercially salable products based on existing patents and knowledge has been started by Curtiss-Wright Corp., in cooperation with New York University.

The company is now building a "Sun Court" at its Princeton, N.J. division, which will include a solar heated house and batteries, stills, driers, furnaces, cooking equipment, radios and food processing equipment activated by solar energy.

Correct von Braun Moon Rocket Prediction

Somewhat confused trans-Atlantic communications could be blamed for a slight twist in reporting one item from last week's IAF meeting at Amsterdam.

As the story reached m/r's Washington editorial headquarters, Dr. Wernher von Braun was quoted as saying that the Army would launch its moon rocket in October. Left out of the message were these vital italicized words: "I *don't* know if we will fire in October. *Certainly* we will fire when we are ready."



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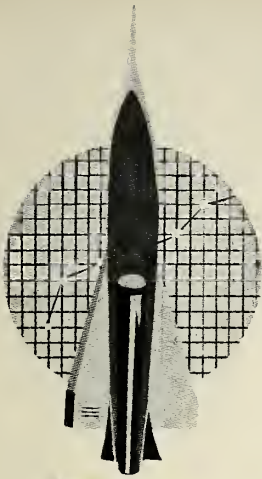
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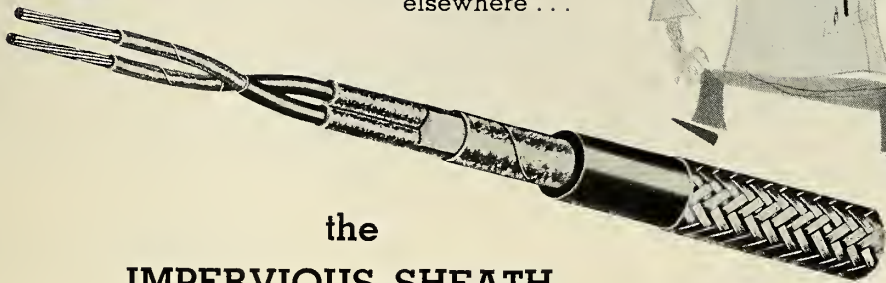




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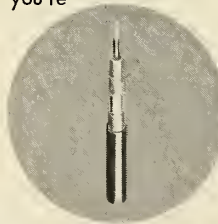


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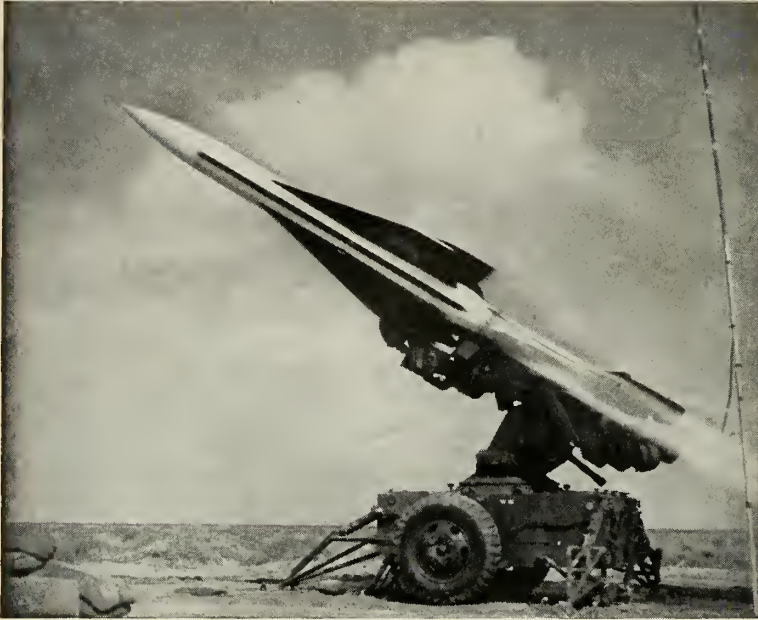


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BEDFORD, MASS.

Hot Gas Engine Designed To Speed Space Craft

An engine that would rain hot gases through magnetic fields to propel a space ship once it got beyond earth's pull of gravity has been designed by Republic Aviation Corp. The engine would produce thousands of pounds of thrust for each pound of fuel, as compared with a few hundred pounds of thrust per pound of fuel in present rocket-type engines.

The engine, however, wouldn't have enough initial quick power to lift a space ship off the ground and push it through the earth's gravitational field, Republic said. This job would be done by chemical fuel rockets.

This engine is the latest device in the growing field of magnetohydrodynamics, or MHD. MHD processes make use of the fact that when a gas is heated beyond a certain temperature, it becomes electrically charged and can be controlled by magnetic fields. However, scientists think it will be at least five to ten years before MHD will be pushing vehicles through space.

Soviets Continue Launch Of Atmosphere Rockets

The Soviet Union has launched a total of 36 meteorological rockets for upper atmosphere research during the period of November 1957 to May 1958, it has been reported in the Soviet press.

The launchings have been made from the Soviet IGY station at Franz Joseph land in the Arctic, and the Soviet expedition ship "Ob." The "Ob" has been cruising in the southern latitudes and has fired off the coast of East Antarctica; in the vicinity of Snares Islands, N.Z.; in the Tasman Sea; the Ross Sea; and in the meridional sector from Bellingshausen Sea to Easter Island.

Engineers In Demand By Electronic Firms

As defense contracts mount, electronic firms are snapping up engineer graduates at rapid rates. Every one of last year's 33,000 engineering graduates has had at least one job offer, reports New York's Engineers Joint Council.

Salaries offered range from around \$7,000 for less experienced men to \$18,000 for senior specialists. Extra inducements are being offered by some companies . . . such as taking a prospective employee's house off his hands if he is offered a job in a distant locality. Pirating . . . raising a competitor's staff . . . is on the rise again.

static equipment

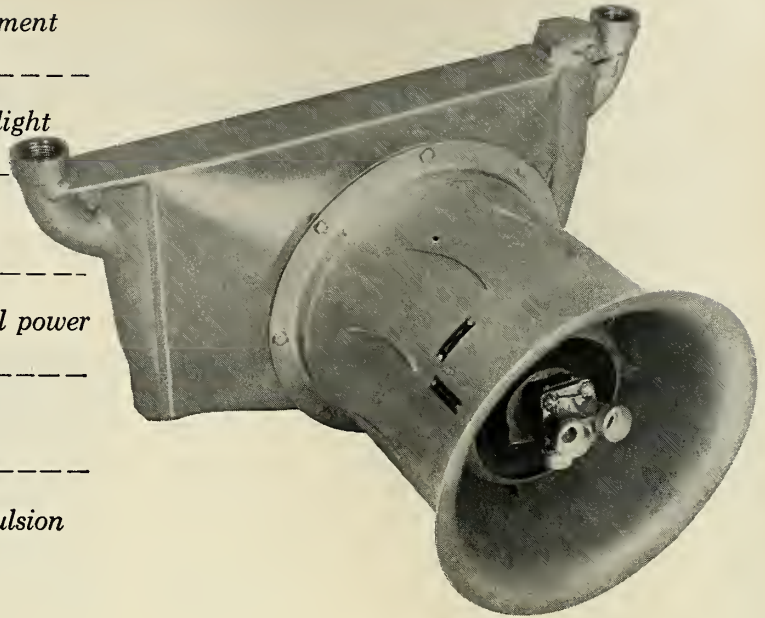
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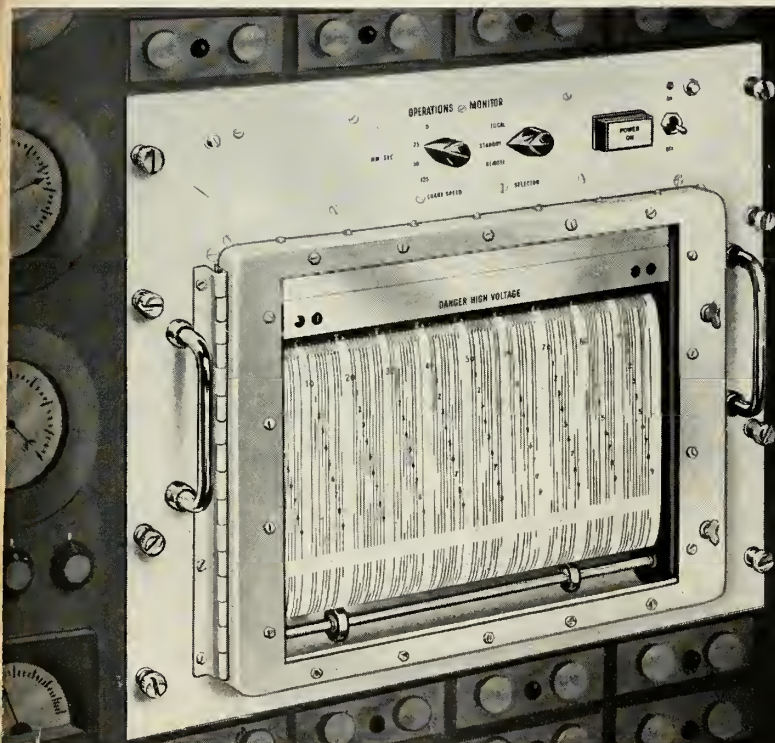
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Wires and Cables: Vital To Missiles

Here is the latest on the machines that make them, evaluate them, and units that connect them.

by Peer Fossen
and
Raymond M. Nolan

In this special report to its readers, m/r describes a group of new developments in the wire and cable field. Teflon, reviewed here in detail, may become the most widely used insulation product for missile wiring.

The Automatic Cable Evaluator is a good example of sequential checkout equipment which will become more and more important as deterrent missiles move into the solid propellant, instantly available generation. The cabling machine described is a notable advance in wiring assembly, since it means that cables can now be fabricated on location at firing sites.

The "Poke-Home" connector with its solderless connection and assembly of wires to contacts is another product reviewed.

On pages 30 and 31, a survey of some representative products in the printed cabling field is presented in a two-page table.

Teflon

Current developments in electrical design call for more and more miniaturization, resistance to higher and higher temperatures, and better dielectric properties. Often all three are required at once. Many of these difficult design problems are being solved with the help of Du Pont Company's Teflon fluorocarbon resins, and their exceptional combinations of properties.

- **General properties**—Much of the success of products made of Teflon (TFE-fluorocarbon resins results from a combination of properties that is not to be found in other engineering materials.
- Exceptional thermal stability (from -450°F . to $+500^{\circ}\text{F}$.).
- Outstanding electrical properties.
- Lowest coefficient of friction of any solid (0.04).
- Almost universally chemically inert.
- High flex life.
- Excellent impact strength.
- Unaffected by outdoor weathering.
- Essentially zero water absorption (less than 0.01% by A.S.T.M. test).

• **Important electrical properties**—*High Dielectric strength*—Short-time dielectric strengths are high, and are un-

affected by aging at high temperatures. The dielectric strength of any material varies inversely with the thickness. For materials made of Teflon TFE-fluorocarbon resins, these values range from 4000 volts per mil in $\frac{1}{4}$ mil film to 400 volts per mil in thickness of $\frac{1}{4}$ inch and greater.

Flat Dielectric Constant and Dissipation Factor—Both the dielectric constant and dissipation factor of parts made of Teflon resins change less over a wide range of temperature and frequencies than do the corresponding values for any other solid. They are absolutely constant from below 60 cycles to above 10,000 megacycles (the spectrum measured to date), and are unaffected by time or heat aging. Because of the low dissipation factor at all frequencies, Teflon resins make the best dielectrics for high-power pulse-forming networks such as those used in radar transmitters, which operate as high as 25,000 volts.

High Surface Arc Resistance—The surface arc resistance of materials made of Teflon resins is high. When subjected to a surface arc, insulation of a Teflon resin will not crack or form a carbonized conducting path. This feature enabled electrical engineers to solve a long-standing problem in traction motors where brush holders of

the best epoxy resins failed in less than a month. Now brush holders insulated with a Teflon resin provide dependable performance with no failures caused by surface arc.

High Insulation Resistance—Both the volume and surface resistivity of parts made of Teflon resins are high, and are unaffected by time or high temperatures. The volume resistivity is greater than 10^{18} ohm-cm., even after prolonged soaking in water. Equally as good, the surface resistivity is 10^{17} ohms per sq., even at 100% relative humidity. When tested for six months at 250°C ., both the surface and volume resistivity were completely unaffected.

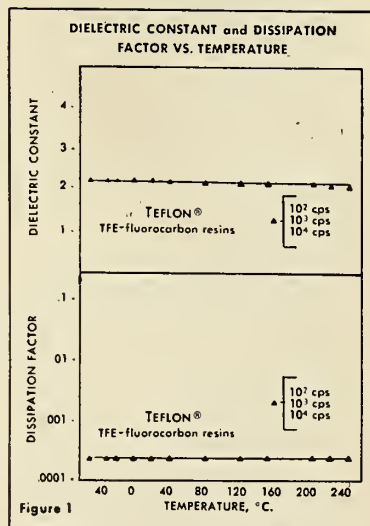


Figure 1

• **Special design considerations**—Actual use surveys show that in many cases, parts made of Teflon resins are specified to take advantage of special design possibilities in addition to their excellent electrical properties.

Ease of Fabrication—Miniaturization and complex electrical systems

... special report on wires and cables

CABLE

Advanced Electronics, Inc.
Aerolite Electronics Corp.
Aeronautical & Instrument Div., Robertshaw-Fulton Controls Co.
Alden Products Co.
All American Aircraft Products, Inc.
Alpha Wire Corp.
Aluminum Co. of America
Amelco, Inc.
American Electric Cable Co.
American Insulated Wire Co.
American Steel & Wire Div., U.S. Steel Corp.
American Super Temperature Wires Inc.
Anchor Specialty Mfg. Co. Inc.
Andrew Corp.
Ansonia Wire & Cable Co., The Associated Co., Inc.
Aviation Developments Inc.
Barker Sales Co.
Belden Mfg. Co.
Bergen Wire Rope Co.
Berkshire Electric Cable Co.
Birnbach Radio Co., Inc.
Bliss Electronic Corp.
Boston Insulated Wire & Cable Co.
William Brand & Co., Inc.
California Technical Industries
Cambridge Wire Cloth Co., The
Chester Cable Corp.
Coaxial Connector Co. Inc.
Consolidated Radio Products Co.
Consolidated Wire & Associated Companies
Cooper Development Corp.
Copperweld Steel Co., Wire & Cable Div.
Dale Products, Inc.
Dayton Aircraft Products, Inc.
Dwyer Engrg. Co., Inc.
Dynamic Gear Co., Inc.
Elco Corp.
Electric Auto-Lite Co., The, Wire & Cable Div.
Electric Parts Corp.
Elgin Micronics, West Coast Div.-Elgin National Watch Co.
Empire Electronics Co., Inc.
Essex Wire Corp.
First Electronics Corp., The
Food Machinery & Chemical Corp., Ordnance Div.
General Cable Corp.
General Electric Co., Missile & Ordnance Systems Dept.
Greenleaf Mfg. Co., The, Div.-Mandrel Industries
Hallamore Electronics Co.
Hallett Mfg. Co.
Hammett Electric Co.
Harco Labs, Inc.
Hitemp Wires, Inc.
Hoover Electronics Co.
Industrial Television Inc.
Industrial Wiring & Cable Co.
International Electric Industries, Inc.
Jefferson Products Co.
Kahn & Co., Inc.
Key Resistor Co.
Kilgen Aircraft Div., The Kilgen Organ Co.
La Pointe Industries Inc.
Lane Electronics Mfg. Corp.
Lewis Engrg. Co., The
Lytle Engrg. & Mfg. Co.
Miljan Div., Paul Omohundro Co.
Minneapolis-Honeywell Regulator Co., Aeronautical Div.
Missile Engrg. Products, Inc.
Mohawk Wire & Cable Corp.
Mutron Corp.
National Standard Co.
New England Electrical Works, Inc.
Normandy Electric Wire Corp.
Organic Development Corp., Spectra-Strip Div.
Pacific Automation Products, Inc.
Phelps Dodge Copper Products Corp.
Plastoid Corp.
Precision Tube Co., Inc.
Prodelin Inc.
Pyle-National Co., The
Reid Metal Products, Inc.
Resdel Engrg. Corp.
Rex Corp., The
Rockbestos Products Corp.
John A. Roeblings Sons Corp.
Rome Cable Corp.
Rowe Industries
Royal Electric Corp.
Schaeffer Air Industries, Inc.
Scintilla Div., Bendix Aviation Corp. Sealectric Switch & Relay Corp.
Sequoia Wire Co.
Southwest Products Co.
Southwestern Industrial Electronics Co.
Surprenant Mfg. Co.
Technical Appliance Corp.
Telecro Industries Corp.
Teleflex Inc.
Teletronic Labs., Inc.
Terminal Radio Corp.
Thermax Wire Corp.
Thompson Products, Inc.
Times Wire & Cable Co., Inc.
Tri-Dex Co.
Tucson Instrument Corp.
Twix Mfg. Co., Inc.

Uniwave, Inc.
Victor Electric Wire & Cable Corp.
Warren Wire Co.
Wells Industries Corp.
Western Insulated Wire Co.
Western International Co.
Westronics Inc.
Westwood Cable Corp.
Wickfield, Inc.
Wilmar Mfg. Co., Inc.
Winder Aircraft Corp. of Fla.
Wire Co. of America, Inc.
Wunderlich Radio Co.
Zippertubing Co., The

CABLE ASSEMBLIES

AC Spark Plug Div. General Motor Corp.
ACF Industries, Inc., Advanced Products Div.
Advanced Electronics, Inc.
Aerolite Electronics Corp.
Aeronautical & Instrument Div., Robertshaw-Fulton Controls Co.
Alden Products Co.
All American Aircraft Products, Inc.
Alphs Wire Corp.
Amelco, Inc.
American Electric Cable Co.
American Electronic Labs., Inc.
American Machine & Foundry Co.
American Super-Temperature Wires, Inc.
Anchor Specialty Mfg. Co. Inc.
Arens Controls, Inc.
Associated Co., Inc.
Beldon Mfg. Co.
Bergen Wire Rope Co.
Berkshire Electric Cable Co.
Birnbach Radio Co. Inc.
Bliss Electronic Corp.
William Brand & Co. Inc.
California Technical Industries, Div.-Textron Inc.
Centronix Inc.
Coaxial Connector Co. Inc.
Consolidated Wire & Associated Companies
Cooper Development Corp.
Cromer Mfg. & Engrg., Inc.
Dale Products, Inc.
Dwyer Engrg. Co., Inc.
Elco Corp.
Electric Parts Corp.
Electronic Assembly Co., Inc.
Electronics Dept. Hamilton Standard Div.
United Aircraft Corp.
Elgin Micronics, West Coast Div., Elgin National Watch Co.
Empire Electronics Co., Inc.
Essex Mfg. Co., Inc.
First Electronics Corp., The
Food Machinery & Chemical Corp., Ordnance Div.
General Railway Signal Co.
Greenleaf Mfg. Co., The, Div.-Mandrel Industries Inc.
Guardian Electric Mfg. Co.
Hallamore Electronics Co.
Hallett Mfg. Co.
Hammett Electric Co.
Harco Labs, Inc.
Hi-Lo Manufacturing Corp.
Hitemp Wires Inc.
Hooner Electronics Co.
Industrial Wiring & Cable Co.
International Electric Industries, Inc.
Walter K. Jaros, Aircrafts
Kahn & Co., Inc.
Kaiser Aircraft & Electronics Div.-Kaiser Industries Corp.
Kilgen Aircraft Div. The Kilgen Organ Co.
La Pointe Industries Inc.
Lane Electronics Mfg. Corp.
Lewis Engrg. Co., The
Lytle Engrg. & Mfg. Co.
Machine Engrg. Co., Inc.
J. A. Maurer, Inc.
Methode Mfg. Corp.
Minneapolis-Honeywell Regulator Co., Aeronautical Div.
Missile Engrg. Products, Inc.
J. J. Monaghan Co.
Mutron Corp.
Network Mfg. Corp.
Normandy Electric Wire Corp.
Organic Development Corp., Spectra-Strip Div.
Pacific Automation Products, Inc.
Phaestron Instrument & Electronic Co.
Phllico Corp. Government & Industrial Divs.
Precision Tube Co., Inc.
Reeves Instrument Corp.
Resdel Engrg. Corp.
Rex Corp., The
John A. Roeblings Sons Corp.
Rowe Industries
Royal Electric Corp.
Schaeffer Air Industries, Inc.
Scintilla Div., Bendix Aviation Corp.
Sealectric Switch & Relay Corp.
Sequoia Wire Co.
Shaw Metal Products Corp.
Sheltered Workshop
Sittler Corp.
Sonex, Inc.
Southwest Products Co.
Superelex Electronics Corp.

call for materials which simplify assembly. Certainly one of the most important assembly and service savings is the ability of insulation of Teflon to withstand solder iron temperatures. Soldering operations can be performed speedily; service failures are reduced, thus lowering inspection requirements; and electricians can carry out maintenance jobs with little or no chance of destroying insulation.

Because Teflon resins have the lowest coefficient of friction of any material, electronic components can be installed quickly and easily in compact assemblies. Miniature feed-thru insulators of a Teflon resin take advantage of this property, together with the good plastic memory. They are stiff but can be deformed enough to be quickly snapped into place. Another example is spaghetti tubing made of Teflon resins, which can be easily slipped over long conductors.

Reliability—Insulation of a Teflon resin is unaffected by soldering iron temperatures, thus improving reliability. Also, Teflon resins contain no plasticizer to cause failure due to brittleness. Insulation of a Teflon resin will not heat age, will not oxidize, and will withstand high transient overloads. More and more safety devices are being made, even more reliable with insulation of a Teflon fluorocarbon resin.

Space and Weight Savings—Because of the ability of insulation of a Teflon resin to withstand high temperature center conductors can operate at high temperatures, and accordingly carry much more power for the same cross section than with ordinary insulation. For example, at room temperature the substitution of coaxial cable with core of a Teflon resin permits a four to one weight saving and an eight to one space saving for equivalent power over coaxial cable with a core of polyethylene. This same principle is applicable to all types of electrical components. Thus, a complete electric chassis can be reduced in size and weight by the use of Teflon resins.

CODE	CORE DIAMETER	CORE MATERIAL	RELATIVE POWER RATING
RG 58 A/U	0.116 in.	Polyethylene	1
RG 188/U	0.06 in.	TEFLON® TFE-fluorocarbon resins	2

Figure 2

Insulation in Extreme Temperatures—In addition to the reliability and weight savings realized through use of Teflon resins in high ambient

temperatures, there are many requirements for an insulation that will perform satisfactorily at temperatures above 500°F for short periods. Particularly important among these are: areas where resistance to fire is needed in emergencies (safety equipment and warning devices); short-lived guided missiles; and insulation to withstand high thermal overloads for short periods of time (wiring in motors or generators where unexpected power surges are possible).

Teflon TFE-fluorocarbon resins are able to retain their good insulating properties at temperatures above 500°F for relatively long periods of time. This is possible because of their high melt viscosity and their very low weight loss at high temperatures. Not only are they completely non-flammable, but even at 788°F, they only lose weight at a rate of about 1/10 of a percent per hour.

LIFE AT EXTREME TEMPERATURES

(TFE-Fluorocarbon Resins in Air at Atmospheric Pressure)

TEMPERATURE		WEIGHT LOSS % PER HOUR	ESTIMATED LIFE
500°F.	260°C.	0.00015	Years
600°F.	316°C.	0.0004	Months to Years
700°F.	371°C.	0.002	Hours to Months
800°F.	427°C.	0.15	Minutes to Hours
900°F.	482°C.		Minutes to Hours
1000°F.	538°C.		Minutes

Figure 3.

Cable Evaluator

James Cunningham, Son & Co., Inc., Rochester, New York, recently put on the market a new Automatic Cable Evaluator. The new unit, named SPACE Self-Programming Automatic Cable Evaluator, is a console-mounted testing instrument which automatically checks for leakage (hi-pot) and continuity between any and all wire ends or terminations of a cable harness or device being tested. SPACE, employing computer type memory, progresses through a series of tests in a logical manner at a maximum rate of 10 tests per second and has a capability of generating its own tape program.

The unit includes two scanning circuits, a tape reader and code storage unit, a motorized tape punch, output meter and leakage and continuity detection circuitry. Decision circuits are provided to channel information from the testing functions. The scanners employ Cunningham Type F Crossbar switches.

• **Working operation**—In the "analyzer" mode, a sample chassis or harness is connected to SPACE through twenty 24-terminal Amphenol Blue

Suprenant Mfg. Co.
Technical Appliance Corp.
Telectro Industries Corp.
Teleflex Inc.
Teletronic Labs., Inc.
Terminal Radio Corp.
Thermax Wire Corp.
Times Wire & Cable Co., Inc.
TranSCO Products, Inc.
Transvision, Inc.
Tricraft Products Corp.
Tri-Dex Co.
Tucson Instrument Corp.
Twix Mfg. Co., Inc.
Victor Electric Wire & Cable Corp.
Warren Wire Co.
Wells Industries Corp.
Westbury Electronics Inc.
Western International Co.
Westronics Inc.
Westwood Cable Corp.
Wheeler Electronic Corp., Sub-Sperry Rand Corp.
Wickes Engrg. & Construction Co. Inc.
Wickfield, Inc.
Wilmar Mfg. Co., Inc.
Winder Aircraft Corp. of Fla.
Wire Co. of America, Inc.
Zipper tubing Co., The

WIRES

ACF Industries, Inc., Advanced Products Div.
Accurate Insulated Wire Corp.
Advanced Electronics, Inc.
Aerolite Electronics Corp.
Aeronautical & Instrument Div., Robertshaw-Fulton Controls Co.
Alden Products Co.
Allied Plastics Supply Corp.
Allied Research & Engrg., Div. Allied Record Mfg. Co.
All-State Welding Alloys Co., Inc.
Alpha Wire Corp.
American Brass Co.
American Electric Cable Co.
American Insulated Wire Corp.
American Steel & Wire Div. United States Steel Corp.
American Super Temperatures Wires Inc.
Anchor Specialty Mfg. Co. Inc.
Ansonia Wire & Cable Inc.
Aristocrat Plastics Inc.
Associated American Winding Co., Inc.
Barker Sales Co.
Beaton & Corbin Mfg. Co.
Belden Mfg. Co.
Berkshire Electric Cable Co.
Bios Labs Inc.
Birnback Radio Co. Inc.
J. Bishop and Co. Platinum Works
Bliss Electronic Corp.
Boston Insulated Wire & Cable Co.
Bram Metallurgical and Chemical Co.
Brand, William & Co. Inc.
Bridgeport Brass Co.
Calcon Mfg. Co. Inc.
Cambridge Wire Cloth Co.
Carpenter Steel Co.
Chase Brass & Copper Inc.
Chester Cable Corp.
Coaxial Connector Co. Inc.
Consolidated Wire and Associated Companies
Cooper Development Corp.
Co-Operative Industries Inc.
Copperweld Steel Co. Wire and Cable Div.
Cuno Engrg. Corp.
Dale Products Inc.
Dayton Aircraft Products Inc.
Delta Chemical Works Inc.
Wilbur B. Driver Co.
Dwyer Engrg. Co. Inc.
Eastern Smelting and Refining Corp.
Eisler Engrg. Co. Inc.
Elco Corp.
Electric Auto-Lite Co.
Electric Parts Corp.
Electronics Dept., Hamilton Standard Div., United Aircraft Corp.
Elgin Micronics, West Coast Div., Elgin National Watch Co.
Elmet Div., North American Philips Co. Inc.
Empire Electronics Co.
Enflo Corp.
Engelhard Industries Inc., D. E. Makepeace Div.
Essex Wire Corp.
Fansteel Metallurgical Corp.
First Electronics Corp.
Fort Wayne Metals Inc.
General Cable Corp.
General Laboratory Associates Inc.
Goldsmith Brothers Smelting and Refining Co.
Gray Mfg. Co.
Greenleaf Mfg. Co., The Div. Mandrel Industries Inc.
Gunnar Laboratories
Hackensack Cable Corp.
Hallett Mfg. Co.
Hammett Electric Co.
Harco Labs.
Haynes Stellite Co. Div. Union Carbide Corp.
Highland Engrg. Co.
Hitamp Wires Inc.
Hoover Electronics Co.
Hudson Wire Co.
International Wiring and Cable Co.

International Electric Industries Inc.
International Wire and Cable Co.
Walter K. Jaros, Aircrafters
Jefferson Products Corp.
Johnston and Funk Titanium Corp.
Kahn and Co. Inc.
Key Resistor Corp.
Kilgen Aircraft Div. The Kilgen Organ Co.
Kulka Electric Corp.
La Pointe Industries Inc.
Leach and Garner Co., Industrial Div.
Lewis Engrg. Co.
Lumen Inc.
Lytle Engrg. and Mfg. Co.
Magnetic Shield Div., Perfection Mica Co.
P. R. Mallory and Co. Inc.
Mallory-Sharon Metals Corp.
Manger Electric Co.
Menaugh Co.
Metals and Controls Corp.
Micro-Wire Tungsten and Molybdenum Products
Miljan Div. Paul Omohundro Co.
Missile Engrg. Products Inc.
Moledetric Products Corp.
Mohawk Wire and Cable Corp.
Monaghan Co.
National Standard Co.
New England Tape Co. Inc.
Ney Co.
Normandy Electric Wire Corp.
North Electric Co.
Organic Development Corp., Spectra-Strip Div.
Packard Electric Div. General Motors Corp.
F. Paul and Stein Brothers, Inc.
Philco Corp., Government and Industrial Div.
Plastoid Corp.
Harold H. Powell Co.
Precision Tube Co.
Progressive Research and Development Co., Inc.
Radix Wire Co.
Rex Corp.
Republic Steel
Rockbestos Products Corp.
Roebbling, John A. Sons Corp.
Rome Cable Corp.
Rowe Industries
Royal Electric Corp.
Rush Associates, Inc.
Schaffer Air Industries Inc.
Scintilla Div., Bendix Aviation Corp.
Secom Metals Corp.
Sequola Wire Co.
Servicair Co.
Sheltered Workshop
Sithler Corp.
South River Metal Products Co. Inc.
Standard Metals Corp.
Superex Electronics Corp.
Sylvania Electric Products Inc., Parts Div.
Suprenant Mfg. Co.
T-C Div., Dyna-Empire, Inc.
Terminal Radio Corp.
Thermax Wire Corp.
Times Wire and Cable Co. Inc.
Titan Metal Mfg. Co.
Titiflex, Inc.
Topper Mfg. Co. Inc.
Transvision, Inc.
Tucson Instrument Corp.
Victor Electric Wire and Cable Corp.
Warren Wire Co.
Washington Aluminum Co.
Western Gold and Platinum
Western Insulated Wire Co.
Western International Co.
Westwood Cable Corp.
Wickfield Inc.
Winder Aircraft Corp. of Fla.
Zipper tubing Co.

CONNECTORS

Aerolite Electronics Corp.
Aircorn Inc.
Airtrox Inc.
Airwork Corp.
Alden Products Co.
Allied Plastics Supply Corp.
Anton Electronic Labs., Inc.
Arrowhead Products, Div. Federal-Mogul-Bowyer Bearings, Inc.
Auburn Spark Plug Co. Inc.
Automatic & Precision Mfg. Co.
Avnet Corp.
Birnback Radio Co., Inc.
Blonder-Tongue Labs., Inc.
Burdy Corp., Omaton Div.
Cal-Ohm Labs. Inc.
Cannon Electric Co.
Circon Component Corp.
Cleveland Metal Specialties Co.
Coaxial Connector Co. Inc.
Columbia Research Labs.
Connector Corp.
Continental Connector Corp.

Due to space limitations, m/r is unable to complete the list of connector manufacturers in this issue. These manufacturers will be listed in a future issue.

What's new in **TITANIUM** welding:

Resistance and fusion welding as fabrication procedures have become increasingly important with the advent of missiles and aircraft designed for sustained operation at Mach 3 and better.

Titanium alloys are available which provide fusion-weld efficiencies of 100 percent, and spot-welded joints with excellent load carrying capacities.

Through its new Toronto, Ohio, rolling mills —designed specifically for titanium operations —Titanium Metals Corporation of America can provide light-gage flat-roll weldable products of consistently highest quality, on the fastest delivery schedules, at the lowest possible price in the industry today.

Q. What are the leading welding grades?

A. Ti-75A, a single-phase unalloyed grade which is readily formable; Ti-5Al-2.5Sn, a single-phase alloy grade which provides excellent resistance to oxidation up to 1200°F; and Ti-6Al-4V, a duplex-phase alloy grade with guaranteed minimum tensile strengths to 130,000 psi. Guaranteed minimum mechanical properties of these grades are:

GRADE	DENSITY lb/cu in	Guaranteed Room Temperature Properties		
		0.2% YS	UTS	Elong. % in 2"
Ti-75A	0.163	70,000	80,000	20
Ti-5Al-2.5Sn	0.162	110,000	115,000	10
Ti-6Al-4V	0.161	120,000	130,000	10

Q. Are special precautions required for welding these grades?

A. Titanium is spot-welded more readily than aluminum and many of the carbon and low alloy steels, and requires no special precautions. Spot-weld machine settings used for titanium and stainless steel are very similar.

Titanium is fusion-welded with inert-gas-shielded arc welding techniques and joint designs which are also similar to those used for other metals. Two fundamental principles must be considered:

1. Coated electrodes and other fluxing compounds cannot be used.
2. Titanium weld joints must be shielded from the normal atmosphere with an inert blanket of argon or helium during welding.

Q. Does that mean chambers are mandatory for fusion welding?

A. No. Open air welding is adaptable to pro-

duction operations when both root and face of the weld are protected from the air. Small parts and complex shaped weldments which are difficult to shield adequately may still be welded more easily and economically inside a chamber. This is described in detail in TMCA's publication, *Titanium Welding Techniques*, Engineering Bulletin #6.



Successful titanium welding techniques have enabled fabricators to produce missile propellant storage bottles which resist internal pressures of 8000 psi at -300°F. This all-titanium bottle, produced by Rheem Manufacturing Company, Downey, Calif., is Ti-6Al-4V, fusion-welded in an argon atmosphere. Designers say use of titanium bottles can add up to 700 miles to the range of an IRBM.

Q. Are titanium welds more susceptible to corrosion attack than the base metal?

A. Titanium welds offer the same excellent corrosion resistance as the base metal. Stabilizing heat-treatments, employed with many other materials, are *not* required.

Successful welding is a key factor in today's designs. It enables designers to draw upon titanium's unique combination of properties: light weight, corrosion resistance, and ability to withstand operating temperatures from -300°F to 1000°F — for the added performance vital to these uniquely critical times.

Titanium Metals Corporation of America has just completed the first comprehensive study of welding techniques yet published by the industry. This 32-page publication draws upon metallurgical considerations to recommend and explain techniques required for quality titanium weldments.

Titanium Welding Techniques, as well as other publications, in the most extensive data library in the industry, is available from Titanium Metals Corporation of America, 233 Broadway, New York 7, New York. This important literature is yours for the asking.

TIMET
TITANIUM METALS
CORPORATION OF AMERICA
233 Broadway, New York 7, N. Y.

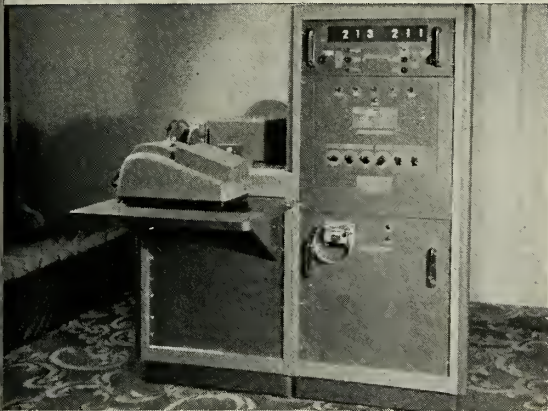
Clip out and mail coupon for helpful Engineering Data on TITANIUM

NAME _____

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CITY _____ STATE _____

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



THE SPACE CABLE EVALUATOR shown here has a capacity of 420 terminations. Space, however, can be supplied with greater or smaller termination capacities.

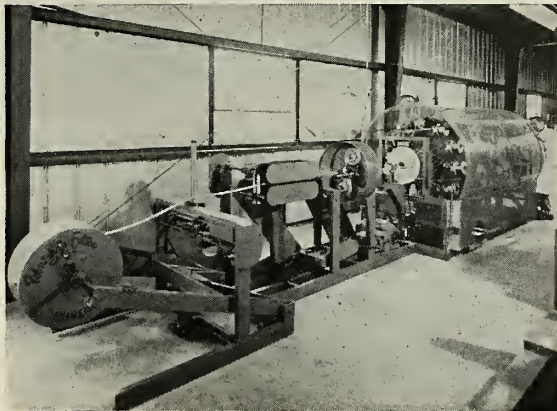
ribbon connectors. This chassis is then scanned through all possible combinations, and holes are punched in the tape for those combinations in which continuity is found. The tape which results from this scanning operation then becomes the test program, and is subsequently used for verification of other similar chassis.

In the "verifier" mode, another chassis to be tested is connected to the test equipment, the tape is inserted in the tape reader and the first frame, containing the coordinates of the first short, is read into a temporary storage consisting of another Type F crossbar switch. All of the possible combinations are then again scanned automatically, or combinations where leakage is found, a separate test is automatically made for continuity.

If continuity is found, a comparison is made with the contents of the temporary storage, and if the coordinates correspond to that in storage, the short is accepted as being intended. If either leakage or an unintended short are found, the coordinates and nature of the discrepancy are printed out and displayed on a visual in-line readout device. Scanning is then resumed either automatically or at a manual command depending on the position of the "manual-automatic" switch. The punched-tape advances whenever tests are completed between the pair of coordinates in storage.

For each chassis or harness tested, a printed record will thus be provided automatically to indicate the coordinates of the test discrepancy together with the letter L, S, O, or R to indicate leakage, short, open or resistance respectively.

A seven-hole biquinary code with an "clear" code is used on the one



ADVANCED CABLING EQUIPMENT employed at Robertshaw's "cable systematics" facility is typified by this new custom built cabling machine.

inch wide paper tape. Tape is initially stored on the reel associated with the punch, and when transferred to the reader is folded in a Lucite container in a closed loop.

• **Handling operation**—The entire instrument is housed in an Emcor console, 40 inches wide, 52 inches high and 25 inches deep. The tape handling and printing units are mounted at seating level. The Amphenol Blue Ribbon connectors are brought out at the back of the analyzer for convenient access to the equipment under test. All chassis are mounted on slides for easy access and removal from the back of the console. Only operational controls are mounted on the front of the console.

Integrated Cable-making

Representing an entirely new approach in the fabrication of custom electronic cable, a unique "integrated" cable making-facility is now fully operational at Robertshaw-Fulton Controls Company, Aeronautical and Instrument Division, Anaheim, California.

Employment of integration techniques, called "cable systematics," is intended to bring custom electronic cabling into line with the advanced nature of present-day electronics and systems development. This will meet the challenge indicated by statistics, which show an alarming percentage of missile failures attributable to faults and breakdowns in electronic cabling and cable systems.

According to company officials, the new facility is the logical result of Robertshaw's requirements for greater

precision, reliability and applicational adaptability in cabling as an integral and vital element in the development of systems and components involving electronics.

Built around a nucleus comprising some of the nation's outstanding cabling experts, the Robertshaw facility is fully staffed for the development and manufacture of all types of complex electronic cable for airborne systems and ground support applications.

• **Machine design**—At the heart of Robertshaw's "Cable systematics" are two completely self-contained cable-making machines of advanced design. Essentially, the philosophy which dictated the design of the new machines has been to produce cable of virtually any size, type and complexity; in long and short runs; at lower cost and in less time.

Technical problems and requirements which approached almost unforeseen proportions were met and solved in the new cabling equipment. Among these were requirements for extremely high and extremely low cabling speeds; short coupling (amount of conductor-wire necessary to thread the machines); adaptability to large and small conductor spools; as well as large or small numbers of conductor spools.

Another requirement involved adaptability to bulky spools containing large-diameter conductors and very small spools containing spider-like coaxials or delicate, shielded members. In addition, balanced planetary action was necessary throughout—to avoid the possibility of stresses and kinks which might change the electrical characteristics of the conductors.

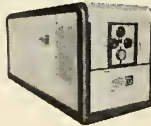
• **Cable design**—Objectives in the

PURECO CO₂

TO
-110°F
WITH
SOLID CO₂



LIQUID CO₂



unexcelled as a refrigerant, as an inerting agent

Pureco CO₂ in liquid or solid form is a convenient, low cost, maintenance-free refrigerant of unlimited capacity, which can be accurately controlled for use in low temperature testing and field conditioning.

Also, Pureco Carbon Dioxide is finding increased use in providing an inert atmosphere in test chambers and cells following or preceding

the testing, handling or storage of explosive or combustible materials.

Pureco's Technical Sales Service is qualified to assist you in adapting CO₂ to any particular refrigeration or inerting application. Call your Pure Carbonic representative. There are more than 100 Pureco locations from coast to coast.



Pure Carbonic Company

A DIVISION OF AIR REDUCTION CO., INC.
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AT THE FRONTIERS OF PROGRESS YOU'LL FIND AN AIR REDUCTION PRODUCT • Products of the divisions of Air Reduction Company, Incorporated include: AIRCO - Industrial gases, welding and cutting equipment • AIRCO CHEMICAL - vinyl acetate monomer, vinyl stearate, methyl butynol, methyl pentynol, and other acetylenic chemicals • PURECO - carbon dioxide - gaseous, welding grade CO₂, liquid, solid ("DRY-ICE") • OHIO - medical gas and hospital equipment • NATIONAL CARBIDE - pipeline acetylene and calcium carbide • COLTON - polyvinyl acetate, alcohols, and other synthetic resins

able itself included: extreme flexibility, uniformity and balance throughout, and maintenance of specified electrical characteristics under environment extremes. Manufacturing versatility was necessary to meet requirements for 1) cable of either large or small diameter, containing large or small numbers of conductors, 2) fulfillment of specifications requiring mixed types of conductors balanced into a single cable or cable system, 3) production orders involving extremely short or extremely long runs, 4) rapid production of complex cable to meet urgent time requirements.

The newest Robertshaw's cablemaking machine, a compact self-contained unit, is designed so that bobbins are easily interchangeable. This permits configurations to be changed rapidly to conform to succeeding project requirements for any type of complex cable.

In addition, a special caterpillar-traction capstan will grip any wire from .025" to 3" diameter, and automatically adjust traction pressure in accordance with the characteristics of the cable and the drag. The machine is designed for speeds ranging from a low 1' per minute to a high of 480' per minute, within a normal "cruising range."

The equipment is engineered to produce an exceptionally flexible lay, which is achieved through a highly precise contrahelical build-up and use of a short pitch ratio. Cables are planned and conductors are laid so that the smaller, more delicate members are protected from crush and stress by the larger members.

As a result of this balanced-engineering concept, the resulting cable and its component members are both statically and dynamically balanced throughout, so that primary objectives of high reliability and consistency of quality are met. Both cabling machines have high reproducibility factors that are particularly valuable in producing short-run samples for prototype use. This may then be followed by production runs meeting the exact specifications of the pilot run.

There is little question, that with previously-existing machinery and manufacturing techniques, it would be difficult if not impossible to produce complex electronic cable meeting the requirements and standards achieved at Robertshaw-Fulton.

• **Overall planning**—In addition to the manufacturing requirements and objectives already discussed, an important phase of precision cabling is the

initial cable planning and cable engineering. At Robertshaw, each job is handled as a custom project. Engineering requirements are analyzed, drawings are checked or new drawings made, and the cable "lay" or build-up is carefully designed in order to assure a uniform, high-quality cable which fully meets all projected requirements.

To further assure final reliability, complete facilities are available for tests involving environmental extremes—such as impact and abrasion resistance, crushing, bending, twisting and electrical connection verification. Additional facilities are available to check for shorts and changes in electrical characteristics of cable items under test.

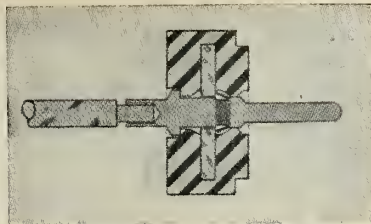
"Poke-Home" Connector

How many missile fizzes have been caused by faulty electrical connections and malfunctioning connectors? No one will ever know for sure, but as the complexity of electronic components and systems increases, the number of connections skyrocket. The points at which wires, cables, and "black boxes"—for the sake of convenience or necessity—have to be disconnected are on the order of thousands.

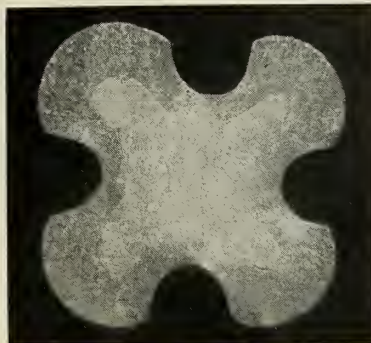
By virtue of the great number of connections alone, the connectors going into a missile system have had to take the blame for numerous aborted missions. Add to this the tough environments in which these connectors must function—extreme temperature ranges, high altitudes, and excessive vibration—and it becomes quite evident why the connector art is in a perpetual state of improvement and new developments.

• **Where error occurs**—To find out what part of the connector is the largest source of potential unreliability, the search centers on those parts containing the largest possibility for human error. Discussions of this facet with any persons responsible for the wiring of missiles and ground support systems will invariably lead to the contacts within the connector, and more specifically, to the attachment of the wire to the contact.

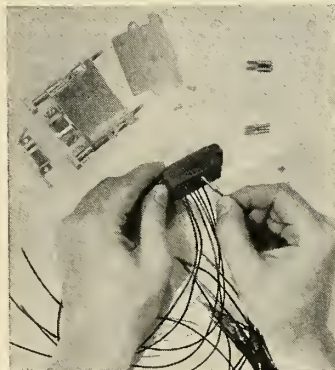
Miniaturization makes connectors get smaller and brings the contacts closer together, and the contacts themselves get smaller because of higher voltage and lower current systems. Consequently, when an assembler solders the wire to the contact, it becomes an operation with many chances for



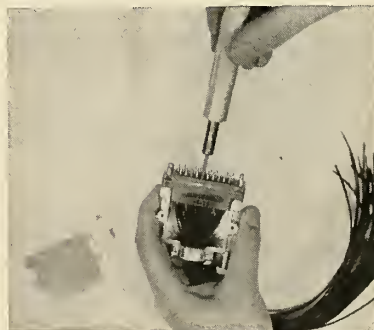
CROSS-SECTIONAL VIEW of the "Poke-Home" contract shows the retaining clip.



THIS "CUT-AWAY" SECTION of the "Poke-Home" highlights the uniformity achieved by Amphenol's new crimping method.



PRIME ADVANTAGE of "Poke-Home" is that the connector can be assembled after the wires are attached to the contacts.



BY USING A SPECIALLY designed tool, the "Poke-Home" contacts can be easily removed for wire repairs or circuit changes.

... special report on wires and cables

Manufacturer	American Printed Ckts.	Dwyer Engineering	Miljan Inc. SRP	Miljan Inc. TB	Rowe Engravers	Sanders Associates
1) Type of insulation material	Teflon on glass	Epoxy glass laminate	Silicone-rubber	Teflon	Fluoro-carbon	Kel-F
2) Manufacturing process	Printate process	Screen etched and then laminated	Flat conductors are molded in silicone-rubber	Conductors are imbedded in Teflon	Silk screen etched and then laminated	Etched and then laminated
3) Type of conductor material	Copper	Copper	Copper	Silver, silver plated Copper, or tinted copper	1) Silver 2) Copper	Copper
4) Dielectric Strength	1000-2000v/mil (thickness 5-12 mils) short time test	1000-2000v/mil (short time test)	250v/mil (short time test)	1000-2000v/mil (thickness 5/12 mils)	2500v/mil (short time test)	2500v/mil (short time test)
5) Temperature range Minimum Maximum	-195°C 260°C	-50°C 125°C	-73°C 260°C	-195°C 260°C	# 150°C	-60°C 175°C
6) Moisture Absorption	0%	#	.2% (immersion at 25°C)	0%	#	0%
7) Surface Coating Required?	No	No	No	No	No	No
8) Is shielding possible?	Yes (shielding not encapsulated)	Yes (if conductors are spaced at least 1/4")	No	No	Yes, by putting a grid over the wires and laminating	Yes, by laminating shield
9) Max. cable width available (inches)	Any width	24	2	.25	Any width	14
10) Max. lengths available (inches)	Any length	60	12 to 14	12	Any length	22
11) Current capacity per width of cond.	*	*	*	#	1) * 2) **	*
12) Is branching possible?	Yes	Yes	Yes	No	Yes	Yes
13) Can tap-offs be made?	Yes	Yes	Yes	No	Yes	Yes
14) Pull strength (PSI) before encapsulation	10	10	NA	NA	#	8
15) Flexibility (max. bend without base cracking)	Repeated 180° bends	360° 1" diam.	#	#	Repeated 180° bend	2" diam. on 180° bend

NA: Not applicable
#: manufacturer has not obtained information.

* Copper Foil Circuit Overload Ratings

Width (in.)	1 oz. foil (.00135 in. thick)		2 oz. foil (.0027 in. thick)	
	Amps	Ohms/in	Amps	Ohms/in
.250	23	.002	35	.0009
.125	15	.004	20	.0018
.0625	10	.008	15	.0035
.0312	5	.016	8	.007
.0156	3	.032	5	.015

** Silver

Width	Amps	{Amount of current which causes a 40°C rise in temp.}
.150	5.0	
.050	2.5	

Specifications on Pointed Cables

Manufacturer	Aerovox	Photo Circuits	Method Mfg. Corp.	Tape Cable Corp.	International Resistance Co.
1) Type of insulation material	Epoxy-fiber glass	1) Phenolic glass 2) Epoxy glass 3) Teflon glass	Silicone	Polyester film insulation	Fluoro-carbon
2) Manufacturing process	Screen etched or photo etched	Silk screen etched (may be etched on both sides of a single base)	Silk screen etched and then laminated	Information withheld pat. pending	Silk screen etched and then laminated
3) Type of conductor material	Copper	Copper	Copper	Copper	Copper
4) Dielectric Strength	750v/mil (short time test)	1) 650v/mil 2) 750v/mil 3) 800v/mil (short time test)	250v/mil	300v/mil	2500v/mil (thickness 1/8" short time test)
5) Temperature range Minimum Maximum	# 175°C	# 1) 125°C 2) 175°C 3) 200°C	# 200°C	-50°C 85°C	# 150°C
6) Moisture Absorption	.2% (24 hours immersion)	1) 1.3% 2) .3% 3) .1% (24 hour immersion)	1.3% (24 hour immersion)	#	0% (24 hour immersion)
7) Surface Coating Required?	Yes	Yes	No	No	No
8) Is shielding possible?	Yes, by laminating but with sacrifice of flexibility	Yes, by laminating shield	Yes, by laminating shield	No	Yes
9) Max. cable width available (inches)	14	12	6	6 approx. 50 conductors	16
10) Max. lengths available (inches)	21	22	11	Any length	16
11) Current capacity per width of cond.	*	*	*	1 amp (all conductors: 1.5 mils thick and 30 mils wide)	*
12) Is branching possible?	No	Yes	Yes	Yes	Yes
13) Can tap-offs be made?	No	Yes	Yes	No	No
14) Pull strength (PSI) before encapsulation	10	1) 5-10 2) 5-21 3) 3-9	2-8	#	7-10
15) Flexibility (max. bend without base cracking)	1.75" on 180° bend	Bending cracks the insulation on all three base materials	Cracks when bent sharply	20,000 cycles (sharp 180° bend with no crack)	1.5" diam. on 180° bend

... special report on wires and cables

human error. This problem provided the impetus for printed circuits in "black boxes." The equivalent improvement has long been needed where circuits must be made and broken by connectors.

• New development—The latest and most advanced addition to the connector field is Amphenol's new series featuring "Poke-Home" contact.

"Poke-Home" offers two very definite advantages; 1) the wire is assembled to the contact by means of an entirely new crimping method, and 2) the assembly takes place outside the connector. After the crimping process, the contact—containing a patented retaining member—is "poked home" in the connector where it is solidly retained.

The crimping of the wire to the contact may be done automatically by machine, or by means of a specially designed hand tool. No. 12, 16, 18 and 20 size contacts can all be crimped by the same tool, and each of these contacts will accommodate several wire sizes. The contact pocket does not have to be altered and a sleeve does not have to be added.

The crimping takes place approximately 1/8 of an inch from the end of the wire pocket, and pressure is applied at four points 90 degrees apart. This assures uniform crimping, and thus uniform connection between each strand of wire and between the wire and the contact itself.

In tests conducted to determine the strength of the crimp (pull test), the wires always broke before they could be pulled from the contact.

The retention forces, after the crimped contact is "poked home," are very high. Forces required to pull the wired contact out of the connector are as follows:

Contact Size	Minimum Retention Forces (Lbs.)	
	Female Contact	Male Contact
12	18	17
16	20	20
20	12	15

However, by using a special removal tool, the intentional removal of a contact for cable repair or circuit change purposes is accomplished quickly and easily.

"Poke-Home" contact conductivity tests give very good millivolt drop results as shown in the following table.

Contact Size	Test Current DC AMPS	Millivolt Drop MV
12	35.0	6.4 avg.
16	20.0	6.6 avg.
20	7.5	9.2 avg.

• Current use—According to the people already using the new "Poke-Home" contact, it provides an uncomplicated answer to eliminating the thousands of points of potential unreliability in connections.

The time and tests required to prove out the validity of this answer were considerable. It took the Amphenol engineers three years of intensive testing and experimentation to obtain the best possible combination of electrical, mechanical, and electromechanical elements in the new contact.

The retaining clip alone required some \$150,000 worth of exhaustive engineering design and tests to provide the contact with the required retention when it is assembled, and when it is removed and reassembled many times.

"Poke-Home" contacts are currently used in special connectors being produced for both the *Titan* and *Atlas* missiles. The rack and panel 93 series connectors illustrating this article are employed in the *Bomarc* missile. The 93 series connectors have a temperature range of -65°C. to +200°C. and are rated at 7.5 amps at 500 volts DC at sea level, 7.5 amps at 125 volts DC at 70,000 feet.

An entirely new family of environmentally-resistant, high-temperature "AN"-type miniature and subminiature connectors with "Poke Home" contacts are now nearing production, and are expected to be extensively used in the missile field.

Printed Circuits

The printed cable, which was the subject of a limited survey by m/r, shows definite promise for future missile and space applications.

Printed cables, in themselves, are not a cure-all. Their use entails problems. There are, however, considerable advantages to be gained with the use of presently-available products. The table on pages — and — gives a breakdown of eleven products which have been available for the past year or more. All have definite advantages, and in more or less unvarying degrees, disadvantages.

• Advantages—The advantages are fairly obvious—size and weight being the most prominent. Another point in favor of flat conductors is high surface-to-volume ratio, causing greater dissipation of I²R losses more rapidly than conventional cables, and resulting in less copper weight for the same current-carrying capacity. Temperature characteristics are generally excellent with some products having a range from -195 to +250 degrees centigrade.

Dielectric strength ranges from 250 v/mil to as high as 2,500 v/mil.

Silk screen etching was used for most of the products surveyed, but several products were imbedded and one product (manufactured by the American Printed Circuits Co.) used a "printate" process. This is a transfer process in which the desired connectors are placed on a master carrier and, by a fusing of the uncured laminate, the circuit is embedded in a dovetail fashion. The conductor is then encapsulated by laminating another layer of teflon on the surface.

The process has several advantages such as: no etchant contamination the circuit is flush with the base, the process does not require the etching off of excess copper, and the conductor does not separate from the base when damp.

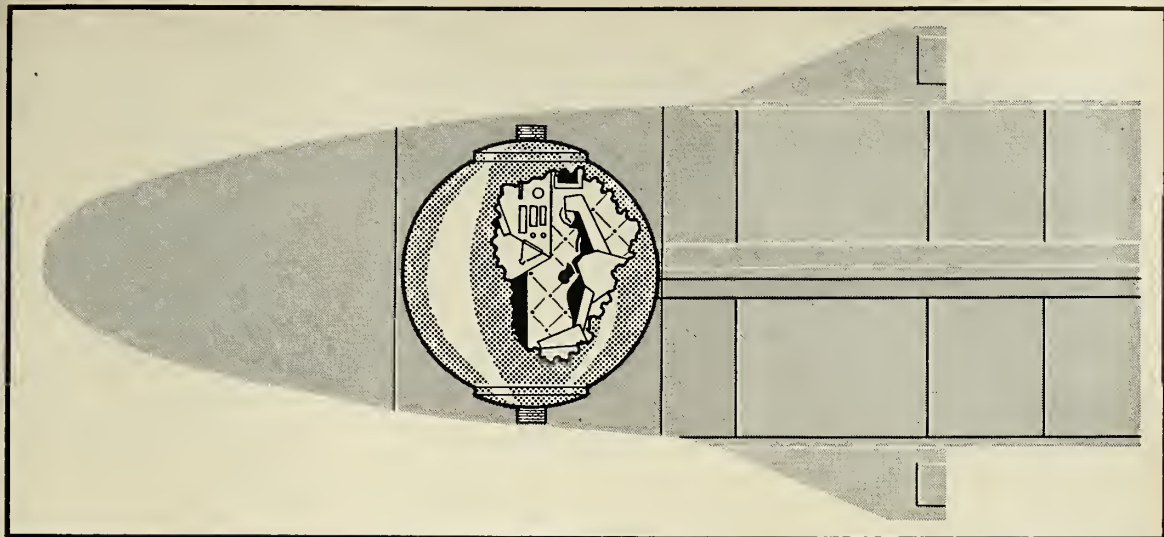
• Disadvantages—Some of the principal disadvantages of the products surveyed were: the base material in some of the available will crack upon sharp bending; each cable has to be designed beforehand for the specific length of run and configuration of branches and tap-offs; and, where silver is used, the silver has a tendency to migrate and short under certain conditions.

However, all of the manufacturers have been working on the problem of bending and it appears that this will not be a drawback in future applications. One of the products surveyed, manufactured by Rowe Engravers Inc., had no length or width limitations and had a base material so flexible that it did not crack even though rolled and then bent 180 degrees.

Several manufacturers, including the Tape Cable Corp. and Sanders Associates, include provision for tap-offs and branching and most other manufacturers can be expected to follow suit.

This will eliminate one major drawback for missile application since the cost of custom-made printed cables, plus the cost of spares in stock, is prohibitive compared to conventional cable. However, the significant reduction in size and weight might very well overcome any cost disadvantage, especially when the cabling is to be used in any sort of a manned or unmanned space vehicle.

The past year has seen many more manufacturers enter the printed and flat cable field and new advances can be expected in a greater number in the near future. Most of the troubles which have plagued earlier manufacturers seem to be well on the way to solution and, if newer entries in the field take advantage of these, printed cables might well turn into the sole wiring product for the space age.★



Sealed "Man Capsule" may be answer as scientists consider . . .

The Human System in Space

by C. Wright Reiniger*

THERE ARE THREE foundation blocks from which man must rise into space: Space Science, Human Science, and Vehicle Science. Yet, only the last of these has brought man to the edge of space. Knowledge of both human science and space science are far short of vehicle science. Space science will benefit quickly from the advance of weapons vehicles into space. This knowledge will chart the environment that must be survived and the unknown dynamics of space.

But so little is known of man in space that there will be no certainty of survival until every human part and process is reduced to a state of predictable performance or control.

The immediate commercial advantage of the knowledge of human science is small. The great bulk of our medical science is devoted to disease medicine. Disease medicine today tells us a great deal about the physiology of man, but still very little of man as he should be.

Knowledge of the normal processes and controls of the nervous, digestive, and skeletal-musculature-vascular systems of man shall prove the final barrier and major foundation to man's emergence into the space.

• **Weapons exclude Man**—All the major aircraft developments of the last

forty years have come about in the interest of meeting more advanced weapon vehicle missions. Until the successful advent of the guided or ballistic missile, man has been viewed as a functional part of these systems.

Now with the development of even better self-correcting weapons, man is no longer needed and no longer a troublesome variable to the designers of advanced weapon vehicles. Ultimately, the assurance of predetermined mission performance will go well beyond the manned systems of the past.

This very exclusion of man is both the source and solution to the space problems that confront us today. First, it is the source because the progress of man in flight has been measurably slowed. This began to happen in the first years of the shift to missiles—the ultimate weapon. Man was viewed as no longer involved. The problems of personal equipment, environment systems, and mission performance aids were aircraft problems. Man was considered phasing out with the advent of missiles.

The technology supporting manned flight was expected to be the least useful of all the technologies creating the missile age. Only a few men refuted this misconception. The resulting restriction and limitation to work only on manned aircraft missions of relatively short-flight duration has created

a deep hole in today's design foundations for man in space.

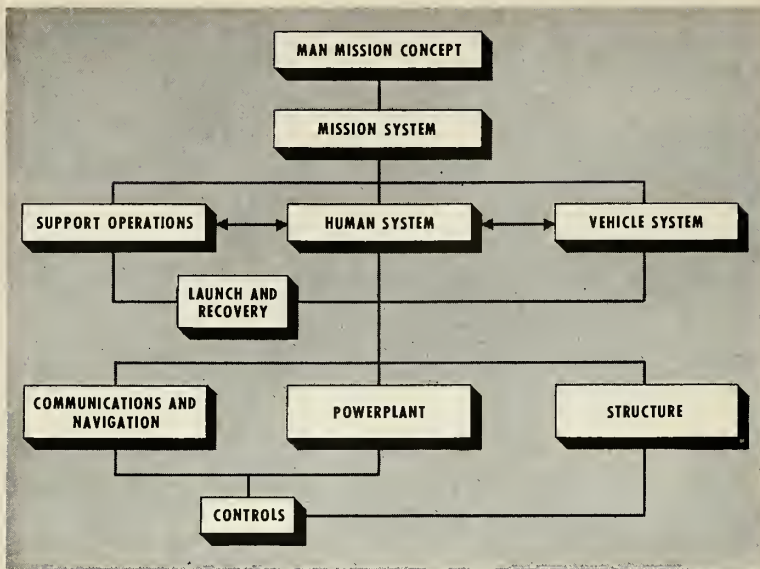
The Aeromedical Laboratory, School of Aviation Medicine, Holloman Development Center; Edwards Test Center; the Flight Safety Directorate at Norton AFB; and many contractors—working with too little, usually too late—have all made outstanding contributions to maintain a usable degree of proficiency and assurance of survival for man in space.

While the rocket has held the promise of space flight for twenty years, there is still no properly funded or properly organized advance development program underway to anticipate future manned aircraft or space man mission requirements. There are two major reasons for this void in man mission science and technology.

First, the airframe and missile contractors have not been capable of extensive aeromedical research and development. The small groups of human engineers that many of these companies have acquired in the last few years are a token effort to solve the problems of supersonic flight. Second, is the still persisting view that man is a necessary resolver of machine deficiencies.

Not only are the airframe and missile contractors not capable of extensive aeromedical research and develop-

*Executive vice president, Space-Flight, Incorporated.



THE MAN-MISSION CONCEPT applied to the conventional weapons systems approach can best be described in the graph as above.

ment, but they rarely engage in research and development themselves. Many expect research and development to be absorbed on speculation by components and equipment suppliers.

In addition, the aerodynamic and structure-oriented prime contractors generally allot crew and crew equipment a lower priority on space and weight. Crew function and survival have been habitually compromised; while solutions to powerplant, structure, and armament requirements have been made more important.

• **The fixed remainder: Man**—The present systems concept has created a broad framework for operational weapon development, assigning recognizable portions to industry contractors. Unfortunately, a remainder exists.

For example: Ground support first loomed into view as a mixed batch of equipments, recognized today by companies "in the business" as the fat on the hog. Before ground support, there were realizations of individuality to airframe, powerplant, armament, and lately, controls. Ground support has largely been brought into focus by the nature of operational missile systems.

Aircraft development still carries along a mixed remainder. This is usually classified as equipment—personal and otherwise. Varied Air Force laboratory groups, contractor project sections, and component suppliers have participated in responsibility for meeting these manned aircraft requirements: crew environment and clothing, nutrition, instrument display, powerplant and control command initiation, crew communication, navigation, hazard pro-

tection, and escape procedure.

The disjointed approach to satisfying these requirements has proven progressively inadequate in solving critical problems of manned flight. Notable items on the record are:

Toxic environment resulting from combustion and fluid leakage fumes; snow, rain, and fog in the cockpit resulting from inadequate and uneven environment control and system capacity; clothing obstruction to adequate ventilation and easy freedom of movement; rudimentary or non-existent solution to feeding and elimination needs; instrument displays seriously limiting pilot response and ability; the frequent physical impossibility of maintaining control command; a maze of manual navigation aids; little or no fire protection; and lastly, the dramatic episodes resulting from second-rate attention to crew escape until long after the advent of supersonic aircraft.

This touches only the surface of the development record surrounding the crew function in manned aircraft. Failure to recognize these demands on Human Science can only prove a decisive deterrent in support of man in space. A re-orientation of development responsibility must come about.

Today, there are two distinct areas of development in progress: Weapon Mission and Man Mission developments (described as the Human System). The redirection of human technology within this framework will allow responsible anticipation of human requirements and mission functions.

• **The human element**—In simplest terms, the Human System is the devel-

opment and integration of all components, assemblies, equipments, and subsystems required for the Man Mission not ordinarily required for the Weapon Mission. It can be compared to the part played by a powerplant, distinguishing between powered and unpowered aircraft.

The Human System consists basically of environment, protection, observation, communication, vehicle command, and escape. Within the Man Mission concept, the Human System will affect all other systems and support operations. The purpose of all other systems of the Man Mission is to deliver the Human System—much as the purpose of the systems within the Weapon Mission concept is to deliver the Warhead System. Man should no longer be required to keep the parts working and preserve the vehicle for another day and another target.

The first ventures of man into space should simulate every major factor of his environment, including gravity. This first venture should make it possible for variations in method and degree of simulation to be experienced at the will of man. This should not be accomplished as a daring aeromedical experiment, but to confirm results of exhaustive laboratory investigation.

The investigation should develop sufficient knowledge of human process and structure, to allow prediction of human performance under possible conditions of environment, psychodynamic control, and mission function.

• **Future prospects**—The establishment of a Human Systems Development Program for space missions has been proposed over the past five years by the author with increasing success. The early interest of command officers such as Brig. Gen. Donald Flickinger encouraged continuing efforts to "sell" and organize technical support for this program.

Later, increasing technical and command level support and guidance resulted in more formal presentation and recognition of the program's merit by Lt. Gen. Donald Putt, Major Gen. Marvin C. Demler, Major Gen. Leighton Davis, Col. Jack Bolrud, Col. Norman Appold, and others responsible for development programs.

Today, the X-15, Dynasoar, and manned satellite projects serve to underscore the recognized need for establishment of a Human Systems Development Program. The successful closing of this gap in the systems concept should prove a forward step, not only to programs for Man in Space, but to all forms of manned flight and life on Earth.★

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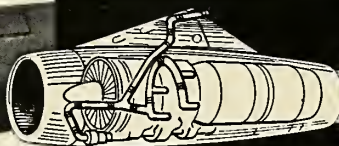
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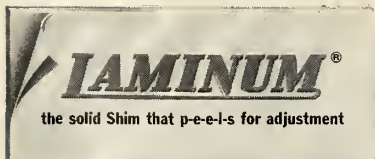
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SEPTEMBER

- American Rocket Society, Fall Meeting, Hotel Statler, Detroit, Mich., Sept. 15-18.
- 13th Annual Instrument Automation Conference, Convention Hall, Philadelphia, Penna., Sept. 15-19.
- ASQC, 5th Annual San Francisco Bay Area Conference, Stanford U., Palo Alto, Calif., Sept. 19.
- Professional Group on Telemetry and Remote Control, 1958 meeting, American Hotel, Bal Harbor, Miami Beach, Fla., Sept. 22-24.
- Standards Engineers Society, Seventh Annual Meeting, Franklin Hotel, Philadelphia, Pa., Sept. 22-24.
- Air Force Association, Airpower Showcase, Dallas, Texas, Sept. 25-28.
- ASME Power Conference, Statler Hotel, Boston, Sept. 28-Oct. 1.

OCTOBER

- Third Symposium on Hypervelocity, Host: Armour Research Foundation, Sherman Hotel, Chicago, Ill., Oct. 7-9.
- Armour Research Foundation and Illinois Institute of Technology, Annual Noise Abatement Symposium, Hotel Sherman, Chicago, Ill., Oct. 9-10.
- Fuels-AIME Conference, American Society of Mechanical Engineers, Old Point Comfort, Va., Oct. 9-10.
- ASME, Lubrication-ASLE Conference, Statler Hotel, Los Angeles, Calif., Oct. 14-16.
- Association of the United States Army, 1958 annual meeting, Sheraton-Park Hotel, Washington, D.C., Oct. 20-22.
- Fourth Annual Symposium on Aviation Medicine, Miramar Hotel, Santa Monica, Calif., Oct. 22-24.
- SAMA Laboratory Apparatus and Optical Sections' Midyear Meeting, Westchester County Club, Rye, N.Y., Oct. 26-28.
- Institute of Radio Engineers East Coast Conference, Aeronautical & Navigational Electronics, Lord Baltimore Hotel, Baltimore, Md., Oct. 27-28.
- 1958 National Metal Exposition and Congress, American Society for Metals, Public Auditorium, Cleveland, Ohio., Oct. 27-31.
- IRE, 1958 Electronic Devices Meeting, Shoreham Hotel, Washington, D.C., Oct. 30-31.

NOVEMBER

- Conference on Scientific Information, AFOSR/Directorate of Research Communication, NAS, NSF and the American Documentation Institute, Mayflower Hotel, Washington, D.C., Nov. 16-21.



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Critical Pressure	99 atm
Specific Heat of Liquid	0.36 cal/gm -10 to 20°C
Density of Liquid	1.45 gm/ml at 20°C
Density of Gas	3.3 gm/liter 21°C, at 1 atm
Vapor Pressure	2 atm at 35°C

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Why A Patent Attorney In Space Age?

He can spot pitfalls for manufacturers and inventors, smooth paths from mind to hardware

by Robert Levine*



WHATEVER the contemplated role of the professional man in society, he must be aware of the fact that a new world is evolving at a pace which strains his comprehension of the many shifting factors involved. Merely by reading the new publications referring to biochemistry, space medicine, magnetohydrodynamics, ULF, monopropellants, organic chemistry, neutron absorption, etc., he readily sees how intricate some of the concepts that he has been working with have become.

Not only have his own specific areas of interest become more complex, but more and more, he must be able to relate his work with accomplishments in other fields that were at one time quite unrelated. In this connection, the patent attorney's roll can be vital to any company wishing to establish or maintain a competitive lead in this changing age of rockets, missiles and space flight.

When the patent system was established, it was thought that whatever difficulties would develop would be rooted in the human frailties in trying to protect creative effort and to guard against usurpation of ideas by others. It is apparent that this concept of inventorship has been radically changed in the last few years.

The true inventor may be someone entirely unrelated to the person who filed the patent application. An inventive idea can no longer be confined: scientists travel from country to country, exchanging ideas broadly, to the extent that results spring up in a multitude of places. Who is the true inventor? By the same process on a smaller scale, who is the true inventor in the corporate "team" which is the breeding ground for the complex

"system" type of many inventions?

• **Inventor coming back?**—But, the cycle seems to be coming around—the individual inventor is becoming "king" again—he is becoming more and more important. But, the inventor is no longer the garret dweller of story-books. He now has the vantage point of a great university, and his inventions are made in the university laboratory. The attitude and perversities of the intellectual scientific seeker are now related to the needs of the financier, the promoter, and the administrator of corporate welfare.

Until very recently, the administrator or the director of research did not have to know too much about the vagaries of research. He thought "common-sense" would see him through. Tasks were assigned on the basis of "man-power available," with little understanding of the direction that this manpower should take. Now, all this is gone, washed away by a technological tidal wave.

The thought and attitudes prevailing in the business world are being revamped, because, whether "business" likes it or not, survival depends not on a known depreciation factor, or the new financing of old capital structure. Survival depends on time, and on the knowledge that the next day's advantage in the market place will be lost the day after by some new technological concept erasing an old product.

• **New role for lawyer**—In this state of affairs, the duties and functions of the patent lawyer become entirely different from his previous role in the business world. His role is now the

role of the trouble-shooter, the man with knowledge of where the industry will be in the years to come. He is called in to appraise the research "problem," as it is now called, so that direction may be given to administration of research.

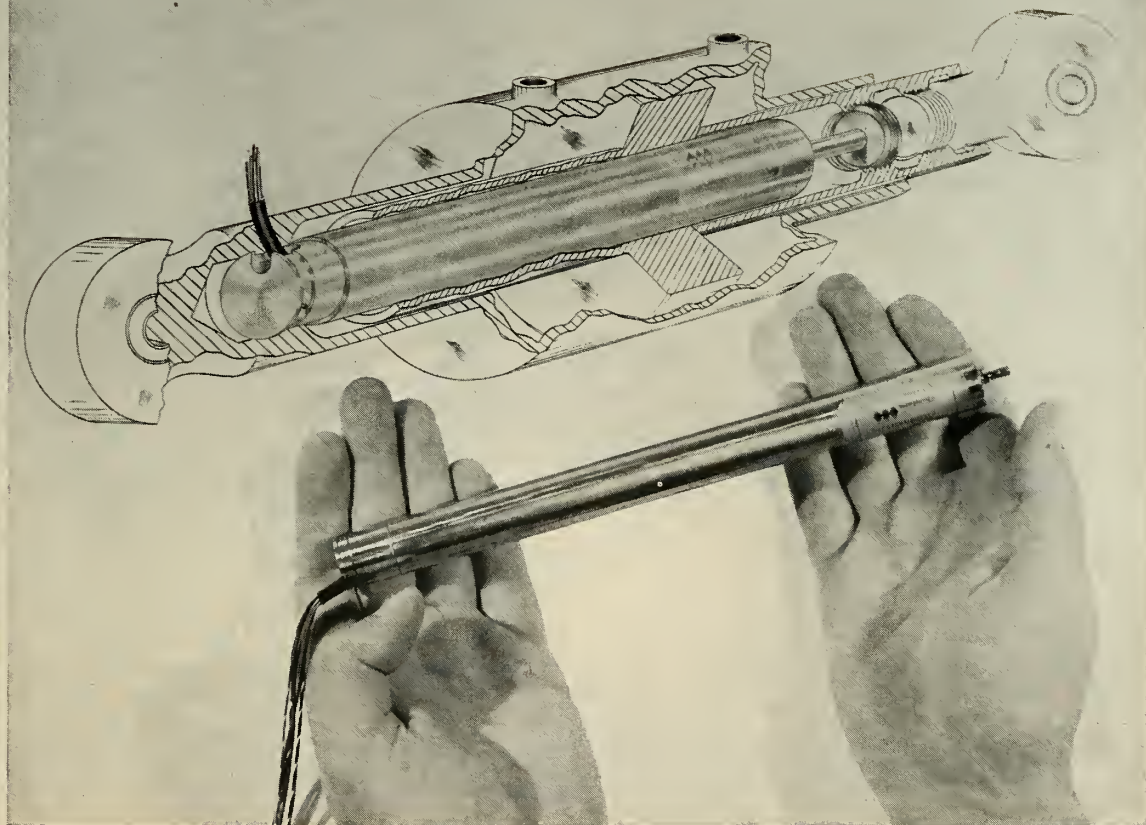
The reason for this is obvious. In the usual business organization, which carries on a multitude of "new product" activities, communication between individuals and departments has now broken down to the extent that the sole answer to research activities lies in the patent department. This department is the communication link and liaison between all departments of the firm; advertising, research, financial, and the outside world of industrial knowledge, as exemplified by activities of competitive firms and fields.

In addition, the problem created by engineers and technicians continually moving from job to job places an additional burden in determining where inventions really originate.

Whatever the patent attorney believes his function to be, management feels that he should always be in the position to rid the company of its troubles immediately; the engineer thinks of him as a negative influence; the comptroller believes him to be a burden upon the budget, and everybody concludes that without him, the world would be easier; except for the fact that they need him badly.

In short, the patent lawyer is looked upon as saviour or miscreant, depending upon whether he is a protector of the inventor, or an advisor to the facts concerning the coverage of claims

* Patent lawyer,
P. R. Mallory & Co., Inc.



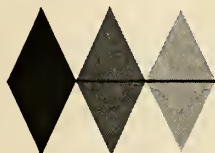
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in a patent that should be avoided.

• **Patent research**—Some examples of where the patent attorney was instrumental in directing research into the missile and aircraft fields come to mind.

One of the most important advances in aviation instrumentation was the Lindberg Engine Analyzer, which has been instrumental in saving thousands of lives in Korea.

The engine analyzer was presented to a research group for evaluation. The results of the evaluation were non-committal. However, the patent attorney was called in to estimate the inventive possibilities. The patent attorney immediately saw that the disclosure as it went to the evaluation group had missed several important practical inventive concepts. Knowing the art, he asked that the disclosure be forwarded to the Patent Department where a new evaluation indicated the practical significance of the device.

As a result, patents were secured for the engine analyzer. The corporation was then able to manufacture the device under license from Lindberg. The invention became one of the most important contributions to aviation in recent years, and has been given several awards for achievements.

Another instance occurs with reference to a sub-miniature snap switch. The switch manufacturer was asked to evaluate several types of precision switches. In order to determine the merits of the switch, the patent attorney was called in.

At his recommendation, the switch was given a high evaluation as to the commercial prospects. This was because on practical test, the patent attorney saw that the switch embodied a stress principle which was never properly presented to the engineers sent out to estimate its significance. This feature was in the aspect of overcoming a "dead stall" point inherent in other such snap switches. This feature was only brought out by going through a step-by-step review with the inventor and finding out that this important aspect, which was understood to him, had never been properly transmitted to the engineers.

This made the sensitivity of the switch exceedingly important in rocketry, guidance equipment and landing gears for jet planes, where instantaneous reactions were necessary in making and breaking circuits. This sub-miniature type switch has now a very valuable place in the aircraft, missile and computer arts.

A third development which was

missiles and rockets, September 8, 1958



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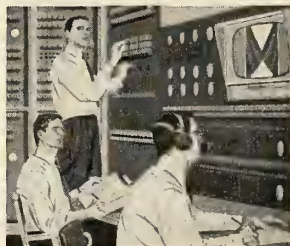
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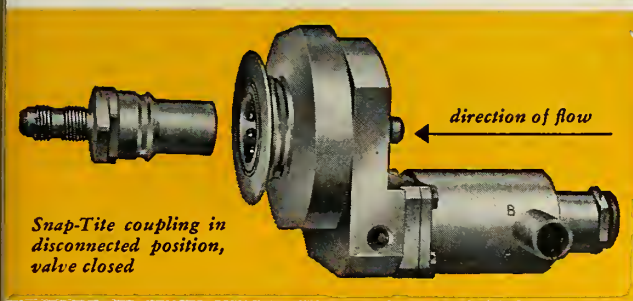
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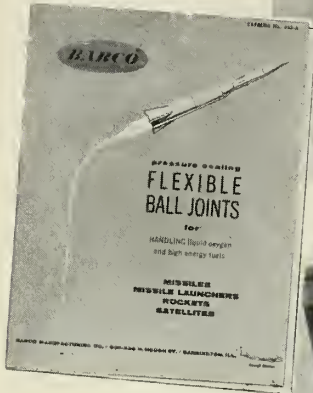


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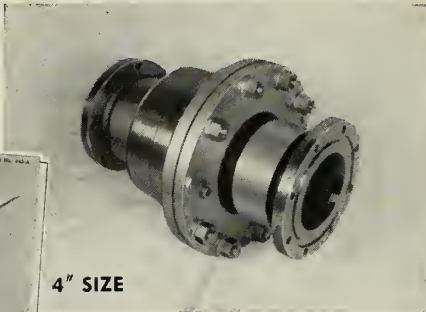
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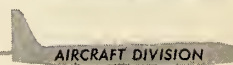
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. . . patent attorney

sparked by the patent attorney was in the "titanium" alloy fields. For years, all new alloys were being subjected to hard scrutiny, and step-by-step, new characteristics had to be evaluated. Since this was a new metal, it made it necessary for the patent attorney to educate engineers and examiners in the U.S. Patent Office concerning new principles involved in alloying titanium, so as to encompass many results unavailable with other alloys.

It is now a fact that titanium today, with its strength to weight ratio, has become one of America's great standbys in the missile arsenal. Moreover, the immunity of the metal and its alloys to corrosion has made it a factor in the chemical and naval industries (submarines)—since salt water and other corrosion-type environments have made no impact on this metal.

The development of these alloys and their protection in industry could only have come about through the untiring efforts of the patent attorney in seeing that patent protection was obtained for the metal. The results of this effort have created an entirely new industry, the future of which is tremendous and marks a breakthrough in providing a requisite metal for fire walls and engine frames where corrosion, strength and heat problems were almost absolute deterrents.

• **How to do it**—The problem of the patent attorney is considerable, especially when research and patent funds are limited.

The patent attorney's experience in untangling the skeins of knotted logic; his analytical approach to the problems involved; and his awareness of the practical and financial results make for his unique position in controlling the business situation. He must be aware of the great challenge to American industry by other nations, particularly in the ideological struggle between East and West.

The importance of this aspect of technological progress in the world today should not be overlooked, especially when your opponent is waging war with terrific advantages of chattel labor, unlimited capital, irrational command of forces, rampant ambition and no need for a return on investment capital or a requirement for profits.

The patent attorney must be able to play the roles of lawyer, production man, research director and financier, as well as other functions ordinarily ascribed to him. These duties and functions have fallen to him by default.



11-52

Man-Machine Relationships: A New Field for Engineers and Scientists

A new field for Operations Research Specialists, Engineers, Computer Programmers and Behavioral Scientists has arisen from SDC's work on relationships of men and machine systems.

It involves two major projects: *1 creating and conducting large-scale training programs in present and planned air defense systems; and 2 operational computer programming for SAGE.*

Attaining the most effective interaction between men and machines in these programs is of prime importance. It requires intensive effort in an unusual combination of technical and scientific areas. As such, it is a new field of endeavor.

Both programs also have these elements in common: • they are constantly changing in problems • they are long-range in nature • they are essential to the welfare of the United States.

The close interrelationship of these programs, the widely diversified missiles and rockets, September 8, 1958

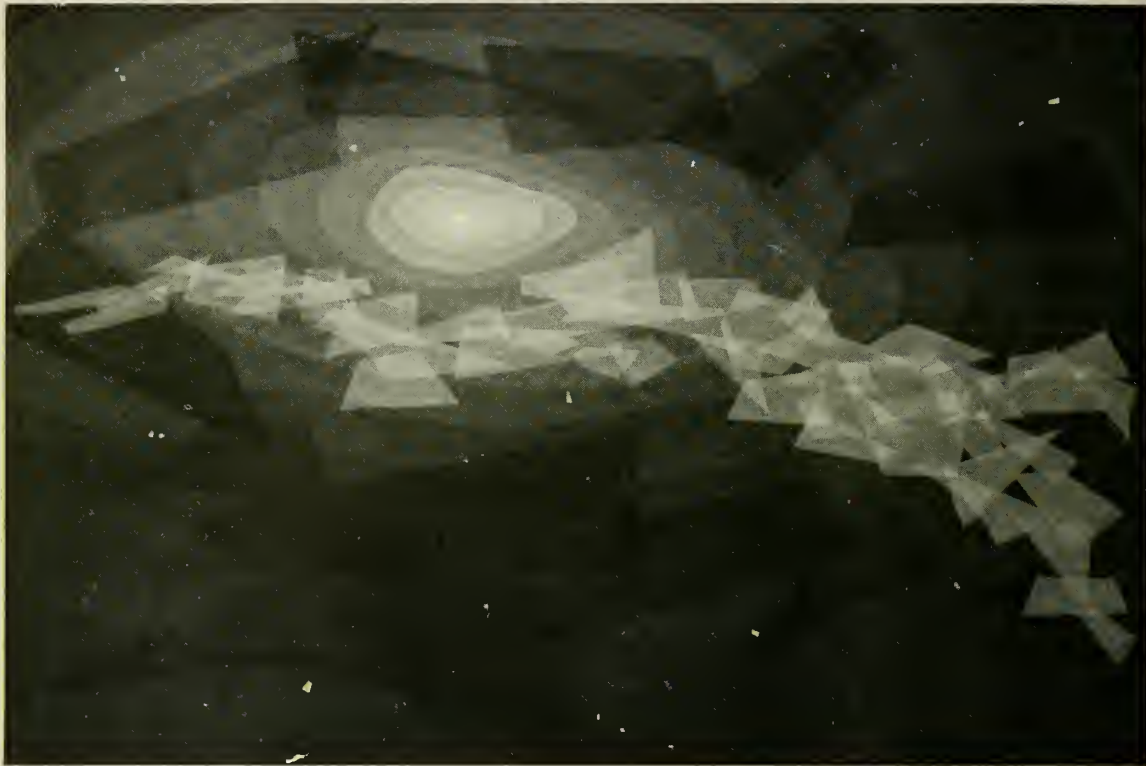
fed specialists engaged in them, and the dominating influence of man-machine relationships make SDC's work unique. Operations Research Specialists, Engineers, Computer Programmers, Behavioral Scientists — all find their assignments reflect the unique qualities of this new field.

The growing complexity of SDC's work has created a number of positions in these fields. Inquiries are invited. Address: R. W. Frost, 2414 Colorado Avenue, Santa Monica, California, or phone collect at EXbrook 3-9411 in Santa Monica.



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"CYGNUS," another inspiration by Simpson-Middleman, painters of the meanings of science. "Knowledge of the Universe," say these artist-scientists, "is not a matter of man's sight, but of his imagination's vision. Our eyes show us Cygnus. But creations of our genius, such as the radio-telescope, reveal unexplored, unexplained sources of energy that man may someday master. They lie amidst and even beyond those mysterious, drifting clouds of cosmic matter, lit by the stars they do not obscure." Painting courtesy John Heller Gallery, Inc.

Space-age research at Boeing

Creative scientists find at Boeing a research environment planned to help them reach and stay at the top in their special fields. Pure research along the very frontiers of knowledge is the sole concern of members of the Boeing Scientific Research Laboratories. Problems associated with man's conquest of air and space are high on the agenda, supplemented by investigations in other, equally advanced areas. Aerodynamicists and mathematicians participate in these programs, along with nuclear physicists,

physical chemists, theoretical metallurgists and physicists specializing in electronics and solid state physics. Scientists interested in imaginative, creative research are invited to communicate with Boeing. Other Boeing openings are available to mathematicians and to engineers of all categories. Assignments are open in the fields of research, design, production and support engineering. For complete details, drop a note now to Mr. Stanley M. Little, Department R-79 Boeing Airplane Company, Seattle 24, Washington.

BOEING

... patent attorney

Wherever there is a "no-man's land" of function, it is usually the patent man who is assigned to the task.

In carrying out such functions, a plan must be followed. Here is a 10-step program that is workable:

(a) Gear the physical plant facilities to new developments.

(b) Be on the alert to new development going on in other sciences and industry.

(c) Watch the universities for latest reports in the field.

(d) Watch and participate in fellowships and scholarships.

(e) Tighten up liaison between departments.

(f) Continually upgrade the knowledge of the research staff by providing scholarships, adult education courses, visiting lecturers and planned industrial trips.

(g) Protect the history of the company growth, so that duplication of effort may be avoided.

(h) Create attitudes of constructive thinking: tooling costs and developments which are discarded are very costly, and in many cases could be avoided.

(i) Use library facilities and government sources as much as possible.

(j) Regularly survey output of all departments. Show an interest in what is going on.

By utilizing the patent attorney in this manner, a company provides itself with yet another weapon with which to fight, not only in the rough-and-tumble competition of commerce, but in the much more deadly battle that now engages the world.*

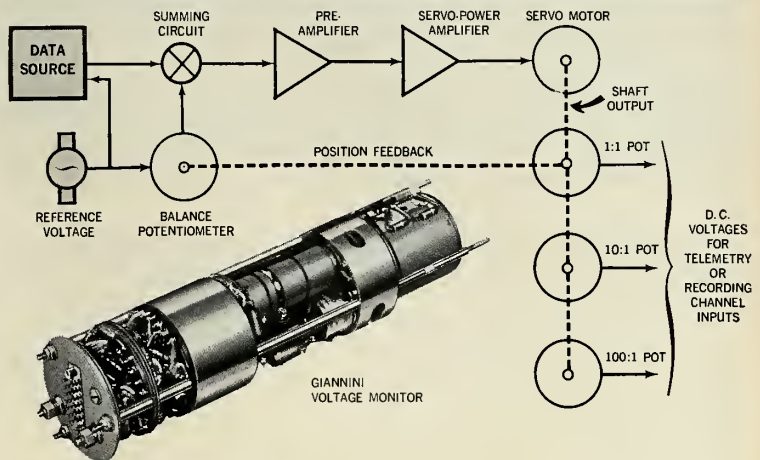
Northam, BJ Electronics New West Coast Merger

Northam Electronics, Inc., has been acquired by the Byron Jackson Division of the Borg Warner Corp., according to an announcement by Borg Warner and Northam's parent company, Norris Thermador Corp.

Northam's Alpadena, Calif., facilities will be merged with BJ Electronics in Santa Anna, Calif. The merged engineering and production departments will be under the direction of John R. Harkness, vice president and general manager of BJ Electronics. Eugene Bollay, formerly president of Northam, will be director of research, meteorology and instrumentation.

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THE PRECISION VOLTAGE MONITOR alters a transducer or control system signal so that data relayed to the telemetering or recording system is less susceptible to system errors. A unit designed for incorporation in the airborne telemetering system of Chance Vought's Regulus II results in telemetered data with approximately 0.04% overall error. This figure is conservative, and includes the effects of all unit error sources such as hysteresis, linearity, temperature effects, and long term drift, as well as telemetering system error.

A VOLTAGE MONITOR CONVERTS AC output signals from an airborne data source into 3 DC voltages, representing the data to four or more significant figures. These three separate units of information are fed into the telemetering or recording system on three separate channels. The result is transmitted information with an accuracy of four or five significant figures.

WITHOUT CHANGING THE CIRCUITRY of the transmitting system in any way, errors incurred in transmittal are restricted to the fourth or higher order significant figures.

Designed to satisfy the extreme environmental demands of aircraft and missile data systems, Giannini Precision Voltage Monitors are also readily adaptable to other airborne or industrial applications requiring precise voltage monitoring, data repeating, or data multiplexing. They are available in voltage ranges from 0.0 to 0.8v to 0.0 to 100.0v, and sizes from 2¼" x 6" to 2¼" x 9".

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Magnesium

by Carl N. Mortenson*

USE OF MAGNESIUM alloys and products in missile systems may exceed that for piloted aircraft structures and associated equipment. Today, magnesium is being used in 20 different missiles, and is being designed into several space projects.

Here are the reasons for this growing use of magnesium in the missile industry: new alloys and products, most important of which are the elevated-temperature magnesium alloys introduced during the last five years. These have prompted many designers to consider magnesium for the first time and others to reconsider it.

There also have been significant advances in shop-processing and fabrication techniques, necessary to permit the use of these alloys in practical structures. The most recent are arc-welding techniques and elevated-temperature forming methods, resulting in improved metal-forming efficiency.

Of equal importance has been the development of improved protective finishing systems and procedures for magnesium, particularly for dissimilar-metal couples and, more specifically, for mechanical fasteners. Many of these finishing systems are already in use and are proving considerably more effective and serviceable than previous methods.

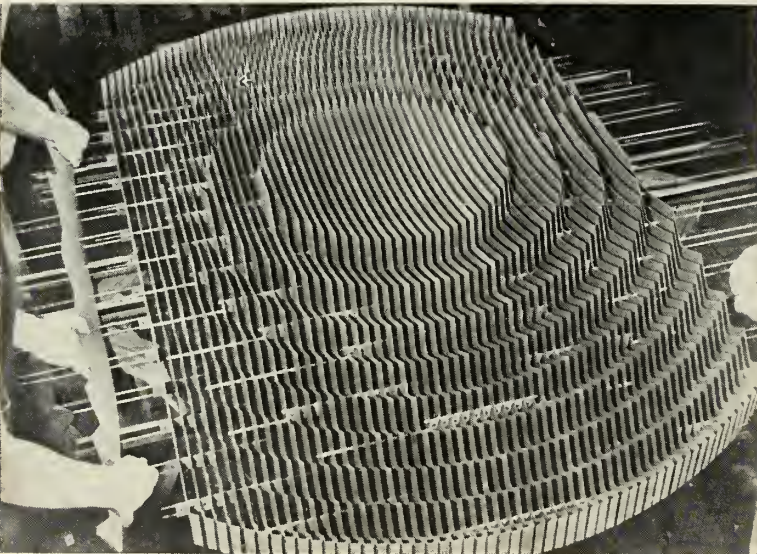
• **Missile uses**—Among the oldest and most significant users of magnesium are the *Nike-Ajax* and *Nike-Hercules* systems. The *Nike-Ajax*, including booster, has approximately 100 pounds of magnesium sand castings. It appears that *Nike-Hercules* and *Nike-Zeus* will have an equal or greater amount.

The missile structure of *Nike-Ajax*, apart from the booster, uses magnesium alloy castings in guidance structure and door; control housings for rudders, elevators, and ailerons; aft housing, and main fin fittings and channels.

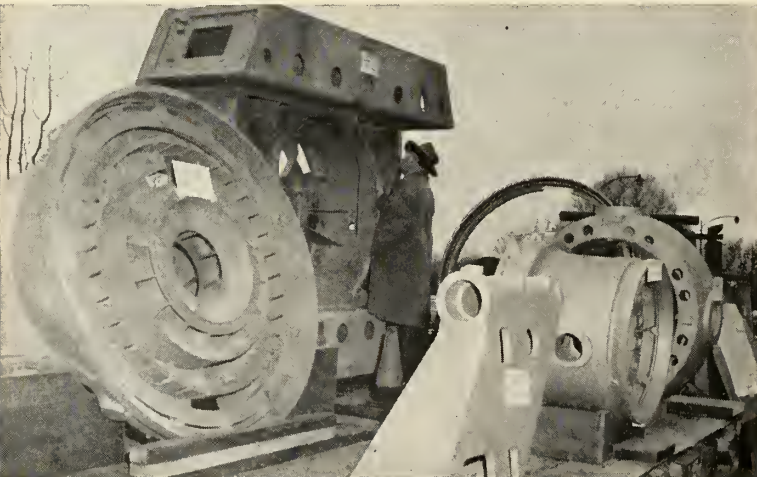
The ground guidance and support equipment required for *Nike-Ajax* and *Hercules* contains 3,500 to 4,000 pounds of magnesium sand castings, extrusions, and sheet. Significant amounts of sheet and extrusions are used in the structure of the system's van-type control trailers. In addition, the M-33 tracking lens assembly mounted on top of some of the vans is practically all magnesium. This particular lens mount has four magnesium sand castings with a weight of approx-



MAGNESIUM FABRICATED radar cabinet for *Nike-Ajax* weighs only 280 pounds.



70-POUND TRACKING LENS assembly is held together by plastic-coated steel wires.



BULKY PARTS of *Nike-Ajax* tracking assembly look heavy, but weigh 3,200 lbs.

Will It Find Biggest Market In Missiles?

imately 200 pounds. The lens, weighing 70 pounds, is fabricated from magnesium sheet held together by plastic-coated steel wires.

The van-type trailers house a number of radar console cabinets. The largest cabinet, fabricated entirely by welding magnesium sheet and extrusions, weighs 280 pounds. Some 12 to 14 different magnesium cabinets are used in the several vans of a *Nike* ground system.

Practically every part of the *Nike-Ajax* tracking lens assembly carried by a flatbed trailer is magnesium, including the large base casting, the trunion and yoke casting, the three tripod-type leg castings, the sheet lens, and extruded A-frame support trusses. Total approximate weight is 3,200 pounds.

• **Surface-to-surface missiles**—The extent to which magnesium is being used in some of the surface-to-surface cruise-type missiles can be seen by reviewing the *Matador*, *Snark*, and *Regulus II* airframes.

Most of the *Matador* fuselage skin is AZ31B-H24 magnesium sheet, with a weight of several hundred pounds.

AZ31B-H24 magnesium sheet is used in the *Snark's* fuselage and vertical fin. A substantial number of magnesium sand castings are used internally. Weight of magnesium in the *Snark* is in excess of 400 pounds.

There are several hundred pounds of magnesium sand castings in the *Regulus II*, including the large 150 pound air-intake casting of AZ91C alloy. The split clamshell vertical fin tip of AZ91C alloy is cast to a thickness of approximately 0.120 inch. A substantial amount of magnesium sheet is used in *Regulus II*.

• **Air-to-air missiles**—One of the earliest of the air-to-air missiles to use a substantial amount of magnesium is the *Falcon*. Virtually 90% of the GAR-1 model structure is magnesium. The body is made from 0.040-inch AZ31B-H24 magnesium sheet (which has been rolled, longitudinally welded, and then stretch-formed to size) and ZK60A-T5 magnesium extruded tube. The four stabilizer frames, each weighing about four pounds, are made from AZ91B magnesium die castings. The four rudders attached to these frames are machined from ZK60A-T5 forgings.

• **Surface-to-air missiles**—The Navy surface-to-air missiles, *Terrier I* and *II*,

use magnesium sand castings, including wings and fins, as well as magnesium plate in fuselages. *Talos* uses an unspecified number of castings.

The most extensive use of the high-temperature magnesium sheet alloy HK31A-H24 is in the *Bomarc* surface-to-air missile. There are an estimated 200 pounds of magnesium per missile, including HK31A-H24 sheet in the fuselage, wing and tail, and HM31XA extrusions used as leading and trailing edges in the control surfaces.

The Marquardt ramjet engines which are scheduled to power later *Bomarc* models use over 200 pounds of HK31A-T6 magnesium sand castings and magnesium sheet alloy throughout the entire diffuser section.

An HK31A-T6 magnesium sand casting, weighing about 20 pounds, forms an access door and hydraulic equipment package in the *Bomarc* fuselage. Use of magnesium saved about six pounds over the previous design.

• **Ballistic missiles**—The most recent use of magnesium in the missile industry is in the ballistics missiles. Illustrating a starting point for magnesium in such weapons, is the use of both room- and elevated-temperature magnesium sheet alloys in the *Vanguard* satellite launching vehicle and the satellite sphere itself.

AZ31B sheet is used in the 20-inch diameter sphere shell and in the tail can and spacer sections. The most significant application, however, is HK31A-H24 sheet alloy as contour skin for the second stage rocket. This is an indication of applications to come in future ballistic weapons, for they will use this sheet in areas subject to the same range of temperature (about 500-550°F) as the *Vanguard* second stage.

Although security restrictions do not permit at this time a disclosure of the exact amount or areas of magnesium usage in the *Polaris*, *Atlas*, *Titan*, *Thor*, or *Jupiter*, it is understood that magnesium sheet and extruded and cast products will find significant applications in these missiles.

Development of still newer sheet alloys with high strength at room temperature has led, for the first time, to favorable consideration of magnesium wrought products for quantity production of large welded structures.

These newer sheet alloys, unlike earlier materials (notable AZ31B), need no thermal stress relief after welding. Combined with excellent weld-

ability and weld-strength efficiency, this advantage will offer higher productivity in large structural assembly operations.

While exhaustive service test data proving complete compatibility of magnesium with liquid oxygen and liquid fluorine is not available, interim laboratory test data and experience indicate that magnesium will perform satisfactorily as a storage container for both. Since these oxidizers are at temperatures of approximately -300°F, mechanical properties at such temperatures, including impact and weld strength, are now being determined for those alloys believed most suitable.

Results already available at temperatures down to -300°F, indicate significant increases in ultimate and yield strengths. Although elongation decreases, there is no sharp drop or change in the slope of the elongation vs. temperature curve, and at -300°F the actual values are still adequate for use in this type structure.

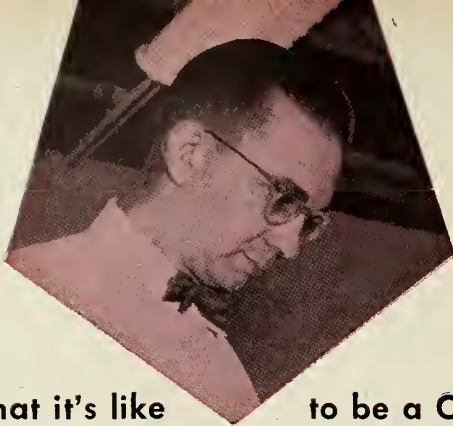
• **Why increased use?**—Where missile performance requirements demand a minimum-weight structure, and where magnesium's strength-to-weight ratio or rigidity-to-weight ratio is unsurpassed, magnesium usage will increase in both the second and primary areas of the missile structure, as well as certain components of the ground-support system.

Structural designers are familiar with the various theoretical analyses used to calculate strength-to-weight comparisons. One concerns the resistance to compression buckling of a column, and is known to be proportional to the parameter $E t^2$, where E = Young's Elastic Modulus, and t = section thickness. Therefore, $E t^2$ /density is of real importance in design of missile skin structures.

Comparison of HM21A-T8 magnesium sheet with another common missile metal for resistance to buckling in the temperature range through 700°F shows:

Magnesium sheet, with an 18% weight saving, which normally represents a difference of one gauge in thickness, will have superior buckling strength at elevated temperatures. Comparing the two materials at equal weight, the magnesium structure would be approximately 60% stronger than

**Magnesium Technical Service and Development. The Dow Chemical Company.*



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to be a Creative Engineer at

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INERTIAL GUIDANCE ENGINEER John V. Prikazsky tells why airborne computer development at IBM Owego, N. Y., offers him the creative engineering career he always wanted.

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the other structure in comparison.

Structural stiffness is also a factor to be considered, particularly related to the problems of aeroelasticity and flutter. If HM21A-T8 magnesium sheet and the other metal are again compared, where stiffness is proportional to $E t^3$, the magnesium sheet, one gauge thicker and 18% lighter, will be stiffer throughout the elevated-temperature range. At equal weight, magnesium sheet is over twice as stiff.

The challenge created by increased missile operating temperatures has been partly met by the introduction and gradual availability of several elevated-temperature magnesium alloys.

Magnesium alloys containing rare earths were developed and came into commercial use in the early 1950s. These alloys are used for sand castings in applications where temperatures of 300°F to 450°F are anticipated. In this range, these alloys have built up a good service record.

Shortly after the rare earth-containing alloys became standard compositions, the magnesium-thorium alloys were introduced—first in the form of sand castings, and later as sheet, plate, and extruded products. Already, these cast and wrought products are in use at temperatures up to 650°F. Short-time elevated-temperature property data for these products up to 1000°F are now being released.

The first magnesium-thorium sheet and plate alloy to reach full commercial status was HK31A-H24. This product was found serviceable up to 550°F for short time requirements, and up to 350°F where creep is the important factor.

A second sheet and plate product, HMZ1A-T8, is being evaluated for long-time exposure up to 700°F, and at higher temperatures for short-time exposure. A similar composition, HM31XA-F, is being produced in extrusions for elevated-temperature use.

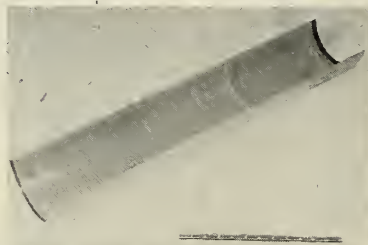
Although magnesium wrought and cast products do not always compete price-wise on a per-pound basis with other metals, it has been proven that a finished part designed especially for magnesium can be produced considerably cheaper than the same prototype part fabricated differently from another material.

One example of this is the growing use of one-piece, sometimes relatively-thin wall, magnesium sand castings to replace complicated fabricated assemblies consisting of many pieces in another metal. Magnesium's advantage of low density makes it possible to produce structures such as missile fins as one-piece sand castings.

• **Heat-sink capacity**—The very high specific heat of magnesium alloys re-



THE 150 LB. AIR-INTAKE of *Regulus II* is a magnesium alloy sand casting.



ONE-HALF OF LIGHT-WEIGHT *Falcon* stabilizer is shown before welding.



NEW K1X1 ALLOY sand casting is being used for new development missiles.

sults in excellent heat-sink capacity. For example, in a hypothetical transient-heating environment, magnesium, on an equal weight basis with three other missile metals, will actually have a considerably-lower skin temperature. This difference can amount to as much as a 200° to 300°F lower temperature for magnesium.

Thus, the strength efficiency of magnesium at its lower temperature may be superior to the strength efficiencies of these other metals at their higher temperatures. This can be a significant factor in the selection of materials for a ballistic-type missile or one of the anti-missile missile projects, such as *Nike-Zeus*.

A little-known advantage of magnesium over other common construction materials is its inherently-high damping capacity (the ability to absorb

vibrations and not transmit them). This characteristic has been explored and is, perhaps, most useful in the form of magnesium sand casting and die castings.

One very new magnesium alloy, identified as K1X1, is being produced in experimental quantities for testing in actual airborne missile components. These structures provide mechanical support for portions of the missile electronic guidance system. In these areas, good damping capacity helps prevent electrical-mechanical malfunctions, sometimes caused by high-frequency, low-amplitude vibrations induced by the launching booster or sustainer power source.

The K1X1 magnesium alloy provides a damping capacity five to seven times that of some other commonly-used metals. Bell Telephone Laboratories have led in the development of testing procedures and uses for the K1X1 alloy.

• **Pending developments**—Many improvements are now known to be possible for galvanic corrosion protection and mechanical fasteners. Several fastener manufacturers are working with the magnesium industry and airframe companies to exploit these possibilities and produce compatible fasteners that will have built-in galvanic corrosion protection. The known use of certain compatible aluminum alloys, including special high-purity compositions, offer special promise. Electroplated steel fasteners utilizing metals other than cadmium or zinc, have shown similar results.

Electroless nickel, applied to magnesium in chemical baths, may prove adequate in special applications. This finish is being applied to some experimental magnesium electrical connectors.

Laboratory work now in progress promises to yield an extrusion alloy with a yield strength in the range of 40,000 to 45,000 psi.

The elevated-temperature alloy bread basket is still not emptied. Newer compositions are being readied for early evaluation.

Under development are alloys of lower specific gravity than the average of 1.88 for the presently available compositions.

What does the future hold? These and other new developments are being released at an increased rate, although in some cases they are limited to specific projects or programs. When missile and space engineering personnel become more familiar with these newer technological developments, it is certain that increased structural use of magnesium will result, opening up new markets for its further world-wide use.★

Soviets Certain They'll Be First On Moon

Long-standing, deeply scientific studies of space travel lend strength to beliefs of leaders and citizens

by Dr. Victor P. Petrov*

"SOMEWHERE in the Soviet Union, there is a youth today, who though he may be unaware of it, will be the first man to land on Mars," so states academician Leonid I. Sedov of the USSR Academy of Sciences. There is not the slightest doubt in the minds of Soviet scientists, government officials, or citizens that the first person to set foot on Mars, the Moon, or any other planet, will be a Russian.

Since their spectacular success with the *Sputniks*, Soviet plans for space travel have been given a shot in the arm. The Soviets didn't need much encouragement however, because they have been planning for the space age for some time; while the U.S. jumped on the bandwagon only after the launching of *Sputnik I*.

• **Space-travel minded**—What have the Russians been doing in this field? A survey of Soviet scientific literature, as well as magazines, newspapers and science-fiction books, indicates that they have been seriously engrossed in the study of space travel for many years, and will continue to pursue the study of space in the future.

Soviet articles and statements on space travel have been written and publicized, not by amateur science-fiction writers, but by learned people of great scientific stature, including many academicians—the cream of Soviet scientists.

We know, that since 1951, the Soviets have seriously probed into the upper atmosphere with the aid of various scientific tools, mainly rockets. Long before the first *Sputnik* went into orbit, the Soviets sent dogs up to altitudes of 125 miles to test the animals' ability to survive in a rocket or satellite.

What preliminary work and experiments did the Soviets perform before sending *Sputniks* aloft, and what are their plans for space travel? Judging by material obtained from their publications, they are dead serious about their plans, and do not space time or money plotting a future path into the universe.

It would be timely to cite the words

of a Moscow correspondent for the *New Statesman*, a British week-end review, who said: "Soviet plans for conquering space have been pretty well disclosed in the press. In this land, even 'science fiction' is purposeful and the author's fantasy is rarely permitted to range far beyond the limits of some foreseeable five-year planning period."

• **Manned flights**—The success of *Sputnik I* permitted the Soviets to declare that it was the first step toward conquering space. However, before sending a manned vehicle into space, they said it would be necessary to study the effect of space travel on animals, just as it was done with rockets. "We will have a *Sputnik* with animals aboard, which will permit us to make a detailed study of their reflexes and behavior, as well as observe their physiological processes," IZVESTIA declared.

This was accomplished when *Sputnik II*, weighing over half-a-ton, was placed in orbit on November 3, 1957. The originally-given weight of *Sputnik II*, incidentally, should be revised considerably upward. There are indications that this *Sputnik* weighed much more than the officially-released figure of a half-a-ton.

PRAVDA said on April 27, 1958, that the weight of *Sputnik I* was 83.6 kilograms (185 lbs.). At the same time, referring to *Sputnik II*, the article said that its scientific and measuring instruments weighed 508.3 kilograms (1,120 lbs.). Nothing was said of the total weight of the satellite.

Again, in its official report to the Special Committee of the IGY in Belgium, the Soviet IGY committee said of *Sputnik II*, "the total weight of the equipment, the test animal and the electric batteries in the second satellite is 508.3 kg . . ." This referred to the weight of the instruments and animal only. In the same report, it was stated that *Sputnik II* was ". . . carrying a payload of 508.3 kg, which is six times heavier than the overall weight of the first satellite."

[Ed. Note: Previous questions on

this same problem prompted m/r to call the Soviet Embassy in Washington for clarification. The Press Attache assured m/r that the total overall weight of the second satellite was 508.3 kg.]

Undoubtedly, the launching of *Sputnik III* gave an additional boost to plans for eventual manned flights into space, if only by demonstration of man's ability to send aloft a vehicle weighing one-and-one-half tons. The size of this satellite allows room for a human passenger and a multitude of scientific instruments.

Immediately, Soviet scientists began talking about space flights to the Moon, Mars, Venus, and even further into the universe. Academician Sedov said that the time is not far off when the Soviets would switch from satellites to interplanetary space ships. He expressed the opinion that it will be possible to fly to Mars within the next twenty years.

PRAVDA, discussing *Sputnik III* in a two-page spread, said that the great size of this *Sputnik* and its equipment brings the Soviets to the threshold of space ship construction. A woman scientist, writing in the magazine *SOVIET WOMAN*, said Soviet scientists had already solved the re-entry problem and will be able to bring passengers back to earth alive. She also indicated that ". . . the problem of survival under conditions of interplanetary flight seems to have been solved."

• **Interplanetary flights**—Successful launchings of satellites in precalculated orbits around the world gave impetus to Soviet plans for constructing larger satellites; sending rockets to the Moon; rockets around Mars and Venus; and finally, manned space ships, for these trips. It is amazing that Soviet scientists were talking about these plans to come in the very near future, even before the *Sputniks* became a reality.

There is no question, said a Soviet

*Professor, U.S. Naval Post-graduate System.

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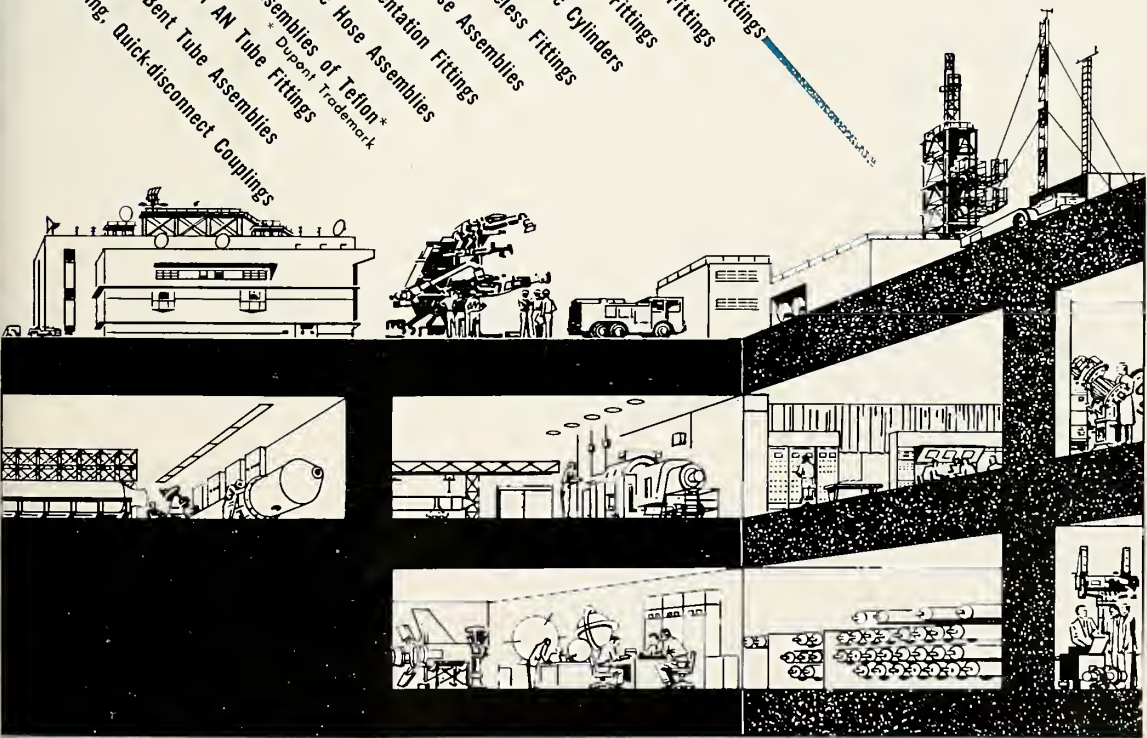
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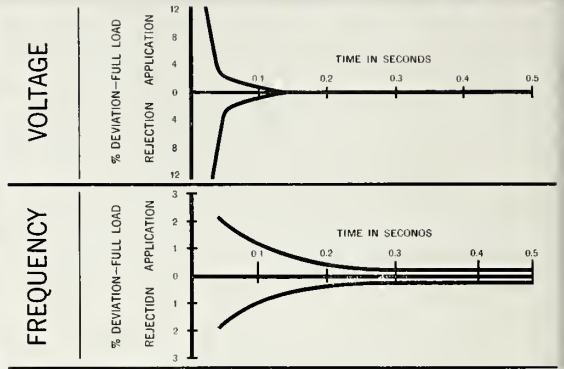


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Snork Missile is powered by this Caterpillar Electric Set, photographed at Cape Canaveral, Florida. Full designation: Caterpillar 60 KW 400-cycle 120-208 Voltage Low Silhouette Portable Ground Support Unit with Precision Control Regulation.



Almost instantaneous return to normal of the new low silhouette Cot power unit (left) under conditions of full-load application and rejection is shown in the above graphs. In each case test was made under a voltage output of 117.4 volts.

Caterpillar Engines help power

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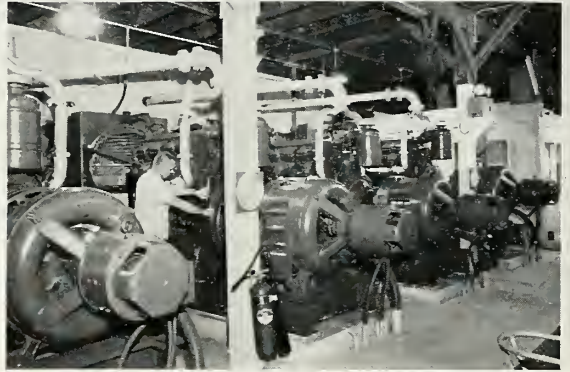
Relatively untrained personnel can operate and maintain these dependable power packages. Only

Weather information needed for missile testing is gathered in this weather station on Eleuthera. Precision equipment used here demands steady, constant diesel-produced electricity.





Central Control at Grand Bahamas Auxiliary Air Force Base is powered by Cot Electric Sets. This is one of 12 such stations that chain southeastward from the Florida Coast to Ascension Island, south of the Equator between Brazil and Africa.



These are Caterpillar Engines supplying electric power on Eleuthero Auxiliary Air Force Base, one of the down-range tracking stations. Each of the engines, generating as much as 68,000 KWH each month, has been operated more than 90,000 hrs.

United States missile program

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Special Governmental Projects, Dept. MI9, Engine Division
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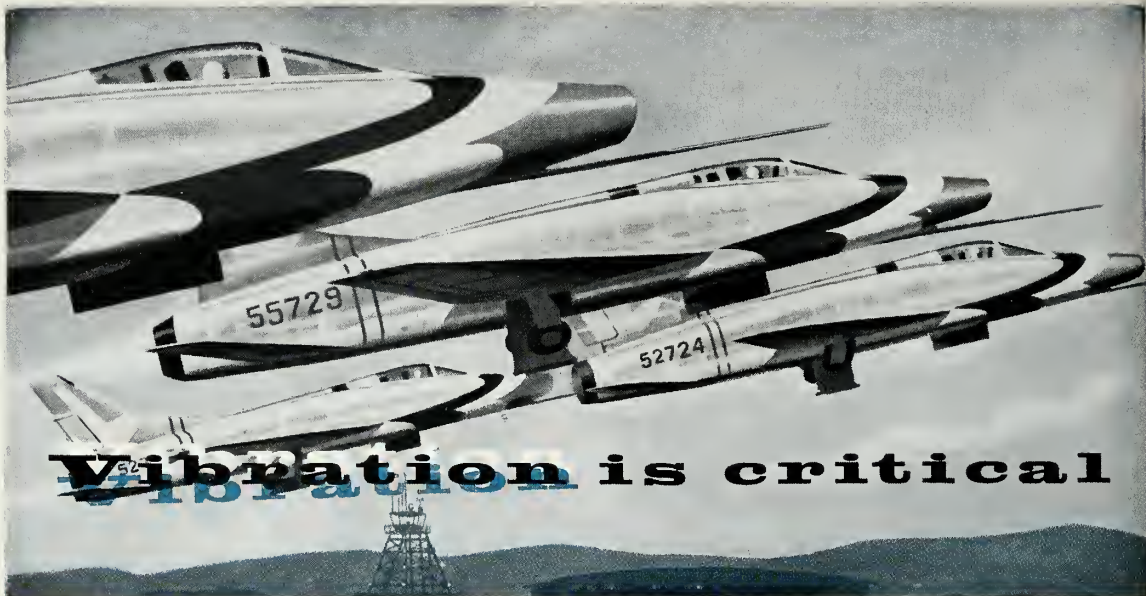
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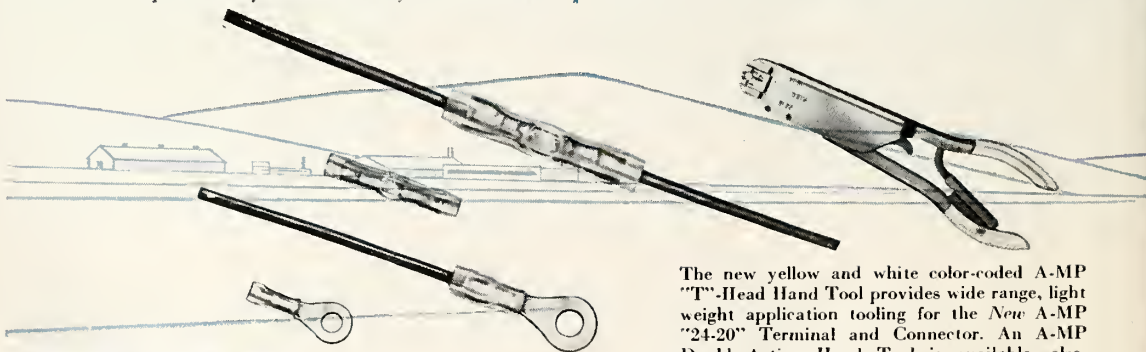


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aviation magazine, that "we can talk about flights to the Moon today, as an event of the near future." This statement was made in October, 1957, before *Sputnik I* was launched. The magazine even goes so far as to describe plans for building interplanetary ships of 1,700 tons each, using earth satellites as workshops. These space-ships will fly to Mars, using the sun's gravitational pull, thus conserving fuel.

The flight to Mars is expected to take 256 days. There will be a waiting period of 440 Earth days on Mars before the space travelers will be able to start their flight back. The entire trip is calculated to take 952 days.

Quite a detailed study of Venus has been planned by Soviet scientist Yu. S. Khlébtsévich, who foresees that a three-stage rocket could be sent into outer space. The third stage of the rocket would orbit around the Earth at a distance of 22,000 miles.

At that distance, the rocket will receive additional supplies of fuel by ferry rockets from Earth. After that, the rocket would blast off on a signal from Earth and travel to Venus. This flight is calculated to take 146 days.

Twenty-four hours before landing on Venus (it will be at a distance of 185,000 miles from the planet), the rocket's special electronic-telescopic instruments, with a thousand-fold magnification, would begin televising the approaching "face" of Venus. These shots of the planet (there will be at least 8,000 snapshots in 24 hours) would be transmitted to Earth.

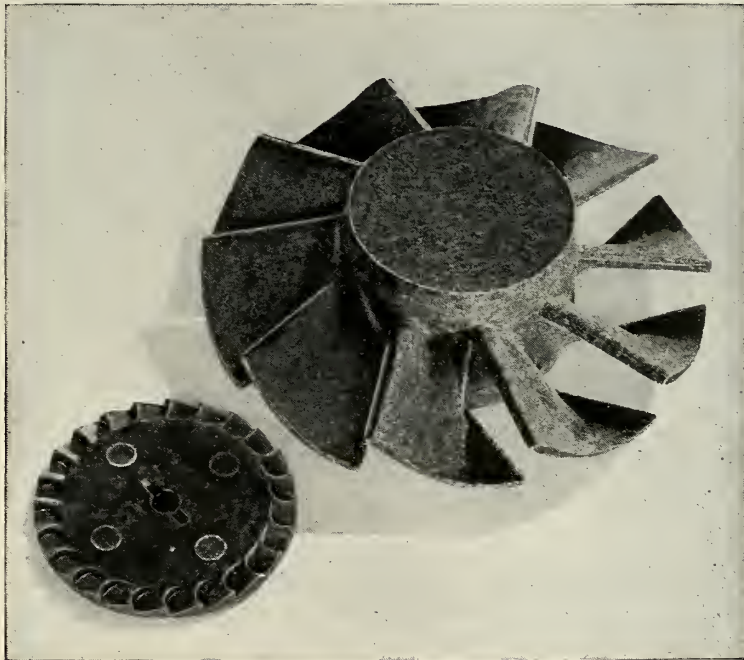
The last view of Venus, before the rocket hit the planet's surface, would appear as if it were taken at an altitude of one hundred meters. Thus, if there were any living beings on Venus, they would be seen with the aid of the rocket's cameras. This flight, according to Khlébtsévich, can be realized sometime between 1962 and 1967.

Another Soviet scientist declared that man is now standing at the dividing line between two eras—the era of man limited by the Earth's environment, and the era of space travel, which is just beginning. The next step, after a series of *Sputniks*, will be a cosmic rocket, which will fly around the Moon.

More and more Soviet scientists are talking about rockets to be sent into space, to the Moon or Mars. It is not future generations, but the present generation, they say, who will witness the first flights to outer space. "Shortly, we will study the Moon or Mars not with the aid of telescopes, but directly . . . perhaps soon a Soviet 'lunaphysical' station will appear on the Moon." It is noteworthy that this was said, not by

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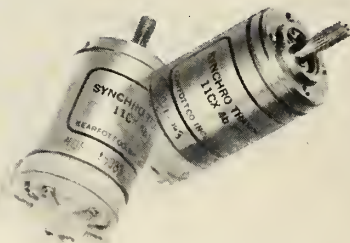
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some excitable dreamer, but by the President of the University of Leningrad!

• **Practicalities of flight**—These general statements bring us to the question: "How do the Soviets actually foresee the practical realization of space flight?" One publication proposes that space travel be divided into stages, and that artificial satellites of the Earth be used as a platform for changing rockets. The Moon will undoubtedly be the first objective in a series of space trips. A trip to Mars, like a trip to the Moon with a surface landing, will probably be preceded by reconnaissance flights around the planet.

The publication goes on to say that thermochemical fuel rockets will probably be the first to venture into space, and that they will be followed by atomic space ships which will be far superior. On returning to Earth, there is the problem of descent without disintegrating like a fiery meteor. The space ships apparently will be unsuitable for landing on Earth. Once in the atmosphere, the space ship will become white hot. Therefore, the publication states, the crew will descend in a streamlined glider. The abandoned space ship will either burn in the atmosphere, or be put into orbit as an artificial satellite.

Academician Sedov expresses the opinion that *Sputniks* will give such a wealth of scientific data, that it will be possible to launch a manned *Sputnik* in the not-too-distant future. However, he says, it will be easier to send an unmanned rocket to the Moon, or send it around the Moon and back to Earth, than it will be to embark on manned flights. He added that the fast progress of astronautics permits the Soviets to state that the present generation will witness manned interplanetary flights of space ships.

While discussing the future possibilities of space flights, another Soviet scientist said that to conduct scientific studies in space, it will be necessary to create manned stations on the satellites. Specially-constructed rockets may deliver members of the crew, cargo, and fuel to the stations as necessary. He also stated that even now, it is technically possible to reach the Moon with the aid of a rocket launched from the Earth.

Writing on the subject of flights into space, another Soviet scientist said that the Moon should be the first step. He added that soon after the investigations by unmanned lunar probes, man will land on the Moon's surface and build temporary shelters and scientific sta-

missiles and rockets, September 8, 1958

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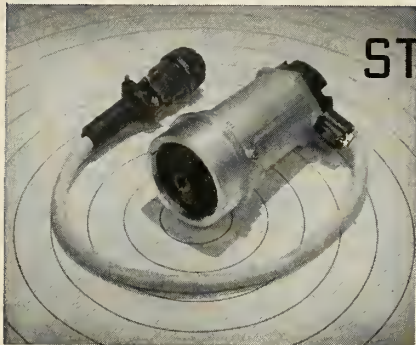
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what are your missile power problems?

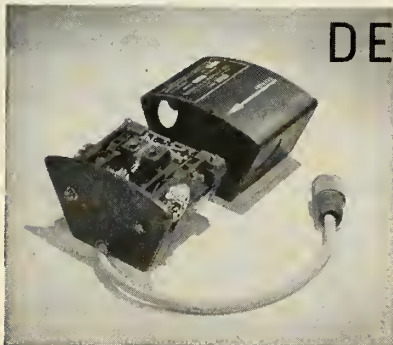
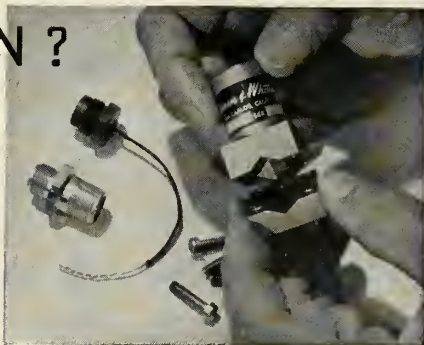


STARTING ?

Here is a rocket-motor starting igniter engineered by Beckman & Whitley. Threads into the propellant chamber and withstands its pressure. Arms and disarms remotely, electrically; provides status signals, electrical and visual. How about one to your specifications?

SEPARATION ?

This tiny guillotine severs electrical or hydraulic lines explosively by electrical command signal, can be equipped with wide range of squib provisions — two examples are shown. Many specialized types with cutting diameters to 4 in. have been produced. What can we do for you?



DESTRUCTION ?

Acceleration-integration mechanisms in this Beckman & Whitley arming and firing device are in duplicate for ultimate reliability. Total arming time adjustable from 2 to 8 sec. Has automatic reset, electrical primer safety switching and return telemetering circuitry, is adjustable for acceleration in either direction. Other types include lanyard and electrical arm/disarm canister and primacord destructors. If your problem is different, let us hear from you.

Pre-packaged explosive power units provide higher reliability and greater power for a given weight and volume of space than any other actuation method. Some of the many other applications to valving, ejecting, fracturing, etc., may be interesting to you. Just ask us.

Beckman & Whitley INC., SAN CARLOS 16 CALIFORNIA

... Soviets certain

tions supplied with air and food from Earth. Later, permanent observatories and institutions will be established there; and still later, industrial enterprises to extract natural resources.

There is no doubt that flights to planets present many more problems than a flight to the Moon. Great distances and the time element necessary to reach these planets seem to be the prime difficulty. Perhaps the answer to the problem of time element is in using photon rockets in space travel, says I. I. Drakin of the Moscow Aviation Institute.

According to Drakin, the use of the pressure force of photons in the motors of space ships would be the answer to the problem of shortening the time needed for flights. He believes that the great speed of such ships, using photon beams, will make it possible to reach Mars in a mere four or five days.

• **Inspiration of space**—NOVOYE VREMIA magazine, soon after the launching of *Sputnik III*, went into poetic ecstasy, saying: "Dreams are the brightest flowers of the human mind. It rushes forward . . . it pulls Man outside to look at the Earth from above, to travel along the Milky Way, to penetrate into the farthest corners of the Universe. *Sputnik III* gave wings to these dreams . . ."

Many books have been published in the Soviet Union on the subject of forthcoming space flights. They inspire the imagination of Soviet youth, and arouse interest in astronautics. Space travel is not far off, and the West should be prepared to meet this new surge of interest, so as not to find themselves back-seat passengers in a future Soviet space ship.★

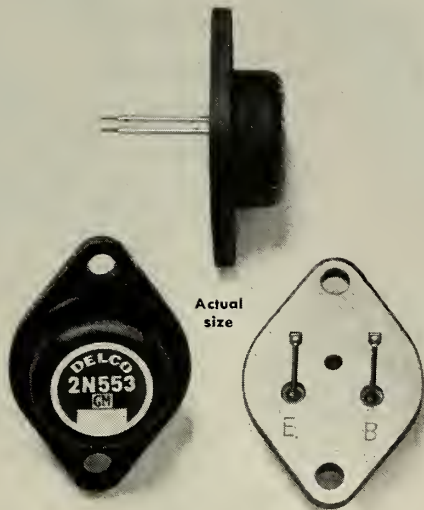
NAA Missile Division Forms Space Laboratories

North American Aviation's Missile Division has formed an Aero-Space Laboratories at Downey, Calif., as an expansion in basic research activities.

The Division's chief scientist, Dr. E. R. van Driest, will head the new department.

Plans include expansion of facilities for experimental observation of physical phenomena, establishment of a satellite information center, and research in space navigation, communication, medicine, space dynamics, and propulsion.

Assisting Dr. van Driest in organizing the laboratories are Harold Bell, formerly chief of technical sciences, and Manuel Sanz, formerly chief laboratory scientist.



ANNOUNCING...

the newest addition to the Delco family of PNP germanium transistors! It's ideally suited for high-speed switching circuits and should find wide use in regulated power supplies, square wave oscillators, servo amplifiers, and core-driver circuits of high-speed computers. It's the 2N553!

NEW HIGH-FREQUENCY POWER TRANSISTOR BY DELCO

No other transistor offers so desirable a combination of characteristics for applications requiring reliability and consistency of parameters.

TYPICAL CHARACTERISTICS $T = 25^{\circ}\text{C}$ unless otherwise specified

Collector diode voltage V_{CB} ($V_{EB} = -1.5$ volts)	80 volts maximum
Emitter diode voltage V_{EB} ($V_{CB} = -1.5$ volts)	40 volts maximum
Collector current	4 amps. maximum
Base Current	1 amp. maximum
Maximum junction temperature	95°C
Minimum junction temperature	-65°C

Collector diode current I_{CO} ($V_{CB} = 2$ volts)	12 μa
Collector diode current I_{CO} ($V_{CB} = -60$ volts)	0.5 ma
Collector diode current I_{CO} ($V_{CB} = -30$ volts, 75°C)	0.5 ma
Current gain ($V_{CE} = -2$ volts, $I_C = 0.5$ amp.)	55
Current gain ($V_{CE} = 2$ volts, $I_C = 2$ amps.)	25
Saturation voltage V_{EC} ($I_B = 220$ ma, $I_C = 3$ amps.)	0.3
Common emitter current amplification cutoff frequency ($I_C = 2$ amps, $V_{EC} = 12$ volts)	25 kc
Thermal resistance (junction to mounting base)	1°C/watt

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Newark, New Jersey
1180 Raymond Boulevard
Tel: Mitchell 2-6165

Santa Monica, California
726 Santa Monica Boulevard
Tel: Exbrook 3-1465

DELCO RADIO

Division of General Motors
Kokomo, Indiana

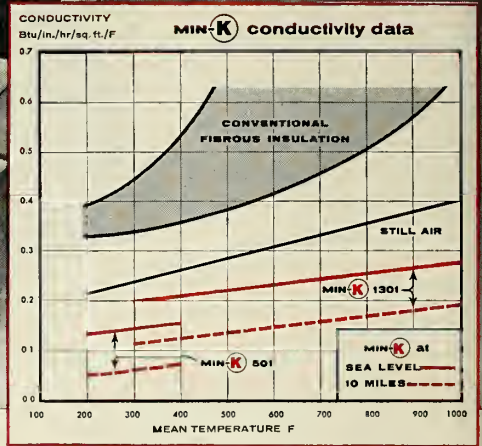
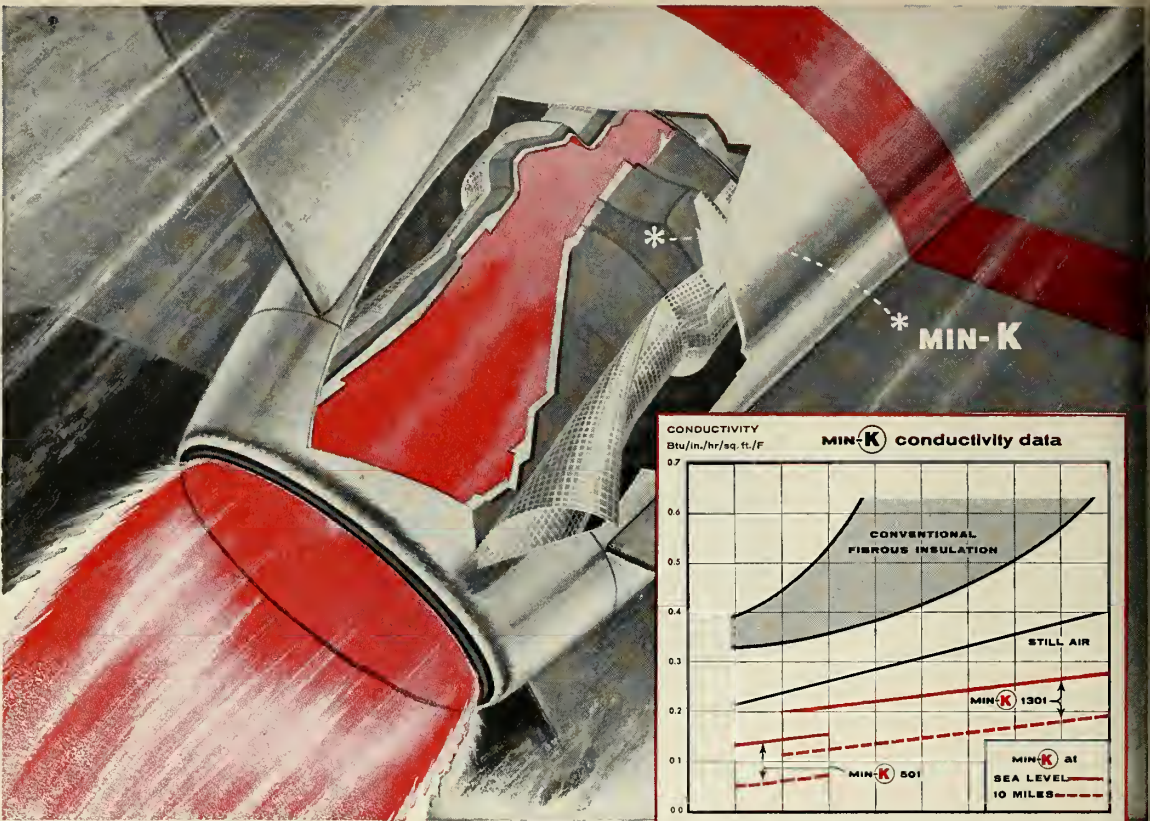


Chart compares Min-K's thermal conductivity with conventional fibrous insulations and still air. Note that Min-K's conductivity decreases with altitude.

Johns-Manville announces . . .

A scientific break-through in missile insulation!

New **MIN-K** has lower conductivity than still air—performs better the higher it flies

- Saves missile space to boost fuel capacity and range
- Protects instrumentation more effectively to increase accuracy
- Offers lower thermal conductivity than any known insulating material
- Now performing successfully in operational U.S. missiles

Min-K is in every meaning of the term—a scientific break-through!

For in Min-K, Johns-Manville research scientists have developed an insulating material entirely new in concept, an insulation so effective that its thermal conductivity is actually below what was long called the ultimate—the molecular conductivity of still air.

Increases accuracy and range

With this new low in thermal conduc-

tivity (less than half that of the best fibrous insulations), Min-K contributes to greater accuracy by providing more effective protection of temperature-sensitive instrumentation . . . increases range by conserving space for greater fuel storage.

Insulates better the higher it flies

Unique with Min-K is improved performance at altitude, for its thermal conductivity drops appreciably as atmospheric pressure decreases. At an altitude of 10 miles, for example, Min-K's thermal conductivity is decreased by as

much as 40%, and further decreases at higher altitudes!

Manufactured by J-M as integral parts—Min-K insulations are precision molded to any shape you specify . . . encased in high-temperature metal foils or laminated to reinforced plastics. Min-K insulations include a wide variety of strengths, densities and temperature resistances.

For detailed information about Min-K, write Johns-Manville, Box 14, New York 16, N. Y. (Ask, too, for aviation insulation brochure IN-185A.) In Canada, Port Credit, Ontario.



JOHNS-MANVILLE



west coast industry

by Fred S. Hunter

Northrop Aircraft, never reluctant to try out promising new ideas, recently engaged in an interesting industrial relations experiment, which may catch on with other companies facing the problem of communicating with large numbers of workers. The company bought open time on a local Los Angeles television station for its president, Whitley C. Collins, to make a personal report on the company to employees.

The time selected was 8 o'clock, Saturday morning, when employees could be expected to be at home with television sets available. This also was several hours before the station normally opened up its day of public programs, eliminating the likelihood of an outside audience. But for the benefit of any dial twisters, who might tune in by accident, one of the station's regular announcers opened the show with a word of explanation and, incidentally, a very good TV commercial. "Northrop is known as a good place to work."

From his office in the Northrop corporate headquarters, and reading from a teleprompter, Collins delivered a detail report of about 3,500 words on the company's general outlook. Northrop made sure its own employees were aware of the program by distributing reminders of the time and station with pay checks the day before.

The television time cost \$975. To cost-conscious Northrop this meant a saving of at least \$1,000. A letter mailing, at a minimum of 10¢ a mailing, would have cost not less than \$2,000 for the company's 20,000 employees. But more important was employee reaction. The response was outstanding.

In the earlier days of the company, John K. Northrop, when he had something to report to employees, used to cover all areas and all shifts with about a dozen speeches. This was a difficult job, but the effort paid off in increased employee loyalty and efficiency. Northrop is too big for this now. So the Northrop industrial council turned to television as the next best means of a personal approach.

Significant items in the Collins report: Northrop's performance has been good . . . We are in the middle of a belt-tightening period . . . Top command in the Air Force is beginning to understand the value of the *Snark*, "a very low-cost weapon," and Northrop hopes for reorders which will extend production beyond 1960 . . . American Bosch Arma is a good company and Northrop is hopeful of a "happy marriage."

Another union has its eye on the missile industry, the International Brotherhood of Electrical Workers. It has formed a new Los Angeles local to organize electronic technicians in this field. This union is now the bargaining unit for maintenance electricians at Convair, Douglas, Hughes, Lockheed and North American, where, incidentally, it has been unusually successful in negotiating higher job classifications, at higher rates, for its members.

The IBEW tried last year to organize portions of the Astronautics division of Convair from the International Assn. of Machinists, but was denied an election by the NLRB. The new Local 250, apparently, will attempt to organize unorganized electronic companies. Three organizers, "well financed," will be assigned to this area, says IBEW International Representative Charles Hughes.

contract awards

LAST MINUTE AWARDS

U.S. Army Signal Corps gave \$294,000 to Avion Division of ACF Industries, Inc., for production of x-band radar beacons to be used in missiles and missile drone test firings to extend the tracking range of ground radar.

Technical Products Division of Waste King Corp., Los Angeles, Calif. received \$300,000 for manufacturing heat exchangers.

The Power Equipment Division of Jeta Metal Fabricators Inc., of Yonkers, N.Y., has been awarded additional government contracts to supply engine generating plants and related equipment to Armed Force installations.

Martin Co. gave Clary Dynamics Division of Clary Corp. a contract for development and production of propellant valves.

By Commander, HQ, AMC, Wright-Patterson:

Lockheed Aircraft Corp. received \$598,997 for MB-1 weapons flight test program.

Northrop Aircraft, Inc., Northrop Div., Hawthorne, Calif. received \$18,691,384 for research, development and flight test SM-62 weapon system.

Goodyear Aircraft Corp., Akron, Ohio, received \$1,787,360 for modification of B-57 aircraft to TM-76A missiles.

North American Aviation, Inc., Missile Development Div., Downey, Calif. received \$500,000 for conducting high performance X-10 drone flights to demonstrate weapon capability of the IM-99 Bomarc, including maintenance, inspection, overhaul and preparation for flight of X-10 vehicles with related ground support equipment.

By Middletown Air Materiel Area:

Dye Oxygen Co., Phoenix, Arizona, received \$43,650 for liquid oxygen.

Union Carbide Corp., Linde Co. Div., New York 17, N.Y. received \$116,002 for liquid oxygen.

By Comdr. HQ AMC, Wright-Patterson AFB:

Marquardt Aircraft Co., Van Nuys, Calif. received \$234,611 for services to accomplish additional testing of RJ43 ramjet engine.

ARMY

By Ordnance District, St. Louis:

Pitman Mfg. Co., Kansas City, Mo. received \$173,784 for truck, missile, maintenance, mobile high reach.

By HQ Redstone Arsenal, Ordnance Missile Command:

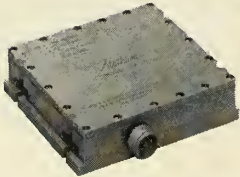
Raytheon Mfg. Co., Waltham, Mass. received \$62,160 for technical assistance for guided missile school instruction.

Associated Aero Science Labs, Inc., Hawthorne, Calif., received \$119,516 for

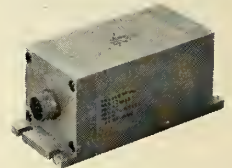


DESIGNED TO FLY

Especially designed to meet the rigid size and weight requirements of airborne instrumentation, Statham's new strain gage carrier amplifiers are transistorized throughout. Operating from normally available 28-volt DC excitation, these units supply excitation to any strain gage transducer of desired range, amplifying and demodulating the transducer's low-level signals to provide an output of from 0 to 5 volts DC. When you require unprecedented accuracy and reliability in the amplification of signals from your strain gage instrumentation, specify a Statham strain gage amplifier.



Model CA3 Strain Gage Amplifier



Model CA5 Strain Gage Amplifier

EXCITATION: 28 volts DC, $\pm 5\%$
OUTPUT: 0-5 volts DC
FREQUENCY RESPONSE: Flat from 0 up to 2000 cps
NON-LINEARITY AND HYSTERESIS: $\pm 1/2\%$
OPERATING TEMPERATURE: -65° to $+165^\circ$ F.
OUTPUT IMPEDANCE: 10K ohms (100K recommended load)
WEIGHT: 14.5 ounces, approximately

For complete technical data, write to:

Statham

INSTRUMENTS, INC.

12401 W. Olympic Blvd., Los Angeles 64, California

See you at Booth 944
I.S.A. Show, Sept. 15-19

Circle No. 32 on Subscriber Service Card.

missiles and rockets, September 8, 1958

... missile business

technical assistance for guided missile school instruction.

By Signal Supply Agency:

Edgerton, Germeshausen & Grier, Inc., Boston, Mass., received \$683,985 for research work for design of experiment in connection with radiation effects on electronic devices, and on radiation monitoring systems.

Philco Corp., Philadelphia, Pa., received \$2,469,381 for engineering design proposals for radar reconnaissance systems.

By Army Map Service, Corps of Engineers:

Product & Industrial Engineering Corp., Washington, D.C. received \$40,139 for topographic map engraving, western U.S.S.R.

Alexandria Drafting Co., Alexandria, Va., received \$38,220 for topographic map engraving, western U.S.S.R.

Aircraft Co., Quincy, Ill. received \$71,750 for topographic map engraving, China (Chekiang).

By HQ, Quartermaster Research & Engineering Command:

Birdair Structures Inc., Buffalo, N.Y. received \$139,493 for air supported shelter, "Pentadome."

Lowell Technological Institute Research Foundation, Lowell, Mass. received \$25,000 for influence of dyeing and finishing processes on fiber properties of polyamide.

The University of Buffalo, Buffalo, N.Y. received \$28,541 for development of chemical resistant rubber from semi-organics for use at extreme low temperatures.

By Pittsburgh Ordnance District:

Spencer-Safford Loadcraft, Inc., Augusta, Kansas, received \$713,905 for trailer, 762mm rocket, 4 wheel XM405E1 128, publication and engineering drawings.

By Corps of Engineers, Office of the District Engineer:

Buchi Plumbing Co., Nashville, Tenn. received \$39,939 for furnishing and installing cooling systems for miscellaneous equipment for the supersonic circuit of the propulsion wind tunnel.

NAVY

By Purchasing Office:

University of Dayton, Dayton, Ohio received \$65,000 for services and materials required to make photographic measurements and to supply the data on IBM cards and to prepare reports related to the determinations of flight data for aircraft and missiles.

By Officer in Charge of Construction, Potomac River Naval Command:

Nicholson Engineering Co., Inc., Washington, D. C., received \$179,887 for conversion of anechoic room to computer facility at the Naval Ordnance Lab.

AIR FORCE

By AFOSR, ARDC:

University of Miami, Coral Gables 46, Fla. received \$50,624 for continuation of research on "Nuclear Emulsion Studies."

University of Virginia, Charlottesville,

Va. received \$38,777 for continuation of research on nuclear interactions of 25-75 mev photons.

New York University, New York 3, N. Y. received \$51,036 for research on "High-Speed Gas Dynamics."

University of Pennsylvania received \$32,000 for photonuclear reaction studies.

Digitron Changes Name to Computer Equipment Corp.

Digitron, Inc. has changed its name to Computer Equipment Corp., in order to identify the nature of its business.

The company, established in Octo-

ber 1957, is engaged in the development of advanced hybrid electronic systems. It recently announced receipt of a contract from Holloman Air Development Center to develop an electronic function plotter.

Air Logistics Acquiring Polaris Engineering Co.

Air Logistics Corporation of Pasadena is acquiring Polaris Engineering of Inglewood as a subsidiary. Located in Pasadena, the new subsidiary will be known as Metrolog Corp.

Dr. Charles J. Breitwieser and Dale

BUCKEYE

KEEPS THE PRESSURE ON FUEL SERVICING

ADAPTERS

- Tapered seat, self-centering, cannot cock. Internal contour provides *maximum flow with minimum pressure loss.*
- Provide the most efficient form of connection for single point fueling.
- Type A-5, with one of several variable housings shown. Types A-2, A-3, A-4, and A-6 also available.
- All adapters meet General Specification MIL-A-6425A.

COUPLING VALVES

- Self-sealing coupling valves mate with adapters shown above to make positive leakproof connection for transfer of fuel. Full flow, minimum pressure drop.
- Valve can be connected or disconnected under pressure without loss of fuel.
- Type D-1, illustrated, meets Specification MIL-N-5877A.
- Other styles available.

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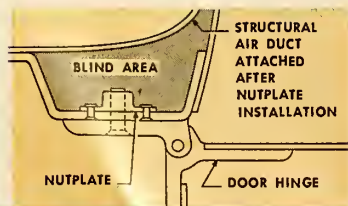
Blind Nut FIX

KEEPS AN F-104 ON SCHEDULE

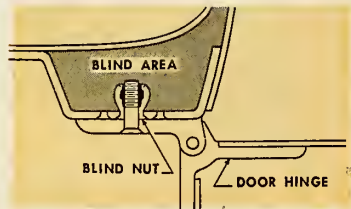


Two damaged nutplates attaching the main landing gear door hinge to the fuselage threatened to keep a completed F-104 from entering final inspection. A conventional repair would have required the removal of a structural air duct to gain access into the closed-out area to replace the nutplates.

Blind Nuts were selected for the fix. The nutplates were drilled out, the holes were drilled slightly larger to accept the Blind Nut O.D. and the Blind Nuts were installed. The fix



was successfully completed in a few minutes, a time consuming and expensive repair was eliminated and the Starfighter moved on schedule into final inspection.



By adding a core bolt to the Blind Nut's two piece basic configuration, this versatile fastener becomes a Blind Bolt suitable for use in tight quarters for production, modification or repair work in aircraft and missile structures. Stainless steel Blind Nuts and Blind Bolts are quietly installed by one man using a hand-held, hydraulically-operated gun.

Learn how Blind Nuts and Blind Bolts can answer your tough fastener problems — write for our Brochure.

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... Business

H. Demmott, former partners of Polaris Engineering, will continue as active management of the corporation which will develop and manufacture electronic instrumentation and specialized components for automation and automatic control systems.

Thiokol Announces Financing Proposal

Thiokol Chemical Corp. has requested Securities and Exchange permission on registration of 113,500 shares of its \$1 per capital stock to be offered for subscription by holders of its outstanding capital stock at the rate of one new share for each 12 shares held. The record date, subscription price, underwriting terms and names of the underwriters will be supplied later.

Thiokol said net proceeds of the financing would be used for general corporate purposes, including expansion of its Utah Division which, it is anticipated, will involve expenditures approximating \$4.5 million during 1958-59.

In addition, Thiokol is also considering the sale to one or more institutional investors of from \$5 million to \$7 million of 15-to-20 year unsecured notes.

Bendix Gets \$1.75 Million Bomarc Fuze Contract

The York Division of Bendix Aviation Corp. has been awarded a \$1.75 million contract to develop and produce a warhead proximity fuze for the Bomarc IM-99B guided missile.

The IM-99B Bomarc is an advanced version of the pilotless interceptor developed by Boeing for Air Defense Command.

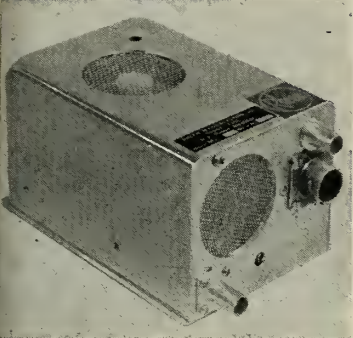
Howard Walker, Bendix-York divisional general manager, said the newest version of the Bomarc is to have improved performance in most of its characteristics—particularly in range—over initial Bomarc missiles.

Bendix-York has also developed, and is now producing, an instrumentation beacon used in testing the present Bomarc series, IM-99A. In test flights from Cape Canaveral, the beacon extends the range and accuracy of ground instrumentation radar, to enable the missile range safety officer to determine the exact position of the missile in flight.

The missile is equipped with its own target-seeking system, and can be equipped with either a conventional high-explosive or nuclear warhead, the company announcement said. The new fuze presumably will be adapted to either type of warhead.

New missile products

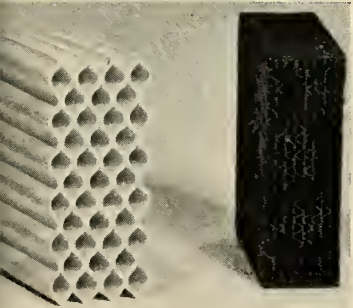
Miniaturized Power Amplifier Developed



A ruggedized, miniature R-F power amplifier only 5-1/3 inches by 3 1/2 x 3 inches, increases signal power significantly in the 215 mc to 260 mc tele-metering band. The model REL-10, developed by Rheem Manufacturing Co., Electronics Div., can be used with most presently available FM transmitters and delivers from 10 to 100 watts of R-F power with 2 watts of drive. The tiny high-output unit is exceptionally reliable in adverse environments of shock, vibration, and temperature and features a self-contained cooling system. It meets the environmental requirements of missileborne instrumentation systems.

Circle No. 299 on Subscriber Service Card.

Corrugated Ceramics Give High Performance



Development of an entirely new ceramic construction, by Minnesota Mining & Manufacturing Company, has added a new degree of freedom in ceramic technology.

The company said that new construction techniques provide high performance at extremely high temperatures, which permit for the first time the production of ceramic heat exchangers, ceramic catalyst supports, and lightweight structural units—constructions which heretofore could be made

only of metals.

However, although the ductility of metals permits them to be rolled and formed into intricate shapes, the new ceramic concept adds the same degree of freedom of fabrication to ceramics. It is expected that the new ceramic construction will significantly increase the operating temperature range of systems in which heat exchangers are used; thus making feasible applications which could not be achieved previously because of corrosion and temperature limitations.

Circle No. 298 on Subscriber Service Card.

New Pocket-Size Oscilloscope Developed

Waterman Products Co., Inc., has developed a pocket-size oscilloscope with direct-reading features. Dubbed the "Pocketscope" high gain model, S-17-A is reported to incorporate new techniques that allow large-scope performance to be gained from the compact model.

Weighing less than eight pounds, the unit measures 4 3/4" high, 5 1/2" wide and 10" deep. Simplified controls allow operation through use of two controls with automatic synchronization.

The direct-reading feature allows

Dramatic achievements are taking place at CROSLLEY. Opportunities for engineers have never been greater than they are today. As man presses upward, civilization's horizons are expanding. What part will YOU play in our race to the "stars"?

CROSLLEY'S contributions to these advanced programs are in the design and development of many important electronics' breakthroughs and accomplishments. The full story of CROSLLEY'S growth plans is yours for the asking. Find out how YOU can participate in the space world of tomorrow.

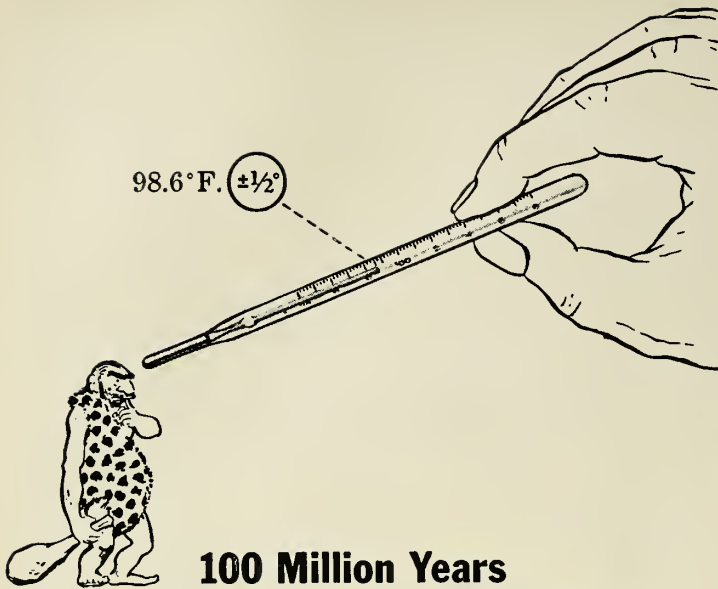
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Crosley**

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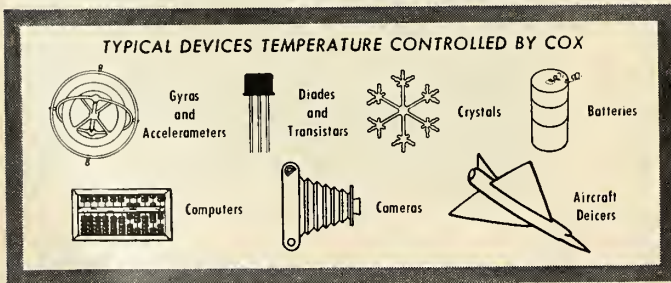
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Cox has designed more than 2000 different successful temperature control installations.

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Engineering Representatives in Most Areas

... new products

direct calibration of scales in volts (from 10 millivolts per division) and milliseconds (from 10 milliseconds per division). Sync signal in excess of 1 volt peak automatically triggers the oscilloscope.

Circle No. 297 on Subscriber Service Card.

**Exotic Liquid Filters
Resist Corrosion**



Filters for exotic fuels and components; including hydrogen peroxide, hydrozine, ethylene oxide and liquid oxygen are now available from Micro Metallic Division of Pall Corporation.

The filters are designed with materials selected for corrosion resistance, plus elimination of dead thread spaces and unvented pockets. They are said to provide the utmost in safety and reliability in systems of unstable liquids. The metallic filter medium used permits construction that can withstand full system pressure, in the event of clogging without collapse of the element.

The largest filters can handle 5,000 g.p.m. of liquid oxygen, removing all particles over 40 microns in size. Smaller elements can filter 30 lbs. per minute of nitrogen, with a 10 micron particle size retention rating.

Circle No. 296 on Subscriber Service Card.


**Two Types of Drift-Free
Strain Gages Introduced**

Research scientists of the High Temperature Instruments Corp. of Bala Cynwyd, Penn., have announced development of two new types of strain gages said to be capable of withstanding high temperatures.

According to a company announcement, one gage type (HT-600) is drift-free up to 600 deg. F. The HT-1200 has been tested at temperature to 1,000 deg. F, without apparent drift.

The instruments are a combination thermocouple and strain gage. The thermocouple hot junction is located in the plane of the grid permitting precise monitoring of gage temperatures. Zero-shift correction charts can be used in strain determinations, with a high de-

EXCELCO



Builders of more large, thin wall,
high strength solid propellant
rocket engine cases and nozzles
for development purposes than
any other company in America.

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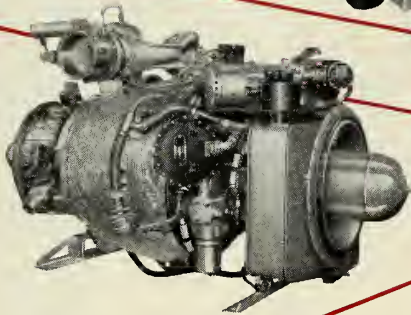
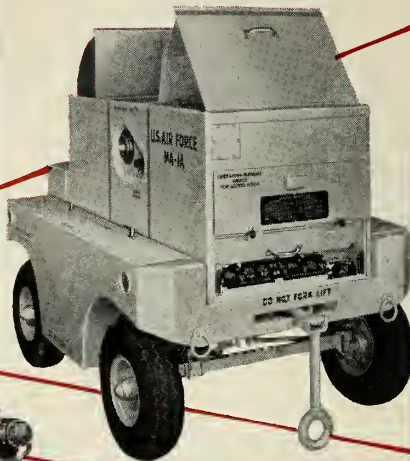
VOLUME PRODUCTION

... the TC-106

(USAF TYPE MA-1A)

**PORTABLE
COMPRESSOR
for
GROUND
SUPPORT
APPLICATIONS**

AT C.A.E.



**MODEL 141
TURBO-COMPRESSOR
ENGINE**

Typical of the finest results of Continental development is the TC-106 portable compressor unit for ground support applications. This advanced new model, with a high performance turbine compressor as its heart, weighs one-third less than its predecessor, yet has 17 per cent higher output, and in addition, other important qualities: greater mobility, less noise, and a completely automatic control system. . . . It is now in volume production at the Continental Aviation and Engineering Toledo plant.

C.A.E. gas turbine models—the J69-T-9, the J69-T-2, and the J69-T-19A are being built for Cessno's T-37A twin jet trainer, Temco's TT-1 Navy jet trainer, the Beech jet Mentor trainer, and the Ryan Q-2A Fire Bee target drone.



CONTINENTAL AVIATION & ENGINEERING CORPORATION

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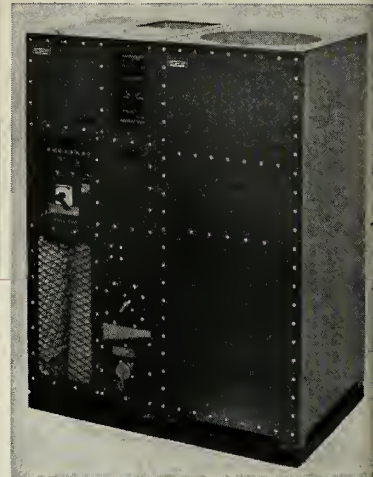
... new products

gree of accuracy, the company adds.

The instruments are available in miniature, but standard size is 1/8 in. x 1/4 in.

Circle No. 295 on Subscriber Service Card.

Small Air Conditioner Used For Support Systems



A new, lightweight, 4½-ton capacity, vapor cycle air conditioning package for missile ground support systems—featuring a six inch compressor—has been developed for the U.S. Army Corps of Engineers by Stratos Division of Fairchild Engine and Airplane Corp.

Utilizing the small, rotary, positive-displacement compressor, which weighs only 10½ pounds, and aircraft type aluminum plate and fin construction condenser and evaporator, Stratos cut the size and weight of its unit to less than half that of comparable ground support air conditioning packages. Designated the VEA4-3, the air-conditioner weighs but 350 pounds, and is 40" long, 24" wide and 51" high.

Circle No. 294 on Subscriber Service Card.

New Pressure Transducer Offered by Fairchild

A new miniaturized pressure transducer for guided missiles and high-speed aircraft is available from Fairchild Controls Corp. With total volume at only ¾" and weighing less than 2 oz., the unit can be adapted to measure absolute, gage, or differential pressures in the range from 0-5 psi to 0-350 psi with a linearity of ±1%. Potentiometer output has a resolution of 0.25% in most pressure ranges.

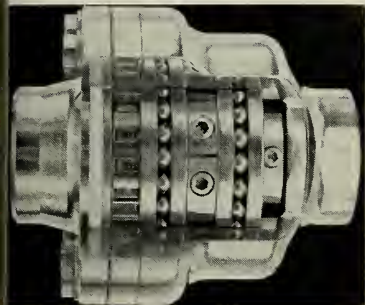
The unit can operate at up to 2,000 cps at 15g with an output signal transmission error of less than 1%. It with-

missiles and rockets, September 8, 1958

tands 25g in the 10-2,000 cps range with no damage or permanent calibration shift. At acceleration force of 40g, the unit will operate with less than 1% error and can withstand 75g without permanent damage or calibration shift.

Circle No. 293 on Subscriber Service Card.

Cryogenic Swivel Joint is Self-Lubricating



Liquid oxygen and other liquefied gases circulate in the thrust bearing spaces of this new swivel joint design, thus taking advantage of the lubricity of the fluid.

Other advantages of the new joint, according to the Chiksan Company, are improved temperature stabilization and the absence of contaminating lubricants. Uniform spring tension against metal disc, which in turn exerts pressure against a seal, is a principal packing feature. A plastic dust seal prevents contamination from external sources. The swivel joint is said to provide low-torque freedom of movement on as many planes as desired, through fabrication of elbows in combination with plane swivels.

Circle No. 292 on Subscriber Service Card.

Transistor Galvanometer For High-Frequency Use

A new high frequency galvanometer has been developed by the Edin Company, Inc. for general use with transistor powered amplifiers in oscillograph recording applications. The ink-writing instrument features flat frequency response from DC to 35 cps, and extended flat response up to 200 cps with compensated signal amplification.

Using a hi-speed D'Arsanvol armature in the field of an Alnico V magnet, the device gains linear phase shift through the use of a single resonant system of pen and coil. The total DC coil resistance is 260 ohms, center tapped.

The stylus is mechanically centered and is retained by a simple spring clip.

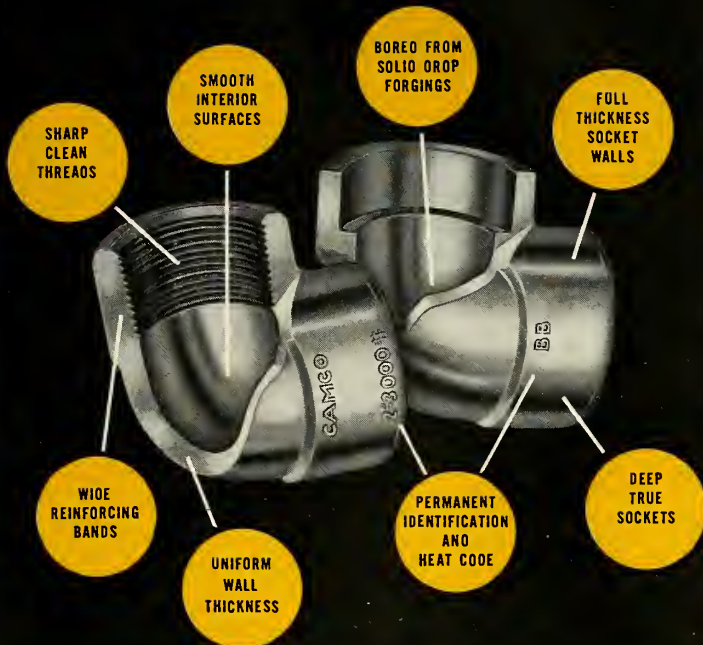
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200,000 applications of pressure fail to shake this gauge's accuracy!



This is the exclusive Lindsay Bourdon Element which makes the RMC-Lindsay High Pressure Gauge capable of such tremendous cycling endurance. Each gauge is qualification tested to withstand up to 200,000 applications of pressure.



You can scratch cycling endurance problems from your high pressure gauge headache list with RMC-Lindsay High Pressure Gauges

Specifically created for the extremely specialized demands of jet aircraft and missile pressure systems, this gauge is radically different from ordinary pressure gauges. The RMC-Lindsay gauge is a multiple coil, helical bourdon tube type; restricted for overpressure. The pointer is attached directly to the end of the coil, eliminating the use of linkages and pivots.

The bourdon principle itself is not a new development, but the RMC-Lindsay techniques in coiling, heat treatment, calibration and material specifications are new and exclusive with RMC. The Lindsay gauge was invented and developed by Mr. James E. Lindsay, now manager of engineering at RMC of California.

Whatever your high pressure gauge problems may be, why not let RMC engineering skill provide the answers. Write to either plant, or contact one of the RMC representatives listed below:

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Boiler Equipment Corp.
P.O. Box 8188, Station F
Atlanta, Georgia

DONALD TATE
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516 S. Eutow Street
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CHARLES SHEA
J. H. Bertram & Co., Inc.
233 Harvard Street
Brookline 46, Mass.

ROCHESTER MFG. CO., INC.
12143 Halsted Street
Chicago 28, Illinois

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911 Marshall Bldg.
Cleveland 13, Ohio

HOWARD SNYDER
Benson Engineering Co.
2514 W. Mockingbird Lane
Dallas 35, Texas

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J. Neill Armstrong, Inc.
205 Sharrow Vale Road
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WILLIAM RUBLEY
Rowe Sales Co.
2140 Westwood Blvd.
Los Angeles 25, Calif.

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1 East 42nd Street
New York 17, New York

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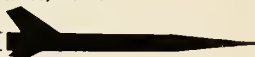
DON W. BRUNER
Benson Engineering Co.
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Wichita 2, Kansas

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LINDSAY PRESSURE GAUGES



book reviews

SPUTNIK INTO SPACE by M. Vassiliev with V. V. Dobronravov, 181 pp., \$3.75. The Dial Press, 1958, New York.

Originally published in Moscow by the State Publishing House in 1955 this book suffers from a number of errors in fact and translation. Part of this may be due to the fact that it was not translated from Russian, but from Italian, which in turn was from a Russian translation. However, there are instances of in-accuracies which are not justified on this basis.

The introduction is written by Mr. William Beller, who is listed on the dust jacket as former managing editor of **ROCKETS AND MISSILES**, a "technical publication". If the reference is to **Missiles and Rockets Magazine**, then the error is that Mr. Beller was never managing editor. If the reference is to the book **ROCKETS AND MISSILES**, then the error is that this book was authored solely by Erik Bergaust, executive editor of **MISSILES AND ROCKETS** magazine.

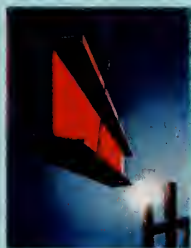
One of the irritating facts about **SPUTNIK INTO SPACE** is that it has been advanced with tongue in cheek as a post-Sputnik report on Soviet satellites and space-flight plans. Actually, the first (and as far as we can tell, the only) edition was published in 1955. This fact is not mentioned, except for one reference to it in the introduction.

Another statement is that the book was never meant to be read outside the Soviet Union, and the implication is that only a life-or-death struggle by a corps of secret agents provided us with a copy. In fact, m/r's international editor purchased a copy of the original Russian edition in a bookstore in August 1957. The book has been readily available in this country since late 1956.

Its content can be described simply: nothing new. Of the myriad space flight books now on the market, there are many that would provide a better basis for educating oneself in the field. This work's prime claim to fame is that its authors are Russian.

Errors in translation include the figure of 435 miles altitude for a *Wac-Corporal* launching, where the Russian version gave a figure of 480 kilometers. However, even 480 km. (298 miles) seems to be incorrect, since a peak altitude of 245 miles is generally accepted for this *Wac-Corporal/V-2* combination. Also, where the Russian version mentions altitudes of 300 km., the English version gives 300 miles and the Russian data is not altered accordingly.

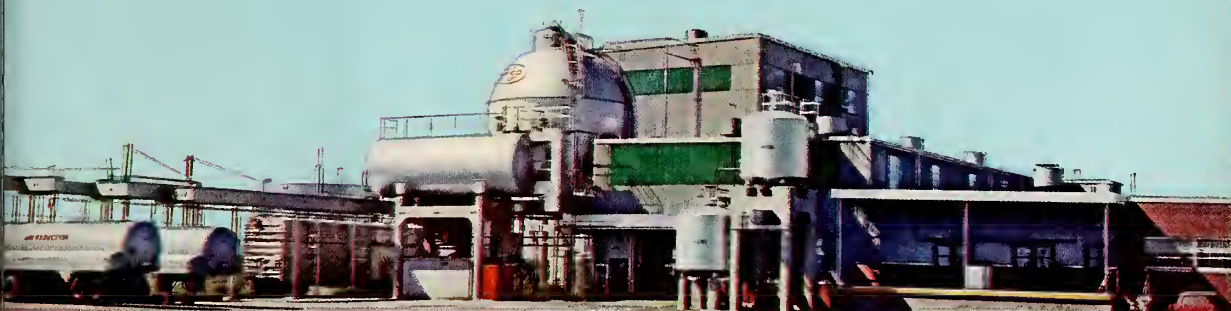
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NEW — DC Aircomatic Fillerarc — motor generator type — for out-of-position Aircomatic welding and for obtaining superior welds with Pureco's welding grade CO₂. Available in 450 Ampere Model.

NEW POWER FOR WELDING

Behind the rise of weld-fabricated products—in manufacturing plants, on construction projects, in railroad shops, and shipyards, in thousands of small and large businesses from coast to coast—is the *power source*...

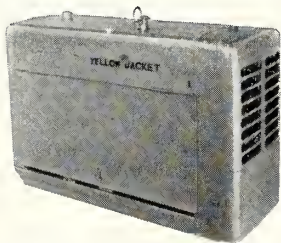
Air Reduction's arc welding machines are rugged, dependable, and designed to meet the power requirements of *any* arc welding job. Representative of the complete Airco line of many different power source combinations are five arc welders shown here.



NEW—AC/DC Heliwelder—engine driven type, air cooled — for inert-gas-shielded and metallic arc welding in the field. Available in 300 Ampere Model.



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DC Yellow Jacket—engine driven type, liquid cooled — for heavy duty steel construction in the field. Available in 300 and 400 Ampere Models.



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WAR AND PEACE IN THE SPACE AGE by Lt. General James M. Gavin, 104 pp, \$5, Harper & Brothers, N.Y.

A highly readable, thought-provoking study of how the Free World has fallen behind the Soviets both technologically and militarily. These are the beliefs of the man who resigned as the Army's chief of research and development.

"Space is the theater of the strategy of tomorrow—space and the human mind," writes Gen. Gavin. He adds that the real tragedy in efforts to close the gap is lack of understanding of the supreme significance of space.

For those concerned with determining the course and shape of missiles and techniques which will enable this nation to survive during what Gen. Gavin calls the "Decade of Decision" (1955-1965), the following points are of particular interest:

- Emphasis on the manned bomber is wrong. They will be replaced by ICBM's and IRBM's.

- There is a dangerous tendency to become so preoccupied with missiles as to overlook equally essential mobile ground handling equipment.

- Mobility (especially of missiles) should get the highest priority in our military programs.

- Nuclear weapons will become conventional tactical weapons.

- Air Force will have a manned reconnaissance satellite by 1965.

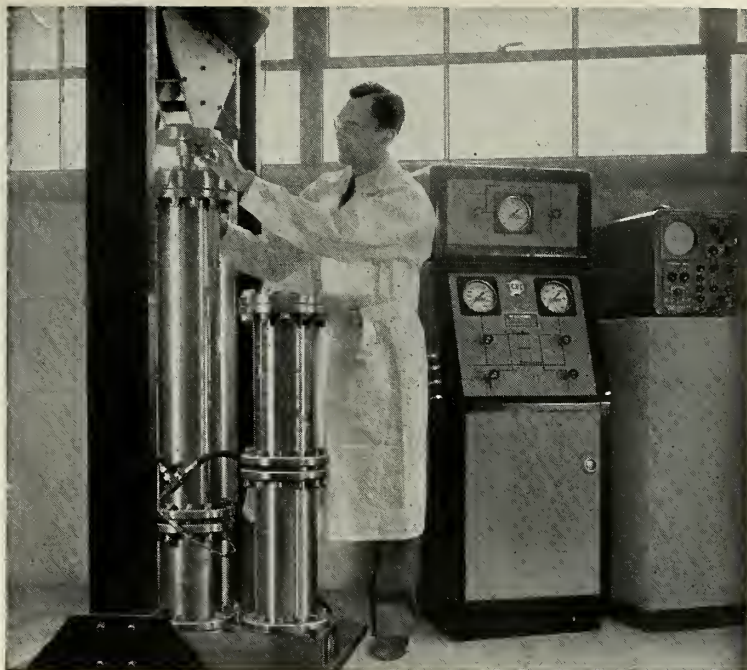
The General not only scores high decisions, which he says permitted the Soviets to forge ahead in the satellite and space fields, but says even the decisions themselves have been coming too late.

He especially criticized the system whereby a military man must appear before Congress and sell the program of his service, even if he frequently does not sincerely believe it to be in the best interest of the nation, but has been ordered to support.

Such was the decision Gen. Gavin faced. He answered with a resignation, and a private status where he feels he can best work for the weapons developments and long range space age requirements he believes necessary not only for the army, but for the nation.

Despite the gloomy present, Gen. Gavin says:

"I am of the personal conviction that the space age offers for the first time a real prospect of a lasting peace . . . if this planet is to remain inhabitable by man, a space program must be developed under the United Nations."



Hyge shock tester takes about 60 seconds to complete acceleration-shock test with up to 40,000 lbf. thrust. Hughes Products Memoscope® oscilloscope retains wave pattern as long as you like for careful study and comparison with master pattern.

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You can produce predictable, repeatable acceleration-shock thrusts to 40,000 lbf. with Hyge

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Hyge is a piston in a cylinder which is divided by an orifice plate. Using nitrogen, you build up a small pressure against

the top of the piston, sealing it to the orifice plate. You can then build up a very large pressure against the bottom of the piston, since you are working against only the small area exposed by the orifice. As soon as the pressure against the bottom overbalances the top pressure, the seal breaks and the whole piston bottom is exposed to the larger pressure. The piston is then thrust upwards at a tremendous speed.

Hyge transmits this thrust directly through a column to a test platform which rides on deceleration rails. Pre-selected metering pins control the thrust pattern, make it infinitely repeatable.

Free bulletin

Bulletin 4-70 gives you much more information on the theory and application of Hyge, including specifications and accessories for the HY-6000 Hyge and the smaller, 10,000 lbf. HY-3000.

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STRAIGHT TALK TO ENGINEERS

from Donald W. Douglas, Jr.

President, Douglas Aircraft Company

I've been asked whether non-aeronautical engineers have good prospects for advancement in the aviation industry.

The answer is *yes, definitely!* At Douglas many of our top supervisory people have moved up from other engineering specialties. The complexity of modern aircraft and missiles requires the greatest variety of engineering skills known to industry.

For example, we now have pressing needs for

mechanical, structural, electrical and electronics engineers in addition to aerodynamicists, physicists and mathematicians. Whatever your background in the engineering profession may be, there are prime opportunities in the stimulating aircraft and missiles field.

Please write to Mr. C. C. LaVene
Douglas Aircraft Company, Box 620-R
Santa Monica, California



keeping track

by Peer Fossen

According to reports from the IAF congress in Amsterdam, Russia is planning to give away 500 satellite tracking telescopes to foreign countries, including Argentina and Poland, to encourage the advancement of astronautics. According to IGY sources in Washington, the U.S. has been involved in a similar program for a long period of time. More than 100 moon-watch teams in foreign countries have received wide-angle telescopes from the U.S. Some of the countries involved are: Argentina, Australia, Belgian Congo, Chile, Japan, Mexico, Curacao, Peru, South Africa, Germany, and Iran.

First things first! Dr. Fred L. Whipple, at the IAF Congress, emphasized the need for an accelerated U.S. program to investigate the "mysteries" of the ultra-violet spectrum, between X-rays and visible light. To do this, Dr. Whipple suggested "shooting" a telescope into orbit, and concluded that "the time to do it is right now." One cannot help but question the merits of such a program at this time when the tremendous barrier of the radiation belt is creating a maximum amount of knowledge-searching for a plausible cause. Coupled with the radiation hazard is the inability of rocket engineers to control the temperamental actions of their power systems for such straightforward experiments as the determination of the existence, if any, of a magnetic field around the moon, or the rate of the decrease of the earth's magnetic field.

Advanced Research Projects Agency has reportedly given a feasibility study program to the Army's Ballistic Missile Agency for a 25,000-lb. satellite program. Confirmation of feasibility of the program was quick in coming from the Army's research team. The program is expected to be one of the United States' first attempts at placing a man in orbit for prolonged periods of time. Unless much larger power plants than are now in existence are utilized for this project, it will be necessary to cluster weapon systems such as the *Jupiter* IRBM.

Looks like Admiral Rickover and USAF are in the same boat. The fact that Admiral Rickover was not invited to the White House pomp and circumstance session in honor of the *Nautilus* under-the-ice cap voyage was given proper coverage in the nation's newspapers. However, another guest of honor was left off the invitation list, namely the United States Air Force. It was the USAF *Navajo* guidance system that enabled the *Nautilus* to make the trip in the first place.

And speaking of the *Nautilus*, a recent news story stated that, even in the event of war, there is no way to communicate with submarines which might be operating under the ice cap. This statement should give some impetus to the underwater long distance systems now being explored by the Bureau of Ships Division.

The Martin Co., Orlando, Florida, recently awarded a contract to Waste King Corporation of Los Angeles for the manufacture of LEV-3 gyro stabilizer systems for test versions of the *Pershing* missile. It is interesting to observe that the LEV-3, long ago described by Dr. Wernher von Braun as "the workhorse of missilery," is being relied upon to guide the *Pershing* during the test phases of the program. The LEV-3 was originally designed and produced in Germany for the V-2 missile. When von Braun's development team and its equipment was brought to the United States after World War II, a substantial number of LEV-3s formed part of the hardware. The current manufacturing price for this system is approximately \$10,000. Systems claimed to be more refined cost many times that amount.

4 Ounce Contact Force Makes Relays More Reliable

Contact force of 4 ounces per contact on 50 "G" models and 2 ounces per contact on 30 "G" models of "Diamond H" Series R and Series S miniature, hermetically sealed, aircraft type relays is one of the most important factors in their proven high reliability.

Though absolute reliability of any similar device is impossible to guarantee—a bitter fact of life recognized by all electronic engineers—close approach to this goal by the relays manufactured by The Hart Manufacturing Company is the basic reason they are found today on many of this country's headline-making missiles.

In addition to contact force far beyond that found on other relays, "Diamond H" relays have greater contact cleanliness. Self-contamination is virtually eliminated by a completely inorganic switch mechanism, as well as use of coil materials which will not dust, flake or out-gas.

Finally, the high degree of reliability that is designed into these relays is maintained in their manufacture by high quality workmanship and a stringent inspection policy at every stage.

In addition to missiles, and their ground control systems, Series R and S relays are designed for use in jet engine controls, computers, fire control, radar and similar critical applications.

4PDT units, they offer an extremely broad range of performance characteristics, including temperature ranges from -65° C. to 125° and 200° C.; ratings to 10 A., 120 V., A. C., and 26½ V., D. C., with special ratings to 400 ma. at 350 V., D. C., or down to millivolts and milliamperes. Dry and wet circuits may be safely inter-mixed.

For more information, write today for Bulletins R250 and S260. For quick facts about "Diamond H" switches, thermostats and other devices, ask also for a copy of the "Diamond H" Check List of Reliable Controls.

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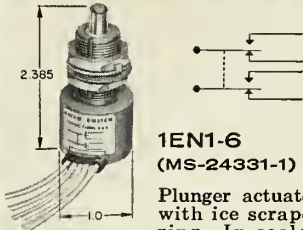
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MICRO SWITCH Precision

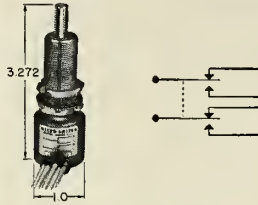
These Switches Reliably Perform Over Rockets...Missiles...Launchers...



1EN1-6
(MS-24331-1)

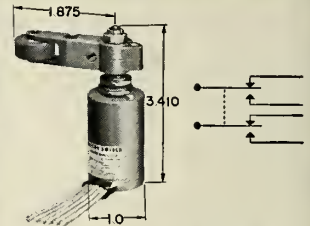
Plunger actuator with ice scraper ring. In sealed enclosure are two

SPDT subminiature basic switches. Operating force 6-12 lbs.; release force 4 lbs.; overtravel—.250 in. Rating: 28vdc 24a. inrush; 4a. resistive; 3a. inductive. Weight—2.5 oz.



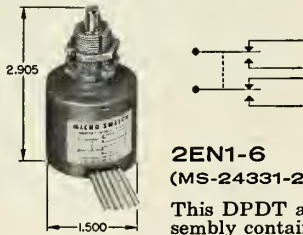
1EN61-6

The longer bushing provides maximum adjustment range of operating point. Overtravel—.500 in. DPDT circuitry and capacity same as 1EN1-6.



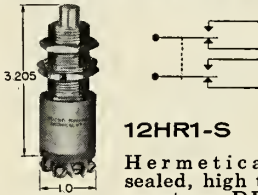
31EN1-6

Adjustable spring-return rotary actuator. Contains two "SM" switches (See 1EN1-6). Operating torque 30 in. lbs.; release torque 9 in. lbs.; total travel 45°.



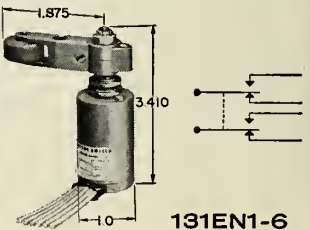
2EN1-6
(MS-24331-2)

This DPDT assembly contains two SPDT high capacity "V3" type switches. Rating: 28vdc—36a. inrush; 10 a. resistive; 6a. inductive. Operating force—6 to 12 lbs.; release force—5 lbs.; overtravel—.250 in. Weight 5.5 oz.



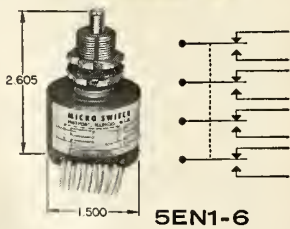
12HR1-S

Hermetically sealed, high temperature DPDT switch for reliable use to 600° F. Metal-to-metal & glass-to-metal seals in accordance with Par. 5.2.2, MIL-E-5272A. Ice scraper ring on actuator. Rating 28vdc-5a. res.; 2a. ind. Operating force 6-12 lbs.; release force 5 lbs.; overtravel—.250 in. Weight 4.5 oz.



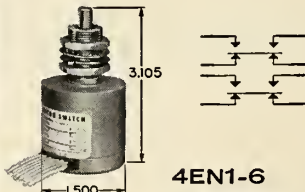
131EN1-6

Special high temperature construction for up to 250° F. Adjustable spring return rotary actuator. DPDT. For rating see 1EN1-6. Operating force 30 in. lbs.; total travel 45°; differential travel 6°. Weight 2.65 oz.



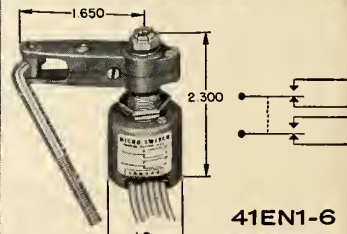
5EN1-6

A 4-pole DT assembly with 4 SPDT "SM" basic switches sealed in enclosure only 1½" dia. Mechanical characteristics same as 1EN1-6 except differential travel 28vdc—24a. inrush; 4a. resistive; 3a. inductive. Weight 4.25 oz.



4EN1-6
(MS-24331-4)

Sealed within the 1½" dia. enclosure is one 4-circuit double-break "TB" series switch. Rating 28vdc—30a. inrush; 15a. resistive; 10a. inductive. Operating force—6-12 lbs.; release force—5 lbs.; overtravel—.250 in.



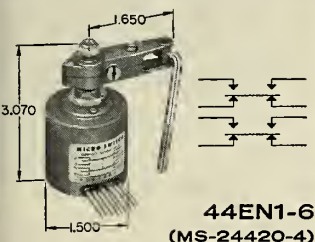
41EN1-6
(MS-24420-1)

Has rotary actuator with linkage for positive drive and release. Lever arm adjustable through 360°. Two SPDT "SM" switches in sealed enclosure provide DPDT circuitry. Operating torque—3 in. lb.

Switches have uses unlimited



350 Functions in Aircraft... Marine and Ordnance Applications



44EN1-6
(MS-24420-4)

Rotary actuator arm adjustable through 360°. Contains one 4-circuit basic switch. Rating 28 vdc—30a. inrush; 15a. resistive; 10a. inductive. Operating torque —10 in. lbs.

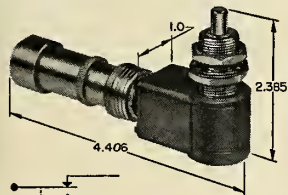
For many years, MICRO SWITCH's Airborne Projects Group have been answering your questions and helping you solve difficult problems by cooperative engineering help and a readiness to design special switches for you.

The twelve "EN" Series switches illustrated in these pages are the outgrowth of one switch. The "EN" Series has now grown to a point where the series consists of ninety-four different switches actually in use—an original concept by the Airborne Projects Group at MICRO SWITCH.

"EN" switches are completely sealed against the effects of changes in atmospheric conditions in enclosures filled with inert gas under pressure. Each switch is fabricated under rigid manufacturing procedures, and tested on a mass spectrometer. The actuator mechanism operates through a seal that maintains pressure and keeps dust and moisture out. A scraper ring on the actuator shaft prevents jamming or binding even in ice or mud... Your request for catalog 77 and data sheets 122 and 138 will be responded to promptly.

MICRO SWITCH... FREEPORT, ILL.
A division of Honeywell
In Canada: Honeywell Controls, Ltd.,
Toronto 17, Ontario

The two-word name MICRO SWITCH is NOT a generic term. It is the name of a division of Honeywell.



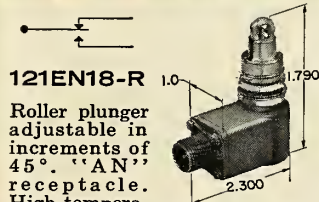
1EN42-R

A special design for high shock applications. Contains two SPDT switches. See 1EN1-6. Quick disconnect connector.

Look in the Yellow Pages for the name of the branch office and sales engineer nearest you.

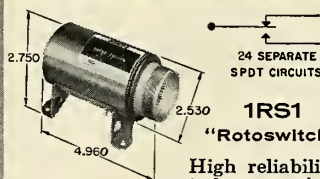


Honeywell MICRO SWITCH PRECISION SWITCHES



121EN18-R

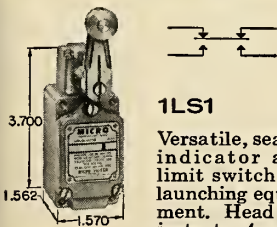
Roller plunger adjustable in increments of 45°. "AN" receptacle. High temperature construction for up to 250° F. Contains two gold-contact "SM" switches. Characteristics same as 1EN1-6.



1RS1

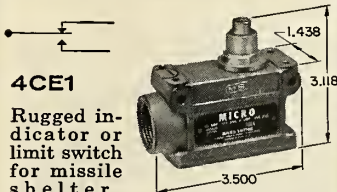
"Rotoswitch"

High reliability telemetering switch for missile program sequencing. Hermetically sealed enclosure contains rotary solenoid and 24 SPDT gold-contact "SM" switches.



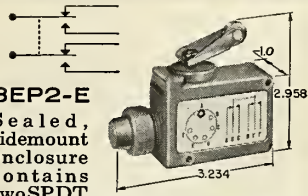
1LS1

Versatile, sealed indicator and limit switch for launching equipment. Head adjusts to 4 positions; arm adjusts through 360°; operation adjusts to either or both directions. Two-circuit basic switch. Rating: 10a. 120, 240, 480vac. Operating force 3 lbs.; release force 1/2 lb.; overtravel 30°.



4CE1

Rugged indicator or limit switch for missile shelter, erecting and launching equipment. SPDT. Rating: 10a. 125vac; 5a. 250vac. Operating force 6-10 lbs.



3EP2-E

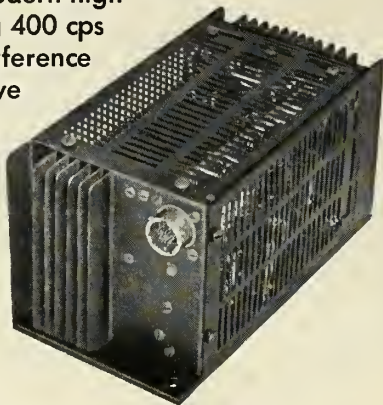
Sealed, side-mount enclosure contains two SPDT high capacity switches. Sealed receptacle. Rating: 28vdc-36a. inrush; 10a. res.; 6a. ind. Operating force 4-6 lbs.; release, 2 lbs.

TRANSISTORIZED POWER SUPPLY

by
CANOCA

A new lightweight power supply for the AN/ARN-14 Navigation Receiver has recently been developed at Canoga. It provides closely regulated 28 VDC and 260 VDC with a minimum size and maximum of reliability.

This unit is designed for modern high performance aircraft using 400 cps power systems. Radio interference and transient problems have been held well below minimum specification requirements. Fully transistorized conservative design has resulted in an unusually rugged, compact, and highly reliable unit.



PERFORMANCE SPECIFICATIONS

INPUT VOLTAGE:	200 VAC 3 ϕ , 320-480 cps
OUTPUTS:	(1) 28 VDC, 0-3 Amps, 1% Regulation, 0.5% Ripple and Noise (2) 260 VDC, 0-150 ma, 0.15% Regulation, 0.02% Ripple and Noise, Output Impedance less than 10 ohms DC to 1 mc
TRANSIENT LIMITS:	LINE: 400 VAC LOAD: 28 VDC Supply — 12 Amps 260 VDC Supply — 0.5 Amps
AMBIENT TEMPERATURE:	-55° C to +55° C, Intermittent Operation to +71°C
MIL SPECS:	MIL-E-5400A, MIL-E-5272A, MIL-I-6181B
UNIT DIMENSIONS:	Length 7½", Height 3½", Width 4"
WEIGHT:	4.5 pounds

May we have the opportunity of applying our design and production know-how to assist you in solving other power supply problems of larger capacity or higher precision.

- ANTENNAS
- RECEIVERS
- RADAR SYSTEMS
- TEST EQUIPMENT
- MICROWAVE COMPONENTS

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CORPORATION
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DESIGN, DEVELOPMENT AND MANUFACTURE TO YOUR SPECIFICATIONS

m/e news

New Highs Recorded For TV-Electronics Fund

Net assets of Television-Electronics Fund, Inc., a mutual fund concentrating investments in the field of electronics and nucleonics, totaled \$178 million on July 31, a new record and at a level 32.1% above its resources of \$135 million on October 31, 1957.

According to president Chester D. Tripp, at the end of the Fund's third fiscal quarter, ended July 31, 95.2% of its assets were invested in common stocks and convertible securities in the electronics field, compared with an 86.9% equity position nine months earlier.

Contest Announced For Miniaturization Advances

Nominations for the 1958 Miniaturization Award competition, established in 1957 by Miniature Precision Bearings, Inc., are now being accepted.

The award recognizes outstanding contributions by an individual or firm to the concept of miniaturization. It consists of an original sculpture symbolizing miniaturization, to be presented March, 1959. Certificates of Merit will also be awarded for outstanding contributions. Selection is by an independent committee of miniaturization experts representing industry, government and education.

According to Mr. Horace D. Gilbert, president of Miniature Precision Bearings, Inc., the award was conceived as "a means of stimulating activity within industry to promote the concept of miniaturization." He urged all companies that are involved in miniaturization to participate in the competition.

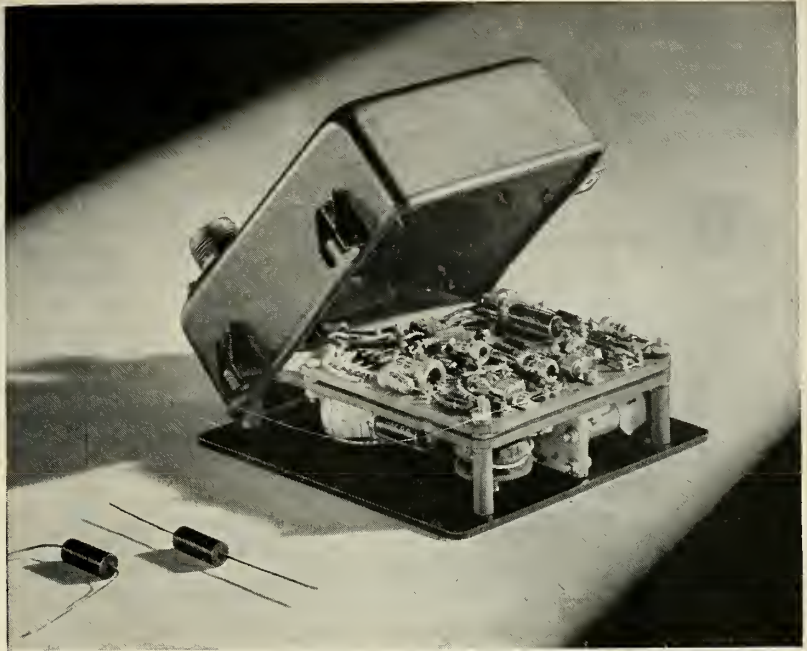
In order to be considered for an award; products, components, or parts should show outstanding ingenuity in the solution of problems; make use of new design concepts and special materials; or indicate development or use of new type components or parts that extend the frontiers of miniaturization.

Participants in the competition may be individuals, companies or organizations which have broadened the horizons of miniaturization by creating a better understanding and use of the concept through education, research, engineering or standardization.

Entries should be submitted to the Awards Committee, Box 604, Precision Park, Neene, New Hampshire.

The 1957 Miniaturization Award was presented to Diamond Ordnance Fuze Laboratories for its development of photolithographic printing tech-

**Airborne
Miniaturized
Mylar*
Capacitors
help reduce
weight and
bulk in
electronic
packages**



Amplifier for oil temperature servo control system utilizes Airborne miniaturized "Mylar" capacitors to save weight and insure high reliability. Entire system, including rotary actuator, is Airborne produced and is designed to meet specifications MIL-E-5272A, MIL-E-5400A, etc. Environmental requirements include -65 to +200°F. and up to 60,000 ft. altitude.

Developed originally for motor start and run purposes, Airborne miniaturized "Mylar" capacitors are currently finding increasing application in electronic circuits where small size, light weight, and high reliability are of paramount importance.

Typical of such applications is one of our own servo control amplifiers, shown above. Used as a component of an Airborne-designed oil temperature control system for high performance aircraft, the amplifier consists of a .1% precision resistance bridge, stable feedback transistor amplifier, reference oscillator, phase demodulator, and relay output amplifier. Production units employ printed circuitry.

Two of Airborne's miniaturized

"Mylar" capacitors are utilized in this particular amplifier — a .1 mfd unit for tuning in the reference oscillator section of the amplifier and a .02 mfd unit for phase shift correction in the stable feedback transistor amplifier section. Capacitors are epoxy encased and are designed to meet or exceed Government specification MIL-C-25A.

Wound of thin metallized "Mylar" film, Airborne miniaturized capacitors are rated up to 600 v d-c, 330 v a-c and have an operating temperature range of -75 to +300°F. At 300°F they will withstand 120% rated voltage for 250 hr.

Write, phone or wire for more information on Airborne special design miniaturized "Mylar" capaci-

tors. Inquiries are also invited on complete electromechanical control systems.

*Du Pont's trademark for its polyester film

TYPICAL SPECIAL CAPACITORS



E-8109 Style E-8104 Style E-8107 Style

CATALOG 57B

Gives detailed information on Airborne special design miniaturized "Mylar" capacitors and Airborne R. F. filters. Write for copy.



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nique in miniaturizing circuitry. In addition to the award, Certificates of Excellence in miniaturization were presented to ten organizations and individuals for their outstanding contributions.

Machine Tool Conference Covers Industry Progress

The 10th National Machine Tool Conference, sponsored by the American Institute of Electrical Engineers, will be held at the Statler Hilton Hotel

in Hartford, Conn. on Oct. 13-15, 1958.

This year's program presents a balanced coverage of the industry's progress in the fields of tooling, gaging, machine control, computers, safety, precision positioning and machine design. Presentations will be made by leading engineers in the industry discussing operating experience with modern machine tool equipment.

In addition, papers on transistors versus tubes and computer fundamentals have been included, in recog-



GIANT RADIO TELESCOPE in Jodrell Bank near Manchester, England, is used to provide the initial tracking lock-on for the moon probe, and is ten times larger than any other of its type. Automatically steerable, it weighs 2,000 tons and revolves on bogies laid in a circle with a diameter of 360 feet. The telescope has the capability of reaching out into space one billion light years. Scientists at Jodrell Bank have already been able to detect radio waves emanating from the nebula in Andromeda, five trillion miles from earth. Pictured is a view underneath the radio telescope showing the stabilizing wheel, the motor house on the diametral girder and, underneath, the hanging laboratory which pivots on trunnions as the bowl rotates.



KEY ENGINEERING OPENINGS AT VOUGHT

AERODYNAMICS

Some of Vought's most vital and interesting problems are in general aerodynamics and automatic flight controls for supersonic and hypersonic weapons. This work involves trajectory and configuration analyses, autopilot studies, control system synthesis and other responsible investigations. Helpful in a number of areas are Vought's low- and high-speed wind tunnels with a speed range from Mach .05 to 5.0.

A limited number of additional specialists may find assignments to match their skills in Vought's aerodynamics activities. These men may have general aerodynamics experience, or a good background in automatic flight control systems.

Current Vought projects include:
DYNA SOAR **REGULUS MISSILES**
SPACECRAFT STUDIES **F8U CRUSADER SERIES**
NUCLEAR SYSTEMS STUDIES

Autopilot Engineer. A.E., E.E., or M.E., (M.S. desirable) plus at least 3 years experience in stabilization, or autopilot and servomechanism analysis and design. To assist in, or direct, autopilot studies and designs for supersonic airplanes and missiles.

Aerodynamics Engineer. Aerodynamics Engineer with A.E., or equivalent, and at least 3 years experience. To work on supersonic aircraft and missiles in aerodynamic analyses of performance, air loads, stability and control, or fluid mechanics.

To arrange for a personal interview, or for a prompt report on these or other current openings, return coupon to:

C. A. Besio
 Supervisor, Engineering Personnel
 CHANCE VOUGHT AIRCRAFT, Dept. P-5
 Dallas, Texas

I am a _____ Engineer,
 interested in the opening for _____
 Name _____
 Address _____
 City _____ State _____

ac'cu·ra·cy: *guided all the way, this long-range missile pinpoints distant, hard-to-hit targets*

This nuclear-armed "bird" is the supersonic missile with which the U.S. can retaliate against the toughest of enemy targets — distant, hard-to-hit military fortifications.

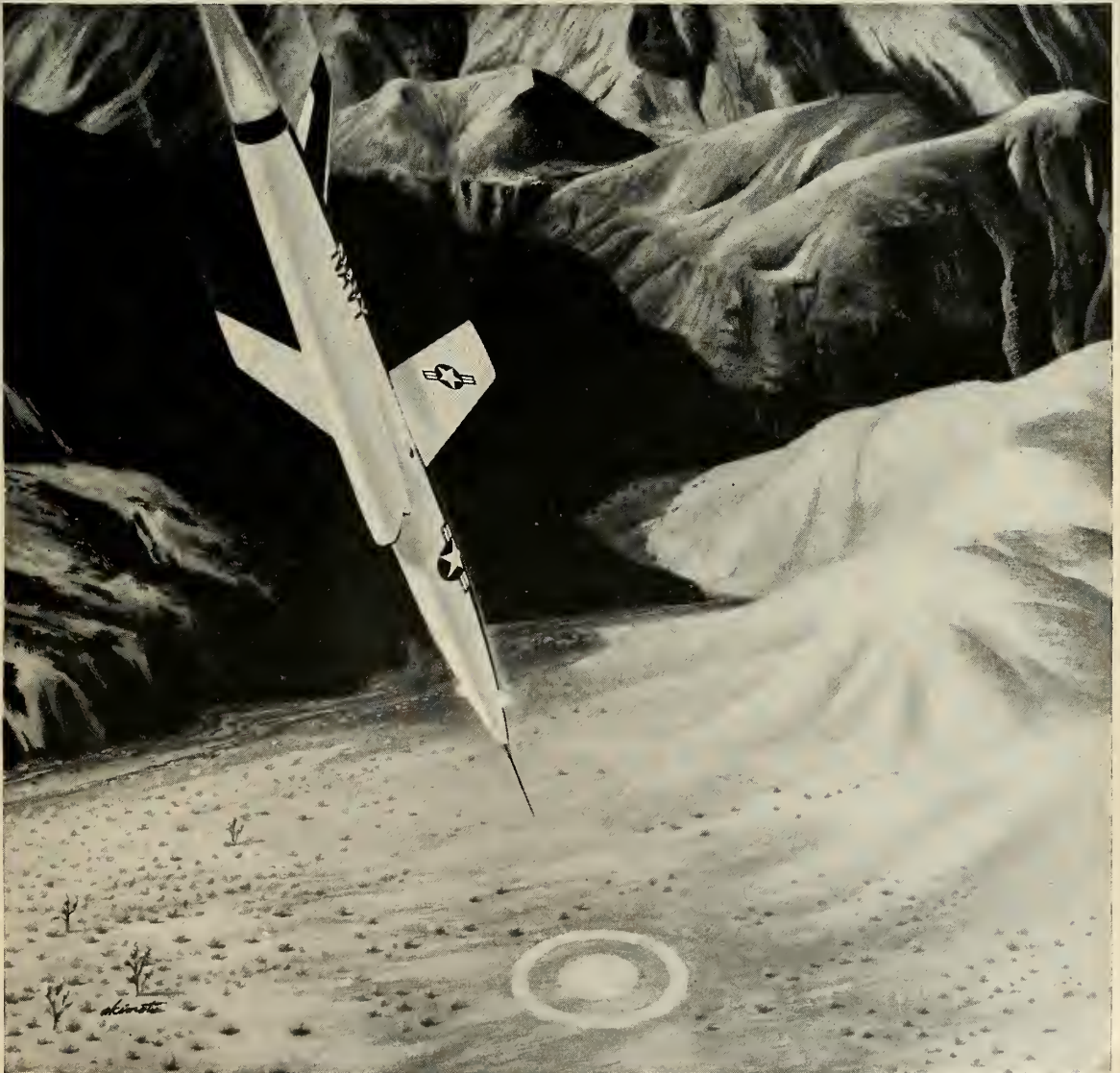
Chance Vought's *Regulus II* provides the extra margin of accuracy that enables the Navy to zero in on such "small" — and deadly — strongholds as H-bomb storehouses, submarine pens, ballistic missile bases.

The instant *Regulus II* launches, its advanced guidance system takes control... constantly compensating, correcting... keeping this Mach 2 missile on target to the instant of impact.

In production now, *Regulus II* provides double deterrence: the power to help forestall nuclear war — pinpoint accuracy to deter localized trouble.

Scientists and engineers: pioneer with Vought in new missile, manned aircraft, and electronics programs. For details on select openings write to: C. A. Besio, Supervisor, Engineering Personnel, Dept. P-5.

CHANCE  **VOUGHT AIRCRAFT**
INCORPORATED • DALLAS, TEXAS



*Advanced missile and
space projects
require Engineers and
Scientists to work on*

THE FRONTIERS OF SPACE

Lockheed Missile Systems Division, recently honored at the first National Missile Industry Conference as "the organization that contributed most in the past year to the development of the art of missiles and astronautics," holds such important, long-term projects as: the Navy Polaris IRBM, Earth Satellite, Army Kingfisher target missile, and the Air Force X-7 ramjet test vehicle.

To carry out such complex projects, the frontiers of technology in all areas must be expanded. Responsible positions in our research and development laboratories and in our project organizations are available now for high-level engineers and scientists.

If you are experienced in physics, mathematics, chemistry or one of the engineering sciences, your inquiry is invited. Please write Research and Development Staff, Sunnyvale 7, California. (For the convenience of those living in the East and Midwest, offices are maintained at Suite 745, 405 Lexington Ave., New York 17, and at Suite 300, 840 N. Michigan Ave., Chicago 11.)

FLIGHT IN THREE MEDIUMS

Several things set the Polaris apart from other outer space weapons in the ballistic missile category, for the Polaris program involves a wholly new concept of weaponry:

1. It will be dispatched from beneath the surface of the sea.
2. It will be radically smaller than currently developed land-launched missiles, yet its payload will be as effective and its range the same as other IRBMs.
3. It will be the first operational outer space missile to employ solid fuel as a propellant.
4. It will travel through three mediums in a single flight: water, air, outer space.
5. Its launching base—a submarine—is not fixed but a mobile vehicle.

OUTER SPACE PROGRAM

Very little can be said about the Earth Satellite program at this time except that its success will necessitate advancing the state of the art in all sciences.

The Earth Satellite Project is perhaps the most sophisticated outer space program to reach the "hardware" stage in the U.S. today.

TECHNOLOGY

ENEMY SIMULATOR

The Kingfisher is the nation's fastest target missile, developed for the Air Force and currently being manufactured for the Army to test the accuracy of our newest supersonic weapons.

It is a ramjet target vehicle with Mach 2-plus capabilities. The Kingfisher not only has the speed to match the defensive missiles, but can also simulate a vast array of supersonic enemy missiles and airplanes attacking from great height. It is instrumented to score near misses and even theoretical hits without itself being destroyed.

It is recoverable from flight by parachute to be flown again, permitting weapon system evaluation to be conducted at greatly reduced cost.

Lockheed /

MISSILE SYSTEMS DIVISION

SUNNYVALE • PALO ALTO • VAN NUYS • SANTA CRUZ
COOKE AIR FORCE BASE, CALIFORNIA
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Valuable**

... So Use
the **A. W. HAYDON**
company's
**SUB-MINIATURE HERMETIC
ELAPSED TIME INDICATORS.**

You, too, can afford the space to keep track of time! From now on, these really small (1/4") Elapsed Time Indicators will keep company with the best of Electronic Miracles.



The illustration shows how the operating time of various sections of an electronic console can be monitored.

The dial type units read up to 2,500 hours in one hour increments, while the digital type units read up to 9999.9 hours in one-tenth hour increments. Designed for military applications, these 4 1/2 ounce units can save valuable panel space in industrial and electronic applications.

The 400 cycle models now in production are described in Bulletin AWH ET 602.



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... m/e news

dition of the importance of these components to machine control. Another innovation appears in a series of five-minute talks on some of the less complex, yet interesting, new electrical products.

Other subjects to be included are "The Controlled Rectifier and Its Application", "Tooling for Guided Missiles & Rockets", "Operating Experience with Relays and Limit Switches", "Photoelectric Line Follower" and "Designing Machines for Servo Drives".

Plant tours through several major Connecticut industries, such as Pratt & Whitney Aircraft Jet Engine Facilities, have also been arranged.

Abraham A. Ribicoff, Governor of the state of Connecticut, will address the conference at a luncheon meeting. Attendance of over 1,000 is expected.

**Conference To Discuss
Interference Problems**

Growing problems of electromagnetic interference with the proper functioning of military electronic equipment will be discussed at an Army-sponsored conference at the Museum of Science and Industry, Chicago, on Oct. 1 and 2.

The meeting, the fourth conference on Radio Interference Reduction and Electronic Compatibility, will be conducted by Armour Research Foundation of Illinois Institute of Technology, under agreement with the Signal Research and Development Laboratories at Ft. Monmouth, N.J.

The Institute of Radio Engineers Professional Group on Radio Frequency Interference will cooperate in the program.

Several papers to be presented will deal with the utilization of computer techniques in relation to large scale interference problems. These will include discussions of predicting the amount of interference existing among various parts of a system, how much interference will be created by the components, and maximum utilization of available frequencies to reduce interference.

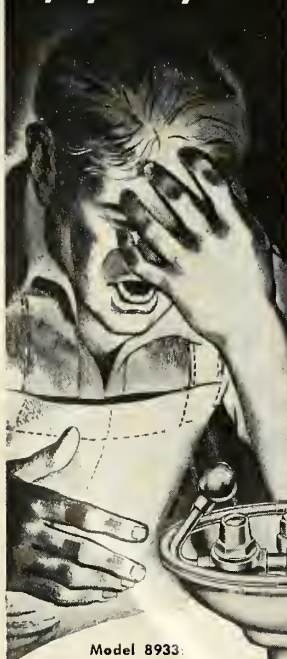
Other papers will be devoted to instrumentation for obtaining objective measurements of the strength of interference, and methods of suppressing interference in equipment.

Discussions of mutual interference between radar installations will include the effect of assigning separate frequencies, equipment spacing, the effect of using modulation of varying characteristics, and operational techniques as a means of diminishing radio interference.

Approximately 450 persons repre-

missiles and rockets, September 8, 1958

My eyes! My face!



Model 8933

Face spray ring acts simultaneously with eye-wash, sending controlled streams of water from specially designed twin fountain heads.

**Provide instant
relief with ... HAWS
EMERGENCY EYE and
FACE WASH FOUNTAINS**

Eye and face hazards are inevitable in industry... so take positive steps to reduce the extent of injury and minimize insurance claims. HAWS Emergency Eye and Face Wash Fountains flood contaminated areas with water—instantly ridding face and eyes of caustics, chemicals and dangerous particles. This instant relief may well prevent permanent damage—bridging the gap until medical aid arrives. Install extra safety—HAWS Emergency Fountains and Drench Showers.

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high reliability . . . extreme compactness . . .

IN THE
NEW SANBORN
850

6- & 8-CHANNEL DIRECT WRITING SYSTEM

If you want a practical direct writing system for straightforward recording in the range from DC to 100 cps — such as computer readout, telemetry recording — look what the new Sanborn "850" offers in compactness, reliability and operating convenience. A complete 8-preamplifier module with power supply, plus an 8-channel flush-front recorder package containing power amplifiers and power supply at rear, occupy only 24½" of "850" panel space.

PERFORMANCE characteristics of an "850" include flat frequency response 0-70 cps, down 3 db at 100 cps (10 div. peak-to-peak amplitude) . . . thermal drift eliminated by current feedback power amplifiers . . . limiting at input to prevent amplifier saturation or cut off, so that damping is never lost . . . drift less than 0.2 div. for 20° to 40° C. changes, line voltage changes from 103 to 127 volts . . . gain stability better than 1% with 20° C. and 20 volt changes . . . linearity 0.2 div. over 50 divisions . . . clear, permanent, inkless recordings in true rectangular coordinates.

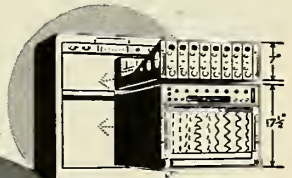
IN RELIABILITY, "850" features include fully transistorized power amplifiers and power supply . . . rugged galvanometers with low impedance, high current, enclosed coil assemblies and velocity feedback damping . . . JAN components wherever practical, such as MIL-T-27 hermetically sealed power transformers, MIL-approved electrolytics in power supplies, etc. . . . forced filtered air cooling for stable operation.

And in operating **CONVENIENCE**, an "850" system provides such advantages as nine electrically controlled chart speeds, selected by pushbuttons . . . a choice of interchangeable Preamplifiers (DC Coupling and Phase Sensitive Demodulator presently available, with others in development) . . . remote control of chart drive, speeds, timer and marker . . . monitoring connection points . . . a Recorder that loads from front and has built-in paper take-up and paper footage indicator.



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TABER TELEDYNE

... is relatively insensitive to vibration or shock because of its bonded strain gauge construction. Use with standard servo indicators, recorders and controllers to measure liquid or gas pressures. Handles extremely corrosive media, including fuming NITRIC ACID. ● Linearity 0.25% ● Hysteresis 0.5% ● Ambient temp. —65° to +250° F (18° to 121°C) ● Pressure Ranges: 0-300 to 0-10,000 (PSIG).



Easily disassembled for clean out and parts replacement.

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NORTH TONAWANDA, NEW YORK

160° C TRANSISTOR AMPLIFIERS... SUB MINIATURE

Want big service in a tiny space? Our 207S is the answer. 400 G's at 2000 cps., 40 db open loop gain and 20 db closed loop gain ± 0.5 db, —60° to +160° C, stainless steel case.



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Cockeysville, Maryland

— developed by Naval Ordnance Laboratory, Silver Spring, Maryland
— product-engineered and produced by Aircraft Armaments, Inc.

AAINC. MODEL 2830 MISS-DISTANCE MEASURING SYSTEM AN/USQ-11

FOR TARGET DRONES



OUTSTANDING FEATURES: Meets MIL-E-5272A 5400B, 16400 -- provides data in 2 min. -- requires transponder in drone only -- measures salvo firings -- determines miss on multiple targets. Target equipment (less power supply) under 2 lbs. Accuracy confirmed by field tests.



TARGET TRANSPONDER

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sending the Armed Forces, industry, research, and education are expected to attend the conference.

Russian Satellite Book Gives Details of "Moons"

A new book—translated from the Russian and now available in the U.S.—gives details on the laws of motion of artificial satellites, motion of the satellite relative to an observer on earth, and other scientific discoveries.

Published in translation by the Foreign Technical Information Center, Office of Technical Services, U.S. Department of Commerce, the book is authored by A. Shternfeld.

Of major interest are chapters concerning observation of artificial satellites, communications between the objects and the earth. An appendix concerns the dissemination of ideas in astronautics, and the question of territorial rights in space above the earth's atmosphere.

In chapters on construction and launching of satellites, Shternfeld discusses the principles of the rocket engine, powder and liquid rockets, design of the engine, energy necessary to place the satellite in orbit, influence of the earth's rotation, and similar problems.

The book was first published by the State Publishing House of Technical-Theoretical Literature, Moscow, in 1958. In English, it makes a 433 page volume.

Magnesium Enclosures House ARMA Guidance

Three magnesium enclosures—designed to eliminate dead weight and cut missile fuel requirements—house the ARMA ICBM inertial guidance system, it was disclosed last week.

Two of the enclosures—a three-deck computer section and a control-central case—are fabricated entirely from magnesium extrusions. The third enclosure—that easing the inertial platform itself—contains two deep-drawn magnesium hemispheres.

According to ARMA—a division of the American-Bosch-Arma Corp. of Garden City, N.Y.—the low weight of the whole system is the result of several factors, including exceedingly small gyros and computers, and the use of lightweight materials like magnesium. Each pound of dead-weight saved cuts the ICBM's fuel requirements by many pounds, company spokesmen added.

ON THE

WAY UP



Official U. S. Air Force photo.

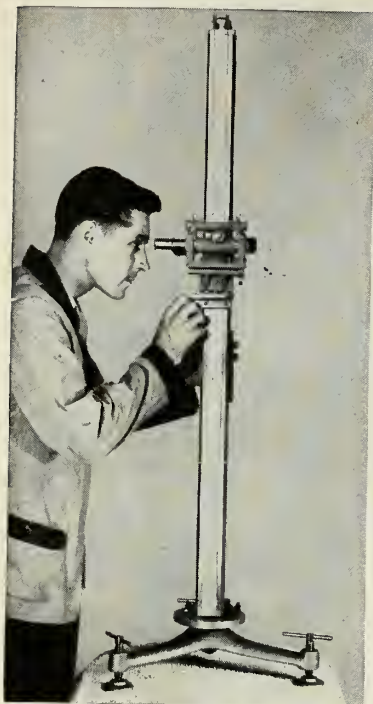
IF YOU, TOO, ARE ON THE WAY UP AND ARE QUALIFIED FOR A SENIOR ENGINEERING OR TECHNICAL MANAGEMENT POSITION IN INERTIAL NAVIGATION, THERE IS UNLIMITED GROWTH POTENTIAL FOR YOU AT ARMA. HERE'S WHY. HAVING DEVELOPED THE ALL INERTIAL GUIDANCE SYSTEM FOR THE AIR FORCE TITAN ICBM, ARMA HAS NOW BEEN SELECTED TO PROVIDE INERTIAL SYSTEMS FOR FUTURE ATLAS OPERATIONAL UNITS.

IF YOU WANT TO BE "ON THE WAY UP" WITH THIS PROGRAM, WRITE TO ARMA PROFESSIONAL PERSONNEL, GARDEN CITY, N. Y. PROMPT, CONVENIENT, CONFIDENTIAL INTERVIEWS.

AMERICAN BOSCH ARMA CORPORATION

6318

Optical instrumentation for accurate measurement of remote or inaccessible objects



Gaertner M901 General-purpose Cathetometer

CATHETOMETERS

Gaertner Cathetometers are designed for accurate measurement of vertical distances or displacements. They are ideally suited for measuring where the object or action is remote or not accessible by ordinary means. Gaertner produces a wide variety of precision-constructed cathetometers to meet your individual requirements.

- **General-purpose Cathetometers**—These combine a high degree of accuracy with a maximum of convenience. Range 100 cm, focusing range 60 cm to infinity.
- **Precision Cathetometers**—For maximum accuracy and rigidity. Readings directly to 1 micron.
- **Micrometer Slide Cathetometers**—For precise measurement of short vertical distances. Range up to 4" or 100 mm. With telemicroscope, focusing range 12 cm to infinity.
- **Co-ordinate Cathetometers**—Permit making precise co-ordinate measurements on objects in a vertical plane. Focusing range 9" to infinity. Co-ordinate measuring range up to 24"x42".

**SPECIAL PURPOSE PERISCOPE
REMOTE OPTICAL STRAIN MEASURING
INSTRUMENTS**

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soviet affairs

by Dr. Albert Parry

An "anti-meteorite shield" is an idea now being suggested by the Soviet engineer F. Yasinsky. "We are on the eve of space flight," he declares, "yet the problem of possible collisions with meteorites remains unsolved."

Data gleaned from the three *Sputniks* is now being evaluated in Moscow with regard to the impact of meteorites and micrometeorites on today's earth satellites and tomorrow's space ships. Yasinsky points out that defense against meteorites must be a fact before interplanetary travel becomes possible.

The Soviet engineer sees little likelihood of a collision with a big meteorite. A space ship could detect such a meteorite by radar and visual means, and so avoid it.

But it is another matter with "small meteorite bodies weighing from a gram's fraction to several tens of grams." Meeting such a body can be fatal for a satellite or a space ship, since "the thermal energy generated by such a clash equals an explosion of several tons of trotyl."

His "space umbrella," as Yasinsky occasionally calls his anti-meteorite shield, is proposed in the form of a disc, 20 to 50 meters in diameter. It will be made of steel in just one layer of one-half meter to two meters in thickness, and fastened to a frame.

The weight of the shield should be "not in excess of one per cent of the cosmic rockets of the future." In the "knots" of the frame, Yasinsky would put several small rocket motors, small containers with fuel ("several tens of kilograms"), and special telemechanical equipment.

The shield will be towed by the ship. However, the moment the space ship reaches its predetermined speed, and the pilot turns off the motor, changing to flight by inertia, the shield will be uncoupled and sent on its "free flight."

The ship's pilot, guiding the shield's motors by radio, will place the shield parallel to the ship, at a distance of "several tens of meters." Continuing on its parallel course with the ship, the shield will then protect the space ship from meteorites.

The thickness of the shield's wall will be calculated in a way to allow its inevitable piercing by meteorites of a dangerous kind. At the blow, the tremendous kinetic energy will become thermal energy. This will result in an enormous heating of the meteorite, along with similar heating of a part of metal torn out of the shield by the meteorite.

Instead of the meteorite, a lump of gas will now fly toward the space ship—a red-hot lump, broadening at a terrific speed, its temperature in millions of degrees.

But en route to the ship, due to the distance between it and the shield, this lump will have time to widen considerably, to cool off, and in part to disperse. Thus the space ship will collide not with the meteorite, but with the far less harmful "porous" gas cloud.

missiles and rockets, September 8, 1958

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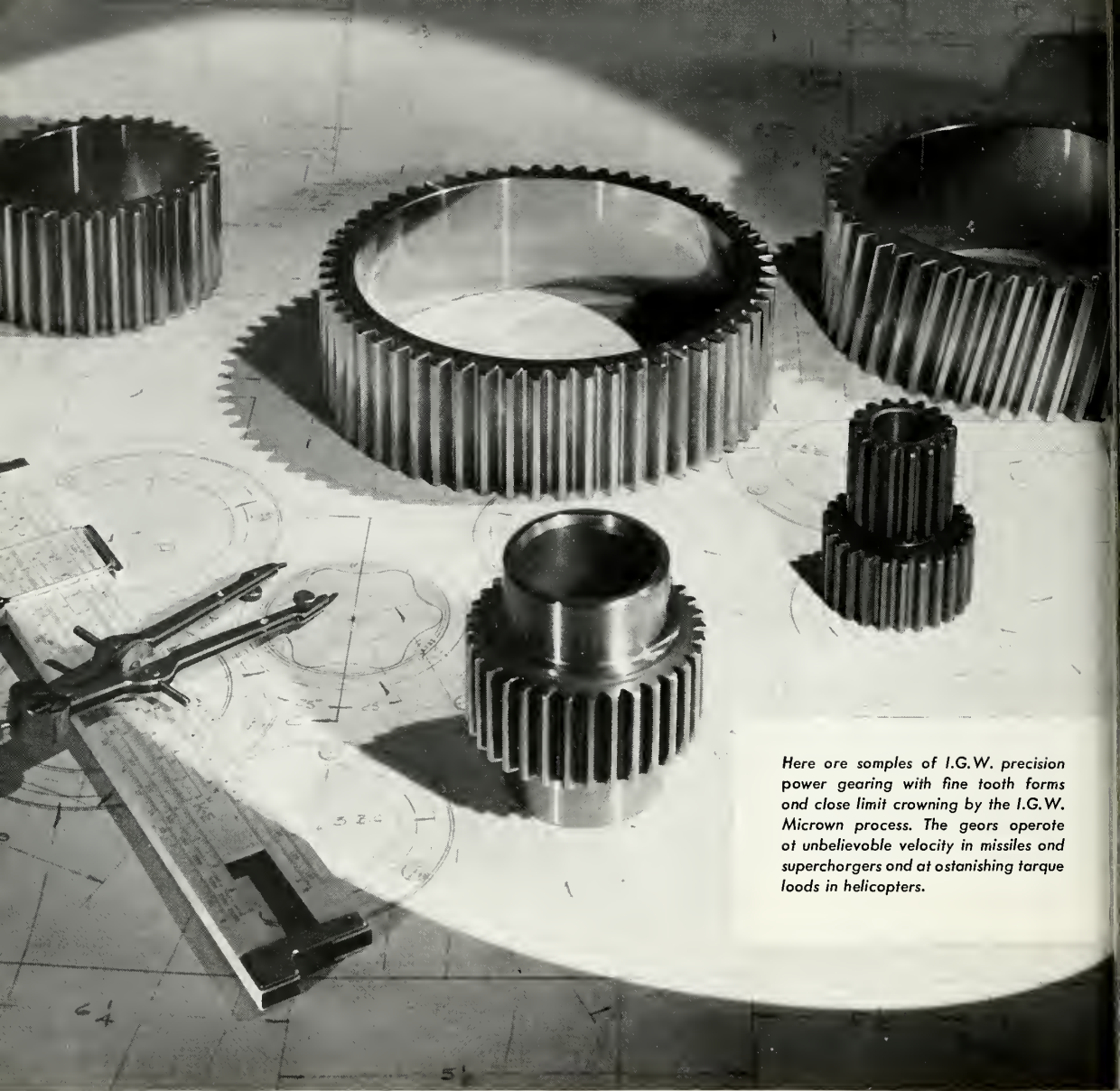


Measuring the bore of a steel liner ground in assembly with the lower housing of the Sikorsky S-56 Helicopter transmission. Its complex, thin-walled casting must be machined with all bores and faces within an angular tolerance of plus nothing and minus one minute and thirty seconds and with linear tolerances of plus or minus .002.

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Soviet-imposed anonymity is the only discomfort or offense that Russia's experts in rockets and missiles may now feel—but this is a slight discomfort compared with the ample salaries, fine country villas, and other plush emoluments which Khrushchev gives his scientists in return for the ICBMs, IRBMs, *Sputniks* and possible flights to the Moon. So said Khrushchev himself in a speech delivered while visiting a chemical factory in East Germany.

And the only reason he does not publicize the identities of Soviet rocket and missile men is to protect them and Russia's scientific and military secrets "from enemy agents who can be sent to destroy such outstanding people who are our treasured personnel." Yet, in time, the names and photos of Red rocket and missile makers will be published, the Soviet chief promised. He did not, however, set the approximate time of such publication.

A **Red Chinese *Sputnik*** is a thing of the near future—the Red government of Peking is "determined to get China's artificial earth satellite into the sky at an early date." This comes from Kuo Mo-jo, president of the Red Chinese Academy of Sciences. The Soviet government of Moscow is expected to help, but not too enthusiastically. Mao Tse-tung is pressuring Khrushchev for a space-age arsenal and, generally, for a greater voice in the space era's international politics. Khrushchev, reluctantly, has given it.

On the recent occasion when Khrushchev and his Marshal, Rodion Y. Malinovsky, visited Mao and his generals in Peking, the Russians had to yield to Mao's insistence on more industrial and military assistance. Military assistance, it is reported, includes Soviet missiles and anti-missiles to be installed for the Chinese Communist forces on China's mainland opposite Formosa. It will be the Red answer to the American ballistic missile pads placed on Taiwan for the Chinese Nationalists.

Red Chinese astronomers will be allowed to come to the United States in 1961 to attend the General Assembly of the International Astronomical Union, of which Communist China is a member. This ruling was made by the State Department, and it also covers other countries with which the United States has no diplomatic relations. A reservation is made, however, stipulating that Chinese delegates and others will not be allowed to lecture in our universities while in this country.

The United States Attorney Gen-

eral, by law, has to make the final decision in this matter, but he is expected to abide by the State Department move. Our leniency is thought to have good propaganda value as a contrast to the failure of the Soviets to permit Chinese Nationalist scientists from Taiwan to come to Moscow for the recent Fifth Assembly of the governing body of the IGY.

Solid benzine as a wonder-working fuel is drawing the attention of Soviet scientists. The Moscow Institute of Fuels, Minerals and Ores is checking the results of experiments with solid benzine at the Soviet stations in Antarctica. The role of Soviet-made solid benzine is of special interest in extremely low temperatures—(noted by the Russians near the South Magnetic Pole as minus 84.3 degrees C or minus 119.74 degrees F at their lowest). These experiments were also made under the conditions of lack of oxygen.


One aspect of such Soviet experiments and experience is, however, not made public. This is the Soviet use of solid benzine in rocketry. However, in *KRASNAYA ZVEZDA*, a brief reference is made to the employment of solid benzine "in motors."

It is explained that solid benzine comes in briquets of white or yellowish color, and that the "cell-walls" of such briquets "possess great solidity and elasticity," being made of "polyvinyl alcohol which is a high-molecular compound." To feed solid benzine into the motor's fuel containers, it is necessary to break the briquet "cell-walls" by compressing the briquets, the Soviet Army newspaper adds.

Seaweed as space-crewmembers' food is discussed by Lieut Col. I. Krestovsky in *SOVETSKAYA AVIATSIA*. In his article, "The Cosmic Breakfast," he states that the Institute of Physiology of the Soviet Ukrainian Academy of Sciences is carrying out experiments with the algae (seaweed) called *chorella*. This contains "a high ratio of organic matter and mushrooms."

These *chorella* plants will not only feed the crew but, by being installed inside the space ship, they will restore the micro-atmosphere of the ship. "A mass of *chorella* weighing 2.3 kilograms can produce, within one hour, 25 liters of oxygen," the article states. In the meantime, these plants will themselves thrive on the carbon dioxide exhaled by the space-ship's crewmen.

Weightlessness is not a handicap in space flight, declares Dr. V. N. Chernigovsky, a member of the Soviet



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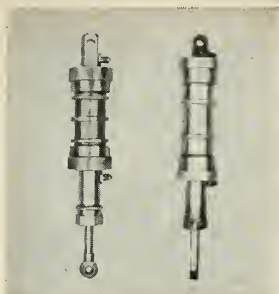
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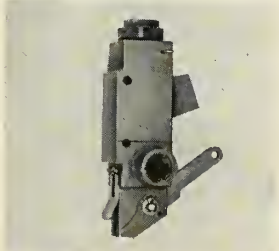
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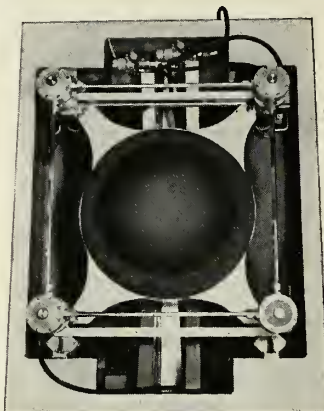
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Vibration Isolation System

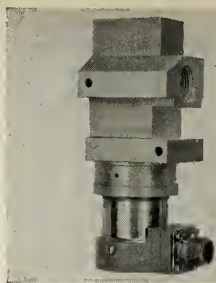
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The system shown above is one of several Kidde pneumatic vibration isolation system programs for protecting delicate missile control systems from undesirable vibratory disturbances and great transients in "g" loading which would affect accuracy of control. The component in the inset photo incorporates the system's mechanical and air snubbers, air spring, servo valve and passive isolator.

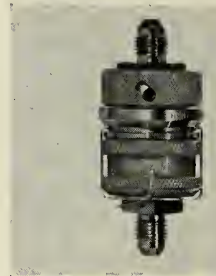
Research on projects like this new vibration isolation system goes on constantly in Kidde's vast creative pneumatics engineering department. For more information on any Kidde components, or help in solving specific pneumatics problems, write or call Kidde today.



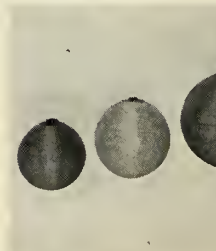
Vibration Isolator



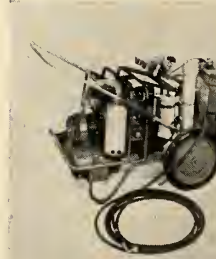
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Academy of Medical Sciences and a corresponding member of the main Soviet Academy of Sciences.

In KOMSOMOLSKAYA PRAVDA, he states that, "data at our disposal does not conclude that weightlessness is a condition preventing man's flight into interplanetary space." Dr. Chernigovsky speaks of the value of Laika's journey as adding to man's knowledge of weightlessness. He hints of inclusion of other dogs, as well as other animals, into Soviet *Sputniks* that will be orbited in the future.

In describing the "Physicists' Town" and its special cosmic radiation observatory and laboratory established in the high Pamirs (Central Asia) by the Physics Institute of the Soviet Academy of Sciences, a correspondent of IZVESTIA declares that the "rain" of cosmic rays in these mountains is "ten times more intensive than, say, near Moscow." He also stated that "nuclear explosions of individual atoms of air caused by cosmic rays occur 15 times more frequent in the mountains than at sea level."

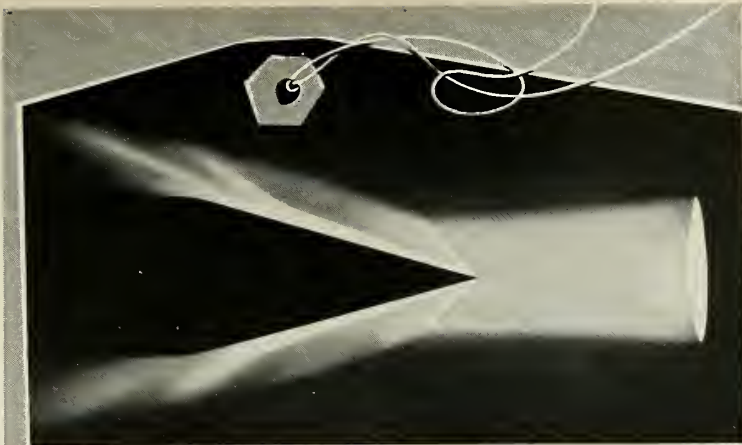
Important results have been achieved in the research carried out in the Soviet Pamir observatory and laboratory by Academician D. V. Skobel'syn, Professor N. A. Dobrotin, and G. T. Zats'epin. These men earned Stalin Prizes for their Pamir cosmic ray work. Professor Dobrotin is in charge of the Pamir group of physicists and astro-physicists.

One million operations per second —this is the aim of Soviet designers for future electronic computers, according to V. Alexandrov, chief of the Designing Bureau of the State Planning Committee of the Soviet Union. Writing in PRAVDA, he urges a much wider utilization, in Soviet computers, of semiconductors made of germanium and silicon, "instead of electronic lamps."

From 2,000 to 30,000 operations per second is the present capacity of Soviet computers, it is revealed in an article by V. Belkin, a staff member of the Soviet Academy of Sciences Laboratory of Computing Machines and Systems.

The *Sidewinder* will be manufactured in Holland, declares KRASNAYA ZVEZDA, quoting the Dutch press. The Soviet Army newspaper comments that "last fall the United States promised to place in Holland its military contracts after the Dutch government had agreed to the installation of American rocket bases in that country." Sharp disap-

missiles and rockets, September 8, 1958



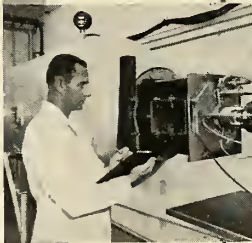
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... moscow briefs

proval of the "imperialistic" deal is indicated by the Red article.

Unfriendly *Sputniks* will have to be chased, stopped, and thrown out of their orbits. So OGOŃIOK quotes General John B. Medaris. The Moscow journal angrily adds, however, that "thus far the warlike zeal of the American general has weak grounds in reality." For, says OGOŃIOK, there is no such thing as an unfriendly *Sputnik*.

It goes on to ask, "Why is it that while the whole world rejoices with each success in man's conquest of cosmic space, some people in the United States so stubbornly strive to make a war arena out of Cosmos?"

You can shoot from the Moon to the Earth more easily than the other way around. This statement comes from Professor F. Rybkin, writing in KRASNAYA ZVEZDA. He quotes Konstantin Tsiolkovsky, the great Russian pioneer of rocketry, to the effect that "at least a four-stage rocket is needed to fly from the Earth to the Moon." He then goes on to say that a single-stage rocket is enough for the flight from the Moon to the Earth.

"In other words," the Moscow professor continues, "in order to shoot from the Moon to the Earth, it is sufficient to possess rockets of a shorter range rather than intercontinental ballistic missiles." This means, he deduces, that "the Moon represents a position dominating over the Earth."

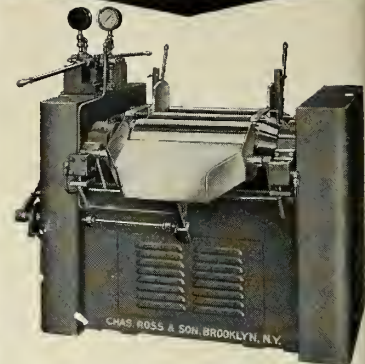
Professor Rybkin proposes international control for man's doings vis-a-vis the Moon and the nearby asteroids—control "which will exclude the possibility of their use by the reactionary forces of capitalism for aggressive purposes."

Making fun of the recent American concern to prevent radioactive substances from reaching and contaminating the Moon in man's attempts to send rockets there, KROKODIL suggests that soon the U.S. will offer resolutions "in favor of liquidating military bases on Mars . . . advocating non-interference in the domestic affairs of the planet Neptune . . . proposing a non-aggression pact with the star Sirius . . . also proposing a disarmament agreement within the limits of the Milky Way."

Wouldn't it be more fitting for Americans, the satirical Moscow mouthpiece inquires piously, to stick to earthly affairs by "following the Soviet example in suspending atomic tests?"

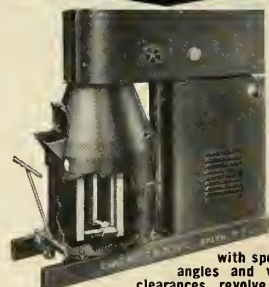
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artificial earth satellites, was discussed in Moscow at the recent Fifth Assembly of the IGY governing body by Professor Sergei N. Vernov, a corresponding member of the Soviet Academy of Sciences. American and other Western scientists present at the lecture found it of great interest, although it did not answer all they wanted to know about the *Sputnik*-gathered store of knowledge.

Dr. Vernov pointed out that the Soviet study of cosmic radiation was begun in 1947 with the aid of rockets. In 1951, Russian scientists measured the ionization caused by cosmic rays up to the heights of 100 kilometers. The figures from this rocket-study of ionization were in part used by Moscow's savants in preparing and analyzing the flights of *Sputniks* II and III.

As a result, it is now possible to make a chart of the distribution of cosmic rays around the Earth and thus investigate the Earth's magnetic field. Special equipment was installed in *Sputnik* II to measure radiation produced data, the analysis of which permitted the spotting of considerable increase in the intensity of radiation.

On November 7, 1957, from 4:46 to 4:49 PM Moscow time, in latitudes above the 58th degree, this intensity rose approximately 50%. The *Sputniks* register a new kind of radiation, which Dr. Vernov calls "the Earth's radiation"—as it originates near the Earth and moves around our planet.

Sputnik III measured ionization, the extent of which experienced strong changes. Surplus ionization, Dr. Vernov asserted, was caused by electrons of low energies. *Sputnik* III has a luminescent counter possessing a high sensitivity in registering photons.

American curiosity was not satisfied about certain aspects of *Sputnik* results at the Fifth Assembly of the IGY governing body in Moscow. American delegates were prepared to give practically every detail gleaned from the *Explorer* and *Vanguard* experience, but the Russians proved cagier.

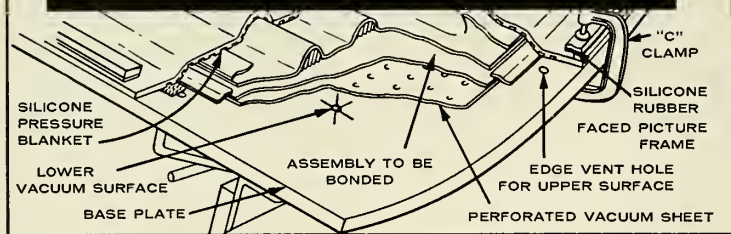
True, the Russians reported on their oceanographic work in the optical tracking of their satellites, also on cosmic ray studies, and on certain special Soviet-devised instruments in the satellite field.

But they refused to divulge the size and weight of each object placed in orbit, particularly those of the final-stage rockets. This data (the Americans pointed out) was needed in aiding density studies. The Soviets refused to say anything definite about the motor used in hoisting their *Sputniks*.

missiles and rockets, September 8, 1957



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An **Astronomical Observatory in satellite orbit** has been a fond dream of astronomers who struggle to peer through the murky turbulence of our atmospheric blanket. Prof. Fred. L. Whipple, Director of the Smithsonian Astrophysical Observatory (SAO), Cambridge, Mass., believes that a respectably sized satellite-telescope, equipped with television transmission, could be designed, developed and built in 18 to 24 months.

Together with associates at SAO and Harvard College Observatory, Whipple has made a study of the scientific and engineering aspects. Initial thinking indicates an 8-in. aperture off-axis mirror of 24-in. focal length. With a conventional TV recording surface, such a telescope would give a resolving power of the order of 20 seconds and a field of approximately 4 square degrees. To cover the entire sky, 10,000 direct images would have to be recorded.

This rate is about the same as the number of images produced in commercial television during six minutes of operation. Doubling the power requirements and operational life would allow a second survey of the sky with "objective grating" spectra, at little additional expense for design or structural changes.

Engineering problems to be faced include: stabilization of the telescope platform against rotation and control of its orientation in space; lightweight, rigid design; power sources; and the stresses of vibration and acceleration imposed during launching. So much of scientific value could be learned from a satellite telescope that we feel justification and funds will be found to place one in orbit by 1961.

Underwater jet propulsion tests were made at the Italian Navy Base at La Spezia in July. Both hydroramjet and hydrorocket propulsion techniques are being studied by Capt. Glauco Partel, who has several designs for such power plants. The July trials were confined to two successful 15 second runs of Partel's hydroramjet, A-80. Fuel used was lithium aluminum hydride. The fuel to be used in tests scheduled for September will be a mixture of sodium hydride in oil.

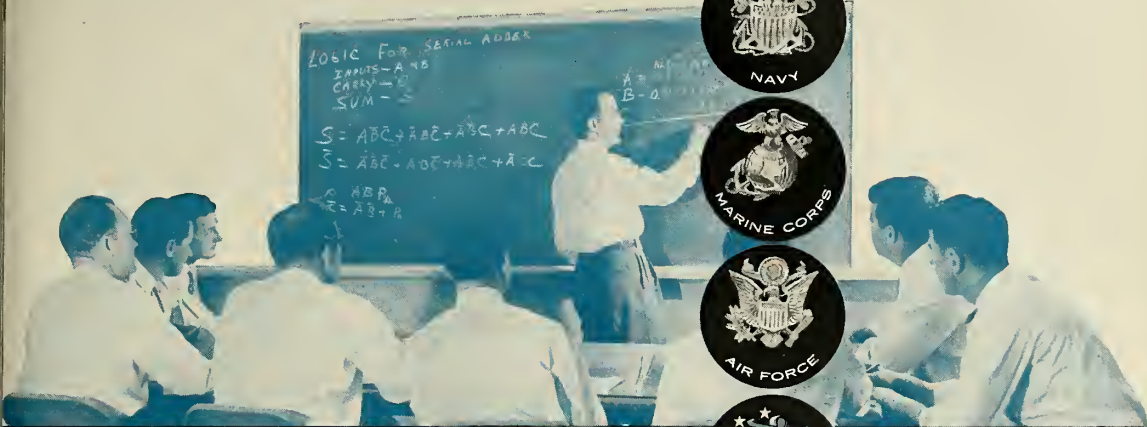
The **Human Factors Division** of the ARS has a Subcommittee on Instrumentation of Biological Parameters, headed by Lt. Col. Hessberg, USAF, of the Aero Medical Lab., Wright Aero. Dev. Center, Dayton. The Subcommittee has suggested two simple approaches for instrumentation of bacteria studies in biosatellites. One concept would use acid-forming bacteria, measuring changes in potential with a diode. The other would use pigment producing (fluorescent) bacteria with photoelectric measurement. Weight and volume requirements for instrumentation were estimated to be less than 3 oz. and 6 cu. in.

Rocket stations for hail defense—In an effort to reduce the destruction caused by hail storms, an extensive series of tests are planned in Bavaria at this time. Sixty rocket stations have been established in three rows along the Inn River and five more at Lake Sim.

Program is under the direction of the Munich-Riem Aerological Station of the German Weather Service on the basis of experience gained by the Swiss. A parallel program utilizing ground generators of silver iodide vapor from a propane gas flame will obtain comparative results of effectiveness and economy. An observers' organization with 267 members from state agricultural agencies has been created to warn of approaching storms.

A **meteorite is small**—everyone knows that. But, how large is a "falling star" that appears as bright as Venus as it streaks across the sky? Willy Ley says "about a half-inch in diameter and weighing about one seventh of an ounce."

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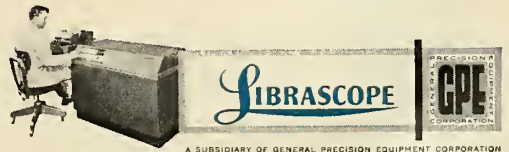


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high-energy fuel briefs from Callery

Callery, GM, Thiokol sign working agreement — The working agreement between these three firms is aimed at developing advanced devices in the field of guided missiles and space travel. Callery, General Motors and Thiokol have already done extensive pioneering in specific phases of missile and space development. Callery will provide the combination with propellant components for space vehicles. The new agreement does not restrict the participants from working with other companies in the same areas.

HiCal® high-energy fuel for the Navy — The first production quantities of HiCal-3 — were made at our new Lawrence, Kansas plant in August. Virtually all fuel from the Lawrence plant is earmarked now for the military. Quantities of HiCal may become available in the future however, for authorized users.

New Muskogee, Oklahoma plant on contract schedule — The Navy HiCal facility at Muskogee, Oklahoma is still under construction, and on contract schedule. First process units will start up in September.

New pyrophoric ramjet fuel: Triethylborane — TEB is spontaneously flammable in air, but does not react with water. Density at 25°C is 0.68. Melting point is -92.5°C. Boiling point is 95°C. Heat of combustion is 20,200 B.t.u./lb. It is miscible with hydrocarbons, so it can be used as an additive to conventional fuels.

TEB has much wider flammability limits than hydrocarbons. Thus TEB permits higher altitude flights and simpler engines. *For further data send for new Technical Bulletin CCC-310 and Handling Bulletin CCC-311.*

A suggested heat sink: Lithium Borohydride — LiBH_4 is a solid — melts at about 532°F with decomposition. Complete decomposition at 1800°F would absorb more than 6,000 B.t.u./lb. It is soluble in hydrazine and the solution may be a good rocket fuel. *Write for Technical Bulletin CCC-130 for more information.*

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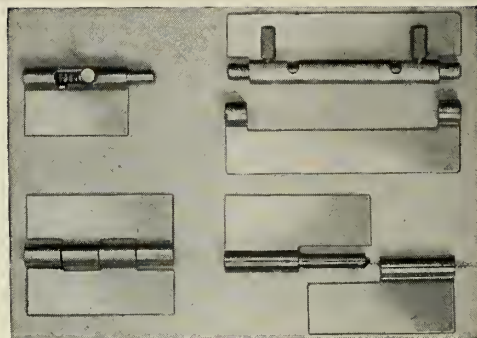
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space age



by Norman L. Baker

First powered flight date for the X-15 continues to be pushed further into the future. Latest reports see summer of '59 as a conservative estimate. Major bottleneck is still the 60 k engine under development by Reaction Motors Division of Thiokol. Reaction Motors is currently receiving assistance from Rocketdyne on the development of the first engine. The 54-60 k sustainer engine for the *Atlas*, for some undisclosed reason completely ignored during the initiation of the X-15 program, will, with modifications, be used as a back-up unit.

Army's ABMA is making great strides in the engine development program leading to the million-pound thrust engine system. Last week the Huntsville area was subjected to the blast of the first successful firing of the free world's largest single engine. Thrust was reported to be in excess of the 300 k thrust engine system under development by Rocketdyne (m/r, Aug. 11, p. 74). The solid propellant motor (reported thrust—450 k) has such a high acceleration level that it will be undesirable for manned space applications.

The second-stage of the *Thor-Able I* (Air Force's first *Pioneer* lunar probe) may have been recovered about 650 miles northeast of Cape Canaveral, although no DOD announcement has been made. Five days after the attempted launch on August 17, a destroyer from Task Group Alpha (200 miles off Cape Hatteras) picked-up a section of a missile approximately 12-feet long and weighing about 500 pounds. The missile section, nearly intact, contained propellant tanks and wiring.

The United States may have to revoke its present policy of not laying territorial claims in Antarctica, or do as the Russians are doing—start building permanent rocket launching bases at that location. According to Prof. S. Fred Singer (m/r, Sept. 1, p. 19), the high energy of the radiation belt discovered by the *Explorer* satellites may force origination of manned space flights from launching pads in the very high latitudes or in the polar regions. Singer advanced the theory that the belt is comprised of protons trapped in the magnetic lines of force of the earth with maximum thickness at the equator arcing in to a region of cleared radiation at the poles.

Fluorine, the near-ultimate in oxidizers for liquid rocket engines, has been combined successfully in large-scale rocket thrust chambers at Bell Aircraft. If fluorine's tremendous logistical problem can be satisfactorily eliminated (a factor that makes it undesirable for missile weapon systems), it should receive extensive use in future space operations. Combined with existing fuels it will be possible to increase the rocket engine's thrust as much as 40% with a payload increase of 70%.

Republic Aviation is in the early stages of development work on a "magnetic pinch plasma engine" for interplanetary travel. Research under way is expected to lead to an operating powerplant. Currently, random undulations in the boundary layer of the pinch is posing a major problem. Ions and negative particles will be compressed in a magnetic field and accelerated in a single exhaust stream. An ion accelerated powered interplanetary vehicle proposed by Boeing would use sun-vaporized cesium for fuel. Both systems have been suggested as power sources for unmanned Mars exploratory vehicles.

The success or failure of a lunar probe is dependent upon two major parameters—exact timing and precise power control. For example, to intercept an area on or in the region of the moon requires launching of the vehicle within a two minute interval with exact final velocity attainment at a prescribed altitude. At a cut-off velocity of 23,700 mph, the vehicle will not reach the moon. An additional 30 mph will send the rocket to an intercept in 4 days, a velocity of 23,860 would cut the flight time to 2½ days.

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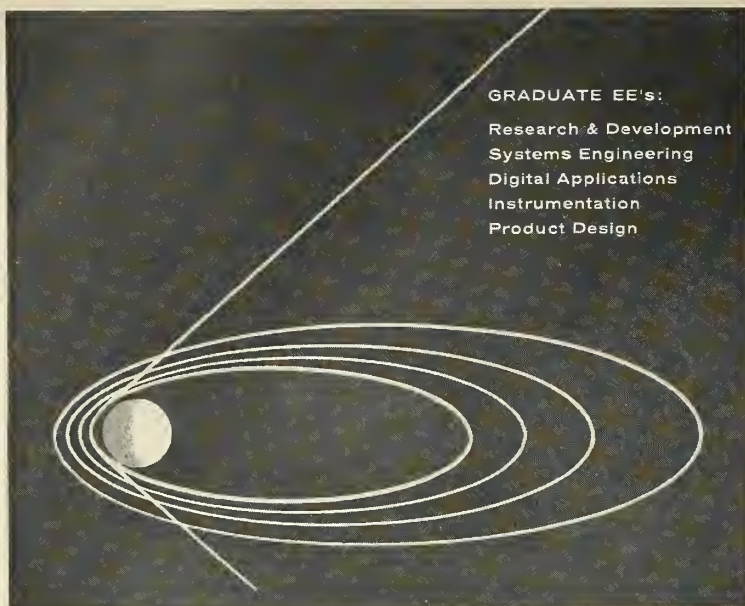
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Ampex Shares Up

To the Editor:

Under "Industry Countdown," August 25, you report Ampex Corp. "dropped per share earnings to 90 cents for the 1958 period (fiscal year) ending April 30," compared to \$1.51 per share in fiscal 1957.

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Instrumentation Advertising
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This is certainly good news, and of course, should be made clear to m/r readers . . . Ed.

Million-lb. Red Engine?

To the Editor:

In regard to the current interest in developing million-pound thrust engines, an extract from the Russian press has recently come to my attention.

In the April 1958 issue of VESTNIK VOZDUSHNOVO FLOTA, an article appears entitled "Some Problems of Rocket Technology," written by a Major General Mel'kumov. On page 81, the author writes, "The thrust of a contemporary single liquid-fuel rocket engine reaches (a value of) 450 (metric) tons."

At 2,200 lb./m. ton, this comes to about one million lbs. Specific inclusion of the word "single" (edinichnovo) seems to rule out a ganged engine, and indications would seem to be that this motor was at least in the testing stage when the article was written.

Stanley Ross
Missile Systems Div.
Lockheed Aircraft Corp.
Sunnyvale, Calif.

Thank you! This certainly supports the opinion of many experts as to the nature of the lead the Russian missilemen have given their country over our own . . . Ed.

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NEW PRODUCT BRIEFS

BATTERY. This primary battery said to operate at -100F, it has been announced. Called the Yardney this battery marks the first time unit has been able to supply ample current at temperatures below according to the manufacturer.

by Electric Corp.

No. 225 on Subscriber Service Card.

TANTALUM CAPACITORS. A new line of tantalum electrolytic capacitors, designed to meet the need for small polarized capacitors used in saturated circuits, is on the market. These capacitors are said to have low leakage currents and low power factors varying between one-third to one-half the maximum limits specified in MIL-STD-883B over the entire operating temperature range. ITT Components Division.

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TRANSISTOR AMPLIFIER. This new gain, narrow-band voltage amplifier designed to operate from printed circuit boards and other very low level signals with carrier frequencies from 60 to 20 KC. Taber Instrument Corp.

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WRENCHES. "B" nut wrenches designed specially for the missile industry have been placed on the market. Torquinox lines has presented a problem in the past because of the extreme high temperatures needed to stop leakage. These tools are designed for the Thor missile, and are being used by Douglas Aircraft Co. as Convair. Spec Tool Co.

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FILTERS. A new Chebishev-type Pass and Low Pass Electrical Wave filters, with cut off frequencies up to 100 MC, is available. These custom designed filters feature high attenuation, low insertion loss and stability over a wide temperature range. Polyphase Instrument Co.

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VIBRATION TESTING. A compact sine wave vibration testing system, the Sine-O-Matic Model CP-3/4, has been placed on the market. A completely packaged testing system, the unit features fully automatic programming and operation. Ling Electronics, Inc.

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SOLENOID VALVE. Designed for missile applications, this 4-way pneumatic solenoid requires only 0.2 amp at 27 volts DC. The valve weighs 11 ounces, and operates with pressures up to 3000 psi. Dynamic Controls Corporation.

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SWITCHING TIME. A device for testing transistor switching times, incorporating a new precision technique for measuring durations in the millimicrosecond region, has been announced. Designed specifically for analyzing the time characteristics of high speed transistors, the APL 300 can measure the switching time of the leading or trailing edge of the output pulse, with an error of 3.0 millimicroseconds. Atronic Products, Inc.

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CAPACITOR. Just introduced is a miniature solid electrolyte tantalum capacitor—said to be rugged, reliable, and exceptionally stable in capacity, dissipation factor, and leakage current over a temperature range from minus 80 degrees C to plus 85 degrees C. ITT Components Division.

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REFERENCE STRINGS. A new line of reference strings designed for an extremely low amount of voltage change over a wide temperature range is on the market. These strings were designed for applications where voltage output and temperature coefficient requirements are not compatible with the performance of a single diode, such as in the precision instrumentation field. Hoffman Electronics Corporation.

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MISSILE LITERATURE

TERMINALS. Mitronics, Inc., has new literature and prints available for high altitude, high voltage, Solderseal Terminals, as well as literature for high end low temperature metallized ceramic and alumina for Hermetic Seal applications. Circle No. 200 on Subscriber Service Card.

GEAR-HEAD PUMP. A bulletin just released by the Blackmer Pump Company of Grand Rapids, Mich., describes a new line of gear-head rotary pumps with a new helical gear reducer developed by Blackmer especially for use with these pumps. Detailed in bulletin 110, are three series, the GX, GXS and GXU, each of which is available in sizes of 2", 2½" and 4". Pump capacities range from 30 to 525 GPM with maximum pressures to 100 psi. Circle No. 201 on Subscriber Service Card.

GYROS. A new 64-page of illustrated Gyro Primers, prepared by the Norden division, United Aircraft Corp., explains how gyros work, gyro terms, and gyro operating principles. Specifications for rate gyros, free gyros, directional gyros and compensated vertical gyros are included in this informative book. Circle No. 202 on Subscriber Service Card.

CRYSTAL FILTERS. A four page technical bulletin (10.7) on the Hycon Eastern 10.7 Mc family of Crystal Filters shows vacuum tube and transistor circuitry, pulse and impulse response photographs, attenuation versus frequency curves, and block diagrams. Circle No. 203 on Subscriber Service Card.

TIMING. A four page brochure containing graphs for computing cumulative errors in electronic clocking is now available from Hycon Eastern, Inc. Theory is discussed and two examples on the use of the graphs are shown. Hycon Eastern Timing Equipment is described. Circle No. 204 on Subscriber Service Card.

GENERATOR CONTROL. The new Magaset dual-mode excitation system for AC generator control is described in detail in a new bulletin, 8.010, available from Electric Regulator Corp. Using circuit schematics, principles of operation, actual performance results, specifications and installation data are fully covered. Circle No. 205 on Subscriber Service Card.

MERCURY SWITCH. Micro Switch, a division of Minneapolis-Honeywell Regulator Co., has issued a new data sheet (#149) on the ultra-small catalogue listing AS419A1 mercury switch. The data sheet gives stand-out features of the tiny switch—only 9/10 in. long and weighing 1.8 grams complete with leads.

Long life, extreme compactness sensitivity of the switch suggest uses in supersensitive control devices which demand outstanding switch ability. Circle No. 206 on Subscriber Service Card.

GEARS. Geartronics Corp. has issued a bulletin, "Facts and Figures," which lists the availability of a wide variety of gears, power transmission components, precision machined parts engineering help. Circle No. 207 on Subscriber Service Card.

FOCUS COIL. Syntronic Instrument Inc., Addison, Illinois, has issued advance technical bulletin giving dimensional drawing, electrical and mechanical characteristics and complete technical details on its new Type F electromagnetic focus coil designed for photographic, flying spot, military and other special purpose 1½"-neck ameter cathode ray tubes. Circle No. 208 on Subscriber Service Card.

MICROSPHERES. A new 8-page illustrated brochure entitled "Eccospheres" is now available from Emerson & Cuming, Inc., Canton, Mass. The brochure describes a hollow glass microsphere product which is used as a dielectric material in molding compounds, domes, heat barriers, foams, cast resins. Circle No. 209 on Subscriber Service Card.

ACHIEVEMENTS. This new 56 page illustrated brochure briefly describes the facilities and achievements of Cook Research Laboratories, a division of Cook Electric Co., Chicago. Cook Research Laboratories has been providing basic and applied research development to industry and governmental agencies since World War II. Significant achievements (as illustrated in the brochure) have been made in several fields; including the development of complete systems for data recording and reduction radar, computers, aircraft and missile control, parachute recovery and instrumentation for outer space research, and basic applied research in electronic and clear applications. Circle No. 210 on Subscriber Service Card.

THERMAL VALVE. A new data sheet containing detailed information and specifications for the new, leakproof miniature thermal relief valve, has been published by the Fluid Regulator Corp., designers and manufacturers of hydraulic and fuel valves. The small, sized, lightweight unit relieves excess pressures caused by thermal expansion of fluids in a closed system. Circle No. 211 on Subscriber Service Card.

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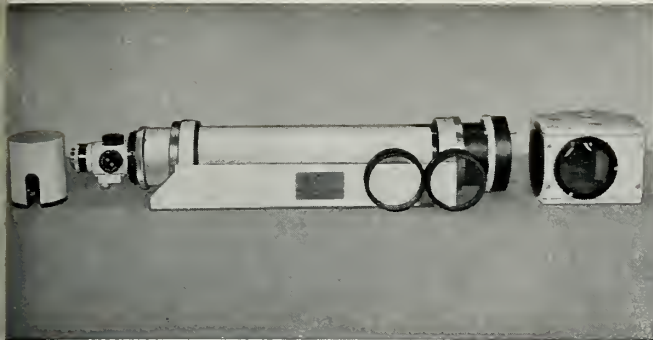
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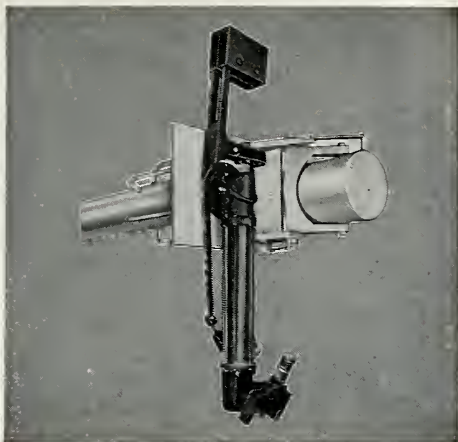


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To align radar antennas with extreme accuracy.

Kollmorgen 30X Collimator.

Measures within a pencil's width at a mile.



**Problem
Solution**

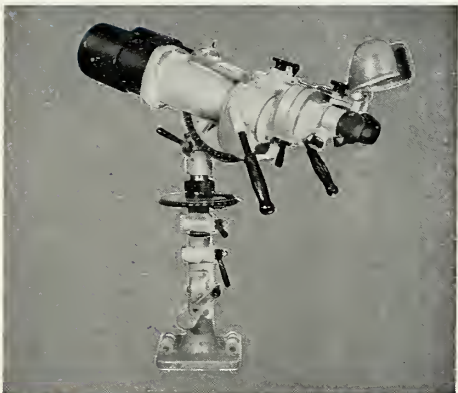
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Kollmorgen Wall Periscopes with non-browning optics, corrosion-resistant materials, 180° scanning.

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The various instruments on this page all have one purpose in common—they allow the observation and measurement of objects which it would otherwise be impossible to see in detail. In bunkers, under water, in the absence of light, in the presence of radioactivity and under many other adverse conditions, Kollmorgen remote viewing instruments have brought the eye of the observer to the heart of his problem.

A letter to us with a simple sketch illustrating your remote viewing problem will place one of America's most respected and versatile designers and manufacturers of optical instruments at your service. For more information write Department 109



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Detailed, long-range observation at sea under varying weather conditions.

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New Electro Instruments A-12 DC amplifier totally transistorized

equal to or better than the best
vacuum tube instruments!

The new Model A-12 DC Amplifier is the preferred systems link for amplification, normalization and impedance transformation. Use of solid state elements assures maximum reliability; power dissipation is only seven watts. Mil-type components are mounted on coated plug-in printed circuit boards for protection against vibration and corrosion.

versatility plus economy

Electro Instruments produces a series of plug-in mode selectors and attenuators for the A-12: single ended, differential and operational, fixed and variable gain.



Eight to a rack
The A-12 is packaged
for high density use;
mounts eight
across in 19" relay
rack panels.

SPECIFICATION SUMMARY

Single Ended Input

Gain:	Fixed gain set to any value from 10 to 1000 inclusive by front panel plug-in units. Gain switching plug-in attenuator available with gains of 0, 10, 20, 50, 100, 200, 500 and 1,000. Adjustable upward 6db from setting with potentiometer.
Input Impedance:	100 megohms shunted by 0.001 mfd (typical).
Source Impedance:	5K or less (to meet noise specification).
Drift:	Less than 2 microvolts in 200 hours at constant ambient temperature. Less than 0.4 microvolt per degree centigrade.
Ambient Temperature:	0° to 50°C.
Noise (Referred to input):	0-3 cps 5 microvolts peak to peak 0-750 cps 4 microvolts rms. 0-50 kc 8 microvolts rms.
Frequency Response:	±3db to 50 kc (typical); ±1.0% to 2 kc
Output Capability:	±10 volts at ±100 ma DC or peak AC to 10 kc

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