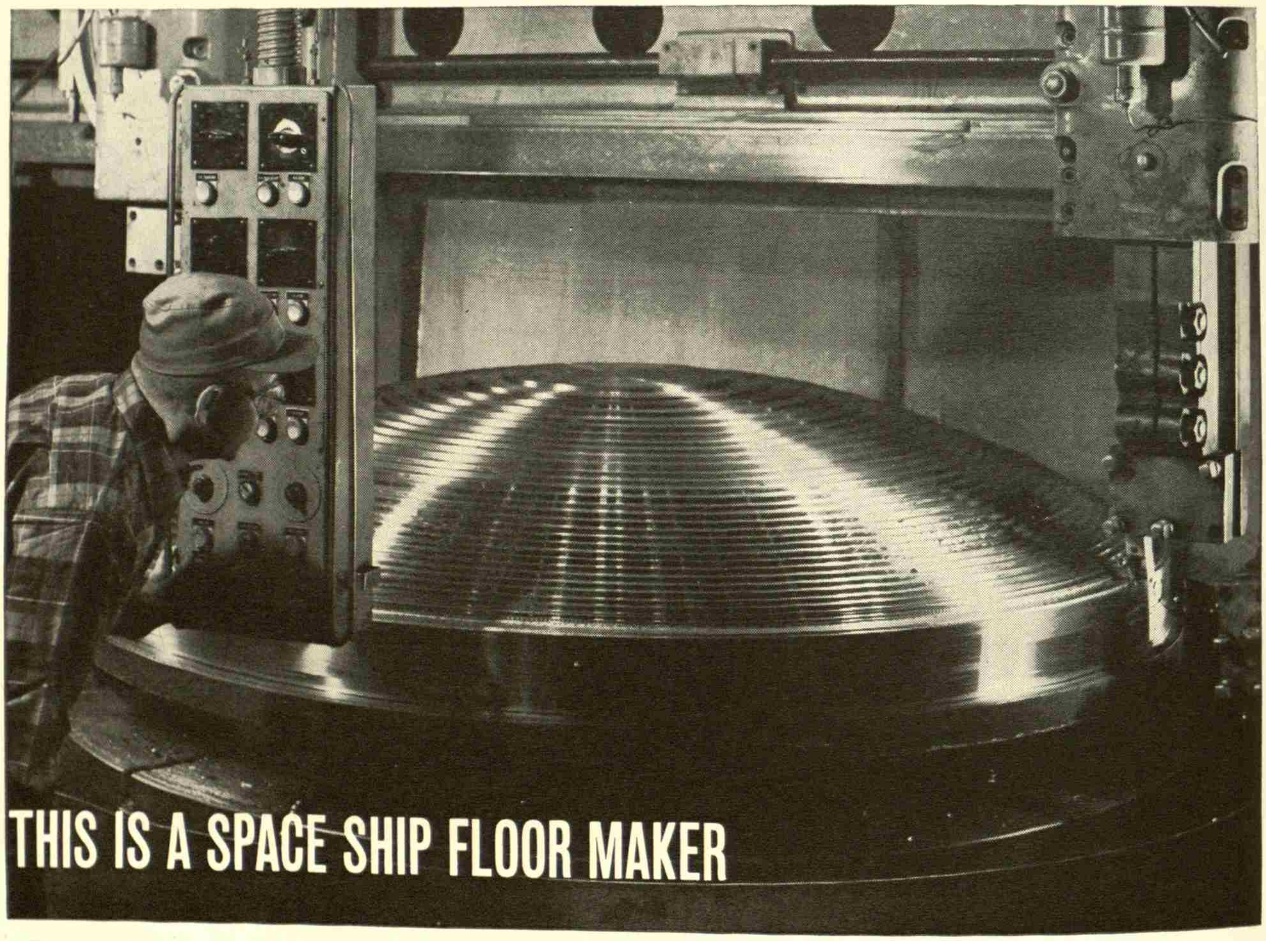
# SPARTAN ENGINEER

.25

MARCH

Sometime within the next several years, the first American will soar into orbit around the earth. He will be sealed in a small, cone-shaped space capsule mounted atop an Atlas missile. The missile will climb 100 miles in less than six minutes, where the capsule will disengage and go into orbit. The man will be alone in space.




The vehicle for this historic voyage is already in production under the auspices of the National Aeronautics and Space Administration's "Project Mercury." One of the methods of heat protection is a beryllium heat sink, forged on two giant steel dies. Both dies are USS Quality Steel Forgings. The top die (shown being rough-machined on one of our vertical boring mills) will be convex, 20 inches thick and will weigh 26,520 pounds. The bottom die, concave and 18 inches thick, weighs 27,700 pounds. Both are 92 inches in diameter.

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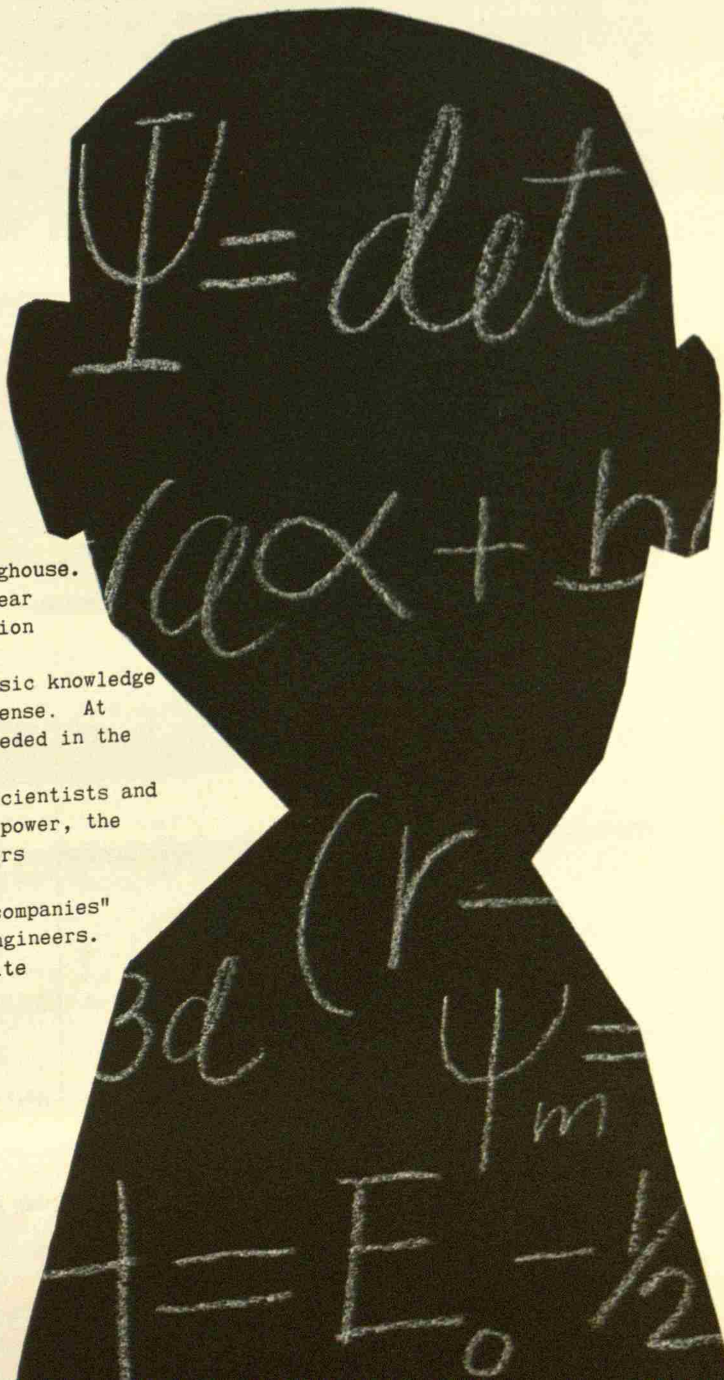
Things
we know about
tomorrow

# Men who do nothing but Think



A phenomenon of modern America is the so-called "think company." It owns no factories, manufactures no products and makes no shipments, but just "thinks" about problems--and brilliant ways to solve them.

We have a number of "think companies" within Westinghouse. One is a group of scientists in the research labs near Pittsburgh who seek basic knowledge, like the production of light by solids, and the origin of magnetism.

Other Westinghouse scientists in Baltimore apply basic knowledge to that most demanding of all problems...national defense. At Cheswick, Pa., another group thinks about products needed in the American home 10 or 15 years from now.

As a result of this kind of thinking Westinghouse scientists and engineers have achieved startling advances in atomic power, the launching system for Polaris, thermoelectric generators and many other developments.

The back-up facilities in the Westinghouse "think companies" help make Westinghouse the best place for talented engineers. For information on rewarding career opportunities write L. H. Noggle, Westinghouse Educational Department, Ardmore and Brinton Roads, Pittsburgh 21, Pa.

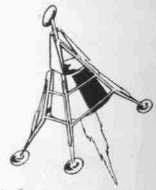
You can be sure...if it's **Westinghouse**

# NASA program-highlights

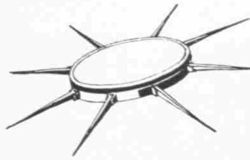
# NEXT DECADE IN SPACE

## Year 4 to 14 of the Space Age

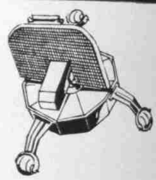
**Project Mercury**—U. S.'s first manned satellite.



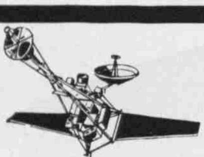
**Project Surveyor**—First soft landing on moon. Conduct observations from stationary position.



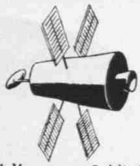
**Project Prospector**—Soft landing on moon and exploration of area within 50 miles of landing point.



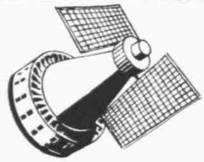
**Solar Observatory**—350 lb. Large flywheel and extended arms rotate to stabilize. Under construction.



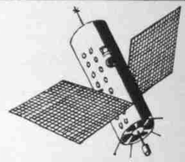
**Project Mariner**—600 to 1200 lbs. First U. S. Planetary missions to Venus and Mars. Modified craft for hard landings on moon.



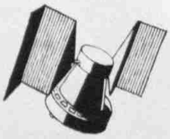
**Project Voyager**—Orbit Mars and Venus and eject instrumented capsule for atmospheric entry and perhaps landing.



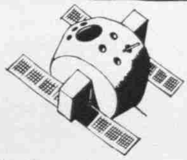
**Nimbus**—600 to 700 lb. meteorological satellite series. Stabilization system will keep cameras pointed earthward.



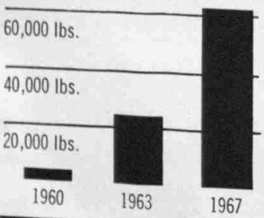
**Orbiting Geophysical Observatory**—1000 lb. geophysical research satellite designed for a near earth circular polar orbit or an inclined highly elliptical orbit.



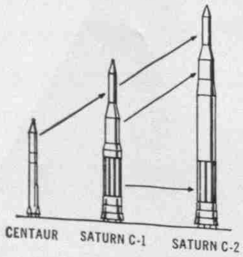
**Project Aeros**—24-hour stationary weather satellite. Launched in equatorial orbit. Three satellites could permit continuous observation of most of earth's surface.



**Orbiting Astronomical Observatory**—Standardized, 3500 lb. satellite, for several experiments with different scientific sensors and specialized devices.




**Anticipated Growth of NASA Spacecraft** in terms of weight of individual near earth satellites.

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You are invited to work alongside the many distinguished and dedicated members of our technical staff. For details about outstanding professional opportunities, address your inquiry to the Personnel Director of any of these NASA Research and Space Flight Centers—

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**NASA Goddard Space Flight Center** • Greenbelt, Maryland

**NASA Langley Research Center** • Hampton, Virginia

**NASA Lewis Research Center** • Cleveland 35, Ohio

**NASA Marshall Space Flight Center** • Huntsville, Alabama

**NASA Wallops Station** • Wallops Island, Virginia

National Aeronautics and Space Administration

NASA

# Editor's Corner

"LOOK TO THE right of you" . . . you see a freshman engineering student; "look to the left of you" . . . another freshman, and you yourself are a freshman enrolled in engineering. "By the time this class is ready to graduate only one of you three people will be with us!"

This awakening statement given by Dean Ryder may be heard at the first meeting of engineering indoctrination. It is quite a shocking thing to hear, but . . . it is true. However, cannot something be done to keep two people out of three from falling by the wayside?

Perhaps one might say, "Well, if the student doesn't 'have it' he just won't make it in engineering." But none of us really 'have it', . . . we've got to learn it. And learning is not the mere presentation of facts and theories to the student. Further, what is learning for one is not necessarily learning for another.

The quality of instruction in college seems to vary from one extreme to the other.

An instructor may know the material to the fullest but if he cannot be effective in presenting the material to the student, he is wasting his time and the student's. The process is then the presentation of facts, not teaching.

I feel that one who is a college instructor should have at least been exposed to the facts of teaching methods. This would make his teaching more logical and more meaningful to the student. However, I have heard an instructor say that instructors are not really interested in teaching; they are here to do research, and teaching just happens to be in the contract.

I'm sorry to say that this seems to be the attitude of some instructors. It's much easier to merely present the facts than to teach. But when graduation day comes and two out of three people mentioned previously aren't there, will it have been the student who failed or the instructor?

*R. V. P.*

# Spartan Engineer

VOLUME 14 NO. 3 MARCH 1961



*COVER:*
*Designed by Sydney Sue Young*

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# *The care and feeding of a missile system*

It takes more than pressing a button to send a giant rocket on its way. Actually, almost as many man-hours go into the design and construction of the support equipment as into the missile itself. A leading factor in the reliability of Douglas missile systems is the company's practice of including all the necessary ground handling units, plus detailed procedures for system utilization and crew training. This complete job allows Douglas missiles like THOR, Nike HERCULES, Nike AJAX and others to move quickly from test to operational status and perform with outstanding dependability. Douglas is seeking qualified engineers and scientists for the design of missiles, space systems and their supporting equipment. Write to C. C. LaVene, Box 600-X, Douglas Aircraft Company, Santa Monica, California.

**Alfred J. Carah, Chief Design Engineer, discusses the ground installation requirements for a series of THOR-boosted space probes with Donald W. Douglas, Jr., President of DOUGLAS**

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# Dean's Letter

## Coming to you from Athens, Greece

AN ENGINEER of today should always be curious. He should be interested in the world around him, the how and why of nature and of man. Travel, even when on business, permits an engineer to exercise his curiosity in new surroundings and with new standards of reference.

To visit the ancient buildings and ruins of Roman and Greek early culture is an opportunity to exercise curiosity and which at the same time should increase our engineering humility. Visible evidence of these early civilizations, still standing, forces us to accept the fundamental fact that as of 3000 years ago, these men were engineers who understood thoroughly their materials, and solved their problems in ways we are now only reapplying.

Limited to marble, stone, and brick, with only crude hand tools, they fashioned things of beauty which have been copied repeatedly throughout history. Making up with a multitude of hands for their lack of machines they quarried, moved, and placed great marble blocks which would strain even our best movers of today. The lintel of Agamemnon's tomb must weight over 100 tons, yet it was quarried, moved over 16 miles in rough country, and hoisted many feet to its place. Then to insure its safety these engineers devised a method of prestressing this marble, so that its own tremendous weight would not cause failure. Today we are just beginning to reapply prestressing in our concrete structures—but will they survive for centuries? We doubt it, because our building depends on rust-prone steel, not suited to the ages. We build to meet the needs of the moment—tomorrow's needs may be different.

This, indeed, is one lesson which we have learned—we expect change as a matter of course, the ancients foresaw only a continuation of the same manner of living. What is the ingredient in our civilization which has lead to our progress into the new? Is it that our engineers have gone beyond the solving of today's problems, and have added curiosity as an element of their education?

*J. D. RYDER*

# BIG ROCK POINT

## Nuclear Power Plant Will Provide Research and Development Facilities and Eventually Commercial Power

*by JEANNETTE McCLEES, E.E.*

CONSUMERS POWER Company and its contractors have embarked upon a courageous and pioneering undertaking to build a nuclear power plant in northern Michigan. It will be located at Big Rock Point in Charlevoix County, between Charlevoix and Petoskey on the shore of Lake Michigan.

Bechtel Corporation is the prime contractor and engineer-constructor. The General Electric Company will supply the nuclear part of the plant and the power generating equipment, and will also conduct the associated research and development program on nuclear fuels.

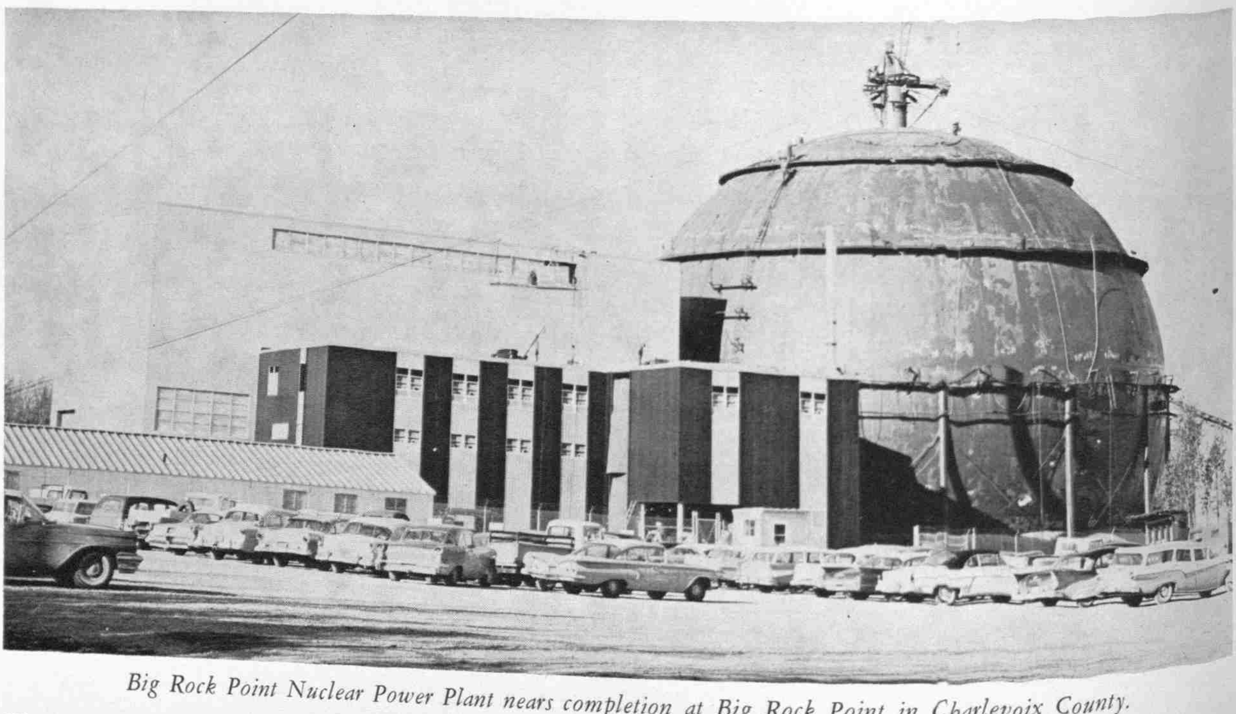
The basic goals of the research and development program are to demonstrate the feasibility of higher heat output in relation to the size of the reactor core, increased fuel life, and lower fuel fabrication costs. This program will continue for four and one-half years after the plant goes into operation.

This plant will consist of a nuclear steam supply system, turbine-generator set, surface condenser and associated auxiliary system.

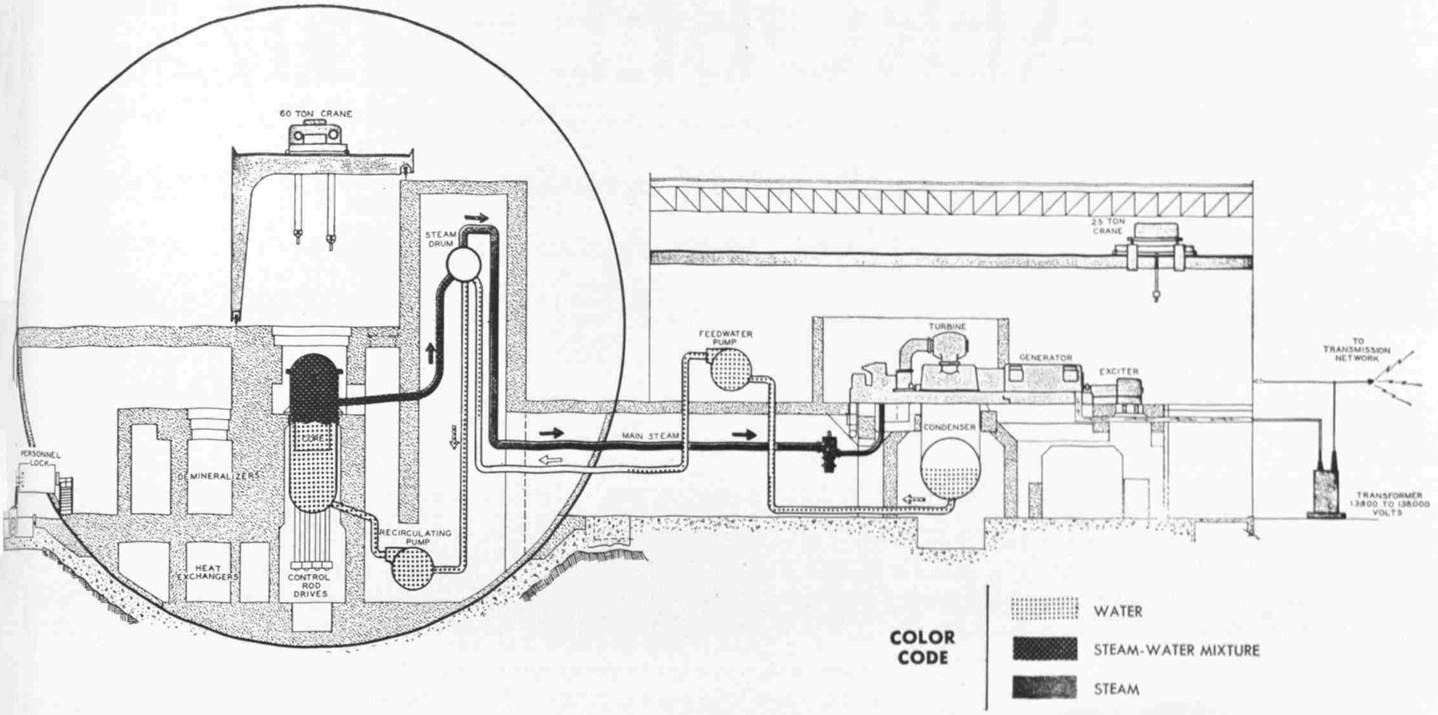
In forced circulation operation, water is pumped from Lake Michigan into the reactor vessel by the recirculating pumps, flowing upward through the core where boiling takes place. The resulting steam-water mixture then flows upward through six 14-inch risers to the steam separation drum. After passing through mechanical steam separators in the drum, the steam then flows directly to the turbine, with the water returning to the recirculating pumps.

The turbine is a 3,600 rpm, tandem-compound, double flow, condensing unit directly connected to a hydrogen cooled generator with a gear-driven exciter. Provisions are being made in the turbine, generator and exciter for the anticipated output based on successful results of the research and development program.

The reactor is of the single-cycle, forced circulation boiling-water type. The steam generated in the reactor core flows to the steam drum, then to the turbine, with no heat exchanger in between. Guaranteed nominal electrical capacity is to be 50,000 kilowatts



*Big Rock Point Nuclear Power Plant nears completion at Big Rock Point in Charlevoix County.*




*Cross-section view of the Big Rock Point nuclear electric generating plant.*

gross at a reactor system pressure of 1050 psia. System components based upon a successful research and developmental program will be designed for power production of 75,000 kilowatts gross electrical output at system working pressures up to 1500 psia. The plant is scheduled to be in operation by early fall of 1962.

Major plant structures include the reactor enclosure and the turbine building. The reactor enclosure structure will be a steel sphere 130 feet in diameter. The bottom of the sphere will be approximately 27 feet below finished grade. Inside the steel sphere will be reinforced concrete structures for biological shielding, equipment, and fuel storage pool. Three air locks will be provided; two for personnel access, with a larger one for passage of equipment.

Major components and accessories of the reactor include the reactor pressure vessel, reactor core, control rods and their drive systems, and the steam supply system.

The reactor pressure vessel is approximately 9 feet inside diameter and 32 feet inside length, and consists of high strength steel alloy material clad on the inside with stainless steel.

The reactor fuel will consist of slightly enriched uranium dioxide pellets with an initial enrichment of about 3.2% and encased in stainless steel tubing. Each tube is about four-tenths of an inch in diameter and six feet long. The power from a single load of fuel will be roughly equivalent to that which could be generated by burning 260,000 tons of coal, enough for a coal train almost 32 miles long. A fuel assembly will consist of 140 of these individual tubes or rods, grouped for ease in handling. A total of 56 of these fuel assemblies will be placed vertically in the reactor to make up the initial core loading. The lower end of each assembly is provided with an orifice for directing the coolant water flow around each fuel rod in each assembly, and also providing a means for adjusting the pattern of water flow and steam generation within the core.

Control rods will be of stainless steel containing 2% boron, having a cruciform cross section and an overall length of about 6 feet. A total of 24 control rods will be employed initially, located on approximately 10.5 inch centers and will enter through the bottom of the pressure vessel. Each of the rods will have a drive mechanism consisting of a hydraulic piston and a mechanical latching feature that will hold the rod in any selected position. Both positioning and scram motions will be hydraulically actuated.

The nuclear steam supply system also includes a drum for separating the steam from the water, piping, and recirculation pumps. Auxiliary equipment includes a shutdown heat exchanger, and a reactor demineralizer system. Initial rating of the system will be 607,000 pounds of saturated steam per hour at a pressure of 1020 pounds per square inch. Based on the successful outcome of the development program, the reactor will be capable of supplying 964,000 pounds of saturated steam per hour at a pressure of 1470 pounds per square inch.

Big Rock Point Nuclear Plant will not be the largest boiling water reactor in the United States. It will, however, be the largest *direct cycle* boiling water reactor plant in the United States, and it will be the largest electric generating plant of any kind in northern Michigan.

Consumers' direct cycle boiling water reactor will differ from an indirect cycle plant in the requirements for

*(Continued on page 34)*

# AEROBEE — HI

## Small, But Efficient Rocket Explores Upper Atmosphere

*by JOHN THORNTON, E.E.*

DURING the International Geophysical Year, many studies of the earth and its surrounding atmosphere were carried on by U. S. scientists. A great deal of emphasis was placed on the upper atmosphere about which scientists knew little at that time. The workhorse of these studies was the Aerobee-Hi rocket. Extremely reliable, the Aerobee-Hi carried payloads of scientific instruments high into the F layer of the ionosphere, gathering data necessary to understand many physical phenomena.

But how were these rockets developed and why do they concern the average person?

When Germany finally surrendered in 1945, the U. S. Army managed to salvage a large number of V-2 rockets. These were shipped back to White Sands Proving Grounds, the Army's testing center. Besides being evaluated as a possible weapon, the V-2 was used extensively for upper-atmospheric research. After a few months, when the supply of captured V-2's began to run low, scientists and engineers of the Applied Physics Laboratory of John Hopkins University and Aerojet-General Corporation drew up initial designs for a small, but efficient, high altitude rocket.

The Aerobee-Hi rocket is a liquid-fueled, fin stabilized rocket. Weighing about 1280 pounds at launching, the Aerobee-Hi is built primarily of stainless steel, magnesium and aluminum. The fuel tanks were built of stainless steel in order to increase their length and reduce their weight, making it possible to carry 30% more propellants.

Three fixed magnesium fins, spaced 120° apart, are used instead of a control system in order to reduce weight. The high speed of the boosted take-off plus the large area of the fins keep the rocket stable throughout powered flight.

Aerobee-Hi's propulsion system consists of a single chamber, liquid-fuel rocket engine using red fuming nitric acid as the oxidizer and a furfurol alcohol-aniline mixture as fuel. The small, regenerative-cooled motor develops 4000 pounds of thrust for approximately 45 seconds, lifting the rocket to a height of 23 miles.

A typical Aerobee-Hi can carry a great variety of instrumentation. Each part of the airframe is utilized. The fins have built-in notch antennas for the telemetering and cut-off receivers. A parachute recovery system as well as cameras can be housed in special extensions.

Aerobee rockets have been used for a variety of experiments. During the IGY, Aerobees carried instruments such as mass specterometers, cameras, radiation detectors and cosmic ray telescopes. Photographs of the earth have been taken at altitudes of over 100 miles, clearly showing the distribution of clouds over the Western United States.

Early in 1952-53, the U. S. Air Force pioneered in the field of space medicine by using Aerobees to carry mice and monkeys as high as 40 miles into the ionosphere.

Besides scientific instruments, the Aerobee-Hi usually carries a variety of flight equipment. Equipment such as range safety receivers are used to prevent the rocket from straying too far. If the Aerobee wanders off course, a command cut-off signal is sent from the ground, activating valves which in turn terminate the fuel flow.

Aerobee-Hi is launched from a 140 foot tower with the aid of a high thrust booster. The 550 pound booster gives the main rocket an initial velocity of 700 mph. The maximum acceleration is about 11g.

Once the Aerobee has been launched, it is tracked by ground-based systems such as radar, as well as with rocket-borne telemetering equipment. Other optical equipment such as tracking telescopes, cameras and theodolites give the scientists a visual report on the rocket's flight. Radar is used in conjunction with computers to determine the location of impact.

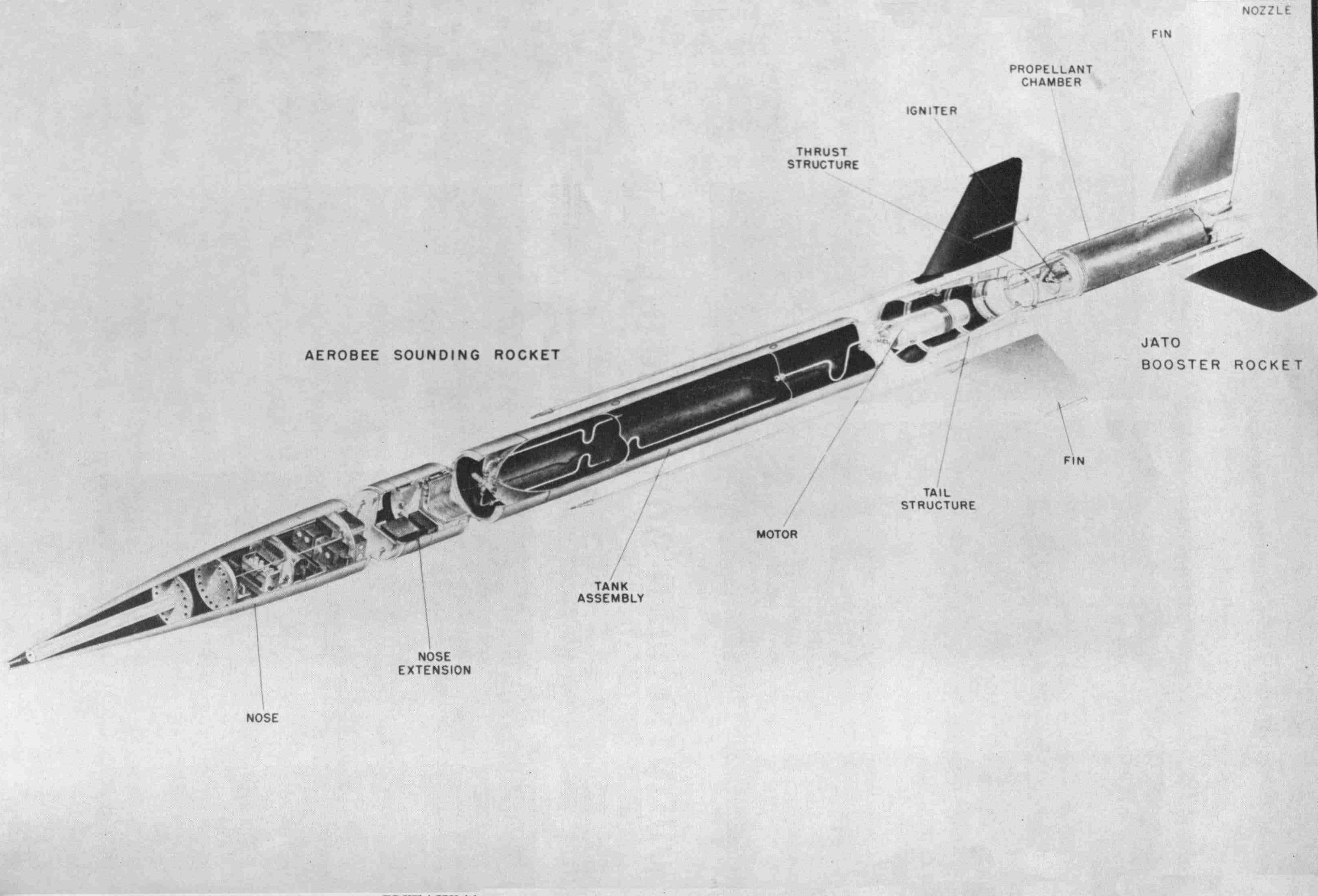
When the flight is over, the instruments can easily be recovered. When the Aerobee-Hi reaches 40 miles altitude on its downward flight, explosive charges separate the tail section from the airframe. The rocket, being aerodynamically unstable, tumbles end over end, losing much of its velocity.

At 25,000 feet, a barometric switch triggers a parachute. Instrumentation is almost always recovered intact by this method. Once in a while, the rocket is allowed to impact without a parachute. Damage to heavily armored instruments such as cameras is small.

Through constant development by the Armed Forces in conjunction with Aerojet-General, the original Aerobee has been greatly improved. An Aerobee-Hi, instrumented by the Naval Research Laboratory, set a new altitude record for single stage rockets in 1957. Since then Aerojet-General has expanded the Aerobee series with more efficient propulsion systems, capable of greater performance.

One new model in the series, the Aerobee 300, is a two stage, solid pro-

*(Continued on page 50)*


AEROBEE SOUNDING ROCKET
NOZZLE
FIN
PROPELLANT CHAMBER
IGNITER
THRUST STRUCTURE
JATO BOOSTER ROCKET
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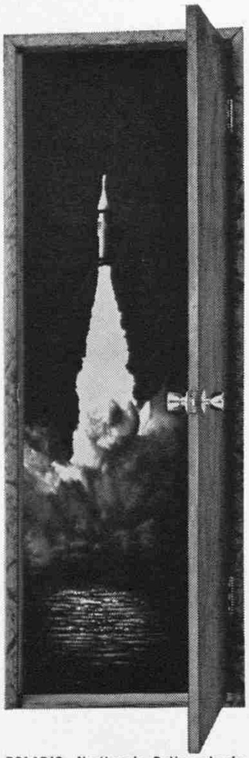
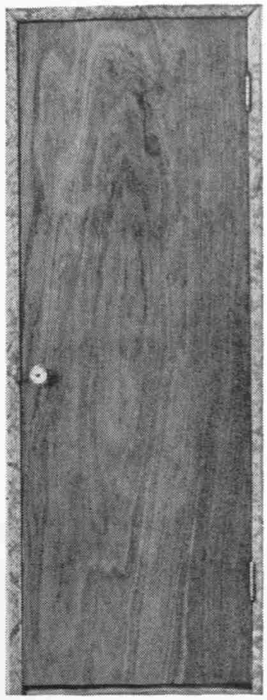
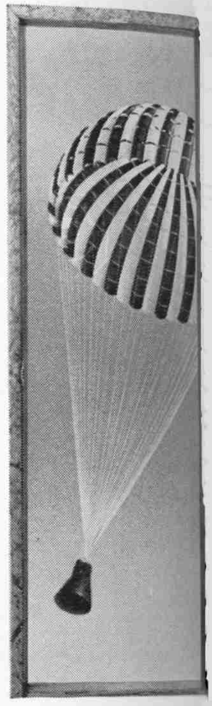
TAIL STRUCTURE
MOTOR
TANK ASSEMBLY
NOSE EXTENSION
NOSE



**POLARIS:** Northrop's Datico checks out Polaris at all levels of maintenance and operation.

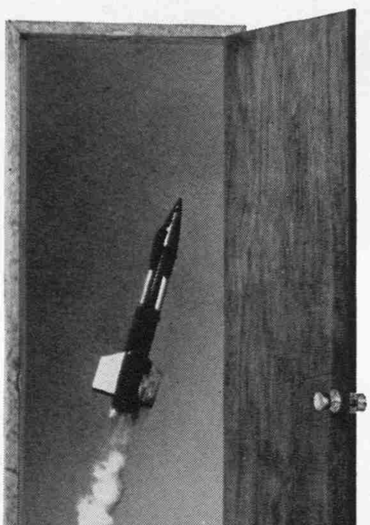


**SKYBOLT:** Guidance and navigation systems are being developed by Northrop for this new and highly secret air-launched ballistic missile.

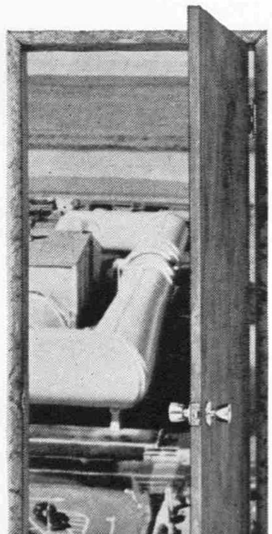


**MERCURY:** The Northrop landing sy tem is designed to bring the M cury astronaut down safely.

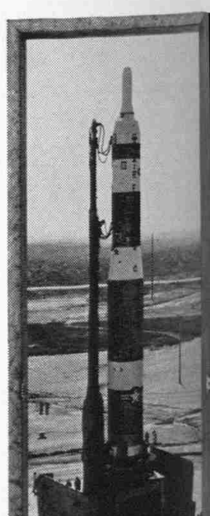
# Northrop is now active in more



**X-15:** Northrop produces Q-Ball, the flight angle sensor for safe re-entry of X-15 and other aerospace vehicles.

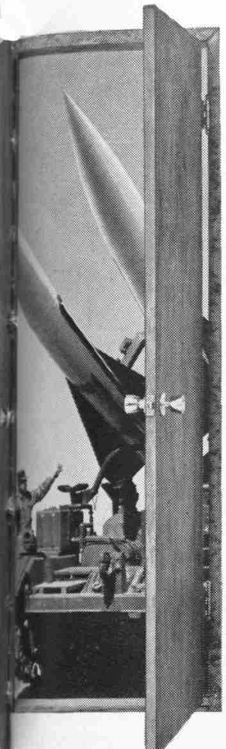


**AERODYNAMICS:** Northrop's Laminar Flow Control technique is designed to greatly increase aircraft range, flexibility, cargo and passenger capacity.

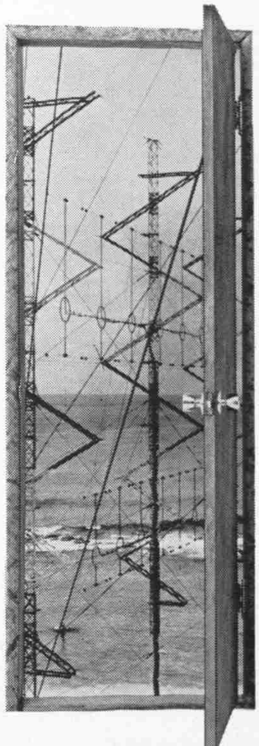


**TITAN:** Northrop supplies complet technical and industrial managemen to activate the T-2 Titan missile bas

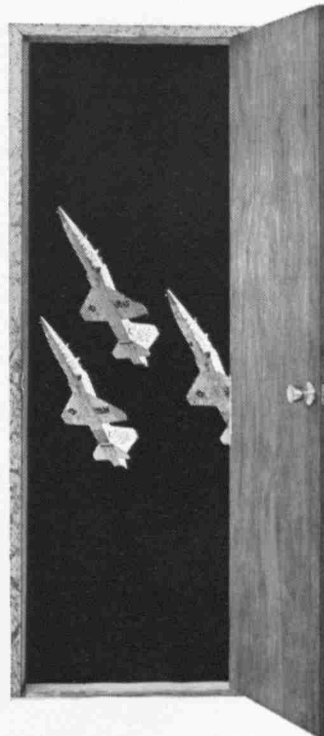
**For work on these advanced programs, we seek exceptional engineers, scientists and mathemati**



WK: Northrop produces airframe mponents, ground handling and unching equipment for this air de- nse missile.

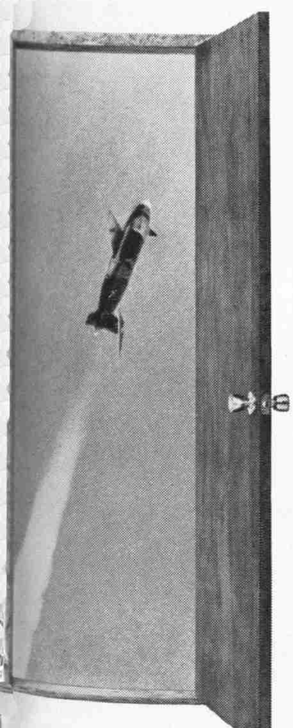


**COMMUNICATIONS:** Northrop designs the trans-Pacific Scatter Communications Network and other world-wide communication systems for U.S. and free world governments.

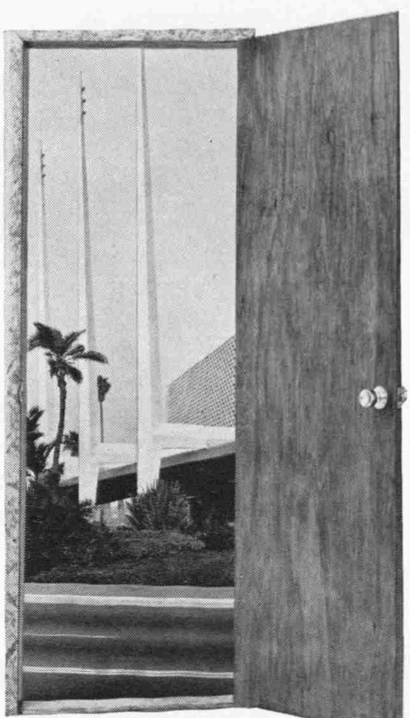


**T-38:** World's first supersonic twin-jet trainer is built by Northrop for the United States Air Force.

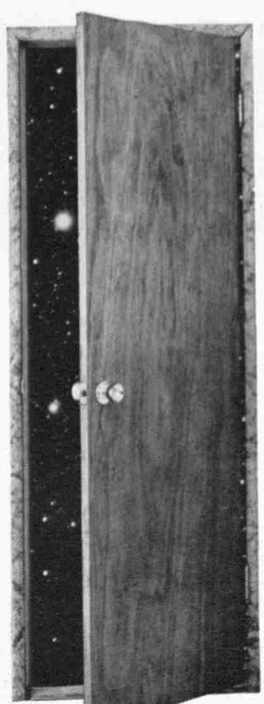
# than 70 important programs



**RGET MISSILES:** Northrop has pro- uced more than 50,000 electroni- ally-controlled aerial targets, and urveillance drones.



**COMMERCIAL METAL PRODUCTS:** Northrop produces aluminum architectural shapes for many important industrial and commercial buildings.



**SPACE RESEARCH:** Northrop's accelerated space research programs reach into such advanced areas as maneuverability, rendezvous, space vehicle maintenance, space probes, and the survival of men in space.

**ite Northrop Corporation, Box 1525, Beverly Hills, California. Divisions: Norair, Nortronics, Radioplane.**

# MAGNETIC DRIVES . . .

## May Replace The Clutch Assembly

*Edited by C. D. CHURCH, E.E.*

THE ELECTRIC MOTOR is simple, rugged, inexpensive, and relatively efficient in constant-speed applications. However, because of its poor torque at low speed, some other apparatus is necessary to adapt it to adjustable speed operations.

The electromagnetic coupling is one of the simpler methods of obtaining variable output speed from the constant speed of an electric motor. Its use has grown rapidly in recent years because it offers reliability, minimum maintenance, compactness, and high efficiency.

The electromagnetic coupling provides the same basic function as the familiar mechanical clutch—a variable output speed is obtained from a constant speed input speed by controlling the amount of slip between the two rotating members.

However, unlike the clutch, the electromagnetic coupling has no mechanical contact between the two parts to cause wear, adjustment, and replacement; torque is transmitted by an electromagnetic reaction between the rotating members. Also, the slip can be controlled much more precisely and over a wider range than with a mechanical clutch.

An electromagnetic coupling has three basic components—a rotor made up of many pole pieces, a hollow iron cylinder or drum that surrounds the rotor, and a coil to provide the primary electromagnetic field. These basic parts are shown diagrammatically in Fig. 1.

The coil is energized with direct current; the magnetic fields thus established are shown. Essentially all the magnetic flux from the rotor poles on one side of the coil flows through the drum in reaching the opposite poles on the other side of the coil. The flux, of course, concentrates in the area directly between the opposite pole pieces.

When the drum is rotated the flux concentrations sweep circumferentially through the drum since they always remain adjacent to the rotor poles. This change in flux density at all points around the drum induces eddy currents, which establish secondary magnetic fields. These secondary fields interact with the primary fields produced by the coil to develop torque and turn the rotor and the external load.

While some couplings are built essentially as shown in Fig. 1, the most advanced designs use variations of the basic design to obtain better operating characteristics. For example, Westinghouse Magnaflow drives use the coupling configuration shown in Fig. 2.

The rotor has a large number of specially shaped poles designed to produce better torque. To avoid the use of slip rings and thus increase the reliability and reduce the maintenance of the coupling, the field coil is stationary.

The use of this arrangement necessitates supporting the rotor poles to the right of the coil from the poles to the left rather than from the rotor hub. This is accomplished without magnetically shorting the poles by using a nonmagnetic metal support ring integrally welded between the two sets of poles.

The drum, in which heat is produced by the eddy currents, is used as the constant speed input member to obtain constant cooling. The drum is finned in the case of air-cooled couplings as shown, but is smooth in the case of liquid-cooled couplings.

Notice the mounting of the motor on the coupling for maximum compactness and minimum number of parts. In smaller units, the same space and parts economy is achieved by mounting the motor and coupling in the same frame.

The torque and speed produced by an electromagnetic coupling can be easily controlled by varying the current in the field coil. The coil current is generally controlled by tachometer feedback control.

In this method a tachometer generator, driven by the output shaft, provides a voltage signal proportional to the output speed. This signal is compared to a reference voltage and the resulting error signal is used to adjust the coil current. This method of control is widely used in automation where adjustable output speeds are required.

Modern electromagnetic coupling designs have a 95% efficiency at maximum speed. For applications in which most of the running is at high speed and high torque electromagnetic couplings are very efficient.

The chief loss is from slipping, which increases with decreasing speed. At reduced speeds efficiency is approximately equal to the percentage of maximum speed at which the coupling is operating; e.g., 75% efficiency at 75% of maximum speed.

Simplicity, efficiency, durability, and easy, accurate control will probably make the electromagnetic coupling very widely used in the future.

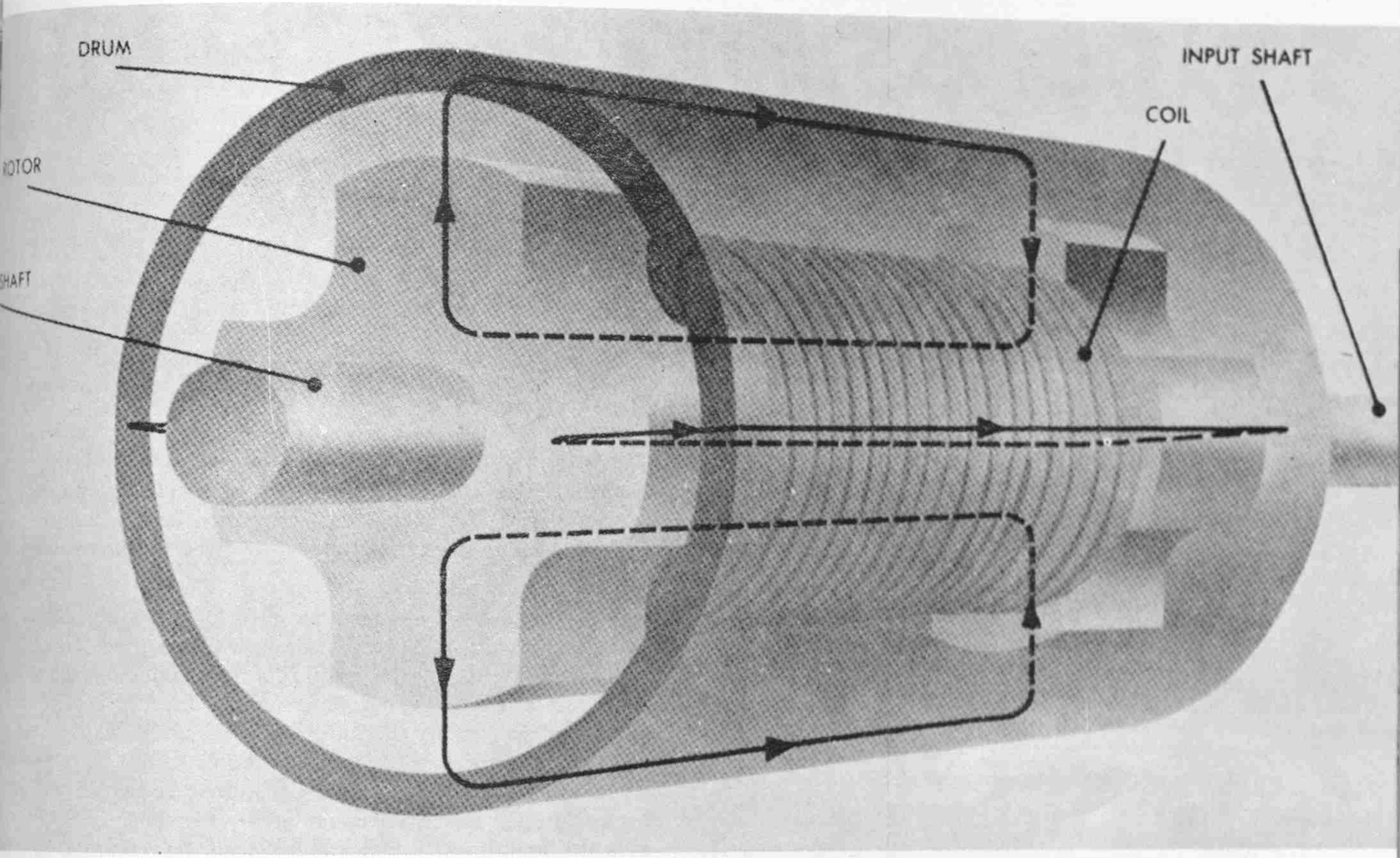



*FIG. 1 (courtesy of Westinghouse)*

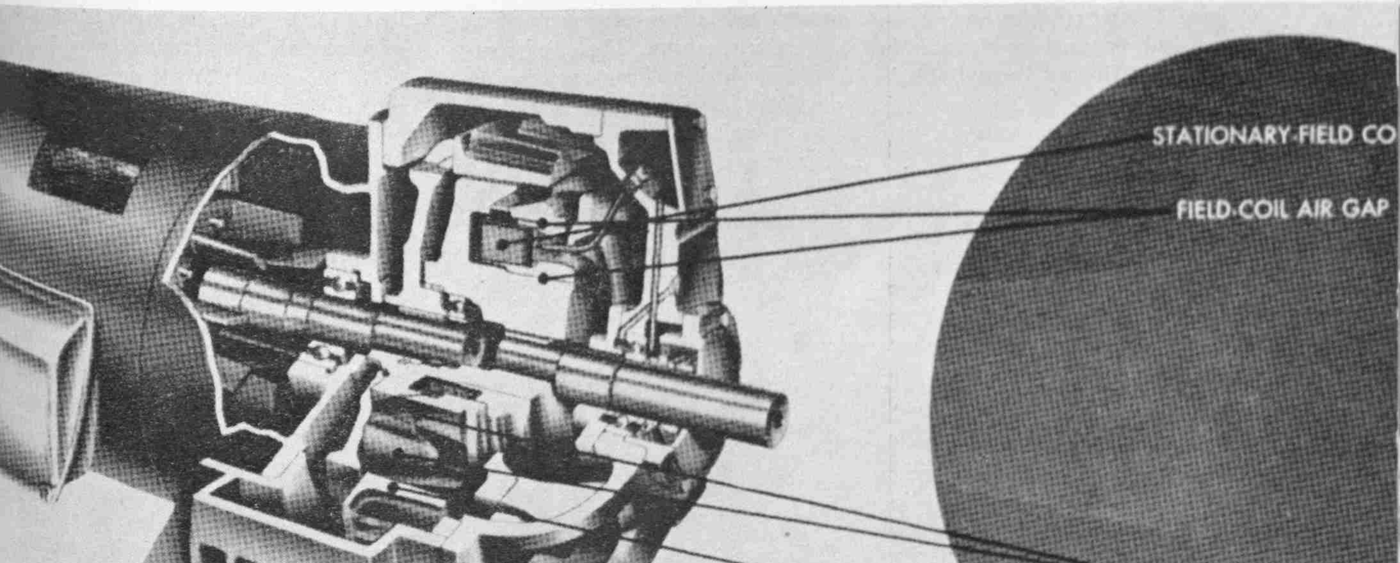



*FIG. 2 (courtesy of Westinghouse)*

# Smog, Smaze and Smust

## An Evaluation of the Air Pollution Problem in Our Society

*Edited by ROBERTA HUFFMASTER, Math and Physical Science*

AIR POLLUTION is not a new phenomenon. Instances of intense air pollution have occurred occasionally since the beginning of history. Originally, these were natural phenomena, such as dust storms and volcanic eruptions, but man's troubles really began with the discovery of fire. Later, with the advent of the industrial revolution, the smoking factory chimney became a hallmark of civilization. For several hundred years, the city of London, England, apparently had a monopoly on intense episodes of air pollution, but little was done about it until after the famous disaster of December 1952, in which 4,000 deaths were attributed to smog. Similar episodes resulting in deaths had occurred in London in 1948, and in Donora, Pennsylvania in 1948. Thus in a few instances, air pollution has killed people.

On the other hand, even a congested community is singularly free of smoke on those days when the wind is moderate or the atmosphere has been cleansed by a storm. It is apparent, then, that only a combination of pollutant emissions and a restricted atmosphere creates an air pollution problem.

In normal atmosphere, even in crowded communities, smoke is rapidly dissipated upwardly, because the hot gases are lighter than the surrounding air. When the wind is blowing, they are also dispersed horizontally. At times, when an atmospheric temperature inversion puts a virtual ceiling on upward dispersion of gases and there is little or no wind, the air volume becomes stagnant and soon fills with smoke and fumes.

Black smoke is probably our most noticeable air pollutant, but it is not the only important one. In addition to smoke, there are a variety of particles and gases which also pollute the air. The chief economic effects of particles are visibility reduction and soiling of surfaces. Health effects are still a subject of controversy.

Smoke is a mixture of both particulate matter and gases, which result from the inefficient and incomplete burning of solid, liquid, and gaseous fuels. The solid particles may be either soot or fly ash. The sources of atmospheric dust and other particulates are numerous. Some examples are flour milling, cement grinding, coal loading, road construction, and traffic.

Gaseous wastes run the gamut of chemical compounds, including sulfur oxides, and various components of motor vehicle exhaust. The chief source of atmospheric pollutants are the combustion of sulfur-bearing fuels, principally coal and oil, and the automobile exhaust including carbon monoxide, olefinic hydrocarbons, and nitric oxide. It is the photochemical reaction of these last two materials that gives rise to the famous Los Angeles-type smog.

Control of gaseous effluents from chemical and most other manufacturing operations is technically possible, although not necessarily cheap. On the other hand, adequate control of automobile exhaust emissions have not yet been developed.

From this the question arises: If adequate controls are available to abate most air pollutants, why are they not used? There may be many reasons, such as nonrecognition of a problem, and the high cost of abatement. Nonrecognition of an air pollution problem may stem either from ignorance or from fear. Ignorance is an especially common factor in the case of chronic disease or economic loss. Anyone can recognize the soiling of fabrics by soot, but the subtle effects of subliminal concentrations of air contaminants on health may go unrecognized for years.

Another facet of the air pollution problem deals with the need for, and the nature of, air pollution control laws. The simplest form of control is the industrial code, under which various industries agree to live up to predetermined standards and police themselves voluntarily. Compliance with the code would then be evidence that reasonable care was being exercised to prevent air pollution.

Advantages of this type of legislation and self-enforcement would be that (1) the superior engineering and scientific talent of industry would develop the code, (2) the developers of the code could hardly call it arbitrary and unreasonable, and (3) the cost of necessary governmental control organization would be at a minimum.

Up to now, emphasis was placed on the nature of the air pollution problem, with only casual mention of its extent in time and space. Often one thinks of air pollution as a sporadic event, much like a storm that comes and goes and is worse sometimes than others. The nuisance effects of air pollution owe their frequency and severity to the weather. In the long run, however, the weather of an area does not change drastically, so the frequency and severity of air pollution episodes in a given locality will also depend on the types and amounts of pollutants spewed into the air.

A good example of the nuisance type of air pollution on a large scale is Los Angeles' smog, and the eye irritation it causes. Supposedly, the irritation was not noticed until 1942. Since then it has increased, until now

*(Continued on page 36)*

# RESEARCH ON CAMPUS

*by C. D. CHURCH, E.E.*

THE RESEARCH of two associate professors here at MSU is of special interest, because their findings will be incorporated into a cyclotron which may be built on this campus.

Drs. Henry G. Blosser and Morton M. Gordon, of the Department of Physics and Astronomy of Michigan State University, are studying their ideas of a more precise method of extracting particles from a cyclotron in which the particles are orbiting at speeds up to 60,000 miles per second. The research has been made feasible by two grants from the Atomic Energy Commission, one for $86,000 and recently an extension for an additional $79,000. A cyclotron for this campus is not definite as yet but hopes are strong and high for one to be built here.

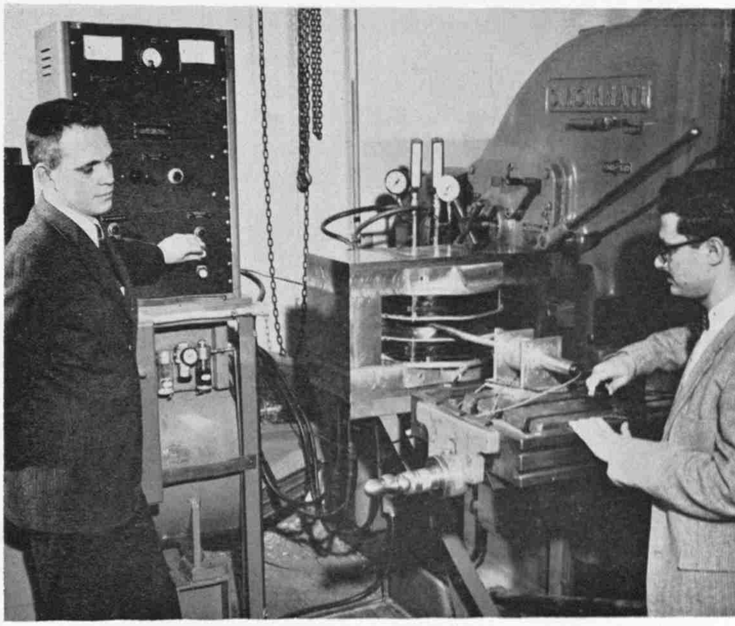
To study their idea and aspects of design, they have constructed a 1/6 scale model of the cyclotron magnet. By inserting probes between pole faces for precise measurement of the magnetic field at various points, the path the atomic particles follow in the final cyclotron can be determined. This can be done with accuracy because the field will not vary with the size of the machine.

"Resonant extraction" is the name given to describe this new method. The purpose of this method is to extract the particles in a fine beam instead of being emitted in a broad spray as they are from conventional cyclotrons. As a particle starts to deviate from its ever increasing circular path it will be acted upon by a periodic series of impulses having a frequency equal to the frequency of the oscillating particle. This behavior is analogous to the response of a swing when given a series of regularly spaced pushes with a frequency equal to the natural frequency of the swing. The resulting motion can be made quite large. This method will be incorporated in the new, sector focused cyclotron which was built to overcome the limit of the number of revolutions which the atomic particles could make. The resonating action will be in step with the periodic focusing forces on the particle produced by the sectors, so the oscillation becomes larger and larger and the particle ultimately leaves its orbit and passes through the pole faces. An entire beam thus ensues as succeeding particles follow.

The model magnet will incorporate another inovation, a digital voltmeter that will read to five significant figure accuracy, thus enabling more precise measurements.

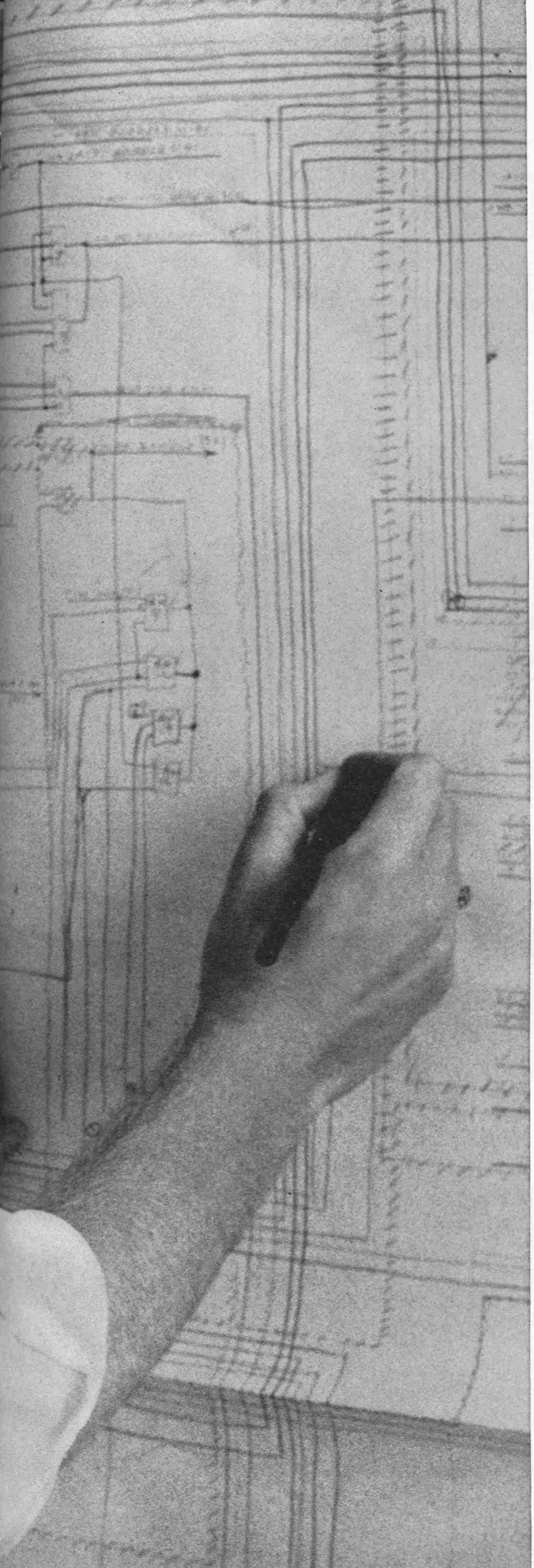
Dr. Gordon estimates that the calculations and compilation of all the data pertaining to this model will be completed in about a year. Assisting Drs. Gordon and Blosser are, Miss Arnette, a full time computer programmer, four graduate and three undergraduate students. Calculations are greatly alleviated and much time saved by the use of the university's electronic computer, "Mistic," for the processing of magnetic data to determine the complex path which a particle follows in the field.

The overall cost of the final machine will be about two million dollars. Its purpose will be to further and, with "resonant extraction," facilitate the study of nuclear interactions in atoms.



*Dr. Henry G. Blosser (left) and Dr. Morton M. Gordon are shown with a 1/16th scale model of the magnet which will be used in the new type cyclotron. The model is mounted on a milling machine, which permits accurate movement and positioning of the probe.*

*A close-up view of the model magnet and probe. By inserting probes between the magnet's pole faces, the magnetic field may be measured at various points. This data will show how the atomic particles will move in the completed cyclotron.*



# ENGINEERING
# MAY

MICHIGAN State's Engineering Exposition, largest free annual engineering exposition in the midwest, will be staged here May 12 and 13.

Attendance is expected to surpass the 20,000 who have witnessed the last several expositions. Spectators are attracted from industries, high schools, and other colleges and universities.

The student exhibits, which are the result of individual achievement in every engineering field, will be judged by a group of professors who will award cash prizes and ribbons. The exhibits will be judged in the following four areas, each of which will be graded on a basis of from one to ten possible points:

1. **Originality;** use of creative imagination and uniqueness.
2. **Engineering Content;** knowledge of engineering needed and extent to which engineering principles were applied.
3. **Workmanship;** actual construction and completion of project, craftsmanship, and neatness.
4. **General Impression;** overall appearance, impact of idea, success of exhibit, and attractiveness.

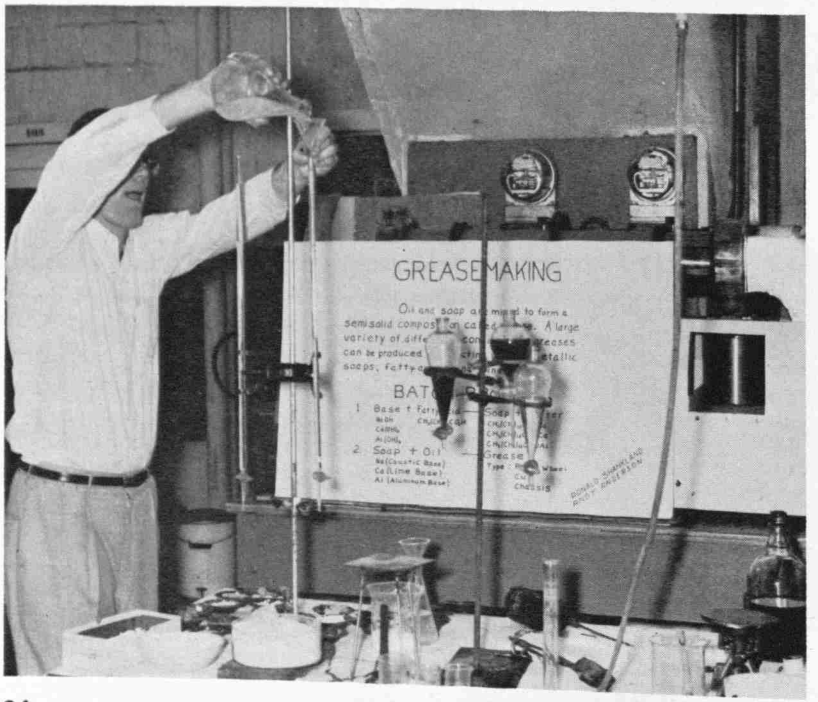
There will be three first place cash awards of $25 each, three second place awards of $15 each, and three third place awards of $5 each.

Industrial exhibits will be furnished by interested concerns and by departments of the college of engineering. The **National Engineers' Technical Society** will also have their exhibits on display.

The annual micro-midget auto race will be on the morning of May 13. These autos are built by students representing the different engineering organizations, and are powered with stock 2½ HP engines. The first driver to complete the rugged 12 mile course receives a trophy and usually a kiss from the Engineering Queen, who is crowned at the race.

The May Hop is the last of the scheduled events and will be held May 13, 1961 in the Union Ball Room. The general theme of the dance is South Seas. During the intermission there will be the annual dubbing of the Knights of St. Patrick, presentation of the outstanding senior awards, and the awarding of prizes for the student exhibits.

Plan to reserve May 12 and 13 for your own enjoyment at the Engineering Exposition.




*(left) An exhibition on greasemaking from last year's exposition.*

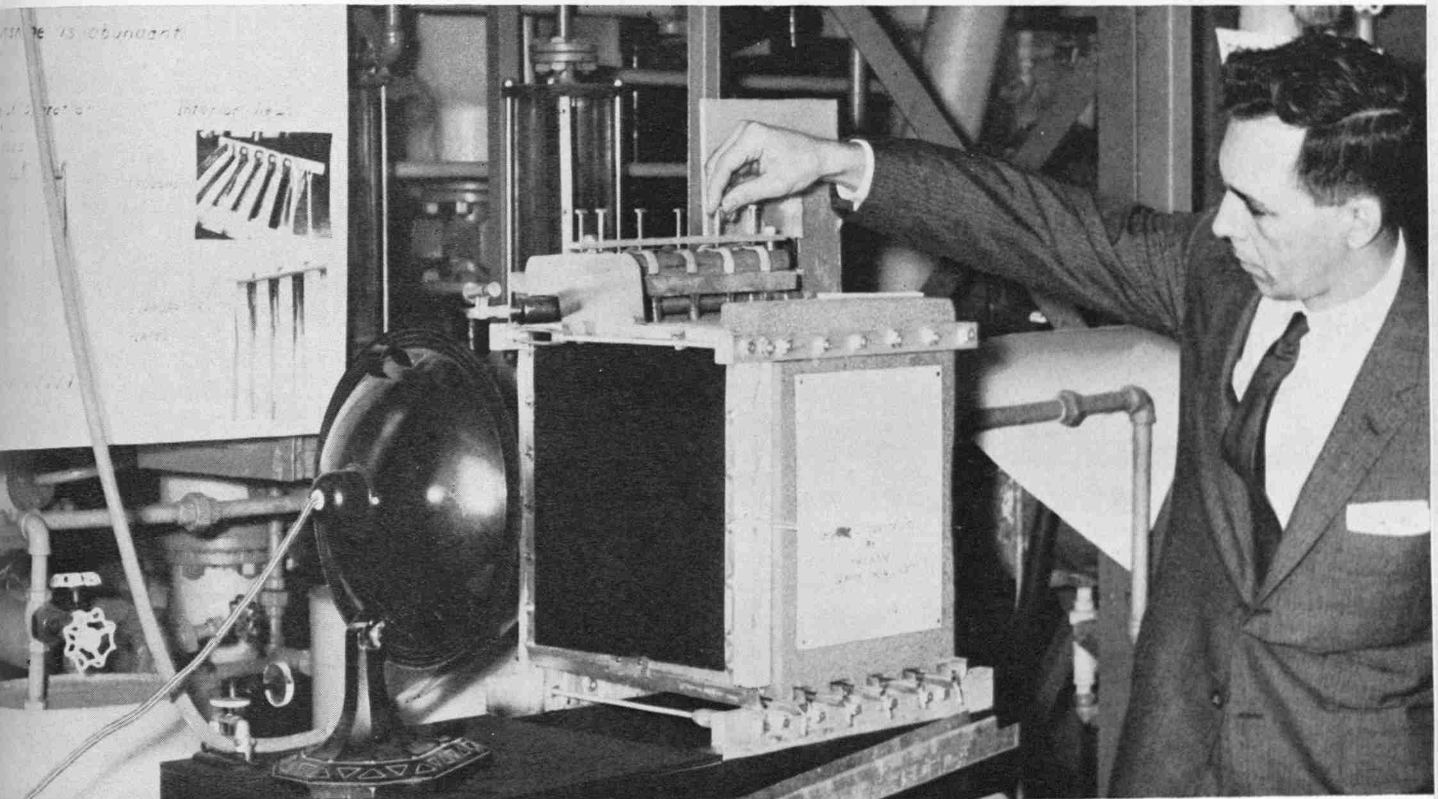
*(upper right) A solar still, one of the exhibits that won a first place last year.*

*(far right) The engineering queen taps new members of the Knights of Saint Patrick at the May Hop.*

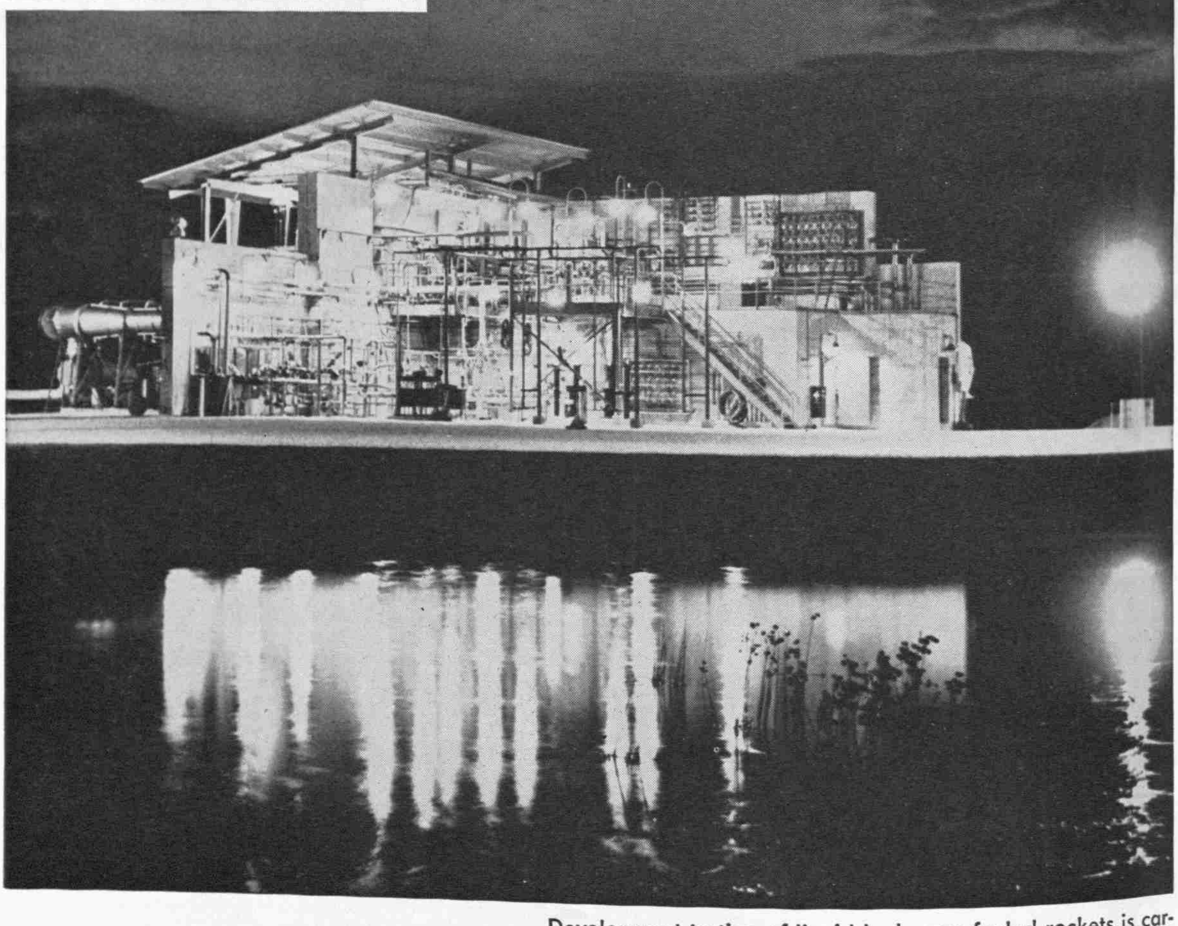
*(right) The driver of the winning car receives a well-earned kiss from the engineering queen.*

# EXPOSITION 1961

DONALD MITCHELL, Engineering Council



# What would *YOU* do as an engineer a



Development testing of liquid hydrogen-fueled rockets is carried out in specially built test stands like this at Pratt & Whitney Aircraft's Florida Research and Development Center. Every phase of an experimental engine test may be controlled by engineers from a remote blockhouse (inset), with closed-circuit television providing a means for visual observation.

# ratt & Whitney Aircraft?

Regardless of your specialty, you would work in a favorable engineering atmosphere.

Back in 1925, when Pratt & Whitney Aircraft was designing and developing the first of its family of history-making powerplants, an attitude was born—a recognition that *engineering excellence* was the key to success.

That attitude, that recognition of the prime importance of technical superiority is still predominant at P&WA today.

The field, of course, is broader now, the challenge greater. No longer are the company's requirements confined to graduates with degrees in mechanical and aeronautical engineering. Pratt & Whitney Aircraft today is concerned with the development of all forms of flight propulsion systems for the aerospace medium—air breathing, rocket, nuclear and other advanced types. Some are entirely new in concept. To carry out analytical, design, experimental or materials engineering assignments, men with degrees in mechanical, aeronautical, electrical, chemical and nuclear engineering are needed, along with those holding degrees in physics, chemistry and metallurgy.

Specifically, what would *you* do?—*your own engineering talent* provides the best answer. And Pratt & Whitney Aircraft provides the atmosphere in which that talent can flourish.

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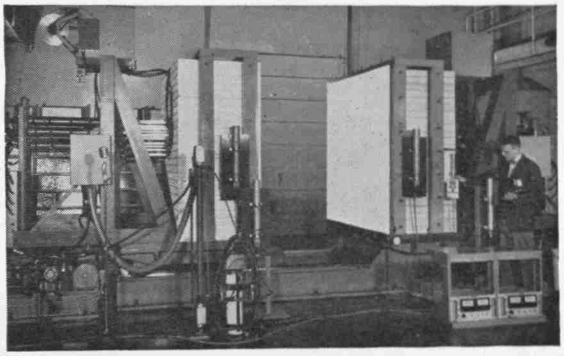
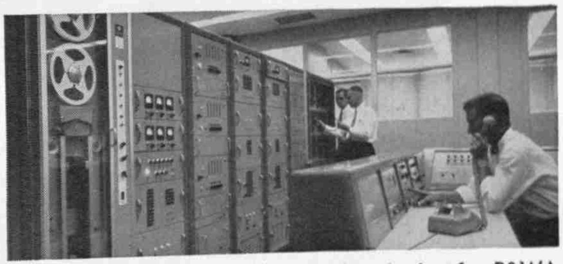
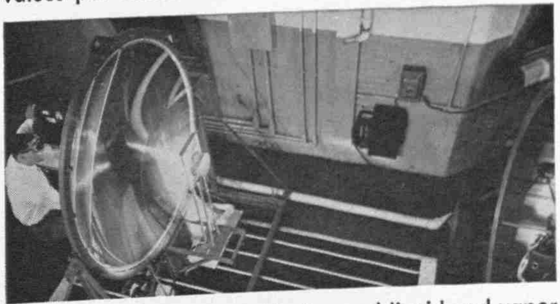
For further information regarding an engineering career at Pratt & Whitney Aircraft, consult your college placement officer or write to Mr. R. P. Azinger, Engineering Department, Pratt & Whitney Aircraft, East Hartford 8, Connecticut.



At P&WA's Connecticut Aircraft Nuclear Engine Laboratory (CANEL) many technical talents are focused on the development of nuclear propulsion systems for future air and space vehicles. With this live mock-up of a reactor, nuclear scientists and engineers can determine critical mass, material reactivity coefficients, control effectiveness and other reactor parameters.



Representative of electronic aids functioning for P&WA engineers is this on-site data recording center which can provide automatically recorded and computed data simultaneously with the testing of an engine. This equipment is capable of recording 1,200 different values per second.



Studies of solar energy collection and liquid and vapor power cycles typify P&WA's research in advanced space auxiliary power systems. Analytical and Experimental Engineers work together in such programs to establish and test basic concepts.

PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

CONNECTICUT OPERATIONS — East Hartford

FLORIDA RESEARCH AND DEVELOPMENT CENTER — Palm Beach County, Florida

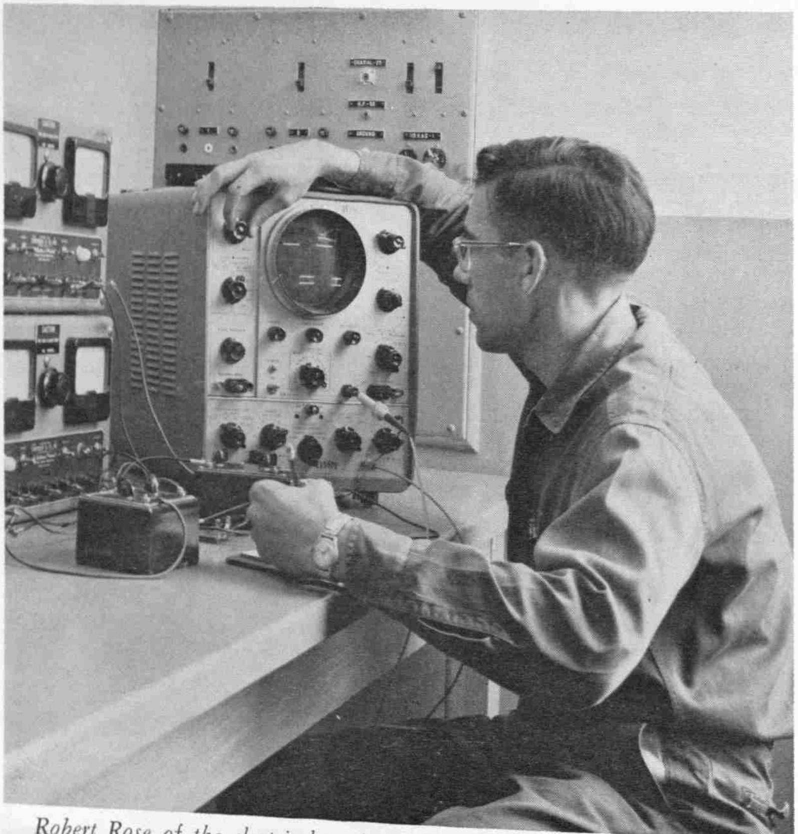

1
ABC 2
DEF 3
GHI 4
JKL 5
MNO 6
PRS 7
TUV 8
WXY 9
OPERATOR 0

# CRT ASSISTANT

## The Oscilloscope Can Work for You to Lighten the Burdens of Research

*by KENNETH LESLEY, E.E.*

CHANCES ARE that unless you are familiar with the oscilloscope you've been doing more work in the preparation of graphs than is really necessary. Recall, if you will, the hours that you, the scientist, have spent laboriously measuring data, compiling them into a usable table and then making a plot of the data. Probably by now your chain of thought has you pondering about how many more productive things could have been done during the time spent on the "coolie labor" just mentioned. Like any other scientist, you desire to spend your time on the immediate pursuit of your technical calling. Proper utilization of the oscilloscope can free more of your time from diversionary efforts.



*Robert Rose of the electrical engineering staff measures frequency response using an oscilloscope.*

Since the development of the oscilloscope as a practical instrument, it has become probably the most versatile electronic instrument that presently exists. Primarily, it is a display unit with the necessary circuits required to facilitate the display of an image upon a fluorescent screen. A cathode ray tube (CRT to the technicians) much like that used for display in your television set is the heart of the system. All of the other components act to properly present the signal to the CRT for presentation. It is not, however, the purpose of this article to describe the operation or theory of the oscilloscope but rather to outline a simple method of graphing through its use.

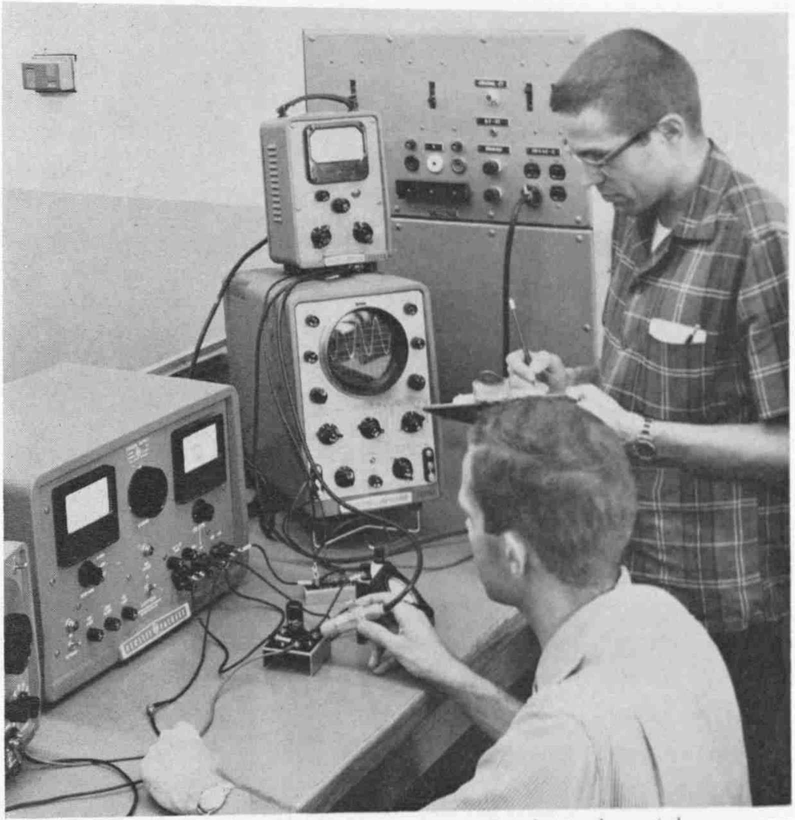
This instrument is not an exotic tool of an electrical engineer by any means and its operation does not require a complete knowledge of the theory of operation. A half-hour to an hour of reading in the instruction manual supplied with it will sufficiently familiarize one with its controls and their functions. Having thus gained a working knowledge of the oscilloscope, you are ready to begin the process of graphical analysis of your specific problem.

A necessary condition for the use of the oscilloscope as a measuring device is that the parameter under study must be transducable to a voltage, since the oscilloscope displays voltage variations. This then is the first step of the procedure. The mechanical engineer must convert stresses and strains into voltage variations; the physicist must convert speed or acceleration into voltages; the chemist must convert temperatures or pressures into voltages; etc. This is probably the biggest problem in the procedure. Its solution requires a knowledge of the available transducers. A transducer is any device that will convert a control signal from one form into another. Suggested transducers that would apply to the situations above are, respectively, the strain gauge, the tachometer, and the thermocouple. Having converted the parameter into a voltage form, we are now ready to proceed to the next step.

The second step of the procedure is obtaining the proper presentation upon the face, the CRT, of the oscilloscope. This is the area in which previous experience with the instrument is of the most value. The oscilloscope has a definite voltage range over which it is operable. Usually the instrument is very, very sensitive and provides a means of attenuating (weakening) the signal to a safe value. Previous experience will be helpful in determining whether a voltage falls within the operating range or whether it must be attenuated if too large or amplified if too small. Once a signal voltage has been properly adjusted to the proper range, it may then be applied to the oscilloscope input terminals.

There are two pairs of input terminals. Their use will be apparent from the instruction book that you will have read and from their descriptive nomenclature. A voltage applied to the "Horizontal Input" terminals cause a horizontal trace across the oscilloscope face while a voltage applied to the "Vertical Input" terminals will cause an up-and-down trace or excursion. The user, who will be familiar with the parameters he intends to graph, is able to set up these parameters so that they will be measured on the abscissa or the ordinate in the standard method used to graph the variables. The variable to be measured along the abscissa will be applied to the horizontal input terminals and the second variable to the vertical input. Once the no-load or normal position of the spot has been adjusted to a convenient reference point, the scientist is ready to test his system.

The third step in obtaining a characteristic graph consists of recording the data obtained from the oscilloscope as the parameters are varied. This may revert to some of the "coolie labor" which we were trying to omit from the original method. One must either sit down, drawing equipment in hand, and record the point by point plot as seen on the oscilloscope or he may resort to a much simpler, time-conserving method. He can photograph his display! Most laboratory-type oscilloscopes have a camera mounting bezel around the face. The camera is then set for time exposure and the parameters are varied. The end result is a photograph of the behavior of the variables. If an oscilloscope is used that has a scale on the face which can be illuminated (a not uncommon feature) and proper calibration data has been taken, the graph is as complete as one plotted in the old time-consuming manner.



*Julian Kately of the electrical engineering staff and a student study a vacuum tube amplifier using an oscilloscope.*

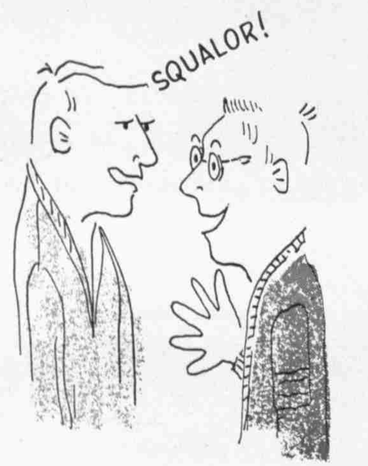
The fourth and final step of the procedure is the one in which the burden falls upon you, the scientist. This is the analysis of the data which you have obtained. It is a knowledge of your field that will give meaning to the validity of the results. The oscilloscope will not lie to you if you have used it properly. You will, however, have to realize its limitations. Realize that a photographed curve will not be as accurate as the hand-plotted curve. Realize also, though, that when hand-plotting a curve from an oscilloscope trace, any portion of the characteristic curve can be minutely inspected by proper gain considerations. Further, realize that if you found it necessary in step two to attenuate or amplify the signal, distortion may have been introduced. Your knowledge of the expected results will help to ascertain the degree, if any, of distortion introduced. By realization of the limitations and applications of this versatile instrument, accurate results may be obtained.

The results obtained from such graphs are usually sufficiently accurate for most studies. They have been obtained in what is probably the most expedient of circumstances making it possible for the scientist to devote more time to the pursuit of his technical work. Use of the oscilloscope as a graphing instrument is just a sampling of its possibilities and holds no suggestion as to the degree of sophistication attainable as a study instrument. It has the capabilities and versatility for application in nearly every field of science.

ELDOR, SOMETIMES I GET THE IDEA THAT COMPANY RECRUITING REPS ARE EXAGGERATING TO US. DON'T YOU FIND IT THUS?

AS YOU KNOW, ALBRECHT, I HAVE ACCEPTED AN ENGINEERING POSITION PRIMARILY ON THE BASIS OF AN HONEST, FORTHRIGHT PRESENTATION.


THEY SAID THAT I WOULD BE WORKING ON NEW UNCHARTED TRAILS THROUGH THE UNIVERSE...WITH THE ONLY LIMITS THOSE IMPOSED BY MY IMAGINATION.




I WILL LIVE IN AN ULTRA-MODERN ALL ELECTRONIC HOME SNUGGLED AMONG THE PINES AT THE EDGE OF A CRYSTAL BLUE LAKE.


WITH MERELY A DOUBLE GARAGE, ONE OF MY SPORTS JOBS WILL HAVE TO SIT OUT IN THE YEAR-ROUND PLEASANT WEATHER.


THEY TOLD ME EXACTLY WHAT MY SALARY WOULD BE, AND I'LL HAVE TO SET ASIDE (TEMPORARILY) MY PLANS FOR AN OCEAN-GOING YACHT.

AND SO YOU'RE JOINING COLLINS?
YES, ALBRECHT, SUCH HONESTY AS THEIRS SHOULD NOT GO UNREWARDED.

Furthermore, Collins is one of the nation's leading growth companies, producing for both government and business. Commercial fields include airline and business aircraft communication and navigation equipment, data transmission, microwave, amateur radio, broadcast and ground communication equipment. Research, development and manufacturing facilities are located in Cedar Rapids, Dallas and Burbank.

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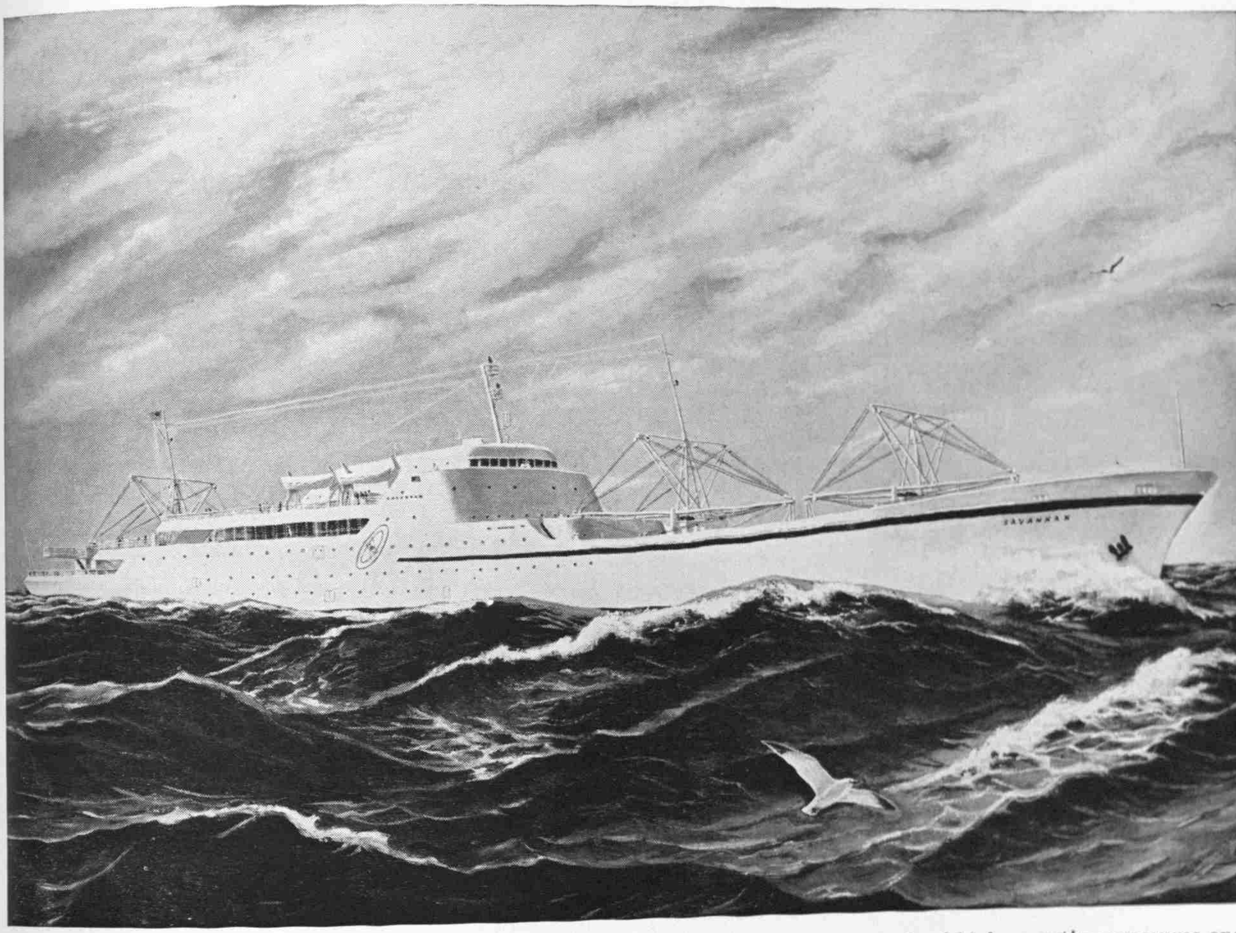
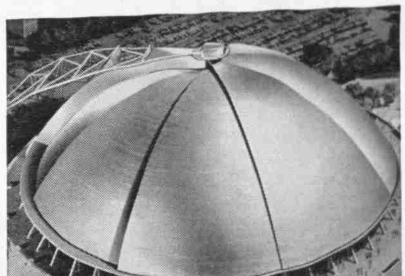
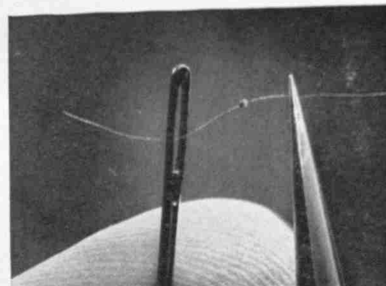










*BIG ROCK POINT*

*(Cont. from page 13)*

shielding, in the equipment, and in the arrangement of plant and equipment. This is brought about by the fact that reactor feed water is in direct contact with the nuclear core, which provides the heat to convert the water to steam.

Boiling water reactors have proved to be inherently safe because they tend to shut themselves down if trouble develops. Safety systems of several types, operating independently of each other, will also assure fullest protection to plant personnel, visitors and neighboring residents.

Big Rock plant incorporates two independent fail-safe protection systems which must both de-energize to result in a scram, or very rapid shutdown.

A tube-type tank heat exchanger system will dissipate reactor heat decay in the remote case of a scram, when the main condenser is unavailable as the heat sink. This condition could be caused by a power failure or loss of cooling water for the main condenser, whereupon the reactor would scram due to an increase in back pressure.

As a further backup to the control rod system, a solution containing boron can be injected into the reactor pressure vessel to reduce neutron activity and insure positive control of the reactor.

An additional safety feature will be the steel sphere enclosing the reactor itself.

Three types of radioactive wastes . . . liquid, solid, and gaseous . . . will be handled by concentrating and storing or diluting and discharging. Continuous monitoring assures all gaseous or liquid releases are below the permissible levels for protection of the site and environs.

The building of the Big Rock Point Nuclear Plant gives evidence that nuclear power is beginning to take its place alongside older, better established forms of electrical energy production. The Atomic Energy Commission sees this project as an important step forward in the search for the technological developments that are required to bring about the pro-

*(Cont. on page 50)*


what is light?
A candle in a dark room?
Transverse and/or Visible electro-magnetic waves?
A universal constant?
How many wave lengths in a photon?
Is light affected by gravity?
A full appreciation of light and all its phenomena is essential to the successful completion of our energy conversion mission.
We use this knowledge constantly—as, for example, in our recent development of a photo-voltaic conversion system and a mechanical-optical system to convert light energy to electrical energy.
To aid us in our inquiries we call on the talents of General Motors Corporation, its Divisions and other individuals and organizations. By applying this systems engineering concept to new research projects we increase the effectiveness with which we accomplish our mission—exploring the needs of advanced propulsion and weapons systems.
Energy conversion is our business
ALLISON
Division of General Motors, Indianapolis, Indiana

*AIR POLLUTION*

*(Cont. from page 20)*

each year may be expected to bring 150 days of noticeable eye irritation. The weather has not changed. There are still 85 days a year when a combination of strong atmospheric temperature inversion and low wind velocity will produce a greatly restricted air volume. The continued increase in days of the irritation may then be laid to increasing automobile traffic, which provides the exhaust gases for the photochemical reaction. It is increasing in other major cities as well. No longer is air pollution news datelined Los Angeles, London, or Pittsburgh. Recent news articles have carried the names Paris, Moscow, Tokyo, and Hamburg. Practically no large American city is exempt, although each may have a problem unique to its own location and economy. New York calls its problem "smaze" (smoke + haze); El Paso speaks of "smust" (smoke + dust). The point is, as cities grow, the ordinary daily activities of a larger population send more pollutants into restricted atmospheres. The emissions of air pollutants per square mile increase until control laws put on the brakes.

Can air pollution be expected to increase? Or will it decrease? Industrial air pollution is probably already past its peak. Considerable research is going on to develop methods for controlling particularly obstinate emissions, and eventually they, too, will come under control.

A different picture unfolds with regard to domestic pollution, or that made by individuals. Single-chamber incinerators, open fires, and trucks send a variety of wastes into the air. In most cases these emissions are uncontrolled, and the tendency of people to congregate in urban communities puts a load of pollution into the atmosphere that will probably continue to increase until economic and politically palatable means of control are developed.

The effect of a changing technology on the extent of air pollution is more difficult to assess. One can visualize changes in power sources that may have considerable impact on air pollution. Adoption of nuclear power will dramatically decrease pollution from power plants. Any trend to gaseous fuels, either natural gas or gasified coal, will markedly reduce smoke, fly ash, and sulfur dioxide emissions. A much greater impact will be made by changes in the automotive power plant. Gas turbines, free-piston engines, fuel cells, and semi-diesel engines all present problems, but fundamentally each has less air pollution potential than the present spark-ignited internal-combustion engine.

The Federal Government entered the air pollution scene on a large scale with the passage of Public Law 159 in 1955. This law directed the U. S. Public Health Service to conduct and support research on air pollution and to provide technical services to state and local governments and to private agencies. Among its activities have been initiation of research in various governmental facilities, particularly the Taft Sanitary Engineering Center; research grants to universities and research institutes for specific medical, scientific, and engineering studies.

One of the problems faced by the U. S. Public Health Service is allocation of research funds to the satisfaction of various communities. Public officials in California press for an all-out attack on automobile exhaust; others want priority placed on emission standards and control of effluents from specific industries; still others want laboratories established in specific localities to study urgent local problems.

In connection with this, the role of universities and colleges in air pollution is primarily a research function, supported largely through grants from the U. S. Public Health Service and various industrial organizations. The work is fundamental and is seldom aimed toward the solution of a specific problem, yet the published results of these scientific studies are usually of more lasting value than those from problem-oriented industrial investigations.

There is also a trend toward including some formal instruction in air pollution subjects in sanitary engineering curricula. Several technical societies have also banded together in the American Sanitary Engineering Intersociety Board to improve training and practices in sanitary engineering, including air pollution control.

For assistance in the solution to pressing air pollution problems, however, many industries have contracted for investigation by research institutes. In many cases this has been a more satisfactory arrangement than grants to educational institutions. Full-time attention can usually be given to the problem, a greater variety of skills is available, and specific studies can be performed under contract.

Another important aspect of the air pollution problem is the cost of air pollution control. This will vary from the few cents required to repack a valve leaking a volatile solvent to multi-million dollar electrostatic precipitators on open-hearth furnaces.

In some instances, control of air pollution may return a profit. As combustion engineers continually point out, smoke indicates a loss of heat, a waste of energy. Accordingly, better combustion not only reduces air pollution but also returns a profit in more efficient utilization of fuel. In most cases, however, the preventive measures are an additional expense.

One should realize that control at the source through the use of abatement equipment is only one means of air pollution control. Industrial zoning and meteorological control are two other methods that have received attention. Meteorological control has two facets: (1) intelligent use of the atmosphere for pollution dispersion and (2) treatment of the atmosphere to prevent accumulation of dangerous or annoying amounts of pollutants.

Man has used the atmosphere for centuries as a means of carrying away waste, most of the time successfully. An air pollution problem arises only when the atmosphere is overloaded. To remedy this situation, some authorities have suggested that when stable atmospheric conditions are predicted the industrial plant curtail its emissions. In this way the great diluting power of the atmosphere could be utilized most of the time, and the emission could well be restricted when a pollution problem might develop.

What can be done to solve the problem? Since it is so diverse and widespread, it can be attacked in many ways. The only successful attack, however, is one that recognized certain basic needs and is directed specifically towards meeting those needs. These are:

1. More information relating the sources of air pollution to effects on people and property. Only when we

*(Cont. on page 50)*

# How do You Measure Achievement?

At Delco Radio Division of General Motors we consider our position of prominence in the fields of electronics and solid state physics a positive measure of achievement.

TALENT—bold, imaginative talent stimulated by the challenge of new concepts—was responsible for this achievement.

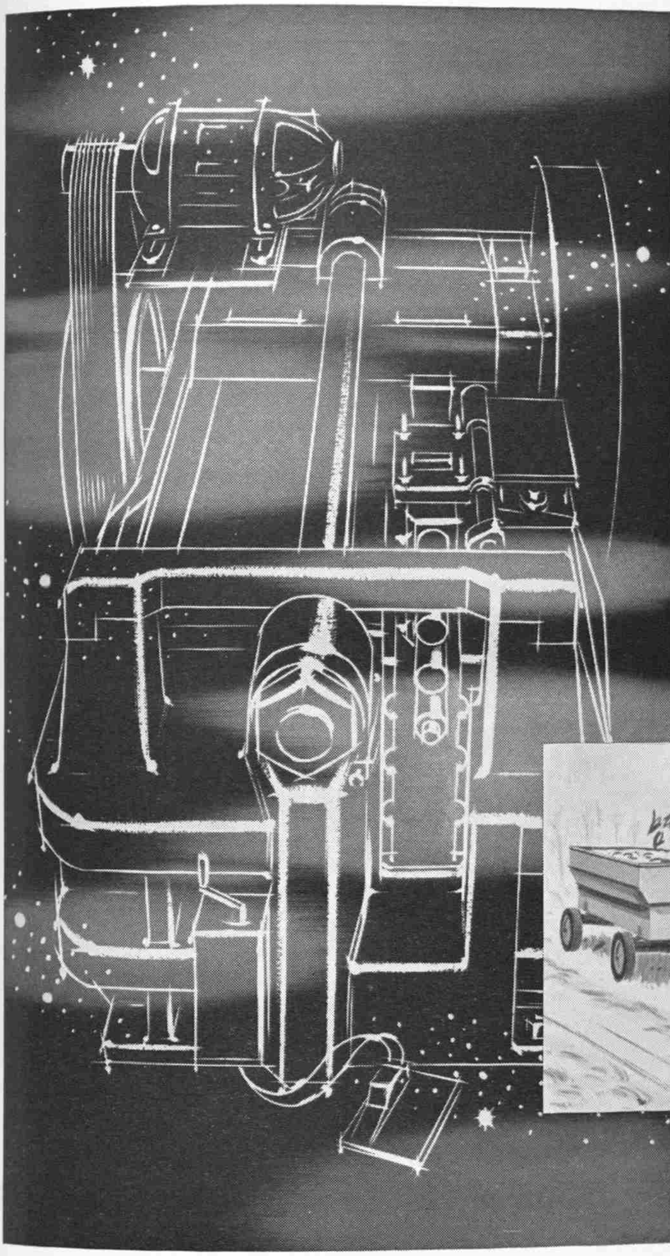
However, past accomplishments are significant only insomuch as they indicate the path of the future. At Delco this path is clearly charted . . . we intend to maintain our leadership.

Our current intensive programs in semiconductor device development and materials research unfold new challenges daily. Meeting these challenges requires a constant infusion of new ideas and new talent—aggressive new talent. That's what we're looking for.

If your interests and abilities are along these lines, and you're interested in becoming a part of this ambitious Delco, GM team, write to Mr. Carl Longshore—Supervisor, Salaried Employment. Or, talk with our representative when he visits your campus.

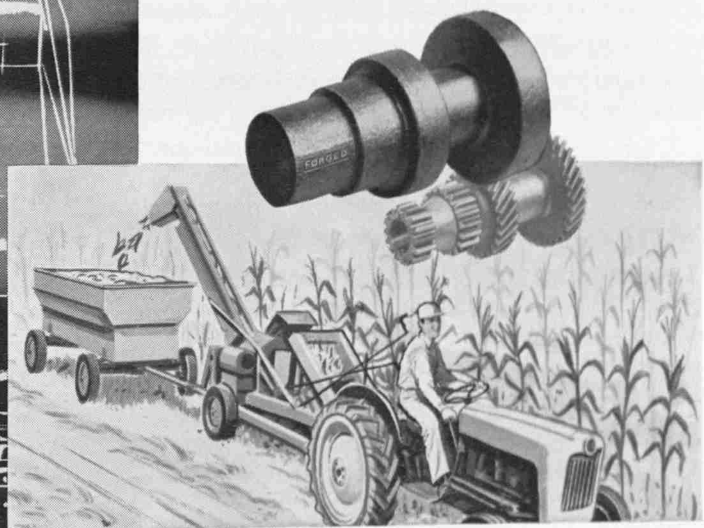
DELCO RADIO DIVISION OF GENERAL MOTORS

KOKOMO, INDIANA



*Upsetter, or horizontal forging machine*

# RESISTANCE TO PUNISHMENT of any severe-service part increased by designing it to be forged




Gear blanks for tractor and farm implement transmissions are designed to be upset-forged, usually with integral forged stub shafts. Forging gives these vital parts maximum resistance to gear-clashing shifts. Transmission life can be equal to equipment life when gears are FORGED.

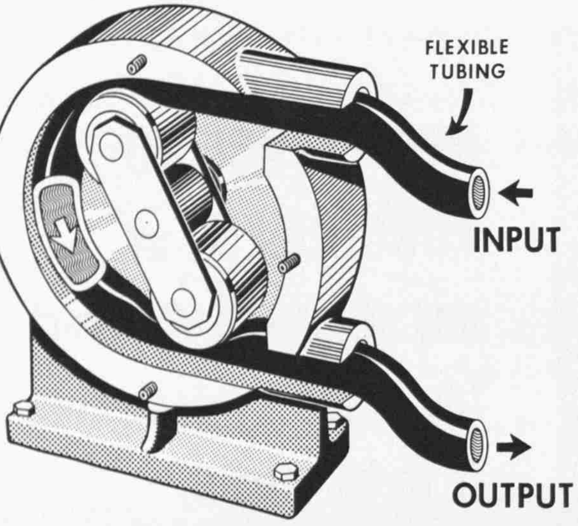
When you *design with forgings* right from the start, you take full advantage of the many benefits which only forgings offer: highest ratio of strength to weight . . . highest resistance to impact, shock, vibration, torsion . . . preferential orientation of flow lines in the forging to concentrate strength where required . . . absence of wasteful inclusions and voids.

Forged parts start out as *better* metal . . . are made *even better* by the hammer blows or pressures of the forging process. Write for literature to help you design, specify, and procure forged parts.

**When it's a vital part, design it to be FORGED**

Drop Forging Association • Cleveland 13, Ohio

*Names of sponsoring companies on request to this magazine*



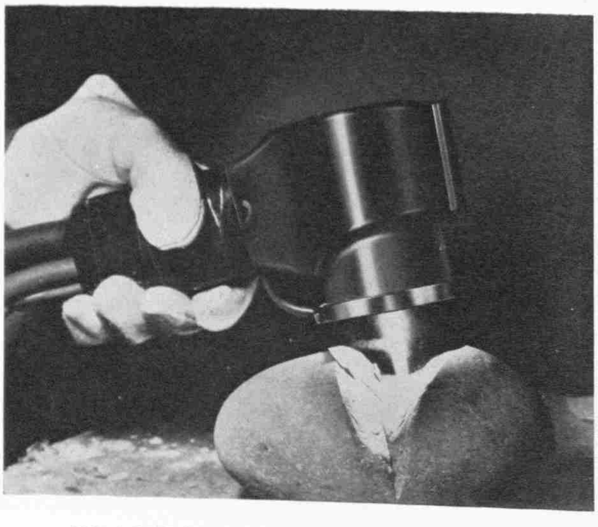

## DRY PUMP

Hailed as "the pump that never gets wet", the Randolph Pump operates on a principle designed to eliminate all contact of moving parts with the fluid being pumped. Intake and outlet are one continuous flexible tube which passes through the pump body where it is exposed to the squee-gee action of ball-bearing rollers.

By selecting tubing material suitable to the liquid being handled, a wide variety of corrosive, sterile, and abrasive liquids or gases can be pumped without contamination or injury to the pump.

The Randolph Pump's versatility has resulted in its immediate acceptance by many diverse industries utilizing processes where corrosion, contamination or abrasion were once a problem.

The pump comes in two sizes, 54 and 185 gallons per hour. Available with or without motor; also with speed controls and explosion-proof fittings for use in hazardous areas.

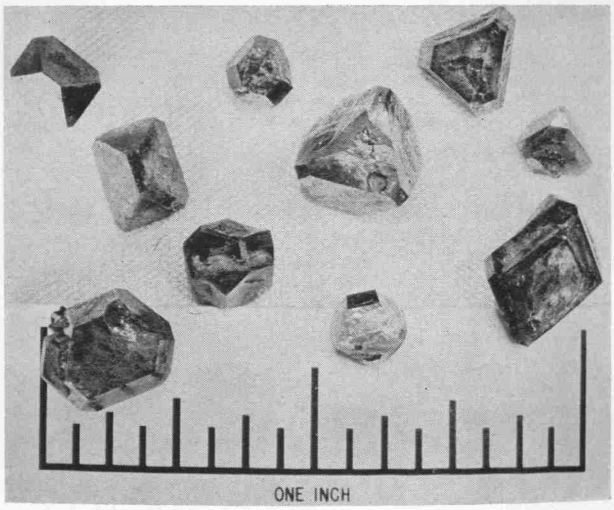


## PLASMA JET ROCK CUTTING

A series of developmental experiments utilizing the new Plasmatron spray depositing device has proven the usefulness of the instrument as a cutting tool for a wide variety of rock formations.

According to Plasmadyne Corporation engineers, developers of the spray gun, the entire cut illustrated above, of granite was completed in less than two seconds. The cutting of the rock is accomplished entirely by the action of the super-heated gases—no abrasive materials are used. In addition to simple cutting, Plasmatron rock cutting is said to be useful in shaping rocks. By using lower gas temperatures, the rocks are actually melted and permitted to flow to desired shapes. The gas pressure can be used to guide the formation of the molten rock.

The Plasmatron guns are being widely used for spray depositing high and low temperature materials such as tungsten, carbides, borides, nitrides, refractory oxides and epoxies.




## MAN-MADE DIAMONDS

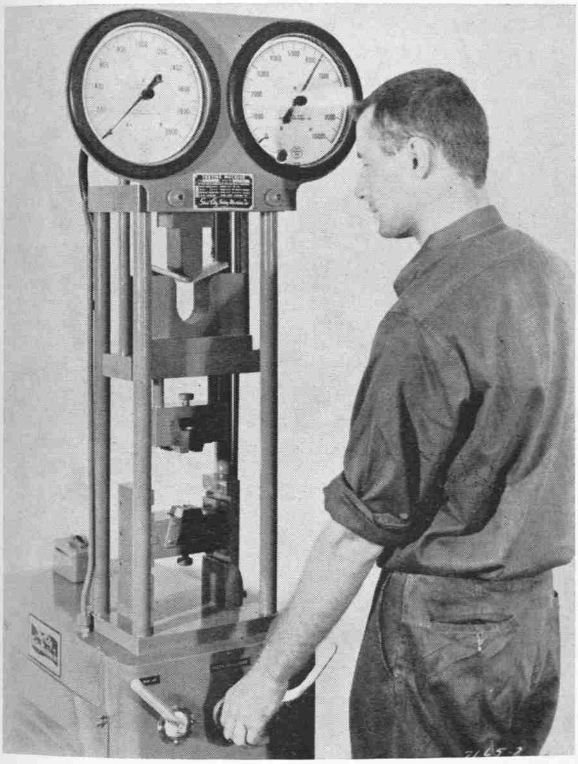
"For the first time in history, man has made large diamonds," according to Dr. Guy Suits, General Electric vice president and director of research. "The large diamonds are over a carat in size. They are dark in color and, because of structural imperfections, they are not yet of sufficient mechanical strength for industrial application," Suits said.

This scientific feat was achieved at the General Electric Research Laboratory in Schenectady, where the first man-made diamonds were announced in 1955. "These new, large diamonds," Suits reported, "are the latest milestone in a high-temperature, high-pressure research program that we have pursued since our initial success in converting common graphite into diamonds."

Suits pointed out that the large diamond work is still in the early development stage. "It is impossible to predict when we will succeed in making large diamonds with mechanical properties comparable to our small diamonds, which have proven to be superior to natural diamonds for many industrial applications," Suits said. Suites observed that GE indus-

# WHAT'S NEW

trial diamonds are of the utmost strategic importance today. "The major source of natural diamonds is the Congo, and the uncertain conditions there demonstrate how fortunate it is that industry can turn to man-made diamonds for many of its needs," he said.



## VERSATILE TESTER

Tensile, compression, and guided bend tests can all be made on a single machine just announced by Steel City Testing Machines, Inc., 8817 Lyndon Avenue, Detroit 38, Michigan. Motor and hydraulic power unit are located within the base of the tester, and the controls are conveniently mounted on the front. Model TE-10-AS, shown in the accompanying illustration, has a capacity of 10,000 pounds, and is equipped with two gauges to register the load applied in two ranges. Similar machines having other capacities can be provided.

Guided bend testing, which consists of bending butt-welded samples that are originally flat into U-shapes at the welds, is performed in the compression testing area of the machine. The fixture, which conforms with AWS, ASME, ASTM, and U. S. Government specifications, consists of a punch secured to the underside of the upper platen and a die mounted on the middle platen by means of two locating pins. Fixtures are quickly interchangeable to permit testing butt-welded specimens of various thickness.

When used as a tensile testing machine, the lower jaw holder is placed in one of the three sets of slots, to suit the specimen length. A variety of jaw inserts are available to hold specimens up to ½ inch thick by 1½ inches wide, or ¾ inch in diameter. The machine shown will accommodate specimens up to 8 inches long; other models will handle longer specimens.

For compression testing, the guided bend fixture is replaced by a pair of hardened compression plates. The space available for compression testing is 9½ inches high by 8 inches between the vertical pulling rods. This space will accommodate a Steel City dial-indicater type proving ring for calibrating the machine.

A feature of the machine is its compactness, with a floor space of only 14 by 24 inches, an over-all height of 74 inches, and a weight of about 500 pounds. Also, the cost, which depends on the number of jaws and guided bend fixtures required, is low, making it practical for performing routine tests instead of doing them on more elaborate and expensive universal testing machines.

## VOTE BY PHONE?

Voters may cast their ballots by telephone in the future, suggests a Michigan State University political scientist.

"The American election system has available—or imminently available—the equipment for allowing each citizen to vote in the privacy of his home, with the final returns becoming available a matter of minutes after the closing of the polls," reports Dr. Ralph M. Goldman.

"Televoting," he believes, would offer individual voters, election officials and the general public the maximum in convenience and efficiency.

In a "telelection," Dr. Goldman writes in the telephone industry journal, "Telephony," ballots would be mailed to registered voters a few days before an election.

On election day, the voter would dial his own special code number and hear a recorded voice say: "The Televoter is now ready to receive your ballot."

By dialing certain code numbers, the voter could vote a straight party ticket, split his ballot or not vote for certain offices. A recorded voice would then tell him how he voted. He could change his vote before dialing a "terminating" code which would irrevocably cast his ballot.

Ballots would be tallied by an electronic computer at a central location. A few minutes after the polls were closed, the final results would be known.

"All that is needed," Dr. Goldman reports, ...."is a well constructed and 'well-instructed' electronic computer plus a simple system of codes for dialing the vote. The only other requirement would be a system for preventing fraud."

# CHROMIUM MANGANESE ANTIMONIDE

## Unique Metallic Compound Has a Variable Magnetic Property

*Edited by GEORGE FOLEY, Pre-Law*

CHROMIUM MANGANESE ANTIMONIDE is the name for a unique metallic compound. This compound, besides possessing an unusual name, also exhibits unusual on-and-off magnetic characteristics. This new material is a brittle, gray manganese compound which will become magnetic as the temperature rises above a point predetermined by its chemical composition. Once the temperature drops below that point it becomes non-magnetic. By slight changes in the chemical composition, the predetermined point can be varied over a wide range of temperatures.

This material was discovered by Du Pont scientists engaged in fundamental research on magnetism, the invisible force that lets a small boy pick up a nail with his horseshoe magnet. A material is magnetic if it is attracted by a permanent magnet. Iron is magnetic, for example, while silver is not. Most magnetic materials normally stay magnetic, their magnetism diminishing gradually as temperature increases until it finally disappears (in iron not until 1420 deg. F).

These properties are not the case with the new compound. It is attracted to a permanent magnet when its temperature is at or moderately above a certain level. When below this level it is not magnetic. Scientists can adjust the level as desired over a range of several hundred degrees.

The compound's abrupt magnetic change occurs because the distance between its atoms determines how the inner magnetic forces are lined up. When the distance is less than a specific length, the forces are aligned in a non-magnetic pattern; when the specific length is longer, they swing into a magnetic pattern. The compound contracts and expands as other substances do, and its range of contraction includes the dimension at which the magnetic forces shift. Hence temperature brings about magnetic change. The temperature at which the transition occurs can be adjusted simply by changing the composition slightly.

Chromium manganese antimonide was the first inter-metallic compound found to exhibit the characteristics described. Several others have since been discovered. Manganese antimonide itself is a well known ferromagnetic substance exhibiting normal properties. The addition of the chromium in proper quantity produces the unusual properties. Scientifically, the change in the material as the temperature goes below the transition point is an abrupt temperature induced shift from the ferromagnetic to the antiferromagnetic state. This process has been named "exchange inversion." Below the transition temperature, the exchange interactions between electrons are believed to align the magnetic moments of the manganese atoms to give a cancellation and no net magnetic force. Above the transition temperature, the electronic interactions change to give a new alignment of magnetic moments yielding a net magnetic force. The change is associated with the decrease in physical size—0.2 per cent in a composition whose transition occurs in the room temperature range.

It appears that there is a critical interatomic dimension at which the transition occurs. This dimension falls within the range of normal thermal contraction of the new material. The transition temperature can be adjusted by varying the proportion of chromium in the compound. Experiments to date indicate that it is practical to vary the transition temperature from near absolute zero to over 100 degrees C. Maximum magnetization of most magnetic substances occurs near absolute zero ($-273.1$ degrees C). In the new compound it occurs instead at, or slightly above, the transition temperature. A maximum magnetization of about 2000 gauss is typical of samples with transitions that occur in the room-temperature range.

Magnetism is a major force in nature and science. The new compound is leading to a better basic understanding of magnetism and may in time lead to some new practical devices because it has magnetic properties never before known. Since atomic structure controls magnetic properties, thorough understanding of magnetism can yield precise information about particles the most powerful microscope can not see. Laboratory investigation of the new compound's behavior is shedding light on previously unknown aspects of magnetism and will extend knowledge beyond its old bounds.

# SIDETRACKED

Famous quotes from great Americans:

General Custer: "I never saw so damn many Indians in all my life."

Abraham Lincoln to his wife: "You and your damn theater tickets."

Eli Whitney: "Keep your cotton pickin' hands off my gin."

George Washington to his men before crossing the Delaware: "Get into the boat, men."

Paul Revere at the end of his famous ride: "Whoa!"

* * *

Prof: "Well, is the theory clear to you now?"

Student: "Yeah, just as though it had been translated into Hindustani by Gertrude Stein and read to me by a tobacco auctioneer."

* * *

A South American man was describing his country to an American woman:

"Our most popular sport is bullfighting," he told her.

"Isn't it revolting?" she asked.

"No," he replied, "That's the second most popular sport."

* * *

C.E. Prof: "Explain the operation of a steam shovel?"

Walt: "Don't kid me, you can't shovel steam."

The deans who think our jokes are rough
Would quickly change their views
If they'd compare the ones we print
With the ones we're scared to use.

* * *

Prof: "Why don't you answer when I call your name?"

ME: "I nodded my head."

Prof: "You don't expect me to hear the rattle all the way up here do you?"

* * *

Dean: "I have a report here that says coke, soda, and whiskey were found in your room. What do you make of that?"

Student: "Highballs, sir."

* * *

During Krushchev's recent tour of Washington, D.C., he was very quiet. However, when he saw the Washington Monument he put his hand over his mouth and snickered loudly: "They'll never get it off the ground."

* * *

"Hey, Dad, I'm home from school again."

"What the devil did you do this time?"

"I graduated."

* * *

Tourist Guide: "We are passing the largest brewery in the United States."

C.E.: "Why?"

Have you heard about the new economy car? It's a cross between a Valiant and a Comet. It's called a Vomit and comes in seven barfy colors.

* * *

Let's eat, drink, and be merry today
For tomorrow we may die;
Let's fill the hours to the brim
Then we shall say goodbye.
The morrow's here — we're still alive,
Last night was such delight!
And just in case we die tomorrow,
Let's celebrate tonight!

* * *

Definintion of a redhead: A communist outhouse.

* * *

A wealthy Detroiter, returning from his grand tour abroad, was asked by an artistic friend whether he had managed to pick up a Van Gogh or Picasso abroad.

"Naw," said the traveler. "They're all right-hand drive over there and besides I got three Buicks anyway."

* * *

He: "What's *that*?"

She: "A ton of steel wool. I'm knitting myself a sports car."

* * *

Know what becomes of doughnut holes after the doughnuts are eaten? IBM makes a fortune cutting 'em up in little pieces and pasting them on cards.

*AIR POLLUTION*

*(Cont. from page 36)*

know the effects of various types and amounts of pollutants can we proceed intelligently against harmful emissions.

2. Development of effective control methods that will not be so expensive as to disrupt the economy of the community.

3. Broad dissemination of the facts of air pollution in language readily understood by the public. Any restrictive law or regulation must have public acceptance.

4. A cooperative approach between business and government toward legislation adequate to protect the public, yet in keeping with the democratic principle of fair play.

By meeting these four needs, much can be done to alleviate one of the main problems of our industrial society.

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*BIG ROCK POINT*

*(Cont. from page 34)*

duction of electrical power from nuclear energy at an acceptable cost.

However, research and development are not the sole considerations in building this plant. It will ultimately produce electricity for the area at a price reasonably commensurate with the cost of generating electricity by conventional means, considered for a long term point of view.

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*AEROBEE-HI*

*(Cont. from page 14)*

pellant boosted rocket which is capable of carrying payloads of 65 pounds as high as 300 miles. Last year, an Aerobee 30 launched from Fort Churchill, Manitoba, climbed more than 260 miles.

Three stage versions of the Aerobee are now being designed for atmosphere and space studies at altitudes up to 1,000 miles.

The Aerobee-Hi is extremely reliable. In over 250 launchings, more than 90% were successful. Another advantage is that only three men are needed to set up and launch an Aerobee.

One factor especially important to most scientific groups is that the rockets cost about $35,000 each. Generally, instrumentation costs another $25,000 to $50,000. Field operations bring the total cost of a launching up to nearly $100,000. But this cost is low as compared to large rockets of the Viking or even IRBM class, which cost two or three million dollars apiece.

Aerobee rockets have long pioneered man's eventual conquest of space. They have been launched from nearly every corner of the globe including the Arctic Aerobees have been fired from the deck of the U.S.S. Norton Sound, becoming the first high-altitude rocket to ever have been launched from shipboard. Much of the data used as the basis of present day satellite and space medicine experiments, has been accumulated by the Aerobee series in the fourteen years since the first live launching. Data recorded in these flights will be especially useful in the relatively new fields of meteorology and weather forecasting.

## ADVERTISER'S INDEX

One of a series

*Interview with*
*General Electric's Byron A. Case*
*Manager—Employee Compensation Service*

# Your Salary at General Electric

Several surveys indicate that salary is not the primary contributor to job satisfaction. Nevertheless, salary considerations will certainly play a big part in your evaluation of career opportunities. Perhaps an insight into the salary policies of a large employer of engineers like General Electric will help you focus your personal salary objectives.

Salary—a most individual and personal aspect of your job—is difficult to discuss in general terms. While recognizing this, Mr. Case has tried answering as directly as possible some of your questions concerning salary:

**Q Mr. Case, what starting salary does your company pay graduate engineers?**

**A** Well, you know as well as I that graduates' starting salaries are greatly influenced by the current demand for engineering talent. This demand establishes a range of "going rates" for engineering graduates which is no doubt widely known on your campus. Because General Electric seeks outstanding men, G-E starting salaries for these candidates lie in the upper part of the range of "going rates." And within General Electric's range of starting salaries, each candidate's ability and potential are carefully evaluated to determine his individual starting salary.

**Q How do you go about evaluating my ability and potential value to your company?**

**A** We evaluate each individual in the light of information available to us: type of degree; demonstrated scholarship; extra-curricular contributions; work experience; and personal qualities as appraised by interviewers and faculty members. These considerations determine where within G.E.'s current salary range the engineer's starting salary will be established.

**Q When could I expect my first salary increase from General Electric and how much would it be?**

**A** Whether a man is recruited for a specific job or for one of the principal training programs for engineers—the Engineering and Science Program, the Manufacturing Training Program, or the Technical Marketing Program—his individual performance and salary are reviewed at least once a year.

For engineers one year out of college, our recent experience indicates a first-year salary increase between 6 and 15 percent. This percentage spread reflects the individual's job performance and his demonstrated capacity to do more difficult work. So you see, salary adjustments reflect individual performance even at the earliest stages of professional development. And this emphasis on performance increases as experience and general competence increase.

**Q How much can I expect to be making after five years with General Electric?**

**A** As I just mentioned, ability has a sharply increasing influence on your salary, so you have a great deal of personal control over the answer to your question.

It may be helpful to look at the current salaries of all General Electric technical-college graduates who received their bachelor's degrees in 1954 (and now have over 5 years experience). Their current median salary, reflecting both merit and economic changes, is about 70 percent above the 1954 median starting rate. Current salaries for outstanding engineers from this class are more than double the 1954 median starting rates and, in some cases, are three or four times as great.

**Q What kinds of benefit programs does your company offer, Mr. Case?**

**A** Since I must be brief, I shall merely outline the many General Electric employee benefit programs. These include a liberal pension plan, insurance plans, an emergency aid plan, employee discounts, and educational assistance programs.

The General Electric Insurance Plan has been widely hailed as a "pace setter" in American industry. In addition to helping employees and their families meet ordinary medical expenses, the Plan also affords protection against the expenses of "catastrophic" accidents and illnesses which can wipe out personal savings and put a family deeply in debt. Additional coverages include life insurance, accidental death insurance, and maternity benefits.

Our newest plan is the Savings and Security Program which permits employees to invest up to six percent of their earnings in U.S. Savings Bonds or in combinations of Bonds and General Electric stock. These savings are supplemented by a Company Proportionate Payment equal to *50 percent* of the employee's investment, subject to a prescribed holding period.

***If you would like a reprint of an informative article entitled, "How to Evaluate Job Offers" by Dr. L. E. Saline, write to Section 959-14, General Electric Co., Schenectady 5, New York.***

*Progress Is Our Most Important Product*

**GENERAL ELECTRIC**