Spartan Engineer

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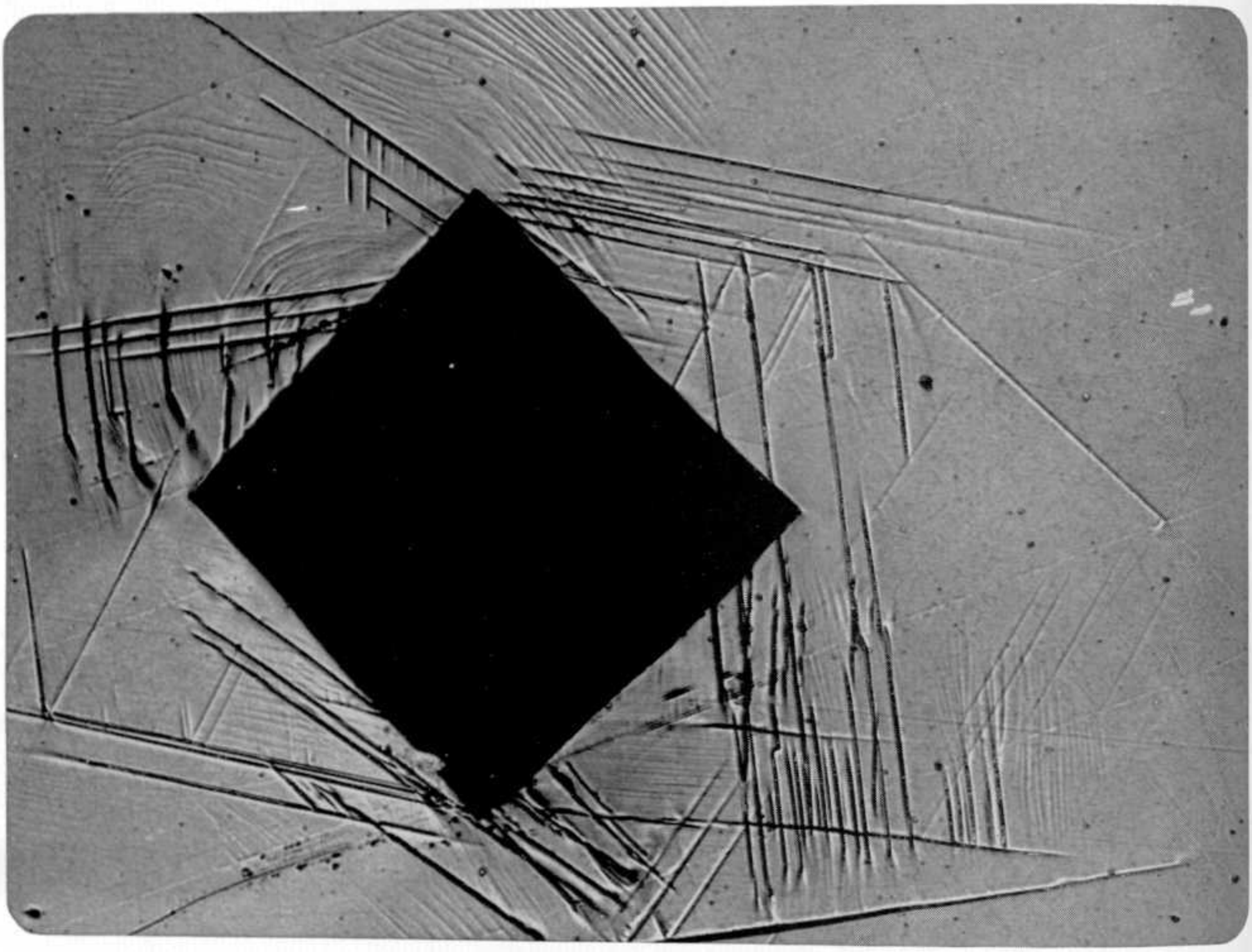
...nterstate Highways . . . Design and Development

SEE STORY ON PAGE 14

VOLUME 11 NUMBER 2 JANUARY 1958 PRICE 25¢



Did you ever hear atoms move?

The physicist positions a single crystal of age-hardened steel under the sharp diamond penetrator. He touches a pedal, and the pyramidal tip of the diamond squeezes into the polished surface of the steel.

The instant that it touches, things begin to happen inside the crystal. Atoms begin to slip and slide, in layers. Some layers abruptly wrinkle and corrugate. If you listen hard when this happens, you hear a faint, sharp, "click." This is the sound of atoms suddenly shifting within the crystal.

You can see the action, too—or, rather, the results of it. The photomicrograph above shows the characteristic ridger and ripples. The black diamond in the center is the depression made by the penetrator.

By studying these patterns, and correlating the information with other data, scientists at U. S. Steel are trying to learn what happens atomically when a steel is bent, flexed or broken. Thus, they try to develop new and better steels for an exacting and ever-growing steel market.

Research is only one area in which we need high-level scientific personnel. Partly, this is due to the fact that men progress so rapidly at United States Steel. Remember these figures: among the 20,000 members of our management team, 99% attained their position through advancement within the corporation. If you want to take advantage of odds like this, write for our booklet, "Paths of Opportunity."
Write to United States Steel, Personnel Division, Room 5680, 525 William Penn Place, Pittsburgh 30, Pennsylvan

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You can get your Master's Degree during regular working hours, while earning the salary and all the benefits of a Chrysler Corporation engineer. At the same time, you will be preparing for a rewarding career as a member of the automotive engineering team that is the leader **in** the industry.

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CHRYSLER **INSTITUTE OF ENGINEERING**
GRADUATE SCHOOL
DETROIT, MICHIGAN

A DU PONT JOB-FINDER CHART FOR BS-MS ENGINEERS AND SCIENTISTS

Here is a sampling of the kinds of engineers and scientists which Du Pont will employ this year with BS-MS training—and their fields of work. The chart is an easy way to match your own interests against joh openings at Du Pont.

For example: If you are a mechanical engineer, run your finger across the "Mechanical Engineers" column. The code letters refer to the type of work (Research, Development, etc.). The departments of the Company are listed across the top. The column across the bottom indicates some of the locations where these departments have openings. Du Pont also has opportunities for other engineering and scientific specialties, but space does not permit a complete listing.

A Research
B Development
C Design
D Production
E Plant engineering
F Sales

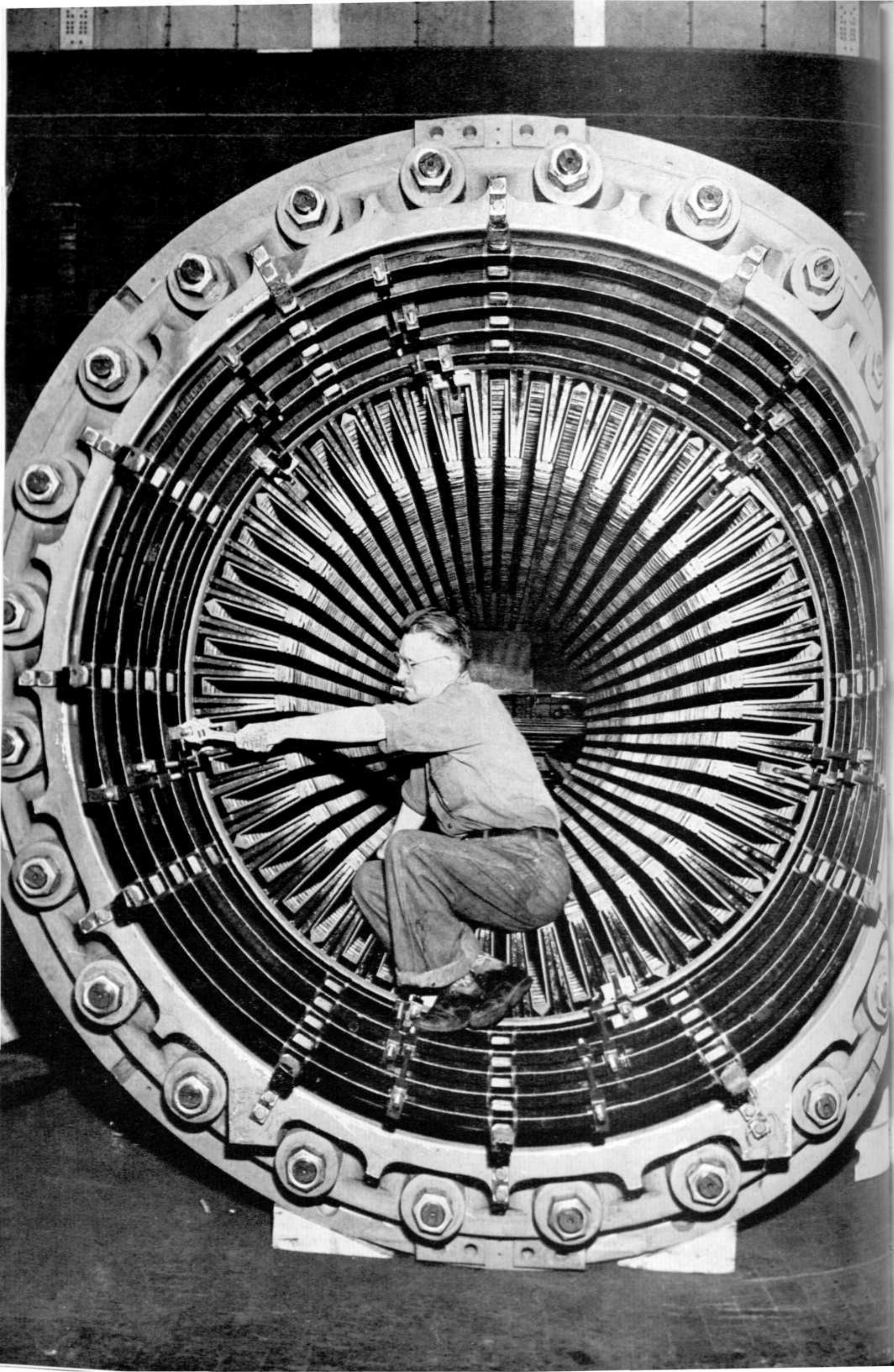
DEPARTMENT ▶	ENGINEERING	ELASTOMER CHEMICALS	ELECTRO-CHEMICALS	EXPLOSIVES	EXPLOSIVES, ATOMIC ENERGY DIVISION	FABRICS AND FINISHES
PRODUCTS	Designs and constructs major plant facilities. Conducts research and development, and provides engineering consultation in chemical and mechanical engineering, instrumentation, and materials technology.	Neoprene Rubber Chemicals Organic Isocyanates	Metallic Sodium Hydrogen Peroxide Vinyl Products Sodium Cyanide Chlorinated Solvents Nylon Intermediates	Sporting Powders Blasting Supplies Dynamite Polymer Intermediates	Nuclear Reactor Materials Heavy Water	Coated Fabrics Paints, Varnishes, Lacquers Synthetic Resin Finishes
CHEMICAL ENGINEERS	A, B, C	B	A, B, D, F	B, D	A, B	A, B, F
MECHANICAL ENGINEERS	A, B, C	B		E	A, B	
ELECTRICAL ENGINEERS	A, B, C			E		
METALLURGICAL ENGINEERS	A, B	A, B			A, B	
CHEMISTS			F			A, B, F
PHYSICISTS					A, B	
POSSIBLE INITIAL ASSIGNMENTS	Wilmington, Del., or Plant Locations	Beaumont, Tex. Louisville, Ky. Montague, Mich. Wilmington, Del.**	Memphis, Tenn. Niagara Falls, N.Y. Wilmington, Del.**	Gibbstown, N.J.	Aiken, S.C.*	Newburgh, N.Y. Parlin, N.J. Philadelphia, Pa.

DEPARTMENT ▶	FILM	GRASSELLI CHEMICALS	ORGANIC CHEMICALS	PHOTO PRODUCTS	PIGMENTS	POLYCHEMICALS	TEXTILE FIBERS
PRODUCTS	Cellophane Sponge Yarn Mylar® Polyester Film Cel-o-seal® Bands	Acids and Heavy Chemicals Biological and Agricultural Chemicals	Dyes Petroleum Chemicals Tetraethyl Lead Fluorinated Hydrocarbons	Photographic and X-Ray Film Photographic Papers Processing Chemicals	Titanium Pigment Pigment Colors Titanium Metal Hyperpure Silicon	Ammonia Antifreezes Urea Products Plastics Nylon Intermediates	Nylon Dacron® Polyester Fiber Orlon® Acrylic Fiber Rayon
CHEMICAL ENGINEERS	A, B, D, F	A, B, D	A, B, F	A, B, D, F	A, B, F	A, B, D, F	A, B, D
MECHANICAL ENGINEERS	A, B, D, E		A, B, F	A, B, E, F	A, B	A, B, D, F	A, B, D, E
ELECTRICAL ENGINEERS	B, D, E, F			E		A, B, D, F	B, D, E
METALLURGICAL ENGINEERS							
CHEMISTS			A, B, F	A, F	F	A, B, D, F	A, B, D
PHYSICISTS				A		A, B	A, B
POSSIBLE INITIAL ASSIGNMENTS	Buffalo, N.Y. Circleville, O. Clinton, Ia. Old Hickory, Tenn. Richmond, Va. Wilmington, Del.**	Cleveland, O. East Chicago, Ind. Houston, Tex. Linden, N.J. Wilmington, Del.**	Deepwater, N.J. Wilmington, Del.**	Parlin, N.J. Rochester, N.Y.	Edge Moor, Del. Newport, Del. New Johnsonville, Tenn. Wilmington, Del.**	Charleston, W. Va. Orange, Tex. Parkersburg, W. Va. Victoria, Tex. Wilmington, Del.**	Camden, S.C. Chattanooga, Tenn. Kinston, N.C. Martinsville, Va. Old Hickory, Tenn. Richmond, Va. Seaford, Del. Waynesboro, Va. Wilmington, Del.**

*Government owned, Du Pont operated **Sales and/or Research & Development only

PERSONALIZED INFORMATION—The kind of work you will do and the location of your first assignment depend on your qualifications and the openings available. Since the above chart was prepared, some of the openings listed may have been filled or new jobs may have been added to the list. For up-to-the-minute information about possible jobs for you, see the Du Pont representative when he visits your campus.

SEND FOR INFORMATIVE BOOKLETS packed with information about careers at Du Pont in chemical, mechanical, electrical, metallurgical and other engineering fields, and in research and development. Just send your name, address, class, school and name of subject that interests you to Room 2494-D Nemours Building, E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Delaware.



Spartan Engineer

. . . of michigan state university

VOLUME 11 NO. 2 JANUARY, 1958

FEATURES

DEPARTMENTS

Cover: Carquinez Bridge presently under construction will link San Francisco Bay area with Sacramento Valley. Design features of the bridge include all-welded design and extensive use of high strength "T-1" steel. Photo by courtesy of The Lincoln Electric Company of Cleveland, Ohio.

Frontispiece: INDUSTRIAL EYE-A symmetry in steel makes an **"Industrial eye"** of this portion of a giant generator stator at General Electric's Large Steam Turbine-Generator Department. This generator, when fully assembled and installed along with its accompanying steam turbine, is capable of furnishing enough electricity to adequately satisfy the electrical needs of some 26,000 persons. It will be powerful enough to simultaneously light over 3,500,000 60-watt light bulbs.

MEMBER ENGINEERING COLLEGE MAGAZINES ASSOCIATED

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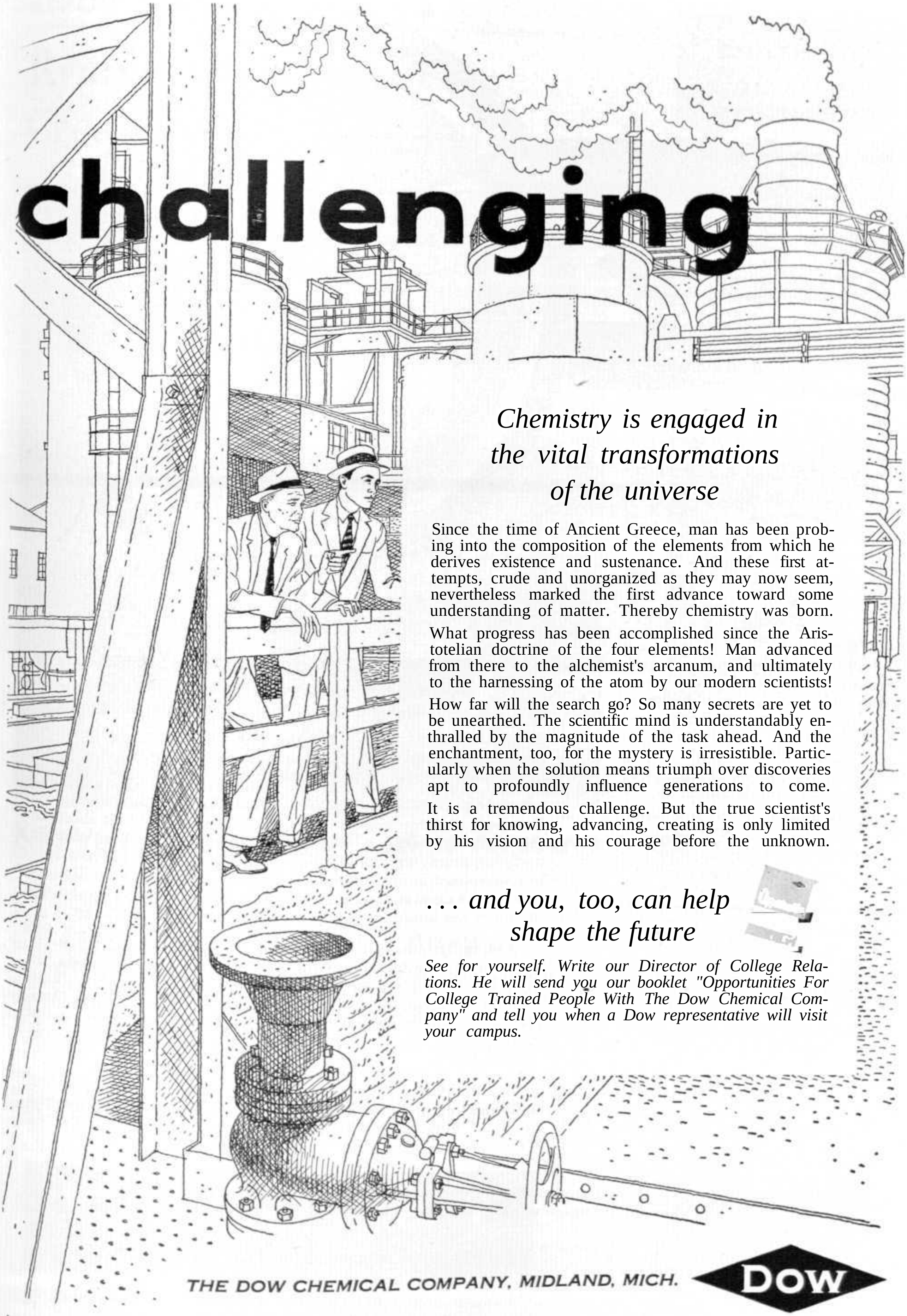
Left to right: Lou Bernardi, Notre Dame, '54; Norman Lorenson, Mich. St., '55; Ernest Schurmann, M.I.T., '53; Dick Swenson, Purdue, '50.


challenging
Chemistry is engaged in the vital transformations of the universe
Since the time of Ancient Greece, man has been probing into the composition of the elements from which he derives existence and sustenance. And these first attempts, crude and unorganized as they may now seem, nevertheless marked the first advance toward some understanding of matter. Thereby chemistry was born.
What progress has been accomplished since the Aristotelian doctrine of the four elements! Man advanced from there to the alchemist's arcanum, and ultimately to the harnessing of the atom by our modern scientists!
How far will the search go? So many secrets are yet to be unearthed. The scientific mind is understandably enthralled by the magnitude of the task ahead. And the enchantment, too, for the mystery is irresistible. Particularly when the solution means triumph over discoveries apt to profoundly influence generations to come.
It is a tremendous challenge. But the true scientist's thirst for knowing, advancing, creating is only limited by his vision and his courage before the unknown.
. . . and you, too, can help shape the future
See for yourself. Write our Director of College Relations. He will send you our booklet "Opportunities For College Trained People With The Dow Chemical Company" and tell you when a Dow representative will visit your campus.
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DOW

Ryan's Diversification Creates Wide Opportunity for Engineers

X-13 Vertijet Adds New Punch to Airpower

Washington—Unveiled in an unprecedented flight at the Pentagon, the Ryan X-13 Vertijet gave military officials a glimpse of the future of air-Power. Like a huge bat, the Vertijet unhooked itself from its nose cable into honzontal flight and roared out of

World's first jet VTOL aircraft, the Vertijet combines the flashing performance of jet power with the mobility of missile launching. It frees supersonic airpower from runways and airports. Without lansing gear, flaps, actuators, the X-13 concept means less weight-more Performance in speed and climb. In the words of a top Air Force neral, "The Vertijet has provided for planners with a new capability manned aircraft of the future."

Achieved in close cooperation with the Air Force and Navy, the Vertijet is based upon Ryan's unsurpassed 2 1/4 million manhours of research, development, and test in VTOL aircraft.

Navy, Army to use New Ryan Nevigator

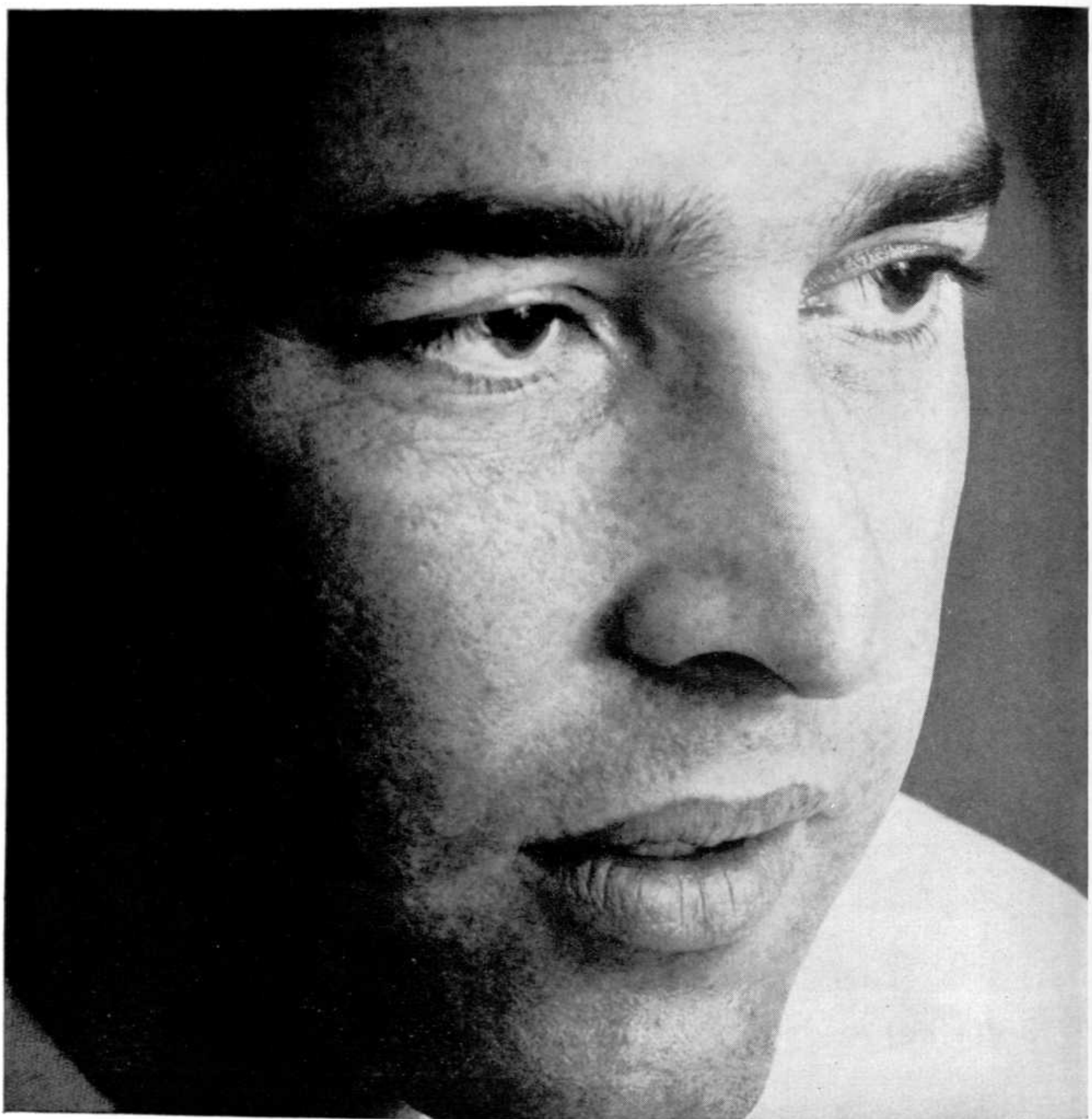
San Diego-Navy aircraft-piston engine, jets and helicopters will soon be equipped with Ryan lightweight automatic navigators and ground velocity indicators. Lightest, simplest, most reliable, most compact of their type. these systems are self-contained and based on continuous-wave radar.

The navigators provide pilots with required data such as latitude, longitude, ground speed and track, drift angle, wind speed and direction, ground miles covered and course and distance to destination. Ryan is also developing guidance systems for supersonic missiles.

More Orders for Ryan Firebees

San Diego—Nearly $20 million worth of Ryan Firebee jet drone missiles have been ordered by the Air Force and Navy in 1957. In operational use, the Firebee is the nation's most realistic "enemy" target for evaluating the performance of air-to-air and ground-to-air missiles. It possesses the high speed, altitude, maneuverability and extended duration needed to simulate "enemy" intercept problems.

America's number-one jet drone, the Firebee is another example of Ryan's skill in blending aerodynamic, jet propulsion and electronics knowledge to meet a challenging problem... answer a vital military need.



YAVNO

...on science and impossibility

"Scientific knowledge is derived from observations of the world. Our imaginations, however, are not bounded by this constraint—we can easily imagine physical nonsense. Not everything is possible. We sometimes get the opposite impression because new scientific discoveries force us to modify an old theory, and give rise to new and unexpected possibilities. But the point is that the old theory was verified for some class of physical phenomena, and a domain of validity was established. The new theory, however radically it may differ from the old one in its conceptual basis, must always agree with the old theory in the predictions it makes for that class of phenomena. Despite the greater generality of quantum mechanics, Newton's laws still apply to macroscopic objects. Parity is still conserved for the strong interactions. The old impossibilities still remain. Within the limits defined by the impossibilities, there is plenty of room for man's inventiveness to operate. In fact, the game is even more challenging that way."

— Richard Latter. Head of the Physics Division

THE RAND CORPORATION, SANTA MONICA, CALIFORNIA

A nonprofit organization engaged in research on problems related to national security and the public interest

HOW A HIGHWAY IS BUILT

Courtesy of Portland Cement Association

The **huge 13-year** national highway program now shifting into high gear over **the** country will give many millions of Americans their opportunity to be **roadside superintendents at** one of **the** greatest shows on **earth—modern, mechanized roadbuilding** on **a** large scale.

To those who consider roadbuilding prosaic, a word of caution is in order. **Childhood remembrances** no longer **apply. Highway** design and construction **today** are **as different** from that of **the** 1920's—our last big **highway-building** era—as 1957 model cars are **different** from the Model A. From a cut-and-fill operation **Involving** mostly manual labor, roadbuilding lias progressed into one of the most complex of modern businesses, involving such varied skills as aerial photogrammetry and soils chemistry, and such specialized tools as electronic computers, diamond-tipped saws and two-way radios.

The path for a modern road may be cleared by a machine capable of removing eight truck loads of earth in one huge bite. The most modern of today's highways are built by paving "trains" of ingenious machines which actually move on rails, mixing, depositing, spreading and leveling the concrete pavement. Even the concrete itself is different, containing literally billions of microscopic air bubbles in every yard.

These are some of the surprises which greet the roadside superintendent behind the barricades. But, engineers point out, such a casual visitor sees only the final phase of roadbuilding. Planning and design of the highway started many years before.

Who's Going Where?

The job of planning an Interstate System highway is staggering. State highway departments are determining right now how many vehicles, of what type, will be traveling between various cities, and by what routes, at various hours of the day in the year 1975. This is not to guide them in building tomorrow's highways, but *today's.* By law, highways now being built on the 41,000-mile National System of Interstate and Defense Highways must be designed and built to carry the traffic of 18 years from now.

This means land purchased now must be wide enough to accommodate the number of lanes required for future volumes of traffic. The road must be located where it will be most needed in 1975 and beyond, as well as today.

The decisions our highway engineers make will play a vast role in shaping the future of America for not only must they plan for the needs of existing communities, but for communities as yet unborn which will result from these new highways. Pavements and bridges must be strong enough now to carry the increased volumes and the types and weights of vehicles that will use them in the year 1975.

To build all roads to the highest standards would be prohibitively costly. But to "under-design" a heavy duty highway is even more wasteful. Thus the responsibility resting upon the shoulders of the state highway engineer and the difficulty of his forecasting job are enormous.

Highways Don't Just "Happen"

In early America, the first roads often followed Indian paths through the forests, or even routes favored by buffalo. Today's major highways are not left to such chance. Once traffic studies and forecasts have shown the needs, the actual routes of the new highways are determined by the most advanced engineering skill.

To reduce driving time and to produce the gentle curves and easy grades necessary for safe high-speed driving, today's roads are sometimes blasted right through hills rather than winding around them. Material removed from this hill of solid rock will be used to fill in nearby low areas.

Selecting the route begins with a survey of the land which the new highway will cross. To determine the most practical and economical route, the engineer must consider the contour and geology of the land, the flow of water, and even such seemingly remote matters as **the** angle at which the winter sun will shine on the snowy slope of a hill. This is where aerial photography comes in: many highways are now designed on the basis of three-dimensional aerial Photographs which **form** an extremely accurate topographical map.

Other engineers armed with boring drills, seismographs, and instruments for chemical analysis gather data on the soil. The surveyors determine whether the ground will be firm enough to withstand the anticipated load of traffic. They also plan how "cuts"—areas where earth is **moved—can** be most **economically** balanced with "fills"—sections where earth must be *added* to minimize earth moving.

Now they are ready to design the new highway. It may take many **months** to reduce the surveyors' intricate findings to scaled blueprints and accurate cost estimates. On the New York Thruway, for instance, an eight-mile stretch required a plan book containing 1,200 separate maps.

An important step remains—acquisition of the right-of-way. Today's superhighways are built on a strip of land often more than 300 feet wide. To obtain this much land is seldom an easy, and sometimes a very time-consuming task. It becomes even more difficult and expensive when—in the case of a city expressway—buildings have to be moved or wrecked and families relocated. For Chicago's Congress Street Expressway, for instance, right-of-way acquisition alone cost $4.4 million out of the total cost of $12.5 million per mile.

With right-of-way purchased, and plans and specifications approved by the U. S. Bureau of Public Roads to qualify for Federal aid, the project is at last ready to be advertised for bids. The responsible contractor who submits the lowest bid gets the contract.

(Continued on Next Page)

Photo taken during land clearance for Chicago's Congress Street Expressway shows some of the several hundred buildings that had to be removed for construction of this portion of the city's vital west side route.

The Builders Move In

The contractor's forces arrive at the construction site, set up camp, and take over like a modern mechanized army. The first machines to see action are usually the bulldozers; they are sent crashing through the landscape to shave off trees, obstacles and underbrush. When rock is encountered, it has to be blasted and hauled away in trucks.

The bulldozers are followed by giant scrapers that clear and shape the terrain along the right-of-way. They rip off sod and top soil, shave off high ground and fill in the low areas. One of these giant scrapers can move as much earth as a thousand men with wheelbarrows.

Next come machines which cut roadside ditches or trenches for drainage pipe. Good drainage is essential on any road. Unless the soil under the pavement is kept dry, it loses its ability to support the pavement. Simultaneously with the installation of drainage pipe, work is begun on other structures such as bridges and culverts.

After the right-of-way has been cleared and drainage facilities installed, the earth movers pull out. They leave the roadway a few inches below grade, ready for placing the pavement. This "subgrade" is compacted tightly by giant rollers to prevent future settlement.

Next, a four to six-inch thick layer of granular material-sand, gravel or crushed rock-is deposited on the subgrade to keep the foundation well drained and free of frost. This material is trimmed by a "grader" to a precise tolerance of about 1/16th of an inch.

Meanwhile, crews have been placing the forms for concrete. Since these forms also serve as rails for the finishing equipment, they must be placed very accurately to make sure the pavement will be uniformly even to satisfy exacting inspection.

Completed portion of Congress Street Expressway knifes through densely built-up west side of Chicago, cutting travel time to some of the city's western suburbs by one-half. Right-of-way amounted to one-third of the Expressway's total cost.

Paving Begins at Last

All this work has been preliminary to building the Pavement. The giant paving machines which can mix and place as much concrete in one day as is used in building 200 average-sized houses now appear. The huge drums of the paver are loaded with dry material-cement and aggregates-delivered by truck from a batching plant. Then in a series of automatic operations, the proper amount of water is added, the concrete is mixed and delivered to the dump bucket The bucket rides out over the roadway on a long boom, places its load-generally about IK cubic yards of concrete—exactly where needed, and returns for another load.

As the concrete is placed on the roadway by the paver, the "spreader" moves up. Using the side forms as rails, this self-propelled machine pushes a big Paddle from side to side to spread the concrete evenly over the space between the side **forms. A** giant revolving screw is also often used for this purpose.

After the concrete has been leveled, it is compacted by vibrators—a row of pneumatically operated "feet," which beat into the concrete at the fantastic rate of about 4,000 times a minute. The vibrators remove any voids that may have been present in the newly placed concrete.

Bringing up the rear is a self-propelled finishing machine called a "longitudinal float." A typical machine consists of a hydraulically controlled steel blade, or "screed," that moves slightly from side to side as the machine progresses along the pavement. This final mechanical operation gives a smooth, true surface to the pavement.

For final finishing, men push long-handled wooden floats back and forth across the finished pavement,

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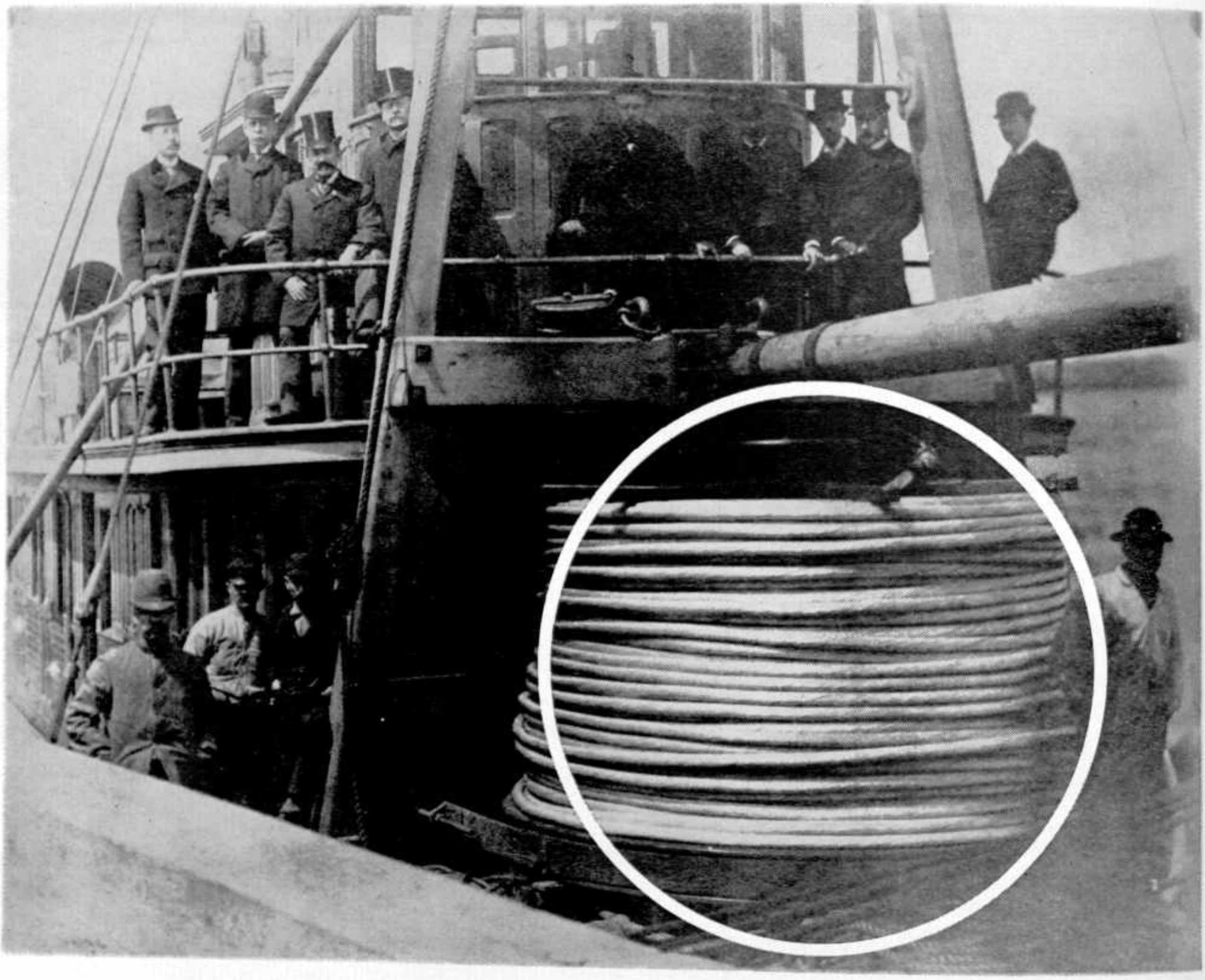

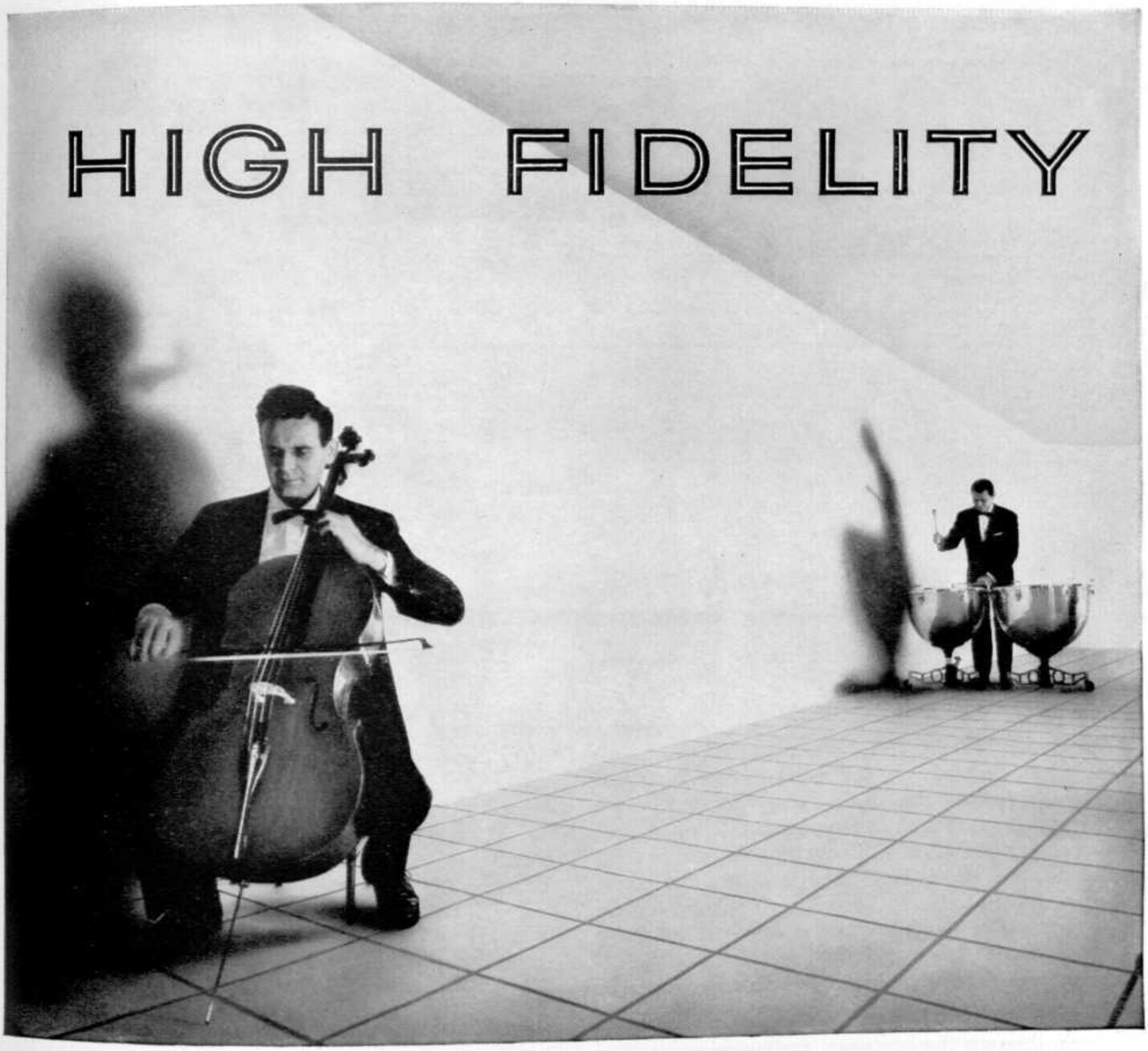

How RCA brings a richer, wider range of musical sound to your home

Before high fidelity, the sound of recorded music was limited—much as piano music would be if you could hear only the notes played on the center of the keyboard. No rich bass notes, no keen, [illegible] vibrant highs.

RCA achievements in the science of acoustics changed all that. Today, with RCA Victor [illegible] records and high fidelity "Victrolas," the *full range of sound* is reproduced so faithfully that you can enjoy music almost as though you were *there.*

And now, Stereophonic Sound! A new and dramatic dimension in recorded music is also yours to enjoy on RCA high fidelity instruments. Stereophonic units can be added to most "Victrola"* Hi-Fi systems any time you choose.

In this, as in almost every area of electronic progress in home entertainment, defense and industry, the leadership of RCA serves you. RCA *means* electronics at its best!

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RCA offers careers in research, development, design, and manufacturing for engineers with Bachelor or advanced degrees in E.E., M.E. or Physics. For full information, write to: Mr. Robert Haklisch, Manager, College Relations, Radio Corporation of America, Camden 2, N. J.

RCA RADIO CORPORATION OF AMERICA

Fiberglas

by O. H. Doutlick

The origin of glass and its manufacture is not known with certainty. Historians state that the Phoenicians discovered glass by a happy accident when preparing a meal upon the seashore. They placed their cooking vessel upon blocks of carbonate of soda and sand, and the union of the sand and the alkali, when **subjected** to the fire, resulted in pellets of glass. Egyptians made jewels of glass as early as 5(K)() H. C. In some ancient tombs, glass has been found that imitates emeralds, rubies, sapphires and other precious stones.

Down through the centuries, craftsmen and skilled artisans have guarded the art of glass-making **with** the greatest of pride and jealousy. They have formed **guilds** and maintained an air of secrecy in the progress of glass manufacture. Venetian and Steuben glassware, with others of skill and beauty, have enjoyed recognition by people throughout the world.

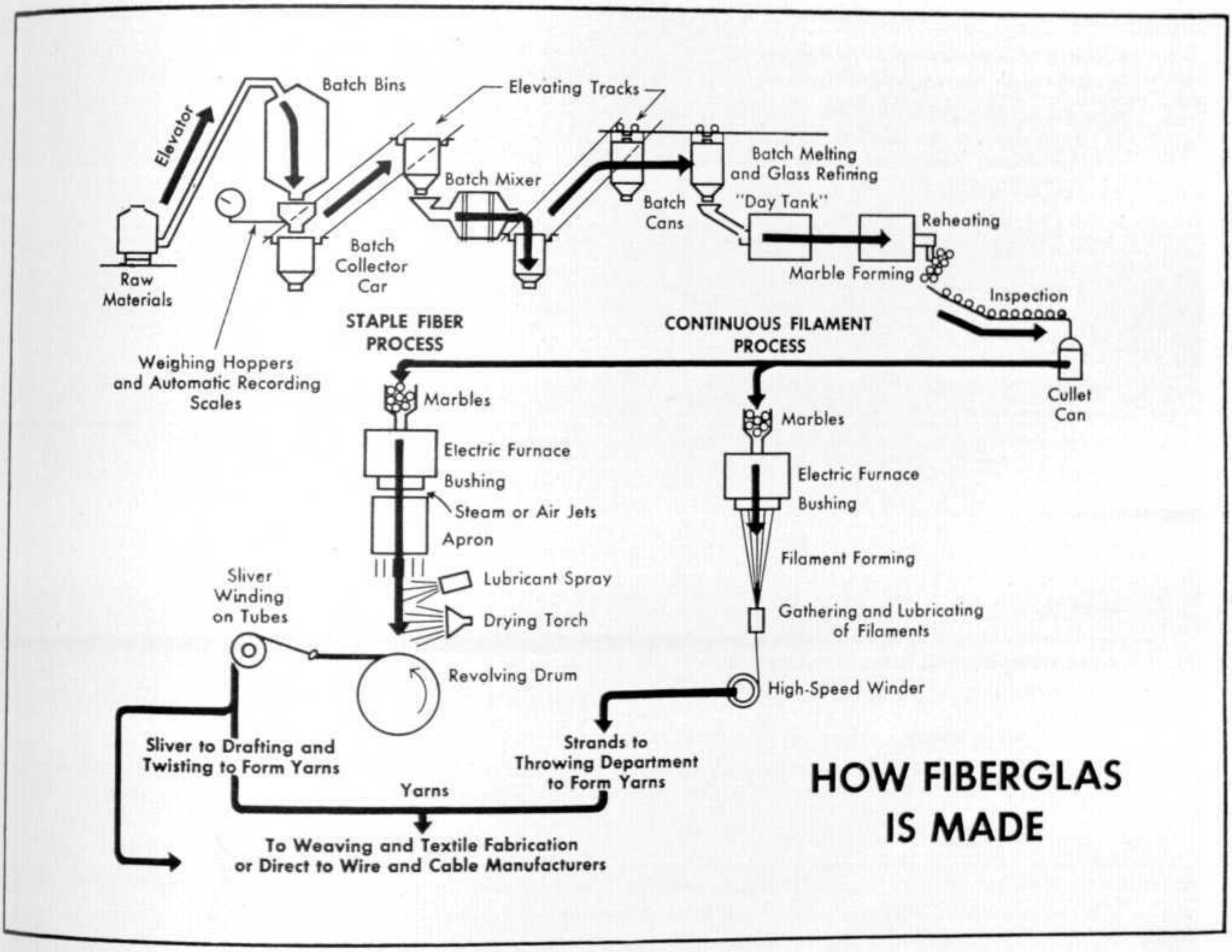
The most recent development, in the glitter and are of glass, is fiberglas, which was still a laboratory curiosity a scant twenty years ago. The versatility of fiberglas moved the product from the laboratory into industry.

Fiberglas was the result of research programs by skilled people to better man's way of life. In 1931 Owens-Illinois Glass Company, one of the largest makers of glass containers, was busily searching for new products to supplement its line of manufactured products. They launched a program of research in glass fibers, on which German technologists had already done promising work. The Corning Glass Works, in 1935, began studying the same field with development and research programs. The two companies started to exchange experimental and research results in an effort to speed their technical progress. After three years of mutual cooperation and the spending of five million dollars in research, they were convinced that mass production of fiberglas was technically and economically feasible. Accordingly, in October of 1938, the two firms organized Owens-Corning Fiberglas Corporation to take over their joint research efforts in this new product.

The Owens-Corning Corporation has granted patent licenses, with reasonable royalties, to several major manufacturers to produce fiberglas in its various forms.

In its fascinating journey toward its various markets, fiberglas starts out as a batch of silica, lime, soda and other chemical ingredients in a huge melting and processing tank. The material progresses through several manufacturing steps, which fall into two basic categories. In the first system, the molten glass is steam-drawn, with high pressure, on to a moving belt which produces a delicate, fluffy mass of short fibers, known as glass wool. In the second system, the molten glass is extruded through minute holes in the bottom of the furnace, and the resulting threads of glass are caught on a rapidly revolving drum and spun into any desired thickness-coarse, or finer than human hair, depending on the end use of the glass filaments. The glass wool and the glass filaments are the basic foundation of the glass fiber industry.

Glass wool is widely used for insulation and **for** filtering. The product provides a vermin and moisture-proof insulating material for homes. When glass is coated with oil, it makes a very effective air cleaner or filter for numerous uses in the home and in industrial applications. The oil, on the surface of the glass wool, will catch dust and foreign substances drawn through the filter.



Glass filaments are the most widely used in the home and industry. The glass filaments are woven into cloth and made into very decorative curtain and wapery material. The material is easy to maintain, durable and has an excellent appearance. The cost of drapery and curtain material to the consumer is competitive to other materials **that** existed before the fiberglasera.

Whatever its specific use, fiberglas boasts a com- Mnation of properties that are hard to match by rival materials. Products made from **fiberglas** arc durable, resist combustion, dimensionally stable (that is, will not contract or expand, warp or buckle) and resistant to moisture, corrosion and aging. Products with fiber- gas may be stronger than steel or aluminum, lighter than cotton and as flexible as silk.

strands of fiberglas are used to **reinforce** plastics, thermoplastic and and thermosetting compositions, in much the same was as steel is used to reinforce con crete. The thermoplastic resins or plastic that are

used are polystyrene and **polyvinyl** chloride. The ther- mosetting plastic used with fiberglas are phenolics. melamines, epoxies and the **polyesters.** The polyesters have found the widest use, to **date,** as **they** are **usually thick liquids that harden** when catalyzed (that is, when aided by a **chemical** that accelerates the react- ion) and heated properh-. The glass strands may be placed in paralled patterns, in random patterns or in layers at various angles depending on the specific loads which are encountered in **the** product or part that is used in a product. Typical examples **of** interest are as follows:

a-Fishing rods, in which all the strands of fiber- glas are made to run lengthwise, when the rod is being made, to take care of the loads when catching and landing **a** fish.

b-Automobile bodies, where the panel strength must be nearly uniform in all directions, so a mat of fiberglas is used.

c-Bathtubs, which are made of plastic reinforced with fiberglas, are items that require a uniform strength and therefore, also use a mat of fiber- glas.

Boats, furniture, lamp shades, safety hats, aircraft ducts, radar scanner, radomes, truck tanks and wash- ing machine tubs, to mention a few products, require the product to have uniform strength in all directions for maximum safety and durability.

The combination of fiberglas and plastics is one of the most easily molded materials known to the mold- ing industry. The materials require extremely low pressures of from zero to 250 pounds per square inch. The use of pressure is generally required only to

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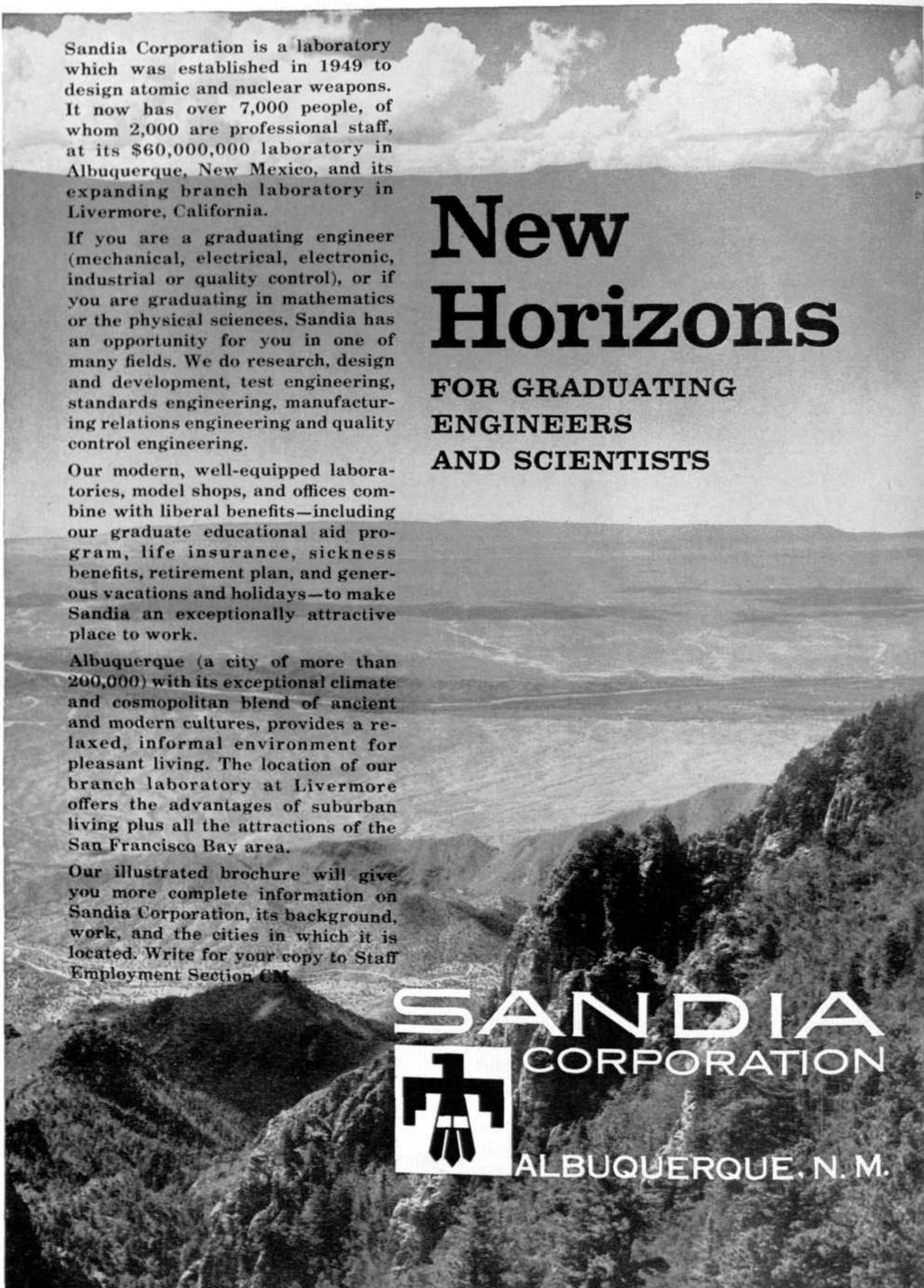
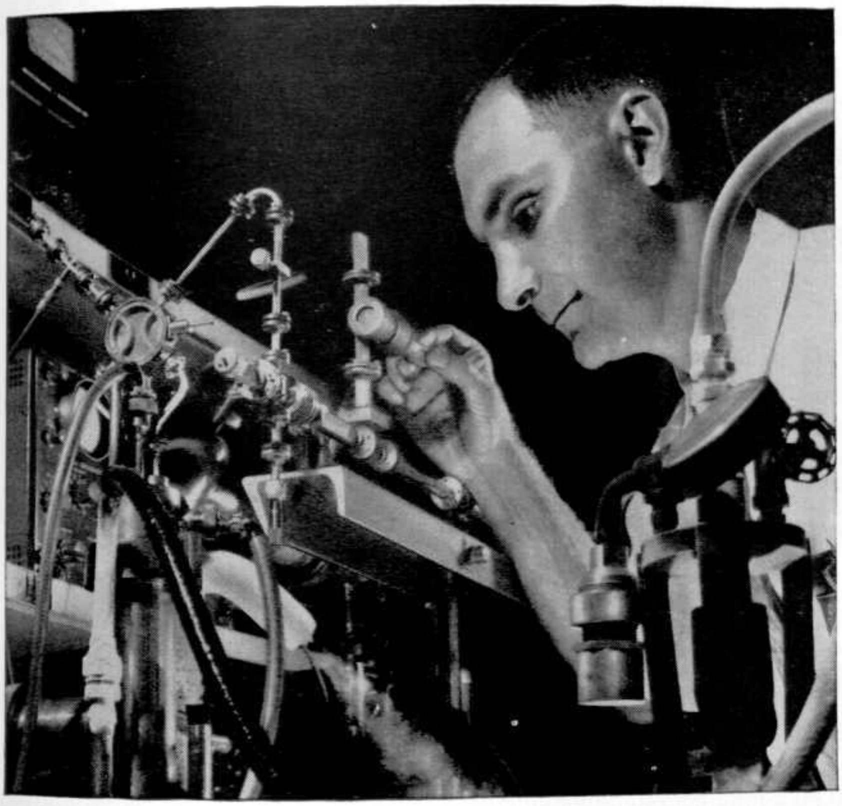


This photograph depicts the view from 10,800 feet above sea level at the crest of the Sandia Mountains, looking westward across the Rio Grande Valley and the northern limits of the city of Albuquerque.



Dr. M. A. Biondi (Massachusetts Institute of Technology, B. S. '44, Ph. D. '49) measuring ultra-microwave transmission through superconductors. This experiment is a joint effort of a group of Westinghouse scientists aimed at obtaining a better understanding of the nature of superconductivity.

Westinghouse Scientists Probe Secrets of Superconductivity, using...

The Coldest Cold

Temperatures within a fraction of a degree of absolute zero are produced routinely by Westinghouse scientists in their search for more knowledge of the important phenomena of superconductivity. These phenomena rank with the nature of nuclear wees as one of the most fundamental problems facing the theoretical physicist. When superconductivity is completely understood, its Principles could well revolutionize the electrical and electronic industries.

The basic principles of superconductivity have eluded an explanation since 1911 when the first example of the complete disappearance of electrical resistance in metal was discovered. Today scientists at Westinghouse Research Laboratories in Pittsburgh, are making significant contributions to the field by their low-temperature research.

Superconductivity occurs in certain metals, alloys and compounds which, below characteristic transition temperatures, completely lose electrical resistance. While in this superconducting state, they are perfectly diamagnetic, i.e. will completely exclude magnetic flux when placed in a magnetic field.

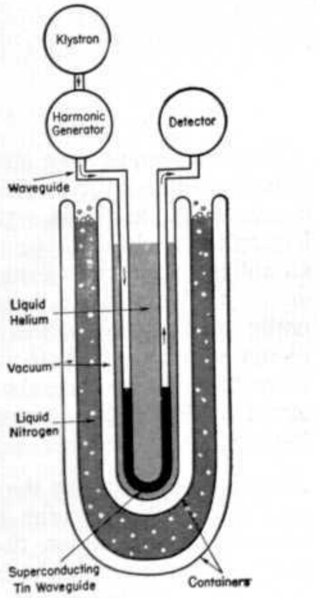
While this fundamental research is being conducted by theoretical physicists in search of knowledge and understanding of first principles, from even the terse description above of superconductivity, the imagination begins to run wild with engineering applications. An electronic computer using superconductivity memory elements will switch 10,000 times faster than conventional computer elements, will store 10 times as much information per unit space as ordinary computers. If the conditions can be fulfilled to make a substance superconductive in temperature regions other than that around absolute zero, design of every electrical or electronic product will be radically changed. Imagine considering the commonest electrical design problem without having to take into account electrical resistance!

While these exciting considerations whet the imagination, they are not the primary object of the low-temperature research going on at Westinghouse. This and many other research projects are being conducted to discover new phenomena and new knowledge of the universe. It is done on the belief that all research is an investment in tomorrow.

To the young, creative engineer this means exciting opportunities for graduate engineers in these exciting fields:

ATOMIC POWER	RADAR
AUTOMATION	SEMICONDUCTORS
JET-AGE METALS	ELECTRONICS
LARGE POWER EQUIPMENT	CHEMISTRY

. . . and dozens of others



Highly simplified diagram of the apparatus used to study the absorption of millimeter wavelength microwaves in superconducting tin waveguide. Studies of this type have shown the existence of a gap in the energy levels of superconductors. These studies have thus provided key information in solving the puzzle of superconductivity.

For more information on Westinghouse research in the field of superconductors and low-temperature studies, or information on job opportunities, write Mr. J. H. Savage, Westinghouse Electric Corp., P.O. Box 2278, Pittsburgh 30, Pa.

Westinghouse

FIRST WITH THE FUTURE

When R Equals Zero

By Richard]. Plvgge

Man lias **always been interested** in **the** world about him. Throughout the pages of **history** he has acquired **a knowledge of the** things **he** could see. Since the **beginning of the** 20th **century, he** has been making an intense **study** of all natural **phenomena;** the invisible and not **naturally** occurring, as well as that **easily** seen. **Lately,** he has been concentrating on the extremes in nature, lie is pushing back tile barriers ol knowledge by **studying** the **depths** of **the** oceans, the **upper** limits of **the** atmosphere, the antarctic, and **the** arctic.

He is also **observing the** extremes of the temperature range; **studying** the high temperature thermal **barrier** and the region near absolute zero. At low temperatures materials exhibit two strange results: superconductivity and paramagnetism. These seemingly **unexplainable** phenomena rank with the nature of nuclear forces as one of the major problems facing theoretical physicists. It is the phenomena of superconductivity in the region near zero that we would like to discuss here.

Near the turn of the century Heike Kamerlingh Onnes, a Dutch physicist, was successful in liquefying helium at 4.5°K. The K stands for the Kelvin temperature scale which is used by scientists. It is also referred to as the absolute scale, because it is zero at absolute zero. Absolute zero on the common Fahrenheit scale is —460° F. Northern Siberia once recorded an atmospheric temperature of — 90° F, therefore, when Onnes liquefied helium, he had produced a temperature about 400° below the coldest man has ever felt.

Using liquid helium as a cooling agent, Onnes began studying the behavior of materials near absolute zero. When working with frozen mercury he noticed that at 4.2° K the material had no resistance to an electric current. Contrary to all the basic physical laws he knew, the resistance, R, dropped to zero at that particular temperature. This phenomena is now referred to as superconductivity.

To understand superconductivity, we'll have to look at conductivity in normal temperature ranges. Physicists believe that conduction is the process in which electrons move through the lattice of atoms which make up the material. At normal temperatures atom lattices contain a great amount of thermal energy. In their high energy states, they vibrate with large displacements. The electrons, in passing through the lattice, find they are hindered by these vibrating atoms. Collisions and interactions between these vibrating atoms and the electrons produce a loss of displacements. The electrons, in passing through the energy to the electron current, and therefore is referred to as the resistance of the material.

As the temperature drops, the resistance also drops, yielding a curve of R vs. T as a straight line in figure 1. This curve is reasonable when we picture the conducting material as a vibrating lattice structure. As the vibrating displacement decreases because of a loss in thermal energy, the atom structure becomes more open space. Therefore, the resistance to the flow of electrons becomes less.

Because impurities in the material cause irregular lattice structures, we find that there is a residual resistance. Due to this residual resistance, the R does not approach zero as the T approaches zero; instead, it levels off at the residual resistance, (figure 1)

In superconductive materials a different effect is noticed. When the temperature approaches zero there is a particular temperature, the transition tempera-

WHEN R EQUALS ZERO, was written by a Grand Rapids senior, Richard Plugge. Richard is majoring in Electrical Engineering and is a member of AIEE-IRE, Tau Beta Pi, Eta Kappa Nu and Pi Mu Epsilon.

RICHARD J. PLUGGE

ture, at which the residual resistance suddenly drops to zero. It is interesting to note that good conductors at normal temperatures retain a relatively high residual resistance near absolute zero, and that superconductors at temperatures near zero are very poor conductors at normal temperatures. In fact, copper is sometimes used as an insulator in superconductive circuits. To date, there are twenty-one elements and many alloys and compounds which become superconductive at transition temperatures between zero and 18°K.

There have been many attempts made to try to explain superconduction. One of the most successful theories was made by Frohich and Bardeen. They believe that at low temperatures the vibration of the atoms in the lattice structure and the wave motions of the electrons are synchronized. The result is that the electrons reduce their energies and ride along with the lattice vibration as oil a wave. Thus, the resistance to the flow of electrons disappears.

Some features that help to formulate a theory of superconduction are that light isotopes become superconductive at higher temperatures than do heavier ones. Also, elements with 3, 5, or 7 valance electrons per atom become superconductive most easily. Superconduction also seems to favor bulky crystal structures with large amounts of empty space. The highest known transition temperature is 18°K. It is for a compound of tin and niobium which has an average of 4.75 valence electrons per atom and a bulky eight atom, wide open crystal structure. One of the aims of solid state physicists is to produce a superconductive material with a high transient temperature so it can easily be used in electronic circuits.

There has been much data obtained experimentally on superconductors. We find the transition temperature is a function of the magnetic field strength, the material, and the absolute temperature. Figure 2 shows the interaction between the absolute temperature and the magnetic field strength for niobium and tantalum. These two elements are the most important as far as practical use is extended today. Below the curves, the element is superconductive. Above the curves, it has residual resistance or normal conduction. One can easily see that the transition from superconductivity to normal conductivity occurs with an increase in the magnetic field strength at a constant temperature. It is this feature that makes superconductive elements of practical importance in circuits today.

There are two ways in which we hope to use superconductors. One is as high frequency antennas, and the other is in switching and computer circuits. At present, the cryotron (figure 3) is receiving much attention as a superconductive computer element. The antenna applications are still very much theoretical.

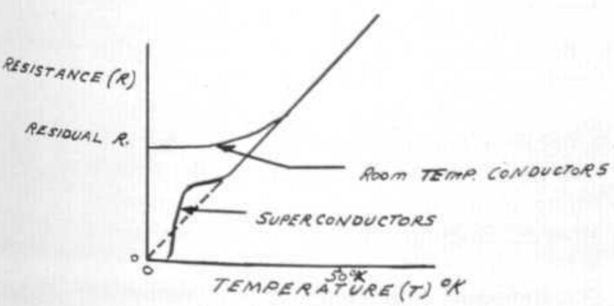


FIG. 1. R VS. T

(Continued on Page 64)

Coal-Fuel Or Raw Material?

by Charles W. Griffen

With the advent of atomic power and solar energy, coal is one of the foremost technological problems of OUR **time. In 1953, For the** first time in its history, coal **dropped from .1 leading place ai** a source of energy to a **position behind** oil. each producing more than **one-third of the energy requirements. Coal** is still a **big and vital element** in the **operations** ol our industrial **societyi Some 400** million tons, the amount **annually being consumed** in this **country,** is not a trifling **quantity.** It accounts lor over three-fourths of U. S. electrical **energy;** it is **Indispensable, in** the form of coke, tor the production of iron and steel; and in many other **ways** is woven through all the basic strata of industry.

The major fact about coal, however, is the vast store **remaining** underground. In carbon alone, mineable **coal reserves represent** 300 times the world's estimated reserves of oil. Carbon is the backbone of all life **and** commerce; carbon compounds in one form or another make up 95', by weight of all the products of human labor. In the past fifty years, coal has had its biggest and most lucrative markets cut from under it by more convenient or more efficient fuels-oil and natural gas for heating, Diesel fuels for ships and railroads. Now it is faced with the emergence of atomic power and solar energy. An intricate shifting of the technological base of industry is in progress. This may well prove to be a very definite asset to our economy. Industry persisted in regarding coal primarily as a fuel, while the petroleum industry began early to do **heavy** research on its basic raw materials.

\\e need only to examine a lump of coal to be reminded of its plant origin from the regular cellular patterns. Some 300 million years later, after being subjected to extreme pressures, the remaining substance consists of from 60 to 96% carbon, the rest heing hydrogen, oxygen, nitrogen, sulfur, and mineral ash. The analysis of coal into its elemental constituents, however, tells us almost nothing about it as a chemical substance. For this we must know the chemical structure of coal, the way in which its atoms **are** linked to form molecules. Until recently the exact chemical structure of coal, due to its great complexity and variability, was almost totally unknown. As the derivatives from coal were studied, their molecular structure fell into two geometrical divisions. From coal tars came a series of compounds, called aromatic because of their pungent odor, whose structure took the form of ring-shaped molecules. The basic unit was benzene, consisting of a central hexagon of six carbon atoms with six hydrogen atoms attached. On this ring all the rest of the compounds were built by the simple addition of one carbon atom at a time. As the number of carbon atoms in the molecule reached ten, two benzene rings were fused, sharing two of the carbon atoms between them to form naphthalene. Three fused rings formed anthracene, which is the largest molecule in the series.

From coal gas and the like came another series of carbon compounds, called aliphatic because of their fatty or oily character, whose distinguishing form was a linear or chainlike molecule. The basic unit in this series is methane, the simplest of hydrocarbons, consisting of a single carbon atom surrounded by four attached hydrogen atoms. From methane the series builds up, again by the increment of one carbon atom per molecule into progressively longer and longer carbon chains.

Charles W. Griffen is a senior in Chemical Engineering from West Springfield, Penna. He is a graduate of State Teachers College, Edinboro, Penna., president of the American Institute of Chemical Engineers and a member of Phi Lambda Tau.

CHARLES W. GRIFFEN

These two broad structual forms—ring and chain, turned out to be the cornerstones of synthetic organic themistry. With the simpler coal derivatives as starting points, molecules could be built up, linked and rearranged by various reactions to form a vast variety of compounds with different properties. Though the number does not begin to approach the enormous **variety** and complexity of carbon compounds in **nature,** no fewer than 500,000 compounds have been synthesized. These compounds embrace the whole range of dyes, drugs, perfumes, plastics, fibers, rubbers, explosives, adhesives, detergents, solvents, insecticides and other products that constitute the modern organic chemical industry.

Throughout this development the exact molecular structure of coal remained a mystery. Exactly how coal was put together was **a** matter difficult to ascertain. To begin with, coal was a highly variable mixture of complex plant substances converted by the coal-forming process into other complex substances. Any attempt to break the complex coal molecules apart by the usual combustion methods so drastically altered them that the resulting fragments could not be confidently identified as bearing any relationsnip to the structure of the starting materials.

In the past ten years, a mounting attack on the problems of coal has begun to clarify the chemical srtucture of coal. The sum of these investigations is that the basic molecular skeleton is now generally agreed to be a ring-shaped structure whose nucleus is the six carbon ring of the aromatic compounds. The total molecule is by no means as simple as benzene. The skeletal ring of carbon atoms is surrounded by hydrogen atoms and a variety of atomic groups such as hydroxyl units (-OH) and methyl units (CH_3). The carbon ring may also be fused with other rings into discrete nuclear groups or clusters. These units, divisible only by chemical means, probably form the basic molecules of coal. They **range In** size from about four to thirty fused rings. **For** a given **coal** the clusters all belong to the same skeletal **arrangements,** T'lie clusters form rather **flat** molecules which **are** stacked so tightly that there may be some chemical bonds between the layers. This gives coal a basic structure like continuous layers of chicken wire.

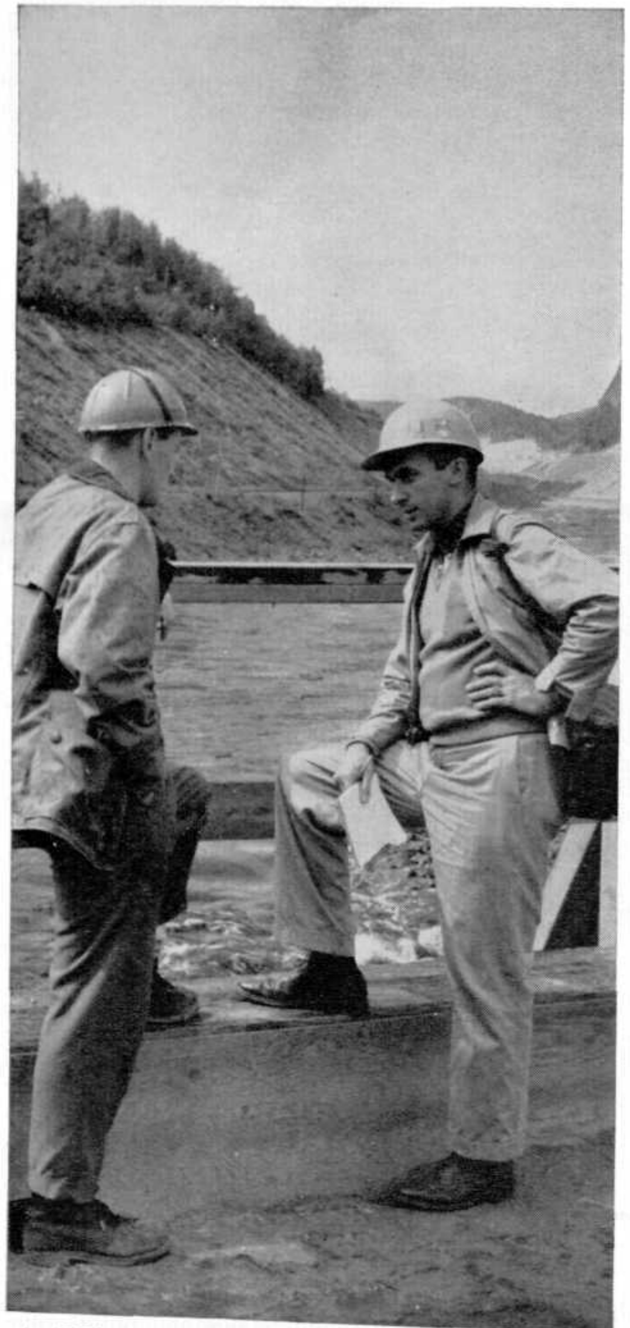
There are five basic processes for extracting tin hidden wealth of materials from coal. Most of them were originally devised in Germany where, because petroleum was lacking, research centered on this alternative source of basic hydrocarbons. The processes range from methods for reducing the chemical parts of coal to the simplest gaseous molecules, then rebuilding them into desired products, to methods for extracting chemicals directly from coal in mixed groups, then separating them. In order of increasing complexity or specialization, the range of coal processes are:

1. Carbonization. This is the oldest process, noted in the by-product coke oven, where charges of bituminous coal are roasted to burn out part of the carbon, drive off volatile substances and give three main product groups: metallurgical coke, coal tar, and gases. The principal gas is CO, used as fuel gas and to make ammonia, methyl alcohol and other chemicals. Only about one-third of the tar finds its way into useful chemicals and nearly half of the coal tar chemicals remain commercially undeveloped.

(Continued on Page 41)

This can be YOU... an "Engineer-Journalist"

Art Fox, B.C.E., Manhattan College '47, reaches 77,000 engineers and construction men as a Senior Editor of McGraw-Hill's ENGINEERING NEWS-RECORD



In ten short years, Art has climbed rapidly in his profession. Just back from a 2,500-mile editorial trip to Canada, here's what he has to say:

"To me, journalism is a form of teaching. Backed by the world-wide resources of McGraw-Hill, through travel, by working with leading engineers, I report on what's new and significant in engineering and construction. I try to make my articles more than instructive—to inspire readers to tackle and solve projects they might otherwise shy away from."

Other than preparing reports in college, Art had no early writing experience. Immediately after graduation, he was employed by a leading firm of consulting engineers. While on the job his appreciation for the inspiration-power of the industrial magazine grew, and in less than a year he applied for a position with McGraw-Hill.

Art started with ENGINEERING NEWS-RECORD in 1948 as an Assistant Editor. Since then, Art has been "up to his neck in engineering" . . . earned his P. E. license while an engineer-journalist . . . been active in A.S.C.E. and other professional organizations.

If you want a fast-moving career in engineering journalism: prestige, variety, a view of the "big picture" in your industry, and more—*we're looking for you!* You *do not* need previous writing experience, but you *do* need: ambition, an alert, inquiring mind and a desire to write.

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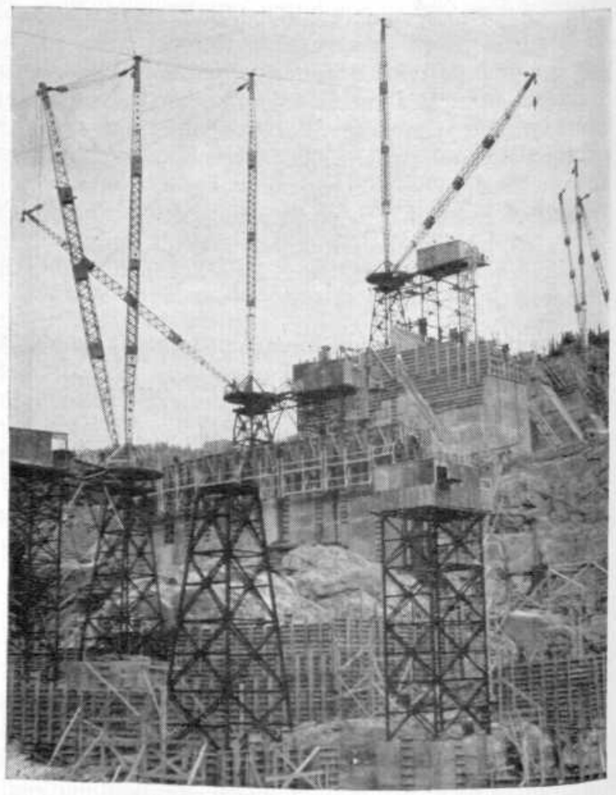
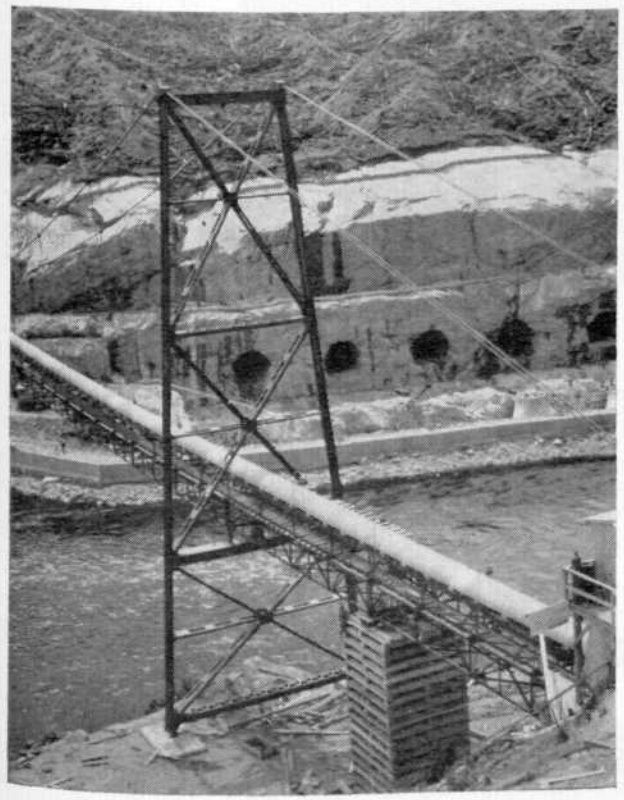
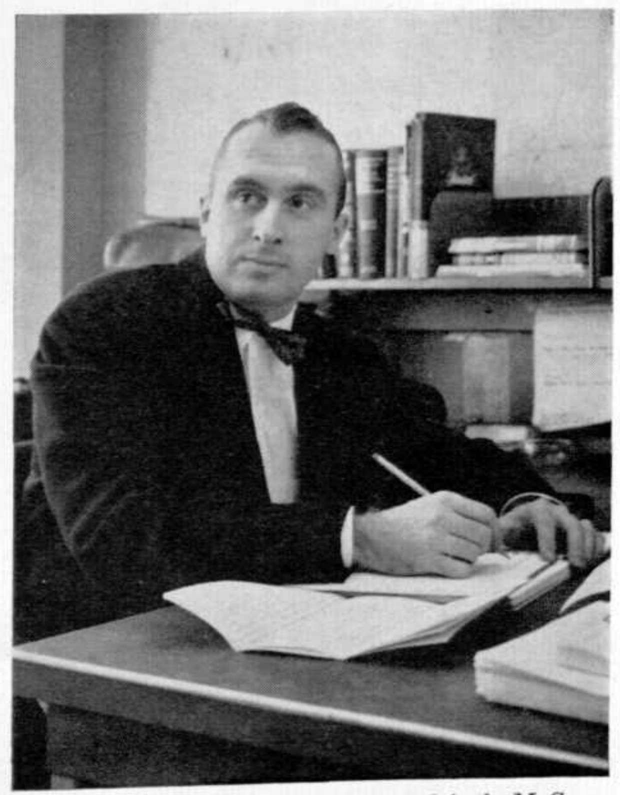
An Editor with a Hard Hat. Art, pictured above at right with Assistant Resident Engineer McCormack, observes progress at the Beaumont Rapids power dam at St. Maurice River, Quebec.



Cranes and Concrete. Another view of the Beaumont Rapids project. Art drove 1,800 miles from Montreal to get three on-site stories. Like other McGraw-Hill editors he got his story *firsthand.*



Dams and Tunnels. Here's a shot Art took of work on the Bersimis Powerhouse. As a McGraw-Hill engineer-journalist, you, too, will expand your professional background while reporting to your industry.



Desks and Plans. Here's Art at his desk in the McGraw-Hill Building. You, like Art, will travel, participate in professional societies and advance yourself financially and educationally—as well as serving your industry and profession.

GREAT LAKES AIEE-IRE PLANNING COMMITTEE

The planning committee of the AIEE-IRE Great Lakes District has been meeting periodically on the Michigan State University campus to plan the three-day technical session at Kellogg Center on May 5, 6, and 7. In conjunction with the district meeting, the AIEE-IRE Great Lakes student meeting will be held, and the technical papers will be judged. In the eight states: Michigan, Iowa, Wisconsin, North Dakota, Illinois, Indiana, Minnesota, and South Dakota, there are twenty schools that have active AIEE-IRE branches at the present time.

The members of the planning committee from Michigan State University are: J. A. Strelzoff, general chairman; Mrs. J. D. Ryder, T. W. Culpepper, B. K. Osborn, H. G. Hedges, W. C. Peterson, and M. A. Melehy.

Eta Kappa Nu

Eta Kappa Nu is the only Electrical Engineering Honorary at Michigan State University. This honorary is selected from the men in the top one-third of the senior class and the top one-fourth of the junior class for their outstanding character, scholarship and general engineering knowledge.

This year Eta Kappa Nu is preforming another service to the Electrical Engineering students. They are sponsoring a series of seminars in which information concerning scientific education, engineering ethics, scientific concepts and other material is presented to supplement the material presented in the classroom.

Eta KaPPa Nu, working with AIEE-IRE also plans exhibits and assists with the Engineering bxposu

The present officers of Eta Kappa Nu are:

President: John Eidson
Vice President: Phil Eiche
Corresponding Secretary: Dave Norton
Recording Secretary: Bob Becker
Treasurer: Stan Auld
Bridge Correspondent: Al Dasher
Faculty Advisor: H. E. Koenig

Engineering Council

The Engineering Council, the student engineering governing body, is one of the busiest organizations in the engineering school. Its predominate and outstanding service is organizing and administrating the annual May Engineering Exposition.

The council which consists of approximately 36 members handles details of the Exposition such as the selection of the Engineering Queen, with the help of the Knight's of Saint Patrick, organizing the student and industrial exhibits, supervising the midget car race and sponsoring the May Hop. The Engineering Council also awards cash prizes to the outstanding student and High School exhibits. This year the Council is also sponsoring the state-wide meeting of engineers during the Exhibition Week.

Because the Engineering Council consists of two representatives from each professional, honorary and social engineering society, it acts as co-ordinator between these societies. One of **the** services they have preformed this year lias been correlating the meetings of the various societies,

The Engineering Council with the help of Dean Ryder has also assisted in organizing **the** knights 01 St. Patrick.

The present officers of the **Engineering** Council are:

President: Ed Janoschka
Vlce President: Bill Schuhardt
Secretary: Ed Fox
Treasurer: Don Stroud
Faculty Advisors: B. C. Kmgo, C.E.
Carl Cooper, Chem. E.
H. G. Keeney, E.E.

ENGINEERING COUNCIL

Row 1: Schuhardt, Fox, Dolph, Janoslhka, Stroud, Cooper, Campbell; Row 2: Robertson, Kleis, Eiche, Van Vliet, Harris, Langdon, Hanna; Row 3: Riddle, Roberts, Theorin, Lindy, Plugge, Salisbury, Olsson.

(Continued on Next Page)

A. S. E.

The Society of Automotive Engineers is the professional society which serves as the center of technical **thought** and **discussion for engineers** of **the** automotive industry.

Here at State the student branch gives interesting **programs to all** engineering students who are interested in going into that field. Last term on October 17, **there was** a **technical** meeting on "Automotive Air **Suspension."** The speaker was Mr. C. O. Slemmons, chief development engineer for General Tire and **Rubber** Co. On November 14, there was an organizational **meeting** and then two films; Styling the Motor Car and one on the Darlington Race.

The student branch plans to have many more meetings this **term** and next where more speakers from industry will come in and give talks.

The 1958 **officers** are:

Chairman . . . . William Harris
Vice-Chairman . . . . Robert Pautsch
Secretary . . . . Fred Rigotti
Treasurer . . . . Jack Kline
Representative to **Engineering**
Council . . . . Robert Pautsch
Engineering Exposition
Committee . . . . Jack Kline
Fred Rigotti
Faculty advisor . . . . Dr. L. L. Otto

M.S.U. Amateur Radio Club

One of the least known of the clubs on the campus is the Amateur Radio Club. For over thirty years this organization has made available to all interested students the facilities for transmitter operation on the "ham" bands, workshop for experimenters, and an atmosphere of congenial fellowship for those interested in radio and electronics.

At the present time, there are many activities underway. Four transmitters are standing by and waiting for any qualified amateur license holder to operate. Teletype reception and transmission is now an actuality. The weather radar is almost completed and the club has hopes of having it in operation during the tornado season.

Last April, the organization was honored by being selected as the State Civil Defense Communications Headquarters. Now during times of emergency, student operators will be on duty.

The club meets every Thursday evening at 8:00 p.m. in the tower of the Electrical Engineering Building. All students are invited to attend a meeting and become acquainted with the members and club facilities.

Chairman . . . . Dick Pry
Secretary-Treasurer . . . . Clyde Replogle
Chief Operator . . . . Don Donath
Faculty Advisors . . . . J. O. Ebert
J. Hemmyc

HOW A HIGHWAY IS BUILT

(Continued from Page 17)

smoothing out the slightest imperfections. Others drag a strip of rough-textured burlap or draw a stiff bristled broom across the slab to give the concrete a grainy, skid-resistant surface. Finally, a curing membrane is sprayed over the concrete to retain moisture until the pavement has fully hardened.

Shortly after the concrete is finished, thin, almost invisable contraction joints are cut. These are sawed in the pavement by a diamond-tipped or carborundum **blade** after the concrete has partially hardened. Sawed joints, now widely used, provide smoother riding than the formed joints used in the past.

Another important development is the use of "air-entrained" concrete which contains billions of tiny air bubbles. These air spaces provide expansion chambers for freezing water and thus eliminate the scaling formerly caused by freezing and applications of salt to melt ice.

When the paving train has placed and finished the concrete, many jobs still remain. Firm shoulders must be constructed; slopes must be sodded and the right-of-way landscaped to prevent erosion as well as to beautify the roadside; and fences and traffic signs must be erected.

When the road is opened for travel, the motorist is likely to notice only the wide smooth ribbon of concrete, unaware of the years of research and planning that give him the world's finest roads. But because the motorist is also a taxpayer helping to pay for these roads, it is up to him to help make sure his money is invested in the safest, most durable highways possible. The roads being built today are a multi-billion dollar investment in America's future. If they are built of the most durable materials, to the high standards demanded by future traffic, they will be one of the best investments America ever made.

Be Sure To See

TECHNICAL ARTICLE

CONTEST

Page 34

TECHNICAL ARTICLE

CONTEST

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2. All students are eligible.
3. All articles should be at least 1500 words in length.
4. All articles submitted become the property of the SPARTAN ENGINEER and may be changed, edited, or published at the discretion of the staff.
5. Judges will be SPARTAN ENGINEER editors and faculty advisors.
6. Judging will be based on suitability, accuracy, reader interest, coherence, illustrations, and general effect on the reader.
7. Contest closes March 1, 1958.
8. Winners will be announced in the May issue.
9. No student may win more than one prize.

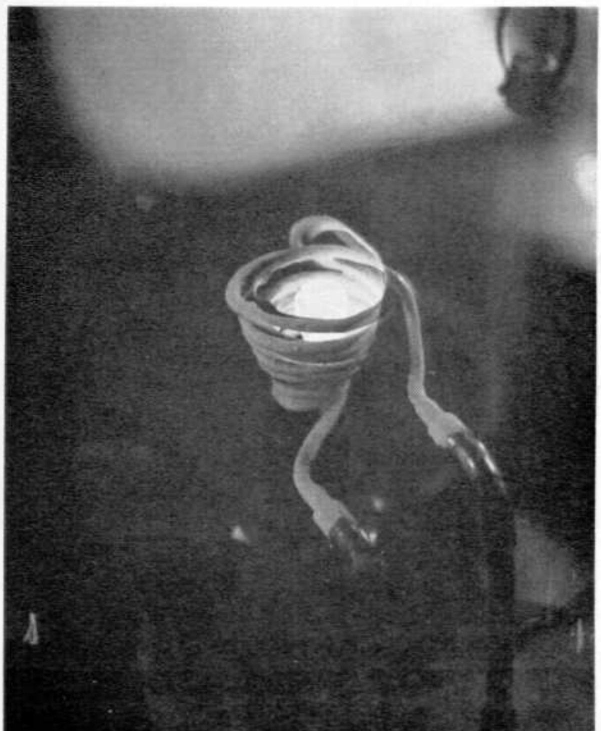
Interested students may leave articles in room 346 of the Student Services Building.

Here is your chance to win a prize and have the fun of seeing your by-line in print!

NEW DEVELOPMENTS

Edited by Norm Dill

Scientists Float Molten Metals Freely In Space



Molten metal floating in air.

Man's newest "wonder" metals are now being investigated **by** heating them thousands of degrees above white heat, while **they** float, freely suspended in space. Called levitation melting, this unique and versatile technique was brought to its present state of development by the combined efforts of scientists at the Westinghouse Research Laboratories and the University of British Columbia.

Levitation melting was given its first major public demonstration at the International Ampitheatre **during** the National Metals Exposition and Second World Metallurgical Congress, sponsored by the American Society for Metals. Levitation melting is used to prepare highly purified **laboratory-scale** ingots of niobium, zirconium, titanium, molybdenum and dozens of **alloys.** Because **they melt** at very high temperatures, and are extremely active chemically at such temperatures, these metals and alloys are difficult to Prepare **with** equal **purity by** any conventional **method.**

In levitation melting, compressed metal powder is placed inside a copper coil which carries a high-frequency current of electricity. Reversing its direction nearly a million times a second, the electric current generates a field of force which floats the metal charge inside the coil. At the same time, it converts the metal into a white-hot molten mass in a matter of seconds. Temperatures of 4500 to 5000 degrees Fahrenheit are achieved in half a minute or less, melting all but the most stubborn of metals.

At white heat, metals such as niobium and titanium are among the most active chemicals known. They react chemically with any known vessel in which they are melted. The traces of impurities they pick up cannot be tolerated in research on the pure metal.

Levitation melting eliminates this problem entirely. No containing vessel is required, since the molten metal floats freely in space, confined only within itself. The whole process is carried out inside a sealed vessel containing an inert gas such as helium or argon, thereby protecting the pure metal from contamination by the air.

Simplicity of apparatus, speed of melting and ease of handling a wide assortment of metals and alloys are other advantages of levitation melting. The molten metal even stirs itself, yielding unusually uniform alloys from mixtures of different metals.

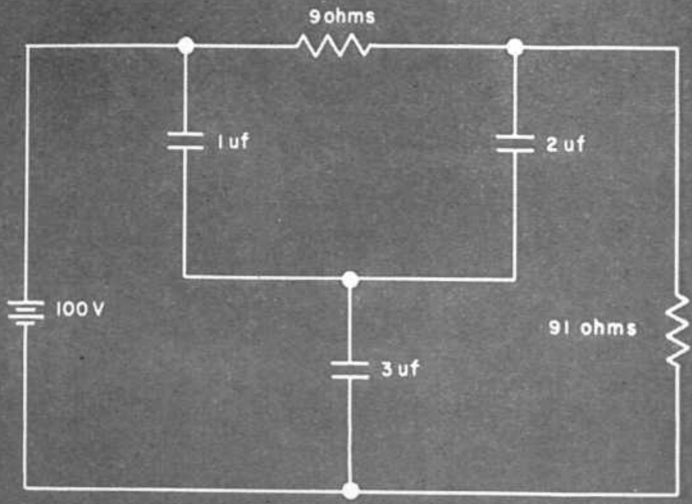
Scientists are using levitation melting to prepare a wide variety of the newest metals and alloys for metallurgical research. Such research with ultrapure metals seeks the fundamental knowledge which lies behind their full-scale use as metals of the future. Thus, in the past few years, titanium has emerged from the laboratory as an important building material in supersonic aircraft and missiles, and zirconium has developed into a vital structural metal in nuclear reactors.

Although not yet "graduated" from the laboratory, niobium—the latest "wonder" metal—may soon become an outstanding high-temperature, high-strength structural metal. Levitation melting is one of the few methods known for the preparation of niobium and niobium-base alloys in the purity required for fundamental research on the metal.

(Continued on Page 40)

CAN YOU FIGURE IT OUT?

In the circuit shown, determine the voltage appearing across the 3 microfarad capacitor. Assume that the circuit has been operating long enough to achieve an equilibrium state.



✱Solution at bottom of page

Gerald Maley tells what it's like to be...and why he likes being...a Product Development Engineer with IBM.

FIGURING OUT A CAREER?

Selecting a career can be puzzling, too. Here's how Gerald Maley found the solution to ***his*** career problem—at IBM:

"What sold me on IBM," says Jerry, "was their approach to engineering. I'd expected rooms full of engineers at desks. Instead, I found all the friendly informality of my college lab." Starting as a Technical Engineer in Product Development, Jerry learned a great deal about electronic computers in a very short time. He was promoted to Associate Engineer after 16 months. Recently, he was made Project Engineer, supervising the development of magnetic cores. "In computer work," he says, "you can actually see electronics at work. This is not the case with all such equipment today. In this new field, you can be an important contributor in a very short time."

* * *

There are many excellent opportunities for well-qualified engineers, physicists and mathematicians in IBM Research, Development and Manufacturing Engineering. Why not ask your College Placement Director when IBM will next interview on your campus? Or, for information about how your degree will fit you for an IBM career,

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***SOLUTION**

The voltage across the 3 uf capacitor is 47 volts. This answer may be verified as follows:

Since the voltage across the 91 ohm resistor is 91 volts in the steady state, then

$E_1 + E_3 = 100$ or $E_1 = 100 - E_3$ (1)

and $E_2 + E_3 = 91$ or $E_2 = 91 - E_3$ (2)

let $Q_1 = I_1T_1 = C_1E_1$

let $Q_2 = I_2T_2 = C_2E_2$

then $Q_3 = I_1T_1 + I_2T_2$ or $C_3E_3 = C_1E_1 + C_2E_2$ (3)

By substituting in equation (3) the expressions for E_1 and E_2 given in equations (1) and (2), we have:

$C_3E_3 = C_1 (100 - E_3) + C (91 - E_3)$

Substituting all known values in this equation gives:

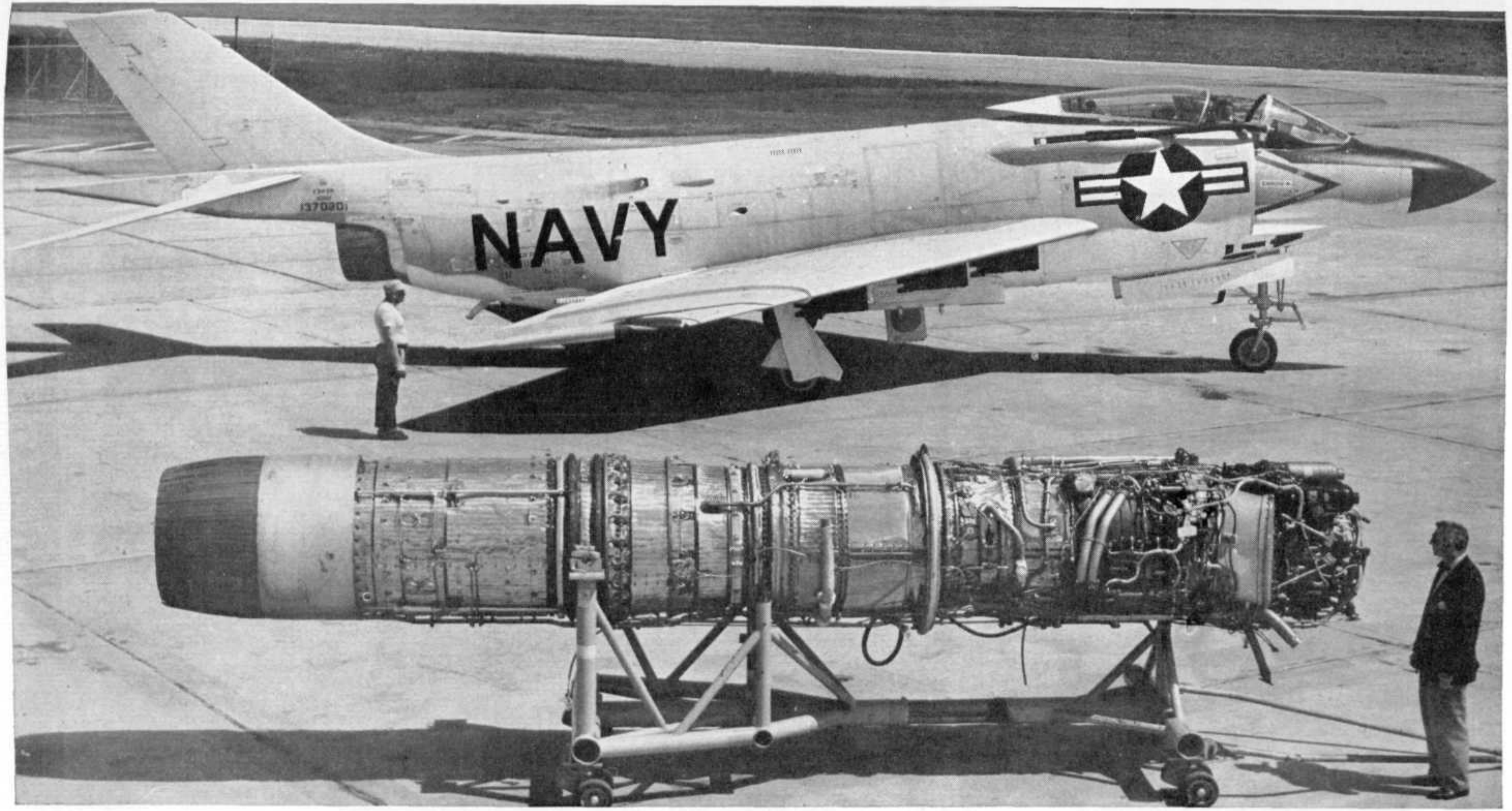
$(3 \times 10^{-6}) E_3 = (1 \times 10^{-6}) (100 - E_3) + (2 \times 10^{-6}) (91 - E_3)$

Dividing by 10^{-6}

$3E_3 = 100 - E_3 + 2 (91 - E_3)$

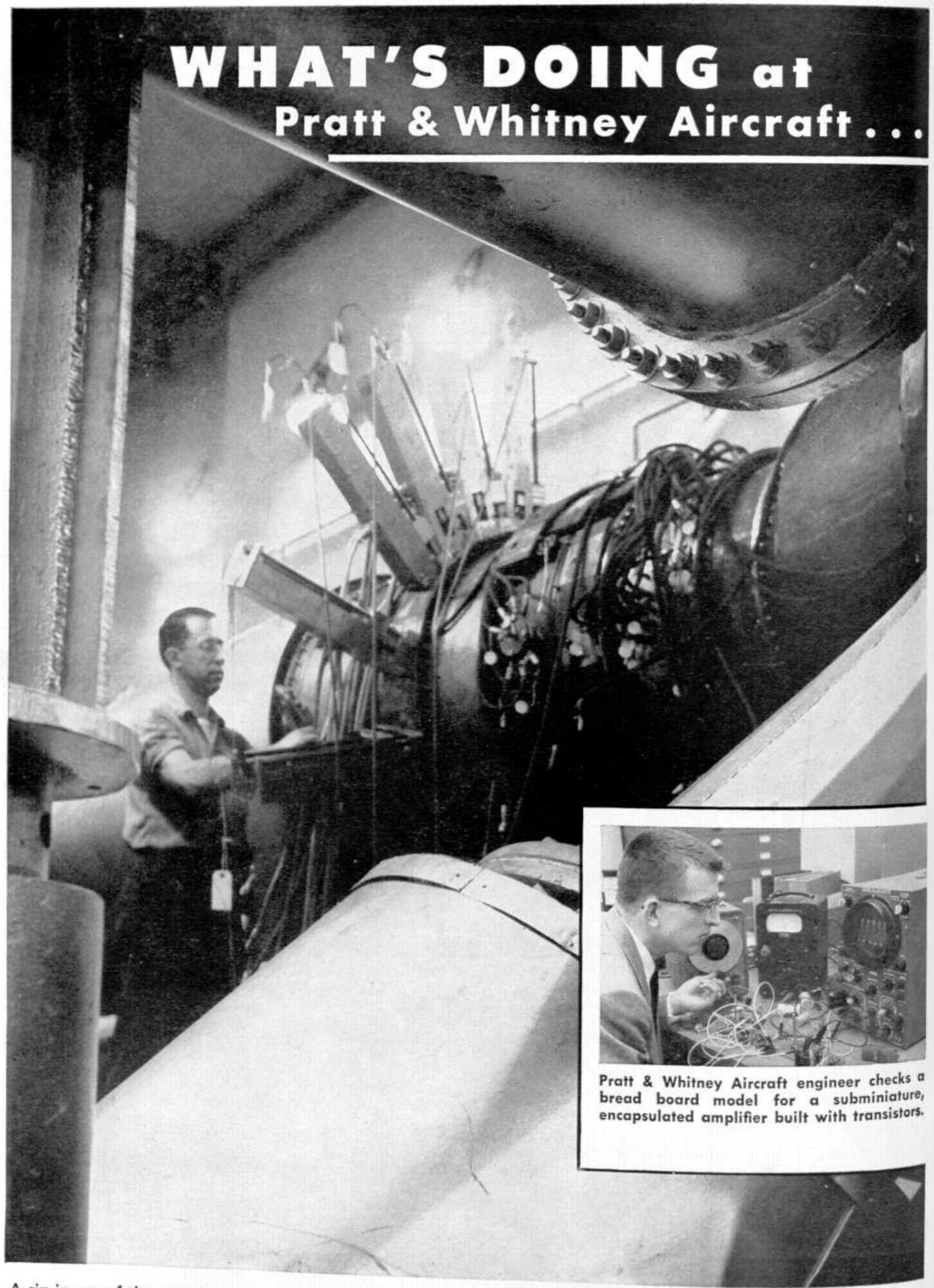
$6E_3 = 282$

$E_3 = 47$ volts <u>Answer</u>



INDIANAPOLIS, IND.: (Special) It takes a lot of teamwork to carry out the missions of carrier-based fighter pilots of our New Air Navy. And, it takes a lot of teamwork to design, develop and produce a fighting machine for these dedicated men. Such teamwork is exemplified in the Allison J71 turbo-jet engine with afterburner (above) which powers the Navy F3H-2N Demon all-weather fighter-interceptor. Many Allison engineers—out of school only a few years ago and now well entrenched on the Allison Division team of General Motors Corporation—contributed to the operational success of this powerful engine. If you would like to know more about the Allison team, write Personnel Department, College Relations, Allison Division of General Motors Corporation, Indianapolis, Indiana

WHAT'S DOING at Pratt & Whitney Aircraft . . .



Pratt & Whitney Aircraft engineer checks a bread board model for a subminiature, encapsulated amplifier built with transistors.

A rig in one of the experimental test cells at P & W A 's Willgoos Laboratory. The six large finger-like devices are remotely controlled probe positioners used to obtain basic air flow measurements within a turbine. This is one of the techniques for obtaining scientific data vitally important to the design and development of the world's most powerful aircraft engines.

. . . in the field of INSTRUMENTATION

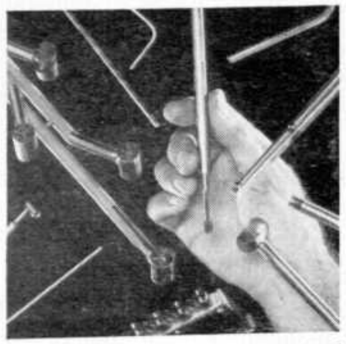
Among the many engineering problems relative to designing and developing today's tremendously powerful aircraft engines is the matter of accumulating data — much of it obtained from within the engines themselves — and recording it precisely. Such is the continuing assignment of those at Pratt & Whitney Aircraft who are working in the highly complex field of instrumentation.

Pressure, temperature, air and fuel flow, vibration — these factors must be accurately measured at many significant points. In some cases, the measuring device employed must be associated with special data-recording equipment capable of converting readings to digital values which can, in turn, be stored on punch cards or magnetic tape for data processing.

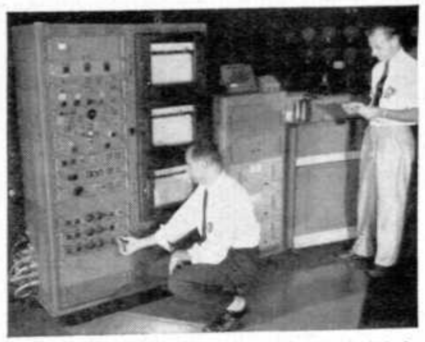
Responsible for assembling this wealth of information so vital to the entire engineering team at Pratt & Whitney Aircraft is a special group of electronic, mechanical and aeronautical engineers and physicists. Projects embrace the entire field of instrumentation. Often involved is the need for providing unique measuring devices, transducers, recorders or data-handling equipment. Hot-wire anemometry plays an important role in the drama of instrumentation, as do various types of sonic orifice probes, high temperature strain gages, transistor amplifiers, and miniaturized tape recording equipment.

Instrumentation, of course, is only one part of a broadly diversified engineering program at Pratt & Whitney Aircraft. That program — with other far-reaching activities in the fields of combustion, materials problems, mechanical design and aerodynamics — spells out a gratifying future for many of today's engineering students.

Instrumentation engineer at Pratt & Whitney Aircraft is shown investigating modes of vibration in a blade of a single stage of a jet engine compressor.



Special-purpose probes designed and developed by P & W A engineers for sensing temperature, pressure and air flow direction at critical internal locations.



The "Plottomat", designed by P & W A instrumentation engineers, records pressure, temperature and air flow direction. It is typical of an expanding program in automatic data recording and handling.

Pratt & Whitney Aircraft operates a completely self-contained engineering facility in East Hartford, Connecticut, and is now building a similar facility in Palm Beach County, Florida. For further information about engineering careers at Pratt & Whitney Aircraft, write to Mr. F. W. Powers, Engineering Department.

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(Continued from Pane 35)

New Polycarbonate

The discovery and initial development of a new plastic material tough enough to replace metals in many applications was recently announced.

Parts made from the new compound, LEXAN polycarbonate resin, are reportedly strong enough to withstand the blows of a carpenter's hammer. LEXAN molding compound is expected to replace cast metals, ceramics and other plastics in some applications.

LEXAN resin offers an unusual combination of toughness, impact strength, heat resistance and dimensional stability. These properties make it promising for applications not previously handled by conventional thermoplastic materials.

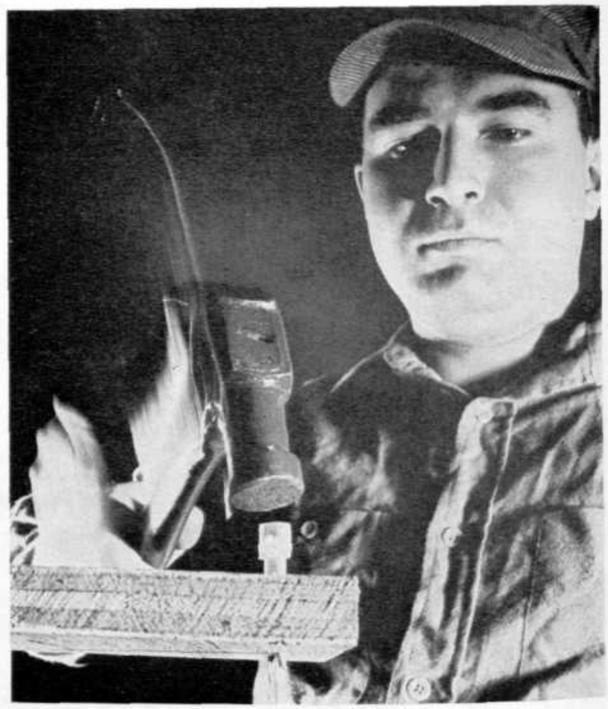
LEXAN resin is now being made in small lots and all available material is being used for testing purposes. The polymer is being evaluated in the form of molding compound, extrusion compound, film, varnish and coatings.

Early studies indicate that LEXAN resin can be made in a variety of transparent or opaque colors, with parts showing good surface hardness and gloss. Properties of the polymer suggest its use in such applications as coil forms, decorative and functional appliance parts, gears, automotive parts, housings, structural parts, handles, drawer rollers, electronic c omponents, and telephone accessories.

Swing ropes of Lexan.

The excellent electrical characteristics, high thermal stability low water absorption, and high tensile strength of LEXAN film make it suitable for use as an electrical insulating material.

Significantly, the original polycarbonate chemistry on which LEXAN polymer is based grew out of research efforts directed at new, improved insulating materials. Like polycarbonate resins, these products have traced a pattern of original scientific discover} leading to development and application in a wide variety of products not always related to their originally intended use as electrical insulating materials.



Plastic nails in your house?

Strange Crystal Growth May Explain Steel Failure

Crystals, which grow as delicate plates from the surface of stainless steel, may explain, for the first time, a destructive failure of the metal known as "stress-corrosion cracking."

This new theory was revealed by an international authority on corrosion, Dr. Earl A. Gulbransen, advisory chemist at the Westinghouse Research Laboratories in Pittsburgh, Pa. Dr. Gulbransen spoke before the Second World Metallurgical Congress, at the International Amphitheatre, Chicago, under sponsorship of the American Society for Metals.

Stress-corrosion cracking can occur in metal structures which are chemically corroded while under an internal or applied stress, such as a pull or twist. It can cause complete failure of the structure.

Stress-corrosion cracking can be- triggered even by such mildly corrosive substances as steam or human perspiration; and it occurs in objects subjected only

(Continued on Page 42)

COAL-FUEL OR RAW MATERIAL

(Continued from Page 27)

2. Partial combustion. This also is based on an old process, the "water-gas" reaction. A jet of steam is blown over a bed of coals in **a** closed chamber to produce large quantities of mixed carbon monoxide and hydrogen, the base of domestic fuel gas. Since the steam cools the coals, the process is inefficiently intermittent and has lost ground to natural gas. However, this simple, important process is the first cheap method for adding reactive hydrogen to coal to get a synthesis gas that can be manipulated into many chemicals. By substituting oxygen for air and feeding the steam and oxygen steadily, the reaction may be made continuous. By raising the pressure, part of the carbon may combine with hydrogen to form methane, thus enriching the gas. The efficiency of these developments is now being increased to produce synthesis gas of great chemical promise.

3. Fischer-Tropsch. If the synthesis gas or the residual gas from coal carbonization are now fed across a catalyst at low heat and pressure, a stream of products results. Heat, pressure and catalyst force the small gas molecules to link up into short-chain molecules. By varying the controls, the resulting proportins of oil or **chemical products** may be altered.

4- Hydrogenation. This process, developed in Germany in 1910 is the first chemical process to work directly from coal. A blast of pure hydrogen is shot mto a paste of pulverized coal and **catalyst** at medium temperature (850° F) and high pressure **(3,000** pounds per square inch) literally to explode the coal molecules and attach hydrogen to their dismembered chains and rings. This, with its massive additions of hydrogen, produces the widest range of coal chemicals: gasoline, Diesel and heavy oils, benzene, phenols and the range of coal tar chemicals, aniline, hydrocarbon gas and high-grade coke. Depending on the catalyst and controls, oil products or other chemicals may be the major yield.

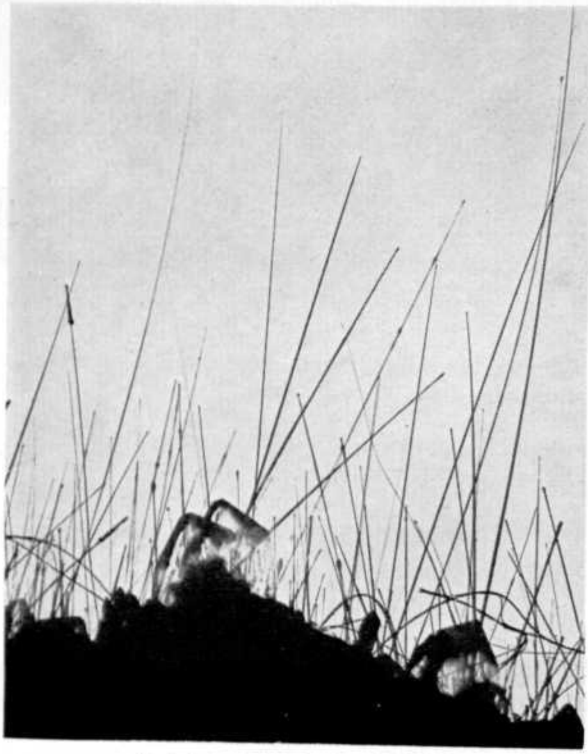
5. Solvent extraction. A great range of solvents has now been explored for selectively dissolving specific chemicals out of coal paste. None of these has yet reached commercial status. Solvents are expensive to handle, being merely temporary vehicles in the process. But with the increasing efficiency of solvent recovery, chemical extraction by this means may prove quite profitable. It is low in heat cost and is the least destructive method of obtaining certain compounds.

For a time during one of the recurrent oil shortages it was thought that the oil industry would lead the way toward making chemicals from coal. But shifting reserve estimates, regional resource patterns and the even more shifty economics of hydrocarbon sources make prediction dangerous. The development of carbochemicals will probably follow the pattern of the petrochemicals. Thus, with atomic and solar energies freeing coal from its role as a fuel, greater emphasis is being placed on the value of coal as a raw material in the production of chemicals.

NEW DEVELOPMENTS

*(Continued from **Page** 40)*

to the internal stresses left in them during their manufacture. Stainless steel pipes, turbine blades—even **coffee** urns and cooking vessels can fail by stress-corrosion cracking.



Stainless steel oxide whiskers.

Dr. Gulbransen described the newly discovered crystals as "submicroscopic platelets of chromium oxide." They form on strongly stressed stainless steel specimens which are exposed to corroding atmospheres containing traces of negatively charged chlorine atoms—more properly referred to as chloride ions.

"We believe that this unique crystal growth has important bearing on the whole general problem of stress corrosion," Dr. Gulbransen said, "for it has suggested to us **a** mechanism on the atomic scale to explain such corrosion.

"We think that this growth of platelets on the surface of the steel could lead to a chemical cutting of the metal. Minute crevices, therefore, might grow downward into the metal surface as the platelets thrust themselves above it. This, we believe, may lead to concentration of stress at the base of the crevices and eventually to failure of the metal."

The experiments are inherently quite simple, but extremely delicate and precise.

In a typical experiment, **a** small piece of stainless steel wire, nine thousandths of an inch in diameter and subject only to the residual stresses it **normally** possesses, is exposed to a carefully controlled atmosphere of oxygen and water vapor at a red-hot temperature of 1100 degrees Fahrenheit.

A small disk of stainless steel, five thousandths of an inch thick and having a hole six thousandths of an inch in diameter, substitutes for the wire in some experiments. After corrosion by the hot atmosphere, the wire or disk is examined and photographed with **the** electron miscroscope. The pictures which result are startling.

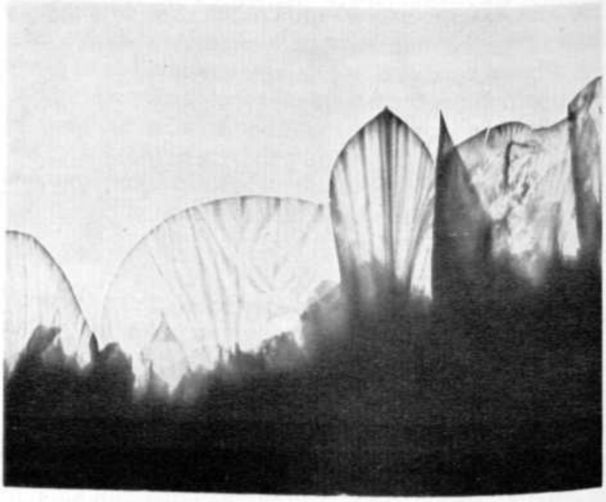
Using very pure oxygen and water vapor, the surface of a typical sample of stainless steel erupts with billions of oxide "whiskers." Only about one or **two** millionths of an inch in thickness, these whiskers grow to **a** height 300 or 400 times their diameter. Their density is about six billion per square inch of metal surface. These dimensions can be visualized by imagining a three-foot chimney built to a height of 1000 feet. The vast number of whiskers on the metal surface is apparent when it is realized that the average human head of hair contains only about 100,000 hairs.

"Completely unexpected changes occur in this crystal growth simply by prestressing the stainless steel and adding only the slightest trace—less than five parts per million—of chloride ions to the atmosphere," Dr. Gulbransen said.

Instead of long thin filaments, we discover rows of thin, upright, parallel plates growing along a definite crystallographic direction.

Under the electron microscope, these crystals are easily penetrated with **a** 60,000-volt beam of electrons, placing their thickness at half a millionth of an inch or less. Analysis shows them to have the characteristic structure of an oxide of chromium Cr_2O_3. Chromium is a metal normally present in stainless steels, and each tiny plate appears to be **a** single crystal of its oxide.

For some time scientists have known that the chloride ion is a major factor in producing stress-corrosion cracking of stainless steel. It would now appear that



These delicate crystals may cause stress corrosion cracking.

(Continued on Page 50)

Reinforced Panels In Construction

by Gary Eugene Gaffield

The architects of the nation owe a tribute to the industrialists, **chemists,** and engineers who pioneered reinforced plastic in building. Architects have always dreamed of a building material which is free from maintenance, termites, rust, discoloration and **disintegration.** Now we have a revolutionary construction material which may be used to build ultra-modern homes and commercial buildings with fewer supporting beams and solid walls, thereby allowing maximum use of floor space and sunlight. Proper utilization of reinforced plastic by architects will certainly mean great progress in the building construction industry.

Fiberglas reinforced plastic is a combination of **flexible** strands of glass and a plastic. The plastic is usually of the thermosetting type, which becomes **quite** hard and rigid upon being heated. Fiberglas has unique qualities when it is added to a plastic. The plastic has an increase in mechanical strength, stiffness, impact resistance, and ability to hold its shape. The improved properties vary with the amount of Fiberglas that is added. The glass strands reinforce plastic as steel reinforces the concrete in our bridges and highways. The glass strands may be placed directionally to resist specific loads, or in a random pattern for uniform strength in all directions. In a fishing rod all the strands run lengthwise to take care of the loads that will be essentially in that direction. In the new plastic body cars a random mat is employed that will have uniform strength in all directions. These products weigh about one-half as much as steel, yet are five times as strong. Reinforced plastic can be shaped into deep intricate parts that are not practical in sheet metal. Formability plus strength permits the use of this material in many applications.

Two important types of reinforced plastic used in building today are corrugated panels, or sheets, and flat panels. They are from twenty-seven to ninety-six inches wide and two to fourteen feet long. The thickness of the materials varies with the requirements of each particular application. The appearance of these two types on the market was made in late 1946 and early 1947. Two companies developed reinforced plastic panels. The Allied Synthetics Company of San Diego and Macrolyn Incorporated of Houston independently worked on the same project. The Allied Synthetics Company manufactured table tops and wall tile; they developed reinforced plastic panels as a side line. The first panels produced by Macrolyn early in 1947 were opaque. They were essentially developed for use by the Great Lakes Steel Corporation as an external covering for Quonset buildings. In the fall of 1947, the first commercial full-size translucent panels were manufactured. The growth of translucent panels has been phenomenal. In 1949, the volume of panel sales was half a million square feet. By 1950, this volume had grown to an excess of a million and a half feet. The translucent panels market in 1956 reached twenty-five million square feet.

Price lists of the Fiberglas panels in 1950-51 ranged from sixty-nine to seventy-eight cents per square foot. In 1952-53 the prices of plastic and Fiberglas advanced. In spite of this, the panel manufacturers dropped their prices approximately fifteen percent. This lowered the selling price to sixty-three to sixty-six cents. Today, the price structure is almost unknown. Prices are ranging from forty-nine to sixty cents per square foot; a seven cent reduction in **four** years.

Gary Gaffield, from Lexington, Michigan, has just transferred to State from Port Huron Junior College. He is a junior majoring in Chemical Engineering, and plans to do further study on the use of plastics in building after graduation.

GARY GAFFIELD

Over the past five years, important advancements have been made in the color stability and surface appearance of Fiberglas panels. The plastic manufacturers deserve the credit for the improvement in color stability. Five years ago, panels showed signs of yellowing after one hundred hours of exposure to sunlight. Today, if a good quality of plastic is used and the panel is constructed correctly, no color change is detected even after one thousand hours of exposure. There are still no translucent white panels that will stay white for even two years in the southern half of the United States. It is impossible to determine whether this is the result of a change in a minute quantity of impurity, or change in the entire mass of the panel.

There is far greater **uniformity** of appearance in the panels manufactured today. Improved manufacturing techniques deserve the most credit, although raw materials are also more **uniform.** Nevertheless, no manufacturer has yet been able to put out a product which is really consistant in appearance from Panel to panel or from month to month. The industry is still faced with certain problems which it must overcome if it is to stay in existence. Perhaps the worst problem is that of surface erosion. Surface erosion gives the panels a rough, irregular surface. While the structural strength of the panel is not affected, the appearance is unattractive, and the light transmission is reduced. Today's industrial competition and the tendency to reduce the quality and **quantity** of raw material for price reduction, does not help to solve the problem of surface erosion. Well-known is the fact that the greater the thickness of resin covering the fiber, the less noticeable will be the erosion in a given period of time. Surface erosion, with its undesirable appearance, will definitely affect the use of reinforced plastics in construction in the immediate future. The plastic industry faces a long, tough, uphill battle in penance for its past sins.

Another problem which must be conquered is the "blooming" of the fibers. Reinforced plastic panels can be made so that the fibers are vertually invisible, yet under certain conditions the fibers will begin to "stand out" or to "bloom" after short periods of time. The "blooming" is thought to be caused by the shrinkage of the plastic away from the fibers. Unfortunately, all panels do not show the same uniform rate of blooming, and therefore, an entire installation, which was originally uniform, might suddenly become blotchy. "Blooming" results in reduced light transmission and questionable bonding of plastic to the glass. All these things point to the fact that the bond between plastic and glass is still the weakest link in the reinforced plastic product. This bond must be improved considerably if the construction industry is to continue accepting reinforced plastic panels.

The proper use of reinforced plastic panels is very important in its application. Every material of construction is a compromise in one respect or another. Whenever a compromise with the perfect exists, limitations must be placed on its applications; plastic-panels are no exception. The present and future success of this new construction material can depend, to a large extent, on its proper use. A nearly perfect material, improperly used or applied, can meet with such public disfavor that its merits are drowned in criticism.

(Continued on Next Page)

Listed below are some of the limitations and **recommendations for the** use of reinforced panels:

1. **Industrial skylights should be** limited in extent. It is possible to obtain too much light and heat in **certain** areas **of** the country by employing too large a proportion of daylighting areas. Present-**day** reinforced plastic panels will burn slowly anil are **difficult** to ignite, but nevertheless, they will burn.

   An **uninterrupted** band **of** roof section, under optimum conditions, might spread a fire **unnecessarily.** Usually a two-foot to six-foot separation **of** a **relatively** non-combustible material will **completely** stop the spread of flame.

   The separations do not interfere with the lighting. Such roof-lighting panels **should** be stopped within two or three feet from the ridge. In the **event** a fire should ignite the panels on one slope, the separation at the ridge would not allow the spread of the flame to the other side of the slope.

2. In certain **types** of construction, such as patios, careful consideration should be given to the **spacing** and **construction** of the rafters. The laps occur **directly** over the rafters so they can not be seen from the underside. By this method, it is also possible to minimize any unsightly collections of dirt and leaves in the laps.

3. Where water-tight installations are desirable, due consideration should be given to providing an **adequate number** of fasteners in both end and side laps. Three or four years ago, some of the **manufacturers** either could not, or would not. **produce** a **panel** whose pitch was sufficiently dose to corrugated metal or **asbestos** so that the panel could be nested with the sheet metal or asbestos without undue strain. Today the **problem is** virtually non-existent among experienced **manufacturers.**

4. Spans should be kept within reasonable limits to avoid undue deflection which might cause leaks in joints under wind and snow loads even though failure of the panel does not occur.

5. For tub enclosures, adequate spacing between the panels and adequate room for expansion of panels on all sides should be provided. Panels heated suddenly with very hot water will expand and bow slightly. If the sliding panels are too close together, they will rub against each other and be difficult to open.

6. Many homes have been constructed with the use of reinforced translucent plastic wall panels behind the kitchen cabinets. These usually dark cabinet positions have the benefit of an outside light source, which make it possible for the lady of the house to see, rather than grope, into her cupboard. The modern kitchen of today is designed to accommodate the wonders of the mechanical age. A neat little trick has been introduced by several custom cabinet builders. Kitchen cabinet doors that slide are made with flat reinforced plastic panels, $^3/_{32}$ to /s' inch in thickness. They are easily fabricated, requiring only a smooth-cut edge and no further finishing. Panels can be made in any color or degree of translucency and all that is required to complete the door is to attach a knob. The entire door may be removed in a matter of seconds for the housewife to clean.

7. Reinforced panels have found wide use as storm shutters. The panels have been subjected to severe tests by the University of Miami proving grounds, and found to perform satisfactorily. Persons in hurricane areas find them easy to install and store. Once again the advantage of translucency finds a use. During a storm, the inside of a house is bathed in a soft diffused light, which defies the horror of the storm. A house, closed for seasonal reasons, benefits from the sunlight, which reduces mildew and dampness. The advantage of using the Fiberglas panels just described, far outweighs the slight additional cost of the material.

There is no question that the corrugated metal and asbestos buildings will continue to be built; possibly in even larger numbers. Insulation materials, such as Fiberglas, have made possible easily installed panel construction rather than high labor cost masonry construction. Also corrugated reinforced panels will continue to enjoy an increased market in the replacement field wherever fenestration is required. The market for corrugated, translucent panels for decorative and functional uses will probably continue to grow in certain sections of the country and fall off in other sections. The use of some panels for such purposes as awnings and patios has somewhat a "fad" status. Other building materials of a similar "fad" status have a history of going through a cycle. After a neighborhood or city reaches the saturation point, people want something new. There are still many sections of the country where translucent panels for patios and awnings are virtually unheard of, and these areas will continue to enjoy growth in the future.

Translucent panels have truly changed the appearance of the entire country. One can say, literally, that they have left their mark on the landscape. There are few places in the country where various colors cannot be seen in the roofs and side walls of industrial buildings, residences, and commercial establishments. The colorful patio roofs and windbreaks, once a landmark of the sunnier climates of Texas, California, and Florida, are becoming more evident in the summer resort states of the North. It has been proven that chickens and turkeys under hail-resistant roosts, produce better because they wake earlier.

Skylights, patio roofs, awnings, woven fences, outdoor signs, garage doors, portable cabanas, free shapes suspended by chains as light fixtures, and windbreaks demonstrate the versatility of this colorful

(Continued on Page 68)

(Continued from Page 42)

chloride ions could stimulate the **growth of** these unique, plate-like crystals in a strongly stressed metal, **which gowth** might result fa cracking and the ultimate failure of the steel.

"**Corrosion in** all its forms **is a** major national **problem,** costing American industry an estimated **$5,500,000,000** annually in replacement costs alone," Dr. **Gulbransen** added. "Our experiments, we think, are typical of a new approach to this whole problem—an **approach** which seeks a better understanding of the fundamental mechanisms involved in corrosion.

"Such an understanding, we believe, will only come from carefully controlled experimentation **on** the atomic scale, not from observations which depend upon massive **effects** under relatively uncontrolled **conditions!**"

Electrons That "Kiss and Tell"

Electrons are revealing the answers to problems that have been plaguing manufacturers for years, thanks to the Electron Diffraction Instrument.

"Why did the paint peel off the automobile?"

"Why **did the** gas pipe rust through?"

The answer to these and many other questions are **being** studied by users of the unit, which "bounces" a stream of electrons off the surface of various materials and produces a characteristic pattern that can be used to guide the development of better manufacturing **processes** and materials.

It is also expected to prove useful in such fields as lubricating films, metal-plating, powder metallurgy, boiler scale formation, and catalyst behavoir.

The Electron Diffraction Instrument is similar to X-ray diffraction apparatus. The basic difference is—electrons penetrate much less than X-rays. As a result, the chemical composition and crystal structure of a substance's surface can be determined. On the other hand, a beam of X-rays from a sample provides information relative to the average of the entire sample.

Electrons can detect samples as thin as 15 angstrom units, (4 millionths of an inch), permitting electron beam transmission through very thin surfaces. Diffraction patterns so produced usually require exposures of only one second to two minutes.

The specimen is positioned by means of a manipulator. The resultant diffraction pattern can **be** observed on the fluorescent screen and photographed with the camera mechanism. Five exposures can be made at one loading of the camera.

A high temperature furnace for studying changes in specimens at variable high temperatures up to 1,000° centigrade is available as an auxiliary device for the Electron Diffraction Instrument.

About the size of a conventional cigaret lighter, the unit incorporates a cylindrical ceramic body into which is embedded a heater coil and a thermocouple. The specimen tray and several other components are made of tantalum to utilize this metal's good conductivity and high melting point.

Because electron diffraction "completes the picture," it is expected that this technique will receive the wide application to industrial problems now realized by X-ray diffraction. The advantages can be summarized as follows:

(1) Electrons can be diffracted by shorter atomic crystal plane spacings. This is because, for practical accelerating voltages, electron wavelengths are about 1/20 that of X-ray diffraction. As a result, crystal size estimates for a smaller size range can be determined.

(2) The electron beam is much easier to collimatc and reduce in size than the X-ray beam.

(3) Sharper patterns are possible because the electron beam is highly monochromatic. And patterns can be seen visually on a fluorescent screen. Therefore, it is not necessary to photograph the pattern for some types of routine control work.

Starting with the electron gun, the filament operates at a fixed potential, variable from 20 to 50 kilovolts and negative with respect to ground. To obtain a more constant temperature, the filament is heated with separate radio frequency source.

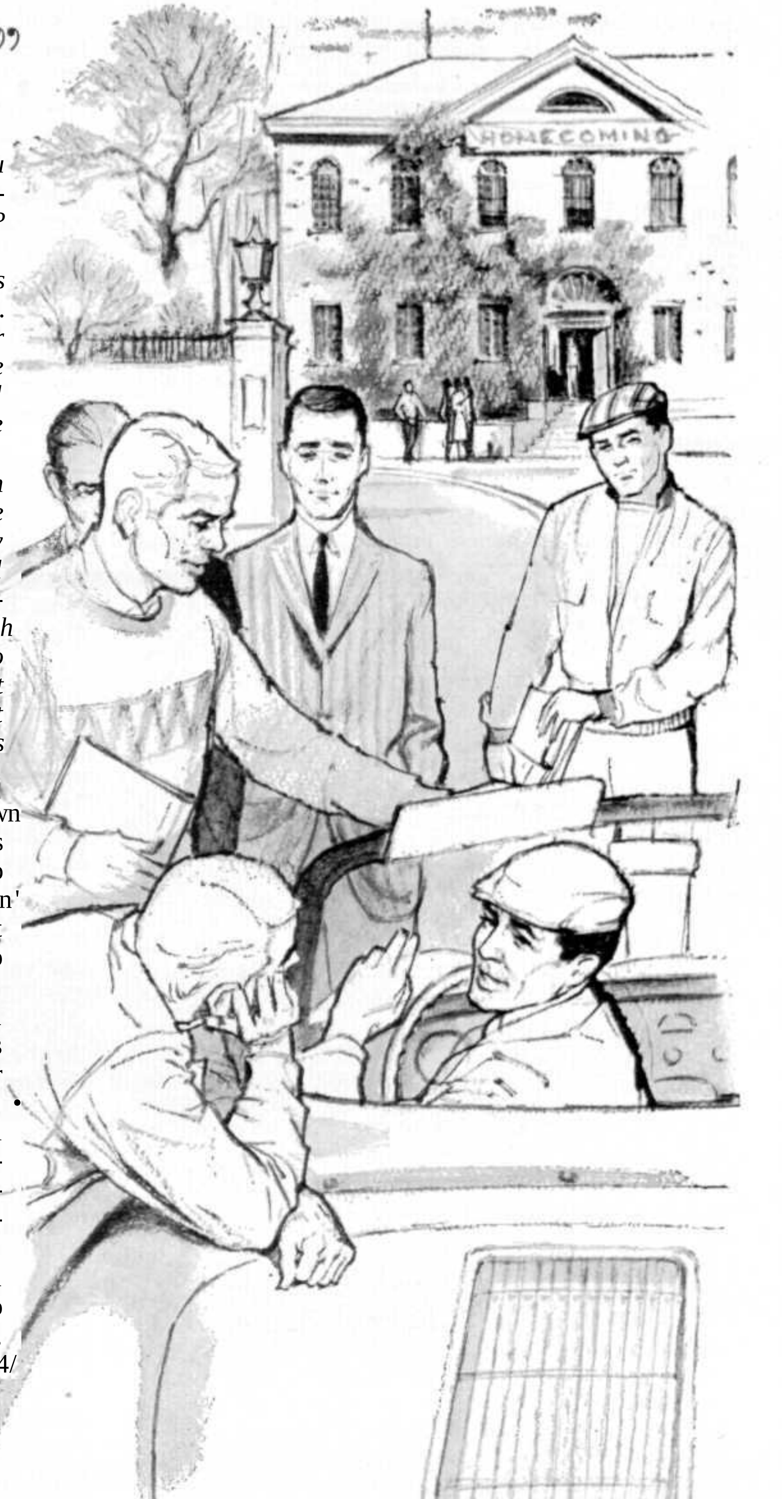
The resulting electrons are accelerated through a grounded aperatured anode and focused on a fluorescent screen in the camera chamber by means of an electro-magnetic focusing coil.

An instrument capable of chemically analyzing as minute amount of material as five micro-micro grams will naturally lend itself to many research and production applications. Here are a few:

CORROSION: The losses due to corrosion are tremendous. Thus, the need to study its cause in the very early stages. The Electron Diffraction Instrument will detect the first changes and help identify the chemical nature of these changes before they are visible with a microscope or detectable by other means. Such analysis has helped in the selection of the best material for gas-turbine buckets.

CATALYSTS: Catalytic action is a *surface* phenomenon. Therefore, the detection and measurement of material forming the surface is of vital importance. Conventional methods of analysis may show one chemical composition, whereas electron diffraction

{Continued on Page 52)


HOMECOMING

*(Continued from **Page 50**)*

photographs reveal a very **thin** layer of another material **responsible** for **the** catalytic action. Thus, the **Electron Diffraction Instrument** permits closer study of **surface conditions** for early determination of poisoning and better control of catalysts.

LUBRICANTS: Lubrication is a function of the surface film. What changes occur in oil **films** determines **the efficiency of** running machinery. Thus, the **importance of** the Electron Diffraction Instrument in **determining** good lubricating films and control processes **for** their production. In addition, the instrument is useful for studying surface changes in bearings and **cylinder** walls, and for detecting and studying **preferentially-deposited** oil films.

METALLURGY: The interaction of thin films of metals can be studied and used as a control for the **processes of** making alloys. For example, a thin film of nickel was deposited on a sample holder and another film of iron deposited on top. The diffraction pattern was taken at room temperature and again **at** a higher temperature. The change in pattern showed alloying **of** the two metals. In powder metallurgy, surface conditions of the powders determine whether they will **alloy** readily.

PIGMENTS: The covering power and other properties of pigments depend upon their crystal structure and chemical composition. For the development of better pigments, control of production, the Electron Diffraction Instrument permits easy determination of material and structure.

SURFACE DEPOSITS: The instrument is a powerful tool for studying the nature of surface deposits as boiler scale and other chemical residues. Early detection of such phenomena may indicate means of control.

GRAPHITE: The crystal structure and orientation in graphite during and after manufacture can be determined by examination with electron diffraction photographs. These photographs are helpful in the use and processing of graphite.

Test Facility Simulates Flight Through The "Thermal Barrier"

The intense heating of aircraft and missiles flashing through earth's atmosphere at speeds above 5000 miles per hour imposes problems of structural design. At supersonic speeds, air vehicles must withstand temperatures above 2500 degrees F. To investigate and overcome structural limitations, the Westinghouse Electric Corporation has developed a complete elevated temperature test facility.

The equipment consists of banks of tubular infrared lamps, three-channel ignitron controller, strip chart temperature recorders, regular control (computer) channels, master control desk, unit substation and bus duct distribution.

The unit can create heat conditions encountered by missiles and aircraft at least three times faster than standard systems now in use.

This increased speed enables us to eliminate time lags and thus more nearly simulate actual heat conditions met in flight. At the unusually high speeds now being reached by missiles, heat is generated much faster than it can be dissipated. As a result, metals distort, melt or vaporize completely. This area in which metals are subjected to such terrific punishment—in the vicinity of 2000 miles per hour and over-is called the "heat barrier."

The test facility—which can create 2500 degree temperature in twelve seconds—will enable aircraft builders and designers to pretest structural parts and whole aircraft in simulated flights through the heat barrier.

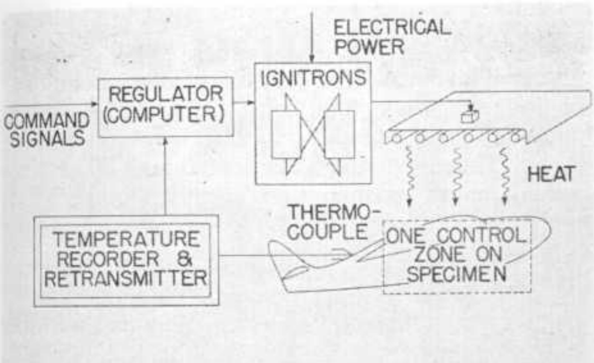
Heating of the aircraft surface due to friction and compression of the air is related to the difference between the effective air temperature and the skin temperature of the vehicle. Under transient flight conditions, the temperature of the aircraft varies with time. Because heat flow is variable, the temperature distribution throughout the aircraft is uneven. This condition results in differential thermal stresses arising in the structure which are superimposed upon aerodynamic structural loads. An elevated temperature test facility simulates all of these load effects in conjunction with the differential thermal stresses. The equipment is used to arrive at solutions of thermal transient distribution throughout different types of aircraft structures.

Banks of quartz infrared lamps are used as the heating source. Each lamp is rated at 1000 watts, 240 volts and is operated, in many cases, at 440 to 480 volts. These lamps operate satisfactorily at 600 volts and up to 900 volts, if necessary. In addition to the 10-inch, 1000-watt, 240-volt nominal rating lamp, 2500-watt, 480-volt and 5000-watt, 960-volt lamps are available. These lamps have an extremely rapid warm-up time.

Induction heating equipment can be used as the heating source. Actually, surface heating with power inputs of 150 to 750 kw per square foot are possible with r.f. induction heating equipment.

The ignitron unit is designed to control the effective heating voltage impressed across a fast-response, variable-resistance load. This unit is an economical method of controlling the amount of heat delivered to missiles and aircraft. The ignitron control unit provides many advantages:

1. Rapid response and a broad range of power control for a large number of infrared lamps.
2. Maximum safety of operation of equipment which is applied under conditions conducive to accidents to personnel and apparatus.
3. The ignitron unit is either manually controlled or used with the automatic regulator control.



ELEVATED TEMPERATURE STRUCTURES TEST SYSTEM

Sufficient gain is provided making the ignition unit applicable to other types of regulating controls which may be developed.

4. Physically, the equipment is built as an independent cubicle which is easily and quickly moved from one location to another with only a reconnection of the incoming power line.

5. Power control characteristics are insensitive to the change in resistance of a load of lamps with change in temperature of the filament, or change in the number of lamps.

Two inverse-parallel ignitron tubes are connected in series with the load and act as valves to control the amount of power delivered. The cathode of one is connected to the anode of the other. The resultant output is an a-c current. The point in the cycle at which the thyratron energizes the ignitron tube determines the magnitude of the power delivered to the lamp, and thus the heating effect.

Each cubicle contains three channels whose outputs can be independently controlled. Three-phase power is used by each three-channel cabinet. The independent channel takes power from one phase only and delivers it to **a** single-phase load.

Ignitron control channels now operating are capable of carrying 800 amperes for five minutes. This current rating holds regardless of voltage. Thus, at 460 volts each channel delivers 360 kw. This corresponds to approximately 120 T-3-1000 CL radiant lamps connected to **a** 460-volt channel. In addition, each channel operates adequately with one lamp connected to a channel.

This equipment has an extremely high short-time overload capacity. Current ratings of 3000, 1600 and 1200 amperes at three, fifteen and twenty-five seconds respectively are achieved. Each short-time rating can be followed by a continuous rating of 300 amperes.

The response of the power control is rapid. For **a** change in control voltage the effective output voltage squared (heating effect into a constant resistance load) attains 63 percent of **its** final value in 0.02 seconds.

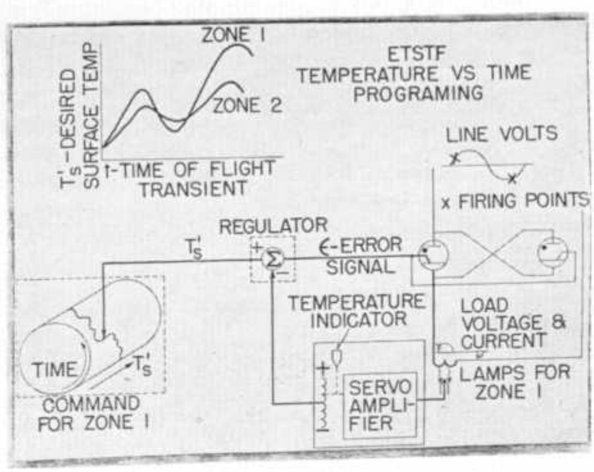
A high-speed temperature recorder transcribes the temperatures of the control zones of the aircraft or missile under test. At present, the **temperature** recorder is calibrated for thermocouples **in** a temperature range from minus 350 degrees F to plus 2650 degrees F. Chromel-alumel thermocouples used with this equipment are provided in three **ranges;** minus 350 to 650 degrees F, zero to 1000 degrees F and minus 350 to 2650 degrees F. The temperature sensing and recording **equipment incorporate** special features, to eliminate the high stray fields induced by the rapid power changes and unusual **power** wave form from the ignitron units.

Future tests will require surface temperatures of 5000 degrees F and above. Exclusive of the temperature recorder, the elevated temperature test facility operates reliably in the higher temperature range.

The regulator develops the control signal used to modulate the ignitron controller. This unit develops the signal either to regulate to a given time-temperature schedule required of the aircraft, or to a given power required signal **as** developed by arbitrary aerodynamic input functions and surface temperature measurement.

The power control response to a signal which is proportional to the error between the power desired to be transferred and the actual power transferred. Since no satisfactory heat transfer measuring equipment is known, two approximations are used.

One method takes the product of the voltage and current to obtain the power to the lamps. The efficiency of transfer of energy from the lamps to the aircraft is then calculated. Thus, the product of efficiency, voltage and current gives the energy into the test floor aircraft.



The second method considers the heat per unit time into the aircraft as proportional to the derivative of the skin temperature. A signal proportional to the power into the aircraft is obtained. The command signal, showing the power into the aircraft required to simulate a given flight trajectory, is developed by the computer. Using an injected coefficient of heat transfer and the effective temperature of compressed

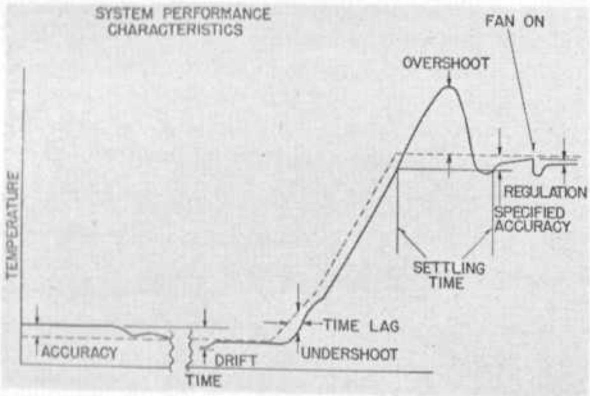
(Continued on Page 54)

NEW DEVELOPMENTS

(Continued from Page 53)

air, and **the measured value of the** skin temperature of **the vehicle, the computer instantaneously** calculates **regulating Signal. This** calculated signal is the **power which is desired to** inject **Into the** aircraft **to** simulate the flight **the** Might **condition which** would occur.

The ventilated bus duct **system** consists **of** low-voltage drop **plug-in busway** using aluminum bus **ban. The receptacles** lor **plug-in** devices are **equipped** with **barriers** to prevent live parts from being accessible at **any time during** installation or removal. Circuit breaker plug ins **prevent** removal from the **receptacle until the** breaker is **in the off position.**



The **bus** duct **requires a** minimum **of** field **measurements** and installation time. Fittings are interchangeable and **reusable. To provide** for future additions or **alterations,** standard **flexible** fittings are available.

A thermal **overload** relay coordinated with the long **thermal characteristics** of the contactor and **bus work,** anil an induction disc overload relay coordinated with the **short-time** characteristics of the ignition tubes, permit full use of the equipment **Capacity.** Both of these relays are arranged to trip (lie line contactor in case of equipment overload. Under these circumstances only one control channel is lost during a test run. Since the shutdown is restricted to a small number of lamps, maximum test data are obtained.

In case of short circuit, the induction disc overload relay trips the ignitron feeder breaker. This short-circuit trip setting is fixed below the setting for the transformer breaker. For this reason the feeder breaker trips off a small portion of the control circuits avoiding possible loss of all control channels. The flow of test data is uninterrupted.

The equipment is suited for ease in maintenance. All electrical equipment is completely enclosed in a metal cabinet. Where applicable, the electronic equipment consists of plug-in type units. This construction permits replacement of faulty components rapidly.

Power for each channel is supplied by its own individual control transformer. No second source of power in any control channel section can cause personnel hazard while work is being done in an ignitron control cubicle.

Other safety features include extensive **interlocking.** For instance, door interlocks are provided to trip appropriate power supply controls when the door is opened. The door interlocks are connected with the channel "on-off" push buttons located on the master control console. Therefore, the line contactors can never be energized from the master control consult when the doors are open.

Wide application of the elevated temperature test facility is foreseen for the missile industry because of the effort to perfect intercontinental ballistics missiles. The missile reaches its highest speed before plunging into the atmosphere, and the ability of its metal "skin" to withstand the searing temperatures is critical at this stage.

Carbon-matrix Technique Replaces Spectrochemical Determination of Elements of Unknown Origin and Basic Composition

A new, simplified technique for overcoming one of the laboratory chemist's chief time-consuming problems, that of spectrochemical determination of the elements in samples of unknown origin and basic composition, has been developed. Known as the "carbon-matrix technique," the new method utilizes a graphite electrode to create the necessary dilution and a known, small amount of germanium to produce a reference intensity in the spectrum.

In making any spectrochemical analysis, it is necessary that the instruments be calibrated with materials of the same basic composition, or matrix, as the samples to be analyzed.

When these samples are of an unknown basic composition, it is difficult to determine the concentration of the various elements present. This is because there is a characteristic wavelength for each element and its concentration is measured by the intensity of light of that wavelength emitted when the sample is excited in an electrical discharge. The light intensity, however, changes with the matrix of the sample, and calibrations prepared for one material may not be applicable to another. Thus, when the matrix is unknown, the spectrochemical method cannot be applied, since the calibration which should be used for the analysis cannot be determined.

The usual way to overcome this difficulty is to mix the sample with some standard substance for which calibrations can be prepared. A procedure involving dilution of up to 800 times the unknown sample with varying amounts of germanium dioxide and then by a mixture of equal amounts of graphite and copper oxide in the ratio of 1 to 40 has given satisfactory results. By using copper as the internal standard and analyzing in triplicate with a series of standards, an over-all accuracy of plus or minus ten per cent is achieved.

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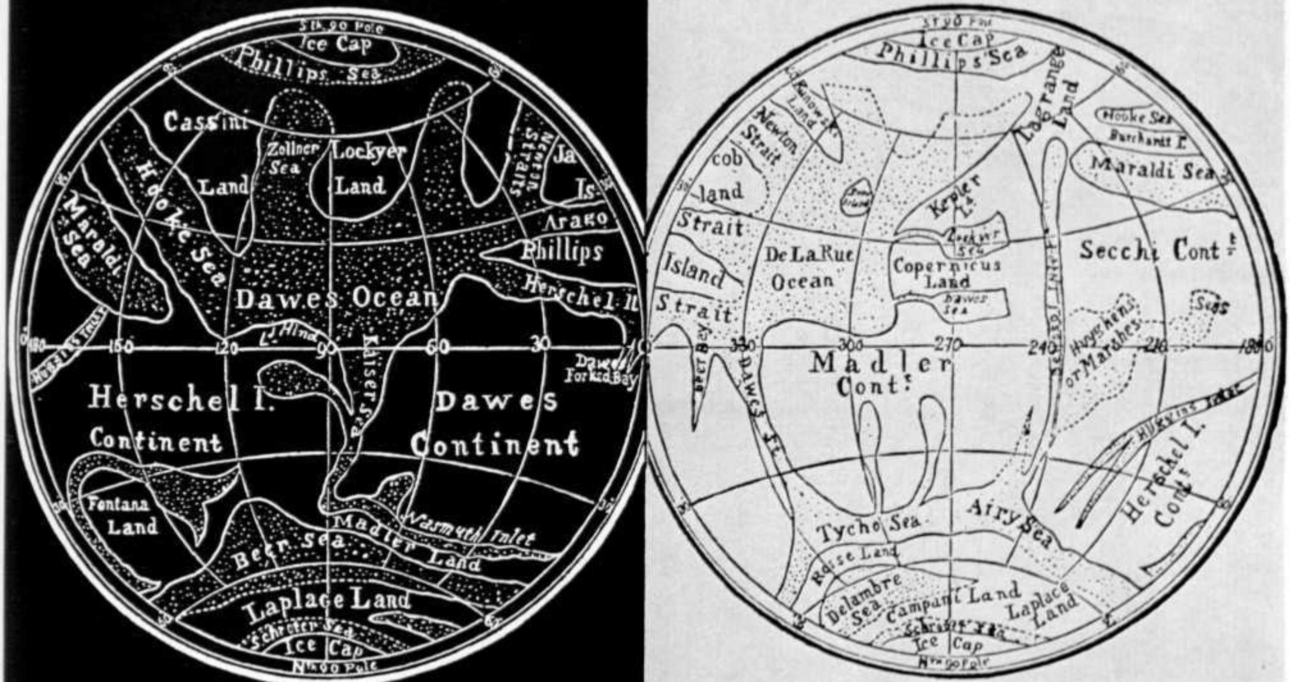
If NEW WORLDS are your oyster



MARS

Map of Mars by Richard A. Proctor drawn in 1867. Following the usage generally adopted for the features of the moon, Proctor named the features after astronomers, especiall astronomers who had observed Mars. From the book, *"The Exploration of Mars"* by *Willy Ley and Werner Von Braun. (Viking Press)*

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This Business Of Modern Forgings

by Robert R. Korff

Primitive man was the first to discover that certain desirable changes take place in metal when it is pounded or worked while hot. Although our prehistoric cousin did not know it, this discovery was the start **of** mankind's use **of forgings.**

Since this simple beginning, forgings have been used by mankind for countless thousands of applications—from waging war to washing clothes. In fact, historians believe that the caveman blacksmiths first **forged** spears and knives. They found, more likely by accident than intention, that metal melted out of rocks made stronger weapons if it was battered and shaped while it was still glowing from fire.

Centuries later, forgings provided the **superior** weapons that made Tubal-Cain and Xenophon and Solomon great. Alexander had forgings with him in his conquests. Later, the Saracens used them to drive the Crusaders out of the Holy Land.

In our own country, forgings aided and, to a large extent, made possible the Industrial Revolution. Today, forgings are the crankshaft in your car, the cable shackles for the elevators you ride, that tiny blade clamp on your jig saw.

Tomorrow, forgings will be parts for turbo-powered automobiles, for atom-powered ships, trains, aircraft, atomic power generating plants—perhaps even for space ships—and, most certainly, parts that will play an important role in automating industry.

How Forged Metal is Shaped

While we can hardly credit primitive man with knowledge of grain structure, what he attempted to accomplish, was, in effect, the same as that which is accomplished with the modern forging hammer-improvement of metal quality.

Forging impact on heated metal has the same effect as kneading a piece of clay. Not only does it shape; it refines. From center to surface, the metal is made more dense and more uniform. At the same time, grain flow of metal being forged is also oriented to follow part contours for added toughness.

What is meant by grain flow? It is a parallel, longitudinal arrangement of crystalline structure, produced by hot rolling the original metal bar or billet.

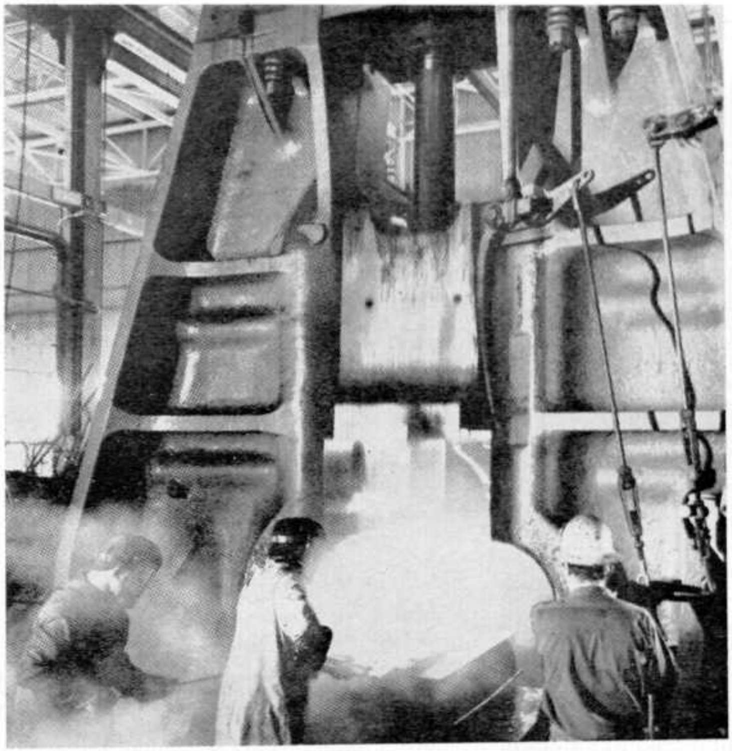
The design engineer, in planning a forged part, can assure that the die impressions are so formed that they will direction grain flow in the most favorable and strength-giving way.

Grain Flow Follows Part Contour

Just as clay responds to pressure and assumes a particular shape, according to the pressure of the craftsman's hands, heated forged metal responds to the shaping and dimensioning effect of closed forging dies. The dies are the forging hammer operators "hands;" the metal held between them is his "clay.

Closed forging dies are made and used in matched sets or pairs. Each mated die contains a precisely formed reverse impression which, when the dies are brought together, shape metal to the exact form and dimension desired.

A metal blank is placed in the cavity of the lower or stationary die. The upper or striking dies is then brought down in repeated blows, carefully controlled by the operator. Each blow brings a further change in the shape of the forging blank as impact and pressure causes the metal to "move" and fill the **die** cavities.



Grain flow of the metal undergoes a similar transformation, changing from a straight flow into an exact repetition of part contours.

One of the greatest values of this characteristic is that the flow lines remain unbroken and thus the part is unified into a continuous structure, strong and tough throughout.

With background on how forgings are made, a natural question would be, "What is a typical forging?" The answer isn't simple, because there is no such thing as a "typical forging." The only limitation on the shape of a forging is the designer's ingenuity. Sound design and forging craftsmanship make it possible to produce a wide variety of shapes, including parts with deep impressions, recesses, bosses, projections or thin sections. Weights vary widely, too—from as little as one-half ounce to as much as four tons.

Dies Shape the Forging

The key to closed impression forgings is the dies. Die blocks are made of high alloy steel, since they must be hard in order to forge metal between them. Die blocks range in weight from a few pounds to several tons each.

The first production step in making a set of closed dies is to fit handling bars to the solid steel block a"d mill shanks for fastening the dies to the hammer. Next is the planing of faces that will eventually contain the die impressions. Then, two sides of each b'ock are planed, providing a perfect right angle with the planed face. This aligns and dimensions the impressions to be sunk in the die face.

Each die face is then coated with a solution to darken it, so that an outline of the impression to be sunk can be drawn on the coated surface, using a template, a forging, or a die drawing as a guide. This is an exacting operation, performed by a skilled specialist using modern precision equipment.

With the design specifications and the outline drawing on the die faces as a guide, another specialist then carefully machines the forging impressions-sinking each to exact part size. Where a slight extra surface is needed for precision finishing or fitting machining is done a few thousandths of an inch oversize.

These impressions are scraped, filed, ground and polished. This assures a smooth surface that will allow forging metal to move easily, filling the die cavities properly for completely accurate production.

A Rough "Proof" Is Made First

When each die block reaches this stage of completion, the blocks are clamped together, face to face, and molten lead is poured into the cavity formed by the die impressions.

The resulting cast or "proof" is an exact replica of the parts that the dies will later produce. This proof sample is carefully checked for accuracy.

After the proof sample has been approved, additional impressions are machined into this or another set of die blocks. These impressions are for the purpose of rough shaping the forging blank before final forging. The number of additional pre-shaping impressions depends on the complexity of the part.

The basic rough or pre-shaping impressions, in sequence, are:

(Continued on Next Page)

MODERN FORGINGS

1. *fullering and edging—to* alter cross section of the metal being forged too thick or thin as required.

2. *blocking—to* "block out" or rough shape the metal into the first definite indication of its final shape.

These die impressions are given the same careful surfacing and inspection as the finishing impressions . . . steps that assure unrestricted movement of the forging metal into each die detail.

The die blocks are now installed in the forging hammer and production of accurately forged parts can begin.

To those previously unfamiliar with the process of forging, this definition now takes on meaning-a closed die forging is the product or result of hot working metal, by impact and pressure, between matched dies containing reverse impressions of the two sides of the part shape desired.

Forgings **Work for Us Everyday**

To the average American, a forging might be characterized as peace of mind—for, no matter where he is, forgings support and sustain the safe operation of every mechanism he uses to fulfill his needs or satisfy his wants.

To the housewife, a forging is all of these things, plus assurance of dependable performance from her modern appliances. That dress for little sister will be finished in time for the school party because mother's sewing machine has forgings in its construction. The pruning that mother wants to do in the garden will be made easier because her shears are tough, strong forgings.

In industry it's much the same story. The boss rigger at an oil well, watching as drill bits chew into the earth to tap its riches, knows he can rely on those bits. They're forgings. Contractor, road builder, mine operator, or jet pilot-each shares a similar assurance. They know the hardest working parts of the equipment they use are forgings.

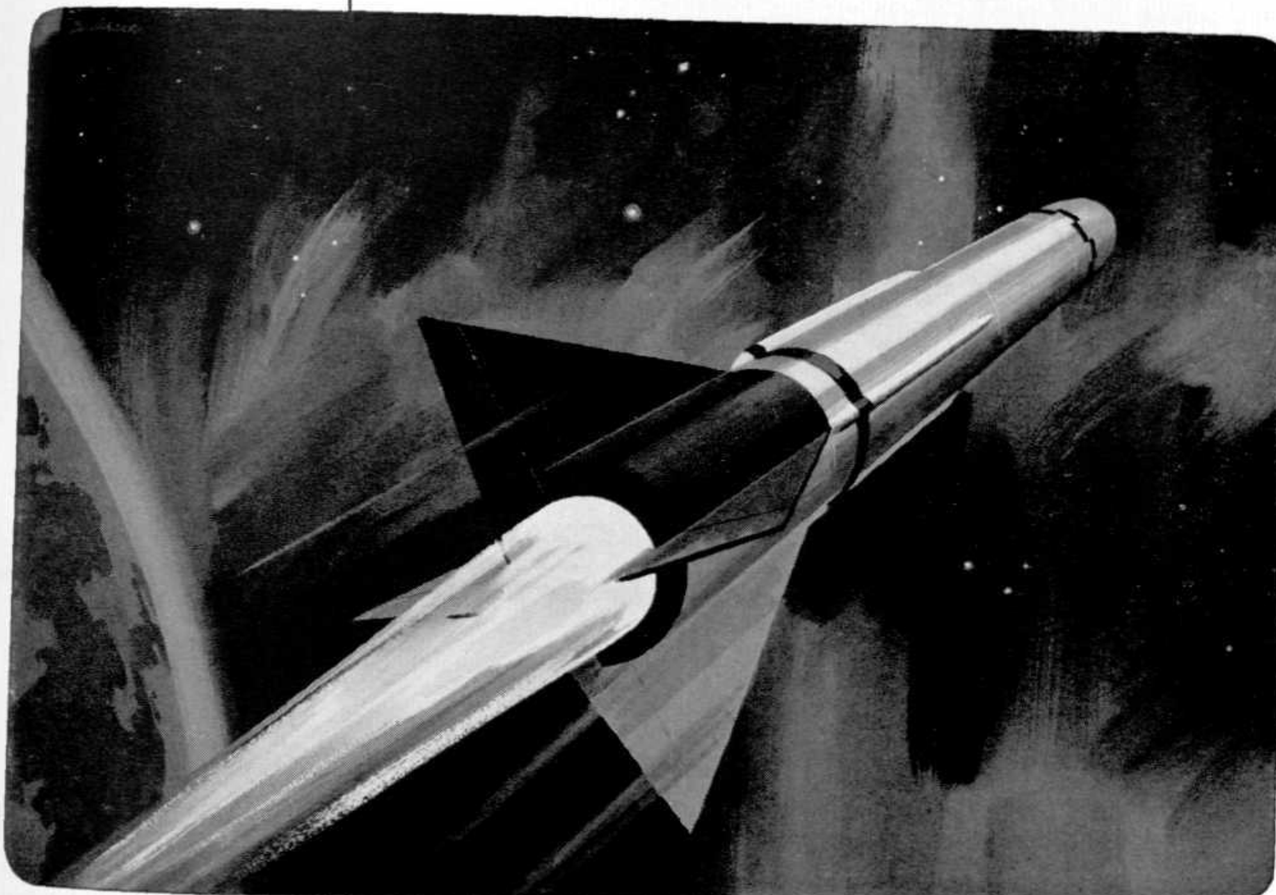
The first caveman blacksmith had the basic idea of the value of forging. But little did he realize how important the process would become to mankind. He wanted only two things from the metal in his tools and weapons, strength and toughness:

1. Strength to withstand unexpected impact or repeated strain far in excess of service actually required. Literally, strength with brittleness.

2. Toughness, or ability to "give" under abnormal load without permanent distortion or sudden fracture.

So successful was he in initiating the process that produced these results in metal, that modern forging manufacturers use this slogan today-"many parts are strong . . . many others are tough . . but a forging is *both."*

IMPORTANT DEVELOPMENTS AT JPL



Weapons Systems Responsibility

The Jet Propulsion Laboratory is a stable research and development center located north of Pasadena in the foothills of the San Gabriel mountains. Covering an 80 acre area and employing 2000 people, it is close to attractive residential areas.

The Laboratory is staffed by the California Institute of Technology and develops its many projects in basic research under contract with the U.S. Government.

Opportunities open to qualified engineers of U.S. citizenship. Inquiries now invited.

In the development of guided missile systems, the Jet Propulsion Laboratory maintains a complete and broad responsibility. From the earliest conception to production engineering—from research and development in electronics, guidance, aerodynamics, structures and propulsion, through field testing problems and actual troop use, full technical responsibility rests with JPL engineers and scientists.

The Laboratory is not only responsible for the missile system itself, including guidance, propulsion and airframe, but for all ground handling equipment necessary to insure a complete tactical weapons system.

One outstanding product of this type of systems responsibility is the "Corporal," a highly accurate surface-to-surface ballistic missile. This weapon, developed by JPL, and now in production elsewhere, can be found "on active service" wherever needed in the American defense pattern,

A prime attraction for scientists and engineers at JPL is the exceptional opportunity provided for original research afforded by close integration with vital and forward-looking programs. The Laboratory now has important positions open **for** qualified applicants for such interesting and challenging activities.

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Around The World In 96.1 Minutes

by Stephanie Cooke

From **Magellan's** three years and a month, to **Phileas Fogg's** eighty days, to Sputnik's 96.1 minutes. That's **progress!**

Sputnik, **which** is Russian for satellite, was launched October 4, 1957, and is still circling the earth. Many people. **United** States politicians in particular, were **unhappy** about **the** launching despite **the** tremendous scientific **advances** it represented, because it was made apparent that Russian satellite knowledge is superior to **the United** States'. The Russians had beaten **us at** what seemed to be our own game - great cause for a mighty power's embarrassment. The launching has succeeded in doing one thing though - uniting purpose in the West. Democrats and Republicans both see the necessity of stepping up the United States' missile development. However, most people are quite happy because at last the initial barrier to outer space has been crashed. The possibility of cosmic flight with the help of rockets was first scientifically sustantiated in Russia as early as the end of the 19th century, in the works of the outstanding Russian natural scientist Konstantin Tisiolkovsky - according to a Soviet news agency. The present day creator of Sputnik and sparkplug of the Red satellite program is Leonid Sedov.

Just what is this object which is causing so much excitement? It is a small sphere, 58 centimeters in diameter, with four antennae, resembling a tetrahedron. There was some controversy over its reported weight, whether 184.3 or 18.43 pounds. The former was the reported weight but the latter seemed more likely as compared to the U. S. satellite weight of 22 pounds. The Russians later verified the 184.3 pound report.

Sputnik is equipped with radio transmitters which had been transmitting signals, exciting anyone who could pick them up, but meaningful only to the Soviets. After listening to the "beep-beep" produced and examining oscilloscope photographs of its sound patterns, scientists decided definitely that coded information was being sent - possibly about weather conditions. But they were unable to translate it. The signals were emitted continuously at a frequency of 20.005 and 40.002 megacycles and could be picked up by ham radio operators, and regular radio receiving systems, also, after being adjusted to the lower frequencies. On November 10th it was officially announced that the transmitters had gone dead.

Sputnik follows an elliptical orbit reaching as far as 570 miles from earth and 170 miles away at its closest point. The orbit follows a direction at an angle of 65° to the equator but does not pass the same point on the equator each time around. It is interesting to note that the Russian scientists were able to plan the orbit so that it passes over Moscow everyday. The Russians chose this particular angle (65°), as opposed to the U. S. choice of around the equator, because of the location of the gravity center of the earth, feeling the center would better help the satellite's motion in this position. It would seem that the) made the right choice since Sputnik has been in its orbit for two months now with no signs of coming down.

Two Bonn Observatory natural scientists estimated the location of launching to have been Irkutsk, Siberia. It was done with a multi-stage rocket. Severa rockets are attached to the satellite. One fires until it exhausts itself, drops off, and the next one fires-

Stephanie Cooke is a senior from Garden City, Michigan. She is majoring in chemistry and has been active in the American Chemical Society. After graduation from State she plans to work as a technical librarian.

STEPHANIE COOKE

This way enough power may be obtained to shoot the satellite beyond the atmosphere. The final stage rocket traveled in an orbit of its own somewhat smaller than and therefore ahead of Sputnik's until early December. Some scientists believe the launching success to be due to an advanced fuel - perhaps exotic mixtures of ammonia or ozone and hydrogen. Others feel that the conventional fuel of kerosene and liquid oxygen is sufficient with multi-stage rockets being the secret.

Sputnik is held in its orbit by its speed - 18,000 miles per hour. It works on the same principle as a ball whirling on a string. Gravity tends to pull it towards the center but its continual high speed moves the ball forward all the time it is being pulled in, resulting in circular motion. If the speed is too small the ball will fall inward, the gravity overpowering the velocity. And if the speed is too great, above what is known as escape velocity, the string will break. Sputnik's minimum speed is around 12,000 niles per hour and its escape velocity is around 25,000 miles per hour.

Because of Sputnik's altitude (not high enough) there is air friction which will eventually slow the satellite down until it falls to Earth. However, because of the unknown characteristics of that segment the atmosphere, it cannot be definitely decided when Sputnik will fall. General estimates of Sputnik's life vary from two days *to* a century or more. The Soviets figured about a month. Of course this has already been disproved since Sputnik has been up for two months. Scientists feel that after it does start to fall the denser atmosphere will create so much friction that the satellite will burn up before it reaches the earth. This theory has been partially supported by the falling of the final-stage rocket. It was burning while falling but whether it completely disintegrated has not been officially announced. This problem of re-entry merited some discussion. While it seems desirable for the satellite to burn up so as to prevent injury to the Earth and its inhabitants, it would also seem desirable to have the satellite land intact, especially since the plans eventually include men traveling in the satellites. Dr. Simon Ramo, chief scientist of the Air Force ballistic missle program, says they have solved the problem, but does not say exactly how. A method hinted at is a series of jumps down and forward glides (called skipping) within the atmosphere, rather than a direct downward plunge.

Satellite experts believe the satellite to be equipped to make measurements of temperatures, and bombardment by solar particles, radiation, cosmic rays and meteors. Soviet natural scientist, A. A. Blagonravov, was quoted as saying that the satellite contained only a radio transmitter and power supply. Whether the transmitter is capable of making these atmospheric measurements was not stated. As was said before though, the radio signals picked up from Sputnik definitely indicated information of some sort was being transmitted. Some sources say Sputnik contains a telephoto camera, others say not, but whether it does or does not, such a camera is a possibility in future satellites.

(Continued on Next Page)

AROUND THE WORLD

(Continued from Page 81)

Sputnik is **being** watched all over the world with avid **interest.** The U. S. has an apparent advantage in facilities although clearly lacking the all-necessary technical information. The U. S. has a special telescopic' camera which can track **a** tennis ball at a distance of 300 miles. There is one located at Pasedena, California, and others are being set up. The USSR wants to purchase ten of these cameras, $100,000 each, indicating **a** lack of tracking facilities. Long range radar systems have been locating the satellite. Also (here are the 150 moonwatch teams that were first **organized to** watch U. S. satellites when launched and who are now getting an unscheduled workout with Sputnik. The teams are made up of professional and amateur astronomers, telescope makers, military men, and space exploration enthusiasts. They are located at observatories around the world and Soviet moonwatch teams are swapping information with U. S. teams. To these people the satellite looks like a bright sphere, in the sky for only a few seconds. Many members of the teams and fascinated crowds regard the whole thing as an exciting adventure as they crane their necks to spot the Sputnik. However, serious astronomers and moonwatchers, their work coordinated by Dr. Armand Spitz, director of the Spitz Laboratories, are faithfully putting in their time starting at six o'clock every morning and recording any information they come across. When all the information was fed to the giant electric brain at Massachusetts Institute of Technology, a nearly exact plan of the satellite's orbit was obtained.

There are different reports as to who first spotted Sputnik. First American spotting credit goes to Dr. Gordon B. Little, assistant director of the geophysical station at the University of Alaska. He was quoted as saying that what he saw at 5:01 A.M., October 6, was a surprisingly bright object which stayed in the sky for about five minutes. There is some speculation, though, that what he saw was the still-orbiting final-stage rocket and not the satellite. Russia gives first credit to a natural science worker at Alma Ata, V. S. Matyagin, who reported seeing the sphere just before midnight October 5th.

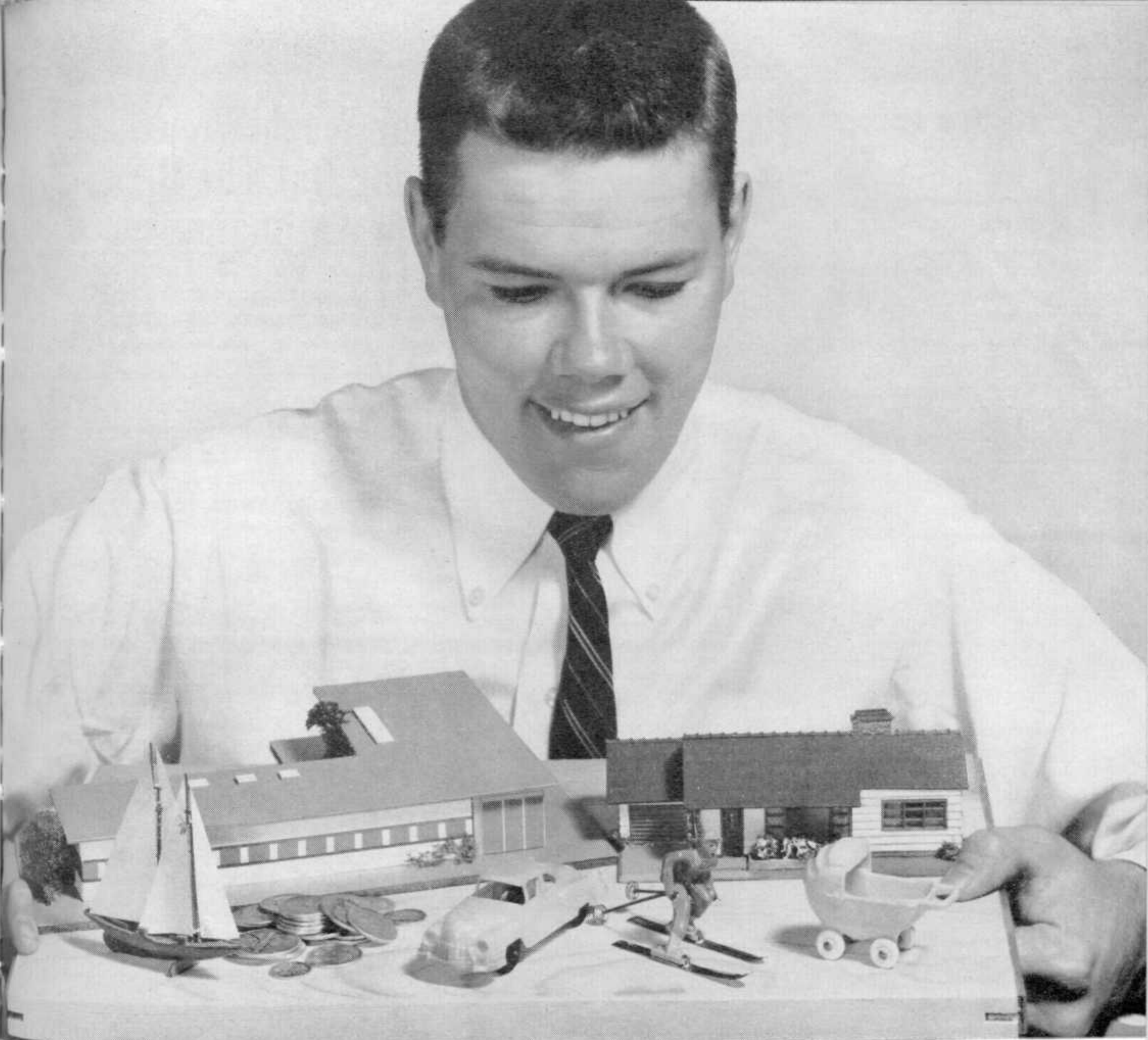
The value of satellites in adding to scientific knowledge lies not only in their reaching great heights but also in their ability to stay there. This type of satellite is an essential forerunner to space travel. The satellite is equipped to convey the nature of conditions at that height. By knowledge of these, scientists will know much better how to construct manned vehicles and high flying missies so that they can withstand the rigorous tests of endurance put on them: extreme temperatures and pressures, bombardment by meteors, cosmic rays, etcetera; and so they can re-enter the atmosphere and land unharmed by the tremendous increase in air density and friction. Also the satellite gives, for all practical purposes, an unobstructed view of the sun, moon and stars. Unhampered by the obscuring and distorting effects of the atmosphere, sun and star photographs taken from a satellite are expected to disclose a wealth of detail that astronomers have never seen. The actual value of this has been demonstrated by sun pictures taken from a balloon carrying a telescopic camera above 95% of the atmosphere. It is possible that the satellite's orbit varies with the shape of the Earth, its irregularities, and the effects of gravity. So precise knowledge of the satellite's orbit should disclose new information about the Earth's contour.

The rate at which the satellite slows down will be an indication of air densities at various heights. Equipped with photocells, the Earth's clouds could be studied by recording the amount of sunlight reflected from the Earth. With an analyzer the sun's ultraviolet rays could be studied; these play little-understood roles in storms. Winds could be studied by measuring the difference between infrared rays emitted from the sun and infrared rays emitted from the earth; the difference varies with wind currents in the lower atmosphere. The auroras could be studied. By observing a satellite simultaneously from two or more points on Earth, experts can use elementary geometric triangulation to determine the precise distances between these points - something geographers have never been able to do. Satellites will be able to observe patterns of weather formation on Earth, enabling meteorologists to make weather predictions months, and possibly even years, in advance. And if escape velocity is reached, through improved fuels and rockets - what then? The moon, the universe! The development of Sputnik has opened the door to first-hand knowledge of the whole universe around us.

Many feel that the Russians are now at a military advantage. They feel that the USSR has increased observation power over the rest of the world, a "Big Brother" in the sky. But it must be remembered that in looking down through the atmosphere to the earth, one is faced with the same problems of one trying to look up through it. The atmosphere simply does not lend itself to clear observation. If the Russians are at any advantage it is in their knowledge gained for the launching and guiding of missiles and rockets. But American scientists have a tendency to deny this advantage, too. The Russians have claimed to have an intercontinental ballistic missile, which the U.S. has not yet perfected. This claim seems entirely possible now. And if apprehension and fear is to be felt, it should be of the ability to so well overcome the tremendous barriers in the field of missile science and research, and of a willingness to pursue progress without regard for cost. As Dr. Werner Von Braun, top U.S. space expert said concerning fear of being kidnapped by the Russians, "That danger no longer exists. I couldn't tell the Russians anything about rocketry. I'd only learn."

Dr. John Hagen, director of the American satellite program, said that the Soviet satellite now spinning around the globe appears to be a test vehicle and that this explains the lack of any advance announcement by the Soviets. The USSR announced that the launching of Sputnik was planned in accordance with the International Geophysical Year program of research and that several more bigger and heavier satellites

(Continued on Page 69)



WHEN R EQUALS ZERO

(Continued from Page 25)

The cryotron Is basically two wires; one wire of tantal...., which is aboul one-half inch long, and a second wire of niobium, which is coiled around the first as in figure 3. The niobium wire carries a current which is called the control current. Both wires are in a superconductive state due to the absolute temperature.

The cryotron is a current operating device. When current flows in the niobium wire a magnetic field is set up which causes the tantalum to shift from superconductivity to normal conductivity. In figure 2, we can see that the niobium wire remains superCOnductive at a much higher field strength than does the tantalum. Using the magnetic field of the control

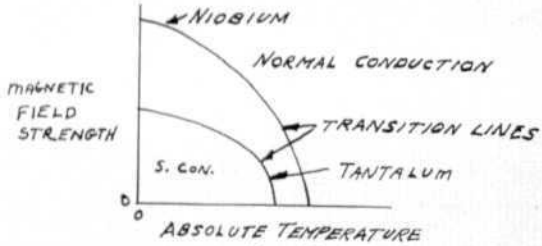
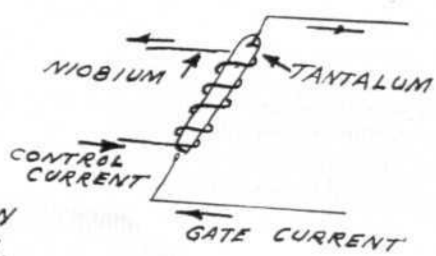


FIG. 2

current to vary the resistance in the tantalum wire between superconduction and normal conduction, we can vary the amount of current flowing through it. With this arrangement we can then obtain current gain and power amplification, because a smaller current in the control winding will effect a larger current moving through the tantalum wire.

The cryotron is of great interest to computer circuits, because it is small, light weight, easily fabricated, and dissipates very little power. It is predicted that a large scale computer would need approximately five thousand cryotrons. This would mean that the computer would dissipate about one-half a watt and fit into a cubic loot of space. Present large-scale computers dissipate many thousands of watts and occupy hundreds of cubic feet of space.

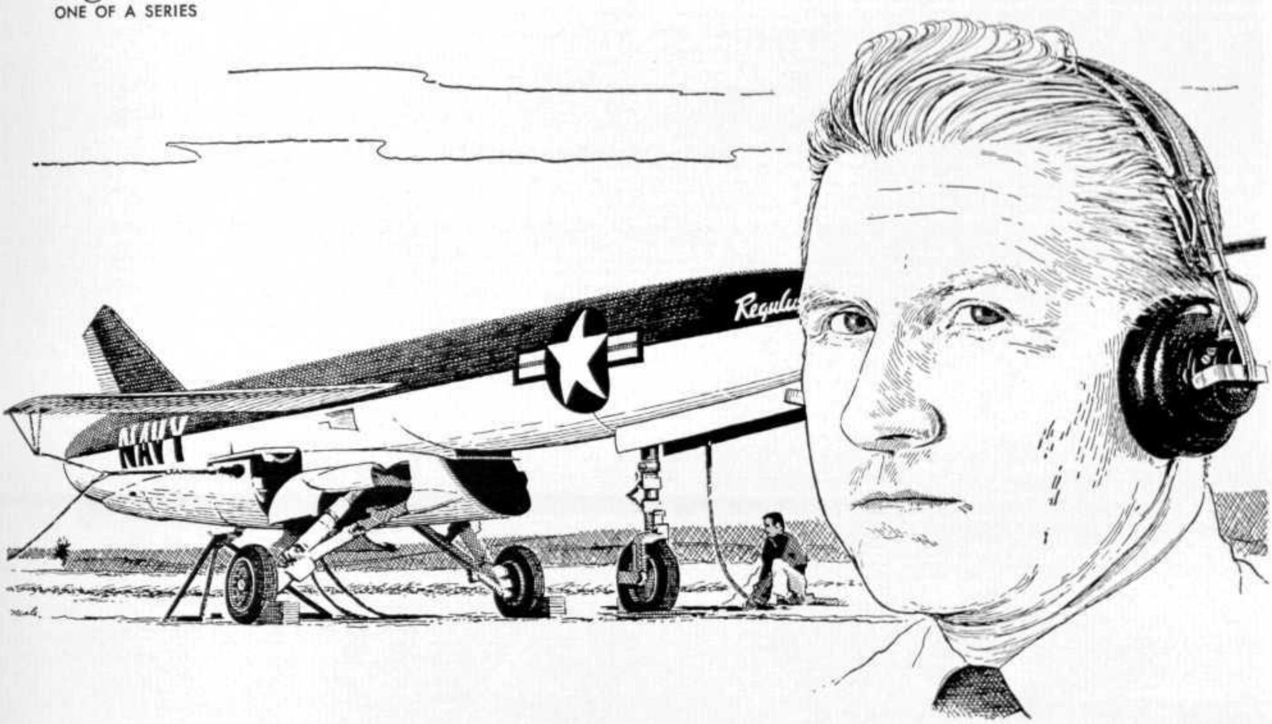
Thus, low temperature research offers us many opportunities. It gives us a limitless temperature range of physical observation. It lowers thermal energy so that other forms of energy can be studied; namely magnetic, and electrical. Superconduction, a low temperature phenomena, is applicable to computer circuits and high frequency antennas. However, before the phenomena has wide spread applications, we must know more about refrigeration techniques, and reduce insulation problems by creating new superconductive materials with higher transition temperatures.



CRYOTRON FIG. 3.

A Vought Vignette

ONE OF A SERIES



Why the Missile Engineer Never Missed Mail Call

Vought's Regulus II missile took shape just a short walk from the desks of its developers. Engineers handled the new hardware and monitored tests in person — literally flying the big missile on the ground at Dallas. It was a convenient arrangement while it lasted.

Then a big USAF Globemaster landed and taxied to Vought's Experimental Hangar. The missile was winched aboard and airlifted to a desert site for flight tests. By nightfall there was a 1,000-mile rift between Regulus II and home base.

Joe Boston was ready to step into this gap. As Project Assistant for Field Liaison, he'd already equipped Vought's desert crew for extensive flight tests. Now he'd make sure that test data and hardware flowed uninterrupted from the desert to Vought. High-speed feedback of facts on one flight could influence the success of the next.

Mail from the desert poured in to Joe at Vought. From project men at the flight test site came parts for immediate rework and return. From the flight test crew's mobile ground station came rolls of telemetered brush records. From the recoverable Regulus itself, came packets of oscillograph data. And from Field Service — for repair or replacement — an occasional wrench or relay.

Joe served as clearing house and consultant. Flight data was reduced and released to design and support groups. It revealed not only missile performance, but the temperatures and pressures of a strange new environment. When data pointed toward design changes, Joe's time and cost estimates helped specialists reach decisions.

Thanks to Vought's fast overland relay of hardware and data, the records of one flight were decoded and digested in time to improve the next hop. Dividends in performance and reliability were obvious after six flights had been logged by Regulus II.

All six had been flown by one vehicle.

Chance Vought uses comprehensive testing and data analysis to assist the engineer through unexplored problem areas. Test facilities strengthen every phase of the development cycle, and procedures are aimed at feeding data quickly into the engineering process.

CHANCE VOUGHT AIRCRAFT
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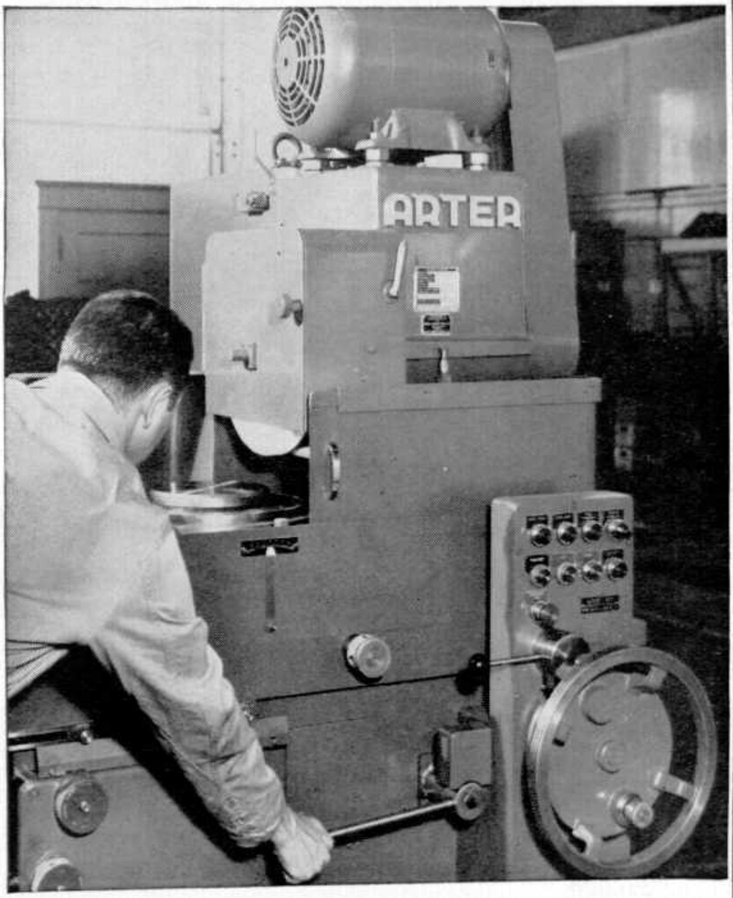
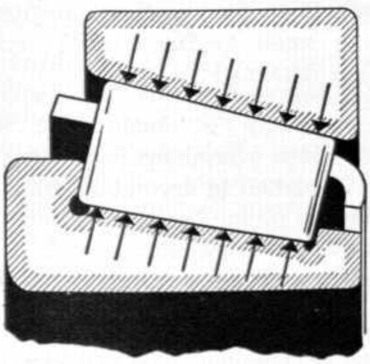
Tear out this page for **YOUR BEARING NOTEBOOK...**

How to get higher spindle accuracy, cut costs too



The engineers who designed this new surface grinder had to be sure of the highest spindle accuracy in order to get the smooth spindle operation required for extreme precision work. To hold the work and wheel spindles rigid, maintain highest accuracy, the engineers specified Timken® "00" tapered roller bearings. Timken "00" bearings make possible the closest machining tolerances ever achieved. Run-out is held to 75 millionths of an inch. And they gave the manufacturer greater capacity in less space, cut manufacturing costs *Vi* over earlier spindles used.



How Timken bearings **hold shafts** rigid **to maintain accuracy**—The full line contact between Timken bearing rollers and races gives shafts rigid support over a wide area. Shaft deflection is minimized. And the tapered design of Timken bearings permits them to be set up with the most desirable amount of end play or preload that gives the best performance.

Want to learn more about job opportunities? Timken bearings help make better machines. Better machines enrich our lives, give us more spare time. It's what the Timken Company calls Better-ness. Want to help create Better-ness? If so—write for your free copy of: "BETTER-ness and your career at the Timken Company". The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN *TAPERED ROLLER BEARINGS*

TRADE-MARK REG. U. S. PAT. OFF.

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL AND THRUST → ← LOADS OR ANY COMBINATION

FIBERGLAS

(*Continued from Page 21*)

compact the fiberglas reinforcement and to force the plastic throughout the mold. If a small amount of fiberglas is used for a large amount of plastic, or if the plastic resin is applied uniformly over the entire area, extremely low pressures become practical.

The combination of fiberglas and plastics require a moderate temperature to cure the liquid plastic, such as the widely used polyesters, to a hardened state. The addition of catalysts and accelerators will cure the molded material without the need of external heat. When heat curing is used, the temperatures required are between 180° F. and 250° F.

The low pressures and low temperatures for the curing of fiberglas with plastics make it practical to mold extremely large parts in a single unit on light forms using simple equipment. Parts 35 to 60 feet in length and several feet in width have been produced by various molding techniques. The low molding pressures also makes possible the use of inexpensive molds when a small number of parts are to be manufactured. For two to five moldings, plaster molds are suitable; for a few hundred, wood, aluminum, or zinc alloys; for larger quantities fine grain cast iron or steel.

The molding method is dependent on the type, size and economical consideration. The well-known contact, vacuum, pressure bag, flexible plunger and vacuum injection molding methods are used to produce parts in small to large shops and factories throughout our nation.

Fiberglas, alone or in combination with other materials, goes into everything from awnings to airplanes, from insulation to decoration, from pipes and pipe wrappings to plastic boats, from ducts to draperies, from sport cars to swimming pools. It combines with gypsum in wallboard and with vinyl in insect screening.

The future of fiberglas is dependent on the ingenuity of man and his foresight. The present day usage of fiberglas, alone or in combination with other known materials, is aglow with the glitter and fascination of durable strands of glass.

REINFORCED PANELS

(*Continued from Page 48*)

panel. The material possesses functional qualities, while retaining beauty and strength. This places it in a class of its own. The presence of reinforced plastic panels introduces a new phase in design and architecture.

NEW DEVELOPMENTS

(Continued from Page 54)

This procedure, while giving satisfactory results, is complicated and sometimes quite lengthy. In addition, when the sample is very small, it is difficult to prepare a homogeneous mixture with the diluent. Many of the samples submitted weigh less than a few tenths of a milligram.

The carbon-matrix technique developed by scientists is, in effect, a simplified method of diluting the sample with a standard substance. A tiny amount of the sample is placed in a small crater drilled into the end of a graphite electrode. When the electrode plus the sample is placed in the electrical discharge, the necessary dilution with a standard substance is performed by the carbon of the electrode.

In this way, the intensity of the emitted light depends in a reduced degree upon the matrix of the sample and an approximate analysis becomes possible.

Scientists Duplicate Sun's Heat With Movie Mirrors

Scientists probing the mysteries of intense heat have produced temperatures approaching that of the suns surface with ordinary motion picture projection equipment.

Highly-polished curved mirrors concentrate rays from a carbon arc into a small but extremely high-energy beam that can produce temperatures above 7,000 degrees Fahrenheit. The technique is actually a scientific version of the use of a magnifying glass to set fire to a piece of paper.

The arc image furnace, as this versatile research tool is known, is not new, but an entirely new twist has been introduced that adds immensely to its usefulness and makes practical the high temperatures required in modern-day research. Previous furnaces have used specially-designed parabolic mirrors to focus the arc's energy onto the substance to be heated.

The new design uses two elliptical mirrors of the standard type found in motion picture projection equipment. One mirror directs the energy of the arc at the other, which in turn concentrates the radiation on the specimen being heated, forming a life-size image of the actual arc.

The new equipment is highly compact and portable and can be operated practically anywhere, at any time. It is said to produce results comparable to that of a solar furnace with a 60-inch diameter reflector, which depends on the sun's rays for its energy and can be operated only under favorable climatic conditions.

The arc image furnace now in use uses arc carbons less than one-half inch in diameter, focused by mirrors approximately 18 inches in diameter and placed about 6 feet apart. The arc draws a current of 200 amperes, which is approximately twice the electrical requirement of a modern home. Normal operating voltage is 80 volts. There is no reason why the arc image furnace cannot be extended to larger arcs with higher power to heat larger samples, and work along those linos is already underway.

In addition to its use of Standard equiment. the new system has the advantages of providing a narrow beam midway between the two minors where a shutter can be plaood to turn the energy on and off very quickly without disturbing the arc. A tilted mirror can be placed at the same point to tip the beam at any desired angle if it is to be used in molting a specimen.

As an extremely "clean" source of high temperatures, the arc image furnace is ideally suited to metallurgical research where purity is particularly important. The beam can be projected through a transparent window into an enclosed vessel in which the atmosphere can be controlled, and which can even bo raised to high pressures if a combination of high temperature and pressure is desired. Because of these features, it is a very valuable research tool, and might well become a useful production tool in the future as high temperature operations become more common in industry.

AROUND THE WORLD IN MINUTES

(Continued from Page 62)

are also to be sent up during IGY. Already one of these has been launched - the one containing the dog, Laika. Scientists around the world arc hoping that, also in accordance with IGY, the Russians will share the knowledge gained, but past experience makes this seem a little doubtful. It is a realization of the USSR's "closed-mouth" policy that I would like the readers to keep in mind while reading this article. If the information at times seems a little vaguo, this is due to the nature of the information available. All the details known are either ones obtained from long-range observation, comparison with similar U.S. developments, or the information regarded as harmless by the Russians and therefore eligible for release. These details have been pieced together to give a fair but far from satisfactory picture of Sputnik.

Lloyd Berkner, nuclear physicist, summed up scientific feelings on the Russian surge in satellite advancement - "It would have been nice if the U.S. had been first, but let's be glad that it's been done." Scientists also feel that now that Russia has actually beaten the U.S. in launching a satellite, the government will pay some serious attention to the program and allot enough money so that the U. S. can catch up. Dr. Ramo does not even feel that the U. S. is behind, but rather that emphasis in research has been put on different subjects. Whether it is correct or not is hard to say not knowing Russia's exact standing.

But why all the interest in space? Why are men so anxious to venture into the forbidding regions between the stars: This was answered by a great explorer, Fridtjof Nansen, when he said, "The history of the human race is a continual struggle from darkness toward light. It is, therefore, of no purpose to discuss the use of knowledge. Man wants to know and when he ceases to do so, he is no longer man."

SIDETRACKED

"So you met your wife **at** a dance! Wasn't **that** romantic?"

"No, embarrassing. I thought she was home with the kids."

Mother: "Daughter, didn't I tell you not to let strange men come to your apartment? You know how it makes me worry."

Daughter: "It's all right, Mother, I went to his apartment, now let his mother worry."

Then there was the M.E. who stepped **up to the** bar very optimistically, and two hours later went away very misty optically.

During a layover on **a** recent week-end trip, we overheard the ticket agent make assurances that a certain train would be on time. One man, after pacing the station platform for more than an hour, stalked angrily to the ticket window.

"Why didn't you tell me this train was late when I asked you before?" he fumed.

"Look here, mister," replied the complacent agent, "I ain't paid to sit here and knock the railroad."

C.E.: Is your sister expecting me tonite?

Little boy: Yeah.

C.E.: What makes you so sure?

Little boy: She just went out for the evening.

First father: "Has your son's Liberal Arts education proved helpful since you took him into the business?"

Second father: "Oh yes, whenever we have a board meeting we let him mix the cocktails."

Angry Father: What do you mean by bringing my **daughter** in at this hour of the morning?

Student: Have to be **at** class at eight.

Four year old: "Daddy, are there any skyscrapers in heaven?"

M.E. Dad: "No son, C.E.'s build skyscrapers.

Girl: Isn't that a lovely moon tonight?

Boy: I'm not interested in astronomy now, and besides I'm in no position to say.

The main trouble with the straight and narrow is that there is no place to park.

Professor: "You in **the** back of **the** room, what was the date of **the** signing of **the** Declaration **of Independence?"**

"I dunno."

"You don't **eh?** Well then **do** you know when **the** battle of Bull Run was fought?"

"Nope."

"Can you tell me anything about **the Battle** of Gettysburg?"

"Nope."

"You can't! I assigned this stuff last week. What were you doing last night?"

"I was out drinking beer with a couple of buddies."

"You were! How dare you stand there and tell me a thing like that? How do you expect **to** pass this course?"

"Wai, I don't, mister. Ye see, I just come in to fix the radiator."

"How can you keep eating this dorm food?"

"Oh, it's easy. I just take **a** tablespoon of **Drano** three times **a** day."

Jane: "I said some foolish things to John **last** night."

Mary: "Yes?"

fane: "That was one of them."

You can lead an engineer **to** water, but why disappoint him?

Student Nurse: "Every time I bend over to listen to his heart, his pulse rate goes up alarmingly. What should I do?"

Intern: "Button your collar."

A beautiful **girl** was walking along the sidewalk one evening on her way to the movie. She noticed a small bird laying at the side of the walk with a broken wing. Instead of going to the movie she took the bird home, bandaged its wing, and fed it. In a few weeks the bird was well enough to fly away.

Now, let's see you guys find anything dirty in that.

Typist: "But, professor, isn't this the same exam you gave last year?"

Professor: "Yes, but I've changed the answers."

Familiarity breeds attempt.

Confucius says, "Modern woman putting up such a false front, man never knows what he is up against."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The proof of the planning is in the finished plans. That's why you're smart to use Eagle TURQUOISE—the pencil the professionals prefer. Look what it gives you: Uniform grading (17 scientific formulas guarantee exactly the blackness you want—from every pencil, every time!). A strong non-crumbling needle point that stays sharp for line after long line of unchanging width. Inimitable smoothness—thanks to Eagle's exclusive "Electronic" graphite. TURQUOISE makes your plans look sharp—and you, too!
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INDEX TO ADVERTISERS

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** Inside back cover
*** Back cover

Pump-turbine design is now the work . . . hydraulics/ the field . . . of John Jandovitz, BSME graduate of College of City of New York, '52.

Water conditioning chemical, service, and equipment specialist in Houston is new assignment of Arthur Brunn, BS Chem. E., University of Tennessee/ *'56.*

Field sales engineering of America's widest range of industrial products is choice of Roy Goodwill, BSME, Michigan State College, '54.

Recent Training Course Graduates

select wide choice of careers at Allis-Chalmers

Starting up a cement **plant** in Mexico after coordinating all work on it is latest job of John Gibson, BS Met. E., University of California/ '54.

Nucleonics is chosen field of R. A. Hartfield, BME, Rensselaer Polytechnic Institute, '53. Currently he is working on design and development of new nuclear power plant,

THERE'S variety at Allis-Chalmers. Whether you're thinking in terms of types of industries, kinds of equipment, types of jobs, or fields of work, the diversification of Allis-Chalmers provides unsurpassed variety. For example:

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Sales	Electric Power	Transformers	Stress Analysis
	Mining	Crushers	Nucleonics
	Nuclear Power	Reactors	Electronics
	Paper	Control	Hydraulics
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ALLIS-CHALMERS

EDITORIAL

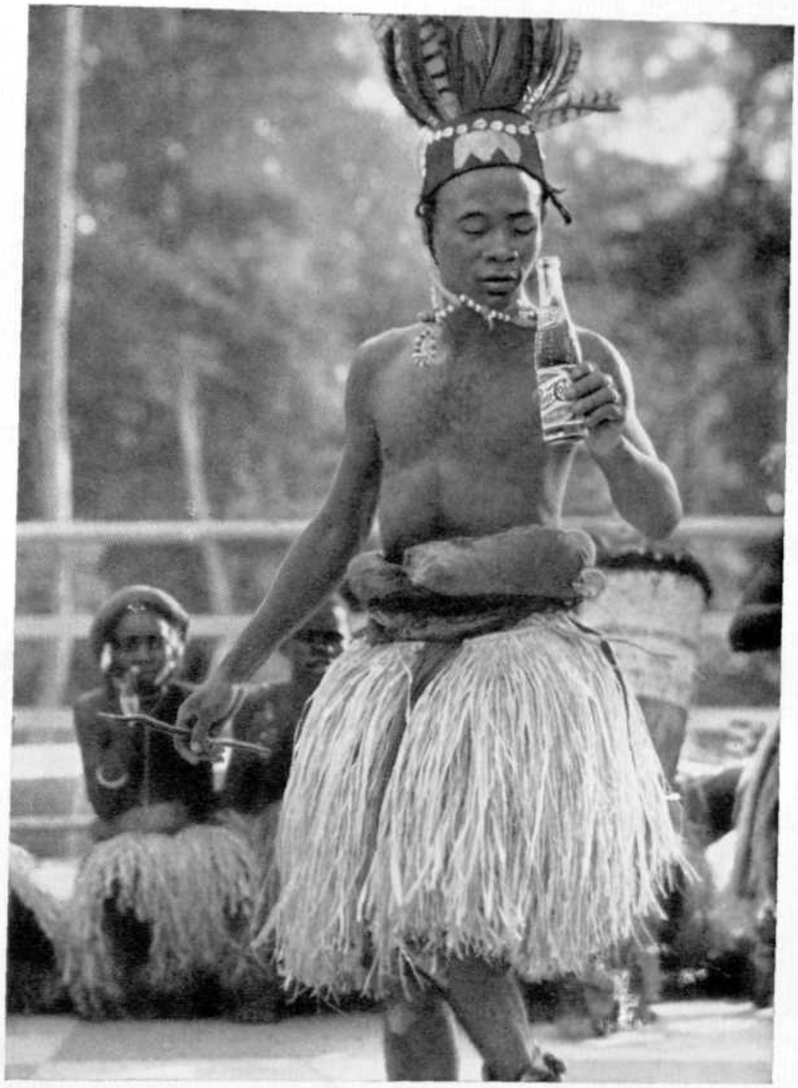
Well, another year has just rolled around and finds the Spartan Engineer staff with offices in the new Student Activities building. Since we have two large offices and plenty of new furniture and equipment, we should be able to concentrate on the content and make-up of a magazine which best appeals to you engineers. Our office, room 346, is open for any criticism, and we'll welcome all suggestion. Incidently, there are three vacancies on the staff at the present time, so why not come up and help us make the S.E. the best collegiate engineering quarterly?

Say, gang, why not pull out those dusty reports and research papers, brush them off, and enter them in the technical writing contest? Better yet, sit down, take pen in hand, and write on some technical subject with which you are familiar. Let your technical interests reap dividends for you. Here is a grand opportunity to pick up some extra cash, and have your article be the cover-feature of the May issue.

PHOTOGRAPHY AT WORK
No. 30 in a Kodak Series

Pepsi-Cola International Panorama, a magazine of places and people, reaches people around the world, builds recognition for Pepsi-Cola as a product associated with the better, happier side of life.

Photography speaks in every language



What better way to say people take naturally to "Pepsi" whether in Leopoldville or Lichtenstein?

This picture leaves no doubt that Netherlanders are neighborly.

To tell its story in 75 countries, Pepsi-Cola **puts pictures to** work **to add** meaning **to the product's global billing** as **"the refreshment of friendship."**

To build up an atmosphere of friendliness and understanding in markets around the world, Pepsi-Cola International publishes "Panorama"—and gives the brunt of the job to photography.

Photography knows no language barrier. It is clear to young and old alike—appeals to everyone. With photography, people are real; situations authentic, convincing. This is what makes photography such a powerful salesman.

Large businesses and small can use this powerful salesmanship—can also use photography to cut costs and save time in many other ways. It can help with problems of product design—can watch quality in production. It trains, It cuts office routine. You'll find that it can work for you, too.

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TRADE MARK

One of a series*

Interview with General Electric's Earl G. Abbott Manager—Sales Training

Advancement in a Large Company: How it Works

Where do you find belter advancement opportunities in a large company or a small one? To help you, the college student, reiolve thai problem, Mr. Abbott answers the following question concerning advancement opportunities in engineering, manufacturing and technical marketing at General Electric.

Q. In a large Company such as General Electric, how can you assure that every man deserving of recognition will get it? Don't tome capable people become lost?

A. No, they don't. And it's because of the way G.E. has been orginized. By decentralizing into more than a hundred smaller operating departments, we've been able to pinpoint both authority and responsibility. Our products are engineered, manufactured and marketed by many departments comparable to small companics. Since each is **completely responsible for** its success and profitability, each individual within the department has a defined share of that responsibility. Therefore, outstanding performance is readily recognized.

Q. If that's the case, are opportunities for advancement limited to openings within the department?

A. Not at all. That's one of the advantages of our decentralized organization. It creates small operations that individuals can "get their arms around", and still reserves and enhances the inherent advantages of a large company. Widely diverse opportunities and promotions are available on a Company-wide basis.

Q. But how does a department find the best man, Company-wide?

A. We've developed personnel registers to assure that the best qualified men for the job are not overlooked. The registers contain complete appraisals of professional employees. They enable a manager to make a thorough and objective search of the entire General Electric Company and come up with the man best qualified for the job.

Q. How do advancement opportunities for technical graduates stack-up with those of other graduates?

A. Very well. General Electric is recognized as a Company with outstanding technical skills and facilities. One out of every thirteen employees is a scientist or engineer. And approximately 50 per cent of our Department General Managers have technical backgrounds.

Q. How about speed of advancement? Is G.E. a "young man's Company"?

A. Definitely. A majority of all supervisors, managers and outstanding individual contributors working in the engineering function are below the age of forty. We believe that a job should be one for which you are qualified, but above all it should be one that challenges your ability. As you master one job we feel that consideration should be given to moving you to a position of greater responsibility. This is working, for in the professional field, one out of four of our people are in positions of greater responsibility today than they were a year ago.

Q. Some men want lo remain in a specialized technical job rather than go into managerial work. How does this affect their advancement?

A. At G.E. there are many paths which lead to higher positions of recognition and prestige. Every man is essentially free to select the course which best fits both his abilities and interests. Furthermore, he may modify that course if his interests change as his career progresses. Along any of these paths he may advance within the Company to very high levels of recognition and salary.

Q. What aids to advancement dan General Electric provide?

A. We believe that it's just sound business policy to provide a stimulating climate for personal development. As the individual develops through his own efforts, the Company benefits from his contribution!. General Electric has done much to provide the right kind of opportunity for its employees. Outstanding college graduates are given graduate study aid through the G-E Honors Program and Tuition Refund Program. Technical graduates entering the Engineering, Manufacturing, or Technical Marketing Programs start with on-the-job training and related study as preparation for more responsible positions. Throughout their G-E careers they receive frequent appraisals as a guide for self development. Company-conducted courses are offered again at a levels of the organization. These help professionals gain the increasingly higher levels of education demanded by the complexities of modern business. Our goal is to use every man advance to the full linaiti of his capabilities.

// you have other questions or want information on our programs for technical graduates, write to E. G. Abbott, Section 959-9, General Electric Co., Schenectady 5, N.Y.

***LOOK FOR** other interviews discussing: • Qualities We Look For in Young Engineers • Personal Development • Salary.

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