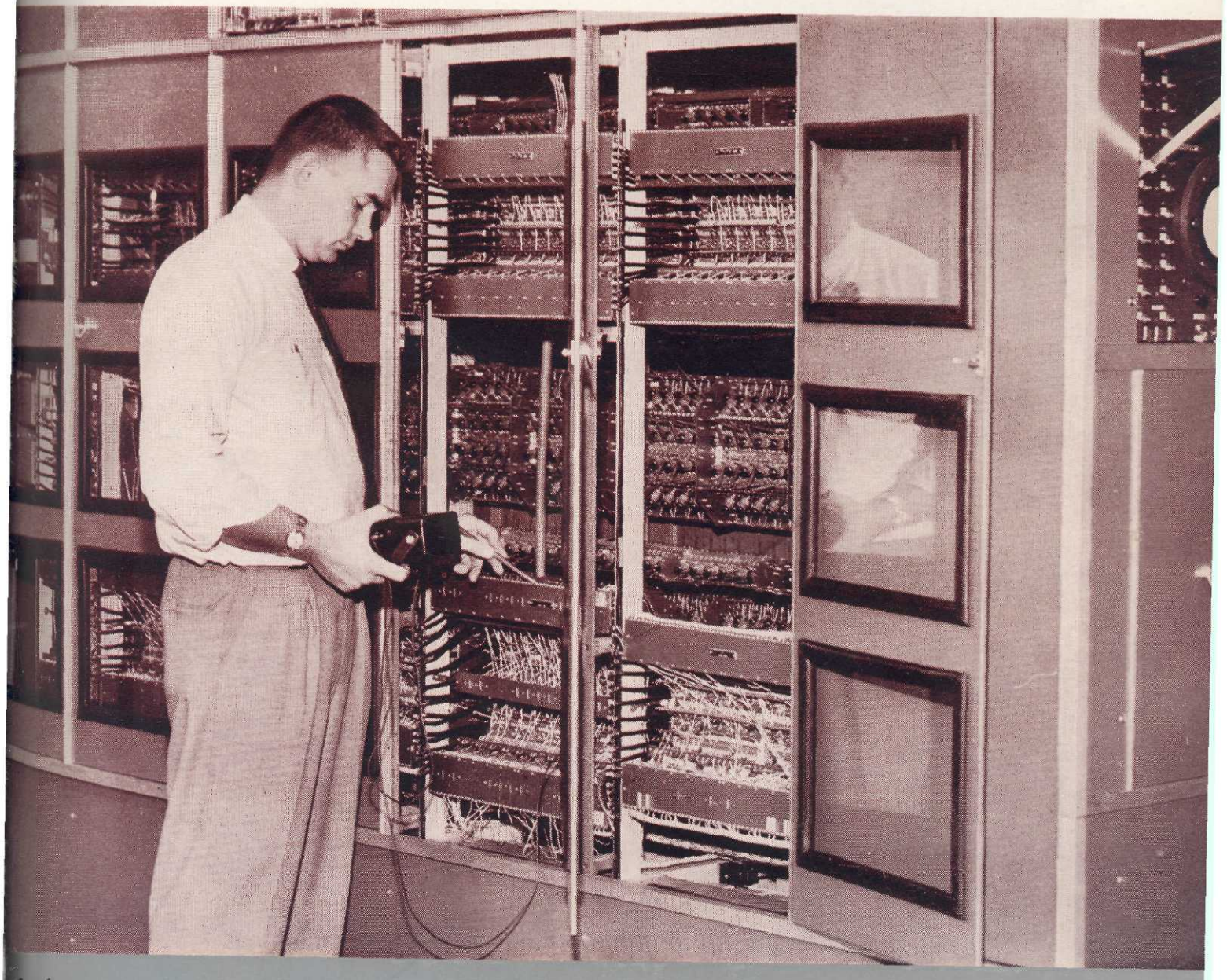
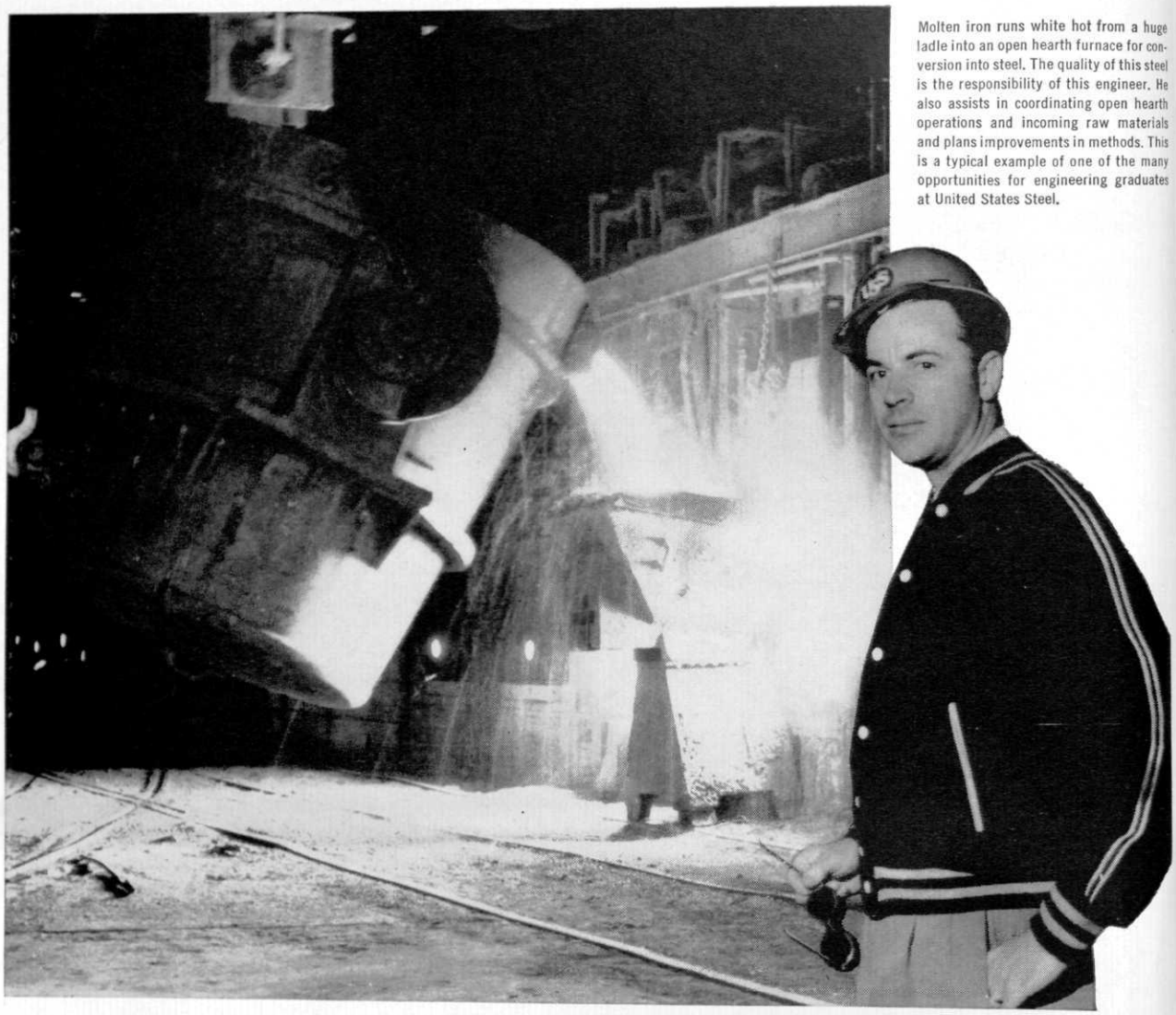
Spartan Engineer



Mistic... Michigan State's Integral Computer

SEE STORY ON PAGE 18

VOLUME 11 NUMBER 1 NOVEMBER, 1957 PRICE 25¢



Molten iron runs white hot from a huge ladle into an open hearth furnace for conversion into steel. The quality of this steel is the responsibility of this engineer. He also assists in coordinating open hearth operations and incoming raw materials and plans improvements in methods. This is a typical example of one of the many opportunities for engineering graduates at United States Steel.

In choosing your career . . . consider United States Steel . . . the leader in the one industry that's truly basic!

IT has been said: "United States Steel is the industrial family that serves the nation and the world." For in our homes and factories . . . in communications . . . in transportation—steel is basic.

This means that in the complex and ramified organization which constitutes United States Steel, unlimited opportunities are presented to the college graduate—whether his preference is engineering, administrative work, or any of a score or more of other activities in this highly diversified industry.

In the final analysis, United States Steel is *men* . . . men of high caliber, exceptional ability, broad vision and complete dedication. Traditionally, United States Steel looks to its young men of today to become its leaders of tomorrow.

For complete information on the opportunities available at United States Steel for young men of ambition and foresight, send for a copy of our free book—*Paths of Opportunity*. Doing so may very well be the beginning of a successful and rewarding career for you at United States Steel.

USS

United States Steel Corporation, Personnel Division
525 William Penn Place, Pittsburgh 30, Pa.

Please send me a free copy of your book, "Paths of Opportunity."

Name .....

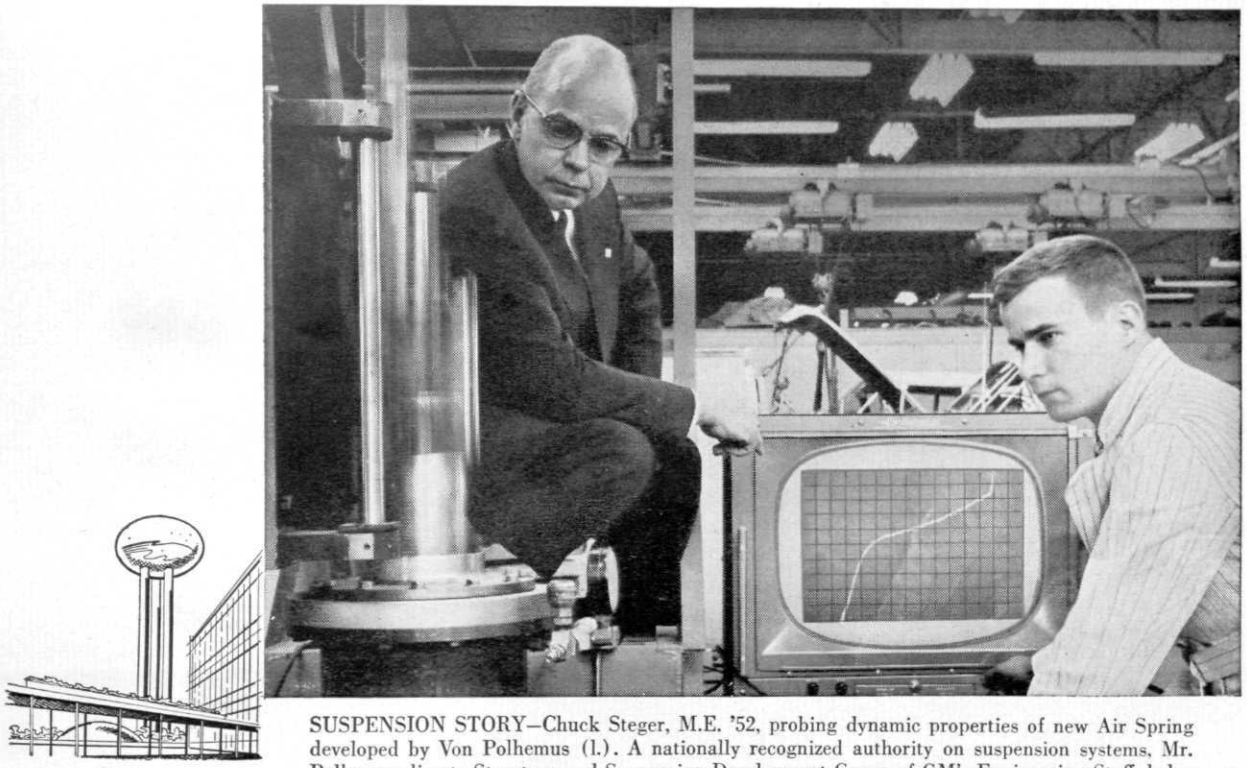
.....

(College) (Course) (Date of graduation)

Address .....

City ..... State .....

UNITED STATES STEEL



SUSPENSION STORY—Chuck Steger, M.E. '52, probing dynamic properties of new Air Spring developed by Von Polhemus (l.). A nationally recognized authority on suspension systems, Mr. Polhemus directs Structure and Suspension Development Group of GM's Engineering Staff, helps guide Chuck in his professional career.

Because *engineering* is a *profession* at GM -we offer you a career-not a job

ONE REASON engineering standards at General Motors are so high is that General Motors recognizes engineering as a profession. And the men who engineer the many different products made by GM are respected for the profession they practice.

That is why, when you are invited to join GM as an engineer, you don't simply take a job—you start a career.

It is a career that is rewarding both professionally and financially—starting on your first day of association with GM at any one of its *35 divisions and 126 plants in 70 cities and 19 states.*

During your early days at GM, for example, you work with a senior engineer who guides your career along professional lines.

You are also actively encouraged to pursue your education towards an advanced degree. For we at General Motors recognize that, in doing so, you will become more valuable to us and the engineering profession.

You are given the opportunity to obtain professional recognition through participation in engineering society forums, presentation of technical papers, winning of patents and other recognition of your accomplishments.

And you are also encouraged to take an active role in your community's affairs—because a truly professional man is a good citizen as well as a good engineer.

All this is for a reason—and a good one.

Many of the men who will fill the key positions at GM in the future are the young engineers joining GM today. This is not theory, it is fact. For 14 of our 33 Vice-Presidents are engineers, 23 of our 42 Division General Managers are engineers, too.

Today we are looking for young engineers—such as you—who may fill these positions tomorrow. The rewards—both professional and financial—are substantial. If you feel you have the ability, write us. It could be the most important letter of your life.

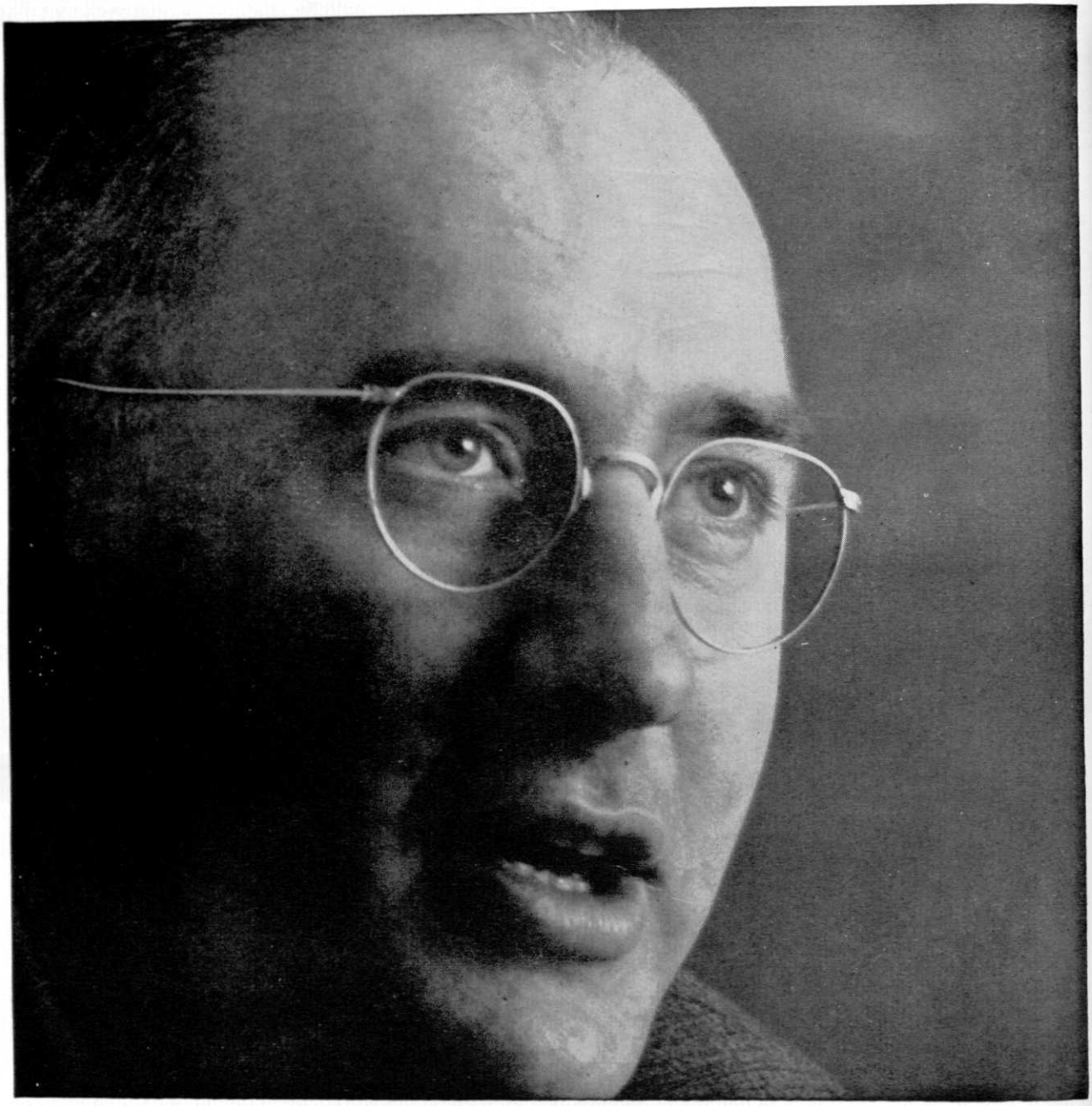
• • •

GM positions now available in these fields:

MECHANICAL ENGINEERING • ELECTRICAL ENGINEERING
INDUSTRIAL ENGINEERING • METALLURGICAL ENGINEERING
AERONAUTICAL ENGINEERING • CHEMICAL ENGINEERING
CERAMIC ENGINEERING • MATHEMATICS • INDUSTRIAL DESIGN
PHYSICS • CHEMISTRY

GENERAL MOTORS CORPORATION

Personnel Staff, Detroit 2, Michigan



YAVNO

...on the engineer and national security

"With our national security at stake, engineers have responsibilities greater than in any preceding age. They face two vital questions: What military *posture* will ensure greatest security? What *means* — what weapon systems — will provide the desired military posture? These questions cannot be answered in purely technical terms; in addition to those factors with which engineers are at home, social, political, strategic, tactical, and operational factors must be considered. Today their influence on national policy decisions must be understood if we are to build and deploy a military capability that can deter war. In choosing weapon systems it is no longer enough to maximize speed, power, altitude, and payload. As more and more powerful weapons become attainable it is imperative that their use be increasingly determined by the real needs of our civilization."

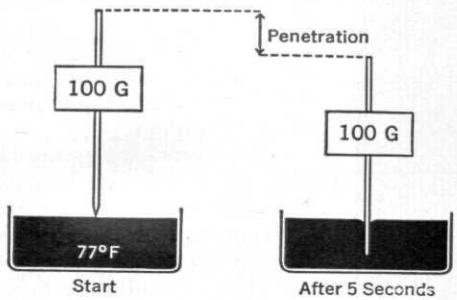
—E. J. Barlow, Head of the Engineering Division

THE RAND CORPORATION SANTA MONICA, CALIFORNIA

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

ASPHALT ENGINEERING BULLETIN #3

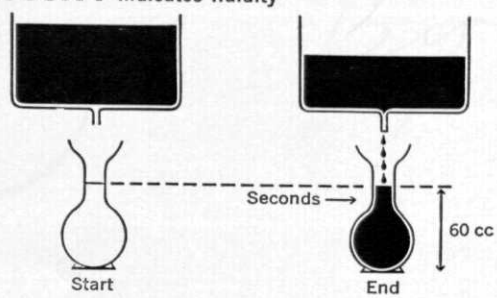
PENETRATION indicates consistency



Consistency is determined by measuring the **penetration** made in 5 seconds by a standard needle loaded with 100 grams. The test is normally run at 77°F and penetration is measured in units of 0.1 mm.

FIG. 1

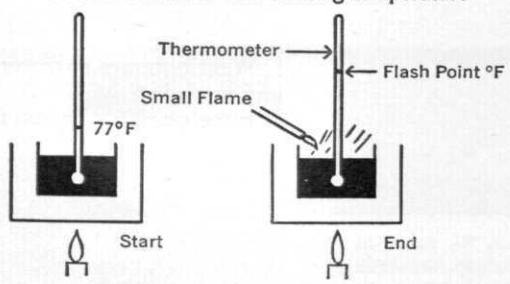
VISCOSITY indicates fluidity



Fluidity is determined at specified temperatures with a Saybolt-Furol Viscosimeter. Results are expressed as Saybolt-Furol Viscosity . . . the time in seconds for 60 cc of the product to flow into measuring flask through a precisely dimensioned orifice. The slower the flow, the higher the viscosity.

FIG. 2

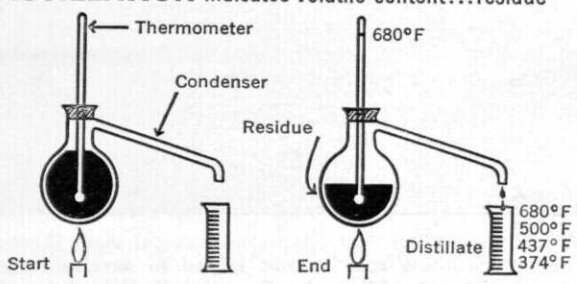
FLASH POINT indicates safe heating temperature



Volatile constituents evolve when the temperature of an Asphaltic product rises sufficiently. The temperature at which they "flash" or temporarily ignite when a small flame is passed through them, during heating of the product, is its **flash point.** This temperature is usually well below the **fire point** or the temperature which will support burning.

FIG. 3

DISTILLATION indicates volatile content...residue



Volatile Content is determined by gradually heating to 680°F, a measured volume of material in a distillation flask connected to a condenser. Relative amounts of volatile materials evaporating at different temperatures and of residual Asphalt are thus determined. Further tests are usually run on Asphalt residue to determine its characteristics.

FIG. 4

Tests on Asphaltic Materials

The suitability of an Asphaltic material for highway or other use depends upon characteristics which can be determined by a series of tests. Four of the principal tests are:

PENETRATION TEST (Fig. 1)
indicates the *consistency* or hardness of Asphalt cements (which are semi-solids) used in hot-mix Asphalt pavements. The softer the product, the greater its number of penetration units. On the basis of consistency . . . denoted by penetration ranges . . . Asphalt cements are classified into grades. Those paving grades now recommended by The Asphalt Institute are:

PENETRATION GRADES

60-70 85-100 120-150 200-300

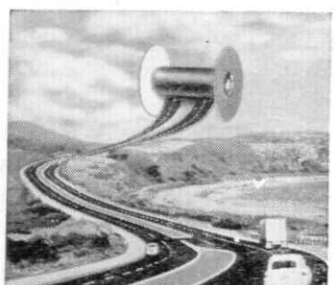
(a 40-50 penetration grade is recommended for special and industrial uses.)

VISCOSITY TEST (Fig. 2)
indicates the fluidity of liquid Asphalts. Viscosity measures the consistency of these products just as the penetration test measures the consistency of semi-solid products. Those liquids flowing too slowly for accurate measurements by the viscosimeter at 77°F are tested at higher temperatures—usually at 122°F, 140°F, or 180°F.

FLASH POINT (Fig. 3)
indicates the temperature at which vapor ignition may occur when heating and manipulating Asphaltic materials.

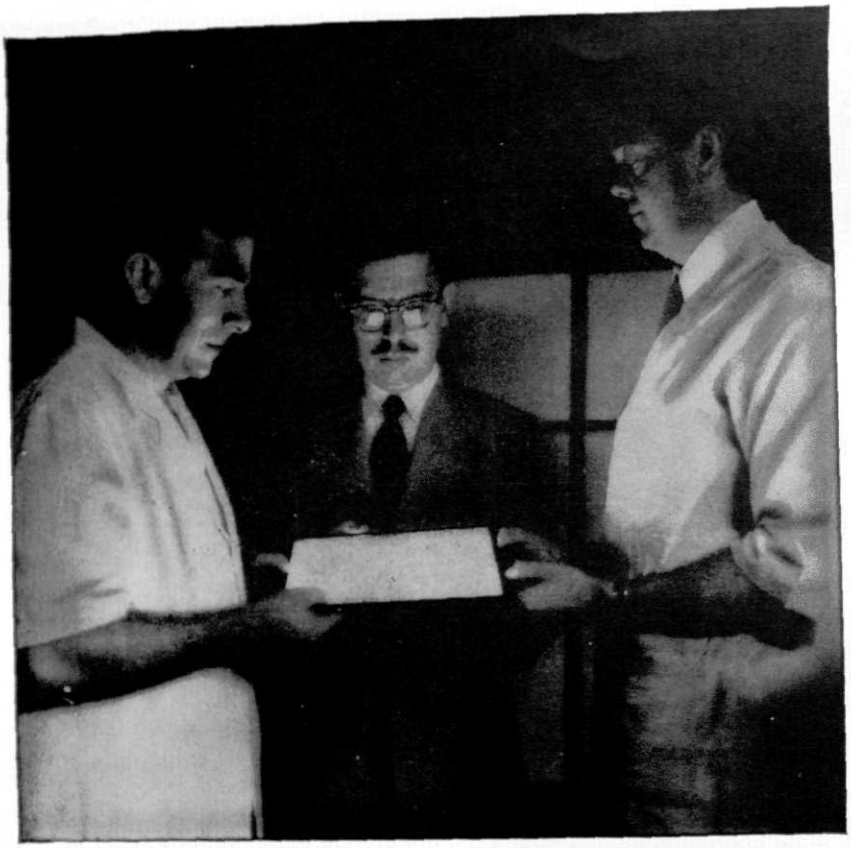
DISTILLATION TEST (Fig. 4)
indicates the amount of Asphaltic residue to expect in liquid Asphalts after lighter constituents volatilize under manipulation and use. It indicates, too, the relative rapidity at which these lighter constituents "cure" out of the Asphalt.

Be sure to cut out and file this data sheet, as well as future sheets and those previously inserted in this publication. Make them your professional reference material.



Ribbons of velvet smoothness . . .
MODERN **ASPHALT** HIGHWAYS

THE ASPHALT INSTITUTE, Asphalt Institute Building, College Park, Maryland



"Glowing wafer" of light (electroluminescence) sheds illumination on the faces of three Westinghouse scientists who helped to develop it. Left to right: Dr. Willi Lehmann (University of Brunswick, Germany); Dr. Henry F. Ivey (University of Georgia, Massachusetts Institute of Technology); and R. W. Wollentin (Rutgers University).

The Light With no Third Dimension

A new source of light is nearing practicality. Called electroluminescence, it comes from a flat surface. By the twist of a knob, you can change the brightness, or even the color, of a room.

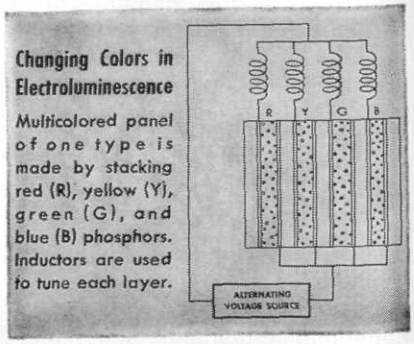
Since electric lighting first became practical, only three basically different light sources have achieved widespread use—incandescent, fluorescent, and gas-discharge lamps. Now a fourth basic type—electroluminescence—is nearing practicality. With fewer theoretical limitations than any of its predecessors, it promises to revolutionize lighting and become a practical light source of the future.

In an incandescent lamp, light comes from a single point. In a fluorescent lamp (form of gas-discharge), light comes from a straight line. In electroluminescence, light comes from an area or flat surface. Electroluminescence is light emission from phosphor powders embedded in an insulator, excited by an a-c field.

Westinghouse engineers gave the first practical demonstration of this new light source. They lighted an entire room with flat electroluminescent panels on the ceiling and three walls. These panels were one-foot-square flat glass plates about as thick as a window pane and coated with a plastic containing the phosphor. They were topped off by an aluminum conducting coating. Hooked up to a source of power, these plates had a brightness of 100 foot lamberts in their present stage of development.

Since some phosphors have more than one emission band, the color and brightness of electroluminescent lighting can be changed by varying the frequency. It is possible to control the color of a room, and brightness too, simply by twisting a knob. Besides supplying ordinary light, this new light source has other fascinating possibilities. Just one is "picture framing" television. An electroluminescent cell might replace the conventional cathode-ray tube in such a set.

Westinghouse engineers, under the supervision of E. G. F. Arnott (Princeton '28), developed electro-



luminescent lighting under the name of "Rayescent" lighting. Westinghouse approached the problem, not as a commercial venture, but as a pure research project. Much work remains to be done in this field. It is typical of the pioneering developments undertaken by Westinghouse.

Challenging opportunities for the graduate engineer exist in many fields . . . including:

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

. . . and dozens of others.

Westinghouse

FIRST WITH THE FUTURE

Please send me more information on

☐ Rayescent lighting

☐ Job opportunities at Westinghouse

Name_____

Address_____

Course_____ College_____

Mail to Mr. J. H. Savage, Westinghouse Electric Corp., P.O. Box 2278, Pittsburgh 30, Pa.

JOB FACTS FROM DU PONT

DU PONT
REG. U.S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

OPPORTUNITIES AT DU PONT CONTINUE TO GROW FOR ALL KINDS OF ENGINEERS AND SCIENTISTS

WHERE DO YOU WANT TO WORK?

by
F. L. Johns
Du Pont
Representative

I wouldn't be entirely realistic if I said that you can choose your job location from Du Pont's 75 plants and 98 laboratories scattered over 26 states. But Du Pont does have jobs open in many of these locations, so there is a good chance that we may be able to match your preferences and qualifications with available openings.

Right now, most of the Du Pont units are east of the Mississippi, but we have plants in Texas and on the Pacific Coast, too. In the past year plants were completed in Michigan, California, Ohio and Georgia. New plants are also under construction in Kansas, Tennessee, Virginia and North Carolina. Perhaps one of these locations has just what you're looking for in a job.

For a complete list of our plant locations, please write to me at E. I. du Pont de Nemours & Co. (Inc.), 2494-B Nemours Building, Wilmington 98, Del.

Career opportunities at Du Pont are greater today than ever before because of the Company's continued growth. In 1957, Du Pont's sales were at the *$2 billion* level. Four new plants were being built. New research programs were being launched, and new products were moving into the production and marketing stages. All of these developments tend to broaden opportunities at Du Pont for the young scientist and engineer.

ALL KINDS OF ENGINEERS

Students with chemical engineering and chemistry degrees are needed, of course. But the opportunities are equally great for students majoring in many other fields. And the type of work for these men varies greatly. Among other things:

Mechanical engineers work in research and development as well as in plant engineering and production supervision.

Metallurgical engineers conduct studies in metal fatigue and corrosion and engage in fundamental research into the nature and properties of elements.

Civil engineers have many assignments, including design and supervision of the construction of Du Pont plants and laboratories.

Men studying for degrees in *electrical, mining, petroleum, industrial* and many other specialized fields of engineering will find equally challenging outlets for their talents at Du Pont.

If you're interested in finding full scope for your ability, Du Pont offers you plenty of opportunity.

Du Pont Training Tailored to Individual

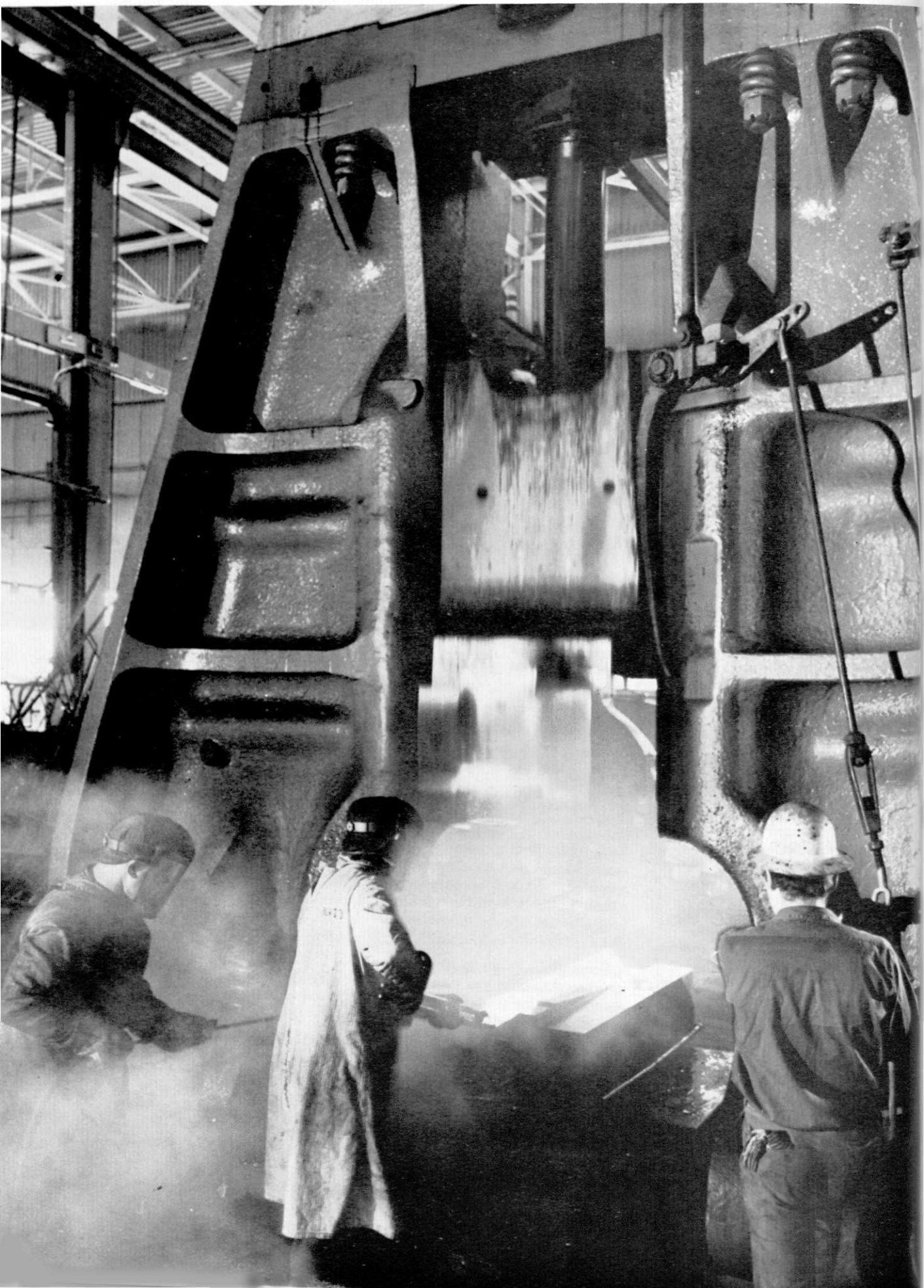
Each of Du Pont's operating departments has its own training program because each has special requirements. But both formal and informal programs are tailored to the interests and needs of the individual.

Generally, you go to work on an assignment at once and start learning right away. This headstart on responsibility is an important factor in your progress. Based on your qualifications, you're given one segment of a project to tackle almost immediately. You learn quickly and informally in consultation with your supervisor and other engineers on the same project. This training is supplemented by frequent meetings, seminars, studies of plant operations and procedures.

And since Du Pont is interested in the progress of the individual, your performance is evaluated at regular intervals by your supervisor. These discussions bring out your strong and weak points and together you work out a program for improvement. This training and evaluation continues year after year as you advance in the Company.

SEND FOR INFORMATION BOOKLET

Booklets on jobs at Du Pont are yours for the asking. Subjects include: mechanical, civil, metallurgical, chemical, electrical, instrumentation and industrial engineers at Du Pont; atomic energy, technical sales, research and development. Name the subject that interests you in a letter to Du Pont, 2494-B Nemours Building, Wilmington 98, Del.



Spartan Engineer

of michigan state university

VOLUME 11 NO. 1 NOVEMBER, 1957

FEATURES

DEPARTMENTS

Cover: PICTURE OF MICHIGAN STATES INTERGRAL COMPUTOR BEING TESTED BY RICHARD J. REID, INSTRUCTOR IN ELECTRICAL ENGINEERING.

Frontispiece: GIANT HAMMER FORGES WORLD'S LARGEST BLADES FOR RECORD BREAKING TURBINE-GENERATOR.

MEMBER ENGINEERING COLLEGE MAGAZINES ASSOCIATED

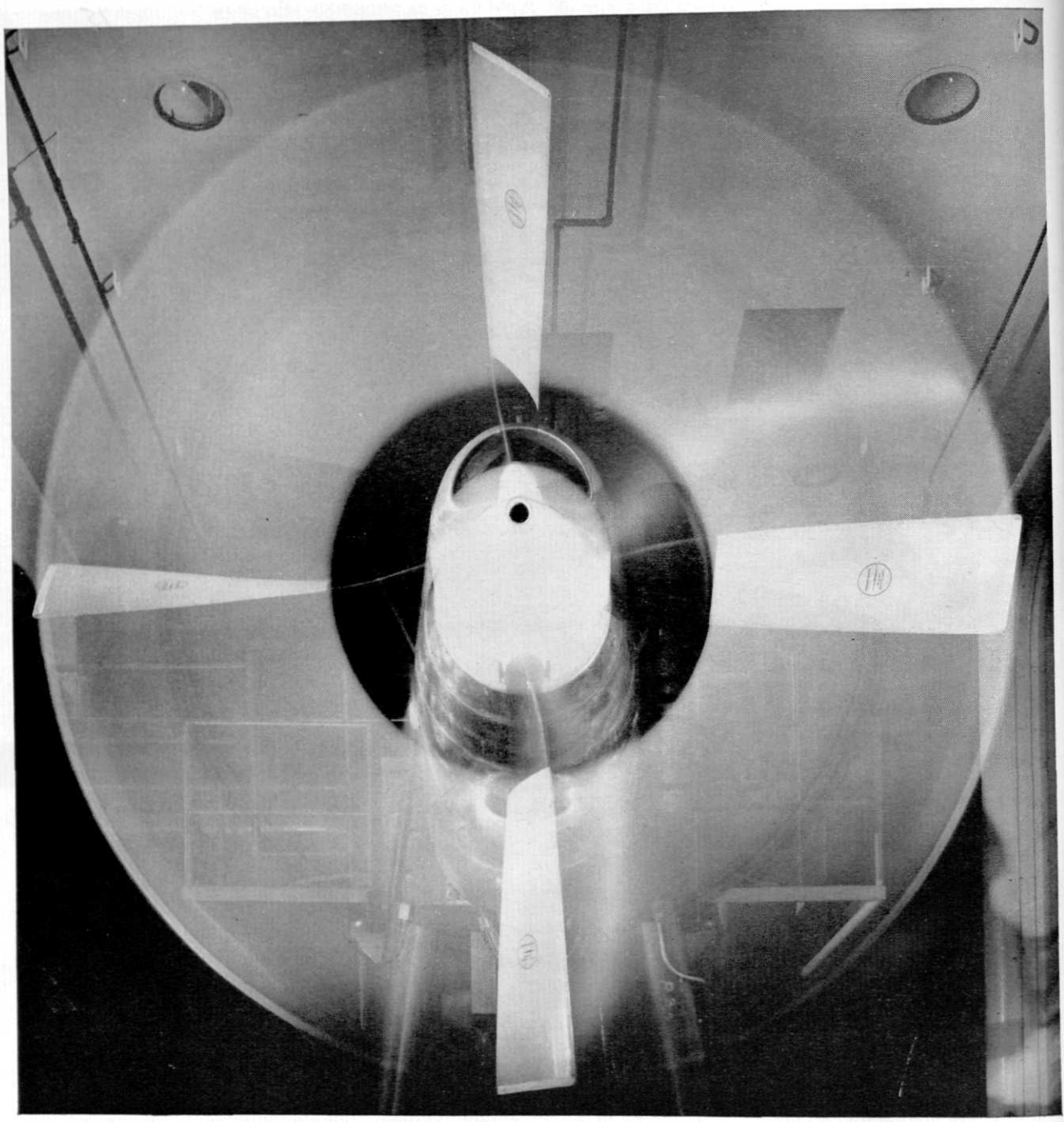
Published four times yearly by the students of the COLLEGE OF ENGINEERING, MICHIGAN STATE UNIVERSITY, East Lansing, Michigan. The office is on the third floor of the Union Building, Phone ED 2-1511, Extension 2614. Entered as second class matter at the Post Office in East Lansing, Michigan, under the act of March 3, 1879.

Address Mail to: P. O. Box 468, East Lansing, Michigan

Publishers representative

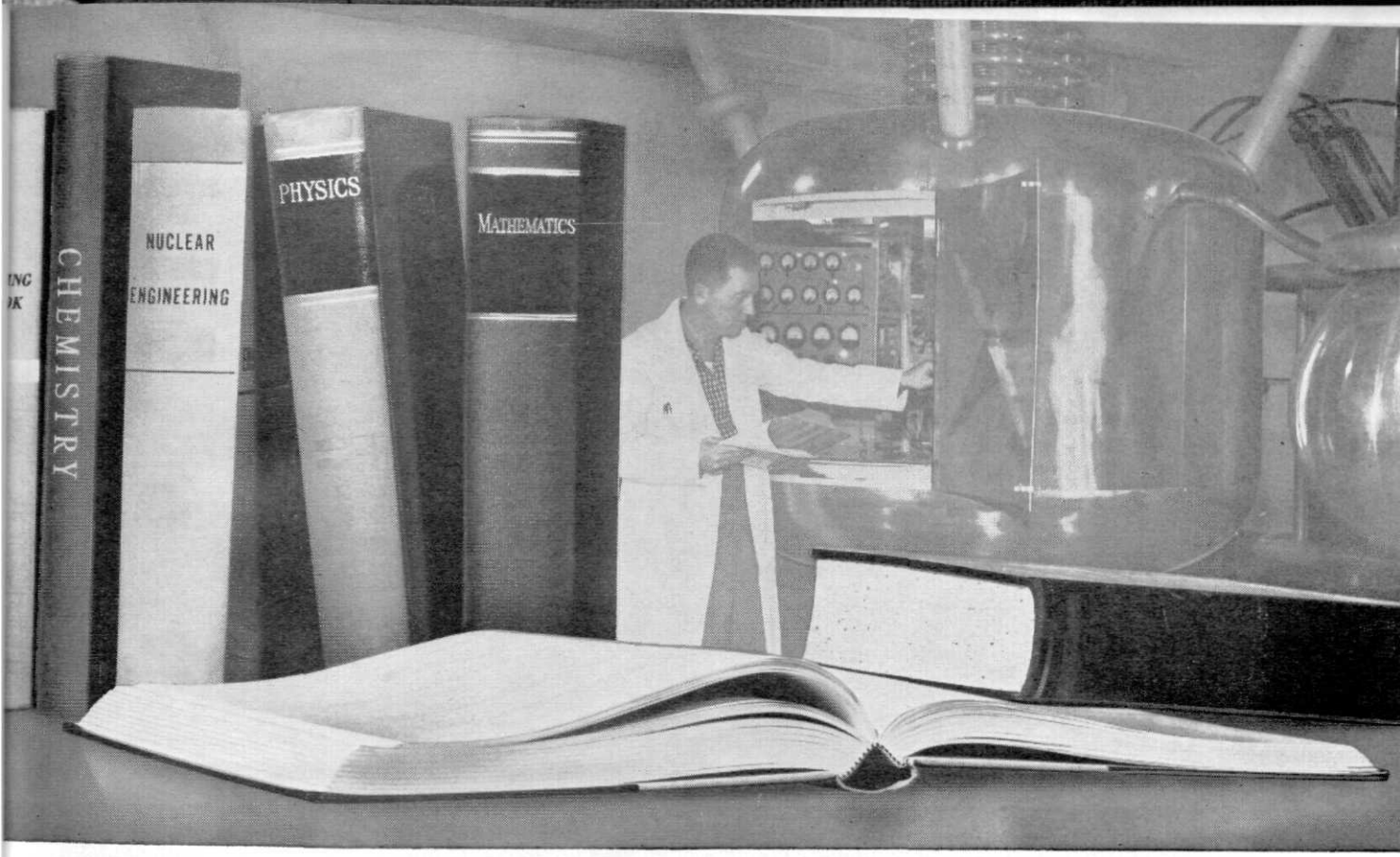
Littell-Murray-Barnhill, Inc.
369 Lexington Avenue, New York
605 W. Michigan Avenue, Chicago

Subscription rate by mail $1.00 per year.
Single copies 25 cents.



INDIANAPOLIS, IND.: (Special) Hundreds of engineers and technicians, applying their academic training first hand, have designed, developed and produced the Allison Model 501 Prop-jet engine and Aeroproducts Turbo-propeller (above) shown in a test cell at the mammoth Allison plants in Indianapolis. These General Motors experts have produced an engine which develops nearly 2.3-horsepower per pound of engine weight. Already in use with Air Force Troop Carrier Wings in the U. S. and abroad, Allison Prop-jet engines and Aeroproducts Turbo-propellers will power America's first Prop-jet commercial airliner, the ultra-modern Lockheed Electra.

Working shoulder to shoulder with propulsion system experts, newly graduated engineers are assuring their futures by carving a niche for themselves on the General Motors team of today. If you would like to know more about this team, write Personnel Department, College Relations, Allison Division of General Motors Corporation, Indianapolis, Indiana.



graduate study opportunity...

an important "plus" benefit at Los Alamos!

When a scientist or engineer comes to Los Alamos to work, it is important to him, and to us, that his fund of knowledge continues to grow. For that reason, the Graduate Center at Los Alamos is one of this interesting community's most valuable assets.

The Center, operated by the University of New Mexico, offers graduate programs in the fields of nuclear, mechanical and electrical engineering, chemistry, physics and mathematics.

Additional facts of interest . . .

- Instruction is by recognized leaders in their scientific fields from the laboratory staff and from the University of New Mexico
- Classes are held in the evening, a few minutes from your Los Alamos residence
- One-half of your tuition is paid by the Laboratory
- Unique laboratory facilities and equipment are available
- Los Alamos technical library, among the nation's most complete, is open 24 hours each day for study and research.

College graduates in the physical sciences and engineering who are interested in accepting important research assignments and at the same time continuing their advanced education are invited to write for more information. Details about the Laboratory, the Graduate Center and the delightful family living conditions in northern New Mexico will be sent by return mail.

los alamos
scientific laboratory
OF THE UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO

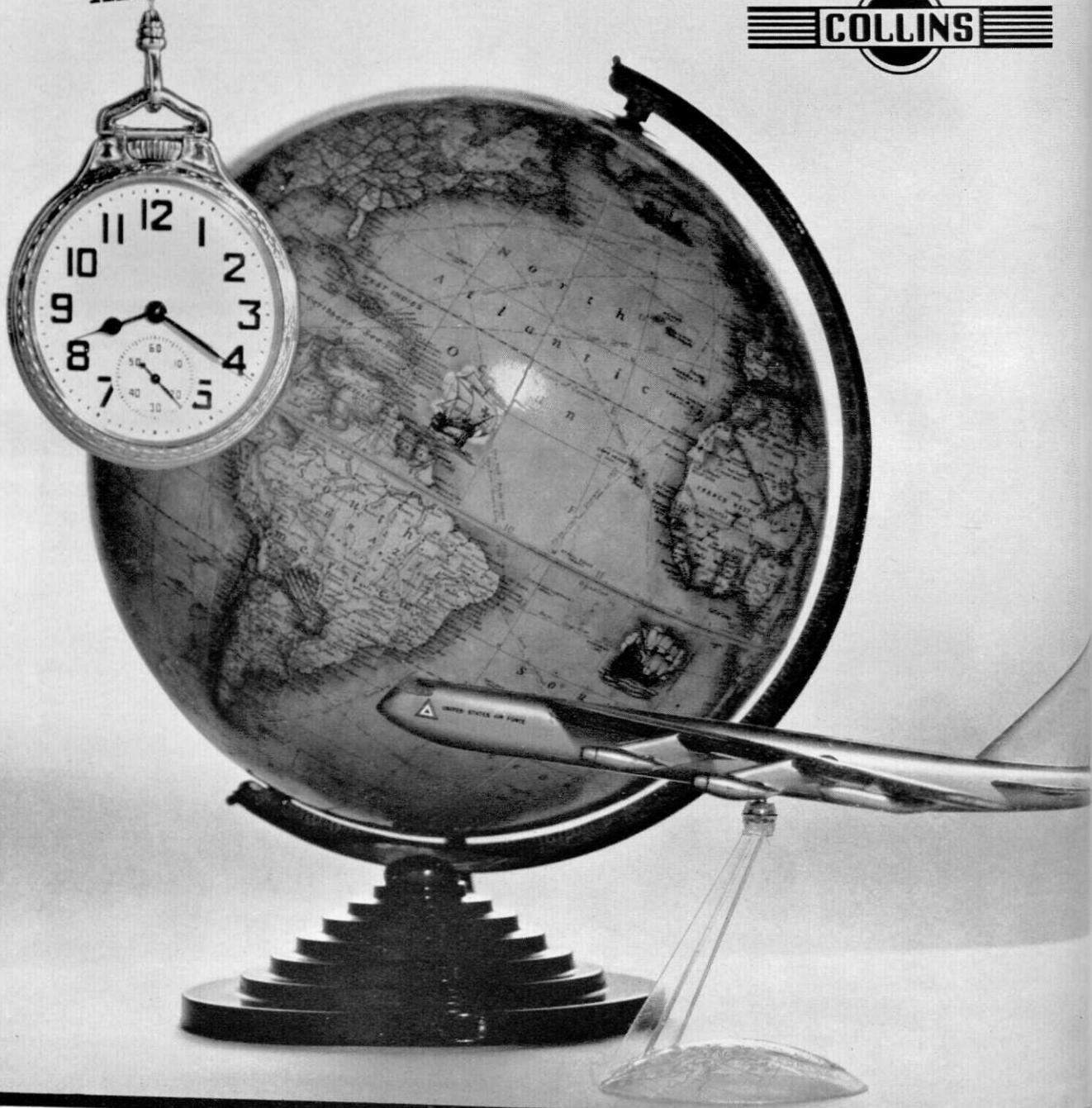
DIRECTOR OF PERSONNEL
LOS ALAMOS SCIENTIFIC LABORATORY
Los Alamos, New Mexico

Los Alamos Scientific Laboratory is a non civil service operation of the University of California for the U. S. Atomic Energy Commission

Collins helped assure the success of SAC's globe-circling non-stop flight. Provided the single sideband ground net that kept Strategic Air Command headquarters in almost continuous contact with this history making flight throughout its 24,325 mile odyssey. Another contribution of Collins creative leadership in electronics.

AROUND THE WORLD IN 45 HOURS, 19 MINUTES . . .

COLLINS



Collins Radio Company is a dynamic, fast-growing company. Your placement office can tell you when a representative will be on campus, or write to—

L. R. Nuss
Collins Radio Company
Cedar Rapids, Iowa

Fred Aiken
Collins Radio Company
2700 W. Olive Ave.
Burbank, California

Harold McDaniel
Collins Radio Company
1930 Hi-Line Drive
Dallas, Texas

QUICK QUIZ FOR ENGINEERS

ARE YOU THE "IMPOSSIBLE" TYPE?

YES ☐ NO ☐

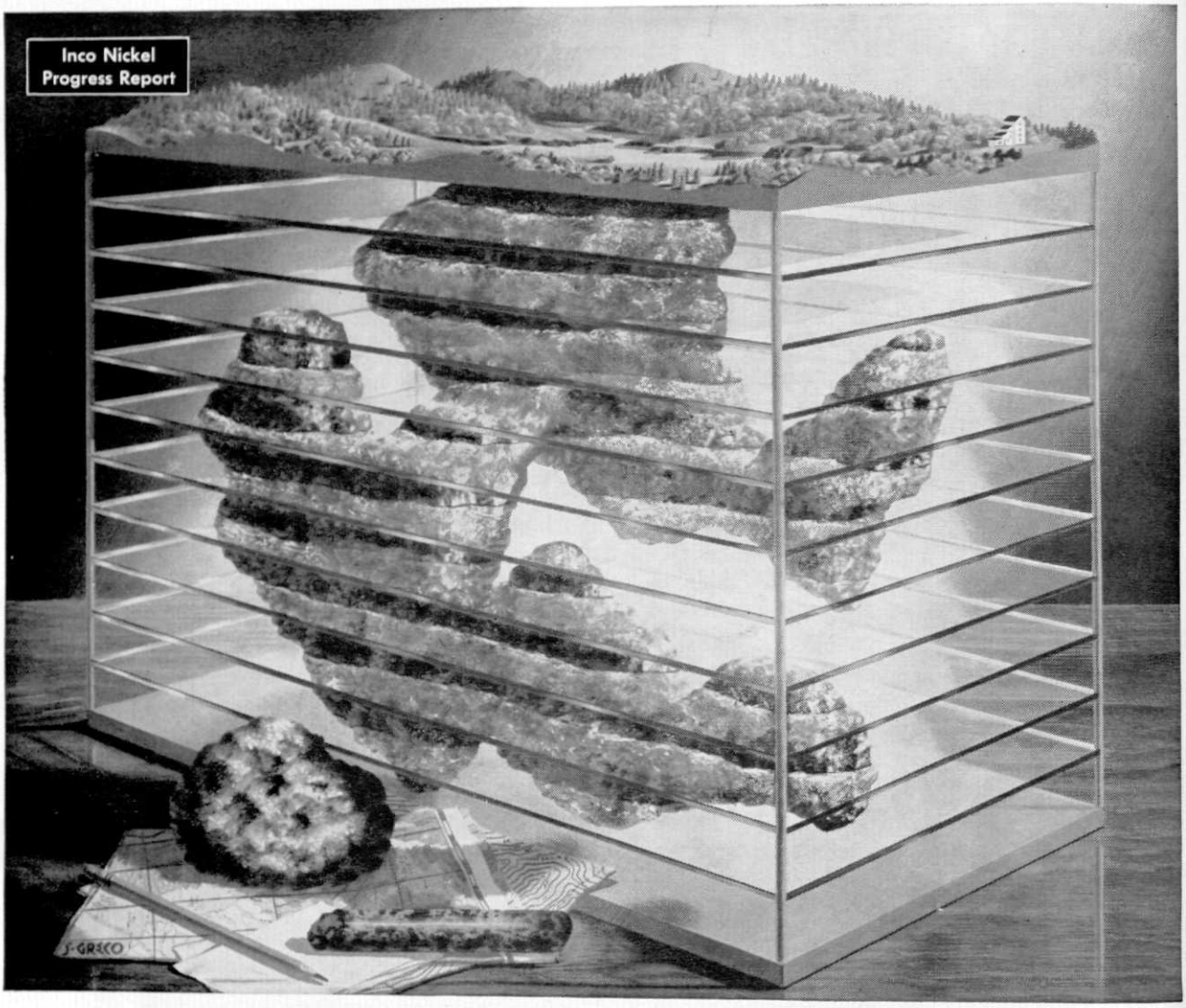
If your answer is yes, you're a Detroit Edison engineering type. The kind who'll tackle an impossible problem—and lick it. You're not afraid to have a new idea. You're the kind of young engineer who works hard at finding faster, more efficient, more economical ways.

In short, you're the inquisitive, exploration-minded sort of engineer Detroit Edison is looking for. At Edison, your assignments will be liberally sprinkled with exciting challenges to your training and ability. And creative engineering is called for even on ordinary jobs.

You'll enjoy a big helping of prestige when you're associated with Detroit Edison, too. It's one of the Midwest's best-known, best-liked, most progressive public utility companies, noted for its pioneering accomplishments and leadership in America's business enterprise system. For some outside evidence of Edison's reputation, take a look at the March 25, 1957 issue of *Electrical World*. It contains eight pages, by some of America's leading electrical equipment manufacturers, devoted to recent engineering accomplishments in Detroit. They emphasize the important contributions Detroit Edison engineers make and will continue to make to equipment and systems engineering and design.

Think we're stretching our story a bit? Here's your chance to find out. Drop us a note and we'll send you a copy of "Detroit Edison Engineering"—it tells about the challenges and opportunities waiting for you. Write to the Employment Department, Detroit Edison, Detroit 26, Michigan. Or check with our representative when he visits your campus.

DETROIT EDISON



Inco mine engineers construct a 3-dimensional "picture" that shows where new, untapped ore bodies lie.

This 3-D model of an ore body shows where future supplies of Inco Nickel will be mined

How do Inco engineers keep a mine "alive"? For one thing, they try to learn as much as possible about the location of ore for the future.

New levels—new exploring

As soon as they open up *new* levels, the engineers start up exploratory drilling, to probe and "feel" in many directions.

Their hollow-shafted drills bring out specimen cores that show where there is worthwhile ore and where only worthless rock.

Hundreds and hundreds of ore samples

These ore samples enable International Nickel engineers to build small models of their mines' ore bodies. So they know where each ore body lies, how large it is, and of what grade.

They know, as well, how to get that ore out of the ground in the safest, most sensible, most economical way possible—know what shafts may have to be sunk, what tunnels and drifts to drive. Know, in a word, how to reach and mine every possible ton of usable ore. And, having mined it, how to extract every possible pound of useful metal.

Reserves—at new highs

Today Inco has larger reserves than ever before—although some of this ore lies a mile or deeper underground. And the Company also reports another fact: its multi-million dollar "mine-more" program makes possible today's high output of Inco Nickel. And looking to the future—in 1961, Inco Canada's Nickel output should be 385 million pounds a year. A hundred million more than in 1956!

"Mining for Nickel," color film, is loaned to technical societies, universities, industry. The International Nickel Company, Inc., Dept. 143f, New York 5, N. Y.

INCO TRADE MARK **International Nickel**

The International Nickel Company, Inc., is the U. S. affiliate of The International Nickel Company of Canada, Limited (Inco-Canada)—producer of Inco Nickel, Copper, Cobalt, Iron Ore, Tellurium, Selenium and Platinum, Palladium and Other Precious Metals

How to make the most of your engineering career
ONE OF A SERIES

go where engineers don't get lost in the crowd

One of the many hurdles that can slow down your progress as an engineer is getting lost in the crowd. It can happen in smaller companies as well as in big ones.

That's because size itself is not the villain. The thing to watch out for is the kind of company organization that swallows you up and erases your individual identity.

Boeing is one company that takes steps to see that engineers *don't* get lost in the shuffle. Boeing engineers, for instance, work in small integrated teams where initiative and ability get plenty of visibility. Each engineer gets a personal merit review every six months—assuring you a continuing opportunity for individual recognition. In addition, Boeing engineers are eligible for advancement at any time between reviews. There are many other advantages to careers at Boeing—including assignment to exciting missile and jet-age projects, high starting salaries, liberal retirement and company-paid graduate study programs.

There are *family* advantages, too. One is a choice of three sections of the country in which to live. In each Boeing community you'll find good housing and schools, a youthful spirit, and abundant recreational facilities for the whole family.

Boeing has openings for engineers, and for physicists and mathematicians—openings with a world of opportunity for advancement.

Now is the time to start planning ahead. Consult your Placement Office, or write:

JOHN C. SANDERS,
Staff Engineer, Personnel Administrator,
Boeing Airplane Co., Seattle 24, Washington

R. J. B. HOFFMAN,
Chief of Engineering Personnel,
Boeing Airplane Co., Wichita 1, Kansas

BOEING
Aviation leadership since 1916
Seattle, Washington Wichita, Kansas Melbourne, Florida

LOOK WHO'S IN THE DRIVER'S SEAT...

...but are you really?

and equally important, are you going to get somewhere?

Perhaps you have heard some classmate say, almost complacently, "Times have changed."

With many branches of industry today openly competing for good science and engineering graduates, who can blame the young graduate-to-be for feeling supremely confident. You know you can get a job, know that salaries are high and are fully aware that men with technical backgrounds are moving up to administrative positions in ever-increasing numbers.

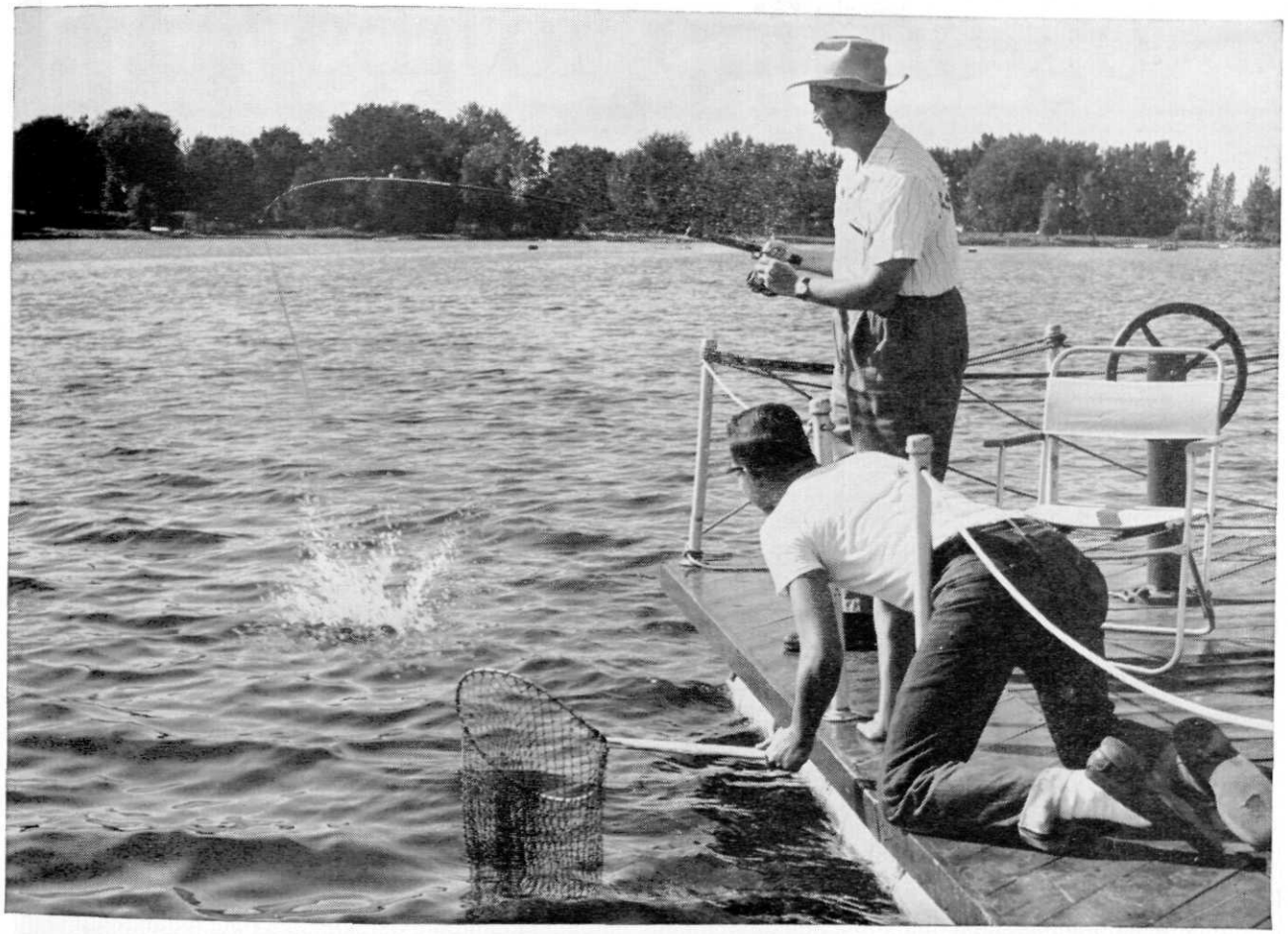
Nevertheless, in many respects, times have not changed at all. That "first job" is every bit as important today as it was five, ten, twenty years ago. Starting salaries remain only one of many factors to be considered. And a man's future is still necessarily linked to the future of the company for which he works. Moreover, a thoughtful examination of such matters as potential growth, challenge, advancement policy, facilities, degree of self-direction, permanence, benefits and the like often indicates that real opportunity *still* does not grow on trees.

For factual and detailed information about careers with the world's pioneer helicopter manufacturer, write Mr. Richard L. Auten, Personnel Department.

SIKORSKY AIRCRAFT

One of the Divisions of United Aircraft Corporation

BRIDGEPORT-STRATFORD, CONNECTICUT



There's fission and then there's fishin'...

just five minutes apart for 3M'er Jim Johnson

From the lab to the lake in only five minutes—that's 3M-land! It's a place where young men like Jim Johnson, with a talent for both engineering and happiness, find life good . . . to them and their families.

There's some kind of outdoor fun going on year 'round—golf, fishing, swimming, boating, hunting, skiing, skating. And never more than five miles from job or home.

There's work, too—vital, exciting, creative work geared to the future. For 3M is a research-minded company. Its scientific plant, including the new multi-million dollar Central Research Laboratory, is one of the finest. In this young, fast-growing company there's always been plenty of opportunity for young men to get ahead, and for new ideas to get a hearing. Witness such original products as "SCOTCH" Brand Cellophane Tape, and the "SCOTCHLITE" reflective signs that guide you safely on highways day and night. More than 22% of the products 3M sells were developed in the last five years.

And as for compensation, 3M engineers and executives are substantially above the average in take-home pay, home ownership, car ownership, and stock ownership! So, if you're interested write 3M, St. Paul 6, Minnesota.

MINNESOTA MINING AND MANUFACTURING COMPANY

WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

This can be YOU

Frank Kovalcik, Purdue '48, Covered 24,000 Miles in 1956 as Western Editor of ELECTRICAL WORLD

IF YOU'RE LIKE MOST PEOPLE, you think of an editor as a man who's "chair-borne" most of the time . . . tied to a desk at an indoor job.

Nothing could be further from the facts when it's a McGraw-Hill editor you're thinking about. Frank Kovalcik, Western Editor of McGraw-Hill's ELECTRICAL WORLD Magazine, can quickly tell you that. He's anything but a desk man . . . covers 11 states and part of Canada. Frank says:

"In 1956, I made eight major field trips, covered close to 24,000 miles. I was underground in a transformer vault in Los Angeles, inside a diversion tunnel in Idaho, atop a steel transmission tower in northern California. Projects visited included The Dalles multi-purpose project, Hoover Dam, Hells Canyon, and even behind the scenes (electrically) at the Republican National Convention. But none of them can touch the "Operation CUE" A-Bomb test I covered a year ago!

"My chance to witness the detonation of a nuclear device came when the Federal Civil Defense Administration and the A.E.C. decided to test non-military effects of the blast. I reported on what happened to electrical utility lines and equipment."

(Frank wouldn't say so, but his story set a record . . . from explosion to editorial pages in four days! The pictures at right were part of his original coverage of this fast-breaking—"hot"—news story for his magazine.)

McGraw-Hill As A Place to Work

Frank can tell you about this, too:

"My first editorial job—with the *Purdue Exponent* in college—didn't use my engineering training, but it showed me the way to communicate what's new in engineering . . . to report and interpret the work of engineers for the benefit of other engineers.

"When I got my B.S. in E.E. I started with ELECTRICAL WORLD in New York. Within a year I was promoted to Assistant Editor and made responsible for a department of the magazine. Before the big jump to San Francisco as Western Editor in '54 I served briefly as assistant to the managing editor.

"As Western Editor my search for news takes me into all important phases of the electric utility industry—and into association with top management and engineering men. Working with them is a constant reminder that the choice of an engineering-editorial career was the right one for me."

YOU—and McGraw-Hill Magazines

You, too, may find the right opportunity for yourself with McGraw-Hill—the world's largest publisher of business and technical magazines. If you are the kind of man we're looking for—both an engineer and an alert, inquisitive, knowledgeable man who likes to report, appraise and write, we want to talk with you.

Send today for your copy of "Successful Careers in Publishing at McGraw-Hill" for information about career opportunities. Or write to us about yourself. We're interested in your background, extra-curricular activities, college record, summer jobs and career goals. Write to:

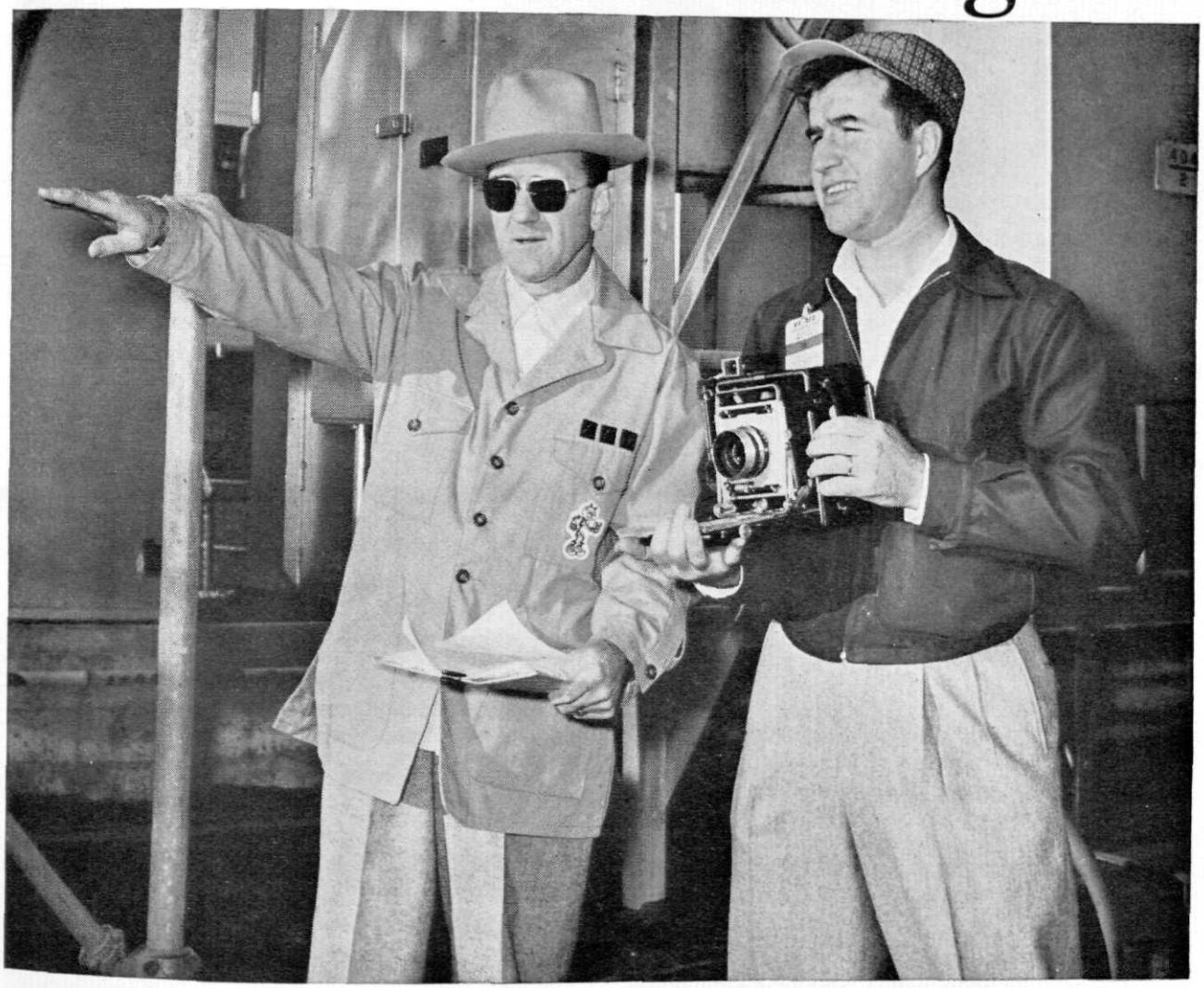
Peter J. Davies, Assistant to The Editorial Director
McGraw-Hill Publishing Company, Inc.
330 West 42nd Street, New York 36, N. Y.

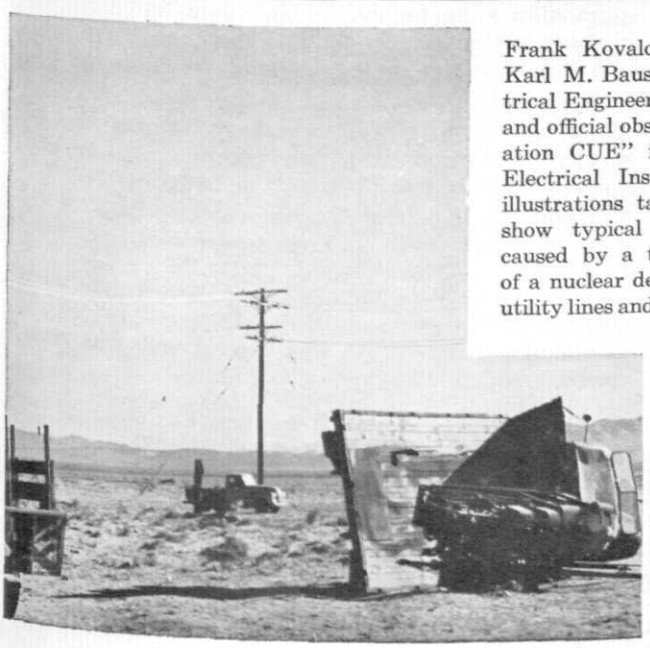
Advertising sales opportunities, too!
Excellent job openings exist on many McGraw-Hill magazines, domestic and international, for advertising sales careers. "Successful Careers" will give you the facts.

McGraw-Hill Publications

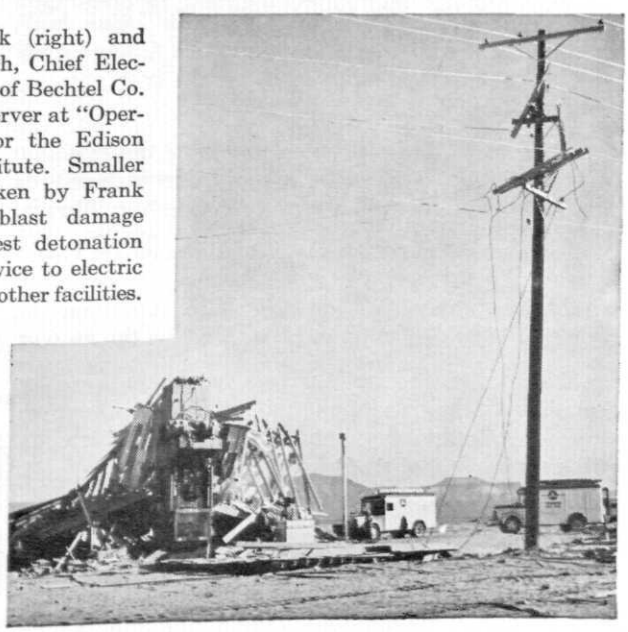
McGraw-Hill Publishing Company, Incorporated · 330 West 42nd Street, New York 36, N. Y.

...an editor on the go





Frank Kovalcik (right) and Karl M. Bausch, Chief Electrical Engineer of Bechtel Co. and official observer at "Operation CUE" for the Edison Electrical Institute. Smaller illustrations taken by Frank show typical blast damage caused by a test detonation of a nuclear device to electric utility lines and other facilities.



Michigan State Integral Computer...

MISTIC

by Helen Buechl

Within the hallowed halls of M.S.U. lies the answer to a schoolboy's dreams . . . no, it isn't the library with its storehouse of knowledge, nor is it the laboratory of the psychology department where live-rat experiments are carried on daily.

It is a mechanical "brain" or computer, as they call it in the Electrical Engineering building where it is being built. The gigantic machine has been under construction since September, 1956, and is now nearing completion, according to Dr. L. W. Von Tersch who, aided by technicians and graduate assistants, is building the mathematical genius from thousands of miles of wires and hundreds of electronic tubes and transistors.

"MISTIC," as it is called, stands for Michigan State Integral Computer. Because it is being built on campus, it will cost about $150,000. If purchased from a commercial supplier, it would cost approximately $750,000.

"Once a problem is translated into the machine in terms it can work with, a multitude of problems can be solved by the computer," says Von Tersch.

To solve 40 simultaneous equations which would take weeks to solve by other means, the computer would need only 193 seconds; 4 to introduce the problem, 181 to solve it, and 8 to produce the answer.

Even coded musical symbols can be fed into the machine which will respond with a variety of answers, depending upon the conditions under which the machine is set to respond.

Information is introduced to the machine by means of a perforated tape. Answers appear on printed paper or perforated tape, resembling the old piano roll in miniature. The tape is then run through a printer which decodes the answer.

Eventually, the machine will store up its own library of these tapes and exchange them with other computers in various parts of the country.

In less than one thousandth of a second it can multiply twelve digit numbers or add two numbers ten thousand times per second.

It will be used to solve differential and liniar equations and problems in economics, statistics, chemistry and agriculture. Most aircraft factories own or lease computers to save long and tedious calculations in research.

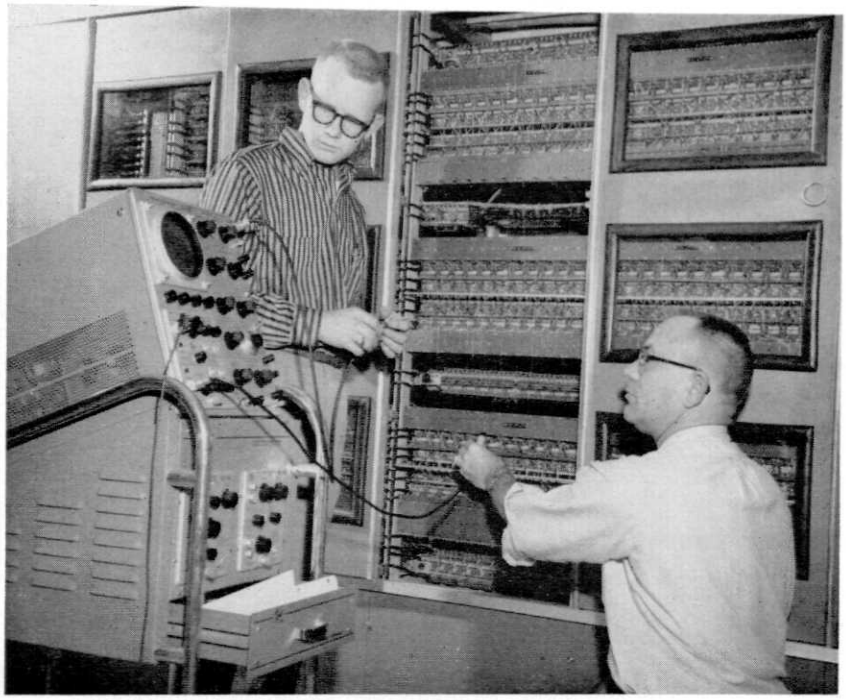
The number system of the machine consists of two numbers only, 1 and 0.

0–0
1–1
2–10
3–11
4–100
5–101
6–110
7–111
8–1000
9–1001

In many digital computing machines it was found that the normal scale of 10 did not work as well for engineering practices, so this binary scale was introduced.

The complete cycle of one problem through the machine begins with the introduction of the information into the computer by means of two tapes. One tape will contain the information to be used, the other will contain the directions. For example, the directions might say multiply the first number by the second, then add to the third, etc.

Then the problem, or program, as it is called,



Robert Trantham (left), junior electrical engineering student from Gleason, Tenn., and an Honors College member, works on the new M.S.U. electronic computer with Dr. Lawrence W. Von Tersch, director of the computer laboratory.

moves into the control section which tells the rest of the computer what to do by means of electrical impulses. The significance of this step lies in the fact that the contents of the memory system of the machine enters here, directs, and then returns to its respective electronic tube. The computer has been compared to a very simple human mind.

The major feature this machine has over the standard commercial adding machine is the fact that it can come to its own decision and get the job done with fewer instructions, i.e., add one thousand numbers without one thousand instructions.

The programing is still difficult and research is being carried on to establish some kind of instructions more closely resembling human language so problems can be more easily set up. Problems take days and sometimes months to write up correctly. If a program is fed into the machine and contains an error, the computer stops because it gets confused and mixed up. The essential functions of the machine include addition, subtraction and shifting; and variations of these three functions produce the answers.

Service laboratories around the country will rent the machine on an hourly rate basis and also pay an hourly fee for the problem change into code.

A similar machine, called Illiac, was built at the University of Illinois in 1953, and provides most of the tapes used experimentally on Mistic now. Other machines are now in operation in Argonne National Laboratory, Oak Ridge National Laboratory, Los Alamos Scientific Laboratory, Rand Corporation of Santa Monica, and the University of Sydney, Australia. The State College at Ames, Iowa, is constructing one which will be completed soon.

Because a knowledge of coding operations is necessary to make use of the machine, a course in computer coding at M.S.U. is being offered during fall term with 60 faculty members and advanced students.

Instructor is Dr. G. P. Weeg, ass't. professor of mathematics and former mathematician in design and guidance at the Sperry Rand Corporation which developed "UNIVAC" and "UNIVAC Scientific."

Thirty people are needed to operate the machine. Since there are approximately 2,000 machines in existance today, 60,000 persons are needed.

Industries which have bought these machines offer an intensive 80 hour two-week instruction program and it is hoped that employees without technical training or even college degrees, will be able to learn to program and operate the machines.

The first calculating machine was invented by Pascal in 1642 to aid collection of French taxes. The machine was capable of addition and subtraction. Interest in a computer flourished in 1850, when one was perfected by Babbage who soon lost heart because there was no mechanical power as we know it today, but 1937 saw the revival of interest in computers.

During the war, the Defense Department took a keen interest in the machines and the government granted research funds to experiment with the machines. After they were perfected in 1949, the government became the leading purchaser, a position it has kept to date.

An interesting example of a computing machine application which, at first sight, seems non-numerical

(Continued on Page 56)

Taconite:

The Steel Industry's New Lease on Life

by James A. McConaghy

In 1951 the United States was forced to import over 10,146,000 long tons of iron ore. The total consumption of the United States in that year was above 123,288,000 long tons of ore. The high grade ores of Lake Superior have been a vital factor in the development of the world's largest industrial concentration. This development is on and near the shores of the Great Lakes.

In the past 100 years 2,300,000,000 tons of high grade ore have been mined and shipped from the Lake Superior region. The thoughtful American is sure to ask, "Just how long can the few iron ore deposits of the United States last at this rate? Our economy is based on a steel foundation and we must have iron ore if we are to survive as a leading world power."

Fortunately for our country a few men saw this problem over forty years ago and devoted their life to obtain the answers. As part of this answer, a new word has been added to our vocabulary that will have great effect on our future economy. That word is Taconite. To the geologist working in the Minnesota iron districts it is a ferruginous chert, or a rock of silicon that contains about 25% iron.

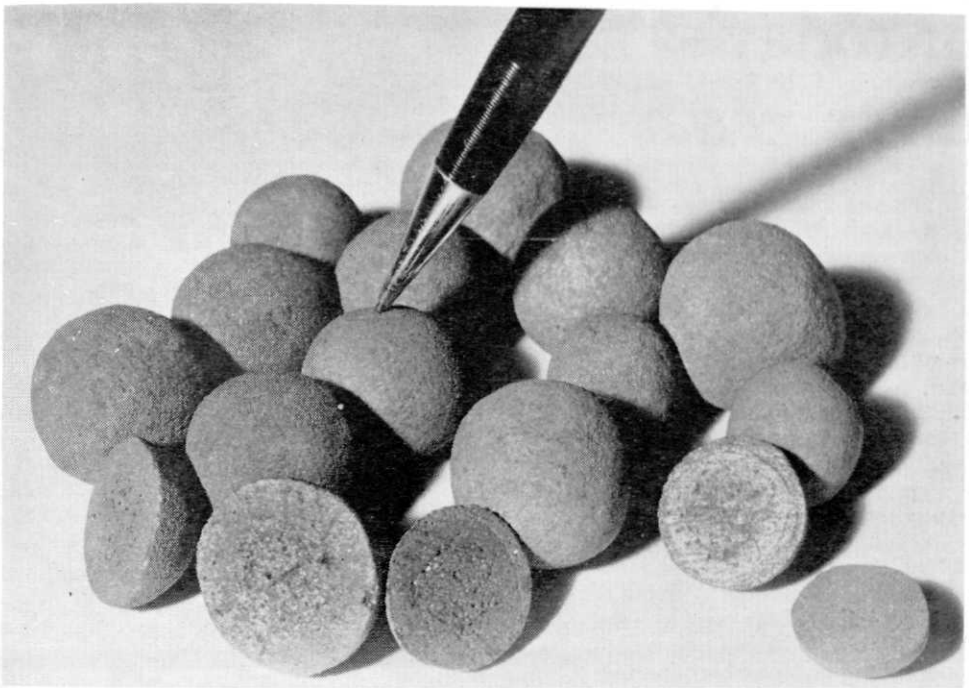
Taconite is found in a zone about 100 miles long extending west from Lake Superior in the Mesabi mountain range. It is estimated that there is enough iron content in this deposit to make ten times as much steel as the United States has produced in all of history. A similar rock called Jasper is found in the Marquette and Menominee ranges of Michigan and Wisconsin. The outer crust of the earth is composed of about 4.2% Iron which makes it the fourth most abundant element. Why then, worry about where we will get the ore to keep the steel plants going? The answer is simple economics. Once a mineral is removed from an area it cannot be replaced. The direct shipping, or high grade ores, of the Vermillion range cannot last over 35 years at the present rate of consumption.

The steel industry buys ore by iron content only, they do not pay for sand and other impurities. Therefore the iron ores are divided into grades. The highest grade ores are called direct shipping or Merchantable ore, and contain over 50% iron. It is only necessary to place the high grade ore into rail cars or boats and haul it to the blast furnaces. The low grade ores contain 35%–50% iron and must be concentrated prior to shipment. This process of concentration is called benefaction. Wash ore is a type of low grade ore that is mined in small particles and needs only washing to remove most sand and impurities. If the ore is in larger sizes that must be crushed prior to washing, it is intermediate ore.

It has been a general practice in all mining operations to use only the best ore and leave the rest until circumstances forced their utilization. However in the Mesabi range, far-sighted conservation policies caused both types of ores to be used at the same time, and even the rocks that could not be used in present refining methods have been stockpiled for the future. Low grade ores constitute 30% of the shipments from Minnesota and give jobs to 40% of the people employed in the state's iron industry. This progressive conservation policy has saved 330 million tons of direct shipping ores by benefaction of low grade ores.

The supply of good iron ore is increased by importing ore from; Cerro Bolivar, Venezuela; Kiruna, Sweden; Labrador; and Liberia. However, we must be able to depend on our iron and steel supply during war time. Because all of these imports are by ocean routes, they are very vulnerable to air and submarine attack, also the costs are increased.

The location of the present Mesabi range was at



Taconite formed into nodules ready for shipment to the mill.

one time the beach of a great sea. As iron bearing silt was washed into the sea it was deposited in a strip about 100 miles long and 1 to 3 miles wide. Before silt deposition was completed, the mud was 500 to 700 feet thick. With time the area was lifted above sea level and was subjected to the pressures of folding and faulting. The iron of the silt was in very small particles which had been washed into the sea from an old mountain mass. Water seeping through the rocks oxidized the minerals and washed away the sand until the iron content had been about doubled. The Taconite is ore that nature has not concentrated through leaching and solution. It is the "mother lode" of the high grade ores.

Oldtime miners swear that the only thing harder than Taconite is an old time miner. Taconite is so hard that it cuts the conveyor belts and destroys the bearings of the equipment that is normally used in ore concentration processes. A completely new method of excavation drilling has had to be developed. A conventional drill will cut through only about one foot of Taconite per hour, and the service life of the drills is very short. The mining engineers working with Taconite have learned a lesson from the Indians of the early United States. The Indians knew that if intense heat was applied to a small part of a flint rock the difference in rates of expansion would cause small particles of flint to spall off. They used this procedure to fashion arrow heads and other articles. The modern adaptation of this principle is a huge machine called the jet-piercer. The jet-piercer uses a fuel of kerosene and pure oxygen to develop temperatures of 4500 degrees Fahrenheit. The rock disintegrates and the small pieces are blown out of the hole with the escaping steam pressure. The jet-piercer can drill a nine-inch hole through twenty to thirty feet of Taconite rock per hour. Special equipment must be made to crush the rock, also trucks and railroad cars must be made of the toughest steel.

The ingenuity and determination of one man, Dr. Edward W. Davis, has been the outstanding factor in developing a successful method for Taconite concentration. Not only did Dr. Davis develop the fundamental process of ore extraction and agglomeration or forming iron balls out of powdered ore, but it was his persuasiveness that sold the idea to politicians of the state. The politicians had to be convinced of the practicability of the process and its value to the state so that they would pass special tax legislation which would attract industry and huge sums of money to Minnesota.

Both state and federal governments have given liberal tax concessions to the mining companies that are exploiting the Taconite reserves. The state tax on high grade ore is 50 to 60 cents per ton, but to encourage development, Taconite is taxed at less than ten cents per ton. The federal government is allowing the companies to write off 75% of their investment over a five year period.

Why must the government make such inducements to companies to encourage them to exploit this almost unlimited reserve of iron ore? By October, 1955 when the first load of Taconite pellets was shipped from Silver Bay, Minnesota, the steel industry had invested 300 million dollars. It is estimated that by 1970 the

(Continued on Page 23)

"For today's engineer, yes..."

"You are probably the most sought after young men in America today. Industries of all kinds want you. You've got a wide choice, so which field do you choose?

"The way I look at it, the aircraft industry has the most opportunity for you. It combines more advanced engineering sciences than any other field... electronics, communications, propulsion systems, hydraulics and pneumatics, thermodynamics... all these and many others. With this variety, interesting careers can be had either by specializing in one area or by moving from one to another.

"Obviously, you are going to want recognition for your work. You know that the aircraft industry pays well... but think about this: aviation is relatively young and its life-blood is young men with new ideas. Numerous important advances have been made just in the last few years. Who knows what new fields—and new opportunities—today's research will uncover?

"So, for today's engineer, yes, I would say that your best bet is the aircraft industry. Nowhere else can you find such opportunity, such challenge... and such compensation and added benefits. In my estimation, there is no place where you can put your college training to better use."

In the aircraft industry there is such a variety of engineering fields that a desire for virtually any *one* can be satisfied. As research continues more areas will be embraced and, as aircraft engineers pierce these barriers and solve today's problems, new challenges and opportunities arise. Northrop engineers have been meeting these challenges successfully for years. Airplanes such as the F-89 Scorpion, the new supersonic twin-jet Northrop T-38 trainer, and missiles such as the Snark SM-62 are examples of Northrop's engineering theory and capabilities.

In Northrop's new Engineering and Science Center, your training can be applied to top priority projects and your future will be made more secure by intensive on-the-job training. Regular reviews reward you for your capabilities and accomplishments, adding further financial security. The extra benefits at Northrop, such as company-paid insurance and over three weeks vacation with pay, are among the most generous in the entire industry.

Write *now* and ask us how your qualifications can be applied to a career at Northrop. Regardless of whether you are an upper-classman or not, we believe we can show you that Northrop offers you a great future. Address Manager of Engineering Industrial Relations, Northrop Division, Northrop Aircraft, Inc., 1032 East Broadway, Hawthorne, California.

NORTHROP

Northrop Division of Northrop Aircraft, Inc.

BUILDERS OF THE FIRST INTERCONTINENTAL GUIDED MISSILE

TACONITE

(*Continued from Page 21*)

total investment in Taconite production will exceed one billion dollars. Besides actual production facilities the investment is for a completely new harbor and two new towns for the employees. After the financial arrangements had been made, there still remained many problems that were of great complexity.

The blast furnace is a fussy eater and its diet must be carefully regulated. The ingredients to make steel are important but the texture of the furnace charge is more important. It must be porous so that gases of the blast furnace will remove the iron content, yet it must be strong enough to withstand shipping and the total weight of the furnace charge without being crushed to dust. Dust will smother the action of a blast furnace.

Most of the problems involving taconite concentration have been solved so that the process is now workable. After blasting and being transported to the mill, the rock is first crushed by a machine that resembles a huge bell. This crusher produces pieces of rock that will pass through a one inch screen. The ore is then transferred to the rod mill where long rods tumble in a revolving cylinder. The ball mill, which is the final crushing process, gives the ore a texture much like that of face powder.

Because the iron is scattered through the ore in very small particles, a major problem has been the separation of iron from sand. Several methods have been devised and each has advantages and disadvantages. The process of floatation is accomplished by placing ground ore in a liquid that has a density between iron and that of sand. Sand, being less dense, naturally floats but the heavy iron sinks to the bottom and is collected. The process that shows promise of being most practical is magnetic separation of the iron by huge magnets. The major disadvantage of this operation is the fact that only a small part of the total Taconite reserve is magnetic. For magnetic separation to be practical as a future method of concentration, an inexpensive process must be found which will change non-magnetic Taconite ores into magnetic ore. Battelle Institute of Columbus, Ohio has developed an experimental process to do this. Gamma Iron, as Battelle Institute calls the finished product, is produced by treating the Taconite non-magnetic ore in ovens of controlled atmosphere. Gamma Iron retains this artificial magnetism for three to four days. If this can be done on a large scale it would open the full Taconite reserve to exploration.

One of the last problems to be solved in Taconite concentration was that of agglomeration, which is the process of forming balls from the powder-fine concentrate. The process called sintering has been used for some time to make use of the powders produced by concentration of low grade ore. Coke is mixed with the powder and burned. This burning causes the iron to fuse into large blocks which are broken and shipped. Another method of agglomeration is briquetting, in which the concentrate is pressed into molds and then baked. The method now being used is called nodulizing. It does not require the machinery of the briquetting process, nor the expensive coke of the sintering method. First the damp powder is pulled onto a revolving fabric drum by vacuum, and the water is sucked out. The cake is then pushed off with a blast of air, and placed in a revolving balling drum which is tilted. Just as damp snow will ball if it starts to roll down hill, the ore forms nodules about the size of eggs as they move through the drum. These nodules are then placed into the furnace.

The furnace procedure is very critical because if the temperature is too low, the balls will be "green" and lack enough strength to withstand shipping. On the other hand if the furnace is too hot the whole charge will fuse together in the furnace. Experimentation has shown that a temperature of about 2400 degrees Fahrenheit gives good results as the nodules are strong enough to be bounced off of a brick wall without breaking.

Labor costs to produce one ton of Taconite concentrate are about the same as for one ton of high grade ore from an underground mine. However, the cost is three times as much as open pit production. Another item that increases the cost of production of Taconite is the large volume of waste material. For each ton of Taconite balls that are produced there will be two tons of tailings, or waste sand. If the Taconite production reaches 40 million tons as planned, then the iron companies will have to find some place to dump 80 million tons of worthless sand each year. One suggested solution is to dump the sand into the Great Lakes. The filling would be negligible and it should improve the fish spawning grounds.

Other than its huge reserves Taconite has other advantages as an iron source. The pellets can be stored in winter for shipment during the ice-free months, so the operation is a year-round enterprise. The uniform quality gives better pig iron. The cost of pellets is high, but so is transportation of useless water. High grade ore is 11.5% water, therefore the annual shipping costs of this worthless water is about $21,500,000 per year. Taconite pellets contain no water. Each ship load of high grade ore is only 51.5% iron, but a Taconite shipment is about 65% iron.

Taconite production has come a long way in the last 47 years since the first plant to produce Taconite ore was started near Coleraine, Minnesota. The many large iron and steel companies, who have made investments in the Lake Superior Taconite ores, are striving for even greater advances. Virtually every concentration plant in the area is a research laboratory. For example, Oliver Mining Company, of Duluth, has an extensive research program that can set up and tear down a pilot plant within a few hours.

The goal for Taconite production is set at 20 million tons annually by 1960. This production should be doubled by 1970. Because of the large investment in a Taconite ore concentration plant, it will operate at full capacity at all times. It will be the function of other iron sources to act as a stabilizer for fluctuating demands on this important national resource.

What Next?

by Judy Simons

A fantastic discovery causes a stir in the plant kingdom.

News of the unbelievable plant growth stimulant, gibberellin, is claiming the hopefully expectant attention of thousands. Agriculturists, horticulturists and botanists have similiar dreams; that their plants will grow faster, bigger, and produce flowers and fruits sooner. They are peering over the shoulders of the gibberellin researchers in hope that their fondest wishes may be granted by this chemical. To these people, gibberellin is a golden promise.

Among the varied miracles gibberellin has performed for the researchers so far are included the overcoming of dwarfness in plants, an increase in fresh and dry weight, earlier seed germination, and fruit setting in the absence of pollination. Flowering and normal seed production has been hastened and dormancy in many plants has been broken. Botanists are looking optimistically to a plant revolution.

Jack, with his fabulous bean stalk, couldn't have accomplished any more than it appears the scientific world may succeed in doing with gibberellins. Their effects are not limited to a few botanical families, but include many economic plants. Among the few plants that have not yet shown any noticeable effect from the use of the chemical are onions, and two species of pine and white spruce.

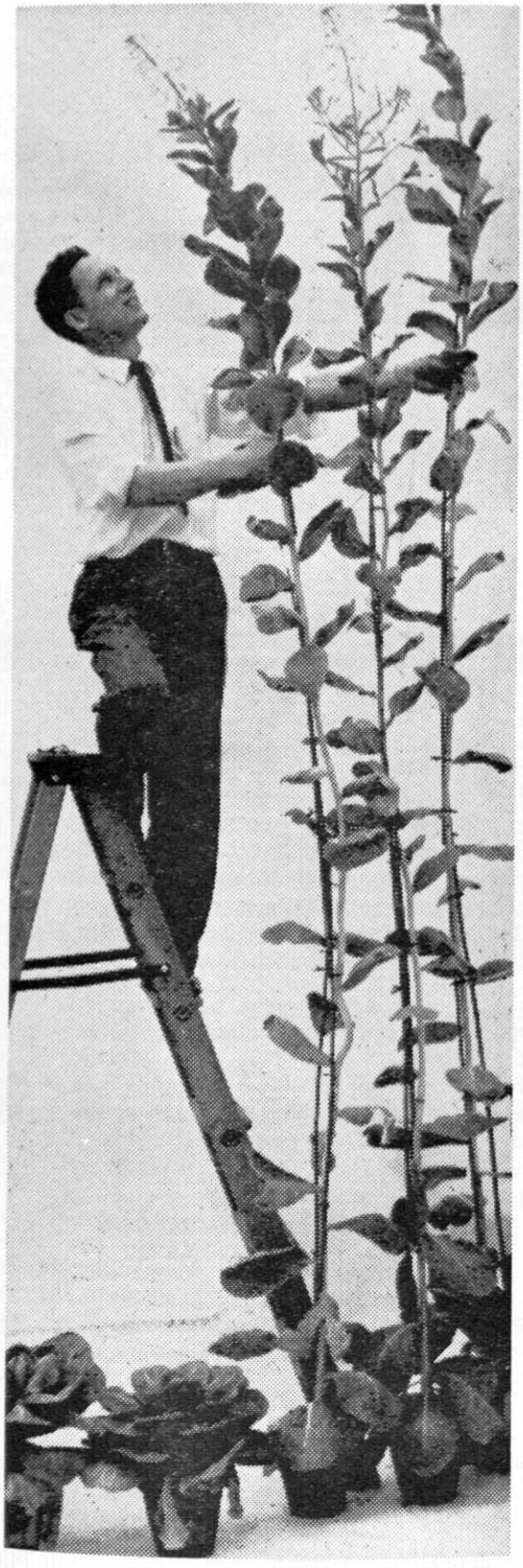
Recently, with the advent of the first commercial sales and advertising of the product, the green-(and not so green) thumbed American gardener has had his interest aroused by it. He says to himself, "Maybe this is just the thing to get that little sapling sitting in the back yard to hurry along to hammock size or perhaps it might get that bed of annuals to bloom before those in the garden of the guy next door."

Just what is the story of this substance that has been called, "What may well be the most important chemical find in twenty-five years . . ." by S. H. Wittwer of Michigan State University, one of the leading gibberellin investigators in this country?

Toward the end of the last century a strange rice disease was discovered in Japan. Because the affected seedlings grew very swiftly, reaching an abnormally large size and then dying, the disease was labeled "Bakanae," meaning, "foolish seedling." In 1926, a Formosan plant pathologist, Kurasawa, became curious about bakanae and discovered that a peculiar fungus, Gibberella fujikuroi, caused it. This was the beginning of the thirty years search which ended in the sensational discovery of gibberellin. His twelve years of attempts to isolate the active principle of the disease failed, but Kurasawa found that sterile filtrates of the culture in which the fungus had grown produced the same overgrowth, when applied to the plants, as the disease itself.

Japanese mycologists, who took up the search, found the disease had inconsistencies and at times had no effect at all or at other times, dwarfed the plants instead of producing gigantic growth. In 1934, this mystery was on its way to being solved by them, when it was found that one of the substances produced by the disease was fusarinic acid, which was responsible for growth inhibition. Finally, in 1938, a team of research workers at the University of Tokyo isolated the plant growth substance. It was named "gibberellin" after the fungus Gibberella.

Then came the attack on Pearl Harbor and World War II. Seven reports had been published in Japanese and all but one had been translated into English by 1943, but the war cut off further reports. It was not until 1950, that about a dozen additional papers were abstracted from Japanese and two U. S. physicians became interested in the work. These men, Mitchell and Angel of the U. S. Army Chemical Corps Biological Laboratories at Camp Detrick in Maryland, met with failure in their attempt to prepare pure gibberel-



Cabbages grow like Jack's beanstalk in the gibberellic acid research of Dr. Sylvan H. Wittwer, Professor of Horticulture at M.S.U.

lin. However, they started the wheels of investigation in motion outside of the Orient.

Two groups of biologists and chemists, one at the Imperial Chemical Industries in England and the other at the Northern Regional Research Laboratories, U. S. D. A., in Peoria, Illinois, worked on the problem. England found that an isolated substance, gibberellic acid, was related to the Japanese gibberellin A (Ga) and biologically identical. The U. S. team isolated this same substance and called it gibberellin X. This gibberellin, they were able to produce by utilizing well aerated fermentation tanks of 300 gallon capacity and treating the organism in much the same way as the fermentations for antibiotics, such as penicillin or streptomycin. These tanks yield twelve grams of gibberellin for every 160 gallons of culture medium in three days. It is in this manner that gibberellins are now being prepared.

Gibberellins and their possibilities for crop production are creating much excitement and speculation in agricultural circles. A patent is pending in Australia for their use in promoting growth of pasture grasses. It may overcome midsummer dormancy in some of these grasses as well as promoting earlier growth in the spring and encouraging later growth in the fall. Increase in yield and dry matter is apparent with as little as one ounce per acre. In Puerto Rico, gibberellin is being considered for application by airplane to increase growth in fields of sugar cane.

Food crops of all kinds have possibilities, especially those grown for their leaves or leaf stalks, such as spinach, rhubarb, celery, lettuce, cabbage and kale. Because of the increase in size of the stalks it appears that gibberellins may enable celery growers in Michigan, to market their crops two to three weeks earlier. Although the yield is not increased in crops such as corn, sugar beets, soybeans, potatoes, beans and broccoli, the crops mature faster, allowing quicker marketing.

The hastening of seed production could be a boom to seed companies. Biennials, plants usually requiring two years to produce seed with a cold period included, have been hurried to the seed producing stage. Our lumber shortage problem may be eased by the use of gibberellins. It has been reported that new growth of nursery stock and forest trees is greatly increased by applications of the growth promoter. Young, one to three year, maple, poplar, oak and tulip trees, have increased sharply in height when tested. More flowers will be available for home use from the florist because of the increased production possible in greenhouses.

These and other unlimited possibilities, lie in store for the plant world. It is believed that the agricultural impact of gibberellins will equal or exceed that of DDT or 2,4-D. This does not mean, however, that the use of fertilizers may be discontinued, as so many people have mistakenly believed. In fact, due to the rapidly increased growth rate, more will probably be necessary to create well balanced growth and to prevent treated plants from becoming spindly. It is be-

(Continued on Page 54)

The Development of Fine-Particle Magnets

by William R. Mitchell

A major development in the field of magnetic technology was disclosed in December, 1956, by the General Electric instrument department. The company reports the development of an unusually versatile and powerful permanent magnet composed of a new fine particle ferromagnetic material which has been quite successful in its experimental stages. Magnets made from elongated sub-miscropic particles of iron which, when pressed together, are found to be as strong as the best Alnico type permanent magnet. This new product is believed to have 100,000 times the resistance to de-magnetization that ordinary iron possesses.

The use of magnets is of fundamental importance to industry for their demand is ever increasing in radio and television sets, photo light meters, and in many aircraft instruments. The average American jet bomber uses over 200 magnets in the instruments which serve to keep the plane aloft and on target.

It was during the 1920's that scientists from General Electric, along with scientists in Japan, found the secret to the new type permanent magnet which they named Alnico. This magnet has been termed the backbone of the permanent magnet production during the past twenty years. There has been continuous work in the improving of the Alnico magnet; however, it has its limitations, and study has been directed toward basic research. In 1930 the concept of "magnetic domains" was discovered, and it has been termed the keystone to modern magnetism study.

In order to understand the development of the new magnet better, it is probably appropriate to discuss just what a magnet is. This information was quite important in developing a new strong permanet magnet. More basic data has developed in the field of magnetism in the past ten years than has been learned in the past twenty centuries.

If one visualizes a simple atom with an electron traveling in an orbit around it, each different orbit finds itself in a miniature magnetic field. However, in most elements, there are many electrons all spinning around each atom in different directions. In nearly all elements there are usually just as many of these electrons traveling around clockwise as there are electrons traveling counter-clockwise. The orbits of two electrons traveling in opposite directions have a cancelling effect on these two respective magnetic fields. The balance in cancelling is found in all of the elements except iron, cobalt, and nickel. These elements differ in that there are more electrons spinning in one direction than the other; this then creates a magnetic field associated with each atom.

If a group of iron atoms, which have lopsided electron spins, were put together—what would happen? It was found that by some very complicated movements the orbits of adjacent atoms would interact in such a way that the associated atoms would become aligned. Then the magnetic field of each iron atom would closely parallel its neighbors, and the spinning electrons within their magnetic field would cause the atoms to become closely bonded.

The concept of magnetic domain showed that in a sample of iron, cobalt, or nickel there are millions of colonies of parallel aligned atoms. These colonies or magnetic domains are found to vary in size depending upon the element. When an outside magnetic field is applied to the sample, the domains tend to readjust themselves immediately into an alignment with the induced field, which primarily is a result of the shifting of the domain's boundaries. This, basically, is how a material becomes magnetized.

Transformers, which are electro-magnetic devices, contain a metal core which will easily withstand being magnetized and demagnetized. This is to say, the metal core has a narrow hysteresis loop which indicates that the magnetic domain boundaries can be moved easily. A metal which would strongly resist movement of its domain boundaries would conversely be indicated by a wide hysteresis loop. This wide loop

William R. Mitchell, student author of this article, is presently working on his graduate degree in Resource Development. Mr. Mitchell received his B.S. degree in geology at Bowling Green State University. While attending Bowling Green he was a member of Sigma Phi Epsilon, Alpha Phi Omega and active in the Bowling Green Geological Society.

WILLIAM R. MITCHELL

is characteristic of permanent magnets, and this is the principle problem confronting scientists who are working in the field of magnetism. How can one make a magnet which will cause the movement of domain boundaries to remain stationary?

It is known that these magnetic dominions have dimensions; thus, the isolation of the domains was attempted. The earliest method which was attempted was the development of case-hardened steel magnets. Particles of carbide were precipitated into molten steel just as it began to set up, in hopes that the carbides would form boundaries around each domain. This would then possibly prevent the reversal of such domains, making a strong permanent magnet. But end results showed that the magnets were quite weak, and not at all the product which was desired.

The idea which led to the present stage of development of a permanent magnet was to prevent domain-boundary movement by the elimination of the boundaries. The domain boundaries in iron have a width of nearly a millionth of an inch, and the development of an iron particle this size would contain no boundary. The object would be to make each particle so small that each physical particle would be a single domain unit. Since the particle cannot be demagnetized by a moving boundary it would be compelled, when large numbers are bound together, to change polarity simultaneously in one immense jump. Such an occurrence would require a large quantity of energy to be exerted, especially when there are strong crystal forces to be overcome.

The first observations of single domain iron particles were made in 1896. Several varied attempts since World War II to make fine-particle magnets in Great Britain and France have proved unsuccessful, primarily because of the poor magnetic properties in the finished product. In regards to the physical relationships, usually those materials which have strong crystal forces also have the capacity for making a strong permanent magnet. Iron, however, does not have strong crystal forces. So even if it were possible to prepare iron particles with single domains, one would not get a very high resistance to demagnetization.

In recent findings at General Electric, they were able to overcome the limitations of the low crystal forces in iron. Their method of conquering the problem was to make uniform elongated iron particles within the single domain. They started with only speculation from the theoretical physicists that ultrafine elongated iron particles might have a high resistance to demagnetization. Viewed under the electron microscope the whisker-like particles are several times smaller then particles of cigarette smoke. The sub-microscopic iron whiskers are formed or grown by electroplating iron onto a molten metal cathode. Later the particles are gathered from the liquid mercury by a conventional magnet. The whiskers are then aligned under a powerful electromagnet and compacted under varying pressures depending upon the type of binding used.

There is great versatility in the types of binder which may be used, ranging from glass to plastic, metal or rubber. This permits molding, drilling, or machining to any desired size and shape. The character of the metal when divided into such fine particles is changed completely. As mentioned previously the resistance to demagnetization is a hundred thousand times greater than ordinary iron which is unbelievable.

(Continued on Page 53)

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

Go with us... and you'll Grow with us!

CONVAIR
FORT WORTH

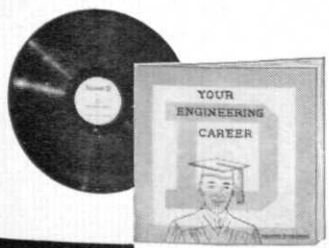
CONVAIR IS A DIVISION OF GENERAL DYNAMICS CORPORATION

We'd like to send you this record!

No matter what branch of engineering you're following—no matter which phase of engineering interests you most—we want you to know SQUARE D and what we have to offer. Of special interest to you, we believe, is the "*human touch*" side of our Company. There are some things you simply can't evaluate in terms of cold facts and figures. A company's basic philosophy, for example ...its attitude and approach to its customers and to its working team.

The "*Human Touch*" record we want to send you deals with some of those intangibles—musically. We think you'll enjoy it.

mail this coupon for your "*Human Touch*" record



Square D Company, Dept. EM
6060 Rivard Street, Detroit 11, Michigan

I'd like a "*Human Touch*" record and a copy of Square D's brochure, "YOUR ENGINEERING CAREER"

I am primarily interested in ☐ Research, Design & Development Engineering ☐ Manufacturing Engineering ☐ Sales Application and Field Engineering

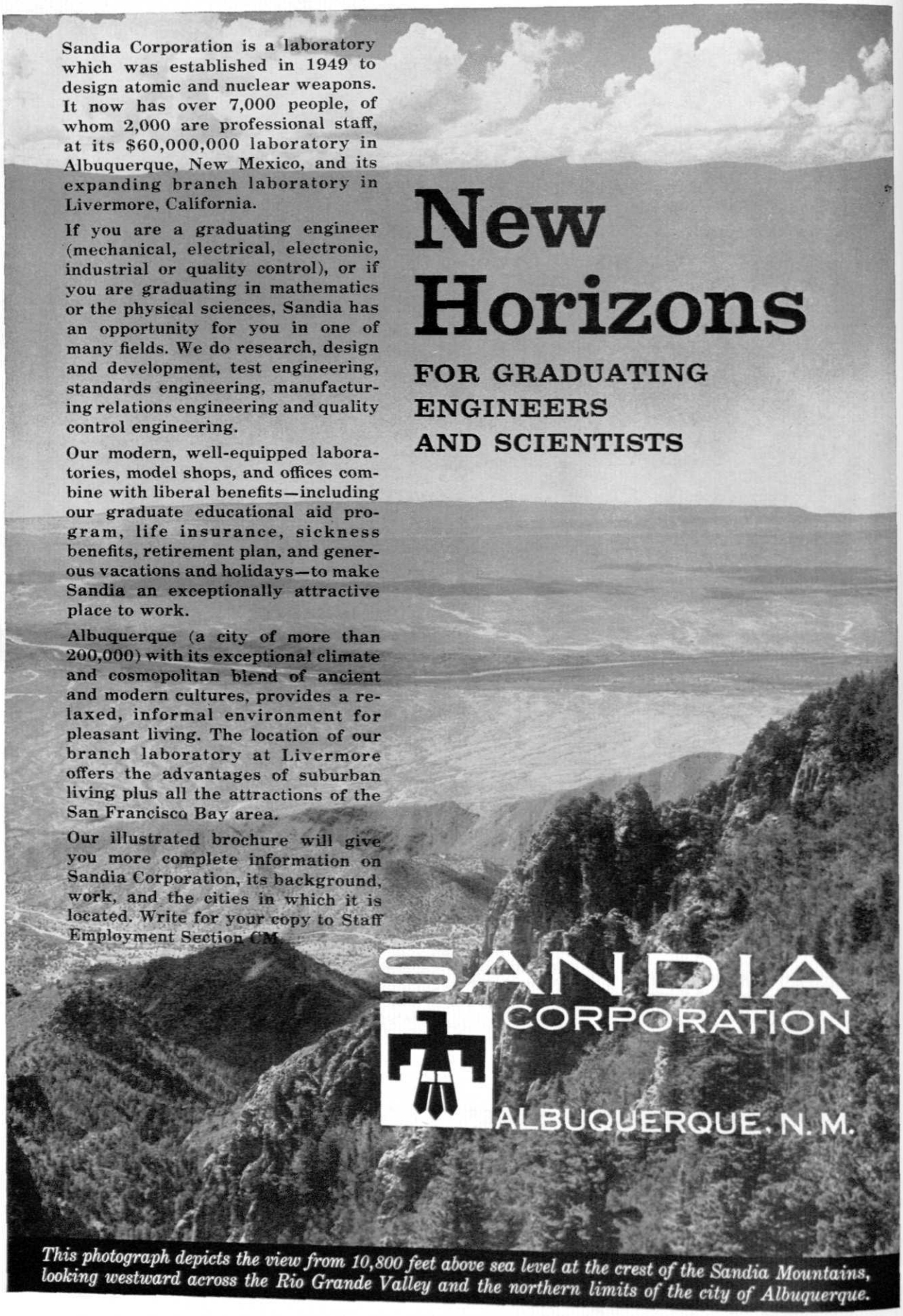
NAME _____

SCHOOL _____ CLASS _____

ADDRESS _____

CITY _____ ZONE ___ STATE _____

SQUARE D COMPANY


New Horizons
FOR GRADUATING ENGINEERS AND SCIENTISTS
Sandia Corporation is a laboratory which was established in 1949 to design atomic and nuclear weapons. It now has over 7,000 people, of whom 2,000 are professional staff, at its $60,000,000 laboratory in Albuquerque, New Mexico, and its expanding branch laboratory in Livermore, California.
If you are a graduating engineer (mechanical, electrical, electronic, industrial or quality control), or if you are graduating in mathematics or the physical sciences, Sandia has an opportunity for you in one of many fields. We do research, design and development, test engineering, standards engineering, manufacturing relations engineering and quality control engineering.
Our modern, well-equipped laboratories, model shops, and offices combine with liberal benefits—including our graduate educational aid program, life insurance, sickness benefits, retirement plan, and generous vacations and holidays—to make Sandia an exceptionally attractive place to work.
Albuquerque (a city of more than 200,000) with its exceptional climate and cosmopolitan blend of ancient and modern cultures, provides a relaxed, informal environment for pleasant living. The location of our branch laboratory at Livermore offers the advantages of suburban living plus all the attractions of the San Francisco Bay area.
Our illustrated brochure will give you more complete information on Sandia Corporation, its background, work, and the cities in which it is located. Write for your copy to Staff Employment Section CM.
SANDIA CORPORATION
ALBUQUERQUE, N. M.
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.

Are You Eating Yourself to Death?

by Karen Paulson

Each year 370,000 Americans die as a result of atherosclerosis, a type of hardening of the arteries; since World War II, the number of Americans suffering heart attacks has increased steadily; heart disease is the nation's number one killer. You may know all these facts, the question remains, what can you do about it?

Recently there has been a tremendous amount of interest in and controversy over—cholesterol and its relationship to coronary disorders. On one side, investigators are saying that the high fat intake of the American diet is responsible for an increase in the cholesterol content of the blood. Others claim that it is the animal but not the vegetable fats that are at the root of the trouble. One or two individuals have implicated hydrogenated fats, the vegetable shortenings on the market, as one of the main causes.

At the present time, researchers are busy studying cholesterol; its functions and its effects. As yet, experimental evidence is too incomplete to tell you that this or that substance is the primary cause of coronary heart disease. In the months ahead, it will be important that you be able to evaluate and interpret the findings of scientists in this matter. In order to do so, you should know what cholesterol is, what its functions are in your body and what happens to your body when various heart disorders occur.

Dietary cholesterol has been known to exist in the tissues of man for almost 200 years. Its name was derived from the Greek words which mean "solid bile." It is a white fatty alcohol which is found in all animal tissue. Since it is absorbed in the presence of fat, bile is important to the digestion of cholesterol just as it is for the digestion of fat. It travels with the fat to the liver and there the undigested cholesterol is excreted through the bile duct and the gall bladder. If there is an overabundance of cholesterol, however, it will tend to precipitate out of the solution and settle either in the bile duct or in the gall bladder. When it does so, it becomes the nucleus for gall stones. Thus it received its name "solid bile."

One of the unique characteristics of cholesterol is that if it is not supplied in your diet, your body will manufacture it. It is for this reason that those people who would tend to make you believe that you should cut cholesterol out of your diet are giving you poor advice. In fact, there is evidence that it is even harder on your body to have to manufacture the cholesterol than it is to digest it.

Cholesterol performs many important functions in the body. It is found in all the tissues but especially in those of the nervous system; it composes a large part of the brain. It acts as an insulator in the white matter of the nervous tissue and is an important part of the architecture of the cells.

As a constituent of the blood, cholesterol helps to transport fatty acids which are necessary for life. It is also believed to be a forerunner of other steroids such as bile acids, sex hormones and adrenal cortex steroids.

The level of cholesterol in the blood serum of man is higher than it is in any other mammals. Experiments show, however, that it is poorly absorbed by man and is also only slowly metabolized or digested. The degree to which it will be absorbed depends to a great extent upon the "kind" of fat with which it

(Continued on Page 64)

NEW DEVELOPMENTS

Edited by Norm Dill

New Technique Eliminates Television Picture Lines

The dark horizontal lines clearly visible in any "close-up" look at a television picture may someday be a thing of the past.

Scientists have developed an experimental method for eliminating these "scanning" lines—now considered a natural limitation on the size of television picture people enjoy watching. Elimination of the lines, the scientists say, could be a step toward larger-size television screens in the home. Elimination of the scanning lines is made possible by a simple but basic change in the construction of the television picture tube found in all standard television receivers.

This change consists of splitting in half one of the tube's cylindrical metal "grids" used to focus its electron beam into a tiny round spot.

The standard television picture is broken up into horizontal rows which appear as black and white lines at the television receiver. The white lines contain the picture information, which is 'painted' by a beam of electrons that sweeps back and forth across the fluorescent screen on the inner face of the picture tube. The black lines between each pair of white ones are unexcited areas of the screen not used in constructing the picture. Present television standards in the United States set the number of picture lines at 525.

Previous research, which has been verified by experiments, shows that the viewer moves back from a television picture until he just fails to clearly distinguish these individual lines. For a 24-inch picture, this 'normal' viewing distance turns out to be about ten and one-half feet. Placed closer than this, the viewer begins to distinguish the horizontal line structure of the picture, which is distracting.

TV without distracting lines? According to scientists it may not be far off.

The new technique employs a method of wobbling the electron beam vertically as it makes its repeated traces across the television picture tube. The slight up-and-down motion of the beam broadens the white lines which carry the picture information and narrows the distracting black lines which lie between them.

This so-called "spot wobble" actually dates back several years, but heretofore the methods for accomplishing it have involved considerable equipment and have not been entirely satisfactory. The new system eliminates these problems by taking advantage of the "split grid" structure inside the television picture tube itself.

The split focusing grid still serves its regular function of sharply concentrating the electron beam on the screen, but at the same time a fluctuating voltage may be applied which wobbles the beam up and down about 15 millon times per second. The "wobbling" voltage is supplied by a single electronic tube fitted to a socket into which the television picture tube is plugged. The "spot wobble" is still in its experimental stages and has not yet been adopted on a commercial scale.

Scientists Control Titanium Furnace With Atomic Radiations

Atomic radiations, in the form of highly energetic gamma rays for radioactive cobalt, have been put to a new and important use by scientists.

Gamma rays are being employed to detect and control the level of molten titanium in a new "cold hearth" arc furnace designed to prepare the purified titanium metal.

To carry out their new assignment, the penetrating gamma rays pass through as much as 15 inches of solid metal. The successful operation of this new titanium arc furnace demands exact control of the molten surface of the titanium ingot inside it. Such control must be foolproof, precise and fast working—yet must be accomplished under extremely difficult conditions. For example, the temperature of the white-hot liquid titanium is more than 3000 degrees Fahren-

heit—made so by an electric arc which consumes as much current as the combined capacity of 150 modern homes.

Gamma rays are penetrating, high-energy radiations which come from the spontaneous disintegration of certain radioactive atoms. By beaming these rays through the walls of the furnace and the 12-inch titanium ingot inside it, engineers are able to "see" the actual level of the titanium. This information is used to automatically raise or lower the ingot to its correct operating level, thereby insuring proper operation of the furnace.

This control by gamma rays, brings a new degree of reliability and safety to titanium arc furnace operation. It is a critical job of measurement and control which would be very difficult to handle by any other means.

To design the gamma ray control a duplicate of the actual cross section of the titanium furnace was built. This included the furnace itself and the titanium ingot inside, with the latter's curved top surface hollowed out something like a bowl.

The source of gamma rays, a small needle of cobalt-60, is placed outside the furnace and in line with the top surface of the ingot. The "hot" cobalt-60 is kept inside a shielded lead "box" having walls about four inches thick. When a door in the "box" is opened, a beam of gamma rays passes through the furnace walls and across the top surface of the ingot.

If the ingot inside the furnace is too high, it partly blocks the beam of gamma rays, reducing the amount of raditaion getting through the furnace. If the ingot is too low, the beam is interrupted less by the ingot, and the amount of radiation through the furnace is greater. These changes in the amount of gamma radiation are used to detect the ingot's position and bring it to its correct level.

A scientist raises the level of molten titanium in a gamma ray controlled purifying furnace.

The gamma rays passing through the furnace are detected by means of two "scintillation counters." Such a counter contains a crystal which changes the gamma rays into flashes of light. The counter then converts the light flashes into electrical pulses and amplifies them. These amplified pulses are fed to electronic circuits which are designed to drive a hydraulic system that raises or lowers the titanium ingot to the exact position required for proper operation of the arc furnace.

The whole system is so precise that it can detect and maintain the level of the titanium ingot to within one-hundredth of an inch of its ideal operating position. If, for any reason, the ingot moves beyond its prescribed limits, the gamma ray control causes immediate shutdown of the furnace.

"Moving Sidewalk" In Dallas

Air travelers tired of trudging through long airport corridors will have the pleasure of riding to and from their planes on a "moving sidewalk" at the new $7 million Dallas Love Field, Dallas, Tex., scheduled to be opened this fall.

Three "moving sidewalk" units totaling 1,435 feet in length will carry passengers in both directions through the three corridors or "fingers" leading out from the main terminal building to the airplane loading gates. The operating speed at first will be 132 feet a minute, about half average walking speed and considerably faster than moving stairs. Passengers may walk while they ride and thereby increase their rate of travel. When the public becomes accustomed to "moving sidewalks," consideration will be given to increasing their speed.

The Dallas "moving sidewalk" is the first ever installed at an airport. It has several unique features, one of these features is that it will go around corners and may be installed in the form of a loop so that passengers are carried in two directions. The curving feature is not utilized at Dallas but will be used in other locations where the course is irregular rather than in a straight line as at Dallas.

Passengers will stand on a rubber carpet fastened to individual 24-in. by 42-in. pallets linked together by universal couplings. The pallets are mounted on 4½-in. diameter rubber-tired wheels which run on a steel track. Three 30 h.p. electric motors, located in the basement under the terminal building, transmit power through lugs on a sprocket chain which engage the underside of each pallet. The rubber carpet does not pull any part of the load but is used only as a cover over the pallets to give passengers a smooth, even platform to ride on. It is made of solid rubber and contains no reinforcing fabric like that used in conventional conveyor belts.

(Continued on page 35)

CAN YOU FIGURE IT OUT?

Re-arrange the numbers 1 to 49 so that all rows, horizontal and vertical, and the two major diagonals, add up to 175 each. It can be done!

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	32	33	34	35
36	37	38	39	40	41	42
43	44	45	46	47	48	49

*Solution at bottom of page

Lee Baker tells what it's like to be... and why he likes being... a Manufacturing Engineer with IBM.

FIGURING OUT A CAREER?

Selecting a career can be puzzling, too. Here's how Lee Baker found the solution to *his* career problem—with IBM:

Despite his impending Service hitch, Lee was hired by IBM in 1953. As a Technical Engineer, he entered the General Manufacturing Education Program, a 10-month course with rotating assignments in all phases of the work: manufacturing, purchasing, production. Then came two years in Korea. Now back at IBM, Lee has been promoted to Production Control Engineer, responsible for designing systems to insure a smooth flow of work through the IBM electronic computer plant. "It takes *creative* engineering ability to design these systems," says Lee, "and *administrative* ability to 'sell' a system to higher management."

* * * *

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,

JUST WRITE TO: Mr. R. A. Whitehorne
IBM Corp., Dept. 850
590 Madison Avenue
New York 22, N. Y.

***SOLUTION**

30	39	48	1	10	19	28
38	47	7	9	18	27	29
46	6	8	17	26	35	37
5	14	16	25	34	36	45
13	15	24	33	42	44	4
21	23	32	41	43	3	12
22	31	40	49	2	11	20

IBM® INTERNATIONAL BUSINESS MACHINES CORPORATION

DATA PROCESSING
ELECTRIC TYPEWRITERS
MILITARY PRODUCTS
SPECIAL ENGINEERING PRODUCTS
SUPPLIES
TIME EQUIPMENT

NEW DEVELOPMENTS

(*Continued from Page 33*)

The shortest of the three "Glide-Ride" units measures 218 ft. in each direction and is installed in the north corridor. The units in the east and west corridors are 250 ft. long each way. All carpets are 42-in. wide, permitting pedestrians to ride two abreast. The corridors are completely enclosed and air conditioned. The "moving sidewalks" rise on a gentle grade from each end so that their center sections are about 8 ft. higher than their ends. This provides an underpass to permit trucks and other service vehicles to drive under the corridors.

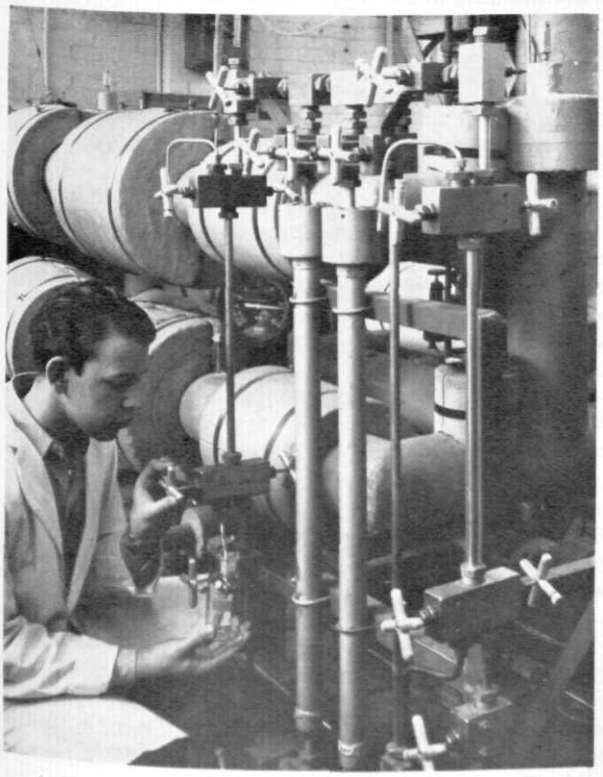
Extensive studies and experiments demonstrate that the "Glide-Ride" conveyors are a safe, practical and efficient method of handling pedestrian traffic and they promise to become as commonplace as elevators and moving stairs when architects and engineers fully realize their usefulness.

'Test Loops' Aid Atomic Studies

To help speed the development of peacetime atomic power, engineers have placed into operation two new experimental atomic "test loops."

The test loops will aid in the development and application of new "atomic" materials and supply information to guide the design and manufacture of atomic power equipment.

Each of the test loops consists of a system of stainless steel pipes containing a fluid which can be pumped past test specimens placed inside the system. Chemicals added to the fluid vary its corrosive effect on the specimens under test. The temperature, pressure and velocity of flow of the fluid are closely controlled.



A specimen being taken from an atomic test loop for laboratory study.

The main function of these new loops will be to study the corrosive effects of hot, pressurized fluids on the structural materials in nuclear power plants. They will be devoted to such specialized tasks as developing and testing corrosion inhibitors, corrosion resistant alloys and corrosion resistant joints in structural materials. Corrosion is a major materials' problem which has been intensified by the advent of atomic power. The new equipment will be a major asset in helping solve many of the problems it presents.

The loops were designed to operate at pressures up to 2000 pounds per square inch and temperatures as high as 600 degrees Fahrenheit.

These conditions, which are similar to those existing in actual atomic power plants, are maintained by a thermal pressurizer and external heaters.

The fluid in the loops is circulated by a "canned-motor" pump inserted directly into the system. Before the fluid is admitted to the loops it is purified and degassed in a special purification system. A small amount of the fluid is continuously diverted from the loop and circulated through a deionizing loop which removes the corrosion products from the fluid and provides for sampling and tests of purity. Pressure, temperature and fluid flow are accurately and automatically controlled in the loop during its operation.

Each loop has two identical test sections which hold the specimens to be exposed to the fluid. Each section is equipped to handle up to 105 specimens at a time, and are so arranged that one can be shut down for removal of the specimens without stopping tests in the other. The result is a flexible test loop of large capacity, and one which is especially adapted to the precise, closely controlled experiments required for a broader understanding of the whole problem of corrosion in atomic power equipment.

High-Temperature Optical Strain Gauge

Testing of materials will never become routine as long as new materials are developed and older ones are improved. This is particularly true in the case of alloys designed for 1200 and 1250 degree F operating temperatures. Where do you find delicate instruments to measure physical properties of alloys at such temperatures? In some instances, the building of an instrument to do the job involves almost as much work as the development of the alloy itself.

One important metal property required is the variation in modulus of elasticity at elevated temperatures. Also vital, is the degree of surface strains incurred by heat cycling.

(*Continued on Next Page*)

NEW DEVELOPMENTS

(*Continued from Page 35*)

To obtain this information, engineers adapted for high-temperature service a standard optical gauge used for measuring strains at room temperature.

The small instrument roughly 1½ inches long by ¾ inches wide by ⅝ inches high consists of a metal framework to hold two tiny mirrors, one stationary and the other movable. The mirrors are mounted on blocks of Refractaloy alloy, which have one knife edge that contacts the sample. In operation, the gauge is clamped to the metal surface, a beam of light is aimed at one mirror, reflected to the other mirror and then back to light source, where a scale indicates the angle of the return beam of light. When the sample is heated to test temperatures, the movable knife-edge rotates slightly changing the mirror angle and in turn the light beam return angle. Since there is no mechanical linkage between the strain gauge and the measuring device, an extremely high degree of accuracy is possible. With proper calibration, changes as small as 20 millionths of an inch can be detected.

The chief difficulty from a materials standpoint in adapting the room temperature gauge to a high-temperature gauge was the mirror surfaces. A successful combination consisted of silver brazing a ⅛ by 5/16 inch strip of 30-mil-thick platinum to the Refractaloy knife edge blocks. Even at 1250 degrees F, the platinum stays bright and reflective and the 20 millionths of an inch accuracy is now almost as easy as it was at room temperature.

Arcs Go 'Round And 'Round In Lightning Arresters

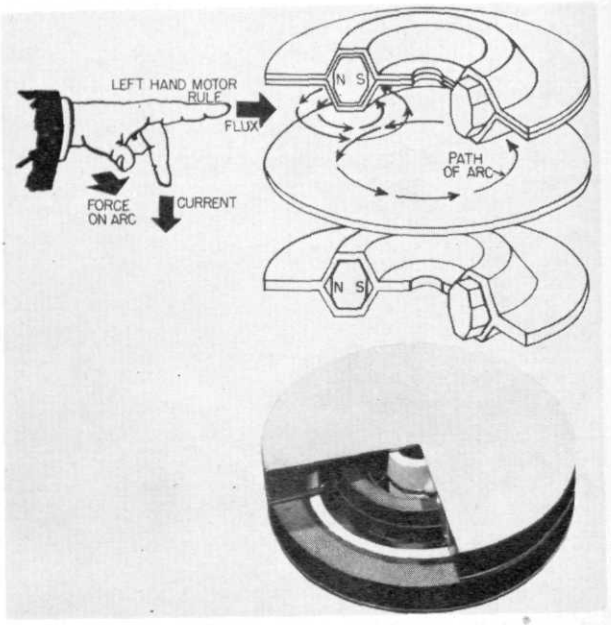
A small doughnut-shaped ceramic magnet is making life miserable for arcs in lightning arresters. The magnet placed mechanically "in series" with the gap surface provides a constant magnetic field in the gap. When the arc is drawn, it is at right angles to the magnetic field, and therefore spins like the armature winding of an electric motor.

Previously, the arc tended to stay in one spot. With discharges of relatively long duration, such as switching surges, there could be pitting at those spots on the electrode surfaces. This could eventually change the arrester spark over.

When the arc spins and moves, pitting cannot occur, so gap life is lengthened. Also, the ability of the gap to interrupt power-follow current is improved.

Since the arc must spin, critical electrode spacing has been simplifield by placing a small pimple on one surface; only this pimple spacing is critical. Once the arc is drawn, the magnetic field drags it off the pimple, and around the gap, which aids arc interruption.

The ceramic magnet is made of barium ferrite, which electrically is an insulator. However, its magnetic life is virtually infinite. The magnet is enclosed in a brass shield so that the discharge currents go around the outside of the magnet and therefore do not demagnetize it. Currents of 100,000 amperes have been measured in the gaps with no ill effects to the magnets.



This photograph shows a cutaway view at the new lightning arresters: Also shown is a diagram demonstrating how the ceramic magnet causes the arc to spin.

The reliability of the new device lies in its utter simplicity. The new magnetic design is being used in all station and line type arresters.

Instant Radar Maps

Airplane pilots and navigators can now consult a map that is only twenty seconds old made night or day in flight by radar. With a device called a radar strip recorder which presents a photograph of the ground beneath the airplane as seen by airborne radar eyes, navigation to pin point accuracy in now possible. The airborne system is equally useful in peace or war.

Previously navigators and pilots have had to rely on memory or hasty notes and calculations taken from radar presentations in the air. The new automatic device requires no operator; it combines electronics and photography to make it easy to determine the airplane's exact position and true flight path at any time desired in flight without relying upon memory or radio equipment on the ground.

Initially designed for use with an airborne radar system, the strip recorder with its associated fast film processor is adaptable to practically all types of airborne radar. In addition, the device is useful as a ground recorder of radar or telemeter information relayed from flying radar sets. In such uses, the strip recorder makes it a simple matter for ground

controllers and observers to monitor the flight path of a missile or drone aircraft.

Instrumental in making the rapid strip recorder feasible is a unique process developing high sensitivity film in only ten seconds. The process uses only one liquid bath, which functions at a high temperature to speed the photographic development. Liquid is literally wiped onto the 9-inch wide film in the radar strip recorder much the same as painting walls with a squee-gee. The transparency which emanates from the monobath developer is then viewed directly on a translucent lighted screen about the size of a sheet of notebook paper. The recording and development process is continuous, so that the pilot, navigator, or other observer sees a slowly moving portion of a long strip of film which is automatically wound up on a roller in the machine. The roll of film is a permanent record which can be used for reference or later compared to other flight records. If desired, prints or other negatives can be made from the transparency roll.

High precision optics and advanced electronic techniques went into the development of the radar strip recorder. The optical system includes mechanical adjustments which enable the pilot or observer to manually correct the machine for airplane wind drift. This wind drift adjustment results in a rectilinear record which maps the ground accurately along perpendicular axes, regardless of wind conditions at high altitude. In addition, special electronic circuits built into the recorder automatically correct for distortions due to the altitude of the aircraft.

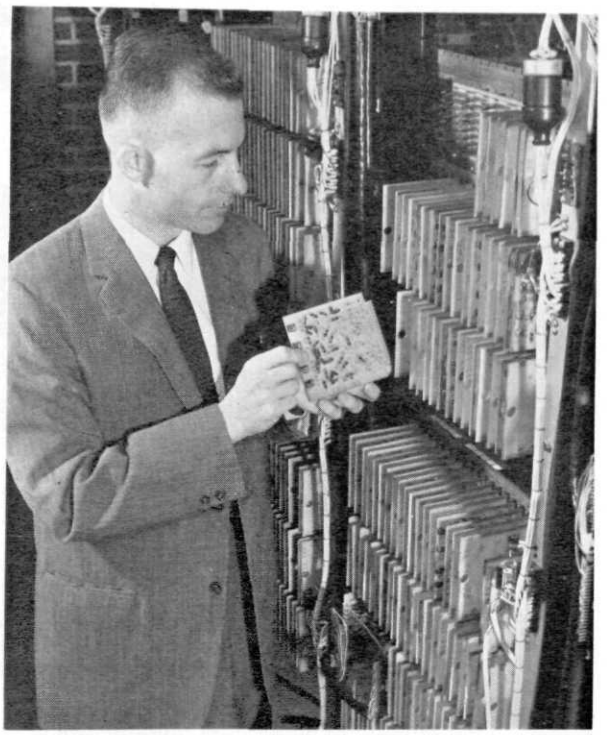
Working equally well day or night, above clouds or in clear weather, the radar strip recorder promises to revolutionize air navigation by combining the accuracies of radar, the convenience and utility of photography and the speed of electronics.

Tracking System To Report 72 Targets In Three Dimensions

A radar track-while-scan system, which automatically tracks up to 72 targets in three dimensions, has been developed. This is a hybrid digital-analog system in which error sensing is a completely analog function accomplished under the control of digital computer which computes, controls and displays information on all 72 tracks. The result is a reduction of equipment required and an increase in accuracy of track over ranges considerably in excess of other types of tracking systems currently undergoing test.

Unique in the industry is the incorporation of three-dimensional information in the track-while-scan system, directly from a single radar source. In addition, individual monitors for each track are provided, and automatic track fault alarms permitting one operator to successfully monitor 12 tracks.

The computer components are made up of plug-in package units, using printed circuits and all static components. Approximately 1500 transistors and 11,000



A hybred digital-analog system in which error-sensing is under the control of a digital computer.

diodes are employed in its various circuits. Magnetic elements are used where presently available transistors do not have the necessary power handling capabilities. All units of the system are broken down into 200 lb. pieces, each having their own transit cases.

The computer has been in operational test for about ten months. Excellent operation results have been attained.

Cooling Aircraft Electronic Equipment

Cooling of electronic equipment aboard high-speed aircraft is a major problem. Two choices are available to designers of electronic equipment; either build the cooling system for the equipment, or build the equipment so that it can withstand high ambient temperature operations. The unit being placed in an oven for tests is designed for operation at 400 degrees F. This requires use of special high-temperature components, along with special construction techniques with heat-transfer paths optimized for maximum heat conduction. For example, ordinary solder will melt at this temperature. Consequently, a special high-temperature solder is used, and is melted with a device that almost amounts to a junior-sized spot welder.

The device shown is a radar coupler, a unit that couples a fire-control system to the automatic pilot control system, to automatically zero an airplane in on its target. This is a redesign of a standard coupler, and the performance of this unit will be compared

(Continued on Page 52)

There's an engineer's world at Western Electric

As THE world's largest manufacturer of communications equipment our continued progress depends greatly on our engineers. They have a key role in the production of some 50,000 types of apparatus and component parts that Western Electric makes in a given year.

● To our engineers falls the monumental task of developing manufacturing operations and of planning the installation of telephone central office equipment across the nation. They devise the new machines, tools and methods needed to do our job. They also shoulder the major responsibilities in carrying out the defense contracts the government has asked us to take over – major projects like the Nike guided missile system and SAGE, the continental defense system.

● In the course of their technical work, engineers participate in such broad managerial functions as production, merchandising, installation, and many others. What's more, we have a record of promotions from within. It's not surprising, therefore, that fifty-five percent of the college graduates in our upper levels of management have engineering degrees.

● Naturally we do everything possible to encourage and speed the professional development of our engineers. Just recently, for example, we inaugurated a full-time off-the-job Graduate Engineering Training Program at special training centers, a program with few parallels in American industry.

● The new engineer moves into the first phase of this program, **Introduction to Western Electric Engineering,** four to six months after he joins us and devotes nine weeks of study to such technical subjects as communications systems, military electronic systems, product design principles. He takes part in the second phase, **General Development,** after the first year on the job. In this phase he devotes nine weeks to courses in human relations, semantics, engineering statistics, electronics, measurements and instrumentation, systems circuit analysis. The third phase, **Advanced Development** (4 weeks per year), is available to selected engineers and is geared to the individual to help develop his creative engineering abilities; goes deeply into such subjects as magnetics, computer applications, electronic switching, radar fundamentals, feedback control systems and technical paper writing.

● Besides this company-wide program, a number of our divisions offer individual engineering courses in their own specialties. We also sponsor a Tuition Refund Plan for out-of-hours study at nearby colleges. Open to all employees, this plan helps our engineers study for advanced degrees at Company expense.

● Truly there's an engineer's world here at Western Electric . . . one in which engineers in every field of specialization can expect to grow.

OPPORTUNITIES FOR ENGINEERING GRADUATES

(Supervisory and administrative opportunities exist in each field)

Analysis for manufacturing operations:
Machine and tool requirements–M.E., E.E.; Space requirements–M.E., I.E.; Test facility requirements–E.E.; Personnel requirements–I.E.; Electric power, light and heat requirements–E.E.; Raw material requirements–Chem. E., Met. E., Phy. Sc.; Procedures and processes–M.E., I.E.; Time and Motion Studies–I.E.; Investigation of manufacturing difficulties–M.E.; Quality control–M.E., E.E.

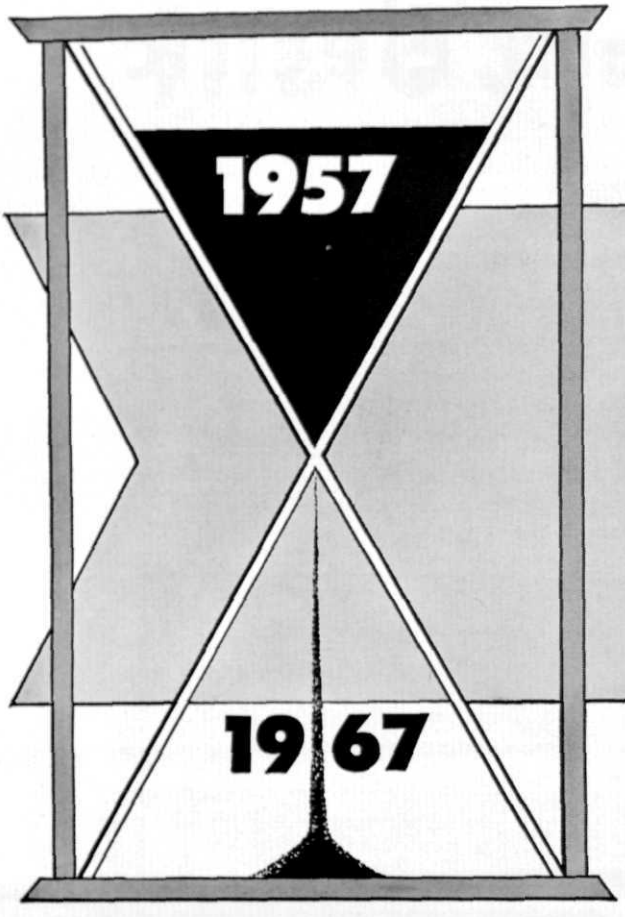
Planning telephone central offices:
Equipment requirements – E.E.; Power and cable requirements–E.E.

Development and design:
New machines and tools–M.E., E.E.; Material handling methods–M.E., I.E.; New equipment and processes–M.E., E.E.; Repair shop methods–M.E.; Testing facilities–E.E.; Testing methods–E.E.; Job evaluation studies–I.E.; Wage incentive studies–I.E.; Production control studies–I.E.; Improved chemical processes–Chem. E., Met. E., Phy. Sc.; New application for metals and alloys–Chem. E., Met. E., Phy. Sc.; Raw material test procedures–Chem. E., Met. E., Phy. Sc.; Service to military on electronic devices–E.E.

For further information write: Engineering Personnel, Room 1030, 195 Broadway, New York 7, N. Y.

Western Electric
MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

● Western Electric has major manufacturing plants located at Chicago and Decatur, Ill., Kearny, N. J., Baltimore, Md., Indianapol Ind., Allentown, Pa., Winston-Salem, N. C., Buffalo, N. Y., North Andover, Mass. Distribution Centers in 30 cities. Installati headquarters in 16 cities. General headquarters: 195 Broadway, New York, N. Y. Also Teletype Corporation, Chicago 14, Illino



10 years from now *will you be proud of your decision?*

The right decision now, at the launching of your career, can do much to influence your success.

Pittsburgh Plate Glass Company has a host of fine young men who are holding responsible positions in the PPG organization. Ten years ago, many of them were faced with the same decision that now faces you: "Which company shall I select?"

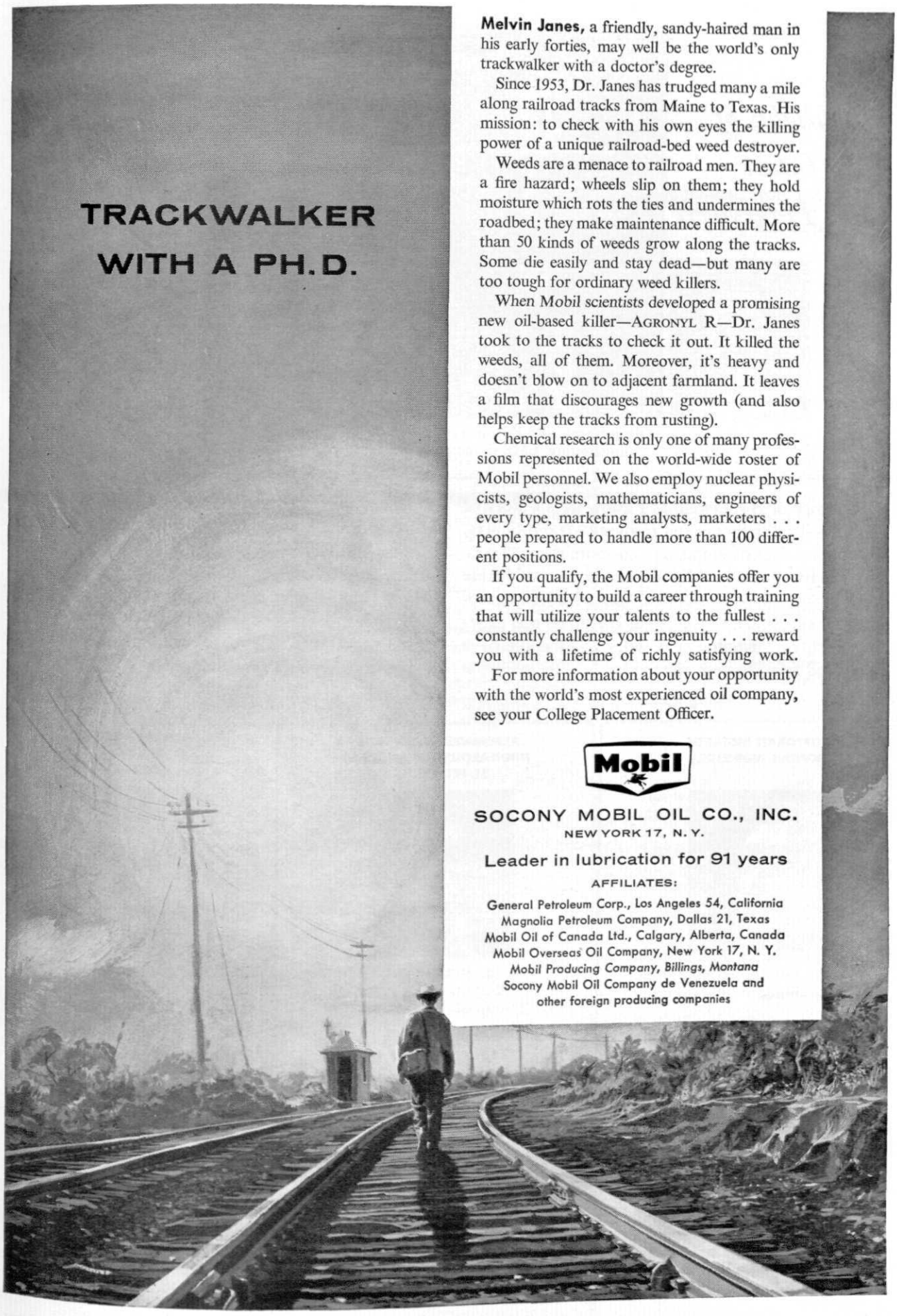
They chose PPG because it offers unlimited opportunity. PPG has never stopped expanding or growing in its 73 years of existence. Its markets are constantly increasing. PPG's management is progressive. It seeks men who can grow with the company . . . men who can take over responsibilities. In PPG, it isn't necessary to wait for a man's retirement or death before you move up in the ranks. Opportunities are opening up all the time in all of its important divisions: Paint, Glass, Chemicals, Brushes, Fiber Glass.

This is your year of decision. We invite you to look into Pittsburgh Plate Glass Company. To help you become better acquainted with PPG, we suggest you get a copy right away of the booklet entitled, "Toward New Horizons with Pittsburgh Plate." Ask your placement officer for a copy or write directly to the Pittsburgh Plate Glass Company, General Personnel Director, One Gateway Center, Pittsburgh 22, Pennsylvania.

PAINTS · GLASS · CHEMICALS · BRUSHES · PLASTICS · FIBER GLASS

PITTSBURGH PLATE GLASS COMPANY

345 PLANTS, MERCHANDISING BRANCHES, AND SALES OFFICES LOCATED IN 250 CITIES



TRACKWALKER WITH A PH.D.

Melvin Janes, a friendly, sandy-haired man in his early forties, may well be the world's only trackwalker with a doctor's degree.

Since 1953, Dr. Janes has trudged many a mile along railroad tracks from Maine to Texas. His mission: to check with his own eyes the killing power of a unique railroad-bed weed destroyer.

Weeds are a menace to railroad men. They are a fire hazard; wheels slip on them; they hold moisture which rots the ties and undermines the roadbed; they make maintenance difficult. More than 50 kinds of weeds grow along the tracks. Some die easily and stay dead—but many are too tough for ordinary weed killers.

When Mobil scientists developed a promising new oil-based killer—AGRONYL R—Dr. Janes took to the tracks to check it out. It killed the weeds, all of them. Moreover, it's heavy and doesn't blow on to adjacent farmland. It leaves a film that discourages new growth (and also helps keep the tracks from rusting).

Chemical research is only one of many professions represented on the world-wide roster of Mobil personnel. We also employ nuclear physicists, geologists, mathematicians, engineers of every type, marketing analysts, marketers . . . people prepared to handle more than 100 different positions.

If you qualify, the Mobil companies offer you an opportunity to build a career through training that will utilize your talents to the fullest . . . constantly challenge your ingenuity . . . reward you with a lifetime of richly satisfying work.

For more information about your opportunity with the world's most experienced oil company, see your College Placement Officer.

Mobil

SOCONY MOBIL OIL CO., INC.

NEW YORK 17, N. Y.

Leader in lubrication for 91 years

AFFILIATES:

General Petroleum Corp., Los Angeles 54, California
Magnolia Petroleum Company, Dallas 21, Texas
Mobil Oil of Canada Ltd., Calgary, Alberta, Canada
Mobil Overseas Oil Company, New York 17, N. Y.
Mobil Producing Company, Billings, Montana
Socony Mobil Oil Company de Venezuela and other foreign producing companies

Highlights of your future with Honeywell

Glenn Seidel, Vice President in Charge of Engineering, BME, Minnesota, '36

The many

People, Places, Projects

"The story of Honeywell, as I know it, is a story of growth—from a thermostat to over 12,000 products; from a handful of employees to more than 30,000; from a basement in Minneapolis to a world-wide organization. For Honeywell, world leader in automatic controls, has expanded as rapidly as this exciting field. And employment, sales and income have increased steadily year after year.

"The future is even more challenging. Planned diversification puts Honeywell in such new fields as office and factory automation, process control, plastics, atomic energy, electronics, missiles and satellites. Whole new areas of opportunity are waiting for today's engineering graduates in each of Honeywell's divisions. Here are some division representatives to tell you about them."

CORPORATE RESEARCH
HOPKINS, MINNESOTA

Dr. Finn Larsen, PhD,
Iowa State, 1948
Director of Corporate Research

"Our Research Center is a focal point for Honeywell's over-all research program. Here, Honeywell scientists and engineers conduct basic research into areas such as Heat Transfer, Metallurgy, Thermodynamics, Solar Energy, Radioactivity, Electronics, etc. This research supplements other research carried on by Honeywell's separate divisions, plays an important part in the company's development program. There's certainly plenty of opportunity for the imaginative scientist or engineer here."

AERONAUTICAL DIVISION
MINNEAPOLIS; LOS ANGELES; ST. PETERSBURG

E. H. Olson, BA,
U. of Minnesota, 1937
Director of Aero Engineering

"In the past six years our engineering force has trebled through our expansion into such advanced fields as inertial guidance, jet engine control, computers, fire control and bombing systems, fuel management, and precision gyros. We have developed and produced more autopilots than any other manufacturer, and built the reference system for the Earth Satellite Rocket. The diversity and wide acceptance of our products indicates the boundless opportunities we have for engineers and scientists."

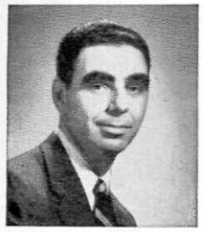
ORDNANCE DIVISION
MINNEAPOLIS; SEATTLE; MONROVIA, CALIF.

Clyde A. Parton, BSEE,
U. of Alabama, 1940
Director of Ordnance

"Here at Honeywell Ordnance we're putting all our experience and imagination into maintaining America's technological lead. We work in such new fields as infrared sensors, missiles, servo mechanisms, new types of turret control systems. We've developed proximity and mechanical fuzes, antiaircraft fire control systems, underwater warfare equipment and other products in widely diversified fields. Our more advanced products, naturally, are still classified, but they offer outstanding challenges and opportunities."

sides of Honeywell

BOSTON DIVISION
BOSTON, MASSACHUSETTS



George J. Schwartz, MIT, '42
Vice President
and General Manager

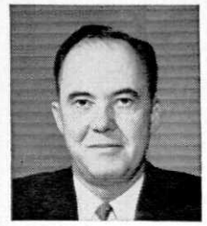
"Our Honeywell division is making the brains of automation. We turn out such small, but complex and important components as gyros, flight controls, servos, synchros, electronic amplifiers and magnetic controls. Engineering projects now in progress point to many new products and applications from our division, including development of new transistor applications. Opportunities? They're here by the score."

MICRO SWITCH DIVISION
FREEPORT, ILLINOIS

R. W. Pashby, BSEE,
U. of Illinois, 1932
Director of Product Research

"Products of our Micro Switch Division help giant aircraft land safely, interlock machine tool operations, feed instructions into electronic computers. These are just a few of their applications—applications which are growing year after year. The development of these precision switches requires high engineering skill, puts a premium on your imagination, offers you tremendous opportunities for advancement and recognition."

RESIDENTIAL, RETAIL AND COMMERCIAL DIVISION
MINNEAPOLIS, MINNESOTA



H. T. Sparrow, BSEE,
U. of Minnesota, 1930
Director of Product Research

"We specialize almost entirely in comfort control. Typical of the advances our division has made recently is the Supervisory Data Center* which enables one man in one location to read and control the temperature of every room in a large building. Our other new products include Air Blenders, Zone Control Systems, Electronic Air Cleaners and many more. Our business is a rewarding one for engineers!"

INDUSTRIAL INSTRUMENTS DIVISION
PHILADELPHIA, PENNSYLVANIA

C. L. Peterson, BSEE,
U. of California, 1924
Vice President and Gen. Mgr.

"No company in the fast growing instrumentation field is growing faster than Honeywell's Industrial Instruments Division. There's practically no physical quantity under the sun that Honeywell instruments cannot measure, and, in most cases, control, from open hearth furnaces to complex processes still on the designer's boards. Finding new applications and designing the instruments, computers and read-out devices of tomorrow, offer you a fascinating present and an unlimited future."

HEILAND DIVISION
DENVER, COLORADO

S. A. Keller, BS,
U. of Pennsylvania, 1941
General Manager

"This division of Honeywell manufactures two different classes of products: Instruments and Photographic Equipment. Our recording oscillographs—typified by the radically new 'Visicorder'—are used in a wide range of industrial, scientific, and military applications. Our famous 'Strobonar' electronic flash equipment is used by 5 out of 6 newspapers and all important press services. The variety of products and markets of the Heiland Division promises an ever-expanding field that challenges young engineers."

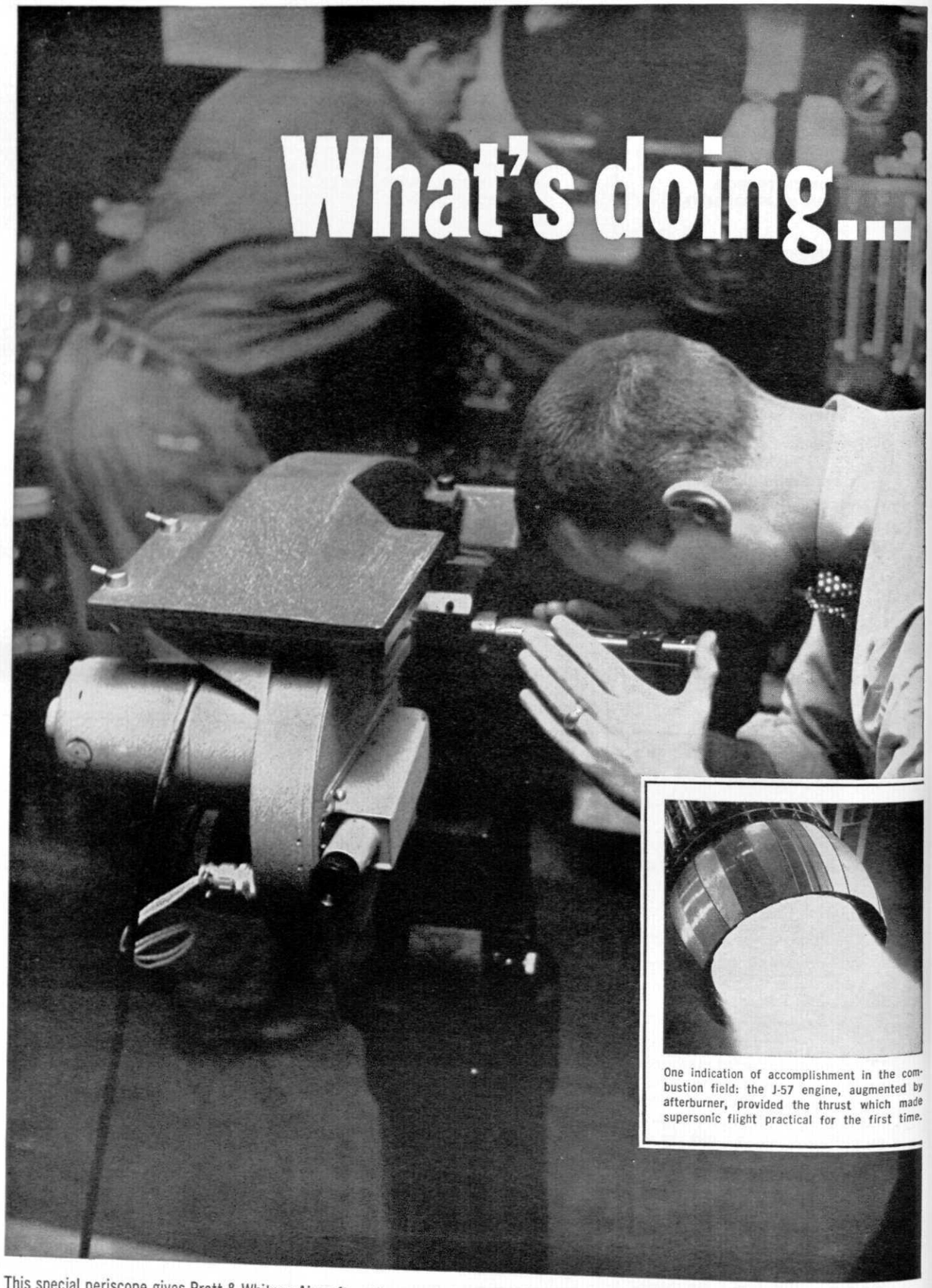
This is Honeywell: more than 12,000 highly engineered products, 14 separate divisions, locations sprinkled throughout this country and abroad, projects by the hundreds on the outposts of every major technological advance. It's a land of opportunity for the engineering graduate. Want to learn more about it? Send for our free booklet, "Your Curve of Opportunity." Write to:

R. L. Michelson, Dept. TC29C
Personnel Administrator
Minneapolis-Honeywell Reg. Co.
Minneapolis 8, Minnesota

Honeywell

H HONEYWELL *First in Controls*

*Trademark



One indication of accomplishment in the combustion field: the J-57 engine, augmented by afterburner, provided the thrust which made supersonic flight practical for the first time.

This special periscope gives Pratt & Whitney Aircraft engineer a close-up view of combustion process actually taking place within the afterburner of an advanced jet engine on test. What the engineer observes is simultaneously recorded by a high-speed motion picture camera.

at Pratt & Whitney Aircraft in the field of Combustion

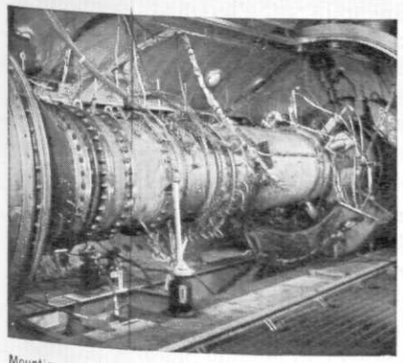
Historically, the process of combustion has excited man's insatiable hunger for knowledge. Since his most primitive attempts to make use of this phenomenon, he has found tremendous fascination in its potentials.

Perhaps at no time in history has that fascination been greater than it is today with respect to the use of combustion principles in the modern aircraft engine.

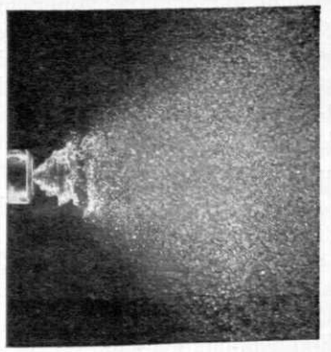
At Pratt & Whitney Aircraft, theorems of many sciences are being applied to the design and development of high heat release rate devices. In spite of the apparent simplicity of a combustion system, the bringing together of fuel and air in proper proportions, the ignition of the mixture, and the rapid mixing of burned and unburned gases involves a most complex series of interrelated events — events ocurring simultaneously in time and space.

Although the combustion engineer draws on many fields of science (including thermodynamics, aerodynamics, fluid mechanics, heat transfer, applied mechanics, metallurgy and chemistry), the design of combustion systems has not yet been reduced to really scientific principles. Therefore, the highly successful performance of engines like the J-57, J-75 and others stands as a tribute to the vision, imagination and pioneering efforts of those at Pratt & Whitney Aircraft engaged in combustion work.

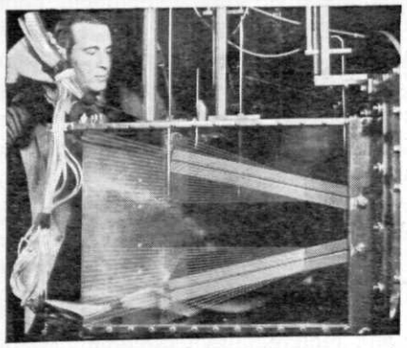
While combustion assignments, themselves, involve a diversity of engineering talent, the field is only one of a broadly diversified engineering program at Pratt & Whitney Aircraft. That program—with other far-reaching activities in the fields of instrumentation, materials problems, mechanical design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



Mounting an afterburner in a special high-altitude test chamber in P&WA's Willgoos Turbine Laboratory permits study of a variety of combustion problems which may be encountered during later development stages.



Microflash photo illustrates one continuing problem: design and development of fuel injection systems which properly atomize and distribute under all flight conditions.



Pratt & Whitney Aircraft engineer manipulates probe in exit of two-dimensional research diffuser. Diffuser design for advanced power plants is one of many air flow problems that exist in combustion work.

World's foremost designer and builder of aircraft engines

PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

EAST HARTFORD 8, CONNECTICUT

CLUBS AND SOCIETIES

A.S.C.E.

The American Society of Civil Engineers is open to all Civil Engineers, sophomores and up. Freshmen can be visiting members only. The meetings consist of general business, then a program, usually a speaker or a movie.

One of the activities that has been planned for this fall term is a joint meeting with the Senior Section of the A.S.C.E.

Officers of the chapter for the year 1957-1958 are:

President.....*Stanley Badelt*
Vice President.....*Dick Carr*
Secretary.....*Darrell Hall*
Treasurer.....*Ken Minto*

Faculty Advisors:

Professor.....*A. H. Leigh*
Professor.....*L. V. Northstine*

A.S.M.E.

The student branch of the American Society of Mechanical Engineers is open for membership to any undergraduate or graduate student registered in a regular course leading to a degree in engineering.

A.S.M.E. is composed of more than 50,000 members, including over 11,000 student members. Student sections are maintained at over 140 colleges and universities throughout the United States and Canada.

An immediate benefit that a student will receive when joining A.S.M.E. is the monthly issue of Mechanical Engineering. Also as a student member you will receive a student pin, membership card and coupons which entitle you to five technical papers free of charge. In addition members in their senior year will receive "The Unwritten Laws of Engineering" and prior to graduation, a copy of the "Professional Guide for Junior Engineers."

This year the bi-weekly meetings will be held on Wednesday nights, in room 111 Olds Hall, at 7 P.M. Activities for the year include field trips, and a joint meeting with the senior section.

Officers of the chapter for the year 1957-1958 are:

President.....*Gayle Gardner*
Vice President.....*Robert Klett*
Secretary.....*Mary Joan Lichty*
Treasurer.....*John Talbot*
Faculty Advisor.....*Dr. G. H. Martin*

Chi Epsilon

Chi Epsilon is the only National civil engineering honorary. It was founded at the University of Illinois in 1922. Chi Epsilon has 48 chapters. The local MSU chapter was founded in 1951.

Chi Epsilon's purpose is to recognize and honor the outstanding men in the field of civil engineering. Its membership is selected from the upper one-third of the junior and senior civil engineering classes. The members are selected for their scholarship, character, practicability and sociability.

Chi Epsilon's activities include tutoring in their field, participation in the engineering exposition, and social functions for its members.

The officers of Chi Epsilon are:

President.....*Emory Garlick*
Vice President.....*Don Stroud*
Secretary.....*Walter Meinert*
Treasurer.....*Murl Webster*
Transit Editor.....*Rassie Carswell*
Faculty Advisor.....*Professor Leo. V. Nothstine*

AIEE-IRE

The American Institute of Electrical Engineers and the Institute of Radio Engineers are National Professional societies for electrical engineers. A joint combination of these two societies form the student chapters. The student branch of the AIEE-IRE has local chapters in the United States, Canada, and South America. The MSU chapter was founded in 1948.

Any electrical engineer or anyone interested who is a student at MSU may join the AIEE-IRE. Its meetings are held on Tuesday nights during the school term.

The AIEE-IRE gives various aspects of Electrical Engineer which are recent or not available in classes, acquaints students with industrial personnel, and industrial proceedure by tours, participates in the engineering exposition and provides social activity for its members.

The officers of AIEE-IRE are:

Chairman.....*Richard Plugge*
Vice Chairman.....*Robert Riddle*
AIEE Secretary.....*J. Medford*
Treasurer.....*Richard Tubbs*
Faculty Advisors.....*Harry Hedges*
E. O. Ebert

(*Continued on Page 48*)

You want a job

PLUS

. . . plus the chance to get ahead

. . . plus the chance for recognition

. . . plus the chance to keep learning

As a leader in many fields, Union Carbide offers a handsome assortment of plus factors with its jobs. It's a top producer of petrochemicals—and U. S. output of petrochemicals has roughly doubled every five years since World War II. It's a leading producer of oxygen—and new steelmaking methods use such vast quantities of oxygen that consumption in '57 is expected to be double that of '55. And these are only two of the expanding fields in which Union Carbide is a leader.

In terms of jobs with plus, this growth means Advancement with a capital "A." As our markets expand, we need more people to handle the development, production, and sale of our products.

Representatives of Divisions of Union Carbide Corporation, listed below, will be interviewing on many campuses. Check your placement director, or write to the Division representative. For general information, write to V. O. Davis, 30 East 42nd Street, New York 17, New York.

BAKELITE COMPANY Plastics, including polyethylene, epoxy, fluorothene, vinyl, phenolic, and polystyrene. J. C. Older, River Road, Bound Brook, N. J.

ELECTRO METALLURGICAL COMPANY Over 100 ferro-alloys and alloying metals; titanium, calcium carbide, acetylene. C. R. Keeney, 137—47th St., Niagara Falls, N. Y.

HAYNES STELLITE COMPANY Special alloys to resist heat, abrasion, and corrosion; cast and wrought. L. E. Denny, 725 South Lindsay Street, Kokomo, Ind.

LINDE COMPANY Industrial gases, metal-working and treating equipment, synthetic gems, molecular sieve adsorbents. P. I. Emch, 30 East 42nd Street, New York 17, N. Y.

NATIONAL CARBON COMPANY Industrial carbon and graphite products. PRESTONE anti-freeze, EVEREADY flashlights and batteries. S. W. Orne, P. O. Box 6087, Cleveland, Ohio.

SILICONES DIVISION Silicones for electrical insulation, release agents, water repellents, etc.; silicone rubber. P. I. Emch, 30 East 42nd Street, New York 17. N. Y.

UNION CARBIDE CHEMICALS COMPANY Synthetic organic chemicals, resins, and fibers from natural gas, petroleum, and coal. W. C. Heidenreich, 30 East 42nd St., New York 17, N. Y.

UNION CARBIDE INTERNATIONAL COMPANY Markets UNION CARBIDE products and operates plants overseas. C. C. Scharf, 30 East 42nd Street, New York 17, N. Y.

UNION CARBIDE NUCLEAR COMPANY Operates Atomic Energy Commission facilities at Oak Ridge, Tenn., and Paducah, Ky. W. V. Hamilton, P. O. Box "P", Oak Ridge, Tenn.

VISKING COMPANY A pioneer in packaging—producer of synthetic food casings and polyethylene film. Dr. A. L. Strand, 6733 West 65th Street, Chicago, Ill.

GENERAL OFFICES—NEW YORK Accounting, Electronic Data Processing, Operations Research, Industrial Engineering, Purchasing. E. R. Brown, 30 East 42nd Street, New York 17, N. Y.

CLUBS AND SOCIETIES

(*Continued from Page 46*)

American Society of Ag Engineers

Any student that is enrolled in either the Agricultural Engineering or the Agricultural Mechanics curriculums is eligible for membership in the Michigan State branch of the American Society of Agricultural Engineers.

The student society is affiliated with the parent national society. Student members who belong to the National receive the National ASAE Journal.

The club usually holds its meetings on the second and fourth Tuesday of each month of the school year. We aim to have short business meetings. The outstanding part of our club meetings is the program that is held after the business meeting. In the past our programs have included such topics as Tornadoes, The Nebraska Tractor Test, Tractor Testing in Italy, and the Possibilities in Sales Engineering. We plan on having just as interesting programs throughout the year.

In June of 1957 the American Society of Agricultural Engineers held their National meeting at Michigan State University. The student club made the arrangements for the student National meeting to be held at the same time.

The club also had the responsibility of publishing the National ASAE Student Journal. Ike Sheppard, as editor of the Journal, was assisted by a very capable staff. This was our most outstanding activity for the year.

The club is planning a tour for sometime in winter term. We are also planning on attending the Michigan Section meetings of the ASAE to be held during winter and spring terms.

Our two advisors have been indispensible to us. They have been an inspiration to all of us. We are thankful for the cooperation given us by Mr. Beuchle and Mr. Wheaton.

OFFICERS

President ..... Burt Shepard

Vice-President ..... Clifford Van Vleit

Treasurer ..... Dick Bauman

Scribe ..... Gene White

Ag Council Representative ..... Lawerence Shedd

Engineering Council Representative Keith Robertson

American Society of Civil Engineers

The student with the qualifications of at least a Sophomore and majoring in Civil Engineering is invited to become a member of the Michigan State Chapter of the American Society of Civil Engineers. This opportunity is one gamble which excludes the possibility of loss. The finishing touches of a graduate engineer are supplied through the benefits gained in the Chapter. Since the Chapter is under the Senior Society, which is made up of men in the profession, many worthwhile contacts are made.

At present, the Chapter is made up of approximately one hundred members. It is general practice to have a meeting every other week. When the big red ASCE banner is seen in the corridor of Olds Hall, a meeting is scheduled for that evening. The only fees assessed are the annual dues.

These meetings include picnics, field trips, films, and get-togethers with the Senior Society. The main event of each year is the Joint Banquet which is held for the Senior Society. It is put on by the students and held on the campus.

The Chapter couldn't have two better men for faculty advisors than Prof. A. Leigh and Prof. L. Northstine. The contributions these men have made for the Chapter are far in excess of those necessary to do the job.

Chi Epsilon

Chi Epsilon fraternity was founded by a group of Civil Engineering students at the University of Illinois in 1922. Candidates for membership are judged on the basis of scholarship, character, practicality, and sociability. Chi Epsilon has forty-eight chapters at engineering schools all over the country.

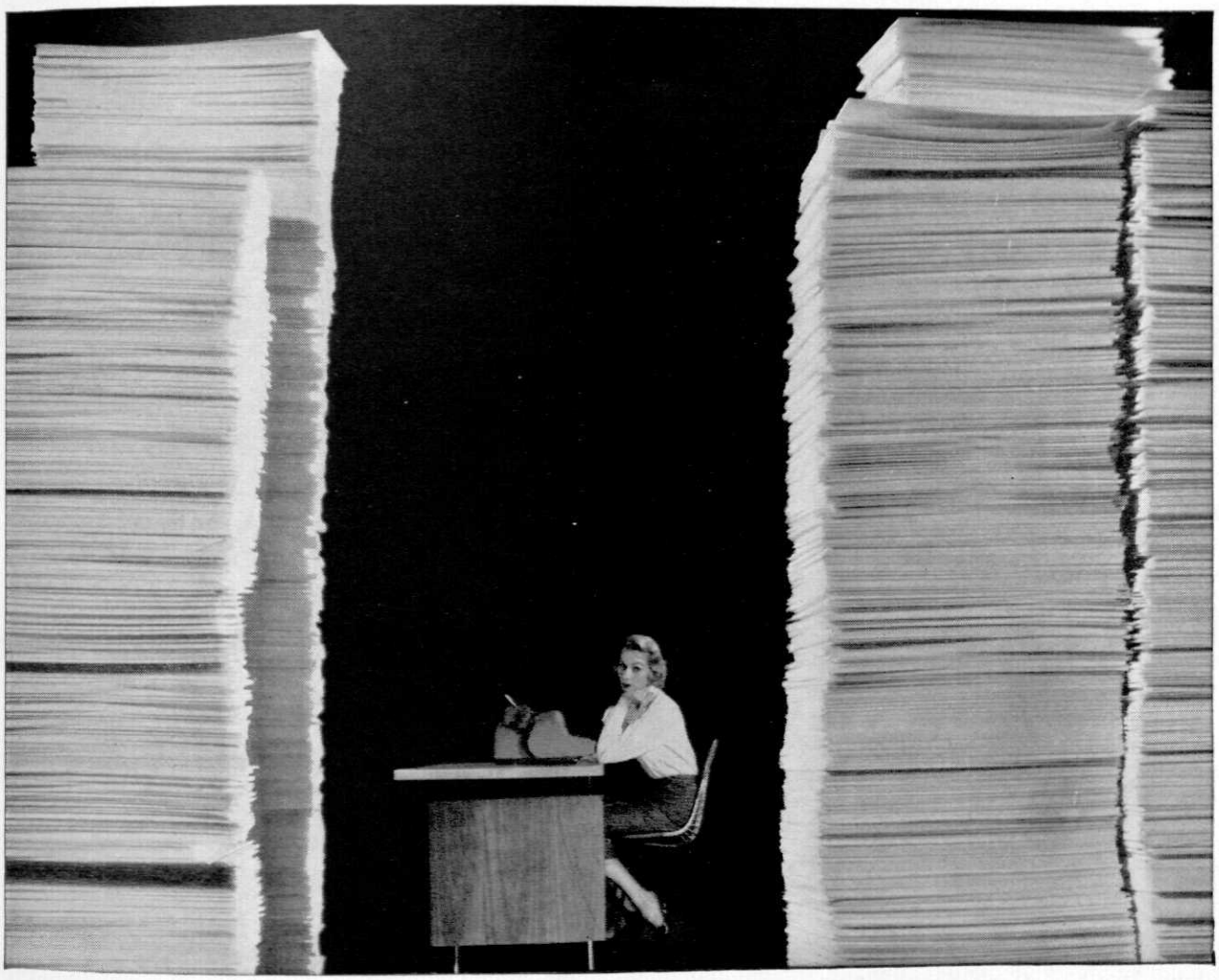
One of Chi Epsilons well known members is Dr. David B. Steinman, the designer of the Straits of Mackinac Bridge.

The Michigan State Chapter of Chi Epsilon was established in 1953. The local group has 36 members.

Many is the wolf who made a monkey of himself grabbing the wrong limb.

° ° °

Staff Positions
Open on the
Spartan Engineer
Apply Third Floor
Union Building



WORLD'S LARGEST ELECTRONIC BRAIN

RCA BIZMAC reduces weeks of paper work to seconds—cuts costs by millions!

In almost the twinkling of an eye, electronics handles calculations that would take any person days of work.

The newest – and largest – electronic "brain" (more accurately, electronic data processing system) is Bizmac, developed by RCA.

Bizmac is quickly becoming one of the most powerful allies of business and industry. It "reads," sorts, catalogs, analyzes, calculates, forecasts—reduces months of paper work to seconds—cuts costs by millions!

For insurance companies, Bizmac can keep its finger on millions of facts daily. It can help department stores keep split-second inventory control. And for the U. S. Army, it keeps track of literally *billions* of ordnance parts all over the world.

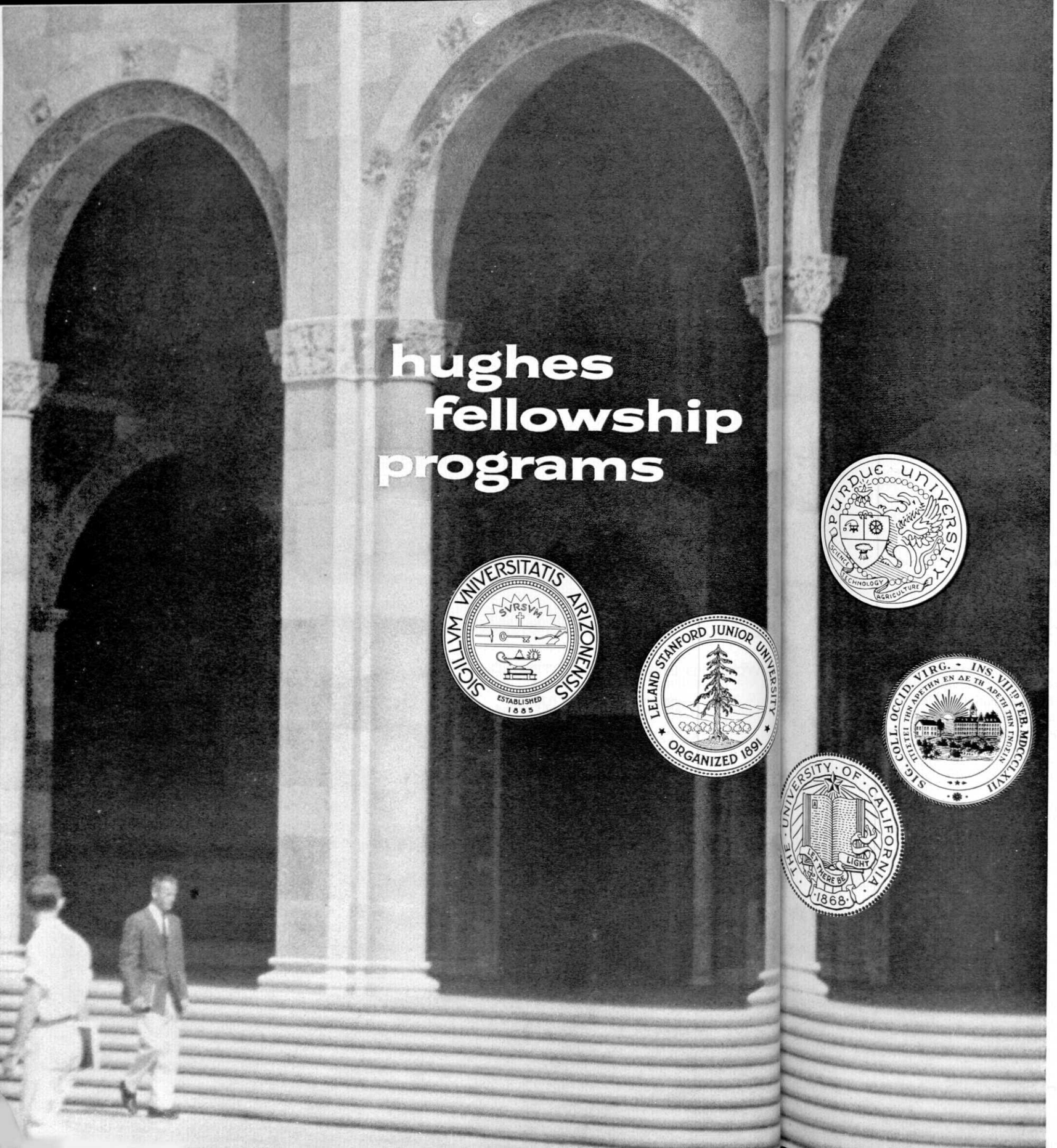
The leadership in electronic research that made Bizmac possible is inherent in all RCA products and services—to help make life fuller, easier, safer through "Electronics for Living." TMK(s) ®

WHERE TO, MR. ENGINEER? 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

ELECTRONICS FOR LIVING



hughes fellowship programs

howard hughes fellowships

Ten awards are open to candidates interested in studies leading to a Doctor of Philosophy or Doctor of Engineering degree or in conducting post-doctoral research.

Each Fellowship provides a cash award of not less than $2000 . . . a minimum salary of $2500 for summer or part-time work . . . up to $1500 for tuition, books, and research expenses . . . and moving and transportation costs. Eligibility is based on the completion of one year of graduate work in physics or engineering, and qualification for graduate standing at California Institute of Technology, University of California (Berkeley), or Stanford University. Application closing date: January 15, 1958.

master of science fellowships

One hundred awards are open to participants who will complete courses leading to the Master of Science degree within 2 academic years. Tuition, admission fee, and books will be provided. During the summer and part-time during the academic year they will have the opportunity to work with experienced Hughes scientists and engineers, while receiving salaries based upon their ability and technical experience.

Applicant must receive his B.S. degree during the coming year in Aeronautical Engineering, Electrical Engineering, Mechanical Engineering, or Physics. Participant may request his graduate school from the following six institutions: University of Southern California, UCLA, Stanford University, University of Arizona, Purdue University, or West Virginia University.

Write, specifying appropriate fellowship, to:
Office of Advanced Studies

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

Hughes Aircraft Co., Culver City, Calif.

(*Continued from Page 37*)

with the standard used with a cooling system, both size wise and performance wise. Biggest advantage of the high-temperature equipment is that some of the space that would be required by a cooling system can be conserved, and the added complexity of a cooling system is avoided.

Advance In Electronics Simplifies Design

Simpler radio and radar receivers will result from the inclusion of crystal filters. A technique known as multiple conversion has been used for years to get around certain filtering problems. Using a crystal filter in the circuit, multiple conversion becomes unnecessary. The result is a radio or radar receiver with fewer parts. The higher the frequency of the receiver, the more applicable this simplification becomes. And higher frequencies are the trend.

Primary applications of the highly reliable crystal filters will be in the field of mobile communication equipment such as military vehicular radios; walkie talkies; taxicab and industrial radios; military communications and navigation equipment in ships and airplanes; intercontinental radio systems, such as over-the-horizon scatter links; telephone systems; radar systems; and missile systems. Many other varied applications for crystal filters and associated devices are also foreseen, including a tiny button microphone which can be worn on the lapel and which will transmit messages or speeches several hundred yards without any connecting power sources. These same quartz crystal devices will make it easier to generate frequency-modulated signals for noise-free communication (better FM stations). Sources of other uses are forecast by electronic specialists who hail the new low-cost filters as one of the more important technological advances of this decade.

Radioisotopes have been described as "the first tool" by which engineers can record continuous changes in auto engine wear as they might occur in actual driving. This is done using radioactive iron piston rings to measure wear under "transient conditions."

These conditions approach what occurs when an automobile engine is in actual service with speed changes, quick accelerations, cold starting, stop-and-start city driving. They open a new field of engine wear research.

Although radioactive piston ring tests are not new, most earlier tests were confined to "steady state" operations with engines running at constant speed and load.

The recent tests varied from one minute to 20 hours. Radioactive wear particles accumulating in the lubricating oil were monitored with a scintillation detector, giving a measurement of the amount of gross ring wear.

The isotopes revealed that ring wear rate at the beginning of engine break-in is high and increases suddenly with each speed change. At higher engine speeds the rate decreases because the ring becomes better fitted to the cylinder wall with time.

Under typical cold starting conditions, the report said, the wear rate pattern indicated that 75 per cent of total wear during a two-hour run occurred during the first six minutes.

City driving indicates "that practically at no time are the engine speed and load constant," the researchers explained. "Transients are even produced by many drivers while waiting at stop lights."

"Because of these continuous changes under actual operating conditions," they said, "a better understanding is needed of wear produced by these transients under laboratory conditions."

They also pointed out that their findings were preliminary and as radioisotopes reveal more information about the causes of "transient" wear it will be possible to improve engine wear performance.

Dependable worldwide communications are now well on the way with the advent of a new type of radio and radar component. The device, called a high frequency crystal filter, makes it possible for more radio stations to transmit without overlapping and interfering with each other. At the same time, the new device greatly simplifies electronic equipment. High frequency crystal filters are to existing conventional filters what transistors are to vacuum tubes.

With more and more radio communication messages crowding the air-waves, allotment of frequency bands to various radio and radar needs has become an ever-increasing problem. Up to now, filters have presented serious bottlenecks to designers of high frequency radio systems. The higher one goes in frequency, the harder it becomes to design a workable filter.

However, mass-produced high frequency crystal filters represent a major breakthrough in the communications art. Now that crystal filters are commercially available, military and industrial designers have already started to work on new designs which will provide significantly better communications and navigation equipment.

One of the biggest headaches with radio receivers in the past has been the constant servicing necessary—particularly tuning and alignment. With crystal filters, a radio receiver does not normally have to be aligned once it is manufactured. The quartz crystals, each about one-half the size of a small silver coin, are extremely stable under severe environmental conditions. Abrupt temperature changes and repeated heavy shock and vibration do not adversely affect the crystal filters.

(*Continued on Page 63*)

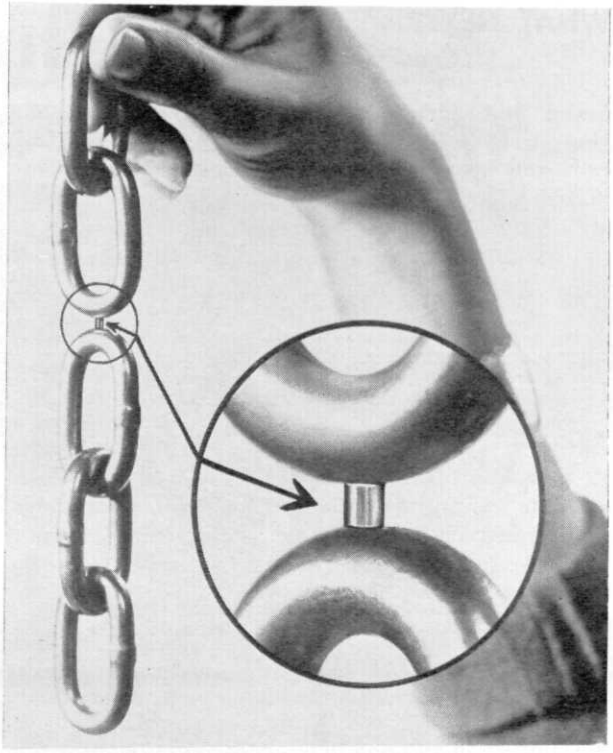
THE DEVELOPMENT MAGNETS

(Continued from Page 27)

Studies also reveal that the tighter these particles are to one another, the stronger the magnetic attraction. Likewise, the further apart these whiskers are, the greater the resistance to demagnetization. The announcement of the new type magnet indicates an advancement of great strides; however, there is much development yet to be accomplished. It was indicated that it will be several years before fine particle magnets will be commercially available—then, only in limited quantity.

There are possibilities that the fine particle approach may lead to magnets of undreamed-of power, for already these magnets in research testing are equal to the strongest magnets that are being produced commercially. It is believed that an increase ten times their present strength will be quite possible with fine particle magnets.

Lastly, this fine particle development permits the use of iron exclusively, relieving the need for using cobalt, which has been an important ingredient in the conventional type permanent magnets. Since cobalt is easily induced with radioactivity, its absence in permanent magnets will be beneficial in that ferromagnets can be used in nuclear reactors.



This tiny permanent magnet (see arrows) weighs only fifty-six ten thousandths of an ounce but is so powerful that it is shown supporting a chain 215 times its own weight.

WHAT NEXT?

(*Continued from Page 25*)

lieved that gibberellin works its wonders of stem elongation by stretching the size of individual plant cells and keeping them elastic longer. The increase in weight is due to the assimilation of larger amounts of carbon. Gibberellin is not thought of as a plant growth hormone, in spite of the fact that it acts similarly.

A small number of plants produce undesireable reactions to Ga treatment. It weakens the stems in grain crops, which causes lodging (the plant falls over). Some greenhouse-grown crops become spindly and turn light green if treated during the winter, due to a lack of sufficient light intensity. Intermediate and late season crops, such as tomatoes and all peppers, have their flowering and fruiting delayed from a few days to several weeks after treatment.

Present production is in the hands of the Northern Utilization Branch of the U. S. Agricultural Research Service, Peoria Illinois. Dr. F. H. Stodola, of the U.S.D.A., has done a great amount of work in the field and he prepared the first gram of pure Ga and gibberellic acid and sent out 100 samples to research workers. Recently commercial formulators have begun the production of large amounts of the chemical. Merck and Company of Rahway, N.J., was the first firm to make it commercially available under the name of "Gibrel," at $10 an ounce, which is enough to cover approximately an acre of land. G. B. Penick and Company and the Eli Lilly Company of Terre Haute, Indiana, are also in production. The Charles Pfizer and Company of Brooklyn, N.Y., plans to market gibberellic acid in a product called "Agristrim."

Gibberellin is applied to the plants at widely varying rates and in many forms. Gibrel is used as a spray and that prepared by the S. B. Penick and Company is in a completely soluble, powdered form. It is fairly stable as a dry form, but should be used within a week after mixing with water. Gibberellins may be developed in foliar sprays in combination with fertilizers, insuring a better balanced plant growth. According to R. G. Fuller, of Battella Memorial Institution, investigators for the Lilly Company, "It is readily absorbed by the roots, stems and leaves and moves rapidly through the entire plant. At very low dosage it evokes useful plant-growth responses, yet it appears to be relatively nontoxic to plants at much higher dosages."

Scientists can't decide what to try next with their new find. Many questions remain unanswered. Detailed studies of the effects on market, storage and nutritional quality of the affected plants, have not been performed. Treated food crops have not yet been cleared by the Food and Drug Administration of the U. S. Government. These are now undergoing tests which include the feeding of treated plants to experimental animals. Chances are, gibberellin is harmless to humans, since some plants are believed to produce it anyway. As yet, there is no evidence proving otherwise.

The researchers want to make sure Ga has no effect on future generations of plants, although past tests have resulted in normal descendents.

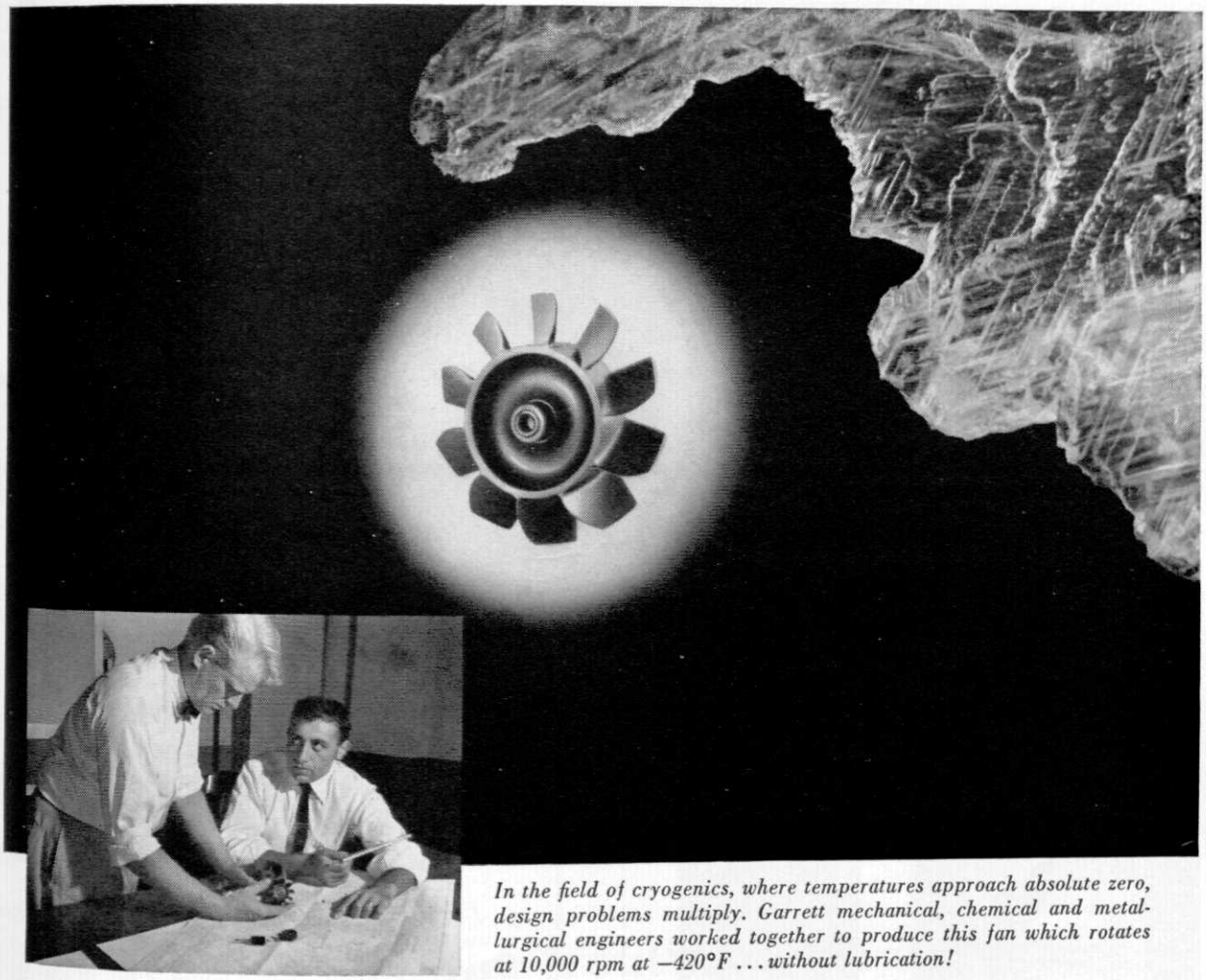
Much laboratory, greenhouse, and field testing is needed before the full power of gibberellins will be realized. By that time, ample supplies will be available at a lower cost, making their use profitable.

Like so many modern scientific discoveries, gibberellin seems to be a fairy tale come true. Just what dreams and needs it will fulfill, depends on the imagination and foresight of the human mind. It is likely, however, that you and I, no matter who we are, will in some way feel a stir of the breeze created by the storm of enthusiam over this new chemical.

JUDY SIMONS

Judith Lynne Simons, author of "What Next" is from Battle Creek, Mich., a senior in Floriculture, a member of the Floriculture Forum and Pi Alpha Xi, national floricultural and horticultural honorary.

Maximum results from a college education...



In the field of cryogenics, where temperatures approach absolute zero, design problems multiply. Garrett mechanical, chemical and metallurgical engineers worked together to produce this fan which rotates at 10,000 rpm at −420°F . . . without lubrication!

Education is the springboard for your future. Couple it with the proper engineering experience, such as you receive at Garrett, and you have the ingredients for a successful career in engineering fields which will be expanding for years.

At Garrett, specific opportunities in aircraft, missile and technological fields include: system electronics; computers and flight instruments; gas turbine engines and turbine motors; prime engine development; cryogenic and nuclear systems; pneumatic valves; servo control units and air motors; industrial turbochargers; air conditioning and pressurization and heat transfer.

In addition to direct assignments, a 9-month orientation program is available to aid you in selecting your field of interest. This permits you to survey project, laboratory and administrative aspects of engineering at Garrett. With company financial assistance you can continue your education at outstanding universities located nearby.

Project work is conducted by small groups where the effort of each individual is more quickly recognized and where opportunities for learning and advancement are greatly enhanced. For complete information, write to Mr. G. D. Bradley.

THE GARRETT CORPORATION

9851 S. SEPULVEDA BLVD., LOS ANGELES 45, CALIFORNIA

DIVISIONS: AIRESEARCH MANUFACTURING, LOS ANGELES • AIRESEARCH MANUFACTURING, PHOENIX • AIRSUPPLY
AIRESEARCH INDUSTRIAL • REX • AERO ENGINEERING • AIR CRUISERS • AIRESEARCH AVIATION SERVICE

MISTIC

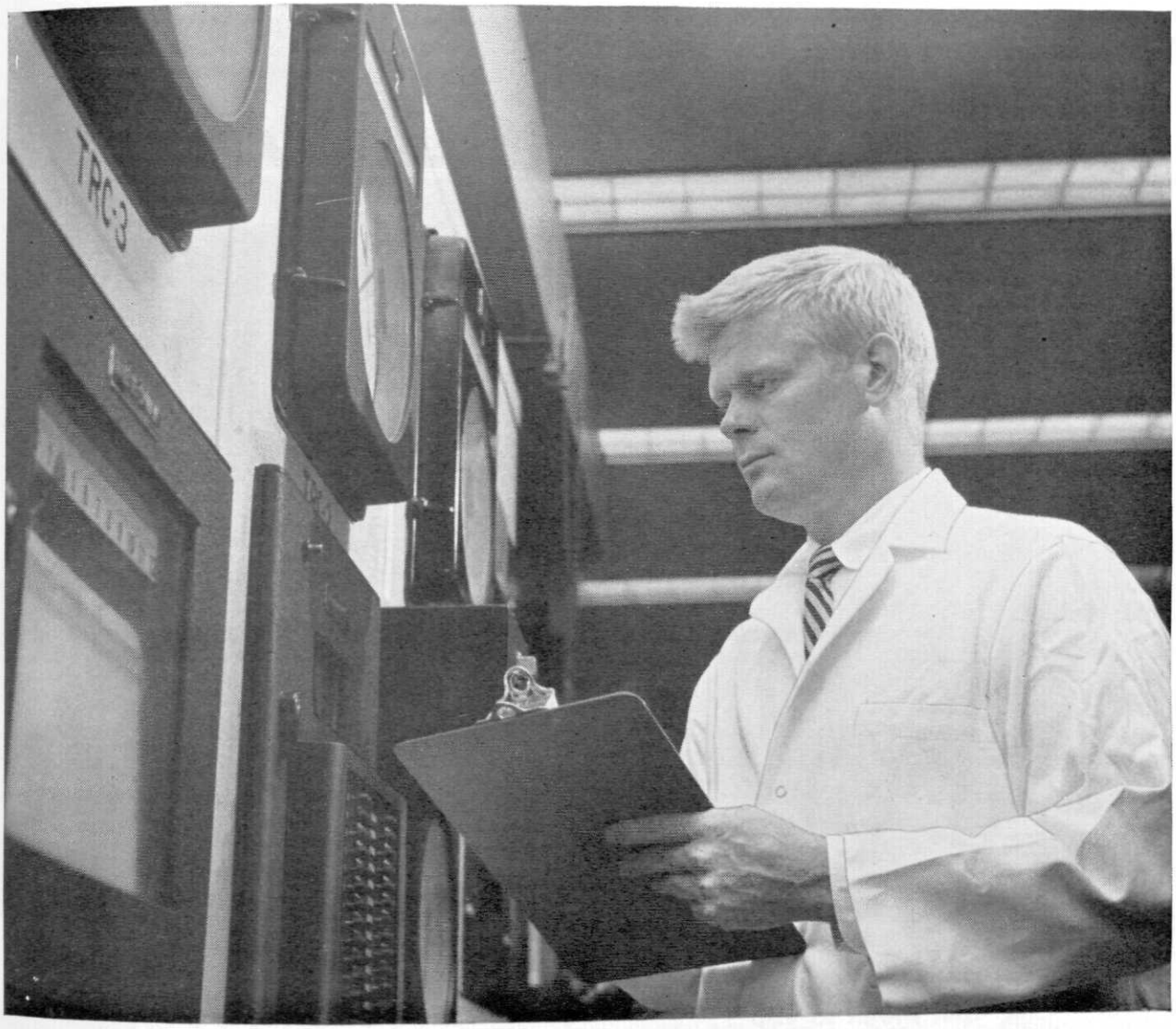
(*Continued from Page 19*)

is the translation from a foreign language into some base language. A dictionary of foreign language words and their equivalents in a base language can be set up in a machine with the mechanical translation consisting of translation via a printer, one word at a time. The only limit seems to be in the enormous size of vocabulary. A limited vocabulary of scientific jargon would aid translation of research papers.

A somewhat surprising application of automatic digital calculators is that of opponent in various games. Possibly the most elementary type of play for the machine is typified by the game of two-handed whist. The machine can be set for card values by code, and the machine can receive a dealt hand.

The latest development in the field of computers is a portable machine which weighs 400-500 lbs. (The Mistic weighs about one ton.) But the problem of power source has not been solved yet, while the large machines can use regular voltage.

Maybe someday the schoolboy won't have to worry about math homework, if Dad can afford a computer. Then too, maybe Dad will be able to calculate the stock market risk and race track possibilities.



Pushing back the frontiers...in chemistry

Exploring new frontiers is still a pretty exciting business, especially in the great scientific and research centers like the Whiting Laboratories of Standard Oil Company. Here men like Dr. Omar Juveland are engaged in important exploratory work such as the search for new and improved catalysts for use in high polymer chemistry. In the photograph, Dr. Juveland is recording data on a polymerization process taking place in this research area.

Dr. Juveland is one of the group of young scientists in Standard's Hydrocarbon and Chemicals Research Division. Born in Lake Mills, Iowa, he did his graduate work in organic chemistry at the University of Chicago. He received his BS in chemistry from St. Olaf College, Northfield, Minnesota, in 1950. He is a member of Phi Beta Kappa, Sigma Xi, and the American Chemical Society.

Busy young men like Dr. Juveland have found opportunity and work to their liking in the Standard Oil Laboratories at Whiting, Indiana. They share in the progress and accomplishment which contribute so much to the technical advancement and improvement required by America's expanding economy.

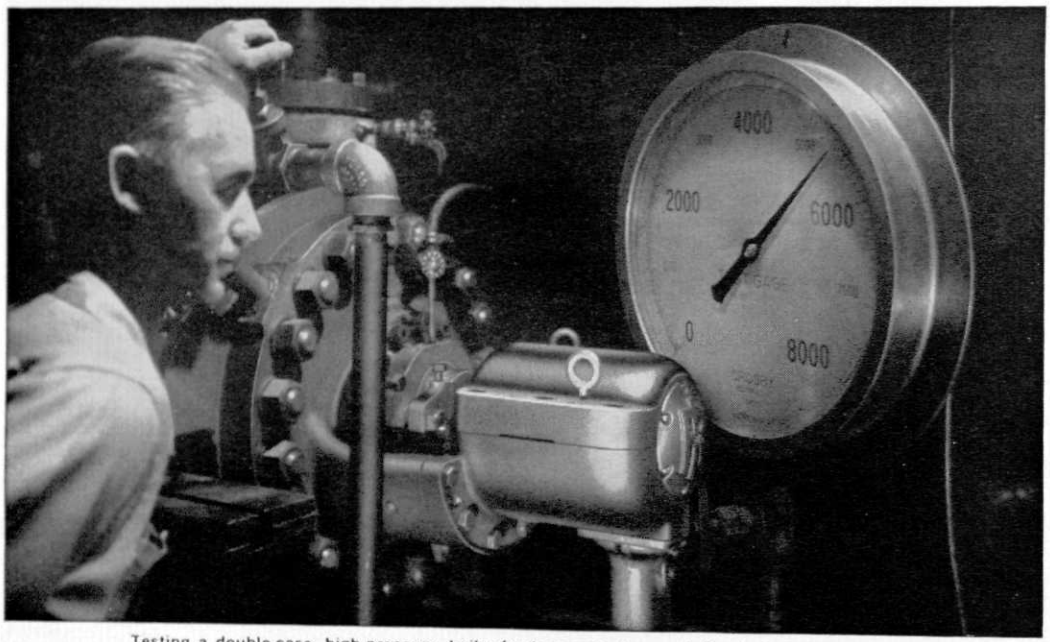
Standard Oil Company

STANDARD

910 South Michigan Avenue, Chicago 80, Illinois

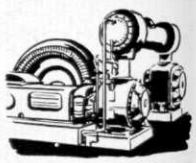
YOUR LEADERSHIP CAREER

with INGERSOLL-RAND



Testing a double-case, high-pressure, boiler-feed pump in Ingersoll-Rand's hydraulic laboratory. Pumps of this type feed hot water into steam boilers at pressures up to 6500 psi.

also means LEADERSHIP in

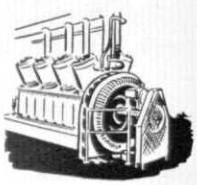


Compressors and Blowers

Rock Drills

Air & Electric Tools

Steam Condensers



Diesel & Gas Engines

If you are interested in hydraulics...

Here's what Pump Engineering at Ingersoll-Rand can mean to you...

No business or industry could long survive without *pumps*. Their vital liquid-moving function is a fundamental part of our modern civilization. That's why pump engineering offers such a varied and fascinating career – cutting across virtually every branch of every industry.

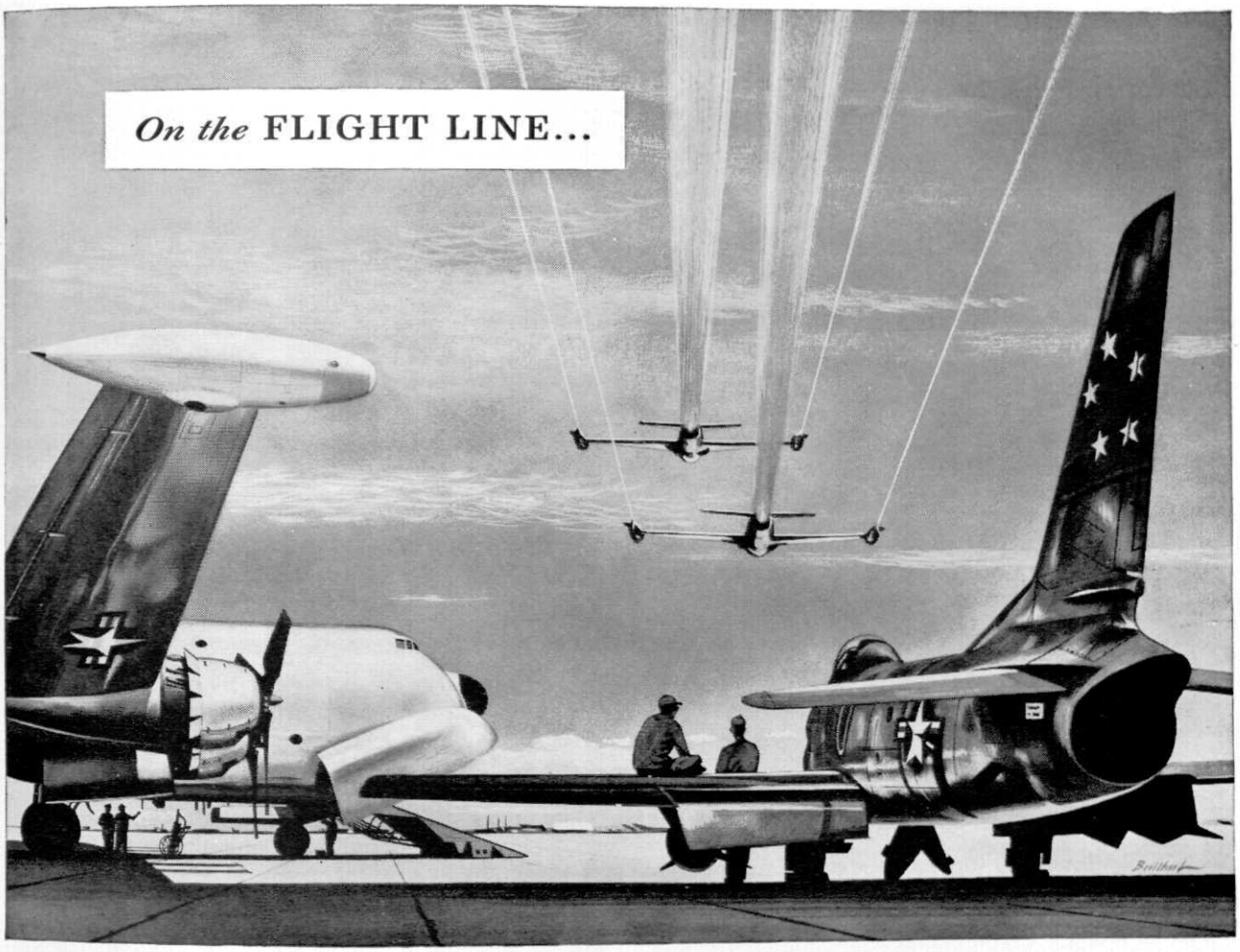
Ingersoll-Rand's Cameron Pump Division in Phillipsburg, N.J., is one of the oldest, largest and most progressive pump manufacturing plants in the world. As an engineer engaged in research, design, manufacture or sales of I-R pumps, you can be sure of three things – prestige, permanence and progress. The Company is a leader in its field, and so are the men you will work with. Here, long-range security and opportunities for advancement are second to none. For further information on leadership careers at Ingersoll-Rand, contact your Placement Office, or write to Ingersoll-Rand, 11 Broadway, New York 4, New York.

EXCELLENT OPPORTUNITIES NOW AVAILABLE:

- Sales Engineering – ME, IE, EM, EE, CE – Bachelor
- Design Engineering – ME – Bachelor & Master
- Production Engineering – ME, IE – Bachelor
- Business Engineering – Engineering & Business Degrees – Bachelor & Master

Ingersoll-Rand

10-689 11 BROADWAY, NEW YORK 4, N. Y.



QUALITY *shows when the chips are down*

★ ★ ★ ★ The Allegheny stainless and super high-temperature steels used in jet and rocket aircraft engines and equipment are pure economy, because they do the job that's required of them, and they *last!* They stand up under metal-killing conditions of heat, load and corrosion, and they're dependable.

There are lots of other jobs for stainless steel that aren't as spectacular, or perhaps as tough, as those aboard a jet. Hospital, dairy and restaurant equipment are good examples, or the many uses in cars, trains, appliances, buildings and homes.

But, in these and thousands of other cases, stainless again gets the call because it does the job better, lasts longer and costs less in the long run than any other material on the market.

There may be many occasions in your industrial future when Allegheny Stainless and other special steels can help you either to make money or to save it. Or you may decide to make our career *yours:* the development and engineering of stainless and heat-resistant steels; tool and electrical steels; sintered carbides and magnetic materials; titanium, zirconium and other special-property metals. ● In either case, we'll be delighted to talk to you and work with you. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pennsylvania.*

WSW 6769

PIONEERING on the Horizons of Steel

Allegheny Ludlum

AL
LEADING PRODUCER
HIGH-ALLOY STEELS

A New Challenge . . .

Solar Energy!

by Frank Schreihans

The rapidly deminishing energy supplies of our country, as well as other countries of the world, is becoming of great concern to present day engineers and scientists. The generations of the future will be dependent on the engineers of today if they are to enjoy as bountiful an economy as our own. How will our children survive without coal, oil, or natural gas?

It is estimated that all of the earth's economically usable fossil fuel may be consumed within 60 to 70 years. In another 100 to 175 years we may run out of nuclear fuels. The sun will be with us, however, as long as there are people on the earth. We are just beginning to think about using solar energy.

All our energy comes originally from the sun. Through the marvelous process of photosynthesis which we are just beginning to understand, the carbon dioxide in air and water combine in living plants through the agency of sunlight in the presence of chlorophyll. But industrialized nations cannot begin to live off the current product of sunshine. For running their machines they depend almost entirely on the solar energy of bygone ages, accumulated by photosynthesis and preserved by geological accidents as fossil fuels. Buried trees give us coal, and the decomposition of small photosynthesizing organisms give us petroleum. These sources of energy are irreplaceable because their rate of production is so very slow.

How much fuel do we consume? In the United States, we feed ourselves about 3000 kilocalories of food per person per day, but we feed our machines at the rate of 150,000 kilocalories. This energy runs our factories, our automobiles, and our trains and heats our buildings. It does all our work for us except what is done by hydroelectricity. The world's demands for energy are increasing rapidly, not only because of the population increase, but also because each person is demanding more of the products manufactured.

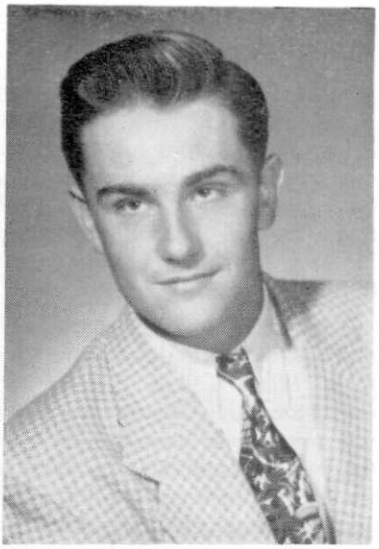
We have learned to use our fuel more efficiently, replacing fire places with furnaces and steam locomotives with diesels. But the most effective solution is to use a substitute for coal, oil, gas, etc.

Solar energy and atomic energy are hopeful possibilities. The total amount of atomic energy that can be produced by nuclear fission of known supplies of uranium (and thorium) exceeds the total amount from all our fossil fuel supplies. When the economic problem of extracting uranium from low grade ores is solved, the atomic energy available can greatly exceed our fossil fuel energy. But uranium and thorium are in limited supply, just as coal and oil are. Nuclear fission of hydrogen remains a difficult and remote possibility for continuing our sources of energy into the distant future.

The eventual answer seems to be the use of solar energy. The climate of the earth will not change sensibily for the next ten trillion years. The sun can be considered an almost infinite source of energy. Each year the earth receives from the sun at least 3.2×10^{21} Btu of energy, or the annual equivalent of about 122 trillion tons of bituminous coal. In a single day, 1.5 square miles of the earth's surface obtains from the sun enough energy to equal that of one Hiroshima type atom bomb. In the United States alone, the energy annually obtained from the sun is fully 2000 times the nation's total energy requirements. Although solar energy is everywhere, the problem is how best to use it.

Very few methods for harnessing solar energy have been developed that can begin to compete economically with conventional sources of power; coal, oil, and gas. This is why large-scale applications of solar energy today are, with few exceptions, the same as those known to the cave man. This does not mean that new, practical, large-scale applications may not emerge within the foreseeable future, particularly as

Frank A. Schreihans, the author of SOLAR ENERGY, is a senior in Chemical Engineering. He is a member of Tau Beta Pi and Phi Lambda Tau, both Engineering Honoraries, he is also a member of the American Institute of Chemical Engineers. He is married and has three children. In his spare time he lifts weights for the Michigan State Weight Lifting Team.



FRANK SCHREIHANS

supplies of conventional fuels decline sharply and prices rise accordingly.

One of the oldest applications of solar energy is in the production of high temperatures. This use dates back even before the time of Archimedes, who was a solar energy pioneer. In 1774, Antoine Lavoisier used solar energy to melt iron. Several years ago, William M. Conn, at Rockhurst College in Kansas City, Missouri, erected a ten-foot parabolic aluminum mirror that was able to produce temperatures up to 3000° C in as little as ten seconds. Conn's solar furnace, which created a 0.3 inch spot of heat, was used primarily in the study of metals and refractories—their melting point, high-temperature and modifications, and potential used as structural components in jet engines.

Solar energy permits extremely high temperatures to be developed instantaneously and without the introduction of chemical contaminants (carbon, for example, in the case of electric furnaces). Despite these advantages, solar furnaces have thus far found few, if any, large scale commercial applications.

The elevated temperatures developed in solar furnaces can be used to generate steam, which, in turn, can operate small engines. The production of power by solar energy seems feasible, but the lenses and reflecting mirrors that have so far been developed have not been notably effective over large areas necessary for the conversion of heat into work. Another barrier is the immense capital investment that would be required to build a sizable plant.

During the past few years, the National Physical Laboratory in Pusa, India, has been investigating the use of solar energy for the production of steam to drive low-horsepower engines. These engines would be used to drive water pumps and small looms.

The distillation of salt water seems economically feasible in areas where fresh water is at a premium. There are several areas in Asia and Africa where solar distillation of sea water and brackish water from wells would be of great help. In one specific case 2000 gallons per day were needed for a fish cannery on the eastern coast of Africa and this water was brought a long distance by ship. Here distillation of sea water would prove economical even at the present.

During World War II, Massachusetts Institute of Technology developed a solar distiller that has now become standard equipment on life rafts. Solar energy can also be applied to the recovery of salts from brine. Currently in the United States hundreds of thousands of tons of salt are annually produced by solar evaporation.

Continual efforts are being made to increase the rate at which sea water can be solar-evaporated. Researchers, working with brines from the Dead Sea, have found that solar evaporation can be greatly accelerated by the use of special dyes that step up the absorption of solar energy.

According to a report by the Presidents Materials Policy Commission, the potential market for solar heating in the United States may be more than thirteen million units by 1975. The report estimates that these heating units will cost about $2000 to $3000 apiece. This could satisfy about ten percent of the nation's energy requirements in 1975. About 20,000 houses in Florida already have roof-mounted solar collectors to supply hot water.

The big advantages of solar space heating will probably be based mainly on a type of heating in which solar energy is not merely captured and put to use at once, but is captured, stored, and used as needed. The difference means a more elaborate and costly building design, but one that is essential if solar energy is to become an effective replacement for the fuels now used for space heating.

(Continued on Page 62)

SOLAR ENERGY

(*Continued from Page 61*)

One of the first ventures in improved solar heating was a house built at Massachusettes Institute of Technology. In this four room dwelling, the sloping south roof was covered by a glass-enclosed metal plate that served as the heat collector. Water warmed by contact with the collector was pumped into a 1200 gallon tank in the attic, and from there, was circulated throughout the house for space heating.

A major drawback of this method is the difficulty encountered in maintaining uniform interior temperatures. Maria Telkes, then at M.I.T., in an effort to overcome this difficulty, devised a chemical method of storing solar heat by use of a compound that undergoes a phase change at a constant temperature somewhere in the desired range of 90° to 100°F. The compound selected was Glauber's salt, the decahydrate of sodium sulfate. At 90°F., this compound loses its water of hydration and, at a uniform temperature and with a continuous input of heat, is gradually converted to anhydrous sodium sulfate. Mainly because of this transformation, one cubic foot of Glauber's salt is able to store about 8.5 times more heat than an equal volume of water when the temperatures of both are raised from 80° to 100°F.

In a solar house employing chemical heat storage, air warmed by contact with the heat collector is circulated to a heat storage bin filled with closed containers of Glauber's salt. From the storage area, the warm air is circulated to the rest of the house. At night, as the circulating air cools down, the anhydrous salt picks us water of crystallization and gives off heat, thus minimizing the fluctuations in air temperature.

This method of chemical heat storage was first put into practical use in Dover House, built at Dover, Massachusetts, in 1948. This four-room house, constructed at a cost of $33,000, including $3000 for the solar heating equipment, uses some 21 tons of Glauber's salt. Although, thus far, chemical heat storage has been applied only to domestic space heating, its use in industrial space heating and in the temperature control of chemical reactors may have very definite possibilities in the future.

Quite likely, solar heating in the future will move ahead most rapidly in southern areas of the United States, where sufficient sunshine is available the year around. In such states as Florida, Texas, Arizona and California, the use of solar energy as a means of producing domestic hot water has already made noticeable headway. In these solar water heaters, a network of pipes is ordinarily mounted on the roof and exposed to the sun from behind one or two layers of glass. The sun-heated water, at a temperature of approximately 150°F., is stored in an insulated tank for use as needed.

Intensive studies have been underway to increase the efficiency with which solar energy can be converted to electricity by the use of either heat-sensitive or light sensitive devices. Where heat is used, the most common devices are thermocouples or thermopiles. In solar thermoelectric generators, the sun's rays are ordinarily intercepted by flat plates, lenses or reflectors. With flat plate generators, about 1% of the intercepted solar energy is converted to electricity. When the solar energy is focused either by lenses or reflectors that continually follow the sun, efficiencies of 3.5% have been attained.

In future large scale applications, the use of thermocouples may be seriously curtailed by the high cost of the thermocouple material that would necessarily be involved if an effort were made, for example, to tap the total solar energy available in an area of several acres. Also important is the problem of electrical resistance of this material. However, there is always a possibility that new, improved alloys will be developed that will overturn all present notions about the upper limits of thermoelectric efficiency.

For the direct conversion of sunlight into electrical energy, photovoltaic cells and photogalvanic cells are available. In the former, electricity is generated when light falls on one of a pair of dissimilar metals or oxides. A typical photovoltaic cell consists of a copper disk covered on one side with a thin layer of selenium. In the operation of a selenium cell, only about 0.1% of the incident sunlight is converted to electrical energy.

As a typical photogalvanic reaction, an electrical potential is generated between illuminated and dark cells of thionine and iron sulfate as a result of the light sensitivity of the oxidation-reduction equilibrium of these two materials. Here again, a serious shortcoming is the low efficiency of energy conversion.

The new solar battery announced by Bell Telephone Laboratories is able now on a small scale to convert sunlight directly into electricity with 11% efficiency. Sunlight has also furnished enough power to run a midget transmitter, which had a broadcast range of about eight miles.

A sizable share of research in the solar energy field is focused on the basic study of photosynthesis. Although photosynthesis is fundamental to life itself, the efficiency of utilization of sunlight in the production of farm crops is extremely limited. In the temperate zone, only about 0.1 to 0.5% of the total solar radiation that annually falls on an acre of land is fixed as organic matter.

One of the major scientific challenges is to discover new ways to utilize more effectively the photosynthetic processes of nature. An ultimate goal is the industrialization of photosynthesis, the large scale growing of crops under strictly controlled industrial conditions to insure the maximum use of sunlight in the production of foods, fuels, and chemical raw materials.

In this field there is always the possibility that ways can be found to combine carbon dioxide and water in the production of carbohydrates, without the use of chlorophyll and living organisms. Theoretically, there is no reason why this cannot be done.

Much work is being carried out today on photosynthetic reactions that do not necessarily involve formation of compounds identical with those produced by living organisms. Such photochemical reactions as the oxidation of water to hydrogen peroxide

on light-activated zinc oxide surfaces are being explored. Research headed by Lawrence J. Heidt of M.I.T. has centered around the study of sunlight as a means of producing both hydrogen and oxygen from aquaious solutions containing cerous and ceric ions. This approach, involving the photosynthesis of energy rich fuels, is believed to offer the best promise of partly overcoming at least two of the major drawbacks of solar energy—its unavailability at night and its inability to be transported about in concentrated form as such. The hydrogen and oxygen could be stored and later combined to give back the stored energy.

The meteorological implications of solar energy can not be neglected. If improved methods for protecting crops against frost could be devised, and growing season thus lengthened, the food supply in certain areas of the world could be increased appreciably. Conversely, if absorption could be induced on snow surfaces so that melting would be speeded, the ground would be available for planting sooner in the spring. Meteorology could make an important contribution to the advancement of solar energy by developing an improved method for specifying the amount of solar radiation at any given point on the globe. Expensive shields and ditches are now being used in California to conserve solar radiation and to influence wind currents as to minimize frost damage.

The Russians have been active in the field of solar power. In 1941, F. F. Molero of the U. S. S. R. Academy of Sciences constructed an experimental solar energy plant at Stalingrad. To focus the sun rays, Molero used 33-foot parabolic mirrors made of ordinary window glass. In 1946, in another Russian project, a solar converter, also employing parabolic mirrors, began supplying power to a cannery at Tashkent in Central Asia, where a solar research institute is now located.

Many problems exist in solar energy research; such as, the cost of solar energy conversion, the intermittancy of sunlight, and the fact that solar energy, although abundant, is diffused over immense areas. The expenditures of billions—as was required for the development of atomic energy—would mean real progress in use of the world's number one energy source.

The biggest problem is manpower. It takes engineers and scientists to develop sunlight into an economical source of power. They are needed to tackle such problems as solar heat transfer, development of improved photogalvanic cells, and better understanding of the fundamental mechanisms of photosynthesis. And in the future, they will be called upon to design, construct and operate the large scale installations that will make possible the mass utilization of solar energy.

As the University of Wisconsin's Farrington Daniels predicted some years ago: "When we have used up much of our coal and oil, exploited our available land with intensive farming, the trebled our population, we will unquestionably be able to call upon the sun to give us the means to satisfy our ever-increasing demands for fuel, food and power. But there is a long and challenging road of research and development which must be followed first . . . We cannot eat sunshine."

NEW DEVELOPMENTS

(*Continued from Page 52*)

Revolutionary Natural Rubber Bridge Bearing

Until the advent of a new natural rubber bearing that has just been introduced in England, bridge engineers were restricted to the traditional nests of rollers or sliding plates for bridge expansion bearings. The problem with these was maintenance. Rollers tend to wear flat after a period of time. Both rollers and plates are subject to rust. Now a new natural rubber bearing fulfills all requirements of longitudinal movement, with the added benefit of long life with no maintenance whatsoever.

This bearing was introduced in the construction of London's Pelham Bridge, a quarter of a mile in length with dual vehicular roadways and pedestrian pavement. The end spans of the bridge are reinforced concrete. The center spans, which total 288 ft. and cross the railway, are constructed with welded steel girders, composite with concrete deck slab. These are the spans that are to be supported on the newly designed rubber bearings.

Wellesley Road Bridge, a smaller London project is also making use of the natural rubber bearing innovation.

Bearings are now available with nominal capacities of 50 and 100 tons. In appearance, the bearings are merely large blocks of rubber—the 100-ton unit measuring 24″ x 16″ x 7⅛″ deep, and the smaller unit 11″ x 16″ x 7⅛″ deep. Actually, however, the rubber is interlayered with steel plates. These plates have a minimum cover of ¼″ of natural rubber about their edges and are therefore unaffected by the elements.

The shear ratings of the bearings are the same in any direction in the horizontal plane. The compression rating of the two bearings is such that for most bridge work the bearing can be regarded as a pinned support, the actual rotational stiffness for the longer bearing being 1,800 tons ft. per radian.

Bearings with greater capacity and different properties are now being developed. Work is being particularly concentrated on bearings with vee'd plates which provide lateral stiffness with the same longitudinal rating and also with domed bearings which have high lateral stiffness in all directions but low rotational stiffness.

EATING YOURSELF TO DEATH

(*Continued from Page 31*)

is absorbed and the form in which it is eaten. There are two kinds of fat; animal and vegetable. Recent experiments carried out by Cooper and associates involved the intake of butterfat versus corn oil.

It was found that with an increase in butterfat and a decrease in corn oil, there was a rise in the cholesterol level of the blood. This result was attributed to two things; an elevating factor in butterfat and a depressant factor in corn oil. This indicates that the rise in the cholesterol level was due not only to the fact that animal fats are more readily absorbed, but that vegetable fats have the property of interfering with absorption.

The above evidence seems to show that if a person's cholesterol level was too high, he could remedy the situation by eating only vegetable fats. A solution is not this simple, however, because the vegetable fats are lacking in some of the essential fatty acids. Therefore it would seriously impair your health if you neglected to eat animal fats; besides, many of the animal fats are the most appealing to the appetite.

Now just what happens when an atherosclerotic condition exists and what bearing might cholesterol have on such a condition? Atherosclerosis results from a thickening of the walls of the arteries thus blocking the passage of blood from the heart to the cells of the body. Of course, when it completely blocks the artery, death results.

There are several things which could cause a thickening of this wall. The exact part that cholesterol plays has not been definitely established, but thus far, evidence seems to indicate that hypercholesterolaemia, an overabundance of cholesterol in the blood seems to coincide with evidences of atherosclerosis.

Ordinarily, the cholesterol is slowly absorbed through the walls of the larger veins. When more cholesterol has been taken into the body than it can dispose of, either by utilizing it or eleminating it, it is no longer able to permeate the walls of the veins. It is especially hard for the cholesterol molecules to penetrate the thicker veins, so it begins to deposit at the sites of these larger veins in the body.

Other particles present in the blood stream begin to become attached to these thick spots along the vein. As this progresses, one of two things can happen. Either the vein will eventually be blocked completely, or the whole lump may break away from the lining of the vein causing hemorrhaging to occur. Death usually results in any case.

Dr. Meyer Texon of the New York University Post-Graduate Medical School has offered an explanation of why sudden heart attacks occur after exertion or emotional disturbances. Bernoulli's theorem in physics states that "fluid in motion possesses energy because of its speed and pressure. When the speed increase and the presure decreases, a suction effect is created." As the blood stream moves along the veins, it also has speed and pressure. In the circulatory system, the suction effect is produced when the blood moves around an abrupt curve and at points of branching.

The suction thus caused pulls the inside of the vessel walls toward the center of the vessel. If the suction continues to irritate the vessel wall, it will begin to thicken at these points, perhaps building up a clot. When stress, exertion or emotional disturbances cause sudden increases in the heart beat and speed of the blood, there will not be enough room for the extra blood to pass by the clot or else the clot will break off and hemorrhaging will take place.

In either case, essentially the same thing happens; the passage of the blood will be blocked or internal hemorrhaging will take place.

An overabundance of cholesterol can cause gall stones and a diseased fatty liver as well as contribute to atherosclerosis. Gall stones can be removed by surgery, however, so their formation is not quite as serious.

Other factors besides dietary ones seem to effect the cholesterol level of the blood and coronary conditions. Many characteristics of modern-day life are potential contributors to an increase in diseases of the heart.

Cholesterol has been studied because the fat intake of the average American has increased greatly in the last twenty years. There is a comparable increase in atherosclerosis. It has also been found that the serum-cholesterol level of the blood is higher in people suffering from atherosclerosis than it is in a normal person.

There is a tendency for a greater number of persons in high income brackets to have coronary diseases; the fat intake is also higher in these groups.

Exercise enters into the picture when it is brought to mind that modern mechanization has cut down on the physical work exerted by human beings. It has been shown that there is a greater degree of coronary ailments among those who hold sedentary jobs than there are among people who are more active regardless of social group.

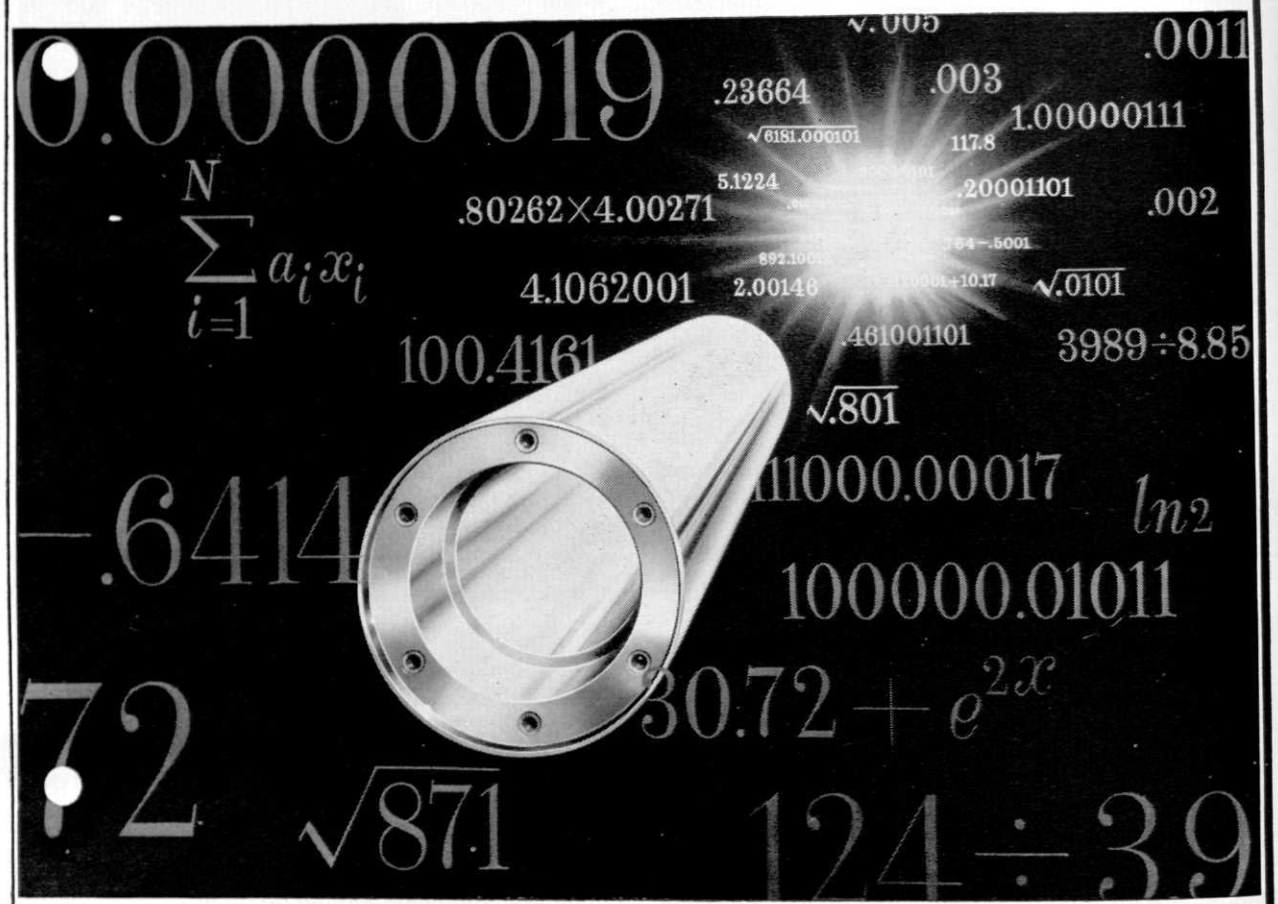
Almost every day, scientists and researchers are finding out something new about cholesterol and heart disease. They are able to establish more relationships like those listed above. The work is far from finished at this point, though, and they will be the first ones to caution you against radically changing your diet until these findings have been definitely established.

One of the prime concerns of doctors, nutritionists and scientists is that you realize the importance of both fat and cholesterol in your diet. Remember that you can eat yourself to death by eliminating certain foods from your diet as well as by overdoing it!

Karen Paulson, author of "Are You Eating Yourself To Death?" is a graduating senior in Home Economics-Journalism. She is president of the Home Economics Journalism club, and a member of the Home Economics club. She is affiliated with Delta Gamma and is pledging Omicron Nu, the Home Economics Honorary.

KAREN PAULSON

Tear out this page for **YOUR STEEL NOTEBOOK...**



Small steel tube with a giant memory

IBM engineers needed a small steel tube—a memory unit for a computer—whose whirling surface would pick up thousands of complicated figures as magnetic impulses, retain and, years later, read them back instantly. This called for the cleanest, most uniform quality steel that could be produced. IBM consulted Timken Company metallurgists, who recommended a certain analysis of Timken® fine alloy seamless steel tubing. IBM found the steel so clean that when properly plated it accurately recorded up to 100,000 electro-magnetic impulses. So strong it withstood the centrifugal forces of 12,000 rpm without distortion or damage. It's another example of how Timken Company metallurgists solved tough steel problems.

WANT TO LEARN MORE ABOUT STEEL OR JOB OPPORTUNITIES?

To learn more about electric furnace fine alloy steel, send for "The Story of Timken Steel Quality". And for help in planning your future, write for "Career Opportunities at the Timken Company". We will reply promptly. The Timken Roller Bearing Company, Canton 6, Ohio.

See the next Timken Televent hour, "The Innocent Years" over NBC-TV, Thursday night, November 21st.

TIMKEN *Fine Alloy* STEEL

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

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING

1958-1959

The Ramo-Wooldridge Fellowships

for Graduate Study at the

California Institute of Technology

or the

Massachusetts Institute of Technology

Leading toward the Ph. D. or Sc. D. degree as offered by each institution

Emphasis in the study program at the California Institute of Technology will be on Systems Engineering, and at the Massachusetts Institute of Technology on Systems Engineering or Operations Research.

The Ramo-Wooldridge Fellowships have been established in recognition of the great scarcity of scientists and engineers who have the very special qualifications required for work in Systems Engineering and Operations Research, and of the rapidly increasing national need for such individuals. Recipients of these Fellowships will have an opportunity to pursue a broad course of graduate study in the fundamental mathematics, physics, and engineering required for careers in these fields, and will also have an opportunity to associate and work with experienced engineers and scientists.

Systems Engineering encompasses difficult advanced design problems of the type which involve interactions, compromises, and a high degree of optimization between portions of complex complete systems. This includes taking into account the characteristics of human beings who must operate and otherwise interact with the systems.

Operations Research involves the application of the scientific method of approach to complex management and operational problems. Important in such application is the ability to develop mathematical models of operational situations and to apply mathematical tools to the solution of the problems that emerge.

The program for each Fellow covers approximately a twelve-month period, part of which is spent at The Ramo-Wooldridge Corporation, and the remainder at the California Institute of Technology or the Massachusetts Institute of Technology working toward the Doctor's degree, or in post-doctoral study. Fellows in good standing may apply for renewal of the Fellowship for a second year.

ELIGIBILITY The general requirements for eligibility are that the candidate be an American citizen who has completed one or more years of graduate study in mathematics, engineering or science before July 1958. The Fellowships will also be open to persons who have already received a Doctor's degree and who wish to undertake an additional year of study focused specifically on Systems Engineering or Operations Research.

AWARDS The awards for each Fellowship granted will consist of three portions. The first will be an educational grant disbursed through the Institute attended of not less than $2,000, with possible upward adjustment for candidates with family responsibilities. The second portion will be the salary paid to the Fellow for summer and part-time work at The Ramo-Wooldridge Corporation. The salary will depend upon his age and experience and amount of time worked, but will normally be approximately $2,000. The third portion will be a grant of $2,100 to the school to cover tuition and research expenses.

APPLICATION PROCEDURE

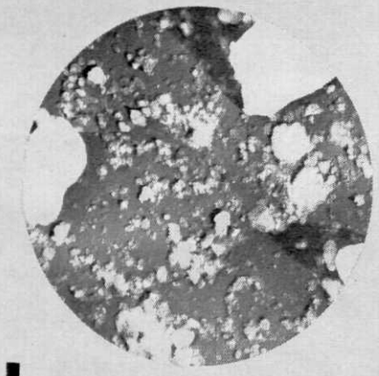
For a descriptive booklet and application forms, write to The Ramo-Wooldridge Fellowship Committee, The Ramo-Wooldridge Corporation, 5730 Arbor Vitae Street, Los Angeles 45. Completed applications together with reference forms and a transcript of undergraduate and graduate courses and grades must be transmitted to the Committee not later than January 20, 1958.

The Ramo-Wooldridge Corporation

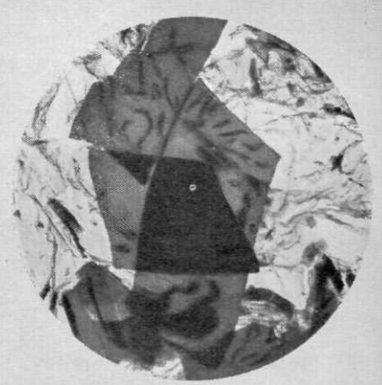
5730 ARBOR VITAE STREET, LOS ANGELES 45, CALIFORNIA • LOS ANGELES TELEPHONE: OREGON 8-0311

Now you can **see** why only leads & pencils give you perfectly

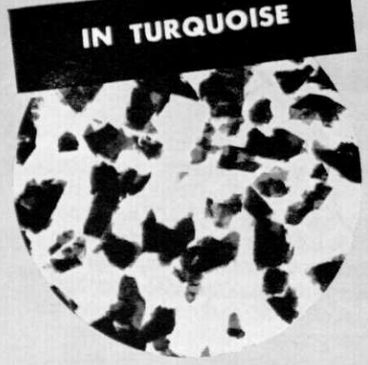
GRAPHITE LIKE THIS



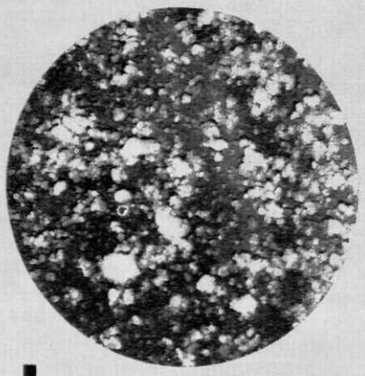
CLAY LIKE THIS



MAKES THIS LEAD STRUCTURE



100% "ELECTRONIC" GRAPHITE



SUPERFINE CLAY

MAKES THIS LEAD STRUCTURE

YOU ALWAYS GET PROVEN QUALITY FROM TURQUOISE DRAWING LEADS AND PENCILS

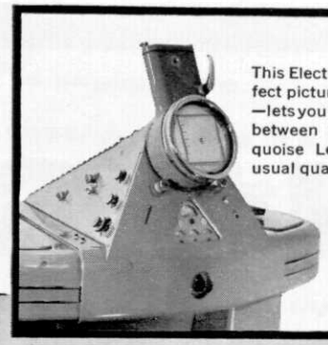
PROVEN GRADING—17 different formulae make sure you get exactly the line you expect—from every pencil, every time.

PROVEN DURABILITY—Because compact lead structure gives off no chunks of useless "dust" to blow away, Turquoise wears down more slowly.

PROVEN NEEDLE-POINT STRENGTH—as electron photomicrograph shows, Turquoise lead structure is finer—and therefore stronger. It holds a needle point under drawing pressures for long lines of unchanging width.

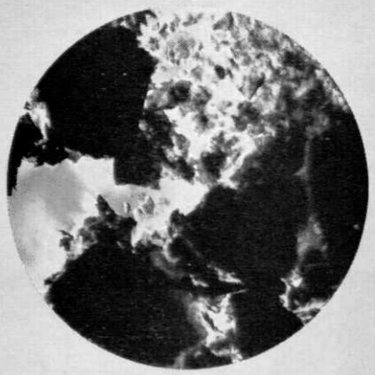
EAGLE PENCIL COMPANY • NEW YORK • LONDON • TORONTO • MEXICO • SYDNEY • BOGOTA

Eagle Turquoise sharp drawings



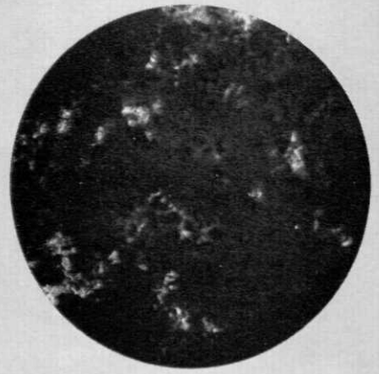
This Electron Microscope takes perfect pictures 7,500 times actual size—lets you **see** the startling difference between Eagle's "Electronic" Turquoise Lead and the lead in the usual quality drafting pencil.

Photographs courtesy of Ladd Research Industries, Inc.



...AND MARKS LIKE THIS

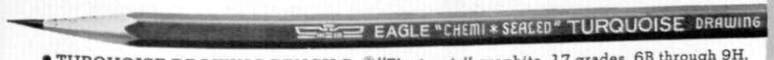
Relatively large, irregular particles of graphite make a rough-edged line. Drawings will be inferior.



...AND MARKS LIKE THIS

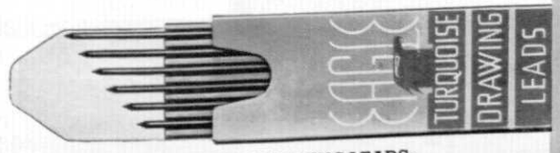
Tiny, more uniform particles deposit as a clean-edged, solid line. Drawings will be perfectly sharp, clearly defined.

WRITE FOR FREE SAMPLE DEMONSTRATION KIT
(including Turquoise wood pencil, Turquoise lead, and Turquoise "skeleton" lead) naming this magazine. Eagle Pencil Company, 703 East 13th Street, New York, N. Y.



• TURQUOISE DRAWING PENCILS: ®"Electronic" graphite. 17 grades, 6B through 9H.

• TURQUOIS CLEANTEX ERASER: Super-soft, non-abrasive rubber.



• TURQUOISE DRAWING LEADS: Fit any standard lead holder. Grades 5B through 9H.

• TURQUOISE LEAD HOLDERS: Hold any grade of Turquoise lead.

EAGLE® TURQUOISE®

PENCILS AND LEADS

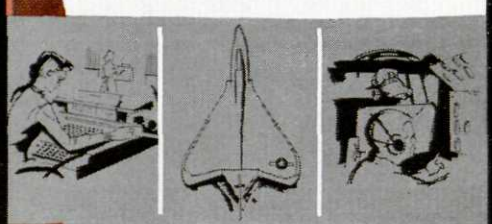
are the largest-selling in the United States!

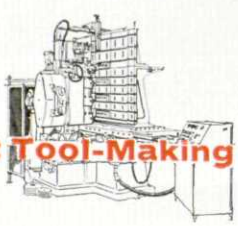
NPC Die Castings

ALUMINUM
ZINC
MAGNESIUM

Integrity, service and quality are the corner stones upon which NPC builds its business and places its faith.

Assurance of performance in virtually all industries





Excellent Tool-Making Facilities

Craftsmen in tool-making and production combine their broad experience and specialized skills with the latest in modern machinery enabling NPC to perform a broad service to many industries.

New Products Corporation

P. O. Box 666 Benton Harbor, Michigan Founded 1922

Crystal Filters

Edited by Norm Dill

Radio receivers operate on the principle of selecting from a wide range of available energy some specific bit of energy containing desired information. Filtering is a scheme used by designers of radio communication systems to accomplish this feat. For years, filters have been used to cut out, or do away with, unwanted radio energy so that desired energy can be effectively used. Home radios and television receivers have several filters built into them. Military radios, in general, have even more filters.

A filter is an electronic network of components which will allow only certain signals to pass through it. Most filters are individually designed for the specific job they have to do. However, there are certain places in radio, radar, and television circuits where the same type of filter often turns out to be necessary. Therefore, manufacturers of radio and electronic devices have standardized certain filter types. Up to now, most of these standard filters have been made of coils and condensers.

Crystal filters do the same basic job as long-standing conventional filters, but crystal filters do the job much better, especially at high frequencies. In addition, crystal filters make possible the design of new types of equipment never before possible.

Single-sideband radio equipment makes particularly good use of crystal filters. In single-sideband transmission, effectively half of each radio signal is filtered out at the transmitter and then later reinserted at the receiver by electronic means. The very nature of a single-sideband system makes a good filter the heart of the system.

Crystal filters are desirable for high frequency single-sideband systems because a crystal filter has an inherently sharper rejectional ability than other types of filters. Use of crystal filters in a radio receiver, especially at frequencies above conventional home radio bands, makes possible the design of a simpler radio set than is feasible with conventional filters made of coils and condensers.

For any communication or navigation system where it is necessary or desirable to transmit and receive a narrow band of information, the job can be done better using a crystal filter than any other type of commercially available filter. In many instances the use of a crystal filter represents the only way to do a given job using standard, commercially-available parts.

There are, in general, three types of filters commercially available. These are:

1. LC Filters
2. Mechanical Filters, and now
3. Crystal Filters

LC Filters are networks made up of coils and condensers; they represent the most conventional approach to making filters which electronic designers have used in the past. Mechanical filters make use of vibrating metal structures to filter out undesirable signals which have been transformed to vibrations. The newest and best type of filter, the crystal filter, makes use of networks of tiny quartz crystals.

High frequency quartz crystal filters are smaller, more reliable, and simpler than their counterparts made of coils and condensers or mechanical structures. The crystal filters also do a better job of filtering.

Nature has arranged things such that it is easier to turn a sharp corner when there is less resistance to turning. In the case of filters, sharp corners are the desired end product. Abrupt changes in response to signals of different frequencies is what designers try to achieve in a filter. The less resistance an element has, the easier it is to bring about abrupt changes in response. Quartz, which is an extremely stable crystal substance, has the fortunate characteristic of possessing very little resistance to vibration at certain discrete frequencies. The frequency at which any particular piece of quartz crystal will vibrate without much resistance is dependent upon the dimensions of the crystal and mounting techniques. In general, a given piece of quartz crystal will vibrate easily at one specific frequency, but will not tend to vibrate at all at any other frequency. This fact is the key to filters made of quartz crystals.

Quartz filters make use of several wafers of quartz; usually either two, four, or eight. The wafers, or individual crystals, are arranged in a lattice or bridge network configuration so that the entire network has certain desired characteristics. The characteristics desired and achieved in the filters are as follows. Consider an antenna normally connected to a radio

receiver. This antenna is susceptible to a considerable portion of the radio energy passing by it. However, the radio receiver is only useful to a listener if some intelligible information emanates from it. If all the information contained in all the radio frequencies to which the antenna is sensitive were simultaneously presented to the listener, the result would be a garbled hodge-podge of noise, with essentially no intelligible information resulting. So the receiver is "tuned" to a narrow range of frequencies which contain only the information desired at one particular time.

Unfortunately, speech cannot be transmitted via radio on one single frequency. So it is general practice to tune a receiver to a specific frequency, the one read on the dial, and allow the receiver to pick up signals close to the dial frequency. Normally, the signals picked up, or detected, are equally spaced on both sides of the dial frequency. The resulting information which comes out of the loudspeaker is therefore a summation of information contained in a band of frequencies. The center of the band is the frequency to which the radio receiver is tuned. This frequency is normally referred to as the center frequency of a station. The band of frequencies over which intelligible information is transmitted is called just that, a frequency band. (In the case of home radio receivers, this band is a few thousand cycles in width.)

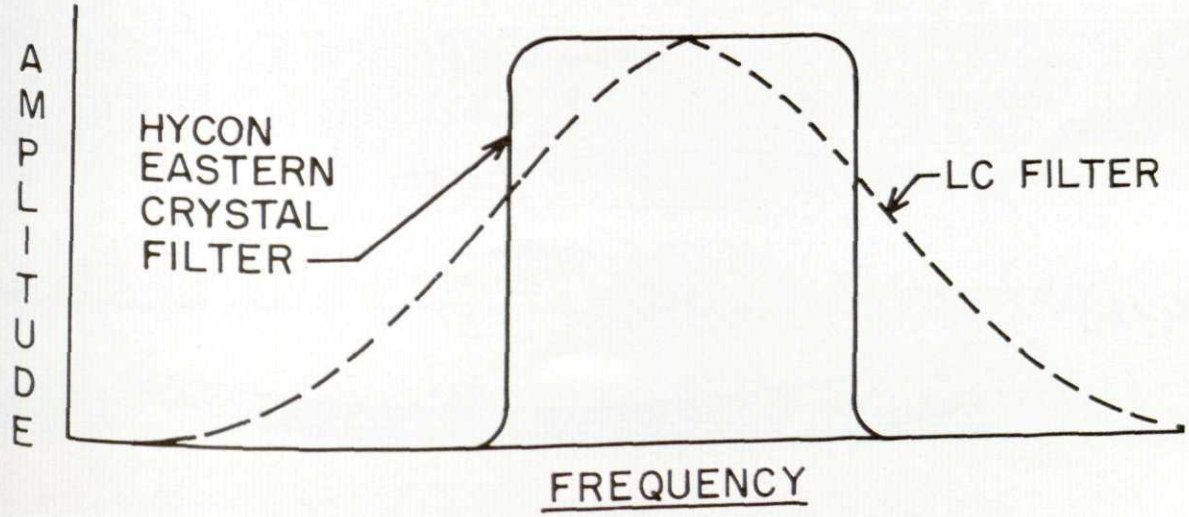
An essential part of a radio receiver, therefore, is a filter which will discriminate against all other frequencies exclusive of the frequency band of the station being received. Crystal filters are designed to make the receivers extremely receptive to the frequency band desired, and at the same time extremely non-receptive to unwanted frequencies, outside the band.

Communication systems more sophisticated than home radios vary the basic theme somewhat. Since the range of frequencies available in nature is necessarily limited, and since more and more people continually want to get on the air with information, many schemes have been advanced to make better use of a given finite band width of frequencies. One of the better schemes is single-sideband transmission in which half the frequencies are arbitrarily filtered out and thrown away. This leaves the omitted frequency band available for other people to use. In order to achieve such clever manipulation of frequencies, however, extremely good filters are required. The filters must be able to allow desired frequencies through a system virtually untouched, but at the same time must suppress immediately adjacent frequencies. Hence the sharp corner. The sharper the corner the filter can turn, the higher is its "selectivity" that is the more nearly can the filter approach the ideal situation of allowing one frequency to pass through, but completely blocking the next adjacent frequency along the line. Crystal filters approximate this Utopian situation much more closely than other existing types of filters.

The ability for a filter to have high "selectivity" is primarily determined by the "Q" of the elements used in the filter. Q or "quality factor" is an arbitrary symbol which permits the engineer to determine how much energy is dissipated or wasted by the filter element. The higher the Q, the less the wasted energy, and therefore, the better the filter. In addition, the same filter, produced at a higher frequency, will require a higher Q for the same performance or selectivity. Conventional coils used in L-C filters have Q's in the order of 200, while the elements employed in Mechanical filters have Q's of about 2000. On the other hand, ordinary quartz crystals have Q's which range from 20,000 to 200,000. In other words, the crystal filter can be made a great deal better than the L-C or Mechanical filter at low frequencies, and furthermore, can be produced at high frequencies where the other filters will not perform.

Quartz crystals have been used for years to control the frequency of oscillation of oscillators. It has

(*Continued on Page 84*)



The graph shows how sharply tuned a crystal filter is compared to a conventional filter made of coils and capacitors. The solid line indicates how a crystal filter restricts bandpass to a well-defined region of frequencies, while the dotted line shows how conventional filters gradually diminish attenuation.

Stovepipes that Fly!

by John F. Artman

Ramjets, commonly called flying stovepipes, look much like their nickname. If you will picture in your mind, a stovepipe you will have an idea of the basic shape of the ramjet. They were invented by Henri Lorin, a Frenchman, in 1913. In those early years of aviation, his invention created little interest. The Wright Brothers had flown their plane at Kitty Hawk, North Carolina on August 25, 1902, only eleven years earlier. Lorin's invention was put aside and attracted little attention until 1938.

In 1938, Rene' Leduc, a French engineer, exhibited his design of the ramjet at the Paris Salon de L'Aviation. Leduc's design was never built, and no one knows if it would have flown. Leduc named his design the Aero-THermODYnamic-Duct or the ATHODYD. Some engineers still use this name, but I shall refer to the engine as the ramjet.

His design was by far in advance of the aircraft being built in 1938. The needle-nosed planes of today bear some resemblance to his design.

In general, thermal jet engines refer to any jet-propulsion device which uses air from the atmosphere, together with the burning of a fuel to produce the fluid jet for propulsion purposes.

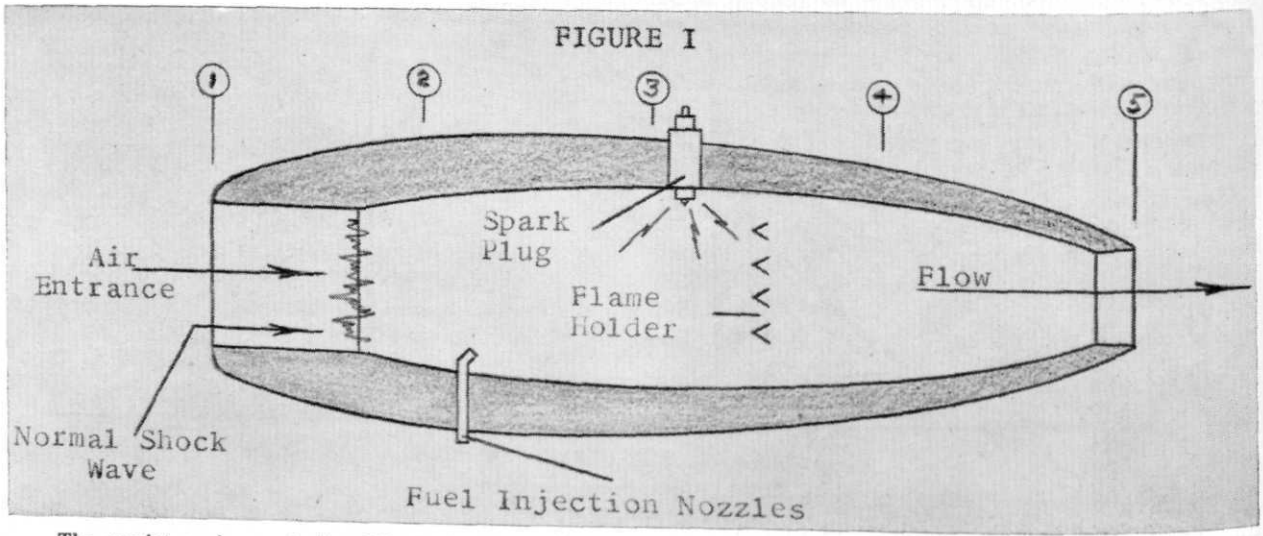
Thermal jet engines may be classified into three main groups; the ramjet; the pulsejet; and the turbojet.

The ramjet is the simplest form of thermal jet engine. It consists of a suitably shaped duct equipped with fuel burners. The ramjet has no moving parts. Inside the engine is a fuel injection nozzzle and a spark plug. The only moving parts of the engine are accessories such as the fuel pump.

They may be linked to the turbojet engines without the compressor and turbine. It is a compressorless engine only in the sense that it has neither a rotary compressor nor a piston. Our interest in the ramjet as an engine lies chiefly in its simplicity, the high speed attainable, and in its low weight.

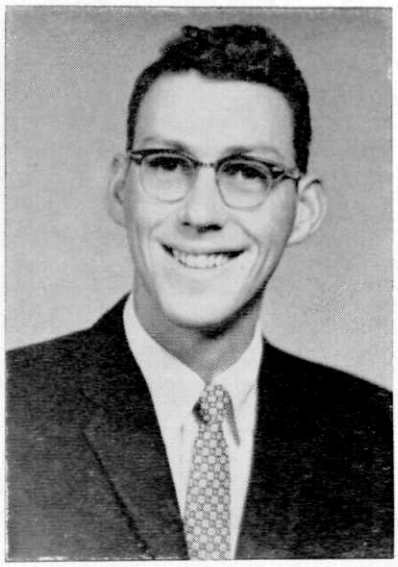
The mechanical simplicity of ramjets may lead you to think that their operation is equally simple. The apparent simplicity is deceiving, as ramjet combustion and flow operations are very complex processes.

FIGURE I



The ramjet engine as designed by Leduc appears above—The supersonic diffuser is between 1 and 2. The subsonic diffuser is between 2 and 3. The exhaust nozzle is between 4 and 5. The combusion-chamber is between 3 and 4.

John F. Artman, the student author of "Stovepipes That Fly," is a Senior majoring in Ag Education and is a member of the Ag Education club. He is from West Branch, Michigan and plans to enter the teaching field upon graduation.



JOHN F. ARTMAN

In the actual engine many problems are far from completely solved. Engineers are trying to solve the effect of varying speeds and altitudes on ram compression efficiency, and the cause of pulsations in the tube. The temperature, pressure, velocity and specific volume all change at the same time, and continuously as the gases progress through the ramjet tube.

Newton's third law of motion is the principle behind the ramjet. His law is that for every action there is an opposite and equal reaction. Those of you who have fired a rifle know this reaction as the recoil that kicks the butt against your shoulder. A jet plane similarly recoils from the thrust of its jet.

The operating principle of a ramjet is to induct air into the unit and increase its pressure. Fuel is burned continuously in this air. Heated gases are produced, and these gases are ejected at high speed out the rear of the engine in the form of a jet. The device is a continuous firing duct, operating with a continuous flow of atmospheric air. Basically this is what is happening in any jet plane you see operating.

Compression is obtained by using the forward motion of the aircraft to produce a very forceful pressure or "ram" in the supersonic diffuser section of the engine.

Because it is necessary to have a high compression pressure, engineers must design the diffuser as efficiently as possible. The velocity of the air entering the diffuser decreases from the speed of the plane to about 200 feet per second. In flight slower than the speed of sound (738 miles per hour or less), the design of diffusers having efficiencies up to 95 percent is possible. In flights faster than the speed of sound (supersonic) the diffuser design is made difficult by various thermodynamic (heat converted into motive power) and arodynamic (pressures exerted by air) uncertainties that are not fully understood by engineers. In a study by Keenan and Kaye, it was found that 85 percent efficiency could be obtained in the supersonic diffuser.

Since the ramjet is mainly a supersonic power plant, shock losses at the diffuser opening are of major importance.

The combustion-chamber design and function is one of the major problems in ramjet design confronting engineers. Large quantities of fuel must be burned efficiently in a small space without excessive pressure drop. The condition of low pressure drop and high efficiency are almost in direct opposite. A high degree of turbulence is necessary for efficient combustion in small volumes. Pressure drop in a ramjet engine is a more serious matter than in a turbojet engine. The engine will not be efficient at low flight speeds since the compression pressure will be low.

At some point in the chamber, ignition of the fuel and air mixture must take place. At this point the speed of the air must be low or continuous burning of the fuel is impossible. To attain enough "back up" pressure it is desirable to speed the combustion gases to sonic velocity. If the speed of the air is very fast it will blow the flame out the rear of the engine. This is a "flame out," the fear of all pilots because they may not have enough time to start the engine before they crash. The correct gas flow speed is attained by use of a "flame holder." Figure II is a drawing of a flame holder.

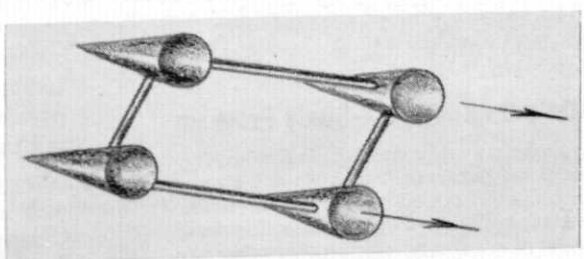
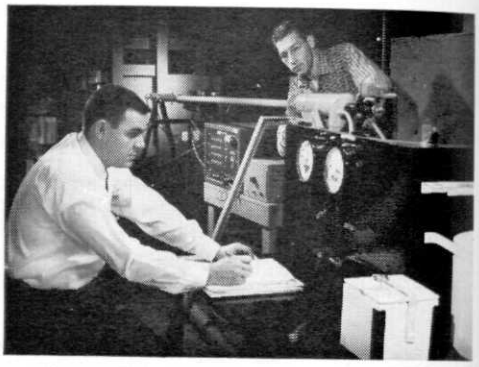


FIGURE II

The combustible mixture passes through these cones in the direction of the arrows. The velocity inside these cones is low. A continuous source of com-

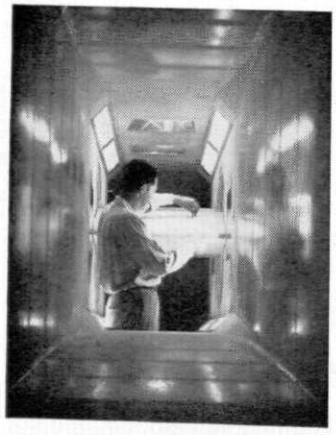
(*Continued on Page 77*)

Electronics Research Engineer Irving Aine records radiation antenna pattern on Lockheed's Radar Range. Twenty-two foot plastic tower in background minimizes ground reflections, approximates free space. Pattern integrator, high gain amplifier, square root amplifier and logarithmic amplifier shown in picture are of Lockheed design.



Mechanical Research Engineer W. M. Watkins (left) directs Research Mechanic Earl Rollo in operating Lockheed's new Hailstone Gun during a test on the effect of hailstones on new types of plastic radome "skin." The gun, which was designed by Watkins and Mechanisms Group Engineer G. W. Louthan, fires up to five hailstones spaced 25 feet apart at speeds ranging from 270 to 500 mph. The hailstones, which are made in the gun, can be varied in size from ⅜" in diameter.

Research Engineer Russell Lowe measures dynamic strain applied by Lockheed's 500,000 lb. Force Fatigue Machine on test specimen of integrally-stiffened Super Constellation skin. The Fatigue Machine gives Structures Department engineers a significant advantage in simulating effect of flight loads on a structure. Among other Lockheed structures facilities are the only shimmy tower in private industry and largest drop test tower in the nation.



C. H. Fish, design engineer assigned to Lockheed's Icing Research Tunnel, measures impingement limits of ice on C-130 wing section. The tunnel has a temperature range of −40°F. to +150°F. and maximum speed of more than 270 mph. It is the only icing research tunnel in private industry.

Advanced facilities speed Lockheed engineering progress

Master's Degree Work-Study Program

The program enables graduates in Engineering, Mathematics and Physics to attain a Master's Degree at the University of California at Los Angeles or University of Southern California while gaining important practical experience on the engineering staff of Lockheed Aircraft Corporation in Burbank, California.

Additional information may be obtained from your Placement Officer or Dean of the Engineering School or by writing E. W. Des Lauriers, Employment Manager and Chairman of the Master's Degree Work-Study Program.

Lockheed's unmatched research and production facilities help make possible *diversified* activities in virtually all phases of aviation, military and commercial.

They enable engineers to test advanced ideas which would remain only a conversation topic in firms lacking Lockheed's facilities. They help give designers full rein to their imagination. They make better planes—and better careers.

California Division

Lockheed AIRCRAFT CORPORATION

BURBANK **California**

STOVEPIPES THAT FLY!

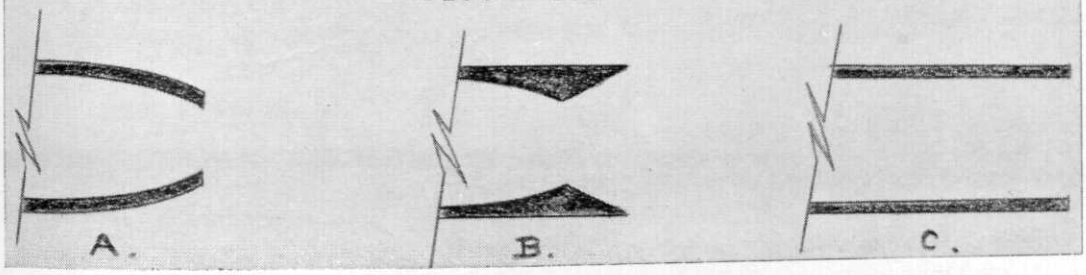
(*Continued from Page 75*)

bustion is present, which reduces the chance for a "flame out." One disadvantage of the flame holder is that it will be a source of pressure loss if the flow speed entering the chamber should change.

Temperatures at the combustion-chamber exit will range from 3,000 degrees Fahrenheit to 4,000 degrees Fahrenheit. Engineers are trying to attain still higher temperatures.

The exhaust nozzle, or the opening at the rear of the engine also determines the speed of the plane. There are three main types of exhaust nozzles. Figure III is a drawing of the exhaust nozzles.

FIGURE III



Nozzle A is the form suitable for speeds below that of sound. Nozzle B would be used for speeds above that of sound. Nozzle C would be used when the combustion-chamber temperatures are so high that the speed of the gases in the combustion-chamber reaches the speed of sound.

The fuel system of a jet engine is equally important as the engine. Power control is accomplished by varying either the quantity or the quality of the combustion mixture.

Quality control, used in most jet engines is attained by varying the fuel flow. Proper precautions must be taken by the pilot, or simple throttling of the fuel can result in harmful burner operating characteristics. Rapid and complete burning of the fuel depends on the fineness of the spray. The quantity of fuel will increase as the fuel is divided into smaller and smaller drops. The rate of evaporation and reaction depends on the area of contact of the fuel with the surrounding air. Fine atomization (breaking of the drops into smaller particles) is essential to efficient operation.

Although not all the factors affecting atomization are fully understood, you may see some of the more important ones by thinking of a garden hose. The fineness of the spray may be seen to vary with; the shape and size of the nozzzle opening; with variation in pressure drop across the opening; and with variation in the relative speed of the air.

These factors are considered by engineers in the design of a jet engine. In design of burner and nozzle openings, pressure drop is an important variable in the control of atomization.

Fine atomization of the fuel is aided by turbulence producing ducts in the nozzle. (See Figure 4 Page 78.) A spring loaded valve cuts off the flow when the fuel pressure drops at the end of injection.

Variable fuel openings are difficult to manufacture and to match. It is difficult to attain uniform characteristics in the different burners of an engine. A nozzle developed in the United States by Ex-Cell-O Corporation has been quite successful. The nozzle appeares in Figure IV.

Other nozzles have been developed and some are quite good. One was developed in England by Joseph Lucas and it is used on the Rolls-Royce Nene jet engine.

Fuels for ramjet engines must have these characteristics. They must be quick to evaporate, have a low flash point, and a very low freezing point. They must also be easily handled and have a relatively high heat content.

With richer mixtures and more efficient conversion of energy, the jet speed is increased. High thrust power is attained by the use of accurately proportioned fuel-air ratios. Such mixtures introduce new problems in burner design. Nearly all the air must come in contact with the fuel spray. Little excess air is left for cooling the combustion gases.

Fuels now used are gasoline, kerosene, and light fuel oils. Each fuel can be tailor-made by chemists for the type of engine in which it will be used.

The ramjet is a very high-speed engine, and there seems to be no limit to its speed. The faster a ramjet goes the more efficient its operation becomes. We are warned by engineers that a ramjet is by no means a perpetual motion engine. The ramjets performance is best at speeds at which other air inhaling engines are ineffective. For flight speeds above 1,500 miles per hour, the ramjet is the only logical power plant for aircraft operation in the earth's atmosphere.

Ramjets weighing only some 50 or 100 pounds are capable of giving power comparable to that of a 3,000 pound reciprocating engine. It can develop as much as 15 to 25 pounds of thrust for each pound of engine weight.

The most outstanding drawback of a ramjet is that it can not start itself, nor can it operate while sitting still. It must be launched by some device such

(*Continued on Page 78*)

STOVEPIPES THAT FLY!

(*Continued from Page 77*)

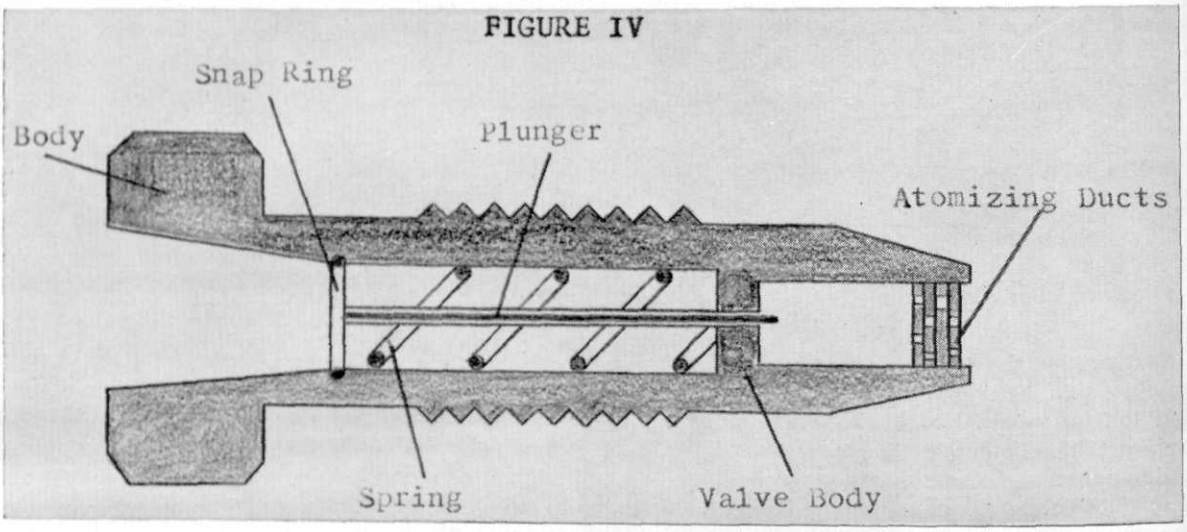
as a rocket or a conventional airplane. Once a ramjet reaches a speed of about 350 miles per hour it is able to function well enough to fly.

At speeds below the speed of sound the ramjet has no real value. At these relatively low speeds the compression pressure is low and the fuel comsumption is high. Any use of the ramjet in this low-speed range will probably be confined to an auxiliary purpose. It could be used as an expendable power plant for a guided missle. It could also be used to supply a quick burst of speed for airplanes.

To be economical an aircraft power plant must be able to burn a fuel that is cheap and plentiful. It must be simple for mechanics to maintain between overhauls, and must operate long enough between overhauls to be useful. It must also be reasonably cheap for the government to manufacture. The use of the ramjet engine will most certainly be by the government.

The ramjet is simple, efficient at high speeds and altitudes and cheap to manufacture. For these reasons engineers believe the ramjet will be a useful power plant of the future.

FIGURE IV



Captain to man leaning over the rail of the ship: "I see you have a weak stomach."

Sea sick A.S.: "I don't know about that sir. I'm throwing it as far as anyone else."

° ° °

"Yes, this is a nice apartment, where is the bath?"

"Oh, pardon me! I thought you were one of those engineering students who wants the place just for the winter."

° ° °

Funeral director to aged mourner. "How old are you?"

"I'm 97; be 98 next month."

"Hardly worth going home, is it?"

The little old lady bent over the crib: "Ooo, you look so sweet I could eat you."

"The hell you could," the baby muttered, "you haven't got any teeth."

° ° °

Professor: "Who was the first man?"

Coed, blushing: "I'd rather not tell."

° ° °

Then there was the country girl who while milking a cow, saw a boy coming up the road. She called to her father, "Oh, father, there is a college boy coming up the road.

Her father promptly replied, "Go in the house."

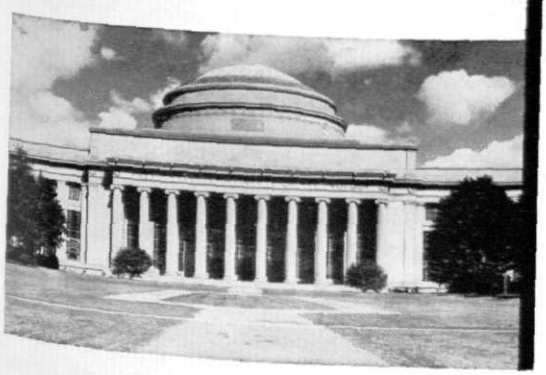
She called back, "But father he is an engineer."

"Take the cow with you," yelled the old man.

announcing . . . RAYTHEON GRADUATE PROGRAM

CALTECH

HARVARD



M. I. T.

FOR STUDY AT CALTECH, HARVARD AND M.I.T. IN 1958-59

The Raytheon Graduate Program has been established to contribute to the technical development of scientists and engineers at Raytheon. It provides the opportunity to selected persons employed by Raytheon, who are accepted as graduate students by Harvard, M.I.T. or California Institute of Technology to pursue, at Raytheon's expense, regular courses of study leading to a master's degree in science or engineering in the institution of their choice.

The Program requires, in general, two or three semesters of study, depending on circumstances, with the summer months spent in the Company's research, engineering, or manufacturing divisions. It includes full tuition, fees, book allowances and a salary while at school. Students also receive health, accident, retirement and life insurance benefits, annual vacation and other privileges of full-time Raytheon employees.

To be considered for the Program, applicants must have a bachelor's degree in science or engineering, and should have outstanding student records, show technical promise, and possess mature personal characteristics. They must be under 30 years of age on September 15 of the year admitted to the Program. They may apply for admission to the Program in anticipation of becoming employees of Raytheon.

YOU ARE INVITED TO ADDRESS YOUR INQUIRY to Dr. Ivan A. Getting, Vice President, Engineering and Research, outlining your technical background, academic record, school preference, and field of interest, prior to December 1, 1957.

Excellence in Electronics

RAYTHEON

RAYTHEON MANUFACTURING COMPANY, Waltham 54, Mass.

What Nuclear Energy Means to Plastics

by Thomas E. Dergazarian

One of the most rapid developments in modern chemical industry has taken place in the production of plastics. Plastics are a variety of synthetic solid materials which at some stage in their production exhibit the property of plasticity, or are capable of being moulded under pressure. Some of these materials become plastic when heated and can be moulded and remoulded by application of heat and pressure. These are said to be thermoplastic. Other materials are thermosetting. They also can be moulded by heat and pressure, but, under action of heat they undergo chemical change and pass into a hard material which cannot be softened and remoulded by further application of heat. The plastics of practical importance are those in which the final shape can be fixed by suitable treatment. The best known of all plastics is rubber. It can be made in various shapes and fixed by vulcanization either with or without complete loss of elasticity or springiness.

The plactics, no matter to which group it belongs, is a compound with a large molecule, or a compound of high molecular weight. The relative molecular weight of a plastic can vary from 1,000 to 1,000,000; comparatively, ordinary table salt, sodium chloride, has a molecular weight of 58.5. In some cases the large molecules have been built up by nature and exist in the raw material used in the manufacture of the plastic, such as cellulose. But in most cases the large molecules are formed during the manufacturing process. There are two methods of forming the large molecules. The first is by addition polymerization of the small molecules, that is where a large number of small molecules simply latch on to each other when heated or induced by some other means of energy to form a long chain. In fact, it is similar to a link chain where each link is a simple molecule or monomer, and the whole chain the large molecule or the polymer. The second method is condensation polymerization. This process is similar to the first except that a molecule of water is eliminated with each two pairs of monomer that combine.

The earliest plastics were introduced as substitutes for naturally occuring materials such as ivory, gums, and resins. But they now have taken their place as new materials possessing their own distinctive and valuable properties. For many purposes they are superior and have displaced wood, metal, glass, and wool.

The first synthetic plastics to be introduced were those derived from cellulose, (trees). In 1865 Alexander Parkes, of Birmingham, found that if nitrocellulose was mixed with alcohol and a certain amount of camphor a horn-like mass was obtained. This mass on warming could be moulded by pressure. This plastic was introduced in England commercially under the name Xylonite. Later in 1869 the same process was done by the Hyatt brothers of New Jersey. They called their product celluloid.

In 1872 it was observed that when carbolic acid was mixed with formaldehyde a resinous compound was formed. But not until 1908 was use made of this reaction. In that year L. H. Baekeland, inventor of Velox photograpric paper, showed that when this resin was heated in a soap solution it first softened and then after a time became quite hard. This thermoset plastic is known to us today as bakelite. It is used in the production of records, varnishes and enamels and in the electrical industry as an insulator.

Many advances have been made since in the production and use of new plastics. In fact the commercial plastics industry has far out-stripped the development of chemical theory of plastics and polymerization. New plastics or synthetic fibers have taken over the fashion world. You can hardly find a pure wool suit any more. There are folding plastic boats for you if you are a sportsman, and believe it or not, a plane with an inflatable fuselage and wings of a plastic fiber that actually flies. Doctors can now replace our arteries or animal arteries with knitted nylon tubes. Automobiles are using more and more plastics in their construction. New construction plastics have been developed for buildings from footings to rafters

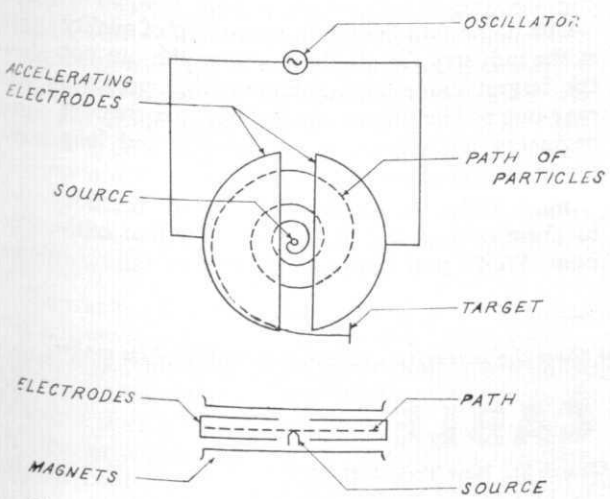
Thomas E. Dergazarian, author of "What Nuclear Energy Means to Plastics" is a student at Purdue University where he is studying for his masters degree in chemistry. Mr. Dergazarian received his bachlors degree at Michigan State University where he was a member of Alpha Chi Sigma social fraternity and Pi Mu Epsilon, national mathamatics honorary.

THOMAS E. DERGAZARIAN

and points between on both inside and outside walls, and you can furnish it with plastic furniture, drapes, rugs and tiles. There just is not a thing that you can name that has not a plastic substitute.

A more recent advance, not in the commercial products, but in the production of raw material is the development of the use of nuclear energy as the source required to produce a large polymer molecule, or to obtain or produce desirable properties in the existing plastics. Naturally, the concept of creation and adaptation of invisible and silent rays or particles to polymer or plastic chemistry is exciting. A national magazine in the building field stated in September of 1954 that "massive doses of gamma radiation have been harnessed to make an ordinarily soft sheet of plastic stronger than the same thickness of today's structural steel and so heat resistant that it could be used in the after burners of jet engines." This is not quite true.

The facts are that nuclear energy is today an accepted tool for the transformation of one kind of plastic (polyethylene) from a thermoplastic to a thermoset molecule. It is a prospective tool for the production of existing plastics and the creation of new plastics.



The cyclotron above is an example of one of the many ways used to accelerate atomic particles to high velocities.

Reference to nuclear energy in the singular is misleading. Bombardment for the transformation or processing of plastic materials may be done by alpha particles, beta particles or electrons, gamma rays and X-rays. The latter two sources are similar. The source of radiation may be a nuclear reactor, a shielded radioactive isotope or an electron generator. These four fundamental particles and rays are all forms of nuclear energy. These energies have definite effects on different plastics since the form of the energies are all different.

The alpha particle is a comparatively slow moving particle and big in size and has little penetrating power. The beta particle or electron has a tremendous velocity and relatively deep penetration power. Gamma rays travel with the speed of light, and have tremendous penetrating power. X-rays are similar to gamma rays but are weaker.

Of all these forms of nuclear energy the two forms that are of the greatest interest to the chemistry and industry of plastics are gamma rays and electrons. They are important because they are easily obtained from isotopes or generated by machines.

Now it is possible to induce polymerization or the formation of large molecules without the use of high temperatures and pressures, and without the use of other chemical compounds to initiate, propagate and terminate the reaction. New and better plastics should result since there is no source of contamination in the material to be treated.

Gamma radiation can best be obtained from a cobalt 60 isotope which has a half-life of 15.3 years. This means that half of the energy of the cobalt isotope is expended in 15.3 years, then in the next 15.3 years half of the remaining energy is expended and so on. The facilities for irradiation by isotopes are

(Continued on Page 83)

What response do you think we got from these ads in your magazine?

Absolutely none—but they did get readership! We know that from our readership survey reports.

Actually, they weren't written to create a heavy response. They were designed to acquaint you with our name and to give you thumbnail sketches of historical figures, both real and mythical, noted for their integrity and durability. Just as Kerite has been noted since 1854.

Our name has been *the standard* of quality in the industry for all these years. We are not the largest cable manufacturer. Our products may not be the lowest priced. But experienced engineers will agree: when quality and long life are a must, specify Kerite.

Meanwhile we would value your reaction to these ads—particularly constructive criticism. Won't you drop us a line?

The value and service life of a product can be no greater than the integrity and craftsmanship of its maker.

KERITE CABLE

THE KERITE COMPANY—30 Church St., New York 7, N. Y.
Offices also at 122 S. Michigan Ave., Chicago; 582 Market St., San Francisco;
3901 San Fernando Rd., Glendale 4, Calif.; 31 St. James Ave., Boston;
4101 San Jacinto, Houston 4, Texas; 1010 Euclid Avenue, Cleveland 17, Ohio;
29 West Lancaster Avenue, Ardmore, Pa.

Since 1854

NUCLEAR ENERGY

(*Continued from Page 81*)

strictly of laboratory or pilot size in scope. For our present industries to convert to a mass production basis would require a fantastic amount of conveyors and control apparatus. Mass production plants would then have to be enormous in size to accommodate all the equipment. However, experimental work can be done on the production of plastics and is being done. But, there is by no means a conclusive amount of work. The chemist knows that radiation polymerization or formation of large molecules can be accomplished at low temperatures, in the solid state and without worry of contamination.

Our present experimental evidence indicates that in some plastics certain properties may be changed by gamma radiation. Sometimes in a way which is desirable and sometimes not. Too much irradiation can destroy the plastic material.

The physical properties of a given plastic are dependent upon the molecular weight and on the extent of cross bridging. Cross bridging can be compared to a rope ladder. The sides being composed of various lengths of polymer, and the rungs also being composed of various lengths of polymer. The ladder is two dimensional whereas cross bridging occurs in a three dimensional plane. If there is little or no cross bridging in long polymer chains then the polymer becomes plastic at high temperatures and can be moulded. As the amount of cross bridging increases in the polymer it becomes less and less plastic, that is it becomes more rigid. Irradiation of some polymers produces cross bridging with the change in properties indicated above. After a certain amount of irradiation the polymer can no longer be moulded. At the same time that the material is losing its thermoplastic properties it is becoming more brittle; a condition which is not always desirable. Too much irradiation of a polymer will cause it to lose its good characteristics and begin to disintegrate. However a controlled amount of irradiation determined by experimental research can increase the resistence to thermal softening which accompanies cross bridging. Since this effect would make it difficult to mould the cross bridged polymer plastic, it would be more satisfactory to induce cross bridging after the plastic has been made into its final form. The high penetrating power of gamma rays, and the fact that they produce the effect at low temperatures means that upon irradiation cross bridging can occur all thru the material without much change in surface appearance or distortion of the object.

The results of beta or electron particle irradiation on a polymer are the same as the effects produced by gamma rays. However, the use of beta particles is three times more efficient than the use of isotopes as the source of radiation. The one great advantage that the electron accelerator has is that it is a machine and can be turned off, whereas an isotope source keeps on producing radiation. There are also technical difficulties in handling large isotope sources such as shipping, storage, maintenance of safe guards against radiation, and also of conveyors and other apparatus.

The electron beam from the generator is a stream of atomic particles that are similar to a current in an electric wire, except that the electrons have been liberated from a conductor, and have been accelerated to tremendous speeds. The output of the electrons can be controlled and modified. However, electron particles cannot be used to study molecular structures and mechanisms or processes of molecule formation, whereas isotopes can.

Plastics have always been known as the wonder compounds. But now, when working with nuclear energy, new prospects for future development have been opened up. There is a promise of new and better materials, improved processing methods and better end products, even when realizing that there are definite limitations to the applications of nuclear energy in the plastics field.

The Michigan father was introducing his family of boys to a visiting governor.

"Seventeen boys," exclaimed the father, "and all Democrats—except John, the little rascal. He got to readin'."

CRYSTAL FILTERS

(*Continued from Page 73*)

been only within the past two years, however, that any serious work has been undertaken to make commercially-available filters containing a network of quartz crystals which will allow a band of frequencies to pass. Lattice filter networks made up of quartz crystals were first proposed by a scientist named Warren Mason of Bell Telephone Laboratories about twenty years ago. However, the mathematical calculations necessary to design these networks and the difficulty of producing the necessary crystals at high frequencies caused manufacturers to shy away from crystal filters. It was Dr. David Kosowsky of M.I.T. and now at Hycon Eastern, Inc., Cambridge, Mass., who developed a highly-simplified mathematical technique for designing crystal filters, and devised new methods for producing and testing the required quartz crystals. Kosowsky went further on and designed shop production equipment which makes the manufacture of crystal filters almost routine. It was this latter step which enabled Hycon Eastern to bring the price to a figure which is competitive with LC and mechanical filters.

At frequencies above a few megacycles, crystal filters are virtually unchallenged by their sisters, LC filters and mechanical filters. The older type filters just won't do the job at high frequencies. At lower frequencies, where long-established techniques have brought LC and mechanical filter prices down to low figures, crystal filters excel only in performance. At lower frequencies, crystal filter prices and mechanical filter prices are roughly the same. A typical crystal filter currently sells for forty dollars when bought in small quantities, or twenty to twenty-five dollars when purchased in larger lots. As with transistors, which sold for about two hundred dollars when originally developed and now sell for less than two dollars, crystal filters will also come down in price when they are in high production.

Although the low frequency crystal filter will play a significant role in single sideband and telephone communication systems, the high-frequency crystal filter may well revolutionize the design of other communication and navigation systems. In addition to performance which cannot normally be obtained even at lower frequencies with conventional filters, the high-frequency crystal filter may be made extremely small in size. Models have already been produced which are about half the size of a small match-box. These miniature crystal filters, in conjunction with miniature vacuum tube and transistor circuitry, are currently being employed in the design of several of the most compact communications equipment ever produced.

Biggest potential use in the next few years of crystal filters will probably be in mobile communications. With the Federal Communications Commission constantly forcing all radio systems to operate in continuously narrower frequency bands because of crowded conditions at high frequencies, narrow band

(*Continued on Page 86*)

A Vought Vignette
ONE OF A SERIES

The propulsion engineer who was allergic to switches

During the Vought Crusader's N.A.A. record-breaking flight across the continent, fuel management was a vital factor. But it wasn't the constant worry it might have been. Fred Alvis had seen to that, beginning four years ago.

When the Crusader project was formed, Fred was just a few years out of Alabama Poly. His was still a new face. Mighty new, Fred would have agreed when he was tapped to develop the functional design of the Crusader fuel system.

Navy specs told Fred his system should be reliable and very lightweight. Pilots, too, gave him a special request. In the ready room near the flight line they described the constant in-flight attention required by complex fuel systems. "Can you fix it so we can forget fuel for a minute?" they asked the young designer. "Can you cut down on those switches?"

Fred went all-out for simplicity, plunging into a three-month whirl of schematics. He was encouraged by close design group assistance in studies and layouts. Soon he was making procurement selections and writing functional reports. Then, with the fuel system mockup, Fred unveiled what he'd done.

It was a showpiece of simplicity. Absent was the usual complex CG control system. Fred had bypassed the problem entirely by canny choosing of fuel cell locations and fuel line sizings. Absent, too, was an emergency system — together with the need for it! There was a unique air transfer system for moving fuel from the Crusader wing tank to the main sump, plus some freshly conceived lesser features.

As mockup and flight tests proved, Fred's ideas more than met weight and reliability requirements. And, as pilots were shown, all simplification features led directly to the cockpit. There Fred had won his war against switches.

Only one had survived.

At Vought, the invitation to find a fresh approach is extended to every engineer. Here, in groups that coordinate for mutual progress, and in test facilities that can evaluate the most advanced proposals, ideas receive the attention they deserve.

BUILDERS OF MILITARY AIRCRAFT
40th ANNIVERSARY
1917 TO 1957

CHANCE VOUGHT AIRCRAFT
INCORPORATED · DALLAS, TEXAS

INDEX TO ADVERTISERS

* Inside front cover
** Inside back cover
*** Back cover

CRYSTAL FILTERS

(*Continued from Page 84*)

pass filters are becoming more and more significant. At the present state of communications art, LC and mechanical filters are being used to their ultimate capabilities. The advent of crystal filters now enables equipment manufacturers to surge ahead with radio and radar systems using narrower frequency bands than were possible before.

An extremely important significance of the arrival of crystal filters on the communications scene is the possibility now of eliminating multiple conversion high frequency receivers. Because it has been hard to filter signals at high frequencies, electronic manufacturers have utilized steps of frequency conversion to get the frequency down to a usable range. In other words, signals at high frequencies could not be easily filtered using LC or mechanical filters, so the signals have been converted to frequencies where filters will work. Often, multiple conversion receivers have three mixing stages where frequency conversion is accomplished. Each of the mixing stages requires an oscillator. In addition to the higher cost, each oscillator added to a receiver causes unwanted noise possibilities. In short, the manufacture and alignment of multiple conversion receivers is more complicated than for single conversion receivers. Crystal filters make possible the design and manufacture of single conversion receivers at high frequencies where this has not been feasible up to now.

Modern Science Defines a Woman

Symbol: WO

Accepted WT 120

Occurrence: Found wherever men exist: seldom in a free state.

Physical Properties: Boils at nothing, may freeze any minute, melts when properly treated, very bitter if not well used.

Chemical Properties: Very active, possesses affinity for gold, silver, and precious stones, violent reaction when left alone. Able to absorb great amounts of expensive food, turns green when placed beside a better specimen, and ages rapidly.

Uses: Highly ornamental, useful as a tonic for low spirits, is probably one of the most powerful income reducing agents known.

Caution: Highly explosive.

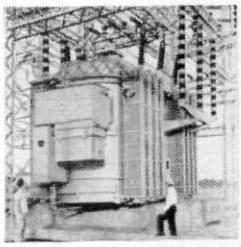
ALLIS-CHALMERS

...where you can design, build, research or sell products like these

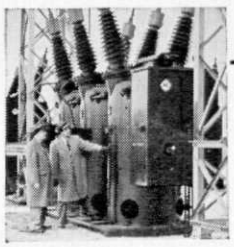
...and grow with 3 growth industries

POWER EQUIPMENT

Steam Turbines



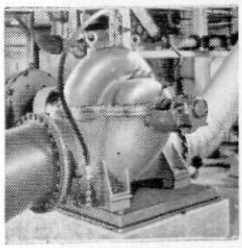
Transformers of all Types



Circuit Breakers

CONSTRUCTION

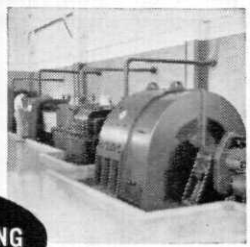
Road Building Equipment



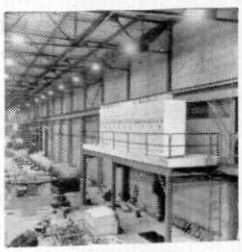
Pumps, Blowers

Cement-Making Equipment

MANUFACTURING



Motors



Control

V-Belt Drives

Opportunities in these fields

- Thermodynamics
- Acoustics
- System Analysis (Electrical and Mechanical)
- Stress Analysis
- Hydraulics
- Electronics
- Process Engineering
- Mechanical Design
- Structural Design
- Metallurgy
- Nucleonics
- High Voltage Phenomenon
- Analog and Digital Computers
- Fluid Dynamics
- Basic Research

You can grow faster in a company that supplies the basic needs of growth! Power, construction and manufacturing *must* grow to supply the needs of our population which is increasing at the rate of 50,000 per week. Allis-Chalmers is a major supplier of equipment in these basic industries.

But there's another factor of equal importance: Allis-Chalmers Graduate Training Course offers unusual opportunities for the young engineer to:

- Find the type of work he likes best
- Develop engineering skill
- Choose from a wide range of career possibilities

Allis-Chalmers graduate training course has been a model for industry since 1904. You have access to many fields of engineering: electric power, hydraulics, atomic energy, ore processing.

There are many *kinds* of work to try: design engineering, application, research, manufacturing, sales. Over 90 training stations are available, with expert guidance when you want it. Your future is as big as your ability can make it.

Or, if you have decided your field of interest and are well qualified, opportunities exist for direct assignments on our engineering staff.

In any case—learn more about Allis-Chalmers. Ask the A-C manager in your territory, or write Allis-Chalmers, Graduate Training Section, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

5196

SIDETRACKED

Student Responses:

Freshman: "I don't know."

Sophomore: "I'm not prepared."

Junior: "I can't remember."

Senior: "I don't believe that I can add anything to what has already been said."

° ° °

A lot of engineers get half drunk on Saturday night because they run out of money.

° ° °

And then there was the deaf mute who fell into a well and broke three fingers screaming for help.

° ° °

Frosh: "What's Doc talking about?"

Engineer: "Integration, you halfwit."

Frosh: "Is he for or against it?"

° ° °

Students are like blotters, they absorb what the instructor says, but they get it backwards.

° ° °

Trying to rest after an exceedingly hard day at the office, poor father was being bedeviled by a stream of unanswerable questions from little Willie.

"What do you do down at the office?" Willie finally asked.

"Nothing," shouted the annoyed father.

After a thoughtful pause, Willie inquired "Pop, how do you know when you're through?"

° ° °

The liner had just sunk and one of the lifeboats was filled beyond capacity. The captain gravely announced the fact and jumped overboard himself. Another passenger got up, said "Vive la France," and jumped. A third said "God save the queen," and repeated the deed. At that a burly Texan got slowly to his feet, exclaimed "Remember the Alamo," and threw a Mexican overboard.

The editor of this column points with pride to the clean, white spaces between these jokes.

° ° °

A woman approached the pearly gates and spoke to Saint Peter.

"Do you know if my husband is here? His name is Smith."

"Lady, we have lots of them here, you'll have to be more specific."

"Joe Smith."

"Lotsa those too, you'll have to have more identification."

"Well, when he died he said that if I was ever untrue to him, he'd turn over in his grave."

"Oh, you mean 'Pinwheel Smith'."

° ° °

Prof. (after the final): "Well, what did you think of the course?"

M.E.: "I thought that it was all-inclusive; everything that wasn't covered during the semester was on the final exam."

° ° °

Engineering is a good deal like golf. Those who are good drivers become managing executives; for those whose best shots are brassie, the advertising profession offers a good opportunity. In case of a good lie, those who approach well find salvation in salesmanship and those good on the green become cashiers and investment brokers. The duffers remain engineers.

° ° °

Marriage is like a hot bath; once you get used to it, it's not so hot.

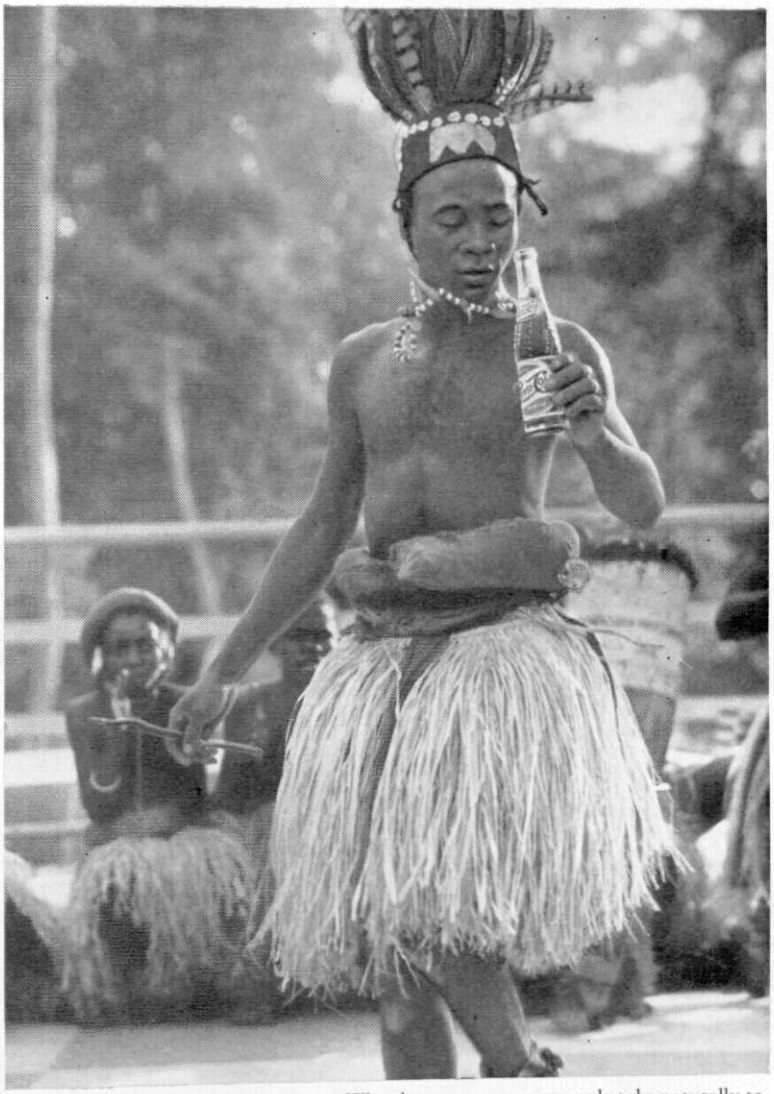
° ° °

E.E.: "I know all about electricity. A politically minded ion hears that there is going to be an electron, so he goes to the poles and volts."

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.

EASTMAN KODAK COMPANY, Rochester 4, N. Y.

CAREERS WITH KODAK

With photography and photographic processes becoming increasingly important in the business and industry of tomorrow, there are new and challenging opportunities at Kodak in research, engineering, electronics, design and production.

If you are looking for such an interesting opportunity, write for information about careers with Kodak. Address: Business and Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.

Kodak
TRADE MARK

One of a series

Interview with General Electric's Hubert W. Gouldthorpe Manager—Engineering Personnel

Your Salary

Although many surveys show that salary is not the prime factor contributing to job satisfaction, it is of great importance to students weighing career opportunities. Here, Mr. Gouldthorpe answers some questions frequently asked by college engineering students.

Q. Mr. Gouldthorpe, how do you determine the starting salaries you offer graduating engineers?

A. Well, we try to evaluate the man's potential worth to General Electric. This depends on his qualifications and our need for those qualifications.

Q. How do you evaluate this potential?

A. We do it on the basis of demonstrated scholarship and extra-curricular performance, work experience, and personal qualities as appraised by interviewers, faculty, and other references.

Of course, we're not the only company looking for highly qualified men. We're alert to competition and pay competitive salaries to get the promising engineers we need.

Q. When could I expect my first raise at General Electric?

A. Our primary training programs for engineers, the Engineering Program, Manufacturing Program, and Technical Marketing Program, generally grant raises after you've been with the Company about a year.

Q. Is it an automatic raise?

A. It's automatic only in the sense that your salary is reviewed at that time. Its amount, however, is not the same for everyone. This depends first and foremost on how well you have performed your assignments, but pay changes do reflect trends in over-all salary structure brought on by changes in the cost of living or other factors.

Q. How much is your benefit program worth, as an addition to salary?

A. A great deal. Company benefits can be a surprisingly large part of employee compensation. We figure our total benefit program can be worth as much as 1/6 of your salary, depending on the extent to which you participate in the many programs available at G.E.

Q. Participation in the programs, then, is voluntary?

A. Oh, yes. The medical and life insurance plan, pension plan, and savings and stock bonus plan are all operated on a mutual contribution basis, and you're not obligated to join any of them. But they are such good values that most of our people do participate. They're an excellent way to save and provide personal and family protection.

Q. After you've been with a company like G.E. for a few years, who decides when a raise is given and how much it will be? How high up does this decision have to go?

A. We review professional salaries at least once a year. Under our philosophy of delegating such responsibilities, the decision regarding your raise will be made by one man —the man you report to; subject to the approval of only one other man —his manager.

Q. At present, what salaries do engineers with ten years' experience make?

A. According to a 1956 Survey of the Engineers Joint Council*, engineers with 10 years in the electrical machinery manufacturing industry were earning a median salary of $8100, with salaries ranging up to and beyond $15,000. At General Electric more than two thirds of our 10-year, technical college graduates are earning above this industry median. This is because we provide opportunity for the competent man to develop rapidly toward the bigger job that fits his interests and makes full use of his capabilities. As a natural consequence, more men have reached the higher salaried positions faster, and they are there because of the high value of their contribution.

I hope this answers the question you asked, but I want to emphasize again that the salary *you* will be earning depends on the value of *your* contribution. The effect of such considerations as years of service, industry median salaries, etc., will be insignificant by comparison. It is most important for you to pick a job that will *let* you make the most of your capabilities.

Q. Do you have one salary plan for professional people in engineering and a different one for those in managerial work?

A. No, we don't make such a distinction between these two important kinds of work. We have an integrated salary structure which covers both kinds of jobs, all the way up to the President's. It assures pay in accordance with actual individual contribution, whichever avenue a man may choose to follow.

*** We have a limited number of copies of the Engineers Joint Council report entitled "Professional Income of Engineers—1956." If you would like a copy, write to Engineering Personnel, Bldg. 36, 5th Floor, General Electric Company, Schenectady 5, N. Y.** 959-7

LOOK FOR other interviews discussing: • Advancement in Large Companies • Qualities We Look For in Young Engineers • Personal Development.

GENERAL ELECTRIC