MEMBER E. C. M. A.

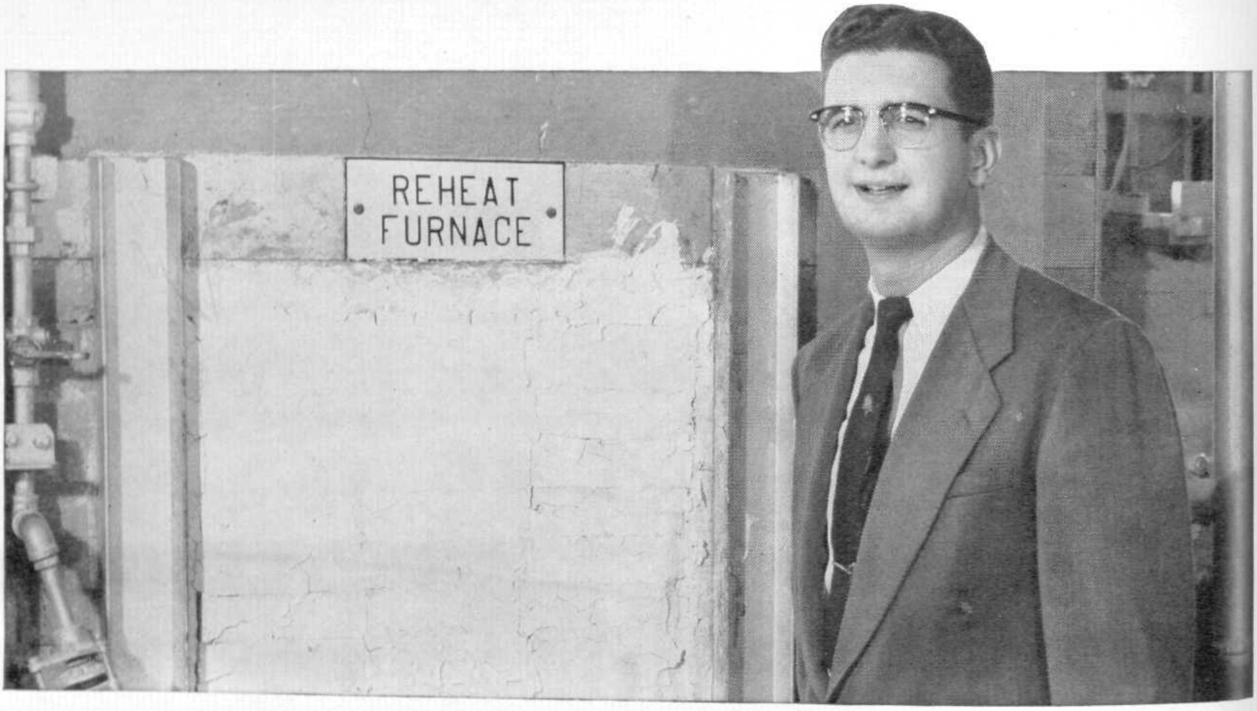
Spartan Engineer

PRICE 25c

VOLUME 10 NUMBER 2 JANUARY, 1957

James R. Bachman, class of '51,
speaks from experience when he says . . .

"I find the Applied Research Laboratory of U. S. Steel an interesting and rewarding place in which to work."



The rapid rise of Mr. Bachman at United States Steel's Applied Research Laboratory in Monroeville, Pa., is typical of that of many scientists and engineers who have come to U. S. Steel from college and who have staked their future with this organization.

Mr. Bachman received his B.S. Degree in 1951 and his M. S. Degree in 1952. Both of these degrees were in Ceramic Engineering. While at college, he served as a Research Assistant on a commercial research refractories problem.

In June, 1952, Mr. Bachman was employed in the Refractories Division of the Applied Research Laboratory as Assistant Technologist. During his four years of employment, he has received two promotions. Today, he is the Supervising Technologist, Refractories Division, at this laboratory.

Mr. Bachman has said: "At U. S. Steel's Applied Research Laboratory, we are actively solving problems that are of vital importance to the steel industry. These problems are many and varied, including as they do activities in the fields of physics, chemistry, mathematics, and electrical, mechanical and metallurgical engineering."

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Spartan Engineer

of michigan state university

VOLUME 10 NUMBER 2 JANUARY, 1957

FEATURES

DEPARTMENTS

Cover: By BOB FREDERICKS AND ERNIE LAPENSEE
FRONTISPIECE: NINE-FOOT GAS RECIRCULATING FAN WHEEL.
See article on page 36.

MEMBER ENGINEERING COLLEGE MAGAZINES ASSOCIATED

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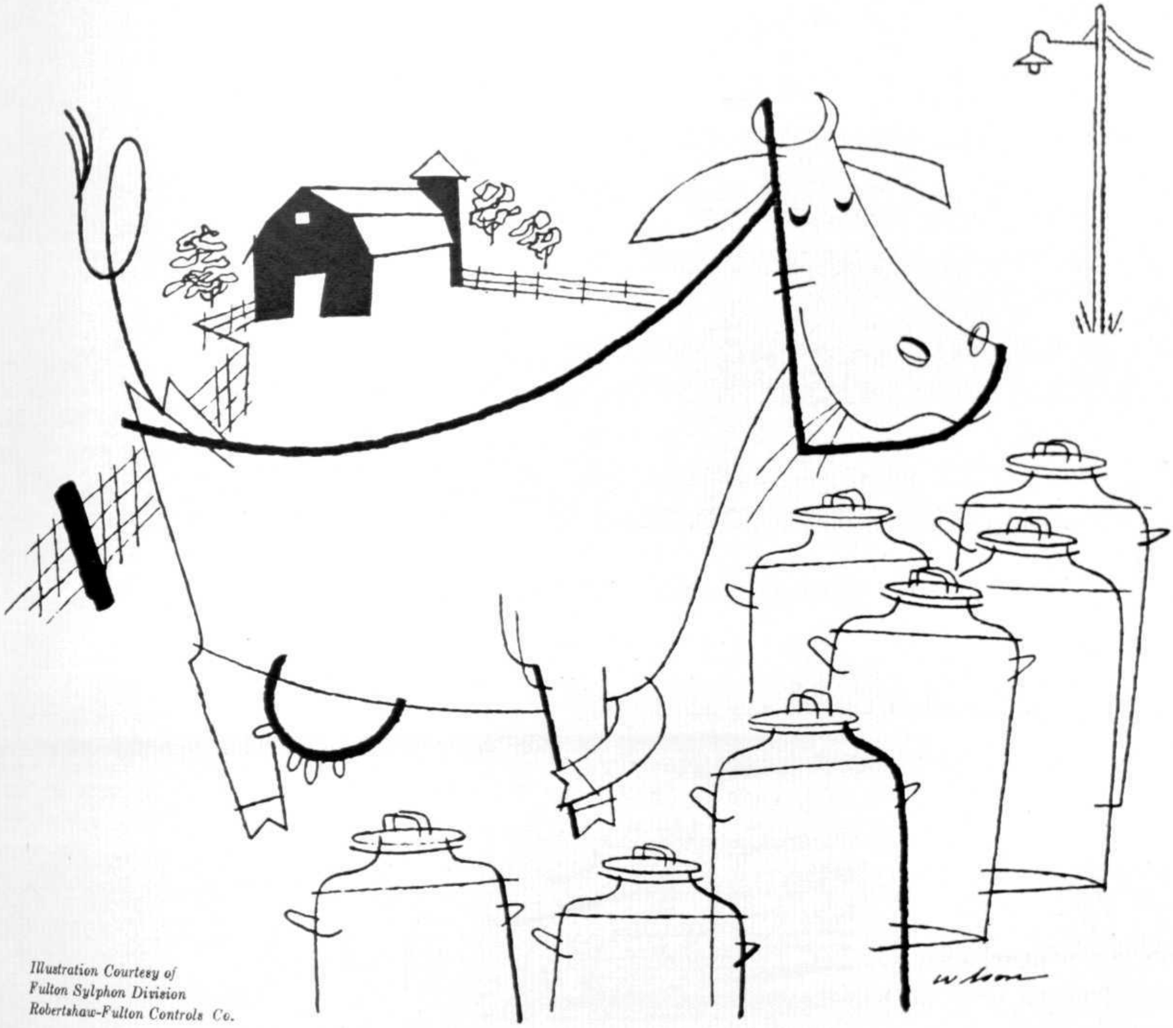

Illustration Courtesy of
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There's satisfaction in meeting a challenge

For engineers worth their salt, challenge is stimulating. We live in such an atmosphere at Detroit Edison, a company internationally known for its bold, imaginative engineering. But let's be specific.

Soon it's going to be sound economics for us to transmit energy at 345 kv. There's not much precedent to draw on; much remains to be clarified about system design, operation, radio interference, line losses, relays, system integration, lightning performance. Where does the challenge stop?

Or take the problem of heat exchange. We're deep in atomic power plant design, where sodium is the primary coolant. Efficient heat exchange is essential! There's the same problem with respect to gas turbines and critical-pressure boilers, too.

We also plan to use our digital computers, and like equipment, in new, untried ways. Applying them to engineering and management problems, for example. But it will take time AND talent to do some creative engineering first.

If these challenges—a few at random—suggest a career that appeals to you . . . well, you appeal to us. Stop at your Placement Office and arrange an early interview.

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Q *Are the assignments interesting?*

A Our engineers are working ten years ahead . . . which means that every project you're assigned to is at a research or developmental level. And you get a crack at responsible assignments from the start . . . modern facilities to test out your ideas . . . with engineering aides to do the routine work.

Q *Are there good men on the team?*

A Well — for one — there's Alexander Kartveli, Vice President, Research & Development, who sparked the Thundercraft series. There's Dr. Theodore Theodorsen, for another — among whose accomplishments is the theory of wing-flutter — who heads our Scientific Research Group . . . and there are hundreds of other engineers and scientists of major stature.

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A Only you can answer that . . . and your talent is the key. But everything that is possible for a company to do — for you to achieve your maximum potential — REPUBLIC does . . . including attendance and presentation of papers at professional meetings and advanced studies at prominent universities and colleges.

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Engineering Employment Manager
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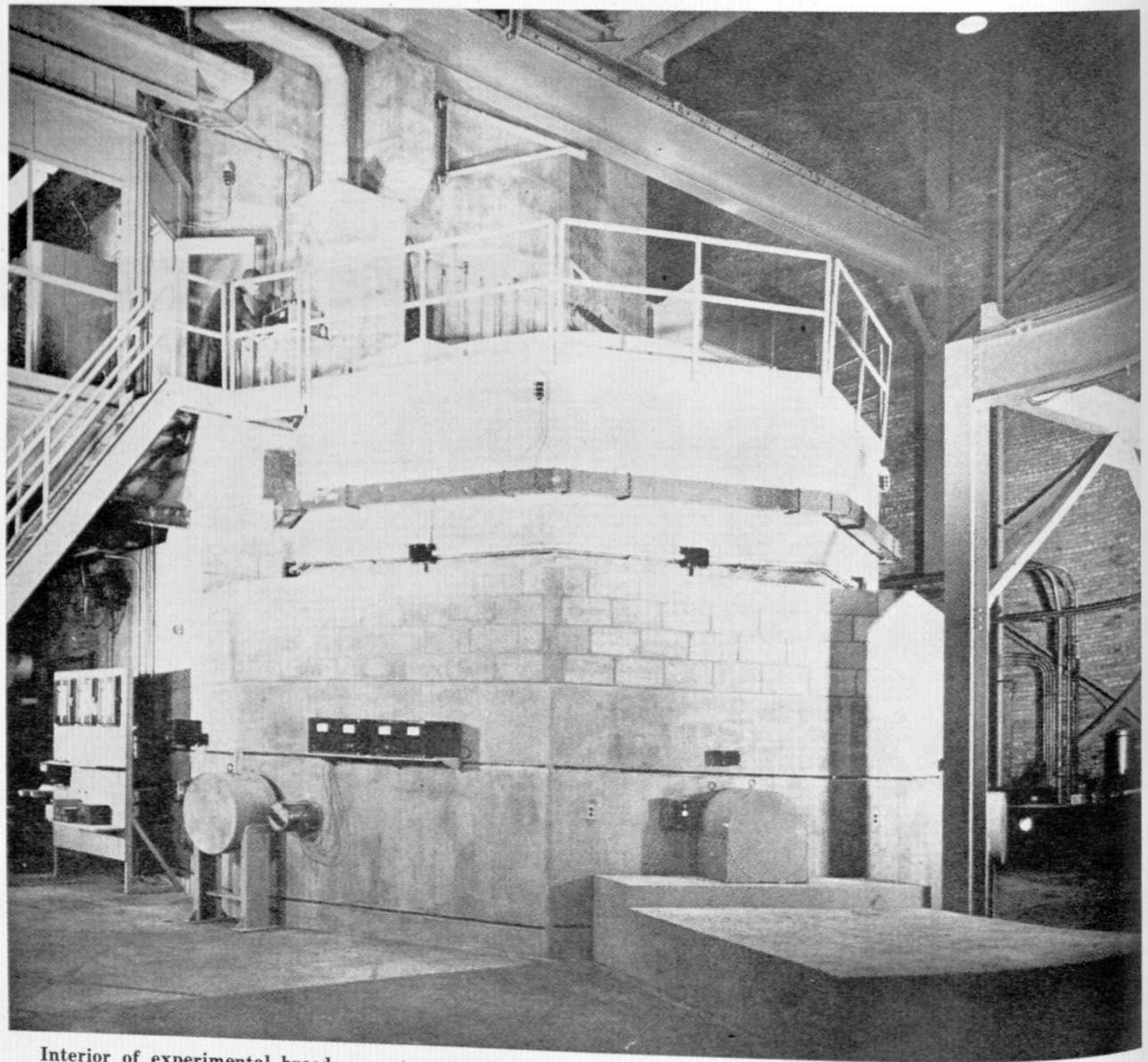
REPUBLIC AVIATION

Nuclear Radiatiffects on Metals

by John J. Green, Mth '57



Interior of experimental breeder reactor at AEC station in Idaho. Reactor is doing dual job of breeding fissionable material and creating heat that can be converted into electrical energy.

I INTRODUCTION

The giant step from fundamental physical research to practical application is often taken quickly. Like analogous transitions in other areas of human affairs it leaves the participants gasping for breath. Such has been the case in the field of atomic and nuclear physics.

The past half-century, and more particularly the last fifteen years, has seen a revolution in the physical sciences. This, most of us appreciate. However, what we may be failing to evaluate is the fact that what was once the sacred domain of the theoretician is now fair game for the engineer. More explicitly we may even say that it is the responsibility of the engineer.

The social scientist points out the culture lag that follows periods of rapid change. To some extent we are experiencing a period of "realization lag." The engineering undergraduate is emerging into a field where huge enterprises are already advertising for "Reactor Engineers" and dozens of texts have been written and titled "Introduction to Nuclear Engineering" or some variation thereof.

As a result curriculum, too, lags. This is natural and it is prophetic to note that our engineering school has already included a course in nuclear energy in the prescribed program. However, the time hiatus does not represent an adequate excuse for the discerning student to remain aloof from the implications of the "atomic age" in his profession. This is not a responsibility of the future; it is with us now.

This article is a survey of just one important engineering consideration of this entire area. The resource materials were largely obtained from investigations into so-called "radiation damage." The object of these articles was primarily the dissemination of information regarding the damage done to the materials used in nuclear reactors by the resultant exposure to radiation. This does not mean that the results of these investigations are restricted in their application.

Consequently our plan of attack will be: first, a brief discussion of the terms and physical mechanisms involved; second, an investigation of five basic effects, and third, consideration of the implications. There has been no attempt toward rigor in the treatment of crystal structure or mechanisms involved. At the conclusion of the article is a substantial bibliography on the subject which will serve to amplify these remarks.

II PHYSICAL TERMS, STRUCTURES, AND MECHANISMS

Our title for the article contains two indicative phrases: "Nuclear Radiation" and "Metals." To investigate effects of one on the other we will have to consider several characteristics of each separately.

A. *Nuclear Radiation*

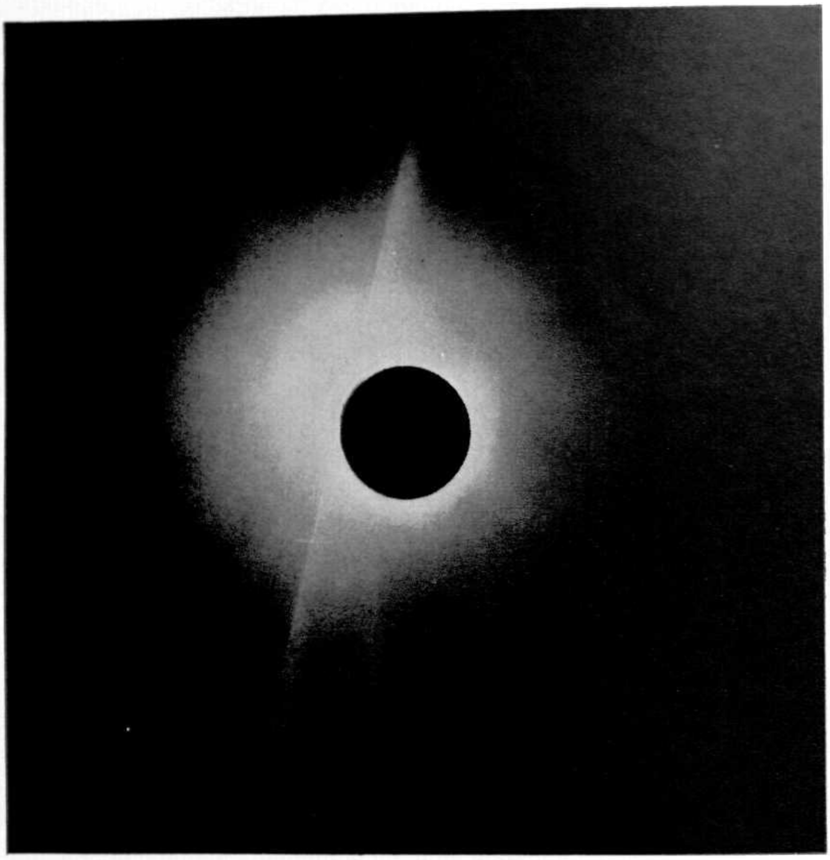
Fifteen years ago the world's best staffed "Metallurgical Laboratory" was in full operation at the University of Chicago. Under the leadership of A. H. Compton (who was a visiting distinguished professor at M.S.U. last Spring) and Enrico Fermi, the laboratory was engaged in the construction of the first atomic pile.

Named the "Metallurgical Laboratory" for security reasons, one of the most critical problems faced by the staff scientists was indeed metallurgical in nature. What would be the effects of nuclear radiation on the reactor and its structural materials?

In a sense, these various types of radiation can be considered as sub-microscopic "missiles." The "missiles" occur in the forms of alpha and beta particles, neutrons, protons and fission fragments. (Gamma rays and neutrons are also emitted but their effects are not within the scope of this article.)

Each is a distinct particle and as such has a certain mass associated with it. The beta particle (or electron) has been experimentally measured at a cgs mass of 9.1 x 10^{-28}gm and assigned a new designation of .00055 amu (atomic mass unit). The proton and the neutron are approximately equal in mass and of the order of 1.7 x 10^{-24}gm. (The proton has a mass of about 1.008 amu and the neutron about 1.009 amu).

(Continued on page 76)



JETS Contribute to Education

by Patrick Miller, Mth., '57

John Dewey was one of the present-day contributors to modern education. In his many works he expressed the idea that effective education must control the individual's environment, so that he may become a sharer in the society. Today, many of our educators are trying to put Dewey's theories into practice.

If we look at our society of today, many of us will conclude that it is one of a highly technical nature. This is especially apparent if we look at the toys many small kids received for Christmas. These ranged from small rocket ships to ray-guns. Formerly, toys may not have been as advanced technically, but they did consist of technical principles, and most youngsters took a great interest in them.

It seems that the young kids of America were always little engineers. Doesn't it seem alarming when we read the newspapers and hear of the shortage of engineers in our society? Just what happens to all the young minds which start out so well on the road to the engineering profession? Is our society one which doesn't give the youth a fair chance to become an engineer or are our educational systems at fault?

If you ask a college student in Liberal Arts why he isn't studying engineering, he usually answers, "Oh, it was that algebra. I could get the concepts and formulas all right, but I could never see any way to apply them." If we support Dewey's theory, we may feel that our system of education has been at fault and something should be done to correct it. An attempt in this direction has been made in the form of the JETS (Junior Engineering Technical Society) Clubs. In the November, 1956, issue of the *Engineer*, the story of the origin and function of the JETS was presented. Probably from an educational standpoint the main purpose of the JETS is in supplying conditions for the students to put into practice what they have learned in the classroom.

We may wonder if the JETS, as such, do supply the necessary purposes in serving our society. A Junior E.E. major, from the Grand Rapids South High School makes the following report. The G.R. South High School JETS club does a great deal of work on projects. These projects are left up to the individual. He may choose to work on a project which involves principles that he is interested in. The G.R. club also started selecting certain noon hours when the members go to the industrial shop for instructions on shop work. In constructing their projects the student must usually combine principles of mathematics, physical science, and industrial arts. This gives him the opportunity to put into practice some of the theories he has acquired in the classroom. Also this tends to show the relationships between these various subjects and their importance. A somewhat astounding fact of G.R. club is that considering the former members, with the exception of two or three, all are now directly involved in some field of the sciences.

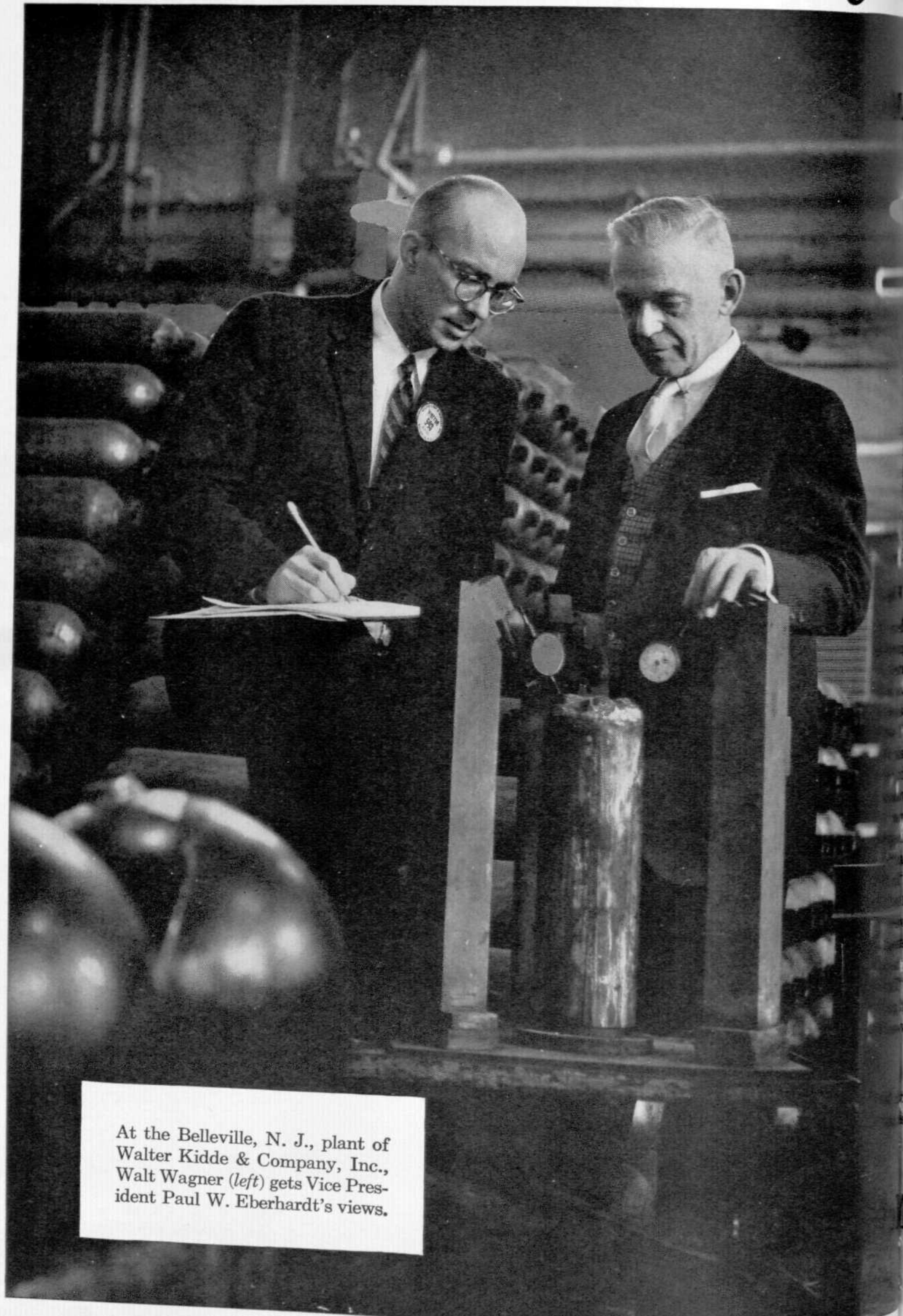
"I really didn't know at all what the engineering profession consisted of," confided a sophomore M.E. major from Okemos, "until after becoming a member of the JETS." These clubs go on many field trips to industrial areas. Many club members feel that these trips give them a more precise knowledge of the work of an engineer. They also feel that it gives them the opportunity to observe aspects of the different fields of engineering. This may help when they try to select the field which is closest to their interests. Many clubs show movies and have professional people of engineering give talks at their meetings. Through these facilities, the clubs seem to give the club members a

(Continued on page 86)

Scotty Browning, a former Olivet club member, is displaying the various parts of a radio he built. Scotty feels that his projects involving eletricity greatly influenced his becoming an E.E. major at M.S.U.

How else can yo[u] use your training?

Walt Wagner, MIT '49, Tells How McGraw-Hill Editors Combine Writing and Engineering



At the Belleville, N. J., plant of Walter Kidde & Company, Inc., Walt Wagner (*left*) gets Vice President Paul W. Eberhardt's views.

Meet Walt Wagner—SB and SM in Business and Engineering Administration . . . *and an editor who never wrote a word for publication before he joined McGraw-Hill!* Today, barely six years out of college, Walt is near the top of his chosen profession as Assistant Managing Editor of FACTORY—the McGraw-Hill Publishing Company's magazine for production-minded engineers and plant-operating executives.

Let Walt tell you how this successful and challenging career of his came about:

"During my last year at MIT, I often wondered whether [I c]ould use my background and training in some field [oth]er than engineering alone. Since FACTORY was one [of] our more important classroom texts, I wrote to the [edi]tors for guidance. After considerable correspondence [an]d meetings with members of the editorial staff, I was [off]ered a job as an editorial assistant on the magazine.

Why I Like An Engineering-Writing Career

"There are many reasons for my liking my career as an [en]gineering-writer. After thorough training, the editor [st]arted me on a couple of major feature stories. Later, [I w]as sent to Chicago where, as Western Field Editor, [I v]isited more than 100 plants of every type and size. "I worked with keen, alert men in front offices and [insi]de the plants of America's leading industries. I was [righ]t there interviewing for the story, as new industrial [adv]ances were made. I wrote on new production tech[niq]ues, new systems, new processes, new labor and [ma]nagement ideas. In short—the new frontiers in en[gin]eering.

"In 1954 I was appointed Assistant Managing Editor [of] FACTORY. Today, I work mainly on big engineering [stor]ies—play a major part along with another Assistant [Ma]naging Editor, the Editor and the Managing Editor [in t]he complete planning of the magazine.

"That's the story—and it's one of the reasons why [I'm] glad I found a way to put my engineering training [to w]ork for me."

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[Wit]h McGraw-Hill—world's largest publisher of busi[nes]s and technical magazines—you can work with engineers, for engineers. Working on any of the 34 McGraw-Hill magazines keeps you in constant touch with the experimental, the new and the significant. You see the over-all view, not a narrow segment of specialization in your field. You know whole industries . . . not just a small part of one company's activities. You rapidly become a sought after authority—and McGraw-Hill's policy permits outside assignments for editors with government projects, industrial associations, and the like.

McGraw-Hill is looking *right now* for people like you. We want engineers who are alert, inquisitive, knowledgeable. Career opportunities exist in virtually every field of engineering as editors with McGraw-Hill, and it's easy to learn what these opportunities are in specific detail. Write for your copy of "Successful Careers in Publishing at McGraw-Hill", or tell us about yourself, your background, extra-curricular activities, college record, summer jobs and career goals. Write to:

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Glen Siedel, Vice President in Charge of Engineering B.M.E. Minnesota '36

"Here are some of the facts about Honeywell that have been of real interest to the young engineering graduates we talk to."

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A growth company is one where men move ahead because of opportunity and challenge . . . where problems are turned into progress . . . where employment, sales and income increase steadily year after year.

Honeywell, today's world leader in the automatic control field, is such a company. For the past 30 years, sales have doubled or tripled every five years ($1,084,-259 in 1926; $244,482,068 in 1955). Employment has increased from 720 to over 25,000 in the same period, and net earnings have climbed from $424,241 to $19,278,648.

This healthy growth of Honeywell is shown in the table below.

The future is even more challenging. Planned diversification puts Honeywell in such new fields as office and factory automation, process control, transistors, plastics, atomic energy, electronics, missiles and satellites. Honeywell has the proven skills to design, engineer and build the equipment required by an increasingly automatic world and to sell its products profitably.

RESEARCH AND ENGINEERING ARE IMPORTANT AT HONEYWELL!

Research, design-development and product engineering are indispensable for continued growth. Honeywell's research and engineering have advanced twice as fast as growth in sales.

Honeywell's growth from a small thermostat company has been stimulated by research. And today research and development work in metallurgy, ceramics, heat transfer, plastics, vacuum tubes, ultrasonics, magnetic materials, semi-conductors, and combustion suggests new growth. Never in history has the potential of these and similar Honeywell development programs looked so promising.

Year	Sales ($000,000)	Net Earnings ($000,000)	Plant Space (Square Ft.) (000)	Employees				
				Total	Hourly	%	Salaried	%
1926	1.1	.4	158	720*	540*	75*	180*	25
1931	5.4	.6	200	1,150	839*	73*	311*	27*
1936	13.5	3.0	432	3,139	2,200	70	933	30
1941	24.3	2.6	603	4,240	2,859	67	1,381	33
1946	45.9	5.7	1,284	9,474	6,490	68	2,984	32
1951	135.2	8.9	2,296	17,182	10,796	63	6,386	37
1955	244.5	19.3	3,460	25,608	14,853	58	10,755	42

**Estimated*

Something New at MSU . . .

The New Brain Michigan State

By Ernest Lapensee, EE '57

By next Fall term Michigan State University will be the proud possessor of one of the country's best "Brains." This "Brain" will do mathematical calculations with phenomenal speed and accuracy but won't have the intelligence of an idiot. The solution of several simultaneous differential equations will be a snap but it won't have the common sense of a two-year-old. By now you may have guessed that our "Brain" is an electronic computer. The computer is a large scale, digital computer and is being built on the fifth floor of the EE building. Building of the computer is being coordinated by Dr. L. W. Von Tersch, Director of the Computer Laboratory at M.S.U. Dr. Von Tersch received his Ph.D. degree at Iowa State and was a member of the faculty there before coming to Michigan State. He spent the past summer at the University of Illinois studying the circuits and operation of the Illiac. The Illiac is a large scale, digital computer at the University of Illinois. Dr. Von Tersch is using the same system of logic for the M.S.U. computer as that used in the Illiac. Due to an agreement between M.S.U. and the University of Illinois, each school will have access to the other school's computer programs. This is quite a boon for Michigan State since the University of Illinois already has a large file of computer programs. The value of these programs is veritably incalculable. If a price were put on them, in man hours and computer time, the value would run in the hundreds of thousands of dollars. All these programs will be reproduced and become part of the M.S.U. file on computer programs. This is one of the main advantages of using the same system of logic as the Illiac.

Computers are marvelous machines. However, they are just machines and no more. A computer cannot do anything unless specific, detailed instructions are fed into it (contrary to some people's belief). These instructions are called programs and give the computer complete instructions for solving a problem. As human beings, we are used to such general orders as telling a child to go into the next room. If we were to give a computer a similar order we would have to tell it in what direction to go, and how far to go. If we forgot to tell it to open the door, it would stop or go haywire when it reached the door. There is more than one way to program or give an order to a computer. This may result in the computer taking different lengths of time to solve the same problem, just as it may take longer for one person to drive from Los Angeles to New York than another person, depending on the route each one takes.

The M.S.U. computer is being paid for by the University. Some of the large scale computers at other colleges are sponsored either by the armed forces or by large companies. (The Midac at the University of Michigan was paid for by the Air Force). Since M.S.U. is footing the bill completely it will be under obligation to no one concerning time spent on, or operation of the computer. Rent for the use of the computer will be roughly $15,000 to $30,000 a month. Dr. Von Tersch has expressed a desire to have the computer open at no charge, for use by all qualified M.S.U. students. These policies, however, have still to be decided.

DR. L. W. VON TERSCH

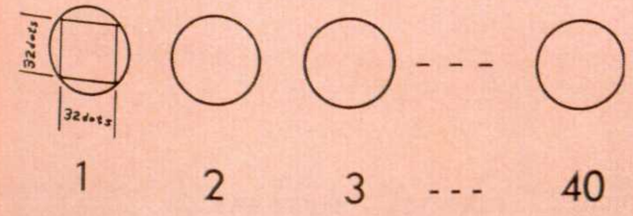
Director of Computer Laboratory at M.S.U.

Most commercial computers are designed for some specific job. The M.S.U. computer is designed primarily for diversified, scientific use, rather than for any particular use.

One of the most important parts of the computer is its memory. The computer uses its memory to store partial answers and instructions while solving a problem. As the solution to the problem progresses, the computer draws upon these partial answers and instructions to arrive at the final answer. This computer will have two types of memory. There will be a fast storage where information that is needed in a hurry is stored, and there will be a slow memory. The slow memory is a drum memory with a capacity of 12,800 words (in computer jargon a number is called a word) and will have an access time of approximately 6 milliseconds. In other words it will take 6 thousandths of a second for the computer to pick out any given word on the slow memory drum.

The rapid memory of the computer, called the Williams tube system, will consist of 40 cathode ray tubes. These tubes are similar to the one in your TV set, only much smaller—3 inches instead of 21 inches. This rapid memory will have a capacity of 1024 words with an access time of 18 microseconds (18 millionths of a second).

Just as the picture on your TV screen is composed of many tiny dots, so will the information on these memory tubes be composed of many tiny dots. There will be 32 rows and 32 columns of dots giving a total of 1024 dots of information ($32 \times 32 = 1024$) on each of the 40 tubes.



Now here's where the similarity to a TV tube ends. The TV tube has a picture because of the different shades of gray for each dot. The shades run from white to black. In the computer, the information on the tubes will either be a dot or no dot.

Each word may be represented as:

$$\underset{\text{1st bit}}{A_0 2^0} + \underset{\text{2nd bit}}{A_1 2^{-1}} + \underset{\text{3rd bit}}{A_2 2^{-2}} + - - - - - + \underset{\text{40th bit}}{A_{39} 2^{-39}}$$

where each part of the word is called a bit. The first bit of each word is on number 1 tube. The second bit is on number 2 tube, and so on. Therefore, we see that each word is 40 bits long. This computer is based on the binary system (contains only 1 or 0) and each bit is also called one binary digit. For each word there is one bit of information on each of the 40 tubes. The first tube corresponds to the bit of information (or part of the word) corresponding to $A_0 2^0$ for *each word.*

This first tube may contain this bit of information for 1024 words since it has 1024 dots. All the A's are either 1 or 0 depending on whether there is a dot or not. For an example, let's pick one of the positions on the tubes and choose some value for the A on each tube and see what word results. We may pick any position from 1 to 1024 but for simplicity let's pick the number 1 position corresponding to the first row and first column. Suppose this position has no dot on tube number one. Then A_0 is 0 and the first bit ($A_0 2^0$) is 0. Suppose this position has a dot on tube 2. Then A_1 is 1 and the second bit ($A_1 2^{-1}$) is .5. Suppose tube 3 has a dot at this position. Then A_2 is 1 and the third bit is .25. If all the other A's are 0, then the rest of the word is 0 and the final value of the word will be $0 + .5 + .25 + 0 = 0.75$. The first bit signifies the sign of the word. If A_0 is 1 the word is negative. If A_0 is 0 the word is positive. We see that our sample word is a positive .75. We also see that there can be no words larger than 1. Excluding the sign bit (the first bit), the sum of all the other bits will never exceed 1. This brings up the question, "How are larger numbers handled?" The answer is that all problems must be scaled down so that all its numbers fall between 0 and 1. When the final answer comes out, the scale is reversed and the correct answer obtained.

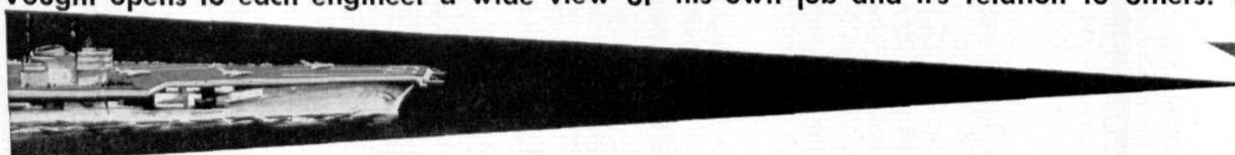
(Continued on page 80)

Keeping up with progress can be a full-time job, but making progress is the key to adventure. This is the province of the engineer,

and today his

New Ideas

are sparking dramatic technical advancements. Chance Vought's respect for a new idea has attracted selective engineers for 39 years. Here, the young engineer needn't settle initially on modest goals, for lack of experience. His *ideas* can elevate him to positions of leadership. To draw technical opinions from all levels, Vought opens to each engineer a wide view of his own job and its relation to others. This broadening begins in the first weeks of



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Mathematics Made Easy . . . .

You Too Can Be Mathematical Genius

by Ann Cutler

(Reprinted from Esquire, Jan. '57)

I was sitting in on an arithmetic class in Zurich, Switzerland. The teacher called on a nine-year-old boy who marched firmly to the blackboard upon which was a list of numbers a yard long. Standing on tiptoe to reach the top, he arrived at the total with what seemed to me the speed of light.

A small girl with beribboned braids was next asked to find the solution to 735352314 x 11. She came up with the correct answer—8088875454—in less time than you can say multiplication table. An adolescent boy wearing silver-rimmed spectacles was told to multiply 5132437201 x 452736502785. He blitzed through the problem, computing the answer—2323641669144374104785—in seventy seconds. It looked like rabbit pulling.

"Genius!" I murmured in awe.

"Oh, but no!" said the teacher. "Both those little boys you watched were very bad in arithmetic. Twice they failed."

"And the tiny little girl—surely she—"

The teacher shook his head. "She, too, flunked. In fact every child here has failed arithmetic at least once. That is why they are here."

The class was one where the Trachtenberg System of Mathematics is taught. The late Jakow Trachtenberg, founder of the Trachtenberg Institute and originator of a startling new system of computing, was of the firm opinion that everyone has "phenomenal calculation possibilities." The reason most of us have difficulty in juggling figures is all the fault of the arithmetic system we are taught.

Trachtenberg, a brilliant engineer with an ingenious mind, conceived his system of simplified mathematics while spending years in Hitler's concentration camps as a political prisoner. To shut out the intolerable world in which he was confined, he scribbled his theories on the backs of German work sheets, old envelopes, scraps of wrapping paper. He continued to simplify until all the drudgery had been taken out of arithmetic. In 1945 he escaped to Switzerland, where he was able to perfect his system and to open his institute.

The great practical value of the Trachtenberg system is that, unlike other special devices invented in the past for special situations, it is a complete system. Much easier than conventional arithmetic, it makes it possible for people with no aptitude at all for mathematics to achieve the spectacular results, that we expect from "mathematical wizards." Quick to take advantage of anything that adds efficiency, many of Switzerland's leading business firms today are using this method of computation.

To prove the point that anyone can learn to do calculation problems quickly and easily, Trachtenberg successfully taught the system to a ten-year-old retarded child. Not only did he learn to compute, but his IQ was raised. Which bears out the findings of the American psychologist, Thorndike, that the study of mathematics is important not only for itself, but because it is the subject most useful in developing the power of reasoning.

Experts believe that in the next ten years the Trachtenberg system may revolutionize the method of teaching arithmetic in schools throughout the world. And, they add, "It is high time." For the manner of teaching arithmetic has not altered in our schools in more than a century, and it continues to be the subject most feared and hated.

But it is adult students who attend evening classes at the Trachtenberg Institute, which opened in 1950 on a quiet, residential street in Zurich, who are most enthusiastic when they recognize the simplicity of the new system. Having experienced the drudgery of learning arithmetic in the traditional manner of rote and parrot and having made boners ever since, they proudly bask in their new-found mathematical brilliance. "*Wunderbar!*" a grey-haired woman exclaimed as she figured out an involved problem. Her job as a buyer for a department store included computing costs and handling figures, she told me. "The buying is nothing. For me it is the records that are difficult," she explained. "I could never understand arithmetic and I made so many mistakes. I was afraid for my job. But now you should see my records. They are perfect."

A young and prospering architect is designing buildings today only because he was able to pass his required mathematics after learning the Trachtenberg system. But not only in specialized professions is a knowledge of arithmetic necessary. Today in normal, everyday living mathematics plays an increasingly vital role.

This is particularly true in America where we live in a welter of numbers. Daily the average man and woman encounter situations that require the juggling of figures—credit transactions, the checking of monthly bills, stock-market quotations, canasta and bridge and billiard scores, bank rates, discount interest, lotteries, the counting of calories, changing dollars into pesos and francs while traveling, figuring the betting odds on a likely looking steed in the fourth race, determining your chances of getting a flush or turning up a seven. And income taxes, among other blessings, have brought the need for simple arithmetic into every home and have made many a man aware of his weakness.

The teacher explained some of the rules to me. In a few minutes I was multiplying 18-digit numbers and feeling like a Grade-A genius. In order to understand the Trachtenberg system of mathematics, it is necessary only to have the ability to count to ten. If in addition to counting on your fingers you can memorize the simple rules that form the keys of Trachtenberg's method, in a remarkably short time you, too, can assume the attitude of an Einstein while performing what to the uninitiated appear to be amazing mathematical feats.

Here are the rules the little girl used in multiplying by 11. And if you're to be known for brain instead of brawn, you have to get the rules fixed firmly in your mind. Once you've learned the rules you can zip through a long row of figures with the swiftness of a flying saucer.

MULTIPLICATION BY 11

1. The last number of the multiplicand (number multiplied) is put down at the right as the first number of the answer.
2. Each succeeding number is added to its neighbor at the right.
3. The first number of the multiplicand becomes the last number of the answer.

In the Trachtenberg system you put down the answers one number at a time—right to left. I started on an easy one:

```
 633
x 11
----
6963
```

633 is the multiplicand so the first number of my answer is 3

I added 3 and 3 and got 6

I then added 6 and 3 and got 9

I then put down the first number in the multiplicand (6) as the last number in the answer 6

See how easy!

By following the same rule I was able to multiply 637894362435215362 x 11 and got the answer—7016837986787368982—as quickly as I could write it.

I had a new parlor trick. Ever since, I've been wowing my friends at parties with my mathematical prowess and winning bets from the unwary by offering to multiply any 30-digit number by 11 in thirty seconds.

In the Trachtenberg system there are no multiplication tables, no division. Instead, every digit from 1 to 12 has a set of rules. The processes are so simple that all problems are worked in the head and only the answers are put down on paper.

(Continued on page 27)

IMPORTANT ON-CAMPUS INTERVIEWS FOR POSITIONS AT

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Mathematical Genius

(Continued from page 25)

Once you have learned the rules for 11, multiplying by 12 is a cinch. The rules for 12 are the same as 11—with one exception: you double each number.

MULTIPLICATION BY 12

1. Double the last number of the multiplicand and put down this as the first number of the answer.
2. Double each succeeding number and add to its neighbor at the right.
3. The first number of the multiplicand becomes the last number of the answer.

```
 564
x 12
----
6768
```

You double the 4 and get 8, the first number of your answer	8
You double the 6 and get 12. Add the 4 (to the right) and you have 16. Put down the 6 and carry the 1	6
You double the 5 and get 10. Add the 1 you carried and the 6 to the right, which gives you 17. Put down the 7 and carry 1	7
Add the 1 you carried to the 5, and you have the last number of your answer	6

Now try multiplying 348126423713 x 12 and see how fast you come up with the answer—4177517084556.

Of all the multiplication tables the 9 is considered by most educators the most difficult to learn. But even the mystic 9 becomes tractable in the Trachtenberg method. Here are the rules:

MULTIPLICATION BY 9

1. The last (right-hand) number of the multiplicand is subtracted from 10.
2. *All* other numbers are subtracted from 9 and added to the neighbor at the right.
3. The first number of the multiplicand is then diminished by 1.

This is how it works:

```
 543
 x 9
----
4887
```

You deduct 3 (the last number) from 10 and get the first number of your answer	7
You subtract the second number, which is 4, from 9 and get 5. Add to the 3 (neighbor to right) and get	8
Subtract the third number, which is 5, from 9 and get 4. Add to neighbor at right—the 4—and get	8
For the last number of your answer you subtract 1 from 5 (the first number of your multiplicand) and get	4

Once you are able to utilize the rules in multiplying 543 x 9, it is just as easy to multiply 63798645978 x 9 and arrive at the solution—574187813802—in record time.

If you can do the 9, you can also do the 8 if you remember the rules are the same but each number is doubled.

MULTIPLICATION BY 8

1. Subtract last number of multiplicand from 10, *double and put down as the first number of your* answer.
2. All other numbers subtract from 9. Double and add to the number at the right.
3. The first number of the multiplicand is diminished by 2.

Here is how it works:

```
 736
 x 8
----
5888
```

You deduct 6 (the last number) from 10 and get 4. Double it and you have 8—the first number of your answer	8
Subtract the second number, which is 3, from 9 and you get 6. Doubling it gives you 12. Add to the 6 at the right and you have 18. Put down the 8 and carry 1	8
Subtract the 7 from 9 and you have 2. Doubling it gives you 4. Add the 1 you carried and the 3 to the right and you have	8
For the last number of your answer you subtract 2 from 7 (the first number of your multiplicand) and get	5

You may say, yes, but it's just as easy to do it the old way. Why go to the trouble of learning a new set of rules? That is true if the problem is a simple one. But if you're faced with 638974863594636857 x 8 you will find by using the Trachtenberg method you can get the correct answer—5111798908757094856—in double quick time. Try it!

Junior, who has probably had as many difficulties with arithmetic as the kids in the Trachtenberg class, can outsmart his teacher when he comes up against the multiplication table of 5 if he will remember the following three simple rules.

MULTIPLICATION BY 5

1. Take each number of the multiplicand separately. When the number is even you start with a zero. When the number is odd you start with a five.
2. To the 5 (or the zero, as the case may be) add in half of the neighbor to the right (the smaller half of odd numbers).
3. To get the last number of your answer, you divide the first number of your multiplicand in half.

It's a great deal easier than it sounds. Here is the way you get the answer to

```
 638
 x 5
----
3190
```

(Continued on next page)

Mathematical Genius

(Continued from page 27)

You put down a zero as the first number of your answer because the last number of your multiplicand is an 8—an even number 0

The second number is a 3 so you start with a 5 and add half of the 8 (neighbor to the right) and you have 9

The third number of your multiplicand is an even number so you start with a zero and add half of the three, which in this case is 1 (the smaller half, remember?) 1

For the last number of your total you divide the first number of your multiplicand—6—in half and you have the complete answer 3

Once you have memorized the rules that apply to the multiplication tables of 11, 9 and 5, you will find that the same rules with only slight variations apply to all the other multiplication tables.

The rules of multiplication by 7 and 6 are very similar to the rule given above for 5.

Multiplication by 7

1. Take each number of the multiplicand separately. When the last number of the multiplicand is even, you double it and put it down as the first number of your answer. When odd, you double and add five.
2. Double every remaining number. Add to one half of number to the right. If odd, add to one half of number to the right and add a five.
3. To get the last number of your answer you divide the first number of your multiplicand in half.

```
 384
 x 7
----
2688
```

You double the last number of the multiplicand, which is 4, and get an 8—the first number of your answer 8

You double the second number, which is 8, and get 16. Add one half of the 4 (number to the right), which gives you 18. Put down 8 and carry 1 8

Double the third number, which is 3, and get 6. Add the 1 you carried, plus the 5 (odd number) and 4 (half the number to the right), and you have 16. Put down the 6 and carry 1 6

Divide the last number, which is 3, in half, which gives you 1 (take the smallest half). Add the 1 you carried and you have 2

Multiplication by 6

1. When the last number of the multiplicand is even, you put it down as the first number of your answer. If odd, you add 5.
2. Add every remaining number to one half of the neighbor to the right. If the number is odd, add 5.
3. To get the last number, divide the first number of your multiplicand in half.

```
 832
 x 6
----
4992
```

Your last number of the multiplicand is 2—an even number—so you put it down as the first number of your answer 2

You add your second number, which is 3, to one half of number to the right and get 4. Three is an odd number so you add in a 5 and get 9

You add 8 – an even number – to one half of number to right (3), taking the smallest part of (1) and again you have 9

Divide the last number of your multiplicand in half and you get a 4 as the first number of your answer 4

The rules for multiplication tables 4 and 3 are variations on the rules of the table for 9.

Multiplication by 4

1. The last number of the multiplicand is subtracted from 10 and put down as the first number of the answer. If the number is odd, add 5.
2. All other numbers are subtracted from 9 and added to one half of the neighbor to the right. If the number is odd, add 5.
3. Divide the first number of your multiplicand in half and take away 1 to get the first number of your answer.

```
 674
 x 4
----
2696
```

You deduct the 4 (last number of multiplicand) from 10 and get the first number of your answer 6

Subtract your second number, which is 7, from 9 and get 2. You add the 2 to one half of the neighbor to the right, the 4, and get 4. Since 7 is an odd number you then add a 5 and get 9

Subtract the third number, which is 6, from 9 and you get 3. Add it to one half of the neighboring figure to the right—the 7—(remembering to take the smallest half) and get 6

For the last number of your answer you divide the 6—first number of your multiplicand—and get 3. You then subtract 1 and you have 2

Multiplication by 3

1. If the last number of the multiplicand is even, subtract from 10, double and put down as the first number of the answer. If odd, subtract from 10, double and add 5.
2. Subtract all other numbers from 9, double the answer and add in one half of the number to the right. If odd, add a 5.

(Continued on page 84)

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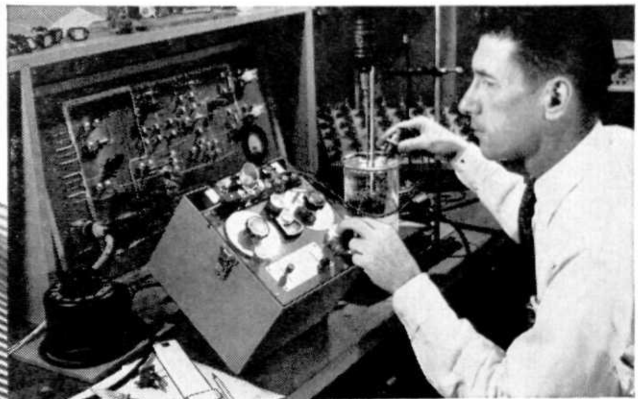

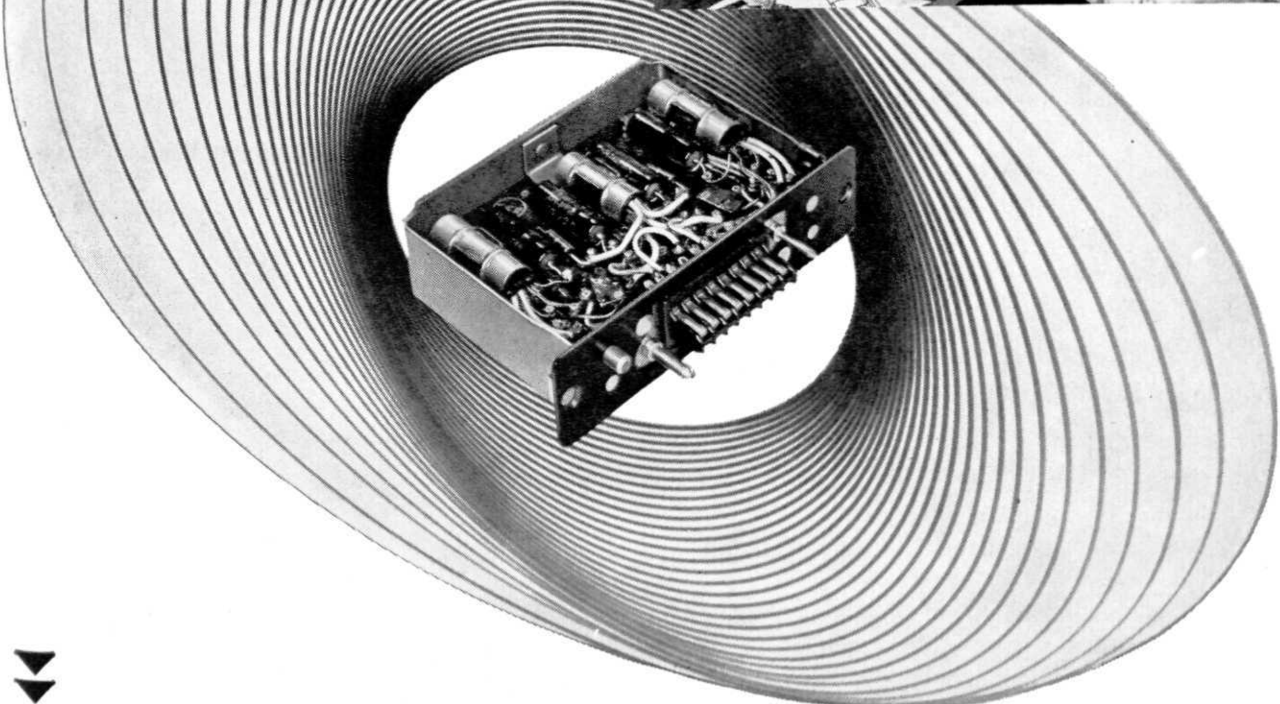

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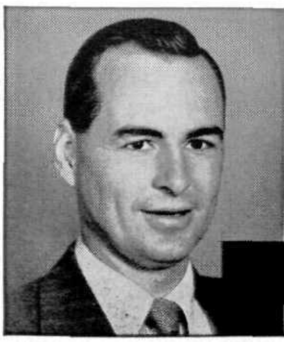
"Van" Wolford wants to know:

How often does Du Pont transfer technical men?

Fred V. Wolford receives his B.S. in Chemical Engineering from the University of Texas in January 1957. "Van" is a member of the Southwestern Rocket Society, Canterbury Club, and local Vice-President of A. I. Ch. E. Like all students, he's interested in finding out about the best opportunities offered in his profession.



Ed Berg answers:

Edward H. Berg received his B.S. Ch. E. from Cornell in 1944 and served as an Engineering Officer on destroyer duty until 1946. Since coming with Du Pont, he has worked at New Jersey plants as a Field Supervisor in Du Pont's Engineering Service Division. Ed was recently transferred to Du Pont's Design Division to further round out his professional development.

WE'VE just completed a study on that subject, Van, so I can speak with some authority.

Using technical graduates who came with Du Pont in 1949 as a base, we found these men averaged 1.7 transfers of location in 7 years. We frequently shift men from one assignment to another at the same location, to broaden them professionally. But it's interesting to note that 38% of those surveyed had not changed their location of employment at all.

Changes of work location depend a little on the type of work a man enters. For instance, there are likely to be more transfers in production and sales, fewer in research.

But one thing is certain. Du Pont transfers are always purposeful. The majority are a natural result of Du Pont's continued growth and expansion. And they invariably represent opportunity for further professional development.

Additional employment information is given in "Chemical Engineers at Du Pont." This booklet describes in detail the work and responsibilities of chemical engineers who work at Du Pont. Write for your free copy to the Du Pont Company, 2507C Nemours Bldg., Wilmington 98, Del.

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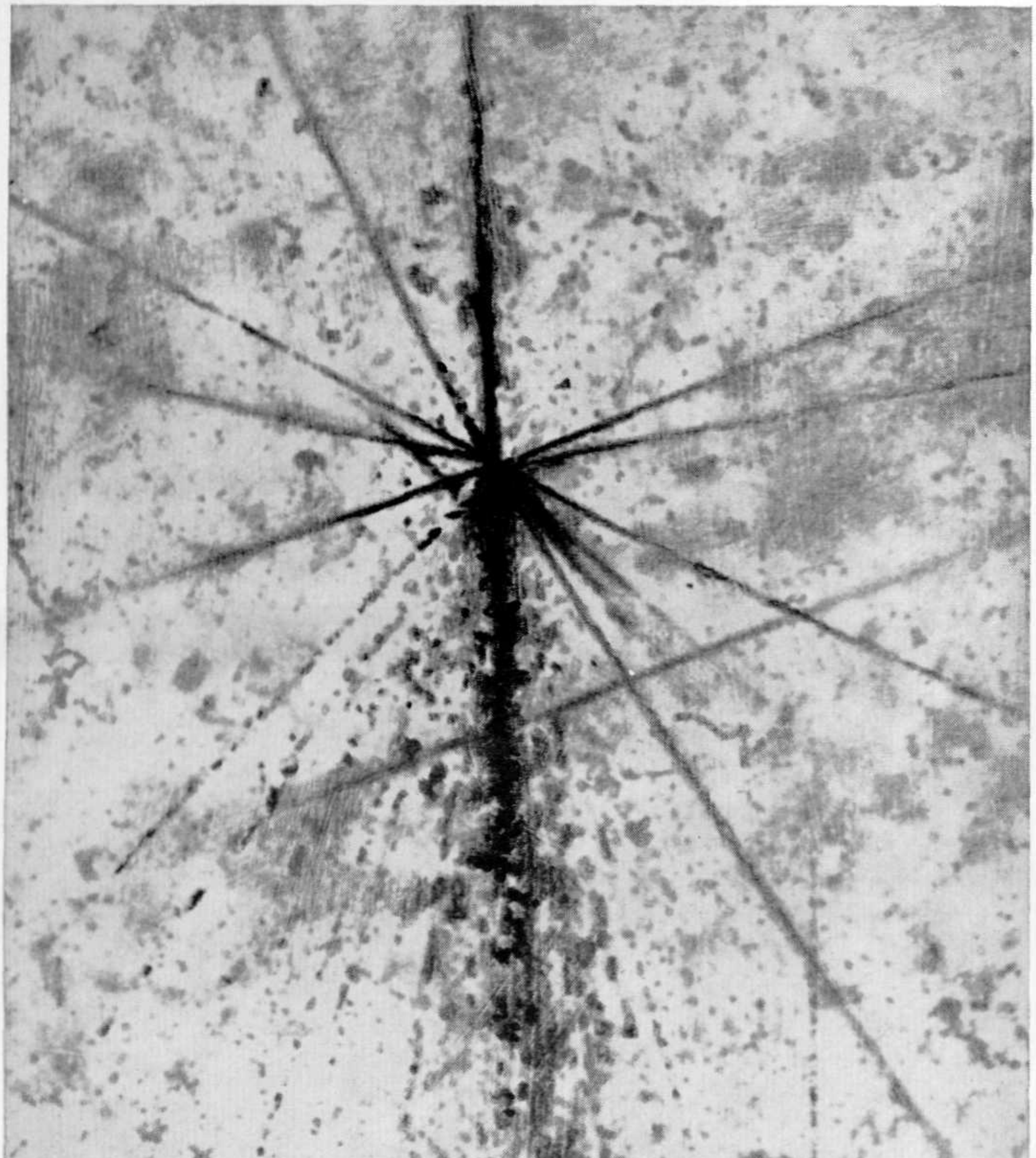
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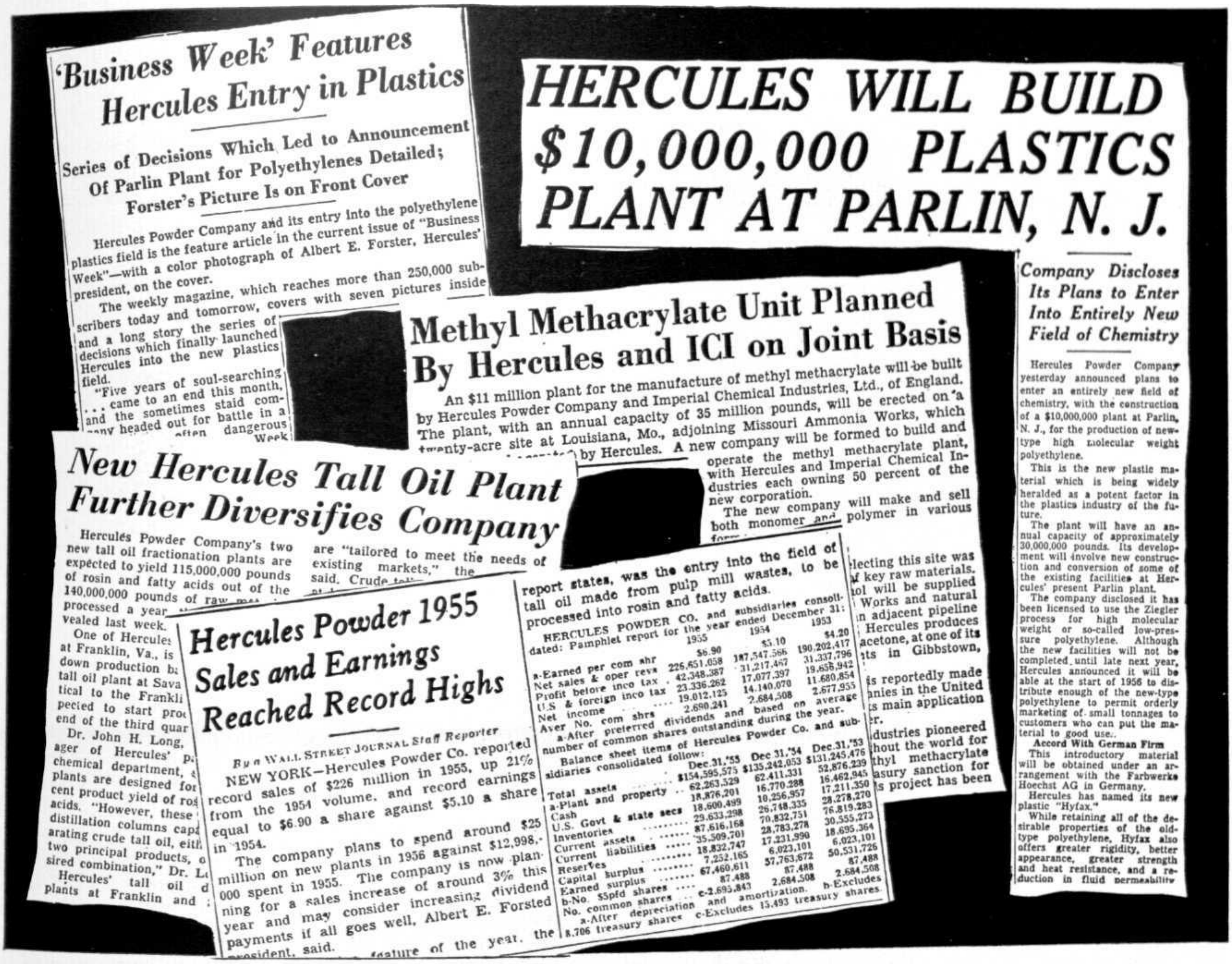

'Business Week' Features Hercules Entry in Plastics

Series of Decisions Which Led to Announcement Of Parlin Plant for Polyethylenes Detailed; Forster's Picture Is on Front Cover

Hercules Powder Company and its entry into the polyethylene plastics field is the feature article in the current issue of "Business Week"—with a color photograph of Albert E. Forster, Hercules' president, on the cover.

The weekly magazine, which reaches more than 250,000 subscribers today and tomorrow, covers with seven pictures inside and a long story the series of decisions which finally launched Hercules into the new plastics field.

"Five years of soul-searching . . . came to an end this month, and the sometimes staid company headed out for battle in a often dangerous

HERCULES WILL BUILD $10,000,000 PLASTICS PLANT AT PARLIN, N. J.

Company Discloses Its Plans to Enter Into Entirely New Field of Chemistry

Hercules Powder Company yesterday announced plans to enter an entirely new field of chemistry, with the construction of a $10,000,000 plant at Parlin, N. J., for the production of new-type high molecular weight polyethylene.

This is the new plastic material which is being widely heralded as a potent factor in the plastics industry of the future.

The plant will have an annual capacity of approximately 30,000,000 pounds. Its development will involve new construction and conversion of some of the existing facilities at Hercules' present Parlin plant.

The company disclosed it has been licensed to use the Ziegler process for high molecular weight or so-called low-pressure polyethylene. Although the new facilities will not be completed until late next year, Hercules announced it will be able at the start of 1956 to distribute enough of the new-type polyethylene to permit orderly marketing of small tonnages to customers who can put the material to good use.

Accord With German Firm

This introductory material will be obtained under an arrangement with the Farbwerke Hoechst AG in Germany.

Hercules has named its new plastic "Hyfax."

While retaining all of the desirable properties of the old-type polyethylene, Hyfax also offers greater rigidity, better appearance, greater strength and heat resistance, and a reduction in fluid permeability

Methyl Methacrylate Unit Planned By Hercules and ICI on Joint Basis

An $11 million plant for the manufacture of methyl methacrylate will be built by Hercules Powder Company and Imperial Chemical Industries, Ltd., of England. The plant, with an annual capacity of 35 million pounds, will be erected on a twenty-acre site at Louisiana, Mo., adjoining Missouri Ammonia Works, which by Hercules. A new company will be formed to build and operate the methyl methacrylate plant, with Hercules and Imperial Chemical Industries each owning 50 percent of the new corporation.

The new company will make and sell both monomer and polymer in various

lecting this site was key raw materials. will be supplied Works and natural n adjacent pipeline Hercules produces acetone, at one of its ts in Gibbstown,

is reportedly made nies in the United s main application

dustries pioneered hout the world for thyl methacrylate asury sanction for s project has been

New Hercules Tall Oil Plant Further Diversifies Company

Hercules Powder Company's two new tall oil fractionation plants are expected to yield 115,000,000 pounds of rosin and fatty acids out of the 140,000,000 pounds of raw processed a year vealed last week.

One of Hercules at Franklin, Va., is down production tall oil plant at Sava tical to the Frankli pected to start pro end of the third quar

Dr. John H. Long, ager of Hercules' chemical department, plants are designed for cent product yield of ros acids. "However, these distillation columns capa arating crude tall oil, eith two principal products, sired combination," Dr. L

Hercules' tall oil plants at Franklin and

are "tailored to meet the needs of existing markets," the said.

Hercules Powder 1955 Sales and Earnings Reached Record Highs

By a WALL STREET JOURNAL Staff Reporter

NEW YORK—Hercules Powder Co. reported record sales of $226 million in 1955, up 21% from the 1954 volume, and record earnings equal to $6.90 a share against $5.10 a share in 1954.

The company plans to spend around $25 million on new plants in 1956 against $12,998,000 spent in 1955. The company is now planning for a sales increase of around 3% this year and may consider increasing dividend payments if all goes well, Albert E. Forsted president, said.

report states, was the entry into the field of tall oil made from pulp mill wastes, to be processed into rosin and fatty acids.

HERCULES POWDER CO. and subsidiaries consolidated: Pamphlet report for the year ended December 31:

	1955	1954	1953
a-Earned per com shr	$6.90	$5.10	$4.20
Net sales & oper revs	226,651,058	187,547,566	190,202,417
Profit before inco tax	42,348,387	31,217,467	31,337,796
U.S. & foreign inco tax	23,336,262	17,077,397	19,658,942
Net income	19,012,125	14,140,070	11,680,854
Aver No. com shrs	2,680,241	2,684,508	2,677,955

a-After preferred dividends and based on average number of common shares outstanding during the year.

Balance sheet items of Hercules Powder Co. and subsidiaries consolidated follow:

	Dec.31,'55	Dec 31,'54	Dec.31,'53
Total assets	$154,595,575	$135,242,053	$131,245,476
a-Plant and property	62,263,529	62,411,331	52,876,239
Cash	18,876,201	16,770,288	16,462,945
U.S. Govt & state secs	18,600,499	10,256,957	17,211,350
Inventories	29,633,298	26,748,335	28,278,270
Current assets	87,616,168	70,832,751	76,819,283
Current liabilities	35,309,701	28,783,278	30,555,273
Reserves	18,832,747	17,231,990	18,695,364
Capital surplus	7,252,165	6,023,101	6,023,101
Earned surplus	67,460,611	57,763,672	50,531,726
b-No. $5pfd shares	87,488	87,488	87,488
No. common shares	c-2,695,843	2,684,508	2,684,508

a-After depreciation and amortization. b-Excludes 8,706 treasury shares. c-Excludes 15,493 treasury shares.

feature of the year, the

A CHEMICAL HEADLINE MAKER OFFERS CAREERS WITH A FUTURE

When the editors of the nation's business press devote cover stories to a company, it's a good sign that the company is setting a fast pace in today's competitive world. By branching off into new fields of creative chemistry, by building its sales from $7,000,000 in 1913 to more than $226,000,000 in 1955, Hercules Powder Company was one of the big stories of 1955. With an investment of more than $28,000,000 going into new plant facilities this year alone Hercules will continue to be a growth leader in the years ahead. This is the type of company in which ability finds its opportunity for advancement; where a young man can grow into the type of job he will find most rewarding. Why not find out more about careers with Hercules from your placement officer? Or write direct to Hercules for additional information.

HERCULES

Personnel Department

HERCULES POWDER COMPANY

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968 Market Street, Wilmington 99, Del.

GR56-2

NEW DEVELOPMENTS

Edited by Norm Dill

New Economical Nuclear Power Reactor

If present efforts toward system simplification are successful, a nuclear power reactor will offer the first real competition to conventional fuel-burning power plants. The atomic power plant is a homogeneous-type reactor in which the fissionable material is contained in a slurry in the reactor circuit.

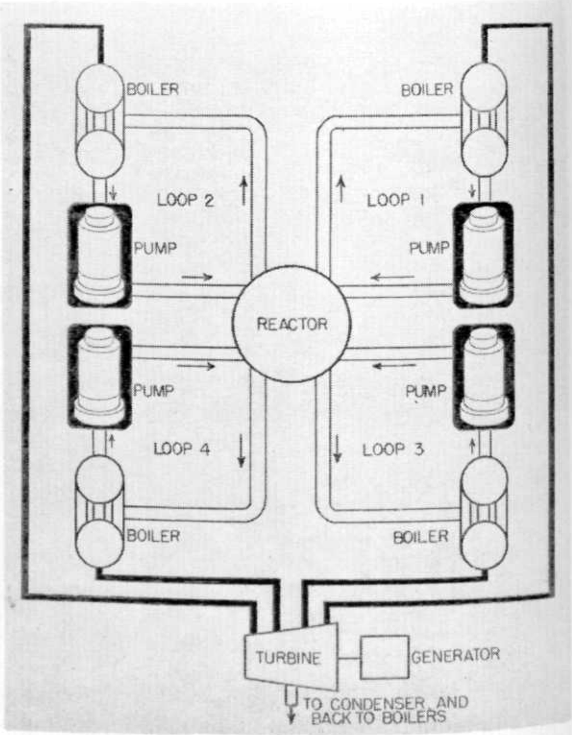
Similar to the circulating system on a home aquarium, a pumping system circulates the slurry between the reactor and pipe coils in a steam boiler. The rate at which fission occurs is controlled by varying the level or amount of slurry in the reactor. Since this fissioning heats the slurry, the steam boiler, in generating steam to run the turbine-generator, acts as a cooler for the reactor.

The competitive prospects of the installation arises from the fact that the reactor selected offers excellent possibilities as a "breeder" reactor, one which generates more atomic fuel than it burns. This means zero or nearly zero fuel cost. Therefore, if capital and operating costs can be kept low enough, competitive electrical power is at hand.

It has been estimated that the thermal efficiency (per cent of heat generated in the reactor which ends up as usable electrical energy) of the plant may be in the neighborhood of 27.5 per cent, considerably lower than our most efficient conventional fuel-burning generating stations. But, the authors point out, there is little economic incentive in going to higher thermal efficiencies in a plant which has extremely low incremental fuel costs.

World's Largest "Canned" Motor Pumps Near Completion

Four 1600-hp, 2300-volt "canned" motor pumps—the world's largest—have entered their final stages of construction. They are the main coolant pumps for the nation's first full-scale atomic electric generating station at Shippingport, Pa. The sketch shows location of the four pumps in the primary (radioactive) loops of the PWR. In this type of pump, both the stationary outer coils and the rotor are "canned" in metal, and the radioactive water flows through the space between them. In addition, the water serves as a bearing lubricant. These are the first canned motor pumps with Class H insulation to be designed for 2300-volt operation. Each pump weighs nearly 14 tons, stands 10 feet high and is 4 feet in diameter. Capacity of each pump is 18,300 gpm at approximately 2000 psi at up to 600 degrees F. There are no external shaft seals in the motor pumps, and suction and discharge nozzles are designed to be welded into the pipeline.

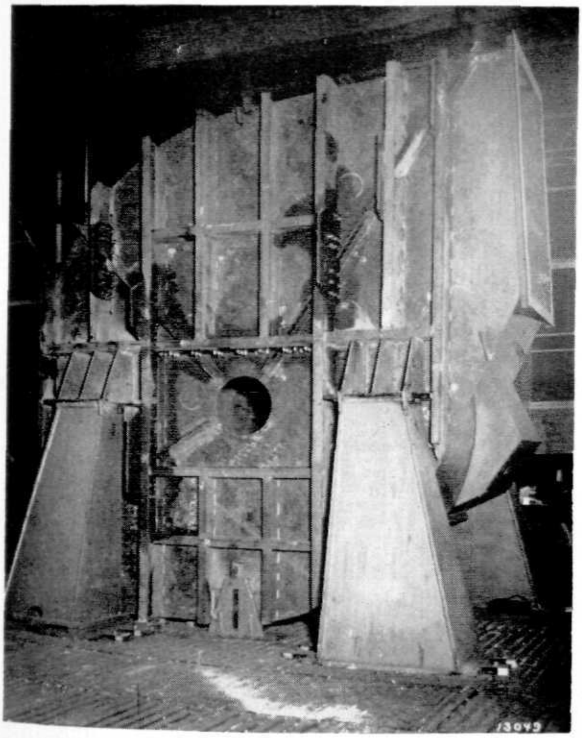


New Fans Designed to Operate "Red Hot"

Two nine-foot gas recirculating fans, capable of handling gases at 850 degrees F, have been installed at an Ohio plant.

To be used on the first commercial supercritical pressure steam generator at the plant, the fan wheels must be capable of a top speed of 25,000 feet per minute while handling the hot gases. These wheels begin to glow from the extreme heat when operating at the high temperatures.

These extreme performance requirements created complex engineering problems in the design of the fans. It is necessary to control the expansion of the fans, for the wheels, in building up from room temperature to maximum operating conditions will expand ⅝ of an inch with the other parts of the unit increasing in proportion. Adding to the problem was the fact that the radial-bladed wheels had to be built without side plates. The solution was extra heavy bracing with the housings supported by pedestals holding them clear of the floor, permitting controlled expansion while maintaining necessary clearances. These pedestals are over eight feet tall, and each one weighs over two tons. The fans are 17 feet high over-all and the casings weigh 60,000 pounds.



Gas recirculating fan housing used in controlling expansion due to high operating temperature.

Revolutionary Engine

The greatest possibility for reducing the size and weight of diesel engines for marine and railroad uses is offered by a highly super-charged two-cycle engine compounded with a turbine driving an axial flow compressor. The cylinder layout which offers the greatest potentiality for such development is the "opposed piston" design.

These are the conclusions of the chief engineer of the Piston Engine, Ernest Chatterton. Mr. Chatterton presented a paper on engines best suited to such developments at the 1956 annual meeting of The American Society of Mechanical Engineers.

An interesting solution of the problem, the "Deltic" engine, has opposed piston cylinders arranged in a triangle with crank shafts at the three corners. Mr. Chatterton declared that this arrangement overcomes most of the technical objections to the opposed piston layout. Furthermore, the space in the center of the delta may be used for an axial flow compressor, making the complete compound engine compact. The engine weighs about 2½ lb. per BHP for an output of 550 BHP.

Apart from space and weight savings which are important in ships and locomotives, a reduction in overall maintenance costs was reported to be derived from the use of small engines. This is obtainable by adopting the "repair by replacement system" which permits saving in skilled engineering service and avoidance of loss of serviceability time with its economic penalties. Even a complete change of engines is possible within a few hours.

Mr. Chatterton presented extensive engineering data in support of his contentions that the development of the high-speed diesel is justified on both technical and economic grounds. They covered practical speed limits, three types of engine, air supply, fuel efficiency, utilization of heat and distribution of temperatures, and power output per unit volume of cylinder.

New Navy Guided Missile

Although performance data about the U. S. Navy's new Sidewinder air-to-air guided missile remain classified, the missile is known to have considerably greater range than the Navy's older air-to-air missile, Sparrow, which had a maximum range of five miles and a speed of about 2000 mph.

The new missile has very few moving parts and no more electronic components than an ordinary radio. Its simplicity of construction and operation make it possible for Navy personnel to handle and assemble it without undergoing any specialized technical training.

The Sidewinder was conceived and developed at the Bureau of Ordnance's Test Station at China Lake, California. It is named after the fast-striking, deadly desert rattlesnake.

The missile will be used both to augment protection of fleet units at sea from enemy aircraft and to help defend the continental United States against air attack. The Navy says two squadrons of aircraft already are equipped with the Sidewinder.

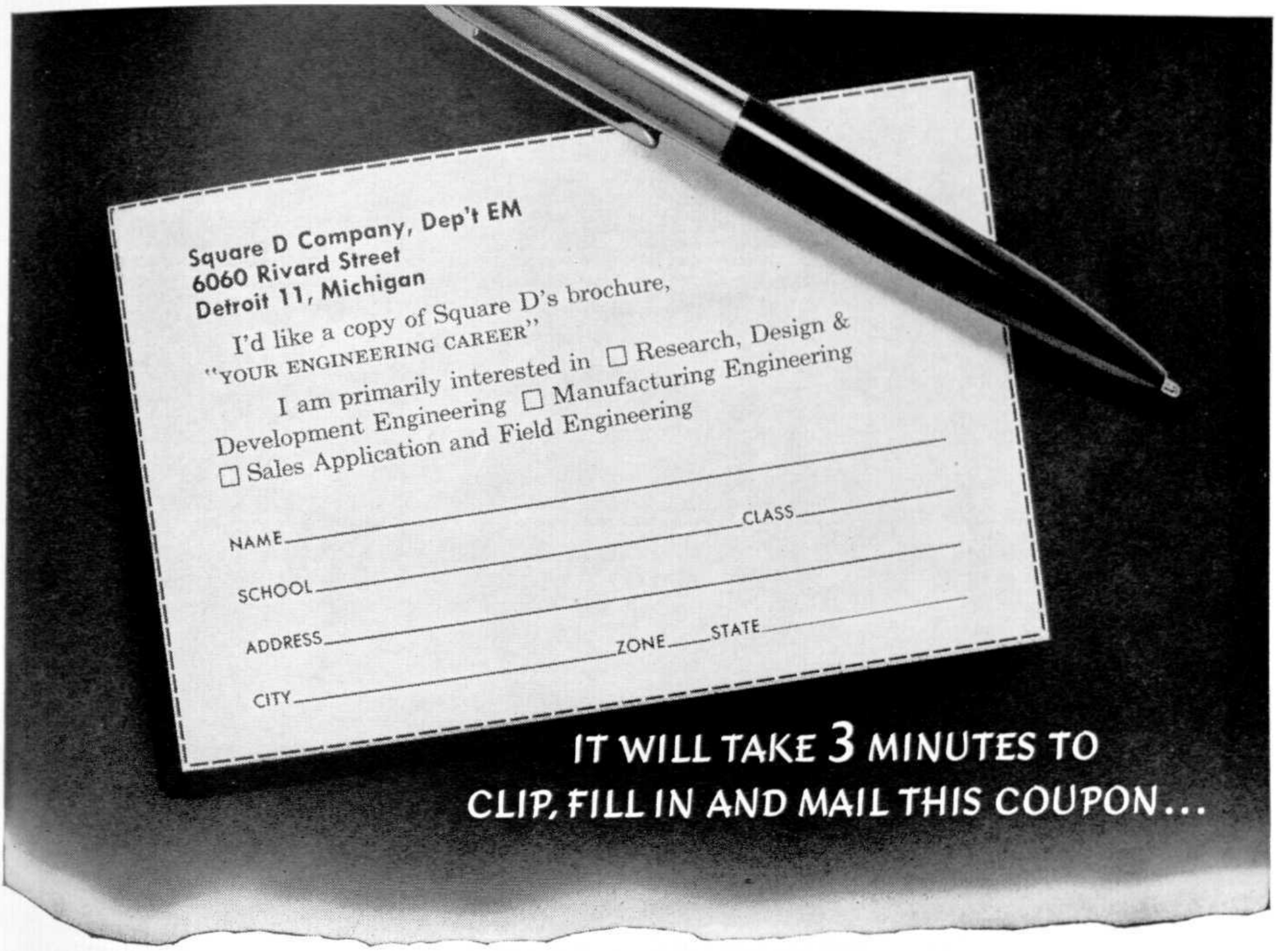
New Powerful Mobile Radar Antenna

An extremely lightweight, mobile radar set of revolutionary design and long range has been developed for the U. S. Air Force.

The key development is the radar antenna: two paraboloids—one of which is coated on the inside with vaporized aluminum to form the radar reflector—are joined at their rims and inflated. Called the Paraballoon antenna, this radar was developed to detect high-flying aircraft and to play a vital role in strengthening the defense networks of America and its allied nations.

An air-supported radome—lightweight, sectionalized and designed to erect directly on the ground—protects the radar and electronic equipment, operating personnel, and the Paraballoon antenna from high winds and ice loads. Within the radome, the Paraballoon antenna

(Continued on page 41)



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NEW DEVELOPMENTS

(Continued from page 37)

is supported in an upright position on a collapsible magnesium base by a difference in air pressure. Thus, a compact and complete radar structural system is obtained which is literally "blown up like a balloon."

Major General Stuart P. Wright, Commander of Rome Air Development Center at Griffis Air Force Base, New York, stated, "This outstanding development is a major breakthrough in the design of ground electronics equipment. The air-inflated Paraballoon antenna is the key to a large and truly mobile radar set. It is now possible to employ high-power radars in tactical situations and locations where time and transportability are of utmost importance."

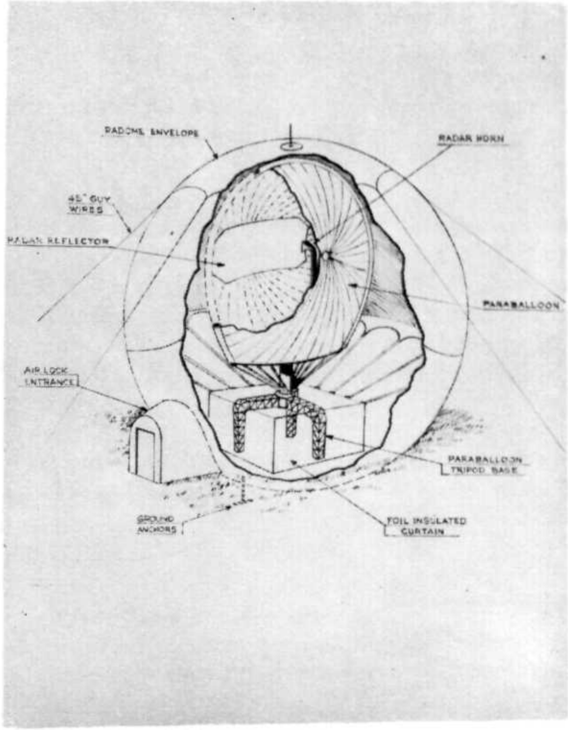
The radome can be deflated and unzipped into sections and the associated supporting structures collapsed. As a result, the entire antenna system can be dismantled in a matter of minutes and packed in shipping containers of small volume. Fully-packed shipping containers weigh about 200 pounds each, and can be easily handled by two or three men.

The "lollipop" shaped Paraballoon antena can be erected and dismantled an unlimited number of times. Even after repeated rough handling, it will retain its desired reflector contour when inflated. In addition, no special fixtures are required for checking the reflector surface contour when the inflated antenna is erected. When the antenna is packed in special airlift cases, air drops of an entire radar set are feasible.

The Paraballoon antenna for this radar system is made from a vinyl-coated fiberglass fabric. This fabric was chosen because of its high modulus of elasticity and consequent low stretch. To form the assembled antenna, two paraboloids of revolution 30 feet in diameter are joined together at their rims and inflated to less than 0.02 psi above the surrounding pressure. When inflated, the two paraboloids are stabilized by a 16-inch diameter fabric tube that is incorporated into the rim of the Paraballoon antenna and inflated to 10 psi. When inflated, the Paraballoon antenna system is 30 feet high. The antenna system weighs only 1690 pounds. Lightweight alloys and air-frame design techniques resulted in a 10:1 ratio in weight saving.

To make the 30-foot wide by 20-foot high reflector, to the inside of one paraboloid is attached a sheet of Mylar that has been coated with aluminum by vapor deposition. The thickness of this aluminum deposit is about one-millionth of an inch. The uncoated fiberglass fabric will not obstruct radar beams as it is transparent to all radio-frequency energy.

The fabric paraboloids are cut off at the bottom to provide a suitable area for attachment to a folding structural magnesium base. Assembly is accomplished with quick operating fasteners. The entire base which is 20 feet long, 8 feet wide and 5½ feet high, is supported on a bearing and driven at 6 rpm by a ¼-hp, 400-cycle, induction motor. The bearing is mounted on a tripod at a height sufficient to provide work space beneath the antenna, where the balance of the radar equipment is located.



Cross-sectional view showing the radome housing, Paraballoon antenna and the general arrangement of the electronic equipment.

The radome is designed so that temperatures ranging from 65 degrees F below zero to 140 degrees F above and wind velocities of 125 mph will cause no interference with antenna rotation. Air pressure inside the Paraballoon antenna is maintained greater than air pressure inside the radome by a fixed amount. This is necessary to maintain the close tolerances needed on the surface of the reflector and prevent any distortion of the radar transmission and reception pattern.

Entrance to the radome is through a pressure-lock door. Air pressure in the radome—approximately 0.17 psi above atmospheric pressure—does not cause discomfort to personnel.

Mounted directly on the ground and stabilized by ten guy wires, the radome is secured to specially developed ground anchors that are adaptable to all types of soil. Tests have shown these anchors to be capable of withstanding continuous pulls up to 3,000 pounds when imbedded in sandy soil. During erection, the 24-foot diameter base circle of the radome is covered by a ground seal cloth to prevent air leakage through the ground. A magnesium-grating floor provides a walk from the air lock to the electronic equipment in the event that frozen ground is thawed by the radome heating units. The radome is sectionalized into five

(Continued on page 42)

NEW DEVELOPMENTS

(Continued from page 41)

side panels and one crown piece for ease of transport and erection. Total radome weight is about 1400 pounds.

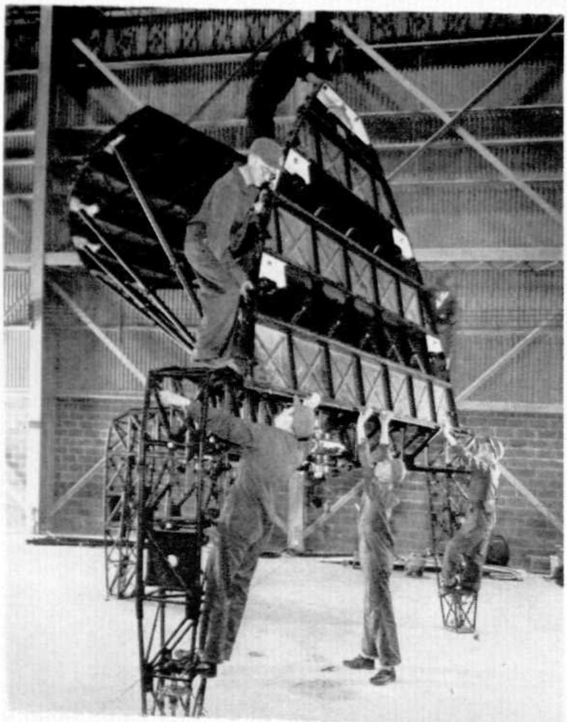
Blowers with sufficient capacity and suitably flat pressure-volume characteristics are used for both the Paraballoon antenna and the radome housing. Wide variations in the amount of air leakage from either inflated area will not result in large pressure changes. This, coupled with rip-resistant fabric, makes the complete system insensitive to minor tears caused by wind-blown objects or gunfire. Specifically, more than fifty 20-mm projectiles can pierce both the antenna and the radome without affecting normal operation.

Heating and air conditioning are provided. The lightweight heater is rated at 120,000 Btu's per hour while the air conditioning unit is rated at 42,000 Btu's per hour. Special ducting is installed to carry the heater combustion products outside the radome.

Adequate illumination is provided for repairs and adjustments. A low-level illumination circuit is installed for use during operation of the indicator (PPI) scope.

The assembly of the complete system can be quickly accomplished with no special erection fixtures. A trained crew of 20 men can set up the entire radar system in two hours.

Only rough leveling of the base area is necessary. The base circle is first laid out and the 25 ground anchors driven. Then the ground cloth is spread and the Paraballoon antenna and electronic equipment placed on it. The radome side panels are attached to the ground anchors, zipped to each other and the crown piece. In 10 minutes the radome is inflated by connected blowers. A 1000-pound capacity block and tackle is attached to the center of the radome crown piece and is used to assemble: the antenna tripod; the antenna base, which is erected on top of the antenna tripod; and the air-inflated tube and paraboloids which are zipped to the base and to each other. A blower and compressor then inflate the Paraballoon antenna. During inflation, the electronic cables are connected and the electronic equipment set in place.



The entire magnesium base of this unit is assembled with quick operating fasteners and is approximately 20 feet long by 8 feet wide and 5½ feet high.

Stresses in "Shell" of Nuclear Reactor Are Made Visible by Scientists

Scientists have found a way to see and study the complicated stresses existing deep inside the solid steel pressure vessel of a power-producing nuclear reactor.

The technique uses a model made of special plastic to make visible the stresses in full-scale pressure vessel—a large, complex steel structure which houses the core of the reactor and the inferno of its nuclear "fire."

Use of the technique will help speed pressure vessel design and insure that this vital structure can easily withstand any design pressures it may be called upon to contain.

The pressure vessels now being studied are those for power reactors of the "pressurized water" type. In a reactor of this type water is pumped through the pressure vessel, where it acts as moderator for the uranium fission process and also removes the vast quantities of heat the process releases.

To make this water hot enough to produce the superheated steam required by a ship engine or an electric power station, it must be kept in a sealed system under pressures as high as 2000 pounds per square inch. Being part of the sealed system, the pressure vessel must withstand these pressures. However, it is a large, complex structure and the walls of the vessel and its head are pierced with many holes for control rods, water pipes, and the like. With such complications, it is extremely difficult to calculate all the various stresses which the high-pressure water creates in the walls and head of the vessel.

The new method of examining the shell of a nuclear reactor uses a laboratory procedure called photoelastic stress analysis.

An exact model of the structure to be studied is constructed from a photoelastic resin, or plastic. Such resins have the ability to show visibly the twisting, bending, or other stresses they undergo when various forces are applied to them. When examined under polarized light, the stresses show up as patterns of colored light.

The plastic pressure vessel model is about two feet high, a foot and one-half in diameter, and about 100

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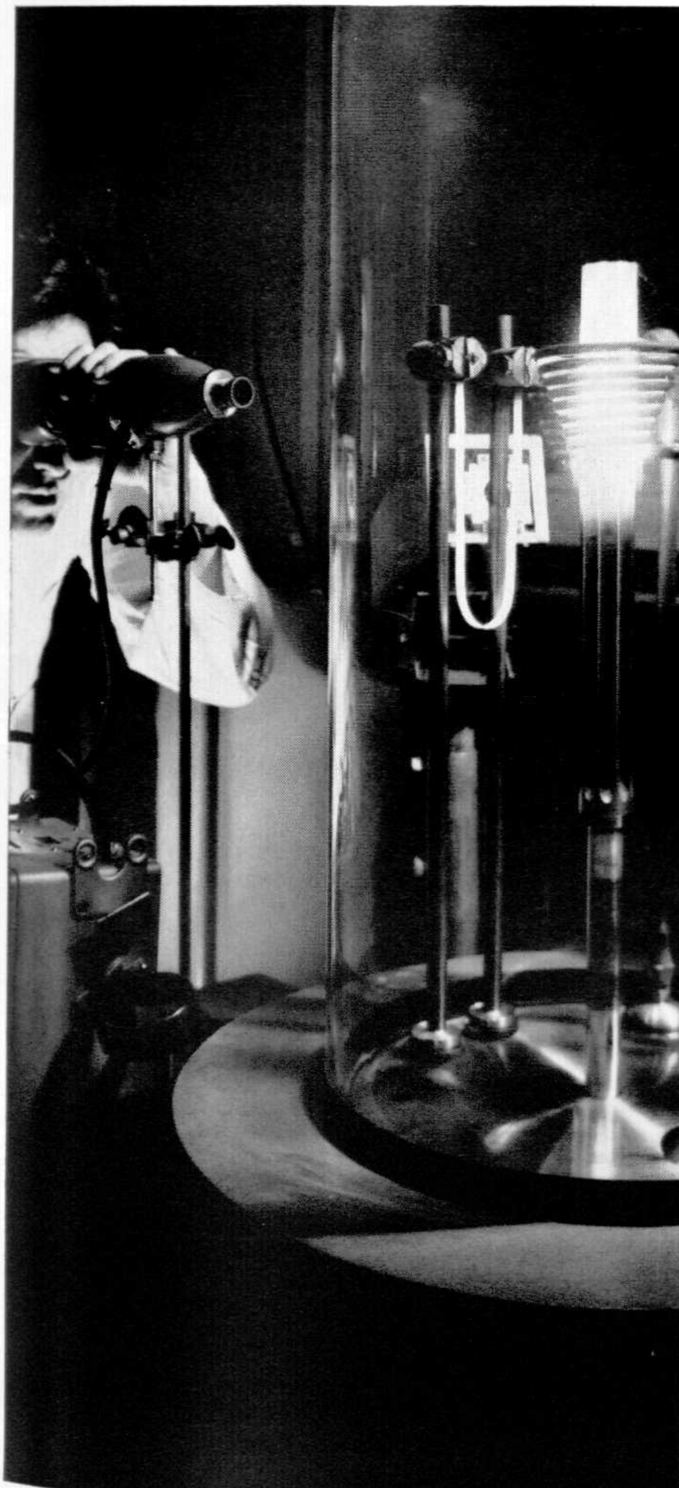
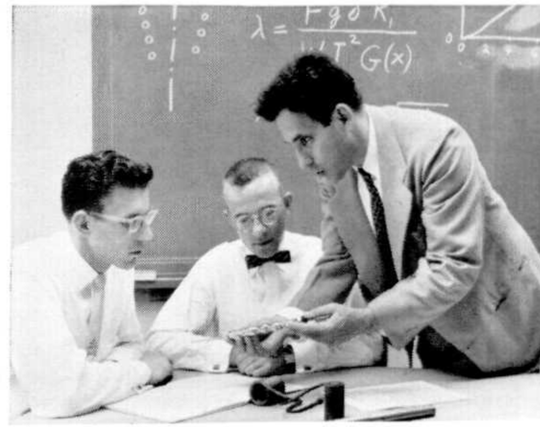
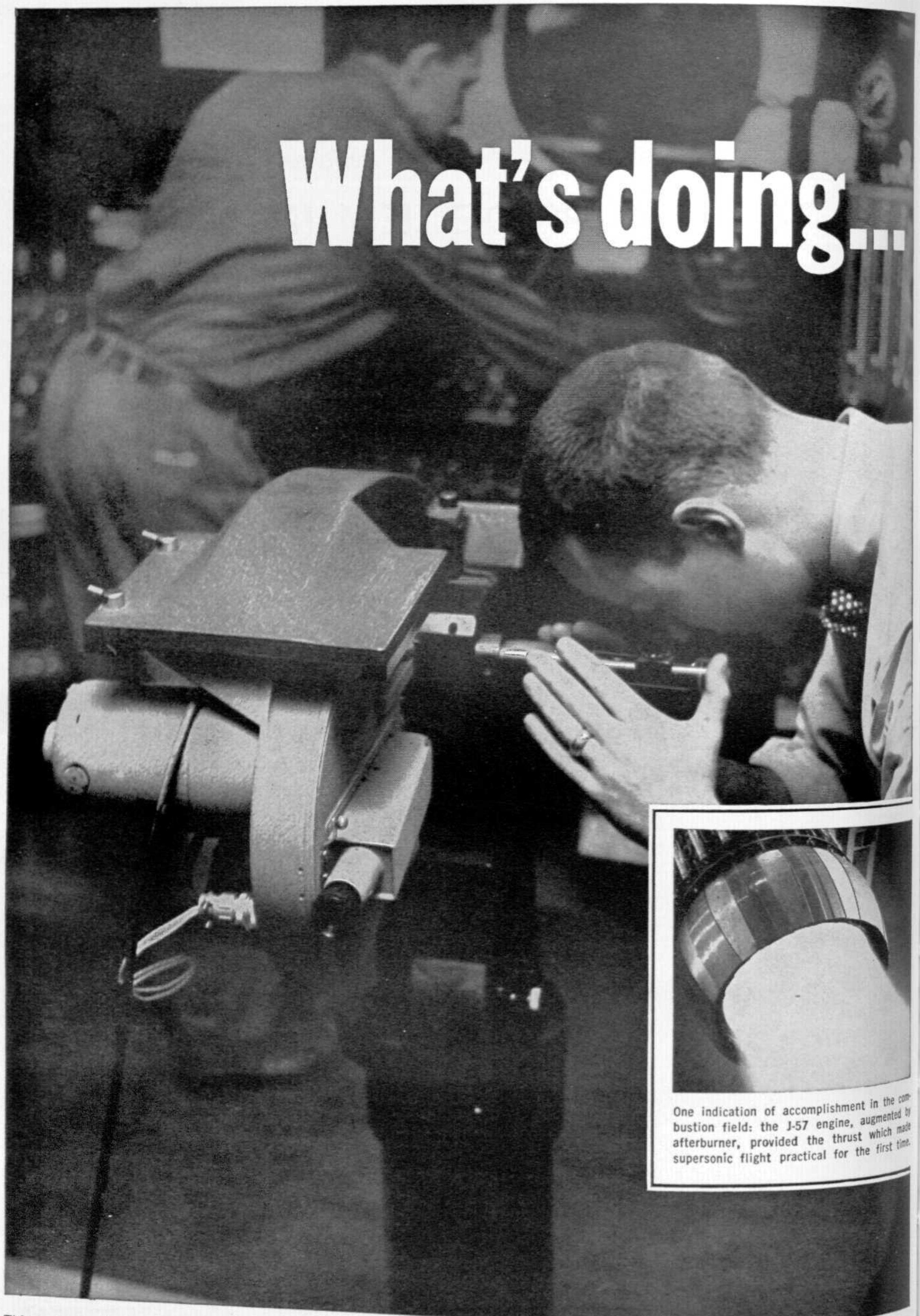


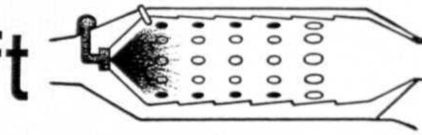


What's doing... at Pratt & Whitney Aircraft in the field of Combustion*



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.



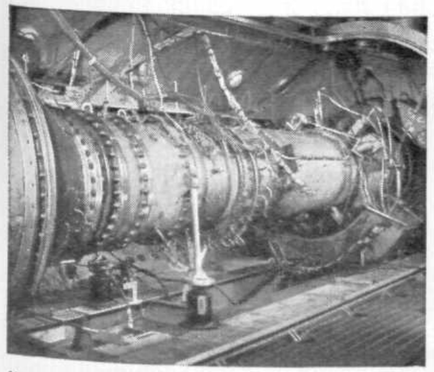
Historically, the process of combustion has excited man's insatiable hunger for knowledge. Since his most primitive attempts to make use of this phenomenon, he has found tremendous fascination in its potentials.

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.

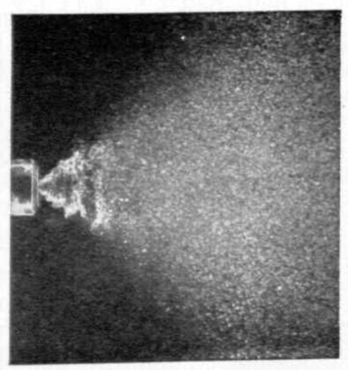
At Pratt & Whitney Aircraft, theorems of many sciences are being applied to the design and development of high heat release rate devices. In spite of the apparent simplicity of a combustion system, the bringing together of fuel and air in proper proportions, the ignition of the mixture, and the rapid 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.

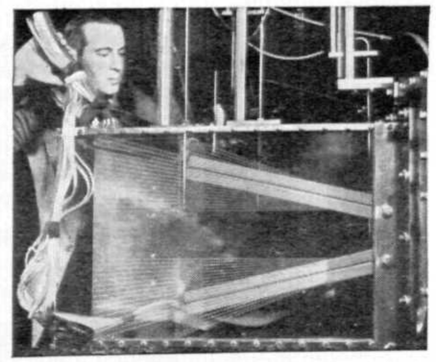
While combustion assignments, themselves, involve a diversity of engineering talent, the field is only one of a broadly diversified engineering program at Pratt & Whitney Aircraft. That program—with other far-reaching activities in the fields of instrumentation, materials problems, mechanical design 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.

**Watch for campus availability of P & W A color strip film on combustion.*

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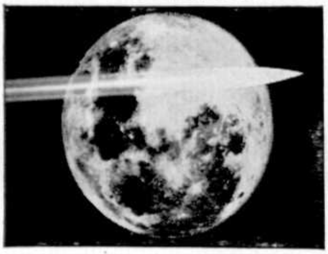

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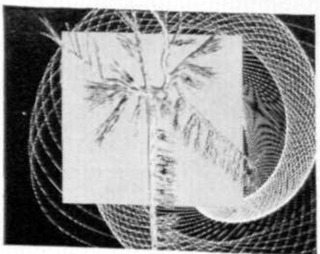

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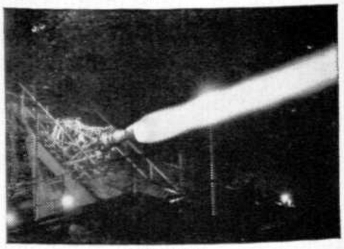

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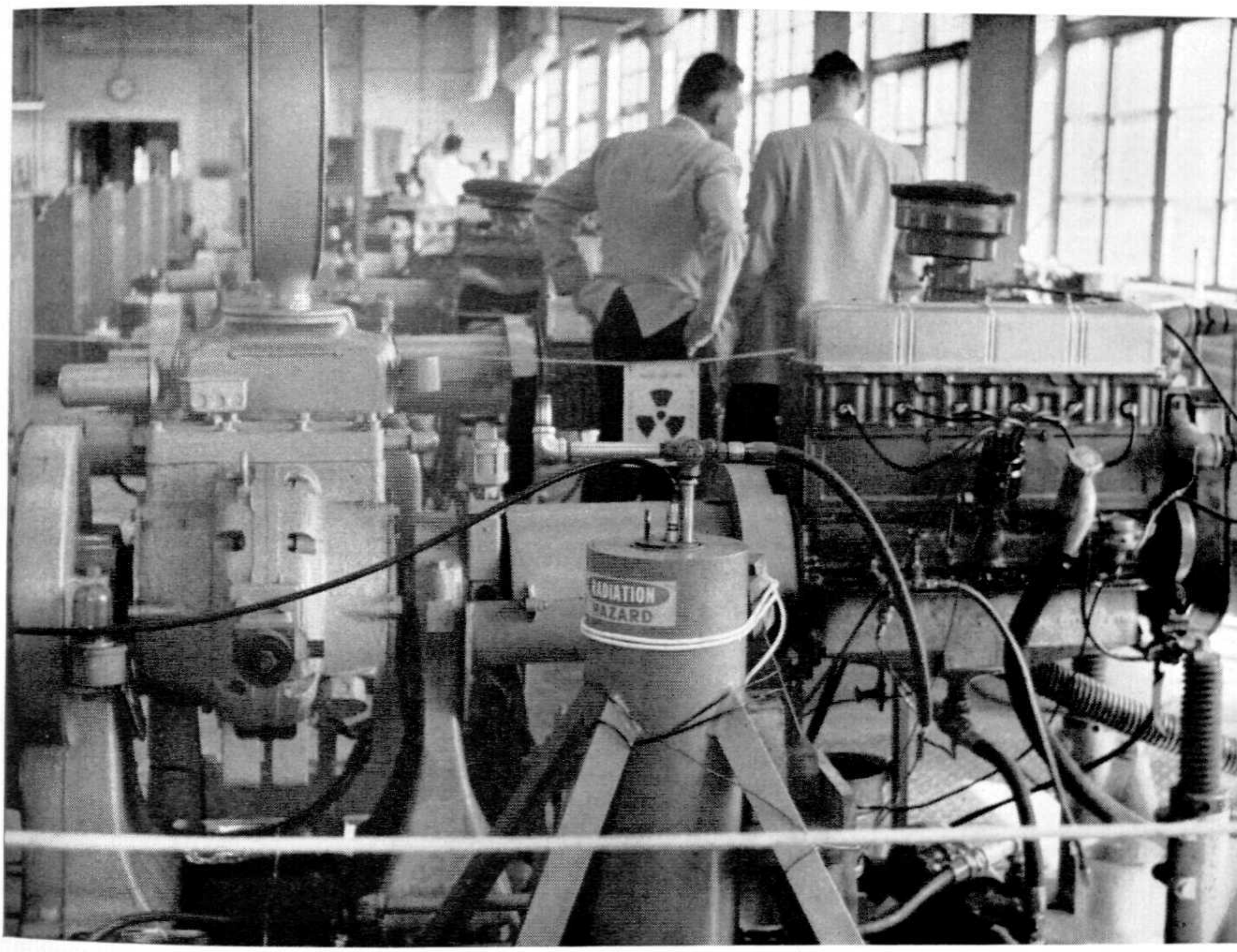

Modern and advanced engines log up hundreds of test hours daily in Standard's automotive laboratory at Whiting. Radioactive carbon traces deposits in the guarded engine (foreground).

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LAMONT ELTINGE is a group leader in the Automotive Research Division of Standard Oil's great Research and Engineering Laboratories at Whiting, Indiana. He and his group dig freely and fruitfully into just about every area you can think of in diesel, automotive, gas turbine, and jet fuels. Current studies range from air pollution problems arising from diesel smoke to laboratory use of radioactive carbon tracers for the basic study of deposits in gasoline engines.

Mr. Eltinge earned his B.S. in mechanical engineering at Purdue in 1947. He is a member of SAE, Tau Beta Pi, Sigma Tau, and Pi Tau Sigma. Along with the important contributions he makes to Standard as a regular member of our team, he finds time to attend Illinois Institute of Technology where he recently received his M.S., and takes an active interest in church work.

Lamont Eltinge and hundreds of young men like him are going places and doing things at Standard Oil. Each concentrates on his own special field of interest and experience, but none is limited to it. Chemists, metallurgists, engineers, physicists and others maintain a continuous relationship for the broad exchange of ideas. Perhaps you, too, would enjoy membership on Standard's team of engineers and scientists.

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On May twenty-first the American Society of Mechanical Engineers will celebrate forty years of service to Michigan State Engineering students. During this time the A.S.M.E. has helped students make a smooth transition from school to industry by keeping them abreast the happenings in engineering. In addition to this, students are given an opportunity to become associate members upon graduation.

This year, as in years past, we have an able chairman to shape the program of A.S.M.E. which will cover automotive, aviation, design, heating and ventilating, refrigeration and air conditioning, power, and many other fields. The organization meets every two weeks with additional field trips for these programs. Under the capable leadership of the chairman, Fred Kummer, and the faculty advisor, Mr. Ditsworth, the year looks very prosperous for all the members.

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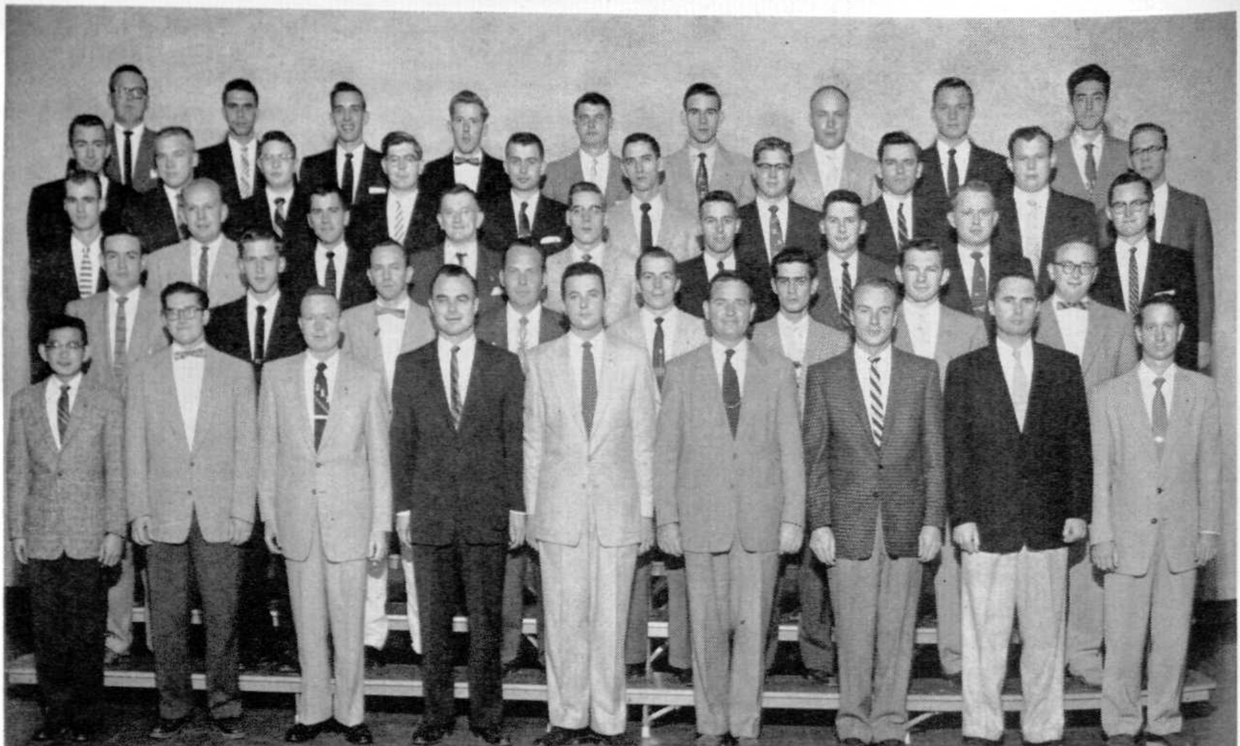
(Continued on page 52)

American Institute of Electrical Engineers Institute of Radio Engineers Joint Student Branch.



First Row, L. to R.: Hironaka, Lapensee, Settersten, Hedges, Shippen, Ebert, Armstrong, Tillotson, Johnson.
Second Row: Greene, Mote, Arnold, Anderson, Matko, Gaunt, Florac, Butterline.
Third Row: Knechtel, Brewer, Garland, Crombe, Talaski, Rowe, Fife, Auld, Tubbs.
Fourth Row: Blost, Bartos, Brown, Shipman, Rollins, Brown, Plugge, Cantrell, Humphrey, Zuber.
Back Row, L. to R.: Olsson, Klinkner, Brown, Patten, Huntoon, Mawby, Pilkington, Hileman, Roth.

"A new era is beginning...

"As I review the progress in aeronautics within so short a span, and marvel at the complex aircraft of today, I call it an achievement little short of miraculous.

"Today, electronically-guided planes take off and land without human touch. Lethal sky missiles seek and destroy invisible targets with uncanny precision. And still other fantastic achievements in both man-controlled and pilotless flight are now in the offing.

"When men go to the moon and planets, electronically-controlled skycraft will take them there. Aviation maps will be studded with stars as well as with cities. New developments in aeronautics will go on and on. Success opportunities and careers will continue to develop for ambitious young men in this exciting field where a new era is beginning."*

LEE De FOREST

Appropriately qualified to speak for aeronautics and other fields in which his own scientific achievements play an important part, Dr. Lee de Forest gives helpful counsel to young graduates headed for successful, rewarding careers.

His expression, "a new era is beginning," has particular significance at Northrop, world leader in the design, development and production of all-weather and pilotless aircraft.

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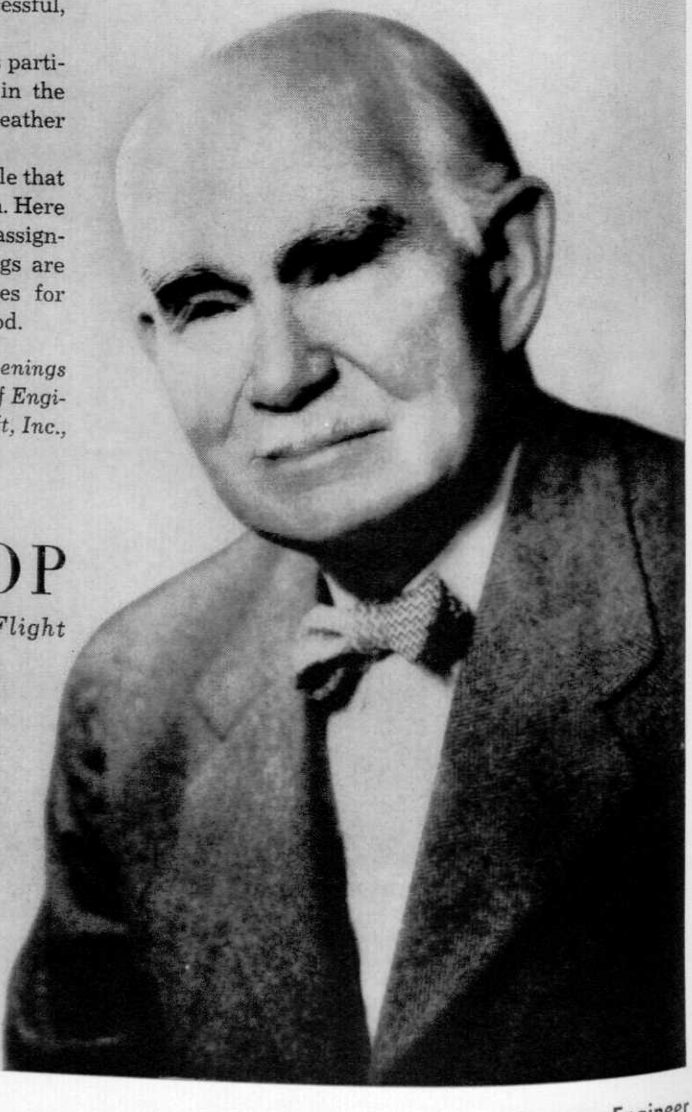

**A statement by Dr. Lee de Forest, pioneer in radio.*

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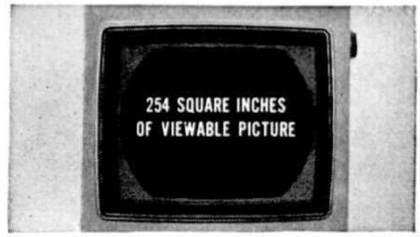
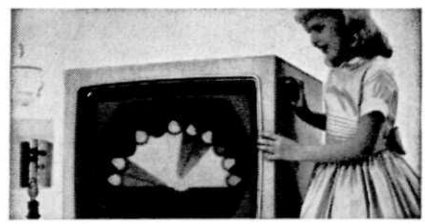
RCA offers careers in TV and allied fields — in research, development, design and manufacturing—for engineers with Bachelor or advanced degrees in E.E., M.E. or Physics. Join the RCA family. For full information write to: Mr. Robert Haklisch, Manager, College Relations, Radio Corporation of America, Camden 2, New Jersey.

Like 2 sets in 1—get Color and black-and-white shows, too! It's RCA Victor Compatible Color TV. See the great Color shows in "Living Color"—regular shows in crisp, clear black-and-white. With Big Color, you see *everything*.



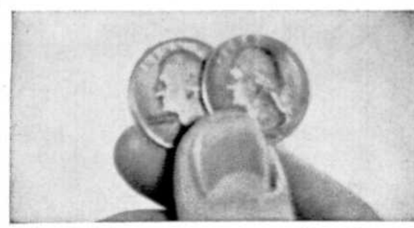
Big-as-life 21-inch picture tube — overall diameter. Actually 254 square inches of viewable picture area. And every inch a masterpiece of "Living Color." Here are the most natural tones you've ever seen—on a big-as-life screen!

Color every night — right now! Something for everyone! You'll have "two on the aisle" for the best shows ever—drama, comedies, Spectaculars, children's shows, local telecasts. For now 216 TV stations are equipped to telecast Color.



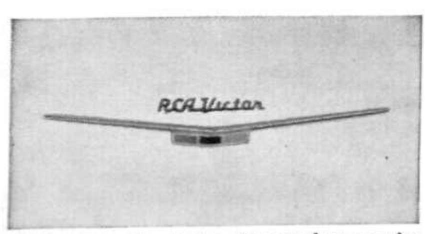
Big Color TV is so easy to tune, even a child can do it! Turn two color knobs and there's your Big Color picture! It's easy, quick, accurate. It's a new thrill when the picture pops onto the screen in glowing "Living Color."

Practical and trouble-free! Service at new low cost! Big Color is *dependable* Color. And RCA Victor Factory Service is available in most areas (but only to RCA Victor owners). $39.95 covers installation and service for ninety days.



Color TV is a common-sense investment—costs only a few cents a day. It's sure to become the standard in home entertainment for years to come—yet you can enjoy Color every night *right now!* And you can buy on easy budget terms.

Now starts at $495 — no more than once paid for black-and-white. This is the lowest price for Big Color TV in RCA Victor history! There are 10 stunning Big Color sets to choose from—table, consolette, lowboys, and consoles, too.



Make sure the Color TV you buy carries this symbol of quality. Because RCA pioneered and developed Compatible Color television, RCA Victor Big Color TV—like RCA Victor black-and-white—is First Choice in TV.

RCA®

RADIO CORPORATION OF AMERICA

ELECTRONICS FOR LIVING

CLUBS AND SOCIETIES

(Continued from page 48)

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.

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

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

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.

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.

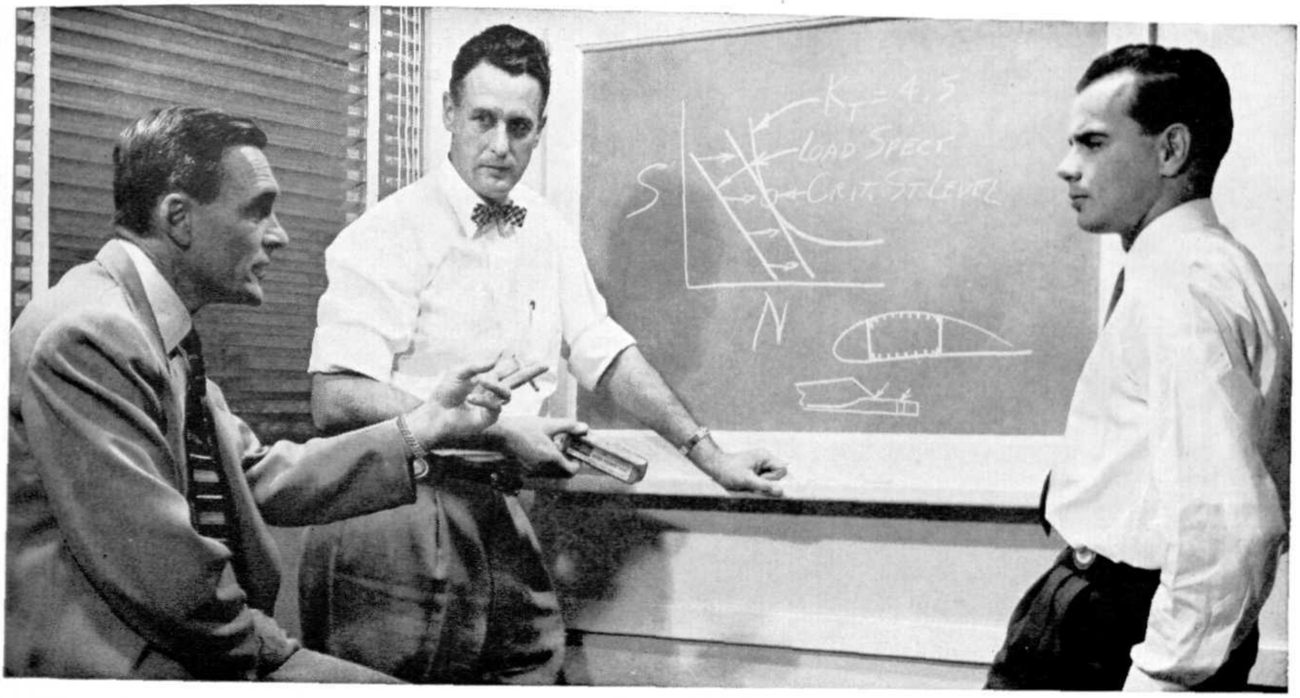
Plans are already shaping up for a better than ever midget racer. Duane Satterlee and committee have been working for quite a few months on it already.

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. Mackson and Mr. Wheaton.

OFFICERS

President................Allen Butchbaker
Vice President..................Leslie Lee
Secretary.................George Bingley
Treasurer..................Patrick Rogers

Have You Joined Your Student Engineering Society Yet?



J. F. McBrearty, *chief structures engineer (left), discusses fatigue test program of integrally-stiffened wing lower surface structure of a new transport with E. H. Spaulding, structures division engineer, and J.G. Lewolt, stress engineer. Lockheed's 500,000 lb. Force Fatigue Machine was used in test program.*

Advanced structures facilities speed careers of Lockheed engineers

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.

Engineers in Lockheed's Structures Division are supported by unmatched research and testing facilities in their constant effort to increase strength while decreasing weight.

Among those facilities are the Lockheed-designed 500,000 lb. Force Fatigue Machine, first of its size; Shimmy Tower, only one in private industry; and Drop Test Tower, largest in the nation.

Facilities such as these give engineers a major advantage in making technical advances – and thus advancing their careers. Moreover, the large number of projects always in motion at Lockheed mean continuing opportunity for promotion as well as job security.

Why Lockheed needs Engineers with Structures training:

1. **"Fail-Safe" Structures** – Lockheed has begun an extensive pioneering effort in the new concept of "fail-safe" structures. Studies are being applied to virtually all phases of Lockheed's diversified development program – already the largest in the company's history.

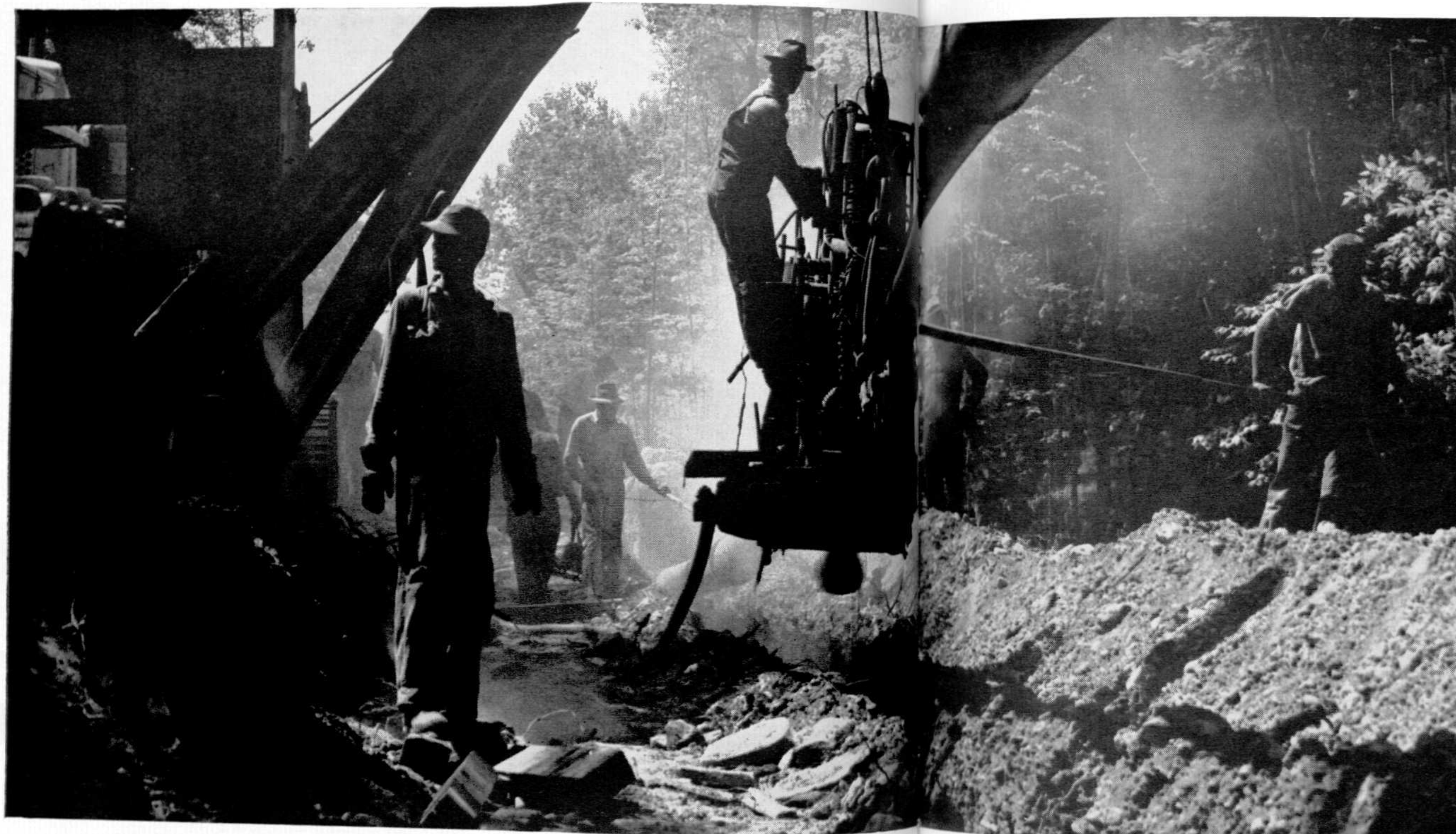
2. **New studies in:** Effect of high temperatures on structures; optimization of thin-wing designs and other aero-elastic problems; new materials such as ultra-high heat treat steel, panel instability at extremely high speeds.

You are invited to contact your Placement Officer for a brochure describing life and work at Lockheed in the San Fernando Valley.

LOCKHEED

California Division • AIRCRAFT CORPORATION • BURBANK

CALIFORNIA



NEW DEVELOPMENTS

(Continued from page 42)

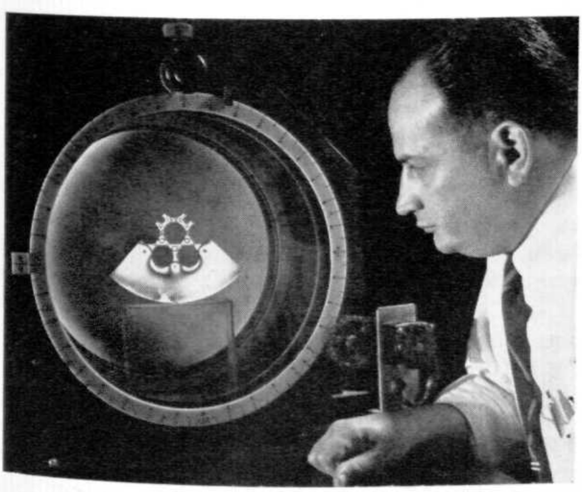
pounds in weight. After the model is cast, it is machined to exact shape. Air is then pumped into the model until it is under a pressure of about four pounds per square inch—a pressure large enough to produce in the model the exact stress patterns existing in the actual pressure vessel under its working pressure of about one ton per square inch.

The model is then cured by heating, which "freezes" the stress patterns permanently into the walls of the model. Samples are then cut from the model and examined under polarized light. The "frozen" stresses can then be studied rapidly and with great precision.

This is the first time that photoelastic stress analysis has been applied on the scale required for study of a reactor pressure vessel. It is possible only because of the recent discovery of a new improved photoelastic resin. Compared to previous materials, this new resin is three times more "sensitive" in forming the desired stress patterns.

The new resin also makes it possible to prepare much larger models than before. A structure as complicated as a pressure vessel can be duplicated for photoelastic analysis only by taking full advantage of this increase in model size.

The success with current Westinghouse studies indicates that the technique will soon be applied to many structures equally complicated and difficult to analyze by other means.



Patterns of light showing the stresses inside the "shell" of a power-producing nuclear reactor.

Tester Checks Safety Thermocouples on Gas-Fired Equipment

A new millivoltmeter, for checking the voltage output of safety thermocouples on gas-fired equipment, has just been announced. The new pocket-size tester is simple to use. The lead clips are merely placed across the thermocouple terminals to test for correct voltage. It will provide faster servicing of such units as gas-fired hot water heaters, clothes dryers, furnaces, space heaters, and gas refrigerators.

Ranges are 10, 30, 100, 300, and 1000 millivolts. Large binding posts, clearly labeled by an engraved-filled panel, are used for range selection. Accuracy is 3% of full scale at ambient temperatures of 50° to 120° F. From —55° to +185° F, an additional error of no more than 2% can be expected. The meter has a low current draw of only 750 microamperes, which is calibrated to within ±2% of full scale. This permits accurate computing of instrument loading when necessary.

Electronic Light Amplifier

The new electronic light amplifier, which can increase by up to 1,000 times the brightness of projected light images, was described as "a development of major potential importance in the field of electronic display techniques."

The main features of the device were discussed by Dr. D. W. Epstein, of the RCA Laboratories technical staff, and Benjamin Kazan, RCA scientist who developed both the new light amplifier and its application in the amplifying fluoroscope demonstrated today.

"An amplifier of this type," said Dr. Epstein, "may find wide application in a number of areas. An example is radar viewing, where the observer frequently must cope with dim images, and where persistence as well as brightness are desired. Since the amplifier also converts invisible X-rays and infra-red images to bright visible images, other possible important uses lie in the military field and in astronomy, where analysis of infra-red radiation from dim sources plays an important role."

Mr. Kazan described the light amplified in these terms:

Developed from the electronic light amplifier originally developed by Mr. Kazan and Dr. F. H. Nicoll, of the RCA Laboratories technical staff, the new device consists of a thin screen formed by two closely-spaced layers, one of photoconductive material and the other of electroluminescent phosphor. Between these is a very thin layer of opaque material to prevent feeding back of light. The layers are sandwiched between two transparent electrodes, and a voltage is applied across the entire assembly.

In operation, an extremely dim light image falls directly on the photoconductive layer, permitting a corresponding pattern of electric current to flow through to the electroluminescent layer. Under the influence of this current pattern, the electroluminescent phosphor emits light, forming a high-brightness image of the original picture. This process occurs because the photoconductive material acts as an insulator in the absence of light, but conducts current under the influence of light. The electroluminescent material

(Continued on next page)

NEW DEVELOPMENTS

(Continued from page 57)

remains dark until it is excited by an electric current, which causes it to emit light.

In today's demonstration, an image too dim to be seen clearly by the human eye was projected against the photoconductive layer of the panel from a slide projector. On the other side of the panel, the image appeared as an extremely bright picture of television quality, formed by the light emitted by the electroluminescent phosphor.

Mr. Kazan pointed out that the far greater brightness achieved with the new light amplifier in comparison with the earlier type has resulted from the availability of improved materials produced by RCA research, and from a new type of construction in the light amplifier panel itself.

Mr. Kazan pointed out that the ability of the light amplifier panel to convert X-rays to visible light made possible the development of the amplifying fluoroscope. In this application, X-ray shadow pictures falling on the photoconductive layer permit a corresponding pattern of electric current to flow through to the electroluminescent layer, which emits light corresponding to the original X-ray shadow picture.

The gain in brightness, plus the added clarity of the image displayed by the amplifying fluoroscope, will permit far more rapid and thorough X-ray examination of metal welds, castings, loaded ammunition, electron tubes, critical structures, and many other objects which must be inspected without being disturbed or destroyed," said Mr. Kazan.

In today's demonstration, the amplifying fluoroscope was shown in operation adjacent to a standard industrial fluoroscope screen of the type in general use. Even in a darkened room, the fluoroscopic image on the conventional screen remained almost invisible until the eyes of the observers had become dark-adapted, and the visible image even then remained difficult for the eye to observe in detail. The same image appearing on the new amplifying fluoroscope, however, could be seen clearly and in detail even when the room lights were turned on. The sample examined with both screens was an electron tube.

Mr. Kazan pointed out that the panel may be constructed in any desired size. The example shown today was a square measuring 6 inches on each side.

According to Dr. Engstrom, further research is expected to produce a photoconductive material which will respond with sufficient speed to changes in X-ray or light emission, making possible the development of an electronic amplifying fluoroscope for various medical uses. The present device, he explained, continues to emit its light for a few seconds after the X-rays have been cut off. He pointed out that this feature in the present device permits its use also wherever it is necessary to obtain an image that will persist for a few seconds after X-ray emission has been discontinued.

Hot Materials Entombed

Engineers at Hanford have solved another atomic problem. Construction of a 500-foot tunnel at the Hanford plant provides for disposal of equipment too radioactively "hot" to be repaired and too heavy to be hauled away for burial.

The tunnel, about as big as an Egyptian Pharaoh's tomb, is outfitted with a spur railroad track. Equipment beyond repair or too contaminated is loaded aboard a railroad car and rolled into the tunnel. A concrete, water-filled radiation barrier gate swings shut, safely entombing the contaminated equipment.

Usually, contaminated equipment that has worn out is crated, loaded on a flat car, hauled to a desert burial site and interred.

Amplifying Fluoroscope for Industrial X-Ray Use

Adjacent to the new electronic light amplifier at today's demonstration was an application of the device as an amplifying fluoroscope for industrial X-ray use—an application which was described by Dr. Engstrom as opening the way to "far greater speed, efficiency and accuracy in the vital field of industrial inspection techniques."

"Producing an X-ray image about 100 times brighter than that obtained with the conventional fluoroscopic screen, the RCA amplifier panel at the same time provides far more contrast than can be obtained with the present type of fluoroscopic equipment," said Dr. Engstrom. "This far greater brightness and increased contrast in turn provide marked improvement in perceptibility of detail. In addition, the X-ray image can be viewed in normally lighted surroundings, rather than in an unlighted enclosure where the eye must become dark-adapted."

Electronic Air Conditioning System

Being demonstrated in a specially constructed room, an electronic air conditioner was described as a truly revolutionary development—an air conditioning system which for the first time operates in complete silence, contains no moving parts, produces no heavy drafts, and can be used either to cool or to heat a room by the simple expedient of reversing the flow of direct electric current.

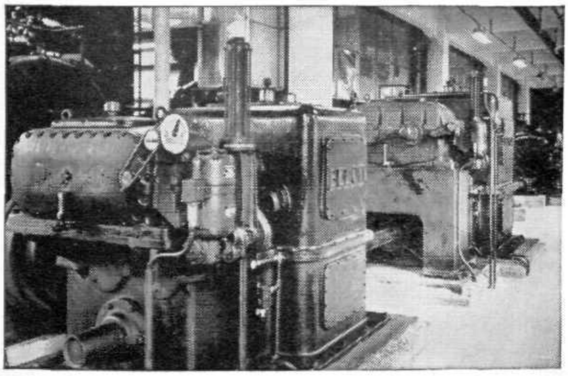
The demonstration system comprises two large wall panels—one measuring 5 x 5 feet, and the other 5 x 6 feet—with surfaces consisting of an array of 2-inch metal squares. To the back of each square is attached a small cylinder of thermoelectric material. Such a material can produce either cold or heat under the influence of direct electric current, depending upon the direction of flow of the current.

The air conditioning system and the refrigerators operate on a principle discovered more than 120 years ago by the French physicist Jean Charles Peltier. In the so-called "Peltier Effect," the passage of a direct current through a junction of two dissimilar materials creates a cooling effect at the junction when the cur-

(Continued on page 61)

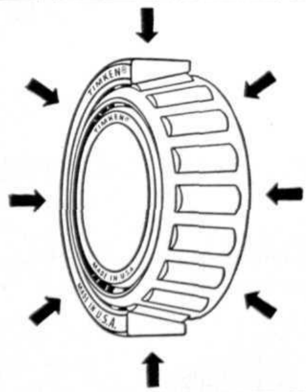
Another page for **YOUR BEARING NOTEBOOK**

How to keep paper machine speeds and tensions under control



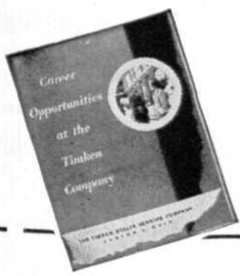
To give better control of roll speeds and sheet tensions in a paper machine, engineers developed a new differential drive system that uses a single line shaft to power individual paper machine rolls. This called for rigid shaft mountings and extremely accurate gear mesh. So the engineers specified Timken® tapered roller bearings for the drive units. Timken bearings hold shafts and gears in rigid alignment. Gear mesh is smoother, more accurate. Shaft wear is eliminated, gear wear reduced.

How TIMKEN® bearings hold gear shafts rigid



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

Want to learn more about bearings or job opportunities?



Many of the engineering problems you'll face after graduation will involve bearing applications. For help in learning more about bearings, write for the 270-page General Information Manual on Timken bearings. And for information about the excellent job opportunities at the Timken Company write for a copy of "Career Opportunities at the Timken Company". The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN

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

TAPERED ROLLER BEARINGS

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

(Continued from page 58)

rent moves in one direction, and a heating effect when the direction of current is reversed.

Starting with this experiment, which has remained largely a scientific curiosity for more than a century, a new approach based on recently-acquired knowledge of the behavior of electrons inside various solid materials was taken. As a result, for the first time, new materials which achieve cooling and heating by this means on a practical scale was produced.

The passage of direct current through the thermoelectric junctions behind each of the small square plates on the wall panels causes heat to be carried away from the squares. At the other end of each junction is a set of small cooling fins which dissipate the heat. When the system is used for heating, the current is reversed, and the heat is "pumped" electronically into the plates from the air outside the room.

The panels replace a complete section of wall, so that the cooling or heating surface is in the room while the fins are exposed to outdoor air. Since the fins are only 4 inches long, they might normally be adapted to any architectural design by shielding behind a decorative panel suiting the exterior appearance of a house.

"Hear-See" Magnetic Tape Player for Television

An outgrowth of a research program which developed a tape recorder for color television broadcast use, the new "hear-see" home magnetic tape player for black-and-white television was described as a development of major significance in the field of home entertainment.

Adding sight to the sound of recorded selections heralds the approach of a new era in the recording art. In its present experimental form, the player presents on a standard home television set, selections comparable in length to those on phonograph records.

Added research is in progress on development of a simple recording attachment for the tape player. Such a system would permit the home user to record his favorite incoming TV programs for repeated viewing, and to make original tape recordings at home for immediate or later playback on the TV set.

Small transistorized television cameras that could be used with such a system of electronic photography already have been developed. A recording system of this type also may be expected to bring about new and more effective techniques of television news coverage, as well as new visual techniques of importance in industry and defense.

In a demonstration, three pre-recorded tapes were played by the new device through a standard television set. They included a special 4-minute recording by Vaughn Monroe, recorded at the David Sarnoff Research Center on September 19; and two 4-minute selections tape-recorded by picking up from the air regular television broadcasts on September 22—one featuring a song by Eddie Fisher, and the other including portions of baseball and football games.

Pre-recorded tapes for the television tape player can be easily produced by techniques already proven in the RCA television tape system for broadcast use, and they can be marketed in the same fashion as standard phonograph records and sound tapes. As television itself has shown, the artistic possibilities of combining pictures with sound are limitless.

New Autoclave Produces Adhesive Bonded Components

The advantages and potentialities of adhesive bonded aircraft components are now being realized by aircraft designers throughout the country. To meet the inevitable trend toward this type of structure, a 30 foot long autoclave to be used initially for the production of helicopter rotor components has been designed. An autoclave is, in essence, a large pressurized oven for curing the adhesives which bond the elements of a structure together. Through its use, large assemblies and sub-assemblies with deeply drawn profiles can be successfully and economically bonded in a single operation. Formerly, this type of operation was performed on a heated platen press, which greatly limited the scope of the design to flat or gently curved panels.

Rivet holes and bolt holes are known to seriously reduce the fatigue life of any aircraft part subjected to alternating loads. Therefore, the success of the helicopter is predicted on the design of a rotor blade structure that is free of such stress raisers. It is now possible to design these components through the use of metal-to-metal bonding and honeycomb sandwich construction.

Through extensive experimentation, successful bonding methods were developed and contributed significantly to the early techniques to be put into practice in the United States. Subsequent rotor blade design took full advantage of the earlier successes. The need for equipment more suited to production led to the present autoclave selection.

The new autoclave is eight feet in diameter and has a volume of 1500 cubic feet. The vessel is almost completely automatic in operation. An entire bonding program can be pre-set in the automatic programmer, and once the proper buttons are pushed it will maintain the correct temperature-pressure-time relationship throughout the bonding cycle within extremely close limits. Other accessories installed within the vessel automatically record the pressure and temperature as well as the actual temperature of the bond line in as many as eight different places along the length of the part. This is all important to insure conformance to the pertinent bonding specifications. Heat for the vessel is supplied in the form of steam, which can, by means of a steam compressor, be boosted if the specification demands it, to temperatures as high as 430

(Continued on page 82)

Hitch your future to a HELICOPTER...

it's going places and so can you

Although acclaimed everywhere as the world's most versatile aircraft, helicopters have had only a few short years to prove it. A product of your generation, they are . . . in fact . . . *younger* than you are.

Like you, they face a future that is at once challenging and promising, but the exciting details of that future remain to be discovered and worked out.

If you expect to be a graduate engineer shortly, all this can be most important to you. Sikorsky Aircraft, the company that pioneered helicopters, is moving into high gear . . . going all out to keep pace with ever-increasing military and commercial requirements. Quite naturally, the world looks to Sikorsky to design and build the helicopters of tomorrow. And for the creative engineering, for the imagination, for the technical abilities that the future will demand . . . Sikorsky Aircraft looks to *you*.

We would welcome the opportunity to give you a more complete picture of our company . . . and to see if there is a place in that picture for you. The next step is yours. Take that step and write to Mr. Richard Auten, Personnel Department.

SIKORSKY AIRCRAFT

ONE OF THE DIVISIONS OF UNITED AIRCRAFT CORPORATION • Bridgeport 1, Connecticut

Basco Noble Muddles Through

By Stephen Prokopoff
(Stephen Stevens, Engineering Drawing)

"Every fantasy has its limits. But trying to make a summa cum laude out of Basco, is going beyond the bounds," Miss Mavis Jaastad, sitting next to Mr. Bitmore at lunch hour in the teachers' room, said in a beguiling tone of voice.

"He is a king-sized headache all right."

"But why, why?"

"Maybe just because she is new in teaching . . ." Mr. Bitmore was the psychology teacher and so he believed in being discreet. Besides, Miss Finch was young, shapely, with golden hair and flawless features. She was coming into the room at that time.

"She is plain ambitious. Thinks she can explore the uncharted continent and thus accomplish in one year what we couldn't make in ten," Miss Jaastad vigorously dented her pastrami sandwich, as she appeared to reflect.

"It's not that," Mrs. Hester Hickenlooper chimed in. "Her head is on the second spin around. At this point, it's hard to know who is interested in whom. Whether it's Basco for one reason or Imogine for another."

"What makes you think so?" Miss Finch remarked calmly, as she entered the teachers' room.

Mr. Bitmore looked uncomfortable. His eyes down like he was being shy. "Well, he's been at Bradford High off and on for ten years now. Basco's face always looked like an unpeeled potato and he had never before worn a matching suit," Mr. Bitmore had tried to explain.

"That's because I'm going to register him for Hanley College this afternoon."

"What!" Mr. Bitmore leaped like he was a short-fused piece of dynamite.

"Well," Miss Finch's brown eyes twinkled sweetly, "you were the one who told me to give Basco an incentive—to motivate him—if I wanted him to graduate this semester. And so I thought going to college would be a strong inducement for him . . ."

"That egghead? You are not serious, Imogine?" Miss Jaastad shrieked.

Imogine fixed thoughtful eyes on the woman that just asked the question. "Basco hasn't been given a chance," she defended herself. "Just because he's a little slow . . ."

"You mean stupid," Mr. McGraw interrupted, joining the conversation. "This is the tenth time I'm going to fail him in phys-ed. Every boy has some redeeming grace. That hulk has nothing. Did I tell you about the time some new teacher came along—a bright young thing like you, Miss Finch, and begged: 'Please, Mr. McGraw, give Basco a chance to shine on the football field . . .'" Mr. McGraw paused, his eyes slightly glazed at the memory. "So I let her talk me into it. And do you know what Basco did? In our first game with our worst rivals, mind you, he ran the ball the wrong way!"

There was a dead silence as all in the room recalled the dismal day.

"But . . . but . . ." Miss Finch spread out her hands. "There must be a way. No one is a total loss . . . because needs of a human being are like a powerful stream. You could cover it up, dam it, divert it, but you couldn't destroy its force. Deny, forget or distort them, you could only drive these needs into dark unconscious closets . . ."

Mr. Bitmore raised his long, lean frame from the deep leather chair, took three steps to where Miss Finch sat, and slightly bent over her. "Imogine, you now are talking Freudonian language. But we are not talking about emotional disorders. We are discussing a thing that isn't there," he pointed his finger to his head.

Imogine scrutinized his bushy eyebrows and his gray penetrating eyes a while. Then she stood up, she looked wounded. "You two seem to think I am on a fool's errand." Fighting back tears, she swung her fine hips in perfect time and stumbled out of the teachers' room.

Mr. Bitmore started to follow her, then glancing around at the others in the room, shook his head twice, gave a dejected sigh and went back to his seat.

Imogine looked at her watch, as she hurried to her room. She had told Basco to cut his lunch period short so they could put in an extra half hour of study. Were all these teachers right or were they just set in their ways? Miss Finch laid her head on the hand that was resting on her desk. At the moment time seemed never so out of joint. Basco was a challenge, but she had to prove . . . She stopped herself. Was she doing this for Basco or herself? Or was she only trying to show the other teachers how smart she was with her new methods?

While searching her mind, her initial meeting with Basco came to her. Somehow she could not yet overcome her shock at Bosco's appearance. He looked to her like a pile of meat, muscles, and bones incredulously put together. She remembered that that happened in the first day of school. She had just finished calling the roll when the door burst open noisily and a prodigious late-comer stomped in. His twaddlehead, flanked by lantern jaws, bobbed six feet nine above sea level. His stubby nose protruded between two glassy eyes. A mass of hair, like a wagonful of straw, was heaped on top of his head. His shoulders were as wide as the door and the rest of him below a narrow waistline, filled his worn jeans to bursting capacity. Without a word of greeting or apology, he clumped to the rear row of desks, where, with no small effort, he forced his torso into a seat.

When class was over, Miss Finch detained him for a moment. "What is your name, sir?" she asked pleasantly. "I want to check my roll call."

He hesitated for a moment, as if thinking it over. And in that moment, Miss Finch recalled the laughter that she had heard in the teachers' room when Miss Jaastad had said, "Lucky you, Imogine, you've got Basco Nobles, the prize of the school!"

"Muddles," he finally said.

"Muddles?" she questioned, scanning down the list. "But it says here . . ." she looked up at him to see if he were joking, but his blank face did not say so. "Aren't you Basco Nobles?"

"Sure, but nobody calls me that."

Miss Finch felt stymied for a moment, her mind flashing back to Ed. VII and the section on disturbing problems that are likely to come up. But somehow someone like Basco had never been under discussion. Ah, try another question, she thought.

"Mr. Nobles," she said, emphasizing the "Nobles," "are you comfortable in that seat?"

He stared at her curiously. "Sure."

"And how do you feel on this first day of school?"

"Not as good as on the last day," and with that he turned and clumped out.

But he never left her after that. Miss Finch badgered and urged and coaxed. She gave him special books to take home; she spent her lunch hours with him; she stayed after school to coach him. And when she went home at night, she re-read her Piaget, Dewey, and Montessori. No, she must not give up. Somewhere, there was a brain that could be touched in Basco. Somehow she would get some kind of a human reaction out of him.

"After all, this is an age of democracy," she told Mr. Bitmore, when he gently urged her to stop her crusade. "Every child is entitled to educational opportunities.

Mr. Bitmore gazed with complacent favor at her. Then he said, "I am not a hanky-panky who's dealing bottoms, but I do not recognize the allusion completely, because every teacher is also entitled to some *recreational opportunities.* We have had two staff meetings, one special luncheon, a spring dance, and a dinner in honor of Dr. Hopgrove and you were to none of them. Why not?"

Imogine stood there, tall, erect in a crepe dress tightly fit across her full breasts and smiled archly. "I know which way you want me to look. But I won't

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BASCO NOBLES

(Continued from page 65)

. . . I won't give up!" She swung her fist as if to drive the last nail into every reason or doubt that Mr. Bitmore might still nourish.

"As I said before, there is no sense in borrowing trouble. College is not for Basco," Mr. Bitmore still trying. "Even if he manages—and I don't see how—to graduate this semester, he is not college material."

"I thought that as a psychology scholar, at least, you would listen to reason, but you're as prejudiced as all of them," and off she stalked away from Mr. Bitmore only to bump right into Basco.

Her head snapped up and there was that fourteen stories tower growing out of his new clothes. He grinned. Her anger abated. "Basco," she fired bluntly, "what are your chances for passing your finals in your other subjects?"

He gazed blankly a while, then blurted innocently, "Oh, I'm going to pass them all right."

Her heart lifted. "Is it all this extra studying that's given you the confidence?" she asked hopefully.

"Naw," he laughed.

In her eyes was a puzzled, defeated look, "What then?"

"It's the teachers. They told me they couldn't take another year of me."

Miss Finch leaned against the corridor wall weakly. "Basco, don't you want to go to college and be somebody some day?"

"Sure, I'd like to be President of the United States, or maybe a space ship inventor," his thin voice said.

She opened her mouth and had good mind to say "I give up," but a few seconds of reflection made her ask him a question. "You'll study hard now, won't you, Basco?"

"I'll try," he promised.

"I want your marks to be high enough so you can get into College . . ."

"But I bet I'd learn more spending another year here, studying with you," he blurted, interrupting her.

After that remark, Imogine made sure she knew when the next staff meeting was being held, and when it was over, she put a lady-like hand on Mr. Bitmore's sleeve. "I need help, Edward," she whispered, and her voice was ethereal.

A smile began to wreath his mouth. "That's good news."

"No, don't smile at me like a Cheshire cat. I'm not giving up."

"O . . . so, he still affects you like seven sleeping pills." He shrugged. "In that case there's nothing I can do."

"Yes, there is," she said. "I was wondering if you know anything about Basco's parents. Maybe his home environment . . ."

"His parents are simple, quiet, hard-working farmers. They are patient people, most patient, I would say. They need Basco's help on the farm and yet they have given him every opportunity to finish high school."

"But maybe there is something there . . . something we don't know about that's holding him back . . ."

Mr. Bitmore shook his head. "Imogine, teaching problems are like Alcatraz—easy to get into and tough to get out of. The only way to get out of this problem is to let Basco alone," he explained.

"Edward, when you talk like that, I feel as if my bones had been pounded into jelly. But here is something for you to grapple with," Miss Finch raised her brows significantly. "Do we merely lock up our criminals and juvenile delinquents as hopeless defectives beyond redemption? Or do we try to 'cure' them, seeking out causes in their homes and childhood? Do we generally give our children more sensitive treatment at home and in school? . . ."

"Oh, Imogine, you are now again bringing in Freud. These broad ripples by the first stone he cast, they are impossible to measure and much less to apply in our case . . ."

"I've gone too far," she admitted. "I can't back down." She put emphasis on the "down" with all her streamlined body.

"If I said you're too new in the field, you'd bite my head off."

"But that's what the school needs—a dose of newness —a new approach."

Mr. Bitmore shrugged again. "There's no substitute for experience . . . and I can see you're going to get it the hard way." He took her hand gently, "How about some coffee?"

She turned away. "No, thanks. I'd rather drink some iodine the way I feel now."

But if she felt bad that night, she felt worse next morning.

"Miss Finch, you've got to help me," Basco like a locomotive roared, coming into class a half hour early.

"What's wrong?" she asked, her face lines beginning to deepen with worry.

"My pop locked me out last night."

"What!" So. There must have been something wrong at his home all the time. That's why he couldn't study. Mr. Bitmore, you see how far you are off. A thought flashed through her mind. Then her eyes went soft. "You poor thing," she said, sit down and tell me what happened."

"It's not his fault, I guess," Basco bit on his lower lip, "I went to the library to get those special books you want me to study for college and by the time I

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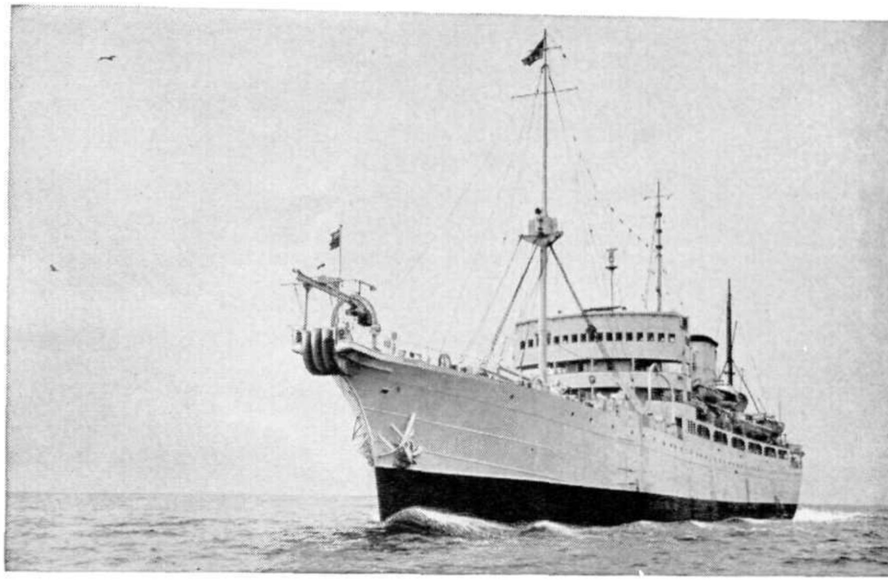

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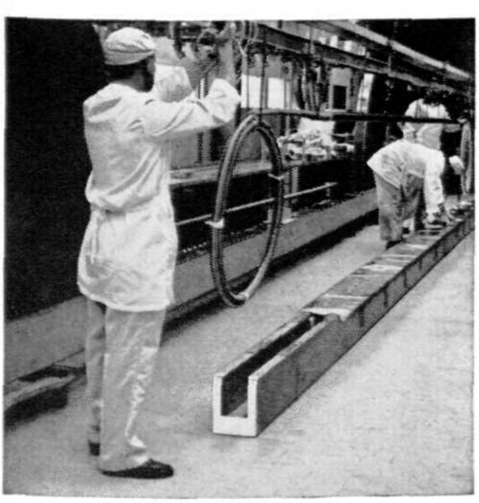
Background of the first transatlantic telephone cables



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Bell Telephone System

(Continued from page 66)

got home, it was too late to do the chores. Pop said the next time I wasn't home to do my chores, he'd lock me out—an' that's what he done."

Miss Finch swallowed hard. "And he just locked you out . . ."

"Ya bet he did, like he said he would an' put a padlock on the kitchen door and tacked on a note: 'Don't try to bust it off on account it's against the law'."

"Well, I never heard of anything like that. It's against the law to starve a child."

"Well, I'm not a child," Basco said, his eyes on Miss Finch's lovely, heart-shaped face.

"Did you eat this morning?" Imogine asked abruptly.

"No, the lock was still on the door."

She opened her handbag. "Here's a dollar. Go get yourself some breakfast. I'll think of something."

"You needn't feel too bad," Basco said, "even if it is your fault."

"My fault!" Miss Finch's voice rose to a high pitch, as her heart fell down inside her like a weight.

"Sure," he brazened it out, standing before her like a prize bull at a fair. "You made me do all that extra studying instead of letting me go home to do my chores. Pop didn't mind as long as it was going to help me graduate from high school but he says he doesn't need a college graduate to milk cows and . . ."

"I'm going to see your father this very afternoon," Miss Finch stormed. "And there's nothing wrong with a college graduate milking cows, either!" she added for good measure.

Imogine did as she said she would—although she was more worried than angry by the time she reached the Nobles' farm. Like a soldier putting on his helmet before a battle, implacable and alone, she ascended the stairs and knocked on the door at Basco's home. She heard a muffled voice inside the house call, "Hildy, someone at the door."

Mrs. Nobles opened the door, pushing her disheveled hair back from her stern face with a hand soapy from washing the dishes. "Well?"

"My name is Imogine Finch. I'm Basco's problems teacher. I would like to talk to Mr. Nobles."

"About what?" Mrs. Nobles asked crossly.

"The question of eating or not eating."

"I don't understand ya."

"Basco came to school hungry today and . . ."

"I'll take over from here, Ma," a voice rasped. The woman stepped to one side and a man's shoulders filled the doorway. "What's yer trouble, Ma'am?" Mr. Nobles peered through rheumy eyes at Imogine, sucking his breath in through his teeth.

Miss Finch's confidence began to ooze down into her thin shoes.

"Basco's a good boy. I've been trying to help him. The least you could do is help him, too."

"How?" the old man snapped. "By fillin' his head with a lot of nonsense? Those other teachers at school who left him alone or failed him were kind and more honest with him than you. You pushed him into something he couldn't do. Why don't you get married and have some kids of your own—instead of messing up others; fillin' 'em with nonsense—nonsense—" His voice broke. "You hurt ma' son more by danglin' that carrot of bein' somebody big before him than any of the other teachers who flunked him four or five times."

"How can you doubt your own son?"

"Because I live with him, Ma'am. If you want him to go to college so badly, then you can feed him. Now, I've work to do. Goo' bye." He slammed the door in her face.

Miss Finch stumbled down the steps, feeling as if she had been taken by pixies. Mr. Bitmore had told her almost the same thing but more gently—and she had been too pig-headed—too young—too inexperienced—to realize that he had spoken the truth.

There was an easy way out for her—but what was the way out for Basco? She could use a big friendly shoulder to cry on—and she knew of only one.

"Mr. Bitmore," Imogine called softly, as she saw him early the next morning, "do you have a few minutes' time?"

"More than a few minutes—if you need me," he said eagerly.

"Well, you see—" She gulped and then just stood there a while boring holes in the floor with her eyes.

"I'm a good listener," he encouraged. "Don't be afraid."

"I went to see Basco's parents yesterday and . . ." With evident reluctance and a burning face, she repeated Mr. Nobles' conversation.

"He didn't have to be so strong," Mr. Bitmore said.

"But he was right, wasn't he?" Miss Finch said. "Just as all of you have been right. The only thing is how can I help Basco now that I've got him into this mess? I realize that college is not for him—even if he could get in."

"If it'll help any, I have a friend, a prosperous farmer who's got a place about twenty miles out of town. He's always in need of extra helping hands. Basco could have a job almost at any time. He'll be away from his parents yes, but independent and on his own—that way he might even win back his folks' respect."

"Oh, if only you could arrange it," Miss Finch sighed heavily.

"I'll give Mr. Drake a buzz right now," Mr. Bitmore said, going into the office.

"I would hate to hurt Basco. Maybe I had better ask him first," Miss Finch hesitated. "It seems like I've

(Continued on next page)

BASCO NOBLES

(Continued from page 70)

been trying to lead him into things without telling him first."

"Hurt? Him! Try and hurt that lump. He has the hide of an elephant. And besides, I think that he would do whatever you'd ask him," Mr. Bitmore snorted.

Miss Finch thought that last remark over carefully as Mr. Bitmore dialed his friend's number.

The door burst open and Basco came hurtling through. "I was looking all over for you, Miss Finch," he said.

"Sh," she pressed her finger to her lips. "Mr. Bitmore is on the phone."

He looked at Mr. Bitmore, "Yeah, I can see." He turned to Miss Finch. "My dad is madder than hell. He says that you're still wet behind the ears and . . ."

Imogine winced. "I'm afraid he's right, Basco. But I'll try to do my best to patch up things between you and your father."

"How ya're gona do that?"

"Would you like to work on a farm twenty miles from here?"

"And not go to college?" Basco asked.

"And not go to college," Miss Finch repeated. "I'm sorry I was wrong, Basco. Not every boy is right for college just as not every boy can be President of the United States."

Mr. Bitmore looked up smiling. "More important, Miss Finch, you learned that a teacher can be wrong—and that's learning a lot."

"Any luck?" she asked.

His smile broadened. "Basco could begin today—if he wanted."

"Gosh, thanks," Basco grinned. "I've always wanted to work on a farm and . . . away from home."

Imogine leaned against Mr. Bitmore's desk weakly. "Got any last words of advice, Mr. Psychology?" Saying this she fixed her thoughtful eyes on Mr. Bitmore.

He beamed. "It's like this, Imogine. Now that Basco is out of the way, I, too, believe in motivation. What is the quickest way to get you out on a date with me?"

A smile sailing up in her eyes, she slightly bent over the desk and whispered, "I'm not keeping anybody after class today, you could start with walking me home."

THE END

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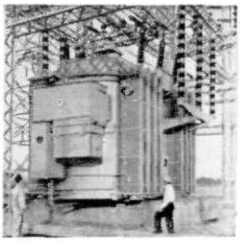

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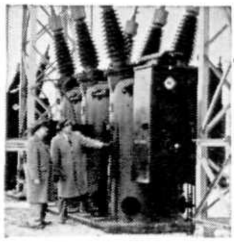

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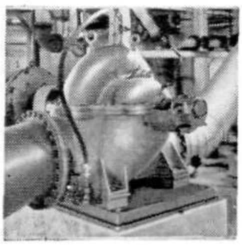

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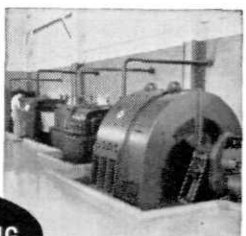

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Student Authors Page

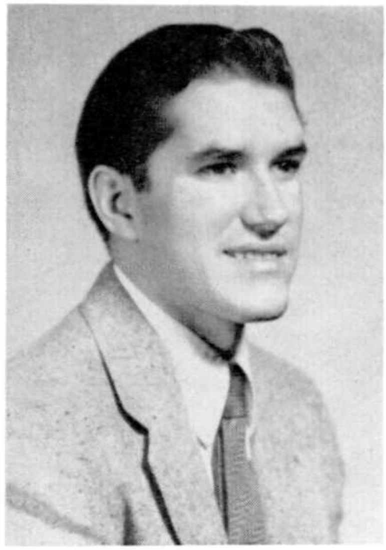
"JETS Contribute to Education" is Patrick Miller's Second Story about the JETS organization for the Spartan Engineer. Pat is a Senior from Maple City, Michigan. Pat is majoring in mathematics. He attended junior college in Traverse City before coming to Michigan State University.

His future plans include teaching math and physical science in high school. Pat is also a member of the Newman Club.

John Green, the author of "Radiation Effects on Metal" is a senior majoring in mathematics. John was born in Detroit, Michigan and now lives here in East Lansing with his wife Barbara and son John. He has been active in the I.F.C. and Union Board and is a member of the Lambda Chi Alpha fraternity.

Besides writing "The New Brain at Michigan State," Ernie Lapensee is Business Manager of the Spartan Engineer, Secretary of The American Institute of Electrical Engineers, Vice-President of Eta Kappa Nu, a member of Tau Beta Pi and a member of the Engineering Council. This is Ernie's second story for the Engineer. The first was a science fiction article.

Ernie is a Detroit senior majoring in Electrical Engineering and lives in East Lansing with his wife Mary. He worked on the Nike guided missile over the past summer and plans to go into guided missile work after graduation.



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NUCLEAR RADIATION

(Continued from page 10)

The alpha particle (or helium nuclei) is roughly four times as heavy. Fission fragments are variable in their mass.

These masses are all extremely small in terms of macroscopic measurement but they represent appreciable centers of energy in the atomic world. First of all when we apply the linear momentum concept from Newton's Second Principle (classically, neglecting relativistic effects), we realize that the "impact" of these particles, treated as missiles, is a direct function of their masses. Second, in terms of Einstein's mass-energy equivalence equation we see that the mass itself represents a concentration of energy. The conversion factor used here is 1 amu equals 931.1 MEV (millions of electron volts).

B. *Metals*

We are all cognizant of the fact that metals only appear to be continuous in their physical make-up. Their true nature, on the atomic level, is discrete in character. The atoms of which they are comprised are arranged in a regular three-dimensional pattern called a crystal structure or "lattice."

Dr. J. C. Slater of M.I.T. expresses the importance of the lattice structure as follows:

"The fundamental fact about a solid is that under ordinary circumstances, its behavior is a unique function of the position of its atoms, no matter how its atoms come to these positions."

The atoms, themselves, are of course composed of a particular array of the elementary particles with "plenty" of free space between the nucleus and the orbital electrons. Essentially then the density we intuitively attribute to metals is merely a product of our macroscopic comparisons with other materials. Two features should be noted. First, the metal crystal, because of the crystal "lattice" formation and the inter atomic arrangement, has a sufficient volumetric capacity for many additional foreign particles to be added. Second, because the crystal is primarily this "free" space, the atoms in the lattice do not represent the excellent closely arrayed target for radiation bombardment that might be first assumed.

Obviously the first considerations involving the two reactants are the mechanisms brought into play.

C. *The Mechanisms*

Neutrons and the heavier charged particles are the important types of radiation in the reactions because of their mass. (Electrons, however, have been actually utilized in the "Elox" process which is mentioned at the conclusion of the article). When the neutron was first observed by Bothe and Becker in 1932 they mistook it for gamma rays because of its extreme penetrating nature. This introduces an important concept. Metals are ultimately (we believe) composed of charged particles. The nature of the metal we have said is a function of the crystal structure. What we parenthetically imply by this is that these characteristics are a function of the electrostatic interactions of the charged particles in the crystal structure. If we consider the neutron as an electrically neutral elementary we can see that essentially it will be unaffected by these Coulomb forces.

The penetrating power of the neutron is then a simple result of a probability consideration. Students who have taken Statistics 351, Statistics for Engineers, will recognize this as an application of the "sample square" method. For the high energy neutron (exceeding perhaps 1 MEV) the expected value of the number of elastic collisions of the neutrons with atoms (nuclei) will be very small. However, when they do occur, the effect can be similar to a geometric progression. The energy transferred in the initial collision will (excepting possibly massive nuclei) exceed the inertial and electrostatic holding forces of the "knocked-on" atom. As a result both the original neutron and the displaced atom have "missile" properties. Glasstone cites the possibility of a 2 MEV neutron producing 6,030 "knock-ons" in the bombardment of aluminum. In summary then a "fast" or high energy neutron has sufficient energy to produce numerous displaced atoms although the probability of each collision is relatively small.

Another consequence of neutron bombardment occurs in the so-called "slow" neutron range (.01 to .3 ev). Because of the neutral charge, it is relatively easy for a neutron to enter the nucleus of the target atom. The result may be an isotope of the original element or possibly even a complete transmutation. It is thoroughly possible that the new material thus formed would be unstable and thus radioactive.

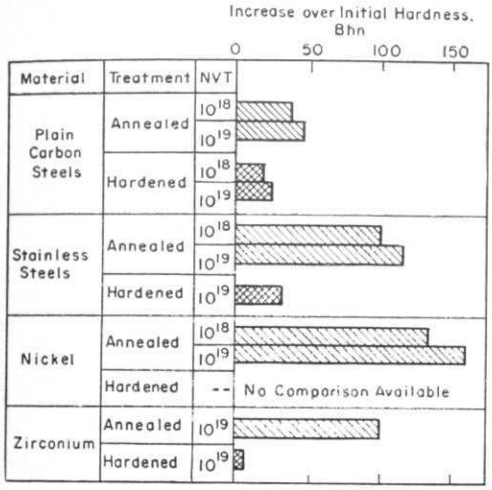
The permeability of particles other than neutrons is limited by factors including their size, energies, subjection to Coulomb forces and so on. One of the main effects created by these particles is the excitation of the orbital electrons and vibrations within the lattice, itself. In the main, however, radiation damage is a result of the neutron flux.

One final mechanism should be considered in the exposure of metals to the bombardment. This is the thermodynamic aspect. Nuclear kinetic energy can be considered as essentially heat energy. The process by which the various collisions occur involves the transfer of the "missile's" energy by instantaneous thermal conduction. This means we have a large amount of heat localized in a small area of the lattice. The natural result is a "thermal spike" or a rise in the temperature to the order of 2000° F. or even above. In this range actual vaporization of some metals may occur. When resolidification occurs, distortion of the lattice is a probable result.

III BASIC PHYSICAL EFFECTS OF RADIATION

A. *Tensile Strength Up, Ductility Down*

We have mentioned the importance of crystal structure on physical properties. Plastic deformation in metals occurs when the metal slips along certain discrete planes which can be diagnosed from a knowledge of the particular structure involved. The planes al-



Effect of irradiation on hardness of some metals.

"N" is the particle magnitude of the neutrons flux.
"V" the velocity of the impinging particle.
"T" the time of exposure.

ways appear to be those which are most closely packed with atoms. This can be somewhat analogously visualized by picturing a deck of playing cards being shifted parallel to the individual boundaries.

When the metal is subjected to irradiation some of the "knocked-on" atoms are knocked out of their normal positions leaving vacancies at these points. These atoms, themselves, are then displaced into "unnatural" locations between the lattice components. There is a resultant increase in the tensile strength because the slippage normally possible is impeded by these so-called "interstitial" atoms (this is probably an electrostatic phenomenon).

This type of lattice distortion has been compared in mechanism and results to cold working methods. Like cold working there is a resultant decrease in the ductility. There is conflicting data on the relative degree of the various effects. In an article in "Scientific American," Seitz and Wigner cite the U. S. Atomic Energy Display at Geneva. Every few seconds a light ball was thrown alternately at two copper cylinders which looked identical but differed in the fact that one had been exposed to the neutrons of the Oak Ridge reactor. The normal cylinder when hit by the light ball, gave no sound but the irradiated one sang like a tuning fork. The authors mention that no amount of normal cold working could endow copper with as much rigidity as the irradiated specimen possessed. Steele and Wallace writing in Metal Progress claim that certain aluminum alloys had yield strengths trebled and tensile strength doubled by radiation exposure. Although ductility decreased, the decrease was not as pronounced as if the same strength increase had been obtained by heat treatment or mechanical means. The late H. A. Saller presented similar evidence for steel in an article for Nucleonics Magazine.

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NUCLEAR RADIATION

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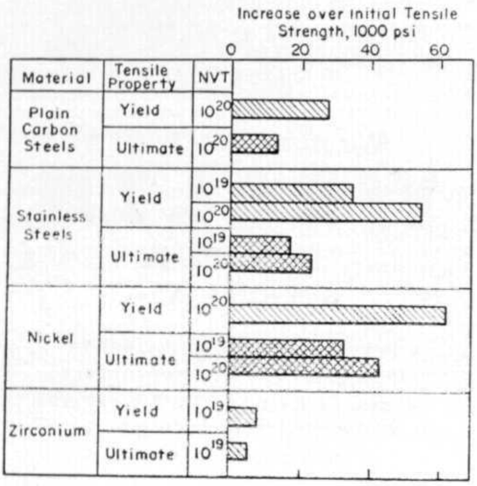


Effect of irradiation on tensile strength of some metals.

"N" is the particle magnitude of the neutrons flux.
"V" the velocity of the impinging particle.
"T" the time of exposure.

B. *Rockwell Hardness Increases*

As might well be expected from the results above, the hardness of metals increases with irradiation. Like the increase of tensile strength, it has been found that a time proportionality does not exist for the exposure-physical change relationship. It appears that a certain saturation point of these dislocations is reached after which continued exposure has negligible effect.

In a comprehensive survey written for Materials and Methods magazine in 1954, D. O. Leeser found nickel-based alloys to be most susceptible to radiation hardening. Changes to the order of 150 Bhn were reached in annealed specimens. Certain low hardness stainless steels showed changes of 15 points Rockwell "C" scale. In general Mr. Leeser found "soft" steels more adaptable to this technique.

C. *Electrical and Thermal Conductivity Down*

Some contradiction appears on this point in available data. In general, one would expect the presence of extensive lattice deformations a deterent to the free flow of electrons. Seitz and Wigner bear this out with data from the operation of the Materials Testing Reactor showing losses in electrical and thermal conductivity up to 30X normal values.

However, H. A. Saller in his discussion of semi-conductors claims that this decrease reaches a limiting value after which an actual conductivity increase occurs.

In examination of much of the available test results in this entire field of radiation effects, it is evident that much basic work must yet be accomplished. Lack of coordination and standardization of techniques is apparently a cause for much (superficially) "contradictory" data. The roll that methods of experimental exposure play in divergent data must be investigated. In addition the possibility of some subtle structure differences may rule out any all-inclusive rule for the effects.

D. *Dimensional Instability Pronounced*

As more atoms are displaced from their normal positions in the lattice, a definite "swelling" of the crystal occurs. Anyone who has had experience packing an army barracks bag will appreciate the problem here. As long as everything is in order and neatly packed, a tremendous amount can be packed in the space. As soon as disarray sets in, the overflow gets out of hand.

Seitz and Wigner discuss the problems of the AEC Materials Testing Reactor in Idaho. When the reactor went into operation with its new Beryllium Oxide moderator there was a 1% expansion the first day! The expansion was not linear with time and at the end of ten days the expansion was not nearly 10% but this is still indicative of a major problem.

E. *Unstable Energy Situation*

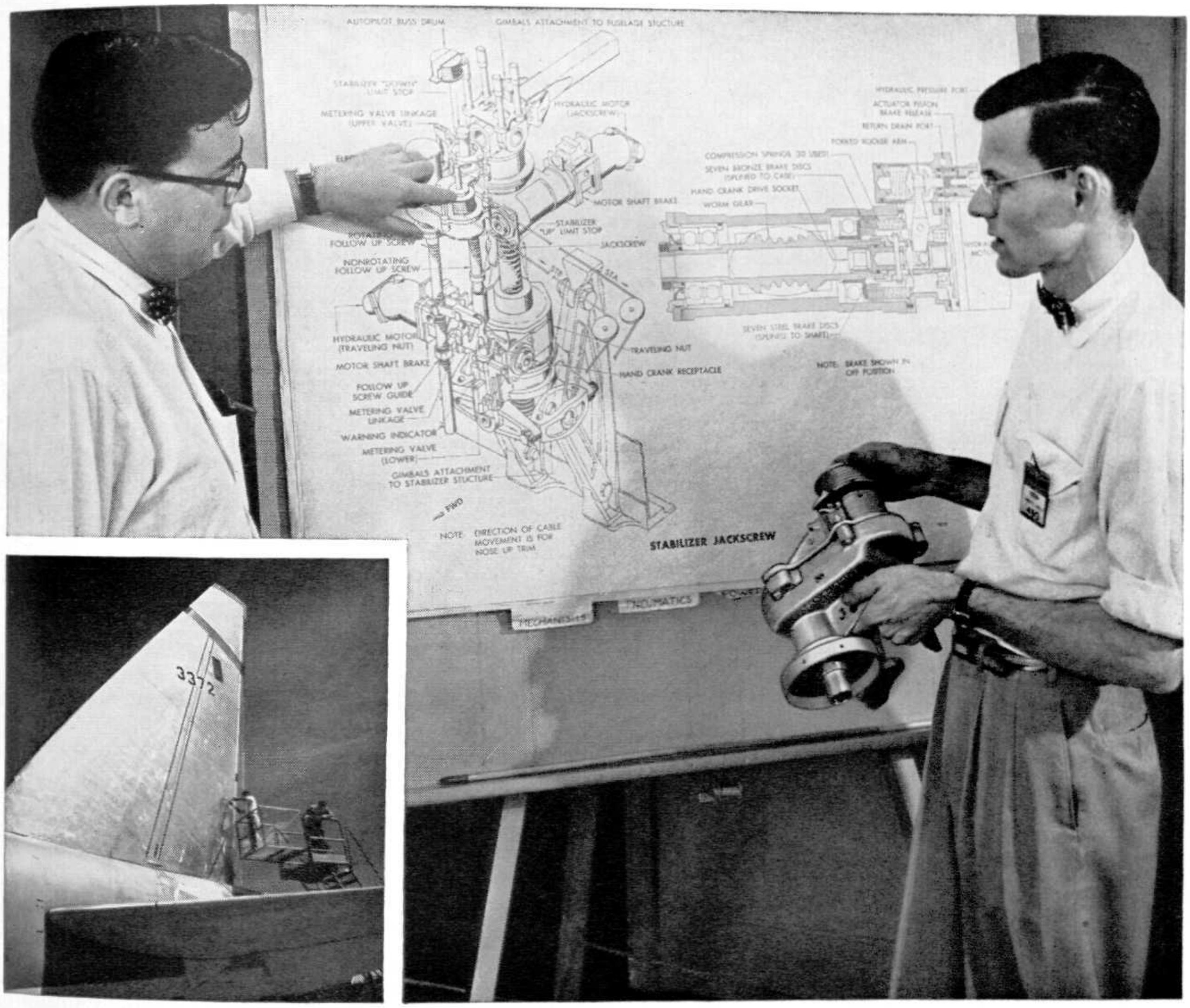
The interstitial atoms represent a considerable amount of stored energy. If there were a concerted movement back into a normal equilibrium position, there would be a sudden energy release. The energy theoretically could reach values to hundreds of calories per mole. Unpleasant complications are a possible result. The phenomena is certainly not impossible. All materials (and humans) display a certain recuperative power after radiative exposure. This is the "self-healing" effect.

IV A FEW IMPLICATIONS OF RADIATION EFFECTS

When the author began this paper he had a few hypotheses regarding methods of harnessing the so-called "radiation damage." The theory was that "damage" in the sense of reactor construction problems did not necessarily preclude application of the principles to another field. One of the last resource articles investigated was the article written by the late Mr. H. A. Saller of the Battelle Memorial Institute writing in the September, 1956, issue of Nucleonics Magazine. Mr. Saller's article was entitled "Beneficial Effects of Radiation on Metals" and contains several excellent examples of potential engineering applications of these effects. Seitz and Wigner point out that the energies residual in lattice defects are being considered as a kind of storage battery.

In the area of hardening metals there would be several obvious advantages. Localized hardening could be accomplished with even greater precision than induction hardening methods. Perhaps even more important is the fact that the hardening does not involve

(Continued on page 80)



B-52 jack screw—a typical Boeing design challenge

On Boeing B-52 bombers, the horizontal tail surface has more area than the wing of a standard twin-engine airliner. Yet it can be moved in flight, up or down, to trim the aircraft.

The device that performs this function is a jack screw, which, though it weighs only 255 pounds, can exert a force of approximately 225 *tons!*

Many kinds of engineering skills went into designing and developing a jack screw so precise that it automatically compensates for stretch and compression under load. Civil, electrical, mechanical and aeronautical engineers, and mathematicians and physicists — all find challenging work on Boeing design projects for the B-52 global jet bomber, and for the 707 jet tanker-transport, the BOMARC IM-99 pilotless interceptor, and aircraft of the future.

Because of Boeing's steady expansion, there is continuing need for additional engineers. There are more than twice as many engineers with the company now as at the peak of World War II. Because Boeing is an "engineers' company," and promotes from within, these men find unusual opportunities for advancement.

Design engineers at Boeing work with other topnotch engineers in close-knit project teams. They obtain broad experience with outstanding men in many fields, and have full scope for creative expression, professional growth and individual recognition. And they find satisfaction in the high engineering integrity that is a Boeing byword.

In addition to design engineering, there are openings on other Boeing teams in research and production. Engineers like the life in the "just-right" size communities of Seattle and Wichita. They may pursue advanced studies with company assistance in tuition and participate in a most liberal retirement plan. There may be a place for *you* at Boeing-Seattle or Boeing-Wichita.

For further Boeing career information consult your Placement Office or write to either:

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

F. B. WALLACE.... Staff Engineer-Personnel
Boeing Airplane Co., Wichita, Kansas

BOEING

Aviation leadership since 1916

SEATTLE, WASHINGTON   WICHITA, KANSAS

NUCLEAR RADIATION

(Continued from page 78)

any general elevated temperatures. These two considerations bid well to solve knotty practical metallurgy problems.

The probable transmutations resulting from slow neutron reaction bombardment leads to another interesting possibility. Alloys and structures heretofore impractical by the most advanced orthodox methods may be feasible now. In other words tailor made metals with characteristics totally unobtainable by any other means are a theoretical possibility.

At least one process on the market, "The Elox Process," involves the bombardment of metals by a charged particle. The terrific problem of machining carbides has been partially solved by using an appropriately shaped electrode maintained at a particular potential. As it approaches the work piece there is a flow of electrons to the metal. The collisions involve a thermodynamic principle similar to the "thermal spike" mentioned earlier. The localized heating is so intense that the metal is vaporized at the surface and carried away by a coolant. We might at this point wonder about the possibility of machining with an incident beam of protons or alpha particles. The mass dependent kinetic energy would thus be greatly increased. It could be assumed that the thermal conduction at impact would also be greatly increased. The net result might well be an expedited radiation type machining. The use of a carefully designed directed flow, however, poses a substantial engineering problem.

All of these considerations are perhaps impractical at the present time. However, as men trained in the techniques of atomic engineering become more plentiful, the whole field is bound to produce startling new developments.

Little Jack Horner
Sat in a corner,
Crib notes under his eye.
He opened his book,
And took a quick look,
And now he's a Tau Beta Pi.

° ° °

"Hey, Murphy, what are you putting in your vest pocket?"

"A stick of dynamite. Everytime O'Leery sees me, he slaps me on the chest and breaks my cigars. The next time he tries it, he'll blow his damn hand off."

THE NEW BRAIN

(Continued from page 21)

The output of the computer may be obtained in 2 different ways. There is a fast output consisting of punched tape and a relatively slow output where the answer is typed on a teletype tape. On the fast, punched output the bits are punched five abreast rather than in single file. This system is called the sexadecimal system. The sexadecimal system is basically a binary system with the bits gathered in groups of 4 and placed vertically. A fifth dot on the tape is not part of the word but is used for other purposes.

```
oooooooooo
oooooooooo
oooooooooo
oooooooooo
oooooooooo
```

one word in the sexadecimal system
paper tape

```
oooooooooooooooooooooooooooooooooooooooo
```

one word in the binary system

In this illustration each position is filled with a dot. For an actual word there may or may not be a dot in any given position.

SAMPLE INPUT TAPE

Instructions Add Next Two Words	Word	Word	Instructions Multiply by Following Word	Word

The computer hasn't even been finished yet and already the rapid memory is being considered almost obsolete. Dr. Von Tersch is making plans about the system which will eventually replace it—a transistor driven core memory, using printed circuitry. This future memory will have slightly more speed and better reliability than the cathode ray tube memory. Its capacity may also be increased.

SUMMARY

The new computer will probably be in operation in the Fall.

The fast memory has a capacity of 1024 words and an access time of 18 microseconds.

The slow memory has a capacity of 12,800 words and an access time of 6 milliseconds.

Each word is 40 binary digits long which is the equivalent of 12 decimal places.

The input is on punched paper tape using the sexadecimal system.

The output is either on punched tape (fast output) or typed on teletype tape.

The Cathode Ray tube rapid memory will eventually be converted to a transistor driven core memory.

Classified Ad: "Young man transferring from Engineering to Science would like to trade one good study lamp for a good mattress."

* * *

Diplomacy is the art of saying "nice doggie" until you can find a rock.

* * *

"You look very downcast."

"Yes, my wife was away for six weeks and I wrote her every week and said I spent all my evenings at home.

"She's back now and the light bill has come in. It's for 50 cents."

* * *

Thermometers — Something else graduated with degrees without having brains.

* * *

Have you heard the new radio program . . . the girl who wanted two bathrooms, or . . . The wife's other John.

* * *

Father Rabbit: "What's Junior so elated about?"

Mother Rabbit: "He learned to multiply today!"

* * *

"Beg your pardon, but aren't you an engineering student?"

"No — it's just that I couldn't find my suspenders this morning, my razor blades were used up, and a bus ran over my hat."

* * *

"Now gentlemen," said the president of the Homely Baby Bottle Co., "we have 50,000 of these feeding bottles in stock and we expect you salesmen to go out and create a demand."

* * *

Pappa Bear: "Who's been drinking my beer?"

Momma Bear: "Who's been drinking my beer?"

Baby Bear: "Barf."

* * *

Secretary — "Professor, isn't this the same test you gave last semester?"

Prof. — "Yes, but it's alright — I've changed the answers."

NEW DEVELOPMENTS

(Continued from page 61)

degrees F. The presently installed equipment provides for bonding pressures up to 100 psi with a design operating pressure limit of 125 psi.

Electronic Boilers

An electronic system designed to analyze the operation of a giant steam generating unit in a few hours—a task ordinarily requiring weeks of work by a team of specialists—has been developed.

By means of "sensing" elements linked to analog scanners, the system can probe hundreds of different boiler locations. At the touch of a button, it begins gathering such data as temperature, pressure and gas composition. Complex electronic devices, operating without human guidance, then sort the information, supplement it with pre-set figures, and punch it in code on continuous tape.

Tape readings are transmitted by teletype to a large electronic computer. Translated automatically into code suitable for computer use, the information is processed mathematically and transmitted back to the boiler site for application by engineers and technicians.

The new system has been developed to help engineers determine quickly and economically such boiler problems as sources of heat losses, the most efficient types of fuels, and when and where to remove combustion waste deposits. Emphasizing the need for a method of correcting material or operating faults promptly, authorities pointed out that boiler malfunctions and abnormal fuel consumption may continue for weeks under ordinary trouble-shooting methods. They said that the system also represents an effort to conserve critically short engineering manpower by reducing the number of personnel and the amount of time required to conduct boiler analyses.

The "brain" of the system is a centrally located electronic coordinating unit. A special "scanning" device makes it possible for the system to gather data from widespread points of a boiler. Each scanning unit collects information from 25 different sensing elements. Any number of these devices may be hooked up with the system, depending on the quantity and location of points from which information is desired.

Recently the system underwent performance tests. It gathered data from 140 boiler locations.

Potentials of the new equipment will be more fully realized when it is applied later this year to the first of three steam generating units of a new type being built. This unit will utilize the highest steam pressure and temperature ever employed in the commercial production of electric power.

Data will be gathered from 500 different locations of the unit. Successful operation of the system on this unit will conserve both manpower and money during the boiler's "proving out" stage, and provide performance data of a type unobtainable in the past.

Tiny Light Cell

A tiny light-sensitive electronic device that may be used to guide missiles by sunlight, spot the flashes of distant artillery, or enable blind operators to find plug-in positions in a telephone switchboard was described at Washington, D. C., by scientists.

The device, a novel type of photocell no larger than the eraser on the end of a pencil, was disclosed at a meeting of the Professional Group on Electron Devices, Institute of Radio Engineers. The transistor-like cell is capable of sensing with a high degree of accuracy both the direction and intensity of a source of light. It was pointed out that the compact device is capable of performing with improved accuracy and efficiency many functions which have been handled previously only with as many as four separate conventional photocells.

The development is based on the recent discovery of a phenomenon that occurs when light is focused by a lens on a semiconductor junction like those used in transistors to generate and control a flow of electrons. It has long been known that when light shines directly on such a junction, a small voltage is generated across the junction from front to rear. In addition to this previously known effect, it has now been discovered that when the position of the light is changed so that a point of light strikes the junction to one side or the other of its center, a voltage also is developed along the junction from side to side.

This lateral voltage has been put to use in a new type of photocell whose most interesting characteristic is an additional photo-output that varies from a positive to a negative value over its surface. The result is achieved by use of three electrical connections instead of the usual two in conventional cells.

This means that a point of light, focused on the photocell by a lens, will produce a signal between two of the connections that varies with the angle between the direction to the light and the axis of the cell. These signals can be read with high accuracy to determine the direction and intensity of the light source. At the same time, the third electrical connection produces a normal photocell signal in response to the intensity of the light and independent of its direction.

LIST OF POSSIBLE APPLICATIONS
LIGHT COMMUNICATION BETWEEN MOVING OBJECTS:

The photocell could be used to receive light signals from a transmitter. The transmitted message is picked up by the photocell using the normal connection, while the new direction-sensitive connections may be used for lining up or "tracking" receivers and transmitters continuously even if one or both stations are moving.

GUIDED MISSILE NAVIGATION:

Since the photocell is capable of detecting the center point of the sun with great accuracy, it could form the

(Continued on page 83)

NEW DEVELOPMENTS

(Continued from page 82)

heart of an automatic navigation system employing the sun as a guide.

ARTILLERY SPOTTING AND RANGE FINDING:

Two spaced photocells would be used in this application. The cells could detect a sudden flash of light at a distance, such as that caused by the firing of a gun, and could determine the direction to the light. The intersection of these directional lines extending from each cell would then locate accurately the position and the distance of the gun. The photocell would be capable of locating sources of infra-red or ultraviolet light as well as visible light.

LIGHT FINDER FOR BLIND TELEPHONE OPERATORS:

The extreme compactness of the new photocell would make possible the design of a lens and photocell assembly small enough to mount on a finger in the manner of a ring. The cell would signal the direction to an indicator lamp locating a call on the switchboard. The signal from the photocell would be fed through a special circuit that would translate it into a low audible frequency for transmission into an earphone. This audible signal would fade as the operator's hand neared the right location on the switchboard.

In addition to these applications, the new cell might be used also in a variety of detecting and measuring functions in which signals provided by a light source are translated into various mechanical effects. As an example, the production of sound from a film sound track.

THE ENGINEER'S PSALM

My sliderule is my shepherd, I shall not want
He maketh me set down to the third place; and leadeth me to interpolate to the fourth.
He restoreth my average; and leadeth me along the paths of correct answers for his name's sake.
Yea, though I walk through the valley of pop quizzes, I will fear no professor; for my slide rule is with me.
His log scale and trig scales they comfort me.
Thou preparest an answer for me in the presence of my instructors, thou anointed my paper with right answers and my brain relaxes.
Surely quality and accuracy shall follow me all the days of my life and I shall dwell in the house of K & E forever.

MATHEMATICAL GENIUS

(Continued from page 28)

3. Divide the first number of the multiplicand in half and subtract 2.

```
  786
  x 3
 ----
 2358
```

You deduct the 6 (last number) from 10 and get 4. Double it and you get 8—first number of your answer 8

You subtract the second number, which is 8, from 9 and get 1. Double it and you have 2. Add to one half of neighbor and you have 5

Subtract the 7 from 9 and you get 2. Double and you have 4. Add 5 (7 is an odd number) plus one half of neighbor to right (the 8) and you have 13. You put down the 3 and carry 1 3

For the last number of your answer you divide the 7 (first number of your multiplicand) in half and you get 3 (the smallest half). You add the 1 you carried and you have 4. You now diminish this by 2 and you have 2

If men have a fear of numbers, the feelings of most women toward anything mathematical is plain terror. Even simple addition gets them down.

Because of their ingrained fear of numbers, women with college educations will permit a grocery clerk who never got past the fourth grade to total up their bill, meekly paying whatever sum he arrives at. The average woman quickly chucks change from a bus driver into her purse, rather than go through the agony of counting.

Barnard College has included a course in Personal Finance in their curriculum because, "The trend toward feminine control of American expenditures makes such a course advisable." In simple English, this means that college professors hope that women will learn to check their household bills and handle their financial problems without getting the screaming meemies.

By teaching her to add by the Trachtenberg system you can save her a lot of headaches and at the same time shine as an example of efficiency.

In the Trachtenberg system you must remember only:

Never count higher than 11.

Addition becomes cumbersome, unwieldy and liable to error when the numbers mount into the higher echelons. It's when she gets entangled with totals like $167 + 9 = 176 + 8 = 184$ that she is apt to make errors, become a nervous wreck and decide that it's just too much for her.

In this system as soon as she reaches 11 or more, she stops, puts a check mark down and continues adding, starting with the left-over number. When she reaches the next 11 she repeats the process.

For a short and simple example, suppose you check the grocery clerk's figures:

eggs	.89
peas	.23
butter	.96
coffee	1.04
oranges	.39
milk	.25
	1.23
	0.23
	3.76

This is how it works:

In the first column you add $9 + 3 = 12$. Don't go higher. Make your first check mark and subtract 11 from 12. This leaves you 1.

Add the 1 to the next number. $1 + 6 + 4 = 11$. Stop. Make a check mark and continue adding.

$9 + 5 = 14$. Make a check mark and subtract 11. You have a remainder of 3, which you place below the line. You count the number of check marks (3) and put this directly below the first 3.

You do the next column of figures exactly the same way and end up with a remainder of 2. Underneath that you put another 2 to designate the number of times you reached 11. In the last column you have a 1 and underneath that you put a zero as you had no elevens.

You now have only two rows of figures to work with instead of 6.

```
 1.23
 0.23
 ----
 3.76
```

To get the final result you add the two sets of figures that you have put down, but you remember to *add in the check mark* neighbor to the lower right.

Thus you add $3 + 3 = 6$; $2 + 2 + 3$ (neighbor at lower right) $= 7$; $1 + 0 + 2$ (neighbor) $= 3$.

With this system even the monthly bank statement loses its terror. Let her try it! List her checks and remind her that no matter how complicated it looks, she need count only to eleven. In fact, since there are no carryovers from one column to the next she can start with any column. The longer the addition, the more she will appreciate this method.

supermarket	79.04
tailor	30.53
shoes	21.53
rent	125.00
electricity	11.38
telephone	5.70
dentist	18.35
drugs	6.43
	152.54
	013.22
	297.96

All operations involving calculations are susceptible to error. Anyone who has ever had anything to do with bookkeeping knows the endless hours spent going

(Continued on page 85)

MATHEMATICAL GENIUS

(Continued from page 84)

over a calculation to "make it come out right." If fatigue sets in, the original error is sometimes repeated over and over. The Trachtenberg method, which uses the rule of 9's, shows up errors quickly. For instance, an error of transposition in a long calculation—the sort of mistake that has kept many a bookkeeper burning the midnight oil—will show up at once. If the number 297 is put down instead of 279, thus throwing the whole calculation off, you find the error by subtracting 279 from 297. You get 18, or two nines, and know immediately that this is where the mistake lies.

To prove the addition you *add across each horizontal row, divide by nine, and jot down the remainder.*

Thus:

		Take out 9's	
79.04	7 + 9 + 0 + 4 = 20	leaves a remainder of	2
30.53	3 + 0 + 5 + 3 = 11	"	2
21.53	2 + 1 + 5 + 3 = 11	"	2
125.00	1 + 2 + 5 = 8	"	8
11.38	1 + 1 + 3 + 8 = 13	"	4
5.70	5 + 7 = 12	"	3
18.35	1 + 8 + 3 + 5 = 17	"	8
6.43	6 + 4 + 3 = 13	"	4
297.96		Add the remainders	33
		Take out 9's leaves	6
		Add the digits in the answer:	
		2 + 9 + 7 + 9 + 6 = 33	
		Take out 9's leaves	6

To prove multiplication, you follow the same rule as in addition. For example:

```
 67392
 x   9
------
606528
```

To prove it you add:
6 + 7 + 3 + 9 + 2 = 27

Take out the 9's and you are left with a zero.

You now add the answer
6 + 0 + 6 + 5 + 2 + 8 = 27

Divide by 9 and you are left with a zero.

This key is applicable to any mathematical problem and is infallible.

Known as the shorthand of mathematics, the Trachtenberg system is applicable to the most intricate problems. The same simple rules are used to arrive at the answer of 5132437201 x 452736502785 = 2323641669144374104785, or in figuring out the square root of 3/48726851.

A great many mathematical experts believe that within the next decade the Trachtenberg system, which has eight major keys, will have as far reaching an effect on education and science as the introduction of shorthand did on business.

The problems shown here are but a small part of the Trachtenberg system. But by memorizing these rules you can build yourself a solid reputation as a full-grown mathematical genius.

EDITOR'S NOTE: This engineering report was received in the Spartan Engineer office the other day. Undoubtedly, much thought, research and experimentation was involved in the perfection of this valuable invention; hence, we passed it on to you for your critical observation.

SURE-KILL INSECT CORP.
P. O. Box 742
Gainesville, Florida

Instruction No. 487
Date: December 5, 1955
From: J. M. O'Byrne, Head Engineer
To: Consumer

The Sure-Kill Killer is a scientifically-designed device that will rid your premises of all types of crawling and flying insects.

EQUIPMENT

Please check your shipment on arrival to see that it contains the following:

(1) Black Block
(2) Red Block
(3) Green Block

INSTRUCTIONS

(1) Unwrap the individual blocks and check for cracks or dents.
(2) Place blocks beside each other on a hard, sturdy surface.
(3) Place insect on the black block.
(4) Place red block on top of insect.
(5) Raise green block two feet above red block.
(6) With a hard slam, bring the green block down squarely on the surface of the red block.
(7) Remove green block.
(8) Remove red block and wash with hot water.
(9) Scrape insect from black block. Wash the block with hot water.
(10) Follow steps (2) through (9) until your premises are entirely free from insects.

The Sure-Kill Corporation hopes you are completely satisfied with your killer.

Ag student: "Ah'm named after my parents. Pa's first name was Ferdinand and Ma's name was Liza."

Engineer: "And what's your name?"

Ag student: "Ferdiliza."

° ° °

He: "Why do the most important men on campus always get the prettiest girls?"

She: "Oh, you conceited thing you."

° ° °

JETS

(Continued from page 13)

fairly adequate definition of the many jobs involved in work in the sciences.

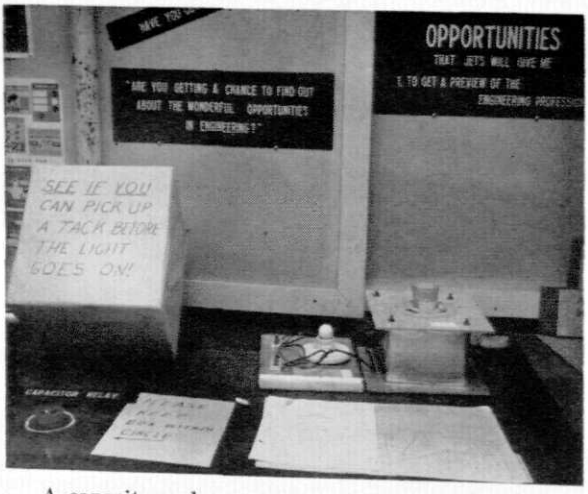
A former Olivet club member, studying E.E. at M.S.U., feels that the connection the JETS offers between high school students and university personnel is very important. The JETS main office is at M.S.U., and every year many of the numerous clubs' members are present at the Annual Engineering Exposition held at M.S.U. This tends to give them some personal contact with some of the professors in the Engineering College. Because they have this relationship and meet many members from different clubs with similar backgrounds, their adjustment to a different type of life is somewhat easier during their first year of college.

Many of the present and former club members feel that they are very grateful for having excellent advisors or club pilots. Usually a mathematics or science teacher in the school system will fill this position. These advisors are very important as far as the efficiency of the club is concerned. Probably the most important qualities of the advisor are to have a genuine interest in engineering and good organizational abilities. As is evident by the tremendous progress of the JETS, many schools have been quite fortunate in having teachers with these qualities. Club members take great pride in the abilities of their advisors, and likewise, the advisors take pride in the club. Since the JETS are a rapidly growing organization it seems that present teachers and future teachers should take an interest in promoting these clubs. As is evident by the experiences of present advisors, they should find their contributions stimulating as well as rewarding.

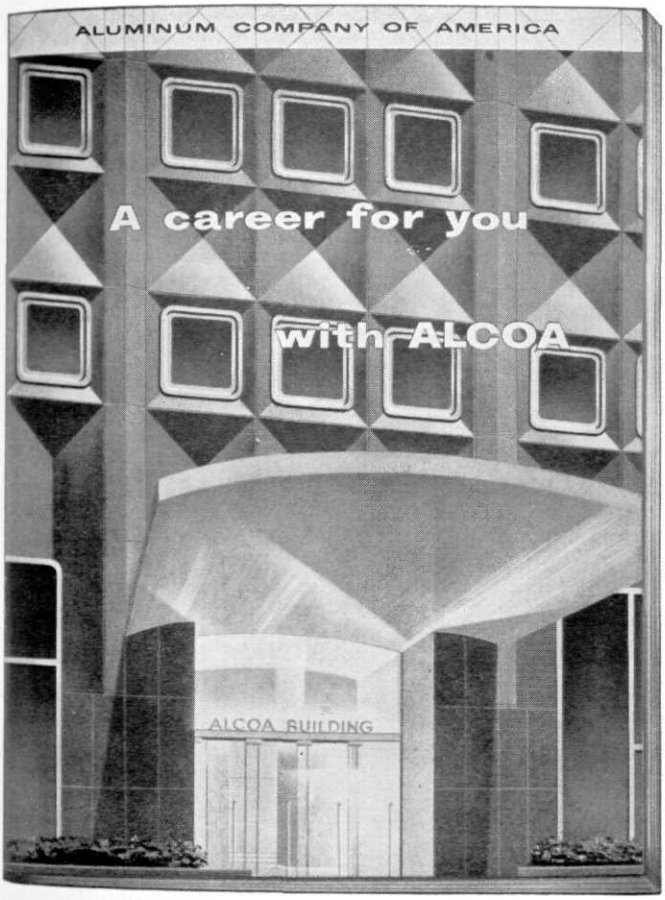
Just how do the students from JETS clubs compare with other students after entering college? Although there is no concrete evidence as of now to make an adequate comparison, only one JETS scholarship student in engineering has changed to some other field. During the same period of time the majority of the entrance scholarship students in engineering have changed to other fields. This may somewhat show how the clubs more or less assure the student's interest in engineering. Probably an important function of the JETS is to provide a test so as to show the student whether his interest is great enough for him to become an engineer. Most of us will agree that it is much better for a student to make this decision at the high school level than after two years or so of college.

One receives quite an experience when talking with these club members. You find high school students asking questions of a very high technical nature. Many of these questions involve use of principles which are usually offered to sophomores and juniors at the college level. Although these students are not able to solve these problems they have a very inquiring mind. This desire to inquire should lead to many useful and practical engineers. Also, when talking with former members at the college level, one finds them very enthusiastic and saying something to the effect that the JETS organization is going only one way and that's the direction of progressive advancement.

At present a committee is working on the possibility of organizing clubs at the college level. This is just another example of their progressive motivation. It seems that an organization of this nature with its many features is greatly contributing to the educational process of our technical society.



A capacitor relay system used in project to turn light on, whenever anyone comes near the tacks. Principle is used in many burglar alarm systems.



so **CHALLENGING**
this industry...
so **REWARDING**
its opportunities
...and so **VARIED**
the careers it offers...

Alcoa wrote this book to tell the story

Few basic industries can match aluminum for speed of growth and diversity of activities. And Alcoa sets the pace for the aluminum industry.

Because of this growth and diversity, Alcoa needs outstanding young engineers who, someday, will take over every important management function at Alcoa. Alcoa's book tells you this story.

If you are earning a degree in metallurgical, mechanical, electrical, industrial, chemical, civil or other engineering field, Alcoa wants to discuss your future with you. Alcoa's book tells you how to go about this.

Engineers who select a career with Alcoa will earn their professional recognition under the men who built the aluminum business. They'll gain their experience with the industry's foremost production equipment, such as America's biggest forging press.

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Please send me a copy of *A Career for You With Alcoa.*

Name________________

Address________________

City and State________________

College________ Degree________ Date of Graduation________

SIDETRACKED

STOLEN BY FRANK W. BRUTT

The ME instructor held the chisel against the rusted bolt. He looked at the ME student and said, "When I nod my head you hit it."

They're burying him at noon today.

° ° °

The designer sat at his drafting board;
A wealth of knowledge in his head was stored;
Like "What can be done on a radial drill,
Or a turret-lathe or a vertical mill?"
But above all things, a knack he had
Of driving gentle machinists mad.
So he mused as he thoughtfully scratched his bean
"Just how can I make this thing hard to machine?"
If he made this body perfectly straight,
The job ought to come out first rate.
But t'would be so easy to turn and bore
That it would never make a machinist sore.
So he'll put a compound taper there,
And a couple of angles to make 'em swear,
And brass would work for these little gears,
But it's too easy to work, he fears,
So just to make the machinist squeal,
He'll make him mill it from tungsten steel!
He'll put those holes that hold the cap
Down underneath where they can't be tapped;
Now if they can make this, it'll be just luck.
'Cause it can't be held in a dog or chuck,
And it can't be planed and can't be ground,
So he feels his design is unusually sound,
And he shouted in glee, "Success at last!
This thing can't even be cast."

° ° °

Ashes to ashes, dust to dust;
If it weren't for paint,
Women would rust.

The tightwad, out of town on his wife's birthday, sent her a check for a million kisses as a gift. The wife, annoyed by his extreme thrift, sent this postcard:

"Dear Jim: Thanks for the perfect birthday check. The milkman cashed it this morning."

° ° °

Papa Robin returned to the nest and proudly announced that he had just made a deposit on a brand new Buick.

° ° °

The more we study, the more we know.
The more we know, the more we forget.
The more we forget, the less we know.
The less we know, the less we forget.
The less we forget, the more we know.
So why study?

° ° °

Lady in streetcar to little boy holding large box: "What's in your box, little boy, cake?"

Little Boy: "Nope."

Lady: "Cookies?"

Little Boy: "Nope."

Lady, seeing a wet spot on the box, running her finger along it and putting it to her tongue: "Oh, I know. Pickles."

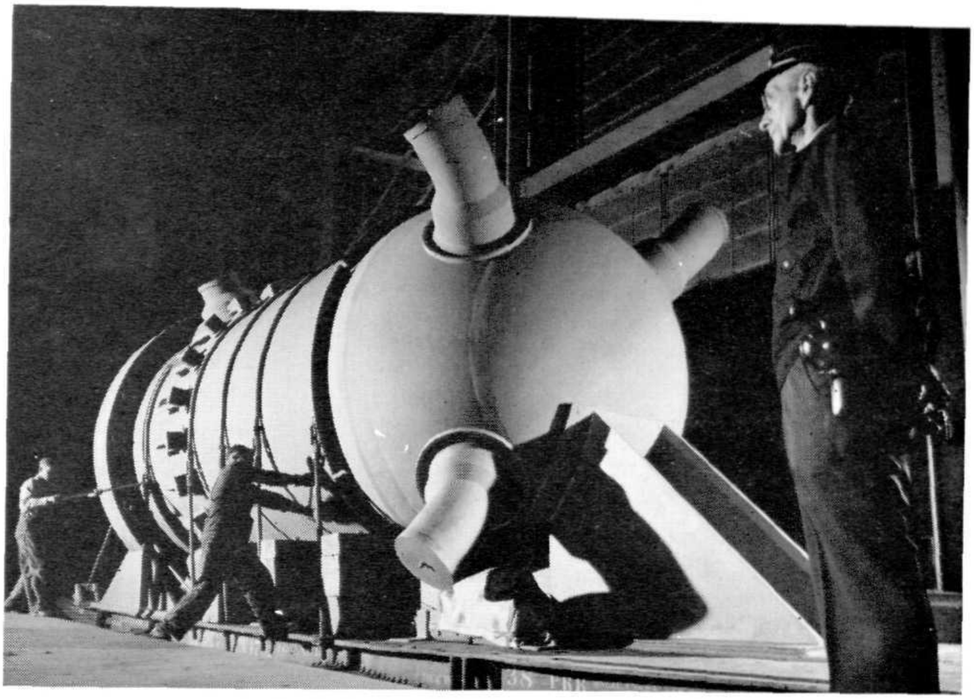
Little Boy: "Nope. Puppy."

° ° °

She: "Did you hear the horrid things they been saying about me?"

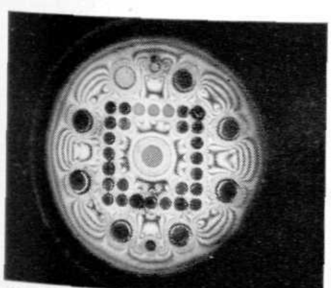
Engineer: "Why do you think I came over?"

PHOTOGRAPHY AT WORK—No. 25 in a Kodak Series

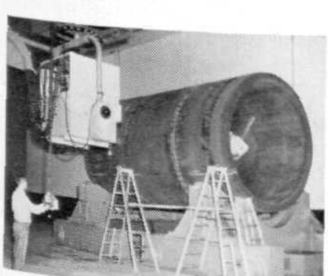


Nuclear reactor vessel for Shippingport, Pa. power plant designed by Westinghouse Electric Co. under contract with the A.E.C. for operation by Duquesne Light Company.

Where atoms turn into horsepower



Photograph showing patterns of stress concentration. It was taken of a plastic model of a reactor vessel loaded to simulate the strains a real reactor vessel would undergo.



Radiographs of the reactor vessel welds were made with a 15,000,000-volt betatron. Every bit of the special steel, every weld had to be proved sound and flawless.

Combustion Engineering designed and built this "couldn't-be-done" reactor vessel for America's first full-scale nuclear power station. And photography shared the job of testing metals, revealing stresses and proving soundness.

COUNTLESS unusual—even unique—problems faced Combustion Engineering in creating this nuclear reactor vessel. Nine feet in diameter with walls 8½ in. thick, it is 235 tons of steel that had to be flawless, seamed with welds that had to be perfect. And the inner, ultrasmooth surface was machined to dimension with tolerances that vie with those in modern aircraft engines.

As in all its construction, Combustion Engineering made use of photography all along the way. Photography saved time in the drafting rooms. It revealed where stresses and strains would be concentrated. It checked the molecular structure of the steel, showed its chemical make-up. And with gamma rays it probed for flaws in the metal, imperfections in the welds.

Any business, large or small, can use photography in many ways to save time and money. It can go to work in every department—design, research, production, personnel, sales, and accounting.

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