MEMBER E. C. M. A.

Spartan Engineer

VOLUME 10 NUMBER 1 NOVEMBER, 1956 PRICE 25c

Leroy J. Sauter, class of '49,
speaks from experience when he says:

"The variety of jobs open to engineers with United States Steel offers satisfaction and a great future."

In 1949, Leroy J. Sauter was graduated from the University of Pittsburgh with a B.S. in Metallurgical Engineering. Today, Mr. Sauter holds the important post of Superintendent, Open Hearth and Bessemer Department at National Works of United States Steel's National Tube Division.

Before his college days, and as far back as October, 1939, Mr. Sauter was employed as a chipper, a molding helper, and helper on an electric furnace at the United States Steel's Johnstown Works. Then, from 1943 until 1945, he served in the U. S. Navy. He entered the University of Pittsburgh in 1946, graduating within three years.

In February of 1949, Mr. Sauter was employed by United States Steel as a student engineer. In October, 1950, he became a process engineer in the Open Hearth and Bessemer Department. In April, 1952, he was advanced to practice engineer in the same department, and three months later, July, 1952, Mr. Sauter was appointed Assistant Superintendent of the Open Hearth and Bessemer Department. His elevation to his present position of Superintendent of this department occurred in December, 1955.

Today, Mr. Sauter supervises 316 men, being responsible for and assuring the productivity, quality of product, and general morale of this group. His responsibility further extends to the complete operation of his department, operating costs, meeting ingot requirements and complete scheduling of equipment.

Mr. Sauter's rapid advancement is not unusual at United States Steel. USS training programs make it possible for men of vision and energy to reach responsible goals within a minimum of time. Mr. Sauter says, "With the vast expansion of the steel industry, opportunities to men presently graduating from colleges and universities throughout the country as engineers are unlimited. United States Steel offers such engineers the opportunity to practice using a large variety and range of specific engineering talents. In the steel industry practically every craft known to man is utilized."

If you are interested in a challenging and rewarding career with United States Steel and feel that you can qualify, you can obtain further information from your college placement director. Or we will gladly send you our informative booklet, "Paths of Opportunity," upon request. Just write to United States Steel Corporation, Personnel Division, Room 1622, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

USS

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Working at AC, THE ELECTRONICS DIVISION OF GENERAL MOTORS is exciting . . . challenges every inch of my engineering ingenuity, currently I am working on a phase of the Inertial Guidance System Program. A month or two ago I was equally absorbed in our Jet Engine Fuel Control Program. I am certainly growing ENGINEERING "KNOW-HOW-WISE" and my salary checks reflect it. I started at a good salary . . . have had regular increases in salary and position . . . gosh, I like it here.

AND, I enjoy AC's *MASTER'S DEGREE PROGRAM,* University of Wisconsin—Milwaukee. I attend evening classes and AC is paying my tuition *and* with no strings attached.

My family enjoys Milwaukee too. Here in cool, southern Wisconsin we have endless miles of swimming beaches, parks, playgrounds that are ours for the asking. We have the cultural and shopping advantages of the big city in a community long known for its small town hospitality.

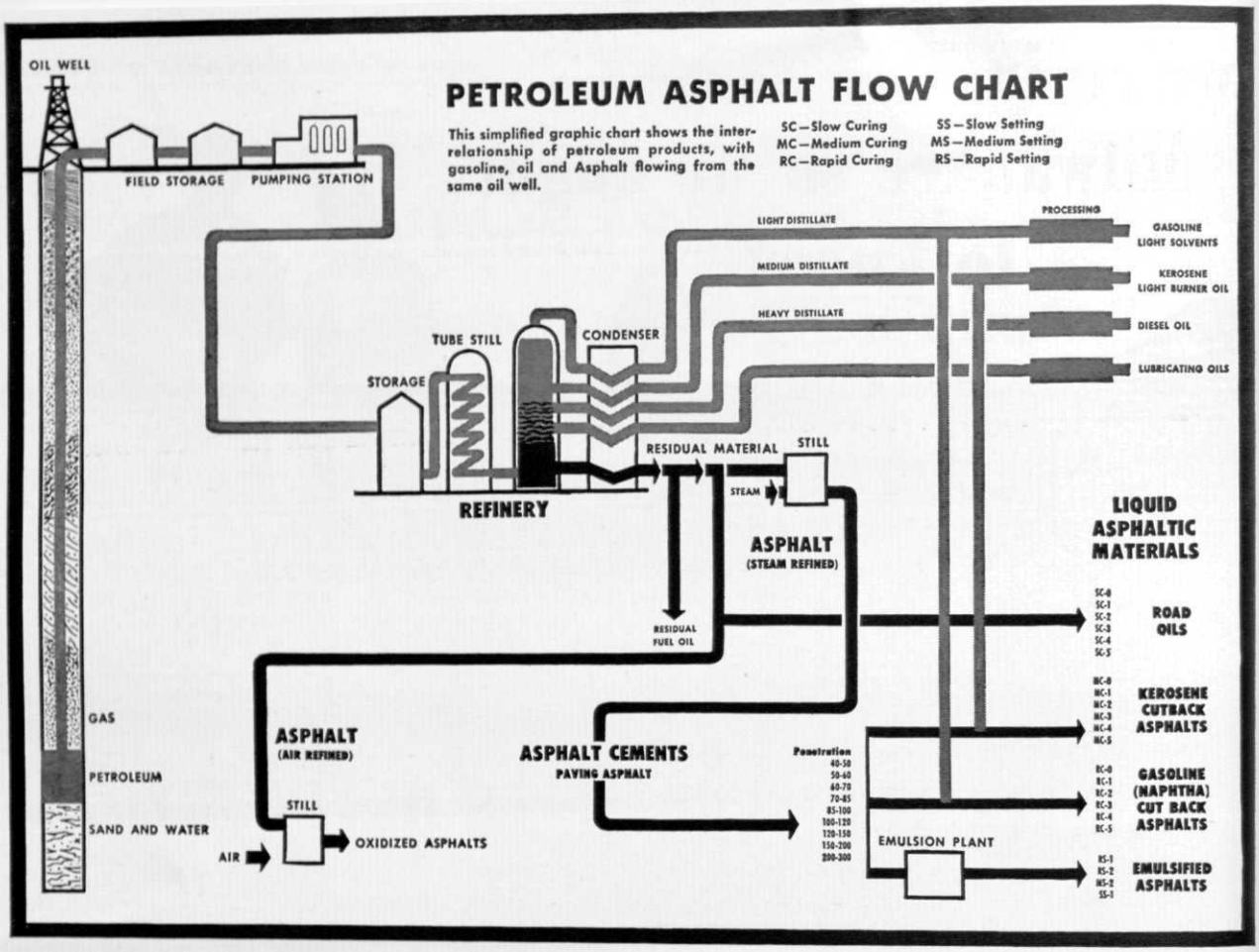
P.S. AC's Permanent Expanding Electronic Program provides openings for more Mechanical, Electrical Engineers and Engineering Technicians. Even "square pegs" are provided "square holes" at AC.

Write today in strictest confidence to my friend, Mr. J. F. Heffinger, Supervisor of Salaried Personnel.

*AC THE ELECTRONICS DIVISION

GENERAL MOTORS CORPORATION

Milwaukee 2, Wisconsin • Flint 2, Michigan



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ASPHALT is a durable and powerful bituminous adhesive used in surfacing more than 80% of the nation's streets and highways.

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Asphalt is a natural constituent of most crude petroleums. From them, it is separated by various distillation processes that also yield gasoline, lubricating oil and other refinery products. ***Asphalt is a petroleum product and is not to be confused with tar, a black substance commonly derived from the destructive distillation of coal.***

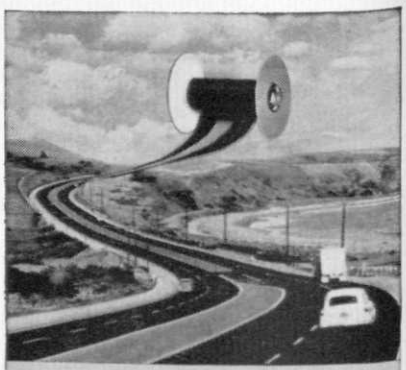
The chart shows grades of Asphalt produced by distillation, blending and oxidation. These range from watery liquids to hard, brittle solids.

The semi-solid form, known as Asphalt cement, is the basic paving material. It is used in hot-mix Asphaltic pavements for roads, airfields, sidewalks, parking areas, dam facings, swimming pools, industrial floors and other structures that require paving.

It's the basis for membrane linings of irrigation canals and reservoirs, protective coating on pipe lines, and structural waterproofing. In fact, Asphalt cements are "tailor-made" for literally thousands of applications, including such every-day items as tires, battery cases, roofings, paints, wall boards, electrical insulating tape and the like.

Liquid Asphaltic materials are likewise used extensively. In the form of road oils and cutback Asphalts they meet a variety of demands for both paving and industrial applications. Road construction and specialty applications also call for ever-increasing quantities of emulsified Asphalts . . . minute globules of Asphalt suspended in chemically treated water.

The engineering advances that Asphalt makes practical warrant your study of the art and science of using this durable, economical material.



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

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

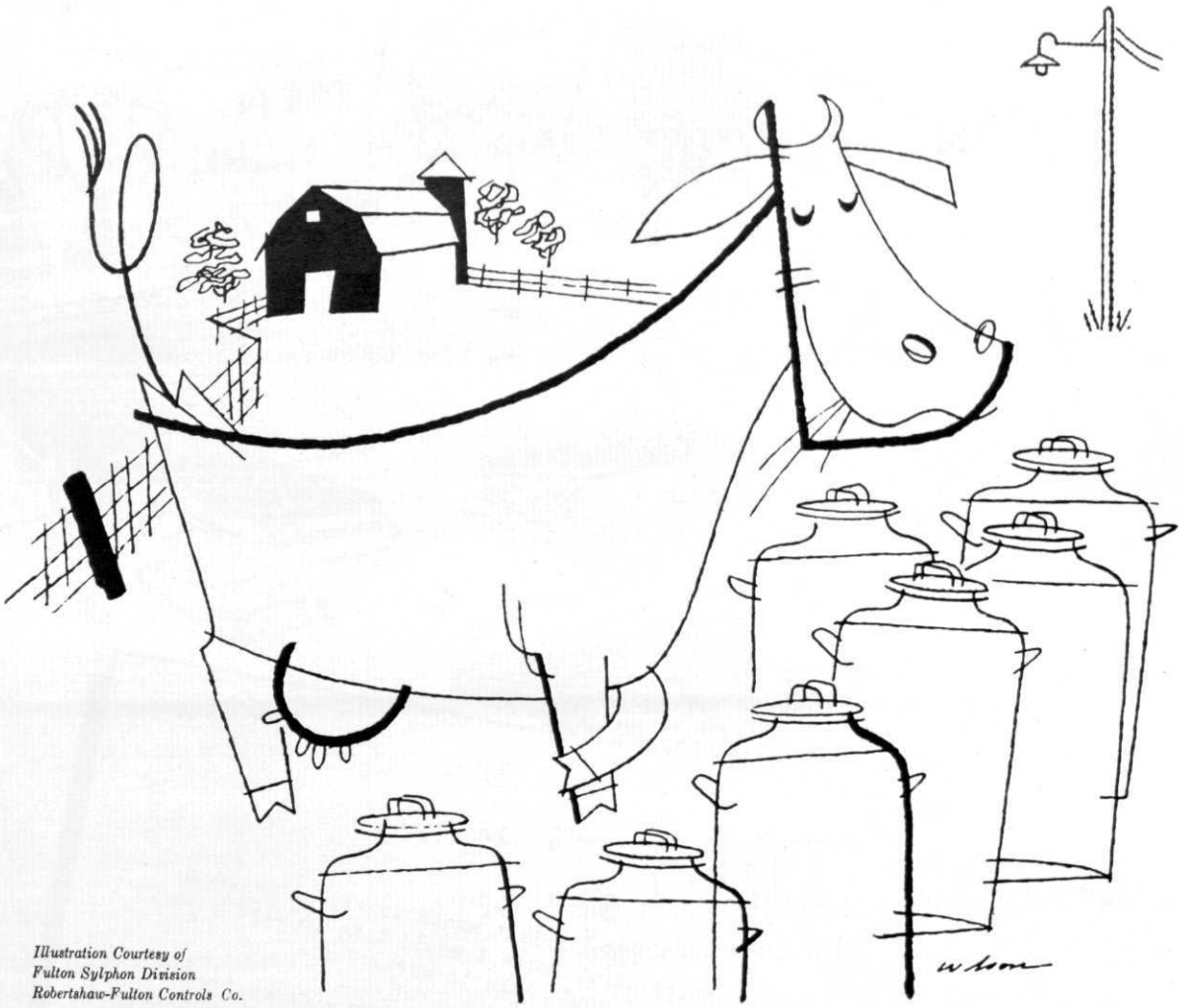


Illustration Courtesy of
Fulton Sylphon Division
Robertshaw-Fulton Controls Co.

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.

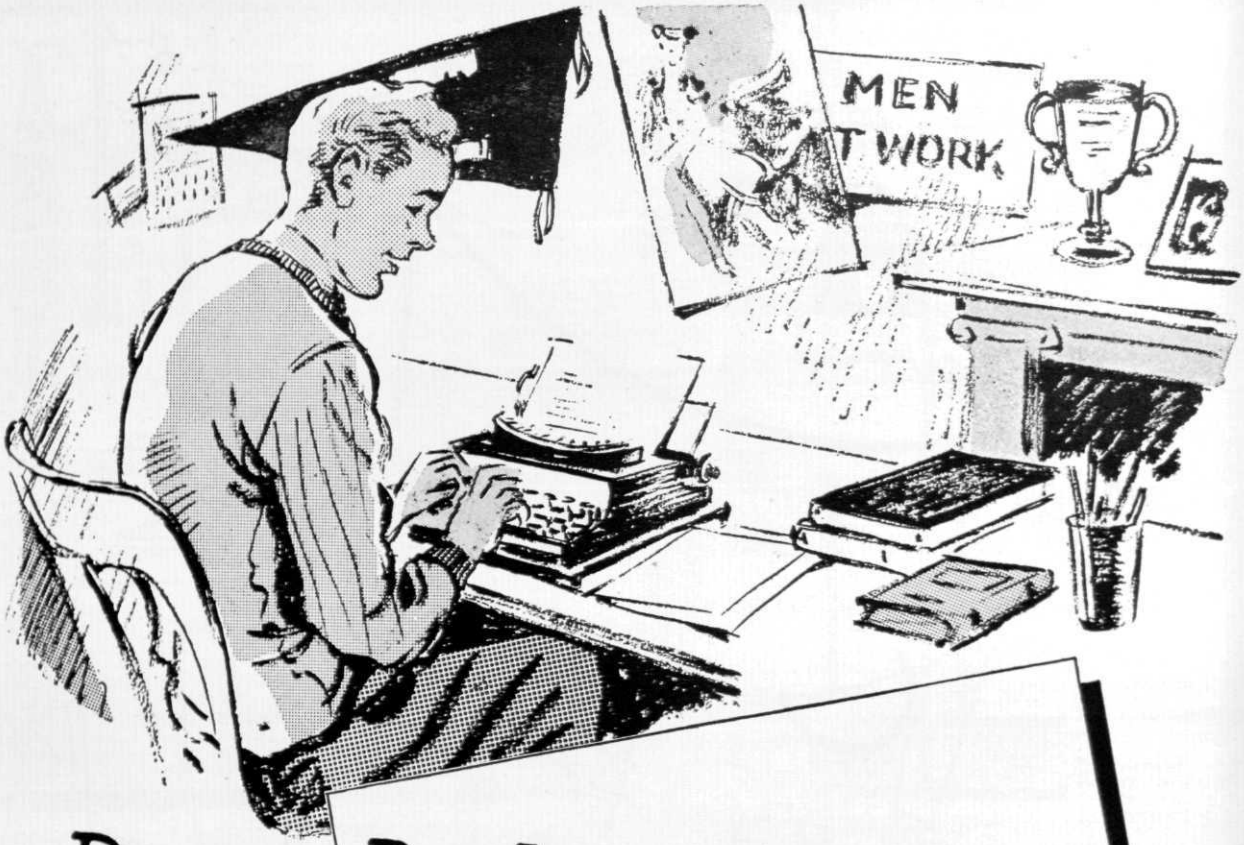
Soon it's going to be sound economics for us to transmit energy at 345 kv. There's not much precedent to draw on; much remains to be clarified about system design, operation, radio interference, line losses, relays, system integration, lightning performance. Where does the challenge stop?

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.

DETROIT EDISON



Dear Dad,

Since I last wrote to you, I've been thinking about where I would like to live as well as where I would like to work.

Bob - you remember him - comes from New Jersey. He's been telling me a lot about it and it all adds up as a good place to live.

Public Service Electric and Gas Company - one of the country's more important utility companies - serves a section of the state between Philadelphia and New York. The Company has excellent training courses for Cadets in its Electric and Gas Operating Departments, in Sales Engineering, and in Commercial Management work.

As Bob says, New Jersey has everything for pleasant living: seashore and mountains for recreation; New York and Philadelphia for big city culture - the Metropolitan Opera - Philadelphia Symphony, etc. He says home life in smaller localities is happy and congenial (you know how Mary likes that kind of life and, after all, I must take her into consideration).

Don't be surprised if I write to you that I've taken a job with Public Service in New Jersey. It sounds good to me.

Affectionately

Bill

Representatives of Public Service Electric and Gas Company will visit your campus sometime in the near future. They will be glad to tell you about the company's job opportunities.

Public Service Electric and Gas Company,
Room 2152A, 80 Park Place, Newark 1, N. J.

Please send me literature on New Jersey and job opportunities with Public Service.

Name.....

Address.....

College.....

A-452-56

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
NEWARK 1, N. J.

Spartan Engineer

of michigan state university

VOLUME 10 NUMBER 1 NOVEMBER 1956

FEATURES

DEPARTMENTS

Cover:

JETS — SYMBOL FOR JUNIOR ENGINEERS:
for story see page 18.

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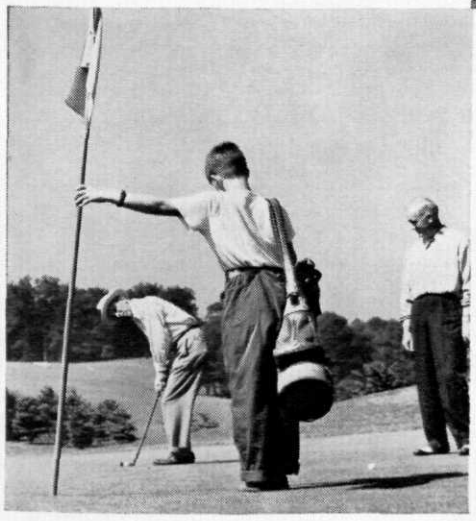
A Douglas engineer lives here



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Those with degrees in mathematics, physics and engineering are needed to solve interesting problems on direct analog computers and differential analyzers.

Knowledge of or experience in dynamics, stress analysis, servomechanisms, heat flow and circuit analysis or non-linear mechanics is helpful.

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Making today's BIG news in air conditioning

NEW BUILDING in New York is the glass-sheathed Manufacturer's Trust Building. It's cooled by a Worthington central station system—so big it does the same job as melting 300 tons of ice daily.

NEW LIFE FOR OLD STORES. Shoppers stay longer, buy more in stores cooled by Worthington units with the new "Million Dollar" compressor. New 3-D circulation aims comfort right where you want it.

Worthington's new residential air conditioners, packaged units, big central station systems — all are making headlines in the air conditioning field. And the same research and engineering skills responsible for their development are applied to all Worthington products — engines, turbines, compressors, construction machinery, as well as pumps.

For the complete story of how you can fit into the Worthington picture, write F. F. Thompson, Mgr., Personnel & Training, Worthington Corporation, Harrison, New Jersey. 4.25D

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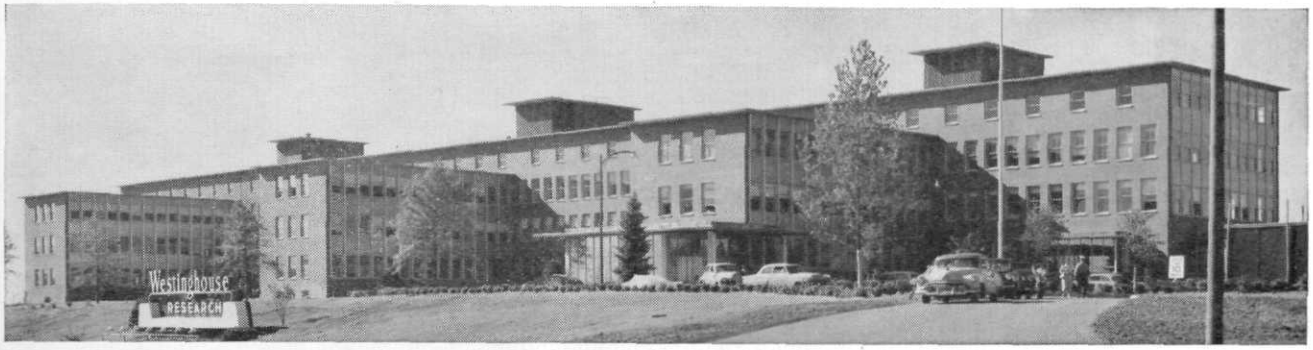

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From its earliest days, Westinghouse has built a farsighted research program knowing that it was an investment in the future of the nation and in scientists and engineers like yourself. Recent evidence of that faith in tomorrow is the new Westinghouse Research Laboratories where more than 750 scientists, technicians and other staff members strive to make the unknown known.

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You are cordially invited to become a part of Westinghouse research leadership. Challenging career opportunities await you in a variety of locations, and continued education at Westinghouse expense is available in 22 universities.

Ask your placement officer to arrange a date with the Westinghouse Interviewer who will be on campus soon. Meanwhile, write for *Finding Your Place in Industry,* and *Continued Education in Westinghouse.*

G-10303

Westinghouse

It's Magic . . .

SILICONES WORKING FOR YOU

by Herbert Horsley, J '58

Black magic today? Probably not black, but there is magic today and it is all about us. It lights our homes and fills them with music, drama, and the Mickey Mouse Club. It makes our work easier and runs the machines of a mighty nation to give us the things we want to buy.

Electricity. A world in itself. A marvelous world that makes our world a better place in which to live.

Yet a battle rages. We have harnessed electricity, but it strains at the leash. It has two weapons at its command—heat and moisture. Electricity at work creates heat. The harder it works for us, the more heat it has to work against us. This heat pokes holes in all the ordinary insulating materials such as: cotton, wood, rubber, paper, and organic insulating materials. Even the smallest crack or pin hole opened up by heat will let moisture in, to provide an excellent path of escape for our electric power.

Other types of insulating materials have been tried without success. Among heat-stable materials are glass and ceramics. These, however, are much too brittle and rigid to use successfully in electric machines.

Asbestos, mica, and glass cloth cannot exclude moisture, so they must be held in place by a resin or varnish to make them waterproof. However, the instability of organic resins and varnishes has resulted in a sadly limited insulation.

This is where the silicone story begins. By combining glass cloth, mica, and asbestos with silicone resins and varnishes, a new class of insulation has been produced. Silicone insulation enables electrical engineers to reduce the size and weight of electrical equipment by 50%, or make electric machines last 10 times as long as they did before.

Silicone products are particularly well-adapted to accept the burden of the problems of electrical insulation. In general, there are three interrelated types of silicone products—resins, liquids, and rubber. There are two characteristics common to them all—temperature stability and water resistance.

The heat stability of silicones can be readily and simply explained. Silicones are made up of silicon-to-oxygen bond molecules as contrasted to carbon-to-carbon bond molecules found in organic products. The amount of energy bonding the silicon to oxygen is 89.3 units (kilocalories per mole). The bonding energy for carbon-to-carbon is 58.6 units or only two-thirds as much. As you can see, it would take much more energy to break down the silicon products than the organic ones.

The water resistance can also be easily explained. The silicon molecule can be thought of as a silicon-oxygen-silicon chain linkage surrounded by hydrocarbon units. This type of molecule presents a surface very similar to paraffin or oil, which resists water.

The Dow Corning Corporation, the world's largest manufacturers of silicone products, was responsible for a large amount of work done in this field.

Many men worked together to develop this new type of insulation. Perhaps foremost in the insulation field is John F. Dexter, manager, electrical section of the product engineering laboratories, Dow Corning Corporation. Dexters' native state of Texas can be proud of his contributions to his field.

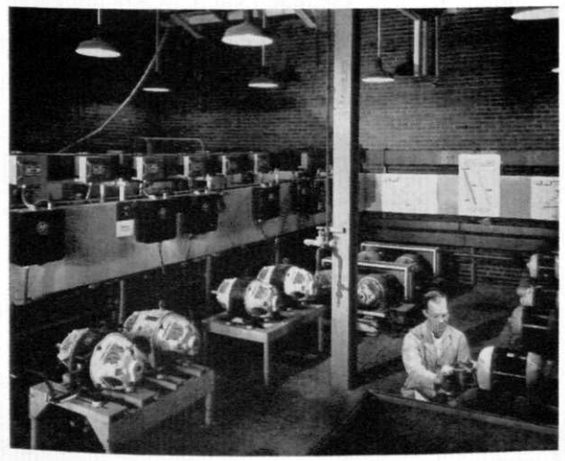
Melvin L. Manning and Henry P. Walker helped to pioneer silicone insulation. Other men whose names are virtually synonymous with silicone insulation are: G. L. Moses of Westinghouse; T. A. Kauppi and C. A. Doremire of Dow Corning.

Without a doubt, the results of what silicone insulation can do are astonishing. An electric motor wound with silicone insulation would have a "life expectancy" of at least 7 years of service at a hot spot temperature of 220 C! A motor wound with ordinary insulation would fail after only three months. In addition to this, silicone (class H) insulation permits weight reductions up to 50%.

Since silicone (class H) insulated electrical equipment has 10-100 times the life expectancy of comparable machines built with the next best type of insulation, this means greater reliability for you. You can increase production while lowering maintenance and production costs. You will have more overload capacity and more efficient use of power in variable load applications.

Silicone insulation, in addition to making the motors last longer, gives the motor more power. It can increase by as much as 50% the power per pound ratio in motors, transformers, generators and solenoids. This means you can meet increased production schedules at a minimum of cost by uprating present equipment with silicone insulation. Recently, a large chemical plant had this exact problem. Production had to be increased at a minimum of cost. This was done by having 31 motors with name plate ratings of 50 and 60 H.P. at 850 rpm rewound with class H silicone insulation to put out 75 H.P. to 90 H.P. at 1150 rpm. New 75 H.P. motors with conventional insulation plus installation would have cost $68,200. Rewinding, plus installation on the original mounts, cost about $19,000. Thats an initial saving of almost $50,000.

Equally important has been the added life and reliability of the silicone rewound motors. The old motors burned out at the rate of one a month or 48 failures in four years. The same motors rewound with silicone insulating materials have failed only six times in the past four years and have been delivering at least 50% more power!



Silicone electrical insulation is tested and compared for stability and durability. In the right foreground is a tank in which motors are subjected to high humidity as part of the test cycle.

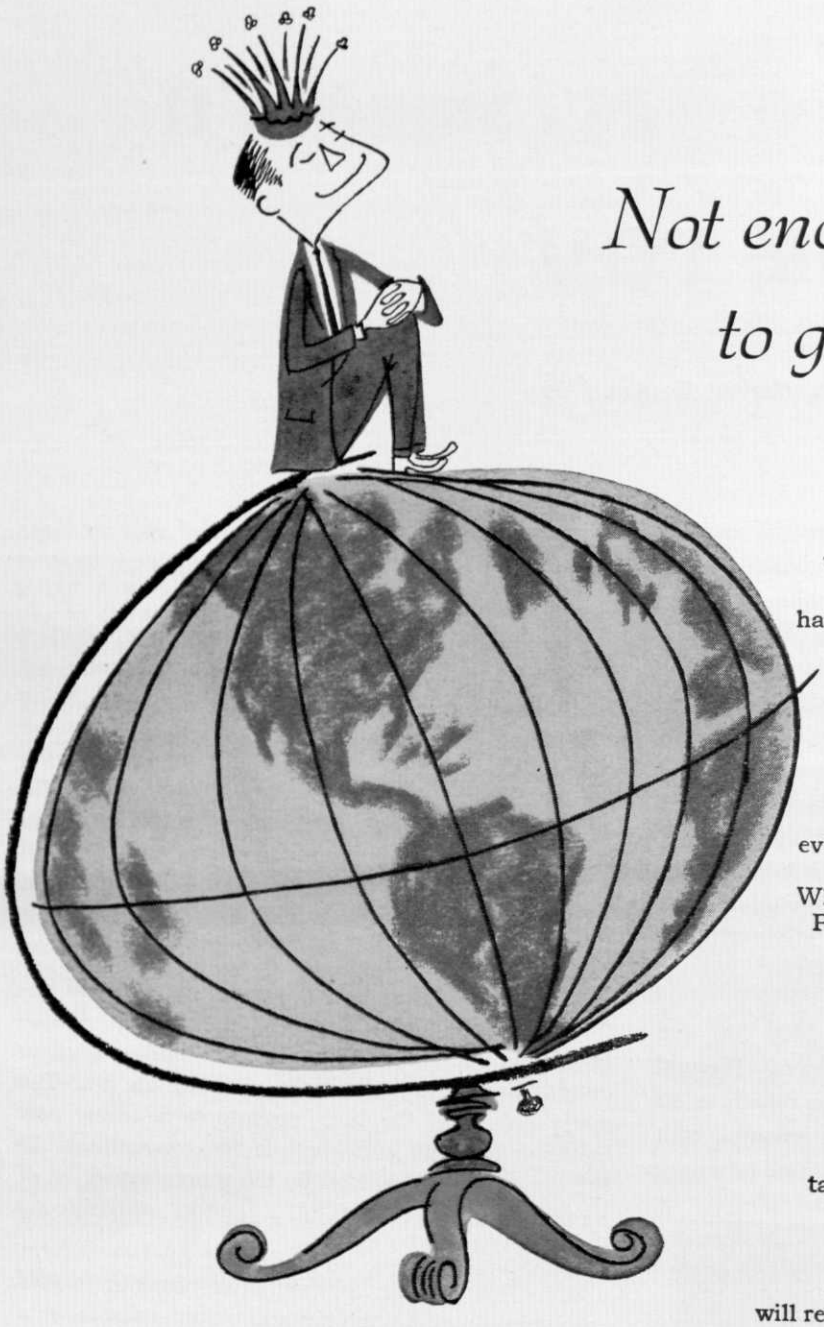
Along the same line, another company found it necessary to get 50% more pumping capacity out of their 22 mixing pumps. These motors were being exposed to outdoor weathering and to a variety of soluble salts. Being exposed to this punishment was all the conventional 2 H.P. motors could stand. To replace these with 3 H.P. motors plus installation would cost $4400. Instead they rewound the old motors with silicone (class H) insulation at a cost of $2300. In addition the savings, they received a bonus of greater overload capacity and better salt resistance.

As every engineer knows, there's many a slip between the print and the plant. In this case, twelve 10 H.P. 1750 rpm motors were installed in a plant only to be proved ½ H.P. too small for the job. The costly delay and the large expense of installing new footings, brackets and controls for conventional 15 H.P. motors were avoided by the simple expedient of uprating the original 10 H. P. motors with silicone (class H) insulation.

Many times in the construction of plants or smaller units space is at a premium and weight must be at a minimum. This was certainly the case when General Dynamics Corporation was building the new atomic submarines. These atomic submarines required 63 integral horsepower motors to drive pumps, compressors and auxiliaries. Each of these motors is completely insulated with Dow Corning silicones. Combined weight of these motors is 27,141 pounds. If conventional motors had been used, the weight would have been 36,000 pounds. Thus we see, silicone insulation is responsible for a total weight savings of 4.5 tons.

The performance of silicone insulated motors is really incredible. At 10 a. m., June 6, 1946, a silicone

(Continued on page 52)



Not enough to go around

How times change!

Not so very long ago, an engineer struggled to obtain a degree. Yet afterwards he just couldn't find a job that would let him utilize his hard-earned knowledge, much less start to build a career. Today, however, the demand for engineers exceeds the supply . . . so much so that there are not enough to go around.

We need engineers and skilled technicians. That hundreds of other companies do, too, is extremely well evidenced merely by thumbing through your newspapers and magazines. Why should you choose us above them? Perhaps you shouldn't. Neither should you come to that decision without first becoming fully aware of our record . . . who we are, what we do, where our future lies. For, in whatever field you choose to pursue a career, your transition from neophyte to veteran will not depend on ability alone. Without ample opportunities to demonstrate your talents, you'll not be able to prove your potential value in any industry.

We would like to tell you about our company. We hope, too, that you will reciprocate and give us the opportunity to evaluate you. You can do this by writing to Mr. Richard Auten, Personnel Department.

SIKORSKY AIRCRAFT

ONE OF THE DIVISIONS OF
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BRIDGEPORT 1, CONNECTICUT

Introducing:

John D. Ryder, Dean of Engineering

by Mel Maynard, J '60

J. D. RYDER

"Engineering students should give consideration of the advantages of taking graduate work here at Michigan State University or elsewhere," states Dr. John D. Ryder, dean of engineering. "Why?" the student may ask. Dr. Ryder goes on to explain that the easy problems have been solved. A bachelor's degree isn't too sufficient and further education will be required in order to solve the problems of the future.

Dr. Ryder's background in the engineering field started when he received his B.S. degree in electrical engineering from Ohio State University in 1928; and received his M.S. degree from the same school the following year.

New York was the destination of Dr. Ryder, after his graduation, where he worked in a test course at General Electric Company, specializing in his work on electron tubes suitable for heavy power use. He then went to Cleveland, Ohio to work in the research department of the Bailey Meter Company, where he was in charge of electrical and electronic research and development. In 1941, he entered Iowa State College as an assistant professor, becoming a full professor and receiving his Ph.D. He was acting head of the department for 20 months, and soon after became assistant director of the college's experiment station.

It was after this appointment that Dr. Ryder began work on the design and development of a high-frequency network analyzer, a form of computer used now by many electrical utilities. In 1949, he transferred his work to the University of Illinois where he was head of the electrical engineering department. He came to Michigan State University July 1, 1954 and has been dean of engineering since that time.

Besides this experience in the engineering industry, Dr. Ryder has to his credit membership in several professional organizations and honorary fraternities, and the publication of a number of textbooks. Also included in his busy schedule, he serves as guest speaker at various functions.

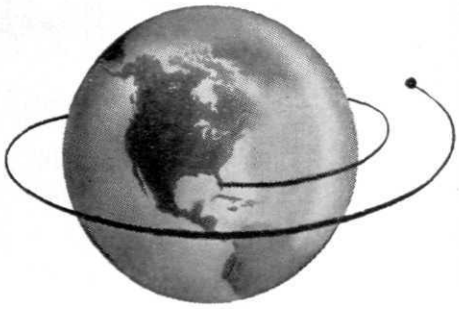
After the completion of the new engineering area, which will soon be in the building process, Dr. Ryder is anxious for the students to have better facilities which will enable better opportunities for each student in their education in engineering. To him, having a mediocre College of Engineering isn't satisfactory. He's hoping that the new campus development will surpass that of any college or university in the nation.

With little spare time for other interests, Dr. Ryder sometimes finds time for color photography and f.m. radio, which he more or less considers hobbies. He also enjoys traveling, which includes climbing mountains and taking pictures.

Dr. Ryder and his wife reside here in East Lansing. They have a daughter, a sophomore at Iowa State University, and a son, a student at East Lansing High School.

Honeywell...*from thermostats to inertial guidance for satellites...*

Two of Honeywell's 12,000 different automatic controls are the Honeywell Round—first entirely new thermostat design in 70 years—and an ultra-sensitive type of inertial guidance system, which will direct the rocket placing the world's first man-made satellite in its orbit.



Over thirty years ago in the *American Mercury* the inimitable journalist H. L. Mencken wrote, "Of all the great inventions of modern times, the thermostat has given me most comfort and joy. Not for a dozen Marconis, a regiment of Bells, or a whole corps of Edisons would I swap the great benefactor of humanity who invented the incomparable thermostat."

Honeywell began in a basement, with the invention of a simple bimetallic thermostat to open furnace dampers on chilly mornings. But extensive research into electricity and electronics, pneumatics, gases, metallurgy, chemistry, plastics, and plain and fancy physics has diversified Honeywell by means of engineering and new-product development into *automatic control for almost every known purpose.*

EXCITING GROWTH: Today, after 72 years, Honeywell has grown and is growing still—the world's leading designer and manufacturer of all kinds of automatic controls. Sales have more than doubled every five years. In the *last 7 exciting years alone* Honeywell has increased sales more than fourfold—from $57 million in 1948 to $244 million in 1955. In these 7 years over 20,000 new employees from all over America have joined Honeywell to find new opportunities. Honeywell now has 31 factories and 160 sales and service offices throughout the world.

MAIN FIELDS: Basically, Honeywell operates in three main fields: heating and air conditioning, industrial instrumentation, and aeronautical controls and ordnance equipment. But the common denominator is always *automatic control.* Heat, color, density, liquid level, humidity, weight, or any other measurable factor—such as attitude deviations of planes or missiles in flight—can all be recorded and controlled.

REMARKABLE DIVERSITY OF PRODUCTS: More than 12,000 *different* Honeywell products give you an idea of the range within which you can build a highly rewarding career. Because Honeywell is operating in almost all the fields known as growth industries, our continuing drive to provide new markets, new products, and new systems promises you a rewarding future.

SMALL UNITS MEAN OPPORTUNITIES FOR YOU: Our employees operate primarily through *personal contacts* with supervisors and fellow workers. Our small units present multiple opportunities for early managerial experience as (1) project leaders, (2) section heads, (3) foremen, (4) department heads, (5) chief engineers, or (6) sales managers. As Honeywell continues to grow, advanced positions are filled largely by men who have worked up from within. So, as an employee, you too will have real opportunities to fill Honeywell's future managerial needs. And Honeywell needs restless men who can accept and discharge responsibilities.

SCIENTIFIC MANAGEMENT: The men who run Honeywell are a top management-science team. Year after year the American Institute of Management has rated Honeywell "excellent"—the top rating among America's best-managed companies. Honeywell's management recognizes that our growth in the challenging future depends in the largest measure upon the initiative, intelligence, and interest of the young people now starting with us.

MODERN PLANTS NEAR SUBURBAN NEIGHBORHOODS: In these expanding units—each conveniently located near pleasant suburban areas with adequate housing, schooling, and recreational facilities—Honeywell offers you rewarding opportunities to do your best work with the most modern facilities:

1. Heating and air conditioning: Complete engineering and manufacturing plants in Minneapolis, Chicago, Wabash, and Los Angeles. We now produce scores of dramatic new controls and systems applicable to *all* types of temperature-control equipment in homes and industry, public and commercial buildings of every type, ships, planes, trains, and buses. Included are systems of zone control, individual room temperature control, pneumatic controls, appliance controls, highly flexible electronic controls, control panels, and the entire range of air conditioning controls.

2. Industrial instruments and controls: Complete engineering and manufacturing plants in Philadelphia. There is hardly a processing industry where Honeywell controls do not function as mechanical and electronic

brains regulating processes better than could be done by human hands or judgement. Honeywell instruments, for instance, are presently in use on every U. S. atomic reactor. Instrumentation holds sweeping potentialities as industry becomes increasingly complex and as automation is applied to more and more of its processes. Typical industrial products include indicating, recording and control types of potentiometers, pyrometers, pressure gauges, industrial thermometers and flow meters, electronic control panels, and thousands of other devices.

3. Aeronautical controls: In addition to extensive research, engineering and manufacturing facilities in Minneapolis, another complete plant is being built in St. Petersburg, Florida, expressly for the development and manufacture of inertial guidance systems. There is also a complete Engineering Development Center for aircraft and missile controls in West Los Angeles. Some challenging engineering interests include automatic flight control systems; hydraulic and pneumatic jet, ram jet, and rocket engine controls; instrumentation; and airborne digital and analog computers. Honeywell is a major supplier of automatic pilots, bombing systems, gyroscopes, and integrated weapons systems for aircraft and guided missiles. The Honeywell electronic fuel-measuring system is the standard of the industry, and Honeywell leads in developing transistorized instruments for aircraft.

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8. Transistors: The Boston plant develops and manufactures high-output power-type transistors.

9. Research: In a complete Research Center in Hopkins, a suburb of Minneapolis, emphasis placed on fundamentals has led to comprehensive basic research programs in the fields of: solid state physics, metallurgy, ceramics, magnetic and dielectric materials, physical chemistry, electronics, heat transfer, and mechanics. Honeywell is continuing its steadily increasing expenditure for fundamental research.

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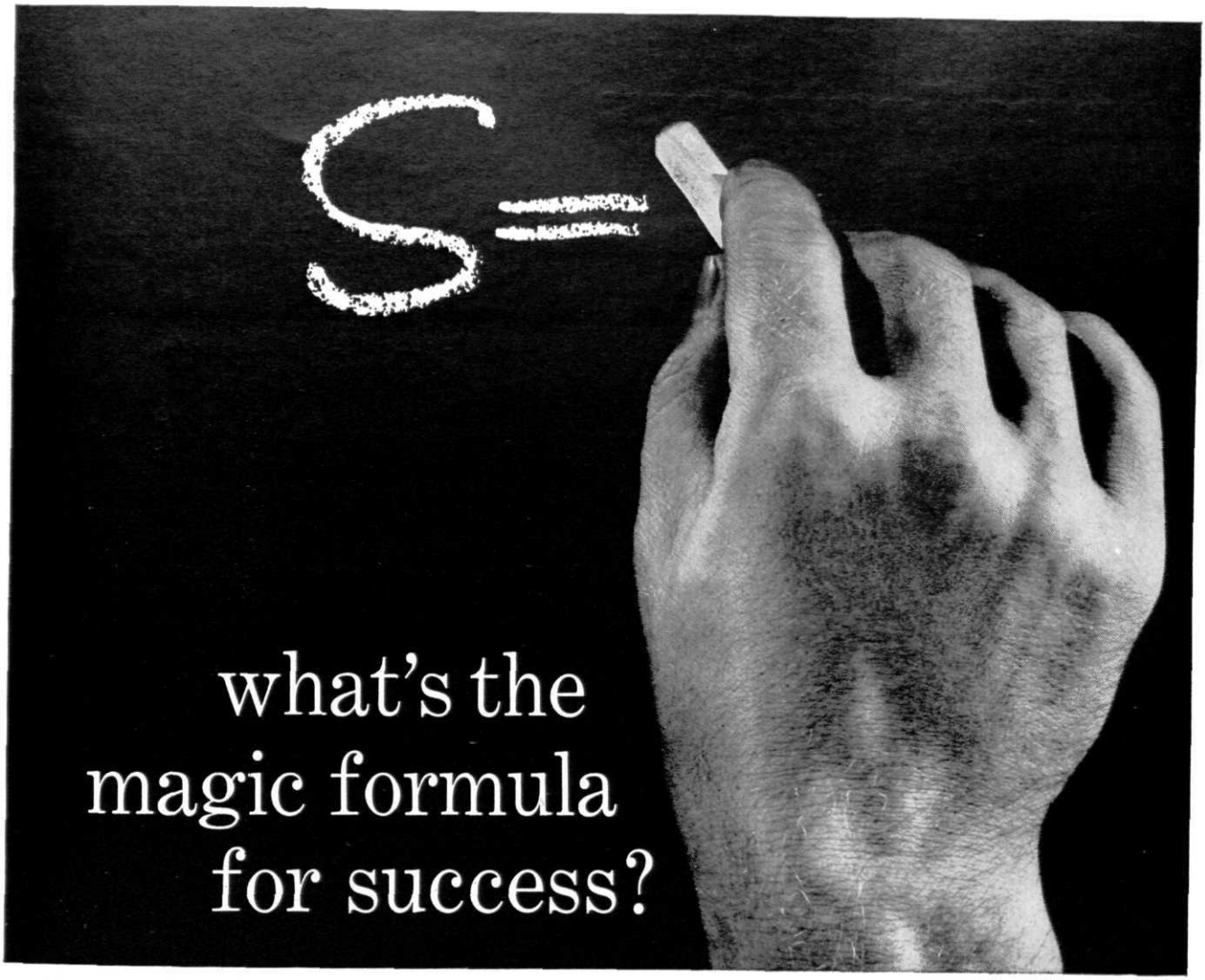

WHEN YOU WORK with the world's most successful industrial corporation—as we do—people often ask you that question.

Folks are naturally curious to know what accounts for General Motors' rapid and continued progress—they're seeking the magic formula.

Well, we believe we have an answer that should be of especial interest to young engineering seniors just about this time of year.

This answer was stated by a distinguished GM executive, Alfred P. Sloan, Jr., Honorary Chairman of the Board of Directors—and it carries a lot of weight. Here it is:

"The only difference between business success and failure is the people in the business and how they work together . . . We have given the people in General Motors an opportunity to perform. We have given them responsibility with authority. And we have made it worth while for them to do worth-while things."

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Personnel Staff, Detroit 2, Michigan

Junior Engineers:

Look to the Future

by Pat Miller, Mth. '57

An early Greek philosopher, Aristotle, said, "Every art and every inquiry, and similarly every action and pursuit, is thought to aim at some good." We may or may not accept this theory, but most of us will generally agree that the individual who knows nothing or very little of his inquiries or their ends will not tend to be too successful in life.

About eight years ago, Dean Lorin Miller and Professor Harold Skamser of the Engineering College of M.S.U. had the opportunity to visit many high schools. They found that many students wanted to study to be engineers. Many of these same students did not have the necessary high school courses to pursue in the engineering field. Also, many did not have an exact idea as to what the work of an engineer would constitute. From the basis of these findings, Dean Miller and Professor Skamser felt that something must be done to help these students who may have the potential to develop into engineers.

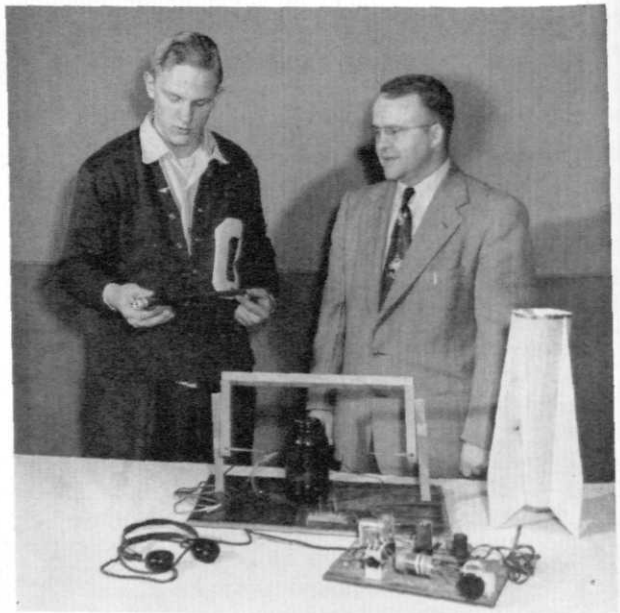
These two men were impressed by the success that the F.F.A. and 4-H Clubs have had in fostering agricultural interests and skills in youngsters. Why couldn't a versatile program be set up in the high schools, which would stimulate the necessary interest and skills in the high school student in the field of engineering? The idea became a reality in November of 1950, as a JETS (Junior Engineering Technical Society) Club was organized in the East Lansing High School. Since that time, 116 clubs have been founded and are scattered over 20 states and two foreign countries.

The JETS operate on the theory that the individual learns by doing. They provide many activities for the student who is interested in scientific inquiry. They range from individual to group projects. These projects may consist of work on a model rocket, Geiger counter, a three-dimensional scale model of one's home, school, or community, and many others too numerous to mention here. These activities stimulate individual interest and serve a great importance in the club structure. Each year there is a contest between these projects. They are displayed at the engineering buildings at M.S.U. at the Annual Engineering Exposition. The projects are judged for originality, scientific accuracy, and general engineering thinking. Prizes are given which include scholarships, drafting instruments, slide rules, and other tools of the profession.

The JETS plan field trips and go in groups to industrial plants, construction jobs, etc. Also included with these trips may be visits to engineering colleges and industrial expositions. Trips of this nature should give the student some idea as to the variations found in work in the engineering field. They also give him insight into such aspects as social mobility, group leadership, and economic and social problems, which are all present in our modern society. In this respect the club tends to introduce many of our social problems to the future engineer. Many of the problems are identical with those he will later encounter if he enters into the engineering profession.

JETS clubs take an active interest in community affairs. Various clubs throughout the nation engage in radio and TV participation. Chapters stage banquets, expositions, etc. These activities, in themselves, tend to promote organizational qualities among the students.

Since most of us will agree that these functions are fine, we may wonder what sources these clubs



JETS club advisor, Mr. Gerden McAllan discussing Jet engine with Lorin Miller of the Olivet JETS Club. Club advisors have a great influence on the efficiency of the club.

use in planning their activities. The two main types are trained engineers and club advisors at the high school level. Both of these have their functions in regard to the club.

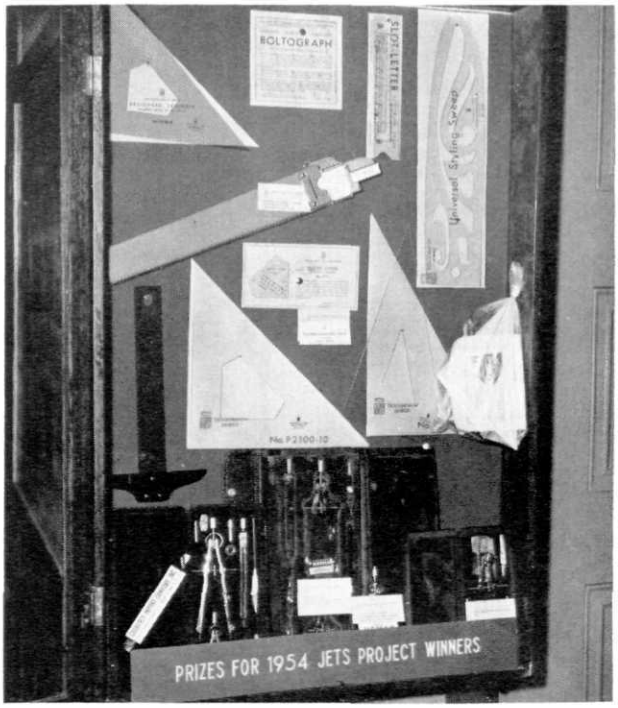
Usually a consulting or practicing engineer in the community is available to form the link between the club members and the profession. Also colleges and universities have available engineers who go to clubs to provide information. This may vary from the types of courses students in engineering are required to take, to reports on the newest types of progress made in the field of engineering.

The club advisor probably has a great influence on the efficiency of a club. The advisor is usually a mathematics or science teacher in the high school system. Most of these advisors find their work stimulating and rewarding, which is evident in their reports. A veteran mathematics instructor at Traverse City confided, "This is the greatest challenge I have experienced in many years. Some of the boys are way ahead of me in their chosen interests and I'm amazed at the technical vocabulary they use." Many advisors also see the JETS clubs as a means of showing practical use of the materials presented in their classes.

Another feature which spurred the JETS movement is its progressive attitude in wanting people to know that it does function as a club. Members take pride in selecting and displaying pins, emblems, and jackets. Vernon Baker, of the Belleville, Michigan, JETS Club, designed the official emblem for the club. It is a monogram with a rocket on a background which may remind one of some modern architecture. It displays many elements of the engineering profession. The JETS have a club pin which expresses membership in the club. The pin itself is a miniature representation of what many people call the engineer's Bible—the slide rule. These pins are provided free to all members by the Keuffel & Esser Company. Many clubs have blue jackets which are worn while they are together as a group. They also have the emblem mentioned above on these jackets.

Oftentimes clubs hold joint sessions. These meetings give the members a chance to exchange ideas. Also a newsletter published at M.S.U. is sent to each club and this contains notes from various clubs. Each year in May the clubs go in groups to M.S.U. to attend the Engineering Exposition. This exposition serves somewhat as a convention for the members. It gives them an opportunity to look at the problems and activities of other clubs. This Exposition is also the highlight of the year for many members. At this time the various projects of the members are judged and prizes are given to the winners.

Even though the JETS appear to be functioning very smoothly on the local level a great deal of work still remains to be done. The JETS have, at present, two major goals ahead of them. They have increased their number of clubs tremendously since 1950, but there are still many students in areas where these facilities are not available. Present high school teachers and also future teachers should take advantage of finding out more about this growing organization. They may find it possible for a JETS club to be organized in their school. As Professor Skamser points out, anyone wishing to inaugurate such a club should write to: JETS, P.O. Box 470, M.S.U., E. Lansing, Michigan. A list of instructions will be sent by return mail at no cost to the local club. "The JETS are rapidly becoming a national or possibly an international organization," explains Professor Skamser, "and regional or state chapters are being set up." This will insure more unity in the clubs. It will give them more opportunity for an exchange of ideas and also help in contending with the individual problems of the areas.



Prizes are given to the project winners at the annual Engineers Exposition. These include scholarships, drafting instruments, slide rules and other tools of the profession.

JETS officials feel that their program, with its realistic approach and enthusiastic response, is making a substantial contribution to many students attempting to enter the engineering profession. The products of these students should lead to a better world for all of us.

The ship was sinking, and the Captain called all hands aft. "Who among you can pray? he asked.

"I can," replied the ensign.

"Then pray, shipmate," ordered the Captain. "The rest of you put on life jackets, we're one short."

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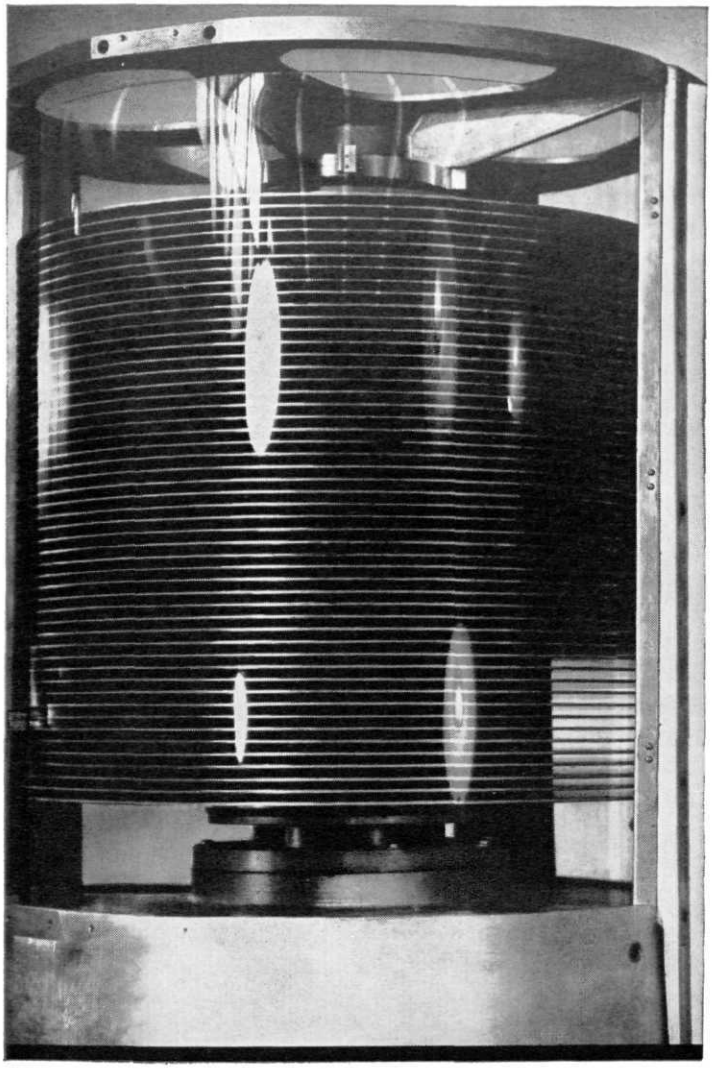

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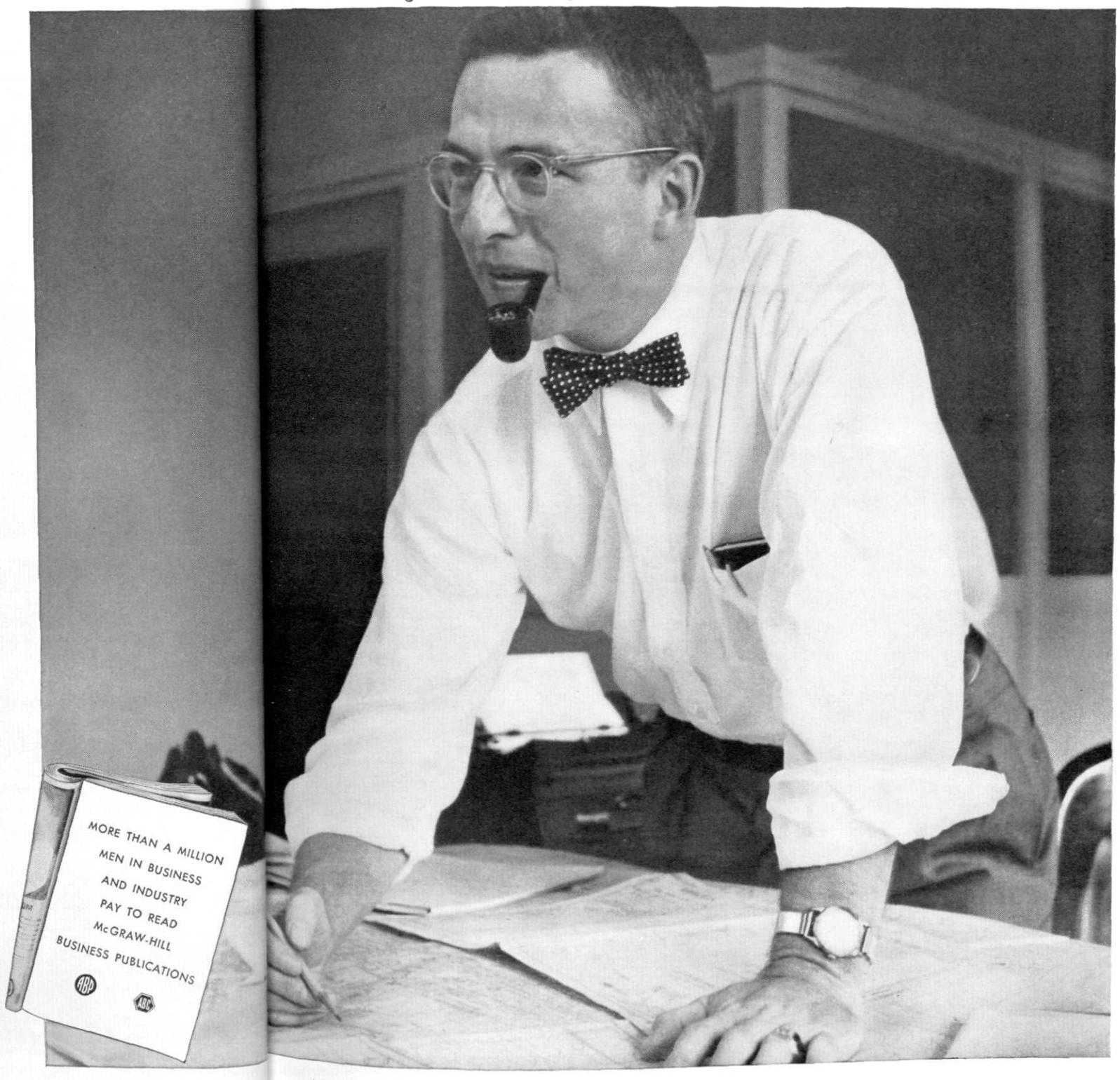

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MARTIN

Man and Metals

by Denton D. McGrady
Assistant Professor of Metallurgical Engineering

. . . a peek at the past . . .
. . . a view of the present . . .
. . . a squint at the future . .

The Egyptian Pharaoh Cheops had water conveyed from the Nile river to his private royal bathing pool by means of a copper pipe. This does not seem so startling until we stop to realize that it occurred 5500 years ago. No doubt man learned to use metals much earlier, particularly gold, silver, and copper nuggets and meteoric iron.

Gold nuggets found in exposed gravel banks near river beds could be pounded into crude ornaments with a stone hammer. Unlike copper, this pounding did not harden gold very much; thus, it could not be made into tools. The distinctive bright yellow color of native gold, in contrast with that of the surrounding sand and gravel, easily attracted attention. Because it is a very malleable metal, gold was easily fashioned into rings, bracelets, and other beautiful and enduring ornaments. That goldsmiths were among the first metal workers is substantiated by the gold ornaments found in some of the oldest archaeological excavations in Egypt, Crete and Iraq.

Even in rather recent times, about 400 years ago, the inhabitants of the upper Amazon River Valley in South America made fish hooks from a gold alloy containing 19.5% copper and 1.4% platinum.

Here in the United States, the mound builders and other ancient inhabitants of the valleys of the Mississippi and Ohio Rivers may have learned to work native copper secured from the northern peninsula of Michigan even earlier than the Egyptians, because copper nuggets, sheets and strips curled up into beads have been found in their mounds. Later inhabitants of the valleys left copper adzes, axes, chisels, and rings in their burial grounds. Although copper was extensively used by the North American Indian for thousands of years, he never completely emerged from the Stone Age as he had not discovered how to melt metals or smelt their ores.

Man may have slowly discovered how to melt metal as he peered, over a long period of time, into the dying embers of a thousand campfires. There, underneath the ashes, was the key to a better way of life. Ignorance and superstition were formidable barriers to cave mens scientific progress. This is not surprising for the experimental methods of science are but 400 years old.

In learning how to melt metal, primitive man may have learned also how to smelt ore to extract metal. Lead and tin could have been readily smelted from their oxide minerals in contact with the charcoal of a campfire. If the fire, fanned by a brisk evening breeze, burned intensely enough to melt the extracted metal, a molten pool of metal would form. Thus the first smelting furnace as well as melting furnace could have been a fire over a hole in the ground – as well illustrated by its survival in the ancient tin smelting furnaces of Cornwall, England.

With the coming of wood charcoal as a fuel, higher temperatures were available and the primitive metallurgist was able to cast the molten metal into the shape of the finished product. No longer did he have to hammer the solid sponge or break away the rock. He had learned to smelt, melt, refine, and cast a few metals into the shapes of articles he wanted. Man had emerged from the Stone Age.

Because of the higher melting temperatures required it was not until about 1000 B.C. that furnaces were developed that could produce and melt the iron-carbon alloys. Historians credit the Chinese with pioneering this development. It spread to India before the Christian Era, and was independently discovered in Europe during the fourteenth century. Secrecy and poor communication seems thus to have retarded the advancement of iron smelting in Europe by 23 centuries.

Alloys of copper and tin, known as bronzes, were the first alloys widely used by ancient peoples. Thus the name "Bronze Age" for the period starting about 2500 B.C. when bronzes appeared in common use along with metallic copper in the eastern Mediterranean countries, namely Crete, Greece, and Turkey. The art of making and using bronze progressed very slowly – for some 4000 years – until the sixteenth century.

Scarcely had the Bronze Age began, however, when the Iron Age emerged. Only a relatively short interval

(Continued on page 60)

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Can't Win All of 'Em

By Stephen Prokopoff
(Stephen Stevens)
Engineering Drawing Department
Author of "The Prophet and the Miracle"

On August seventh of nineteen hundred and fifty-five, a winsome young lady of twenty-two, jammed the rear end of her new Oldsmobile into my middle aged Chevy's front end. A year later, not a day sooner, her insurance company slammed a subpoena on me. The way the thing was put over sent me at once hightailing to a highly recommended counselor.

"The case looks bad, very bad—against you," the counselor said, knitting his brows, pretending he was thinking. "If you want me to act for you, then I suggest we better have a jury try you. It's easier to confuse a body of six than a body of one, you know."

"Why confuse?" I was surprised.

"It is not as bad as it sounds. Legally, it means plant a doubt in minds—against the opponent's line of thinking, see?" he winked and gave me a knife-edge smile.

"Since you phrased it that way, so be it," I sighed resignedly.

On September fourth, my counselor and I entered the court house. Six jurors were already seated, a more beaten up collection could not have been rounded up in Railroad and Canal Streets. It was composed of four men and two women who looked as if they had been jostled off their park benches without warning. I suspected at once that these people couldn't intelligently wrestle with the simplest problem of justice.

Mr. Charles Funk, my counselor, and I were asked to take our seats on the left side of a long table that stood in the middle of the floor and that squeaked the moment an elbow touched it. The justice of the peace swore in the jury and invited middle-aged, short, stocky, and tricky Mr. Waldo Schlegel, plaintiffs counselor, to question each juror's competence to evaluate evidences that would be presented by the two contesting sides.

"Ladies and gentlemen of the jury," Mr. Schlegel removed his gold wire spectacles from his thin, arched nose and cleaned them with his handkerchief. "I represent two plaintiffs. In fact, they are the All People's Insurance Company and Miss Lorna Wistful. I hope you are not prejudiced against me because I am representing the insurance company, or are you?" Mr. Schlegel asked the question affably.

"N-No, n-n-o," shaking heads the jurors responded in somewhat subdued noises.

Mr. Schlegel turned to the judge and said, "In that case, your honor, these good people are acceptable to us."

"Mr. Funk, you may now, if you wish, interrogate the jury members," the judge looked from his elevated bench at my counselor.

Mr. Funk rose to his feet. Tall, with blond curly hair, and eyes of blue like color, a color of the space between the clouds—I guessed him at about twenty-eight, he made a few steps toward the jury box, his eyes on the man to the extreme left. From this man they wandered over to the next juror, and then the next and the next. Subsequently he looked over at the judge, "Your honor, to us these people are all intelligent and trustworthy. I have no questions to ask them." He returned to the seat next to me.

"In that case, I'll swear the jury again . . . and now the counselor for the plaintiff may proceed," the judge nodded at the attorney.

"Miss Wistful, take the stand and be sworn in," Mr. Schlegel was delighted with himself. He had a good reason. I had seen this witness a year ago. Even in that moment she charmed me, disgusted and angry as I was. But now this tall, willowy, green-eyed brunette who was standing on the dais with her right hand, in black glove raised and who was saying in a clear, pleasing voice, "I do," made me think that I had no more chance to win than a snowball has to survive in hell's fire. Her attorney took her through a series of questions, gently leading from who she was and where she lived to why the accident happened.

"If Mr. Sleepwell hadn't run into me, in my lane, there would not have been an accident," she said prettily dropping her lovely eyes and fluttering her eyelashes. The jury smiled and comfortably settled themselves for an interesting afternoon feeling that they once more were sunning themselves on the park benches.

"Your witness, counselor for the defense," Mr. Schlegel invited formally, showing an air of pleasure and confidence.

"Miss Wistful, did you see the defendant before you ran into him?" Mr. Funk made a few steps toward the stand and stopped.

The witness shifted slightly in the chair, lowered her head a little and in an uncertain voice like a scolded child said, "N-no."

"Do you remember what color the light signal was when you crossed Larkin Street?" Each time Mr. Funk asked a question, he moved a little closer to the witness stand. It looked to me as if he were pulled by an irresistable force which he was incapable of overcoming. I knew then what was happening to my attorney.

Miss Wistful slowly raised her head, studied him for a moment, and said in her quiet, plaintive voice, "N-o . . . I don't."

"Your honor, the defense rests," my attorney announced. His voice was a bit husky and far away, as if it came from a cloud.

What luck, o' why did I have to pick on the young, handsome, marriageable counselor, I thought. Then he turned to me, "Mr. Claude Sleepwell, take the stand."

I stepped to the small elevated platform and was sworn in. "Mr. Sleepwell, what is your full name; where do you live? . . ." My attorney now led through a series of questions. In the process I noticed that he suddenly had lost interest in the case, and I knew why. He appeared as if he had gotten lost on the way somewhere. The most vital questions in my defense, he neglected to bring out. He seemed to have forgotten what they were. Unexpectedly he swung around and mumbled, "Mr. Schlegel, your witness."

"Mr. Sleepwell," the plaintiff's counselor tried to appear ferocious and expert in the knowledge of just what had taken place at the Mechanic and Taylor intersection a year ago. "You say that your front wheels were in the other lane, facing Northwest. What were they doing there?" he displayed a certain aloof amusement.

"Standing, naturally."

"Naturally, you say. But why?" Mr. Schlegel's black, unruly hair stubbornly fell across the scowl on his forehead despite his frequent efforts to smooth it in place.

"Waiting for a truck in front of me to clear off so that I could move into the outer lane" I squirmed and the chair squeaked.

"Was your car moving or standing put?"

"Standing still."

"After the truck cleared off, what did you do?"

"Stayed put."

"Why?"

"I saw a car speeding towards me and thought I better have it pass me before I threw my car into gear again."

"How far from you was that car?"

"Difficult to fix the point."

"Approximately?" Mr. Schlegel craftily invited me to commit myself.

"I can offer only a rough estimate sir." Intuitively I divined his thoughts.

"Let's have it," a smirk appeared on his dark lined face.

"I imagine, mind you, that the block between Mechanic-Taylor and Mechanic-Larkin intersections to be about a thousand feet. But when I saw the car first, it was quite well within the block."

"One more question." The insurance company attorney didn't intend to burden me with more than just that one, because insofar as he was concerned it was in the bag. "When you were standing put, in what position was your car in reference to the center lane?"

"About a hundred and twenty degrees to the line of motion along the lane." I was pleased with my adroit answer.

At that point, the old good judge pulled out of a crumpled paper bag two toy cars. Placing them on the bench and smiling benevolently he spoke up. "These may be useful in showing the jury what happened at the intersection of Mechanic and Taylor Streets."

"Thank you, your honor," Mr. Schlegel took the toys and pivoting on his heels he faced the jury. "Ladies and gentlemen, these two play cars will show you the physical impossibility for the plaintiff's car to do the things the defendant wants you to believe it did. Now watch carefully." He pushed fiercely his hair to the back of his head with a wiping motion, picked up a piece of white chalk and drew lines on the black board representing the streets, the intersections, and the lomes. He then held the imaginary Chevy with one hand against the board at the angle I told him my car was, and the other car he pushed along the side of my car with his other hand. Most of the jury members couldn't see what he was doing because his back was turned towards them. "Besides this physical evidence against the defender, his distance of a thousand feet between him and an on-coming car is completely impossible. Good people of the jury, the defendant is not telling you the truth. The facts remain, Mr. Sleepwell places complete faith in his calculated and thought out answers, but the fact demonstrated on the black board conclusively proved that it was he who was responsible for the accident. In view of these facts, I ask you to see that the defendant covers the cost of the repairs on the plaintiff's car in full! I thank you." With his face flushed, the attorney handed the toy cars back to the judge and sat next to his witness on the other side of the rickety table.

While the opposing attorney had been arguing, Mr. Funk's eyes now and then moved from Mr. Schlegel to Miss Wistful; each time she gave him a bashful but inviting look. His turn seemed to have come too suddenly. He stood up, his face went scarlet, hesitatingly he opened, "Ladies and gentlemen of the jury, I . . . I partially agree with my opponent. Though my witness said 'roughly a thousand feet,' I think it is rather too rough. But ladies and gentlemen, I still think that Miss Wistful was not blameless at the time

(Continued on page 31)

Left to right: Dan Palmer, Texas A&M, '54; Ted Webb, Caltech, '55; Bob Stancil, Georgia Tech, '54; Chuck Herndon, Illinois, '50.

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CAN'T WIN ALL OF 'EM

(Continued from page 29)

the accident occurred. The day was clear, there was ample space to her right, if she had been careful and had watched the traffic ahead of her, she wouldn't have run into the defendant. These facts and the evidence, extracted from her on the stand, that she did not see the defendant's car and did not remember the color of the signal light at the intersection, are proof enough that she was negligent. Ladies and gentlemen, bearing this in mind, I know you will not want my client to pay the repair bill."

When Mr. Funk sat down, I leaned toward him and whispered in his ear, "You are confused about the thousand feet. You didn't listen carefully to what I said. Also you have failed to bring into the case Newton's First Law of Motion. If it's not too late may I stand up and demonstrate on the blackboard where the opposing attorney was wrong?"

"Don't make it worse than it is," I was counseled.

"If there is nothing more to be said, the jury may retire to the chamber through the back door and deliberate," Judge Bittersweet recommended.

The jury filed out and went through the back door into the back storage room. I was asked at the time to move and take a chair next to the thin partition that separated me from the jury. I could hear almost every word that passed among the jurors. "Well, what did he sit there in the car for? A thousand feet is a long distance. He could have made it even if an express train was crowding him," a harsh feminine voice declared acidly. "Those toy cars showed clearly that the defendant wasn't telling us the truth," this time a male's tired voice offered his thinking. Soon after some one said back of the partition, "We all then agree that . . . " Presently a knock on the door from the jury side was heard.

"The die is cast," Mr. Schlegel remarked to my attorney.

The judge let the jury in and then ascended to his chair. "Foreman, please read the decision," he looked at the jury box.

The plaintiff's family was jubilant. It had come in full force to see their darling vindicated.

My attorney seemed not a bit surprised, leaned over and said to me blandly, "You can't win all of 'em." The remark sounded as if losing a case was like losing two pennies on the picnic ground—nothing to lose sleep over. With that he drew me to a dark corner and advised, "Mr. Sleepwell, I suggest you pay and forget the day you met with the accident. But if you still have a cause to doubt the verdict, you can appeal, you know. While he talked to me his eyes wandered from me to Miss Wistful.

Without further elaboration I told him to prepare the appeal.

On October sixteenth of the same year, we again met with Mr. Waldo Schlegel, this time in the Circuit Court. After the preliminary routine and the procedural questioning of the witnesses, Mr. Schlegel produced two of his own toy cars—a yellow one representing the Chevy and a red one the Oldsmobile. As before, he demonstrated the physical impossibility for the red car to run into the yellow, and, as before, he confused the issue by citing the thousand feet which I had used to approximate the length of the block in the previous court appearance. Having repeated his old charges, and thrown a few barbs for good measure at me, he turned confidently to the judge and said, "I am through, your honor."

Mr. Funk, for some unknown reasons to me, decided to question further the delightful Miss Wistful. She took the stand a second time. This time she artificially allowed her luscious black hair to turn gray when and where it wanted to and the streaks of it were very attractive in addition to her ravishing figure in stylish red and black dress and a disarming smile that could have made a clock stop. On the stand she didn't try to be smart, only eager and willing to answer, 'Yes,' 'No,' 'I don't remember,' 'I didn't see . . . ' her voice trailed off uncertainly. It was difficult for the young attorney to engage her in contention even on the points that were obviously against her. All of a sudden he seemed to turn from a sly lawyer that could take off ones socks without unlacing his shoes into a courteous gentleman. He threw not a single jab at her in retaliation for the rash stabs her counselor had given me.

Then he was asked by the bench to present to the jury his reasons why I should not be made to pay the repair bill of $95.95. In a few brief words, he offered the usual reasons, all in all nothing to awaken the sleepy jurors with. Without further ado he turned to the bench and abruptly ended, "we rest."

I saw the writing on the wall. When he sat down, I stood up. "Your honor, if possible, I would like to make two corrections to the opposing attorney's arguments." My attorney was completely taken by surprise. His head snapped up and he looked at me. "You know," he said a little thickly, shaking his head in wonder, "most men spend their lives warily treading straight and narrow paths in an effort to avoid trouble, and yet they step into all sorts of pitfalls. On the other hand, there are guys like you who actually seem to beg for a bear trap," he hissed at me trying to talk me out of my intentions.

"Attorney for the plaintiff, I am willing to grant the defendant time to enter his corrections at this point of the proceeding if you are willing to go along with me in this," the court invited.

"I am willing, your honor, only if his corrections have bearing on the presented facts."

"They have, your honor," I reassured the court.

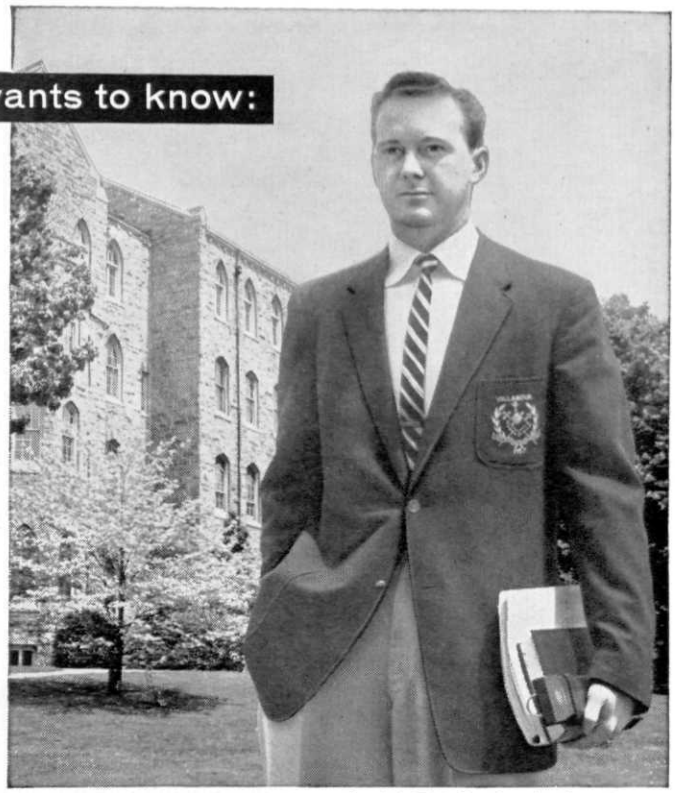
"Present them to the jury, then," the judge ordered.

"Ladies and gentlemen, I find myself in an unenviable position. Being in my fifties, of faded looks and aging posture, I know I cannot compete with young and engagingly beautiful Miss Wistful on the

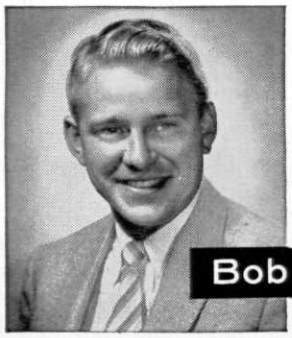
(Continued on page 63)

John Nettleton wants to know:

How would a graduate degree affect my chances for advancement at Du Pont?



John C. Nettleton expects to receive his B.S. in chemical engineering from Villanova University in June 1957. He has served as president of the student chapter of A.I.Ch.E., and as secretary of Phi Kappa Phi fraternity. John is now wondering about the pros and cons of advanced study in his field.



Bob Buch answers:

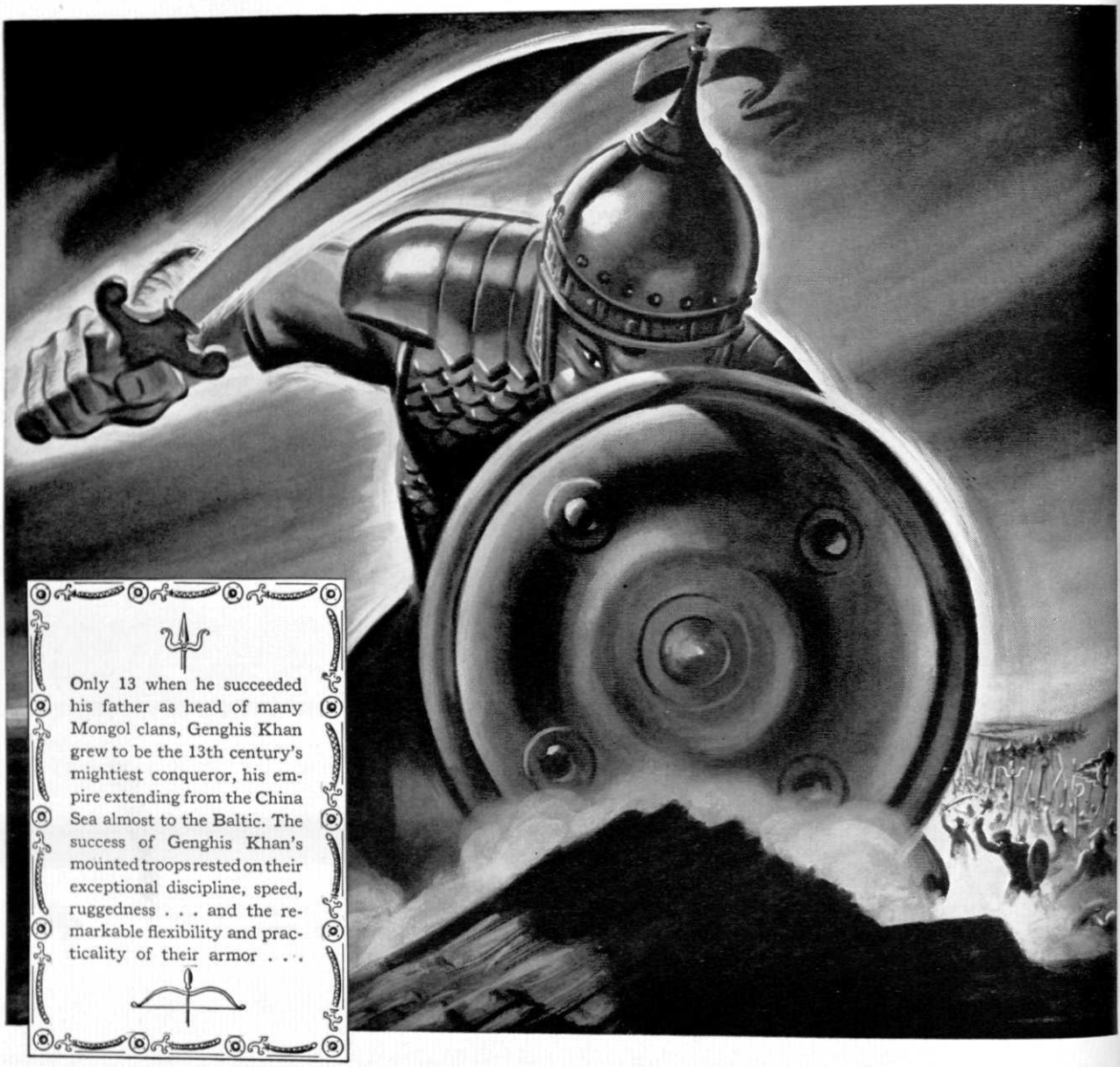
Robert J. Buch, M.S., Ch.E., came to the Engineering Development Section of Du Pont's Grasselli Research Division from the University of Louisville four years ago. Since then, he has engaged in many kinds of chemical engineering work, from pilot-plant operation to evaluation of the potential of proposed research programs. Within the last year, Bob has taken the responsibility of procuring B.S., M.S., and Ph.D. technical graduates in all phases of chemistry and chemical engineering for the Grasselli Research Division.

AN advanced degree would undoubtedly have a *favorable* effect in technical work, John, but let me enlarge on that just a little. In your own field (and mine, too) a higher degree is considered to be evidence of ability in carrying out original research. It is therefore helpful in obtaining work in research and development, where that skill is definitely important. You might say that it gives a man a head start in proving his ability in those areas.

It's less important in some other areas, though. For example, in production or sales work ability for handling human relationships is just as important for advancement as technical competence. If an engineer is sold on production work or sales, a graduate degree in marketing or business administration might be more helpful to him than advanced technical training in getting started.

But I've noticed this at Du Pont. Once a man lands a job in his chosen field and actually begins to work, his subsequent advancement depends more on demonstrated ability than on college degrees. That's true throughout the entire company—in scientific work, administration, or what not.

So an advanced degree is not a royal road to anything at Du Pont, John. But when coupled with proven abilities, it is unquestionably helpful to a man in research and development work. It often gets him off to a faster start.



Only 13 when he succeeded his father as head of many Mongol clans, Genghis Khan grew to be the 13th century's mightiest conqueror, his empire extending from the China Sea almost to the Baltic. The success of Genghis Khan's mounted troops rested on their exceptional discipline, speed, ruggedness . . . and the remarkable flexibility and practicality of their armor . . .

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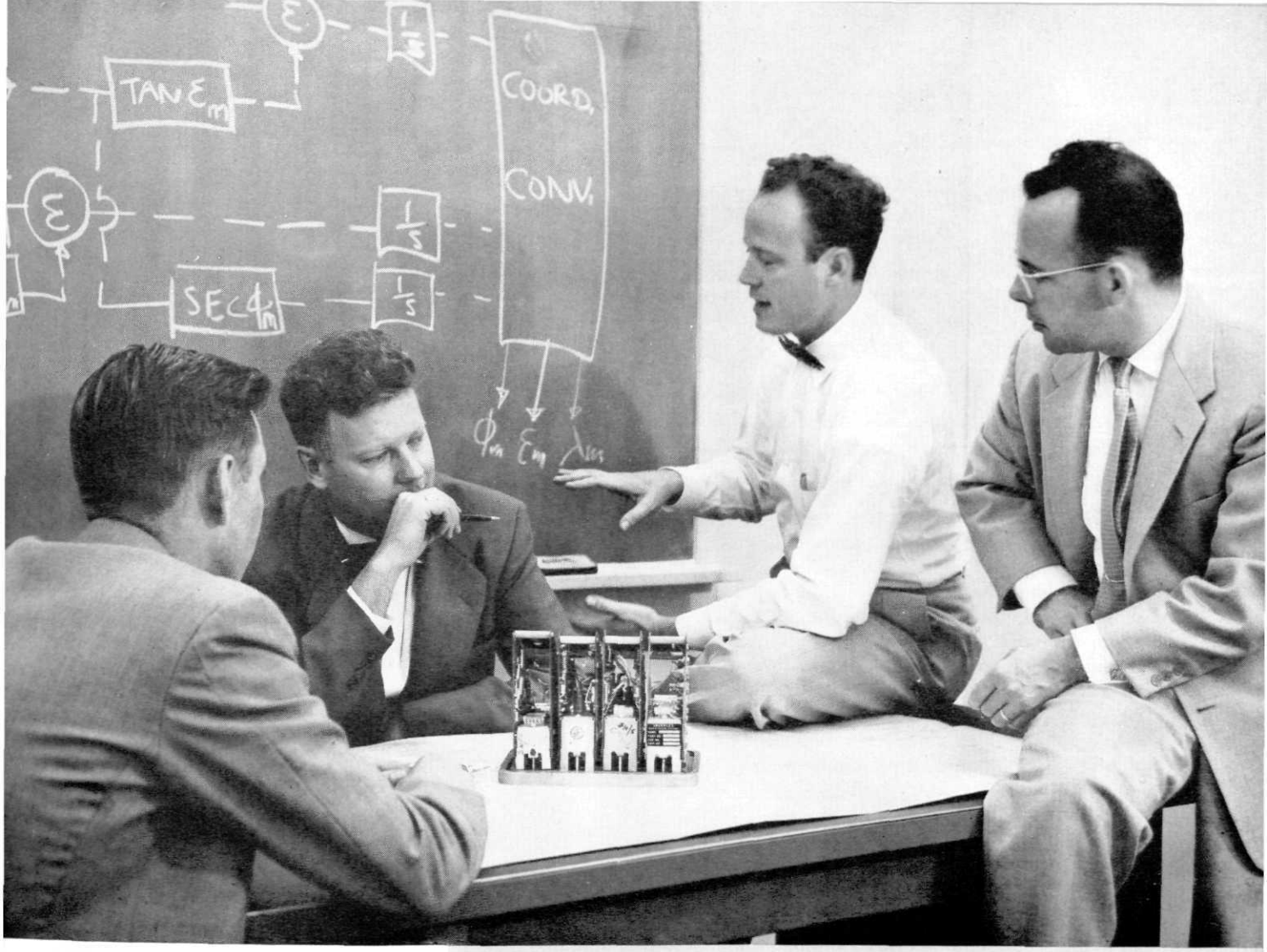

G. D. Schott (second from left), Flight Controls Dept. Head, discusses new techniques in the mechanization of autopilots with R. D. Wertz (left), Flight Controls Research Engineer; R. J. Niewald, Flight Controls Analysis Section Head, and B. C. Axley, Servomechanisms Analysis Group Engineer.

MISSILE SYSTEMS FLIGHT CONTROLS

One of the most critical problems encountered in the development of a successful missile system involves attaining rapid responses of controls *consistent with system stability*. Moreover, it is a problem of increasing importance as new aerodynamic configurations require major advances in flight controls performance.

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NEW DEVELOPMENTS

Edited by Norm Dill

New Metals Testing Chamber Operates At 452 Degrees Below Zero

Metallurgists are conducting tensile tests on metals at temperatures as low as minus 452 degrees Fahrenheit. The metal specimens are stressed within a specially designed chamber, which has been cooled with liquid helium. Results of these tests will provide engineers with needed information regarding types of metals that are best suited for use under extreme temperature ranges. Information of this sort may well be useful in the design and development of guided missiles and future supersonic aircraft.

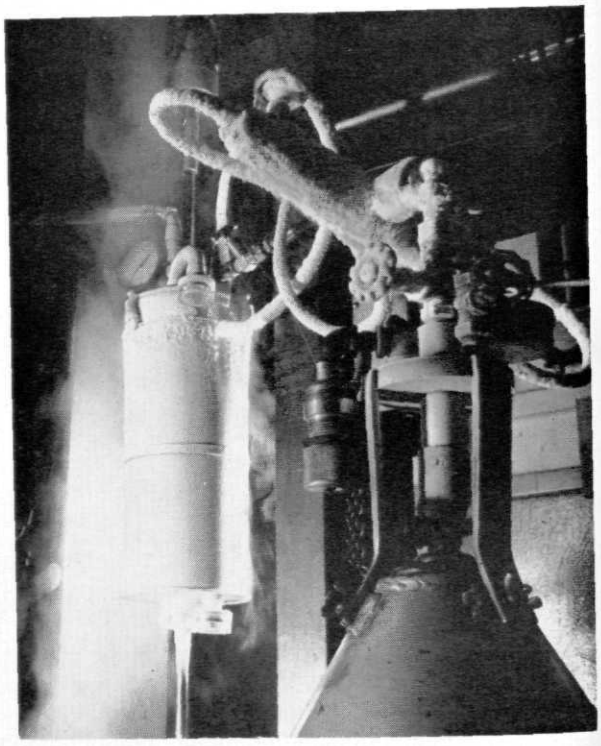
It is not at all impossible that aircraft of the future will use fuels that are stored as liquefied gases in metal containers at extremely low temperatures. Preliminary studies of the properties of metals at low temperatures will be essential to developments of this kind.

Oxygen for human consumption during high altitude aircraft operation already is being stored in liquid form in metal containers at temperatures of about minus 300 degrees. This arrangement is more practical than using compressed gas since an equivalent size storage space contains a much larger supply of oxygen in liquid form.

Although much larger testing apparatus has been used in low temperature experiments in the past, the newly developed chamber, which is only slightly larger than a hand fire extinguisher, is believed to be the first of its kind to use liquid helium in order to attain the minus 452 degree mark for purposes of tension testing. Prior to the use of liquid helium as refrigerant, tests were conducted at temperatures as low as minus 320 degrees Fahrenheit using liquid nitrogen.

The new testing temperature of minus 450 degrees is just short of *absolute* zero or minus 459.6 degrees Fahrenheit, the point at which, theoretically, all molecular motion ceases. The aims of these ultra sub-zero investigations are concerned with obtaining a better understanding of the strength of metals and the factors that cause embrittlement failures. For example, normal grades of steel become brittle and rubber loses its elasticity when subjected to these extremely low temperatures.

In addition to providing basic engineering data necessary to the development of such things as low temperature liquid fuel and coolant storage tanks for guided missiles, the studies will improve our understanding of why metals behave as they do under various conditions.



Specially designed chamber used for testing at 452 degrees below zero.

Rapid temperature changes are made possible by heating and cooling a separately enclosed area above the chamber while other tests are in progress. Thus, when a rapid change is desired, "trap doors" in the roof of the chamber are opened, and fans circulate the hotter or colder air into the main section of the chamber.

In this section airborne electronic systems are "taken up" to altitudes as high as 80,000 feet in about 25 minutes. At an initial rate of 5,000 feet a minute, the chamber reaches an altitude of 50,000 feet in 10 minutes, slowing down on its way up to the 80,000 feet mark.

In the other section of the two-part chamber are the humidity rain-making and salt-water spraying devices. A standard test in this section would be run as follows. The item to be tested, a computer, for example, would be placed in the chamber at room temperature at a relative humidity of 95 percent. The

temperature would then rise to plus 185 degrees F in two hours. After remaining at these conditions for six hours, the chamber would return to normal in the next sixteen hours. The equipment would undergo this treatment for ten consecutive days.

The entire chamber is fiberglass insulated. Walls and ceiling are made of stainless steel. The equipment required to create these artificial conditions, including compressors, steam generators, cooling systems, pipes, valves and controls are "housed" beneath the floor of the plant in a specially excavated pit. A special two-feet thick, four-ton steel door moves down into the pit in front of the altitude chamber thereby permitting "floor-level" loading of heavy electronic equipment.

A New Power Plant, the GM-14

GM-14 is a free piston gasifier, an experimental workhorse and prototype of six free piston gasifiers which the Office of Ships Construction and Repair of the U. S. Maritime Administration has had installed in a repowered, converted Liberty ship, the SS William Patterson, which will operate in trans-Atlantic service.

A vestpocket version of this type of power producer is the free piston engine in XP-500, an experimental passenger car.

For almost three years the GM-14 has been tested. It has undergone scores of engineering modifications and logged more than 7,000 hours of endurance runs, consuming as much as 1,000 gallons a day of Bunker "C," lowest price petroleum fuel on the market.

The GM-14 is designed for ship propulsion or power station operation. It generates 1250 gas horsepower which is piped to a power turbine, virtually in the same manner as the gasifier unit under the hood of the X-500 pumps gas to a turbine at the rear of the car.

GM-14 is an engineering hybrid, combining elements of a Diesel engine, an air compressor and a gas turbine. Engineers consider it an excellent heavy duty producer because it uses cheap, relatively unrefined fuels and has high thermal efficiency.

In the GM installation the large gasifier consists of a single cylinder with two pistons as contrasted with XP-500's Siamesed or twin-cylinder version with four pistons. The two piston assemblies in GM-14 weigh, 1,145 pounds each, and they bounce back and forth in the cylinder at approximately 600 cycles per minute.

The large engine's inherent balance is indicated by the fact that although it never has been bolted to the floor, it never has moved. It is simply mounted on a steel frame.

New Type Gyroscope Developed By Westinghouse Research Engineers

A new type of gyroscope—believed to be the first practical commercial device of its kind—has been developed by research engineers. The new gyroscope —called a "vibragyro"—is designed for use on aircraft and missiles.

The vibragyro is the product of two years of research aimed at developing a unit lighter and more rugged than the conventional rotating-type gyro now generally in use on aircraft.

A gyroscope is used to stabilize aircraft in flight; that is, it corrects any deviation from the desired flight path, whether the deviation results from a rolling, yawing, or pitching motion.

The scientists explained that research on the vibragyro was initiated on the assumption that conventional rotating gyros were approaching their peak development.

The vibragyro is based on a method of stabilization used by the common housefly and other two-winged insects.

The fly is equipped with small organisms called "halteres" which, by vibrating rapidly, govern its balance during flight. The vibragyro is based on this same principle of vibrating masses.

This is in contrast to the rotating method of stabilization which is based on the same principle as a spinning top.

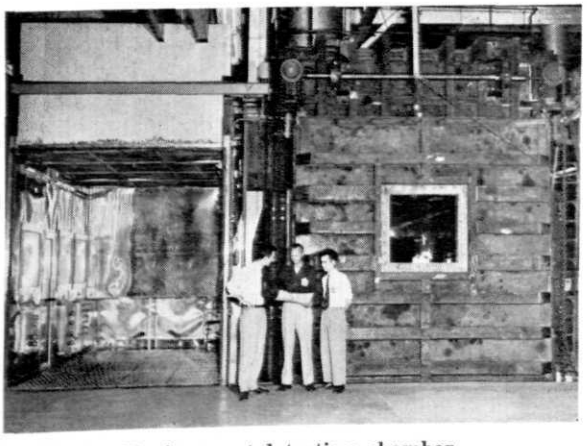
The vibragyro, because of its inherent ruggedness and reliability, might prove to be the most feasible type of gyroscope for stabilizing missiles.

It has no ball bearings, is of simple construction and rugged design. In addition to these advantages, the unit is light in weight, small in size, and has a long life. It appears to be exceptionally well suited for use under conditions where a sensitive, yet shock-resistant and reliable gyro is needed.

World's Weather in a "Box"

An environmental testing chamber used to evaluate the effect of various weather conditions on airborne electronic systems has been developed.

Considered as one chamber, the "box" actually consists of two sections 10-feet high, 18-feet wide and 16-feet deep. In one, rain, humidity and salt spray tests are conducted. In the other, altitude and temperature tests. In a matter of minutes the temperature can be reduced to a minus 100 degrees F. Similarly, the temperature can be raised to a sizzling plus 500 degrees F. This is done with one man operating the chamber from a set of controls near the rear of the facility.



Environmental testing chamber.

(Continued on page 39)

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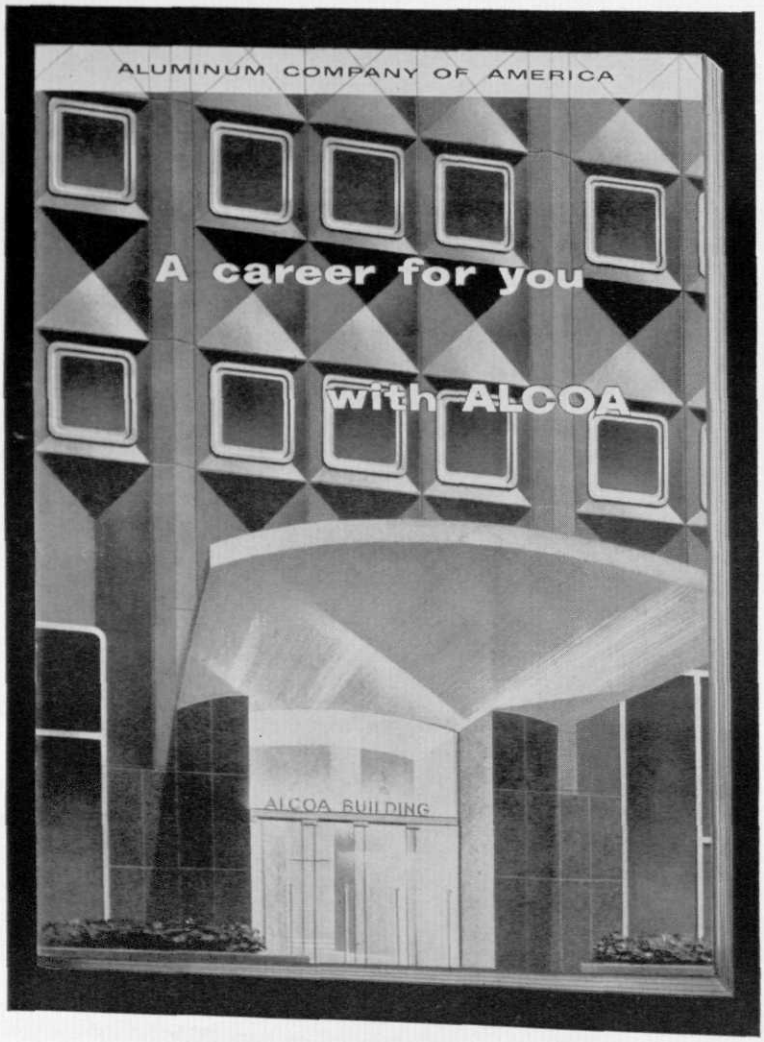

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Name _____

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NEW DEVELOPMENTS

(Continued from page 37)

HOT SAFE

What is probably the world's "hottest" safe – and one which no burglar would want to crack – has been devised by atomic experts for storing and studying radio-active materials.

The safe is a 15-ton, cylindrical installation that operates much like a soft-drink dispensing machine. It suspends up to 780 "hot" samples on large horizontal discs mounted one above the other inside a six-foot vertical cylinder. These samples are test pieces of uranium which have been subjected to chain reaction in plutonium-producing reactors for the Atomic Energy Commission.

The floor vault can store materials with as much radioactivity as exists in eight pounds of radium, more than the total amount produced in North America before World War II.

The top of the storage cylinder, located at floor level, is a steel disc, 10 inches thick and eight feet in diameter. It is located in the Hanford radiometallurgy laboratory and was designed as a vital, supporting tool for research into nuclear bombardment effects on fissionable fuel.

To insert or remove a sample, technicians remotely rotate the discs below the floor level until desired specimens are lined up under access holes in the discs above. Samples needed can be inserted or extracted without having to remove any other sample in storage. This arrangement minimizes the escape of radiation.

To remove a sample, the technician on duty lifts a plug from the cylinder top, places a one-ton lead cask over the opening and turns a wheel to line up the wanted sample.

Once the sample has been properly positioned, a claw mechanism is lowered through an opening in the heavy cask to lift it into the cask. After that it can be transported safely to the main laboratory for study.

Samples that are the "hottest" radioactively are stored on the lowest disc, six feet below the laboratory floor. This puts 18 inches of steel between them and the working area.

During insertion or removal of samples, a vacuum system sucks air from the laboratory into the safe, through a filter and out an exhaust stack to prevent loose radioactive particles from escaping into the laboratory.

Wheels Balanced on a Film of Air

A new machine for balancing automotive wheels and tires on a film of air has been developed by General Motors Research Staff.

It utilizes a so-called air-ball pivot approximately an inch and a half in diameter to register automatically both amount and location of unbalance on wheel and tire assemblies. Each wheel and tire is balanced on a film of air two thousandths of an inch thick.

The idea for the device developed from an air "lubricated" bearing engineers built for a trick exhibit –a bearing that "floats on air with the greatest of ease."

The new semi-automatic balancing technique follows this operating sequence:

Wheels with tires already inflated move horizontally along a conveyor to an elevator. The elevator lowers the wheels in pairs onto air-ball pivots. Sixty pounds of air pressure is supplied through the vertical stems of the pivots so each tire and wheel is "lifted" on a cushion of air.

When poised on the air-ball pivot, each wheel and tire naturally tilts toward its heavy or unbalance point. This might be compared with a small cardboard disc being balanced on a pen or pencil tip. If the disc is off center or unbalanced, it will tilt toward its heavy side.

As the wheel and tire tilt, an electronic computer registers both the amount and location of unbalance. Next, an automatic marker stamps the amount of unbalance in ounces on the inside of the wheel rim, directly opposite the "heavy" side of the wheel. As the wheels leave the machine on a conveyor, all the operator has to do is look at the number of ounces a wheel is out of balance and attach a weight to the rim opposite the "heavy" side to compensate for the unbalance.

Meanwhile, if a wheel and tire assembly is hopelessly out of balance and cannot be corrected within the balancer's tolerance limits, the automatic marker stamps an "x" on the inside of the wheel rim, identifying it as a reject. It is taken out of production immediately.

Seeing-in-the-Dark

That eerie experience of "feeling your way" in the dark has posed so many scientific problems that scientists have launched an intensive investigation into this unseen world.

An example of the electronic devices now in the development stage is 'Ebicon' from the initials of the phrase 'electron bombardment induced conductivity' which is the phenomenon basic to its operation. It is an improved type of television tube.

The human eye is an instrument that covers an enormous range of light intensities, but at the lowest levels of illumination, such as under starlight conditions and even lower, the eye's performance becomes limited by the particle nature of the light itself. This is where electronics has stepped in.

Because electronic devices can be designed to operate with very large lenses, which collect great quantities of light particles, and because they utilize these particles more efficiently than the human eye, they offer possibilities of vision at illumination levels far below those required for ordinary vision.

(Continued on page 40)

NEW DEVELOPMENTS

(Continued from page 39)

Why do we want to see the dark? There are a number of reasons for wanting to push the visibility limit as far as possible.

Among these are:

1. Military – Ability to place enemy troops and movements under closer surveillance during darkness.

2. Medical – To improve X-ray fluoroscopic techniques which now are limited by amount of radiation a patient can stand.

3. Astronomy – To increase the capabilities to see great distances into space which are now limited by the sensitivity of photographic plates.

4. Atomic energy – It is now possible to detect and measure atomic particles by the scintillation counter. In the future, and by "seeing in the dark," it may be possible to see and record the results of high-energy atomic reactions as they take place inside of luminescent crystals.

The Ebicon tube works in this manner:

As particles of light strike the tube, they produce electrons which are then accelerated by a potential of approximately 20,000 volts. Then, these electrons are shot through the key point of the tube—a "storage" target" consisting of a small aluminum-coated metal screen and a selenium semiconductor. This "target" serves the dual purpose of storing and multiplying the electrons. Through this multiplication process a signal is received which is large enough to operate conventional electronic amplifiers.

The Ebicon tube is of simpler design than the sensitive tubes now in use and will require less complex associated camera equipment. Also, fewer camera adjustments will be necessary during operation.

Other uses might include color television, closed circuit telecasts such as inside manufacturing plants where lighting is limited and virtually any indoor or outdoor event regardless of time of day or weather conditions.

Scientists Devise Atomic Vulcanizing Process

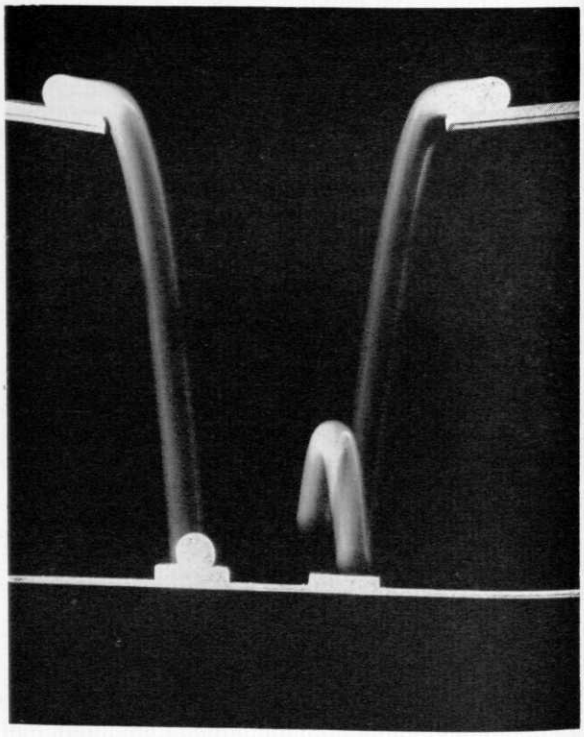
An ultra-fast method of using atomic "bullets" to vulcanize silicone rubber has been devised by three scientists. The process beams two-million-volt electrons at a silicone gun and almost instantly converts it into silicone rubber. Its discoverers say that the technique produces a better rubber in two seconds than conventional vulcanizing methods yield in several hours.

While not yet ready for commercial application, irradiation with high-energy electrons will eventually become an important method of vulcanizing silicones industrially. It duplicates all the good features of chemical vulcanization without introducing chemical agents, which remain in the rubber and spoil some of its desirable properties—especially those required for electrical insulation.

Another advantage of this new "atomic bullet" technique is the ease and precision with which it can be controlled. Curing of the rubber is accomplished by exposure at ordinary room temperatures, in which no heat, no pressure, no chemicals are required. Control of the process consists merely of regulating the voltage, which speeds up the electrons, and governing the length of time of exposure to the radiation.

The scientists say the high-energy electrons required for the process can be obtained from a standard electrostatic generator—a high-voltage machine which accelerates electrons and focuses them into a beam. In a way, they explained, this is similar to what occurs in a television picture tube, where electrons are accelerated and then focused on a screen, thereby giving a television picture. However, the voltages used in the television tube are only a fraction as high as those used in the vulcanizing process.

Vulcanization takes place when the speeding electrons smash into the silicone molecules and cause them to arrange themselves into new patterns. This process, often referred to as cross linking, changes the silicone from a non-elastic, putty-like mass into a solid with the bounce of natural rubber.



The high-voltage machine used to focus electrons.

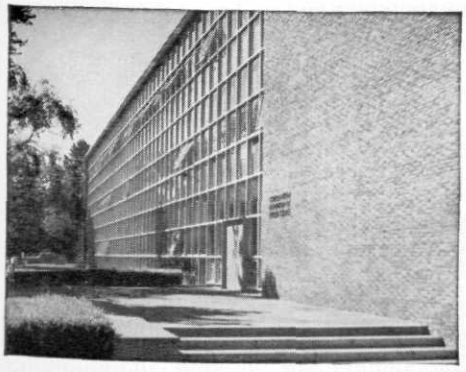
Flame Spray Ceramics

A novel process for coating a wide variety of substances – by feeding powdered ceramic materials through a simple flame gun – has been developed. Coatings resulting from the process—called "Flame Spray Ceramics"—are superior to those produced by

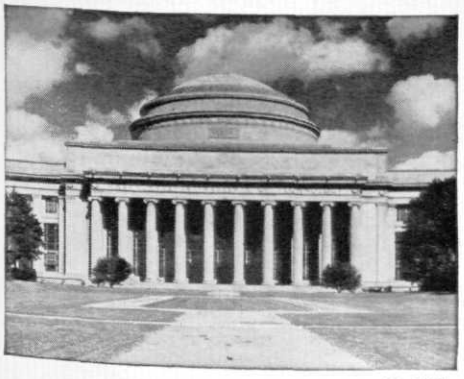
(Continued on page 72)

announcing ..... RAYTHEON GRADUATE PROGRAM

FOR STUDY AT HARVARD AND M. I. T. IN 1957-58



HARVARD



M. I. T.

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

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

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

YOU ARE INVITED TO ADDRESS YOUR INQUIRY to Dr. Ivan A. Getting, Vice President, Engineering and Research, outlining your technical background, academic record, school preference, and field of interest, prior to December 1, 1956.

Excellence in Electronics

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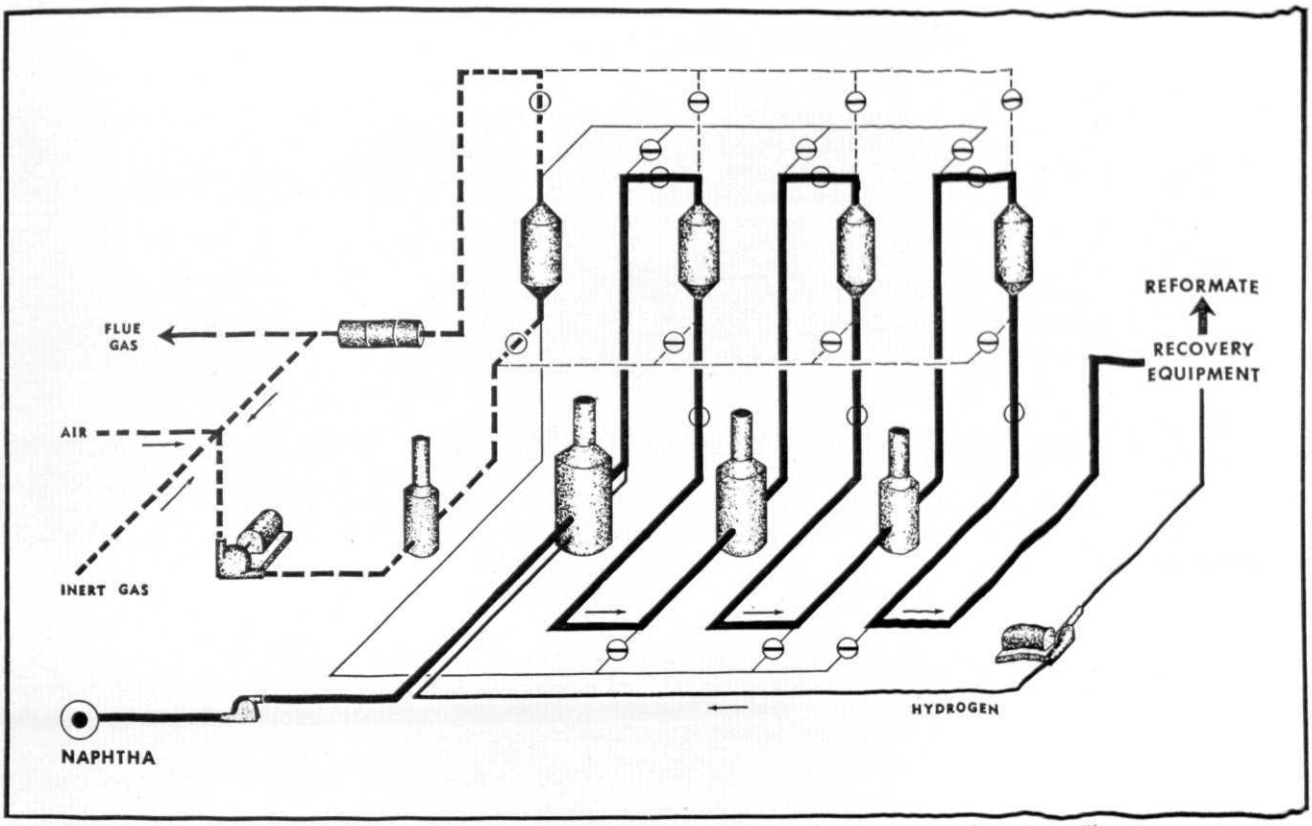


The diagram, with a minimum number of reactors, illustrates cyclic regeneration. Piping arrangement permits the swing reactor to substitute for any other reactor in the system. High activity of catalyst is maintained —without interrupting production—in the ULTRAFORMING process.

HOW TO KEEP $1,000,000 WORTH OF CATALYST ON THE JOB

When you have a million dollars' worth of platinum catalyst in a single refinery unit, you hope you can keep it steadily on the job. That's too much money to be standing around idle. Also, you'd like to keep the catalyst working at high efficiency.

Most catalysts lose activity with use. The platinum that "reforms" 40-octane gasoline to 100-octane gasoline is no exception. And the higher the octane number, the faster the catalyst loses activity.

For years activity could be restored only by taking the catalyst out of the unit and sending it away for special treatment. To keep from having too many of these shutdowns, refiners had to operate at relatively low octane numbers.

Standard Oil research scientists came up with a better answer. They developed a new type of platinum catalyst, and they learned how to regenerate it repeatedly—while it is still in the unit. When a swing reactor is provided, the unit need not even be shut down. The new process is called ULTRAFORMING.

During a year of ULTRAFORMING at Texas City, one reactor was regenerated 53 times. The unit is still producing 100-octane gasoline.

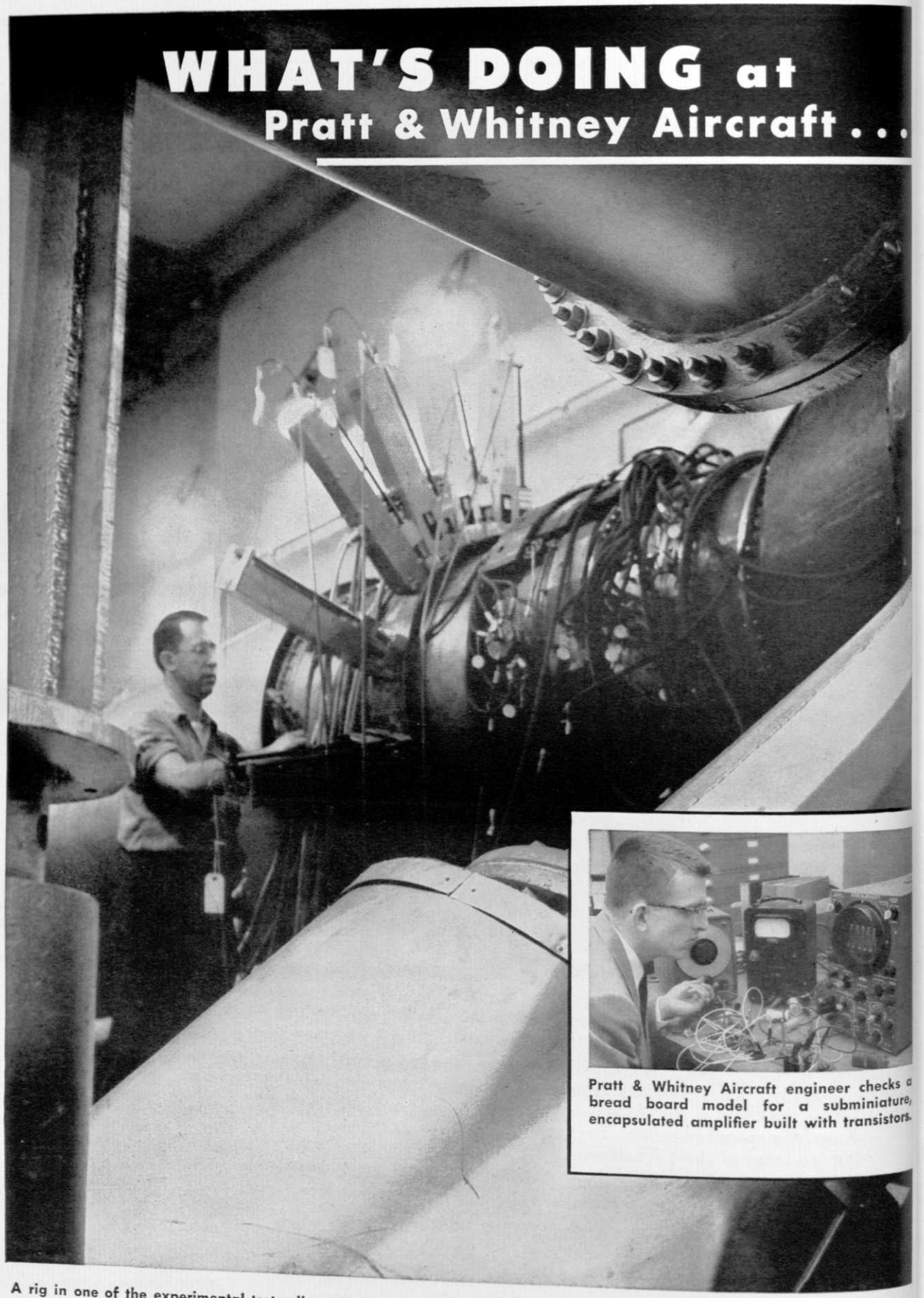
ULTRAFORMING also gives high yields of by-product hydrogen. The hydrogen can be used in upgrading other oil products. Or, it can be reacted with nitrogen from the air to make ammonia.

ULTRAFORMING is only one of the many major achievements credited to the scientists who have made careers at Standard Oil.

Standard Oil Company

910 South Michigan Avenue, Chicago 80, Illinois

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



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

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

...in the field of INSTRUMENTATION

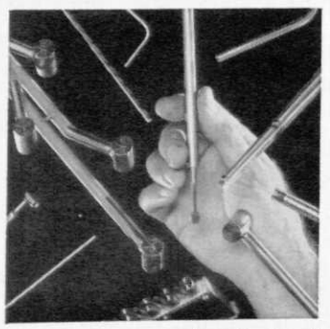
Among the many engineering problems relative to designing and developing today's tremendously powerful aircraft engines is the matter of accumulating data — much of it obtained from within the engines themselves — and recording it precisely. Such is the continuing assignment of those at Pratt & Whitney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

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

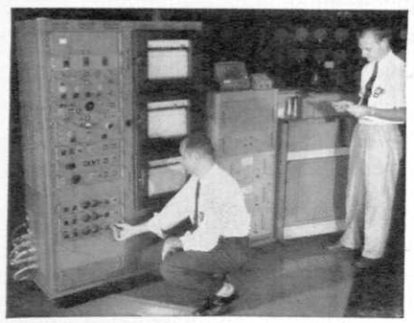
Responsible for assembling this wealth of information so vital to the entire engineering team at Pratt & Whitney Aircraft is a special group of electronic, mechanical and aeronautical engineers and physicists. Projects embrace the entire field of instrumentation. Often involved is the need for providing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

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

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



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



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

World's foremost designer and builder of aircraft engines

PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

EAST HARTFORD 8, CONNECTICUT

Meet Dick Foster

Western Electric development engineer

Dick Foster joined Western Electric, *the manufacturing and supply unit of the Bell System, in February 1952, shortly after earning his B. S. in mechanical engineering at the University of Illinois. As a development engineer on a new automation process Dick first worked at the Hawthorne Works in Chicago. Later, he moved to the Montgomery plant at Aurora, Illinois where he is pictured above driving into the parking area.*

Dick's day may begin *in one of several ways: an informal office chat with his boss, a department "brain session" to tackle a particularly tough engineering problem (above); working with skilled machine builders in the mechanical development laboratory; or "on the line" (below) where he checks performance and quality and looks for new ways to do things.*

Here Dick and a set-up man check over *the automatic production line used to manufacture a wire spring relay part for complex telephone switching equipment. This automatic line carries a component of the relay on a reciprocating conveyor through as many as nine different and very precise operations—such as percussive welding in which small block contacts of palladium are attached to the tips of wires to within a tolerance of ± .002".*

Examining the plastic molded "comb" *components of the wire spring relay Dick recalls his early work when he was involved in working-up forming and coining tools for the pilot model of the automation line for fabrication of wire spring sub-assemblies for relays. At present he is associated with the expansion of these automation lines at the Montgomery Plant.*

Dick finds time *for many Western Electric employee activities. Here he is scoring up a spare while tuning up for the engineers' bowling league. He is active also in the golf club, camera club, and a professional engineering society. Dick, an Army veteran, keeps bachelor quarters in suburban Chicago where he is able to enjoy the outdoor life as well as the advantages of the city.*

Western Electric offers a variety of interesting and important career opportunities for engineers in all fields of specialization in both our day-to-day job as the manufacturing and supply unit of the Bell System and in our Armed Forces job.

If you'd like to know more about us, we'll be glad to send you a copy of "Your Opportunity at Western Electric" which outlines the Company operations and specific job opportunities in detail. Write: College Relations Department, Room 1030, Western Electric Co., 195 Broadway, New York 7, N. Y.

Western Electric

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Manufacturing plants in Chicago, Ill.; Kearny, N. J.; Baltimore, Md.; Indianapolis, Ind.; Allentown and Laureldale, Pa.; Burlington, Greensboro and Winston-Salem, N. C.; Buffalo, N. Y.; Haverhill and Lawrence, Mass.; Lincoln, Neb.; St. Paul and Duluth, Minn. Distributing Centers in 29 cities and Installation headquarters in 16 cities. Company headquarters, 195 Broadway, New York City.

CLUBS AND SOCIETIES

AIEE-IRE

The American Institute of Electrical Engineers–Institute of Radio Engineers requires an electrical engineering major for membership in the student branch.

Meetings, which include speakers, movies, and tours, provide the link between classroom and industry. Since meetings are also attended by graduate engineers, members have an opportunity to learn the latest developments in their field from men who have observed them first hand.

Talks thus far this year have been by Dr. Von Tersch, Director of the computer laboratory at MSU on "computers"; Dr. Sanderson of the Naval Research department, on "The Artificial Earth Satellite," and Dr. J. D. Ryder on "Advances in Electrical Engineering."

Officers:

President.....Howard Shippen
Vice-President.....Robert Settersten
Treasurer.....Richard Tillotson
Secretary A. I. E. E......Ernie Lapensee
Secretary I. R. E......Nick Armstrong

PHI LAMBDA TAU

The Phi Lambda Tau fraternity was founded at Michigan State University in 1925 to mark with distinction those who, as Engineering undergraduates, have demonstrated outstanding initiative, fellowship and scholarship; also those of the faculty who have conferred honor upon our Alma Mater by their attainments in the field of engineering; and finally to further the interests of those concerned with engineering in the engineering schools of America and throughout the entire world.

Phi Lambda Tau believes that by selecting its members on the three outstanding qualities of initiative, fellowship and scholarship, it has the opportunity to honor the students who will be most successful in the engineering field and will be able to contribute the most to the School of Engineering.

Phi Lambda Tau has pledged itself to a program of service to the School of Engineering in an effort to demonstrate our spirit of initiative and fellowship. The first projects this year were in helping the Freshmen during Orientation and Registration, and welcoming the Engineering Alumni back to a coffee hour and luncheon in which Phi Lambda Tau participated.

A. I. Ch. E.

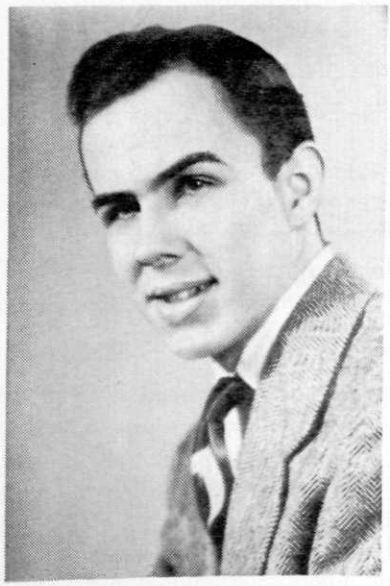
Officers for A. I. Ch. E. were elected for this year during the spring term. The new officers are:

President.....Bob Warner, Petoskey senior
Vice-President...George Miller, E. Lansing senior
Secretary.....Ed Sawyer, Springboro, Pa., senior
Treasurer.....Dick Bourns, Lansing senior

The first meeting this fall was a "Meet-the-Faculty" night. A short talk was given by the head of the Chemical Engineering Department, Dr. C. Fred Gurnham. In his talk, Dr. Gurnham pointed out the benefits of belonging to the student chapter, and told what the parent national institute did and what its benefits were to the students.

Dr. Gurnham then introduced the members of the faculty. Refreshments were served in the Chemical Engineering Building and during that time students mixed with faculty to discuss many topics about Chemical Engineering.

Plans are being made to have a field trip fall term. Details will be announced at the next meeting which is November 8, 1956. This year A. I. Ch. E. plans to have programs which will be of interest and be of benefit to the underclassmen as well as upperclassmen. Programs include two meetings a term plus field trips and a spring picnic. Plans also include a contest for design of a body for A. I. Ch. E.'s race car. If you are interested, come to our meetings. Make this a big year for A. I. Ch. E.

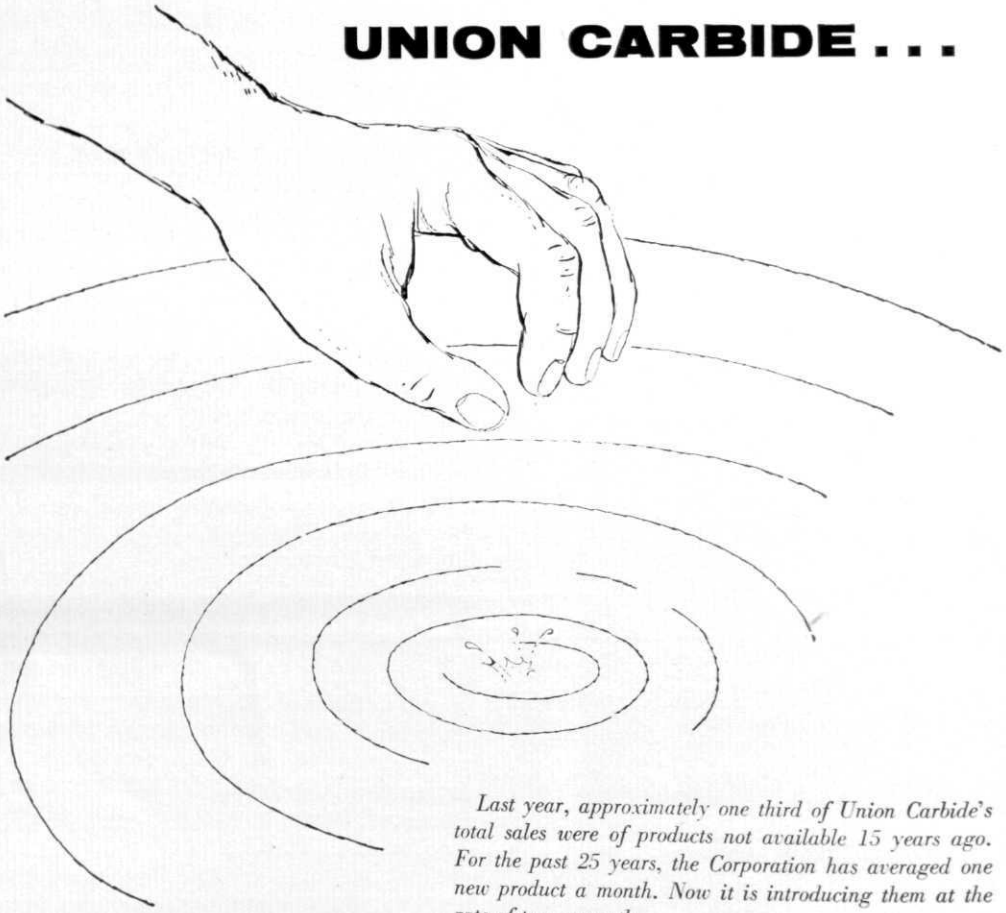


BOB WARNER
President of A. I. Ch. E.

(Continued on page 49)

Ideas grow and grow at

UNION CARBIDE . . .



Last year, approximately one third of Union Carbide's total sales were of products not available 15 years ago. For the past 25 years, the Corporation has averaged one new product a month. Now it is introducing them at the rate of two a month.

Ideas born in Union Carbide Laboratories grow . . . from exploratory and fundamental research to applied research and product and process development . . . through pilot plants to production to sales. In all these fields the Divisions of Union Carbide need engineers, chemists, physicists, and business and liberal arts majors. For more information write Co-ordinator of College Recruiting.

UCC DIVISIONS INCLUDE:

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CLUBS AND SOCIETIES

(Continued from page 47)

ETA KAPPA NU

The main objective of Eta Kappa Nu, National Electrical engineering honorary, is to become acquainted with and be of service to fellow electrical engineers, and to further advance the electrical engineering profession.

Requirements for membership are rigid. Members are chosen on the basis of high scholastic achievement and good fellowship.

Members initiated into Eta Kappa Nu this term are: Melvin Anderson, Onley Arnold, Eugene Hanson, Ronald Hileman, Conrad Roth and William Wallschlarger.

OFFICERS:

President ..... John Wirth
Vice-President ..... Ernest Lapensee
Secretary ..... Gordon Morin
Treasurer ..... Frederick E. Brewer

American Society of Civil Engineers

OFFICERS:

President ..... Richard Hertzler
Vice-President ..... Onto Lindy
Secretary ..... Richard Carr
Treasurer ..... John Bischoff

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

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

These meetings include picnics, field trips, films, and get-togethers with the Senior Society. The main event of each year is the Joint Banquet which is held for the Senior Society. It is put on by the students and held on the campus. They treated in return last spring by inviting the Chapter over to Fords Proving Grounds at Dearborn. It proved to be very interesting to all that attended.

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

Any questions pertaining to the Chapter could be answered by contacting one of the officers or faculty advisors.

Tau Beta Pi

Tau Beta Pi is the highest national engineering honorary. The Tau Beta Pi Association was founded at Lehigh University in 1885. The second chapter of the present 100 graduate chapters throughout the United States was founded at Michigan State University in 1892.

This year the officers of the Michigan Alpha chapter are: President – Rex Morin, Vice-President – Craig Sterling, Corresponding Secretary – Keith Iverson, Recording Secretary – Robert Fox, and Cataloger – John Greene.

New members are initiated in fall and winter term. Those eligible for election fall term are those in the upper one-fifth of the senior engineering class scholastically and the three outstanding juniors. In winter term Tau Beta Pi membership is extended to the top one-eighth of the junior class.

Tau Beta Pi has a club room where the members can relax, study or socialize, it is room 405 Olds Hall.

The key of Tau Beta Pi is a yellow gold Bent and can be seen on the tie clasps of many of the Professors in the Engineering College.

The purpose of Tau Beta Pi as stated in the preamble of the constitution is "to mark in a fitting manner those who have conferred honor upon their Alma Mater by distinguished scholarship and exemplary character as undergraduates in engineering, or by their attainments as alumni in the field of engineering, and to foster a spirit of liberal culture in the engineering colleges of America."

Chi Epsilon

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

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

The Michigan State Chapter of Chi Epsilon was established in 1953. The local group has 36 members. The officers for the 1956-57 year are:

President ..... Roy Rodd
Vice-President ..... Kent Johnson
Secretary ..... Tony Avellano
Treasurer ..... Val Krumins
Transit Editor ..... Karl Kettelhut

The highlight of the fall term will be the initiation banquet which will be held November 29th. At this time the fall quarter pledges will be formally initiated.

"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.

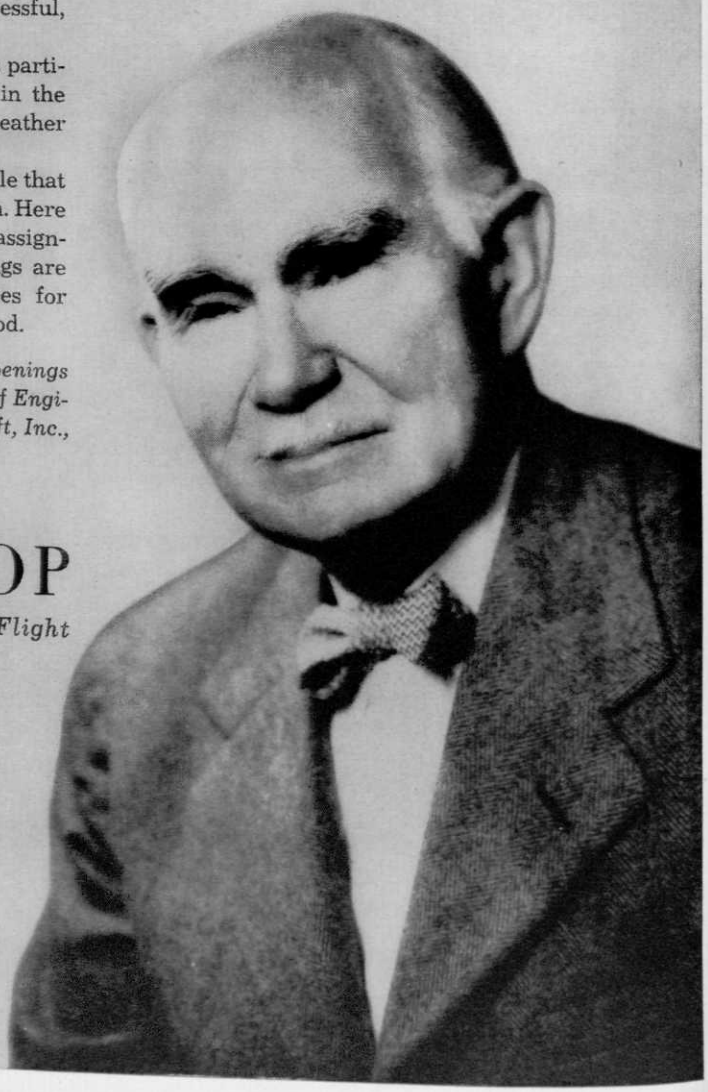
His expression, "a new era is beginning," has particular significance at Northrop, world leader in the design, development and production of all-weather and pilotless aircraft.

At Northrop, permanent positions are available that offer full play for individual talent and ambition. Here the graduate engineer will find interesting assignments for which he is best fitted. Surroundings are attractive, co-workers congenial, opportunities for advancement unceasing, the compensation good.

For detailed information regarding specific openings in your field of specialization, write Manager of Engineering Industrial Relations, Northrop Aircraft, Inc., 1001 East Broadway, Hawthorne, California.

NORTHROP

Pioneers in All Weather and Pilotless Flight

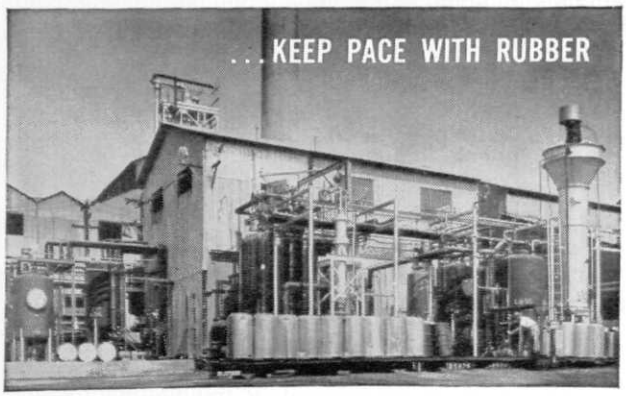


*A statement by Dr. Lee de Forest, pioneer in radio.

CAREER OPPORTUNITIES WITH *HERCULES*

HERCULES' CONTINUING RESEARCH offers many challenging opportunities for a career in the development and sales of processing materials for construction and other industries. New York City's Coliseum is typical of the many modern buildings and other projects where Hercules Vinsol® Resin is used as an air-entraining agent in concrete. Other Hercules products require specialized application in many industries offering more career opportunities for you.

HERCULES IS A LEADING SUPPLIER of chemical materials to the protective coatings industry, a field where there is always a future for the young man of vision. For example, multicolor lacquer, based on Hercules® nitrocellulose, was used as an interior finish on this new 48-passenger bus. Other uses are challenging.



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GR56-1

SILICONES

(Continued from page 11)

insulated (class H) motor was generator loaded to operate at its test temperature of 240 C in Dow Corning's motor test lab. Every 500 hours since, it has been shut down and exposed to 100% relative humidity for 24 hours. As of July, 1956 this motor was still on test after 58,090 hours at an average temperature of 240 C! That's equivalent to 353 years operation at the Class H temperature of 180 C.

Consolidated Edison Company of New York has purchased 106,175 H.P. of silicone insulated motors. These motors were rated from 200 to 2,500 H.P. for station auxiliary power drives. Since the initial purchases in 1945, the cost of silicone insulation has been more than compensated by increased dependability which is so vital in large power plants. It has also been found that money is also being saved in not needing the heavy vault construction and fire protection that ordinary motors require.

Westinghouse recently built a 400 cycle silicone insulated generator designed to service aircraft aboard ship. It is rated at 600 kw at 12,000 rpm and weighs only 2100 pounds. The same machine under conventional design would weigh 7500 pounds. This 300% increase in power per pound ratio was accomplished by skillful design, high speed operation and the use of silicone insulating materials. It was first used aboard the U.S.S. Timmerman.

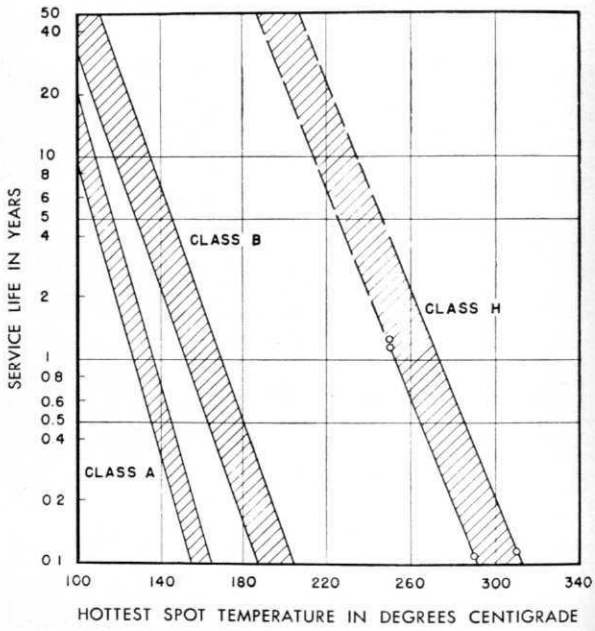
It was World War II that impelled Dow Corning to undertake the evaluation of silicone products (at that time mostly resins) invented by research chemists at Corning Glass Works. These first resins were produced at Dow Corning in Midland, Michigan. The results of these preliminary tests, reported to the AIEE, indicated that silicone insulation had a temperature advantage of about 100 C over the next best type of insulation. This meant silicone insulated motors could be expected to operate several hundred times as long as ordinary insulated motors where thermal aging is the primary factor.

During the past few years, these test results have been confirmed by the performance of thousands of motors rewound with silicone (Class H) insulation. This type of insulation has been known to save hundreds of thousands of dollars a year in maintenance costs alone.

All types of business are incorporating silicone insulated motors in replacing the kind previously used. Heavy duty in a steel mill burned out conventional armatures in lift truck motors every 2 or 3 weeks. The first silicone insulated motor was still working there after 57 months!

The life expectancy of silicone insulation was determined in the Dow Corning motor test laboratory where both heat and moisture were turned loose on identical Class B and silicone (Class H) insulated motors. Motors were alternately exposed for 7 days

LIFE EXPECTANCY OF CLASS A, B, AND H INSULATION AT VARIOUS HOTTEST SPOT TEMPERATURES



to 100% relative humidity and then operated at temperatures as high as 310 C until they failed. The harder a motor works, the hotter it gets and the faster the insulating walls break down to cause motor failure. The graph shows the relative life expectance of Class A, Class B and silicone (Class H) insulation at various hottest spot temperatures. It indicates that silicone insulated machines may last up to several hundred times as long as the other types of motors where heat is a major problem.

The first silicone product to gain commercial acceptance as an electrical insulating material was Dow Corning 4 Compound. It was designed as a moisture proof seal for aircraft ignition systems. Early in World War II it proved its usefulness by helping to bring the first flight of Thunderbolts safely over the ocean from Brazil to Africa. It kept the ignition systems of high-altitude bombers and carrier-based planes from conking out over Berlin, Tokyo and "The Hump." After all these years it is still specified for aircraft ignition and electrical control systems. It is still used to seal the junctions in radio and radar equipment.

Large savings on wages are also realized by the use of silicone insulation. Increased production in a large foundry was accomplished by speeding up the operating cycle on an overhead crane driven by three ordinary motors. However, in doing this, motor service life was dropped to 20 days. There was no room for larger motors. Three hours of wasted time while these motors were being serviced or replaced was costing $1000 per hour or $40,000 a year for idled man power. Rewound two years ago at an extra cost of $370 for silicone insulation, those motors have saved about $80,000 in wages alone.

Plant engineers got 50% more pumping capacity by having twelve, 50 and 60 H.P. motors rewound

(Continued on page 60)

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Some Practical Applications SERVOMECHANISMS

By Winslow Palmer
Reprint from Sperry Engineering Review

Summary—

The basic servo loop of a small energy signal controlling a much larger output of energy presents a fascinating and almost limitless number of applications. When the basic loop has man as one of its parameters the servo has an even greater potential. This paper describes some practical applications of the servo and tells of some of the author's personal experience as the human link in a servo system and as a designer of servomechanisms to rule out the human factor. Included are some interesting future possibilities of this challenging device.

INTRODUCTION

During the last few years, the term "servomechanism" has appeared with increasing frequency in technical literature, and has been treated as something wholly new. In fact, however, we have always used servomechanisms; the term is simply a name for a type of control system that has always been with us. For instance, some years ago the author had occasion to become quite familiar with a certain type of servomechanism which has had rather wide application for a great many years. It consisted of a self-propelled prime mover which would release energy in varying amounts on demand depending upon certain acoustic input signals; generally of the form "giddap" or "whoa." This source of energy was used to accomplish certain tasks that were beyond the abilities of a human; to wit; moving large objects from one place to another with some measure of precision.

This was a true servomechanism: the energy expended in performing the work was far greater than the energy expended in the command which controlled the operation. Further, there was some correlation between the intensity of the command (the amount and grandeur of the profanity employed), and the severity of the task (the size of the object and the steepness of the hill up which it was to be moved).

The fact that this servo control loop includes a biomechanical link does not invalidate the idea that the entire system is a servomechanism and can be analyzed and understood in terms of the laws of feedback control systems.

The two dominant characteristics of a servomechanism are: (1) the energy controlled is usually far greater than the controlling energy, and (2) the controlling signal or energy is obtained by some measurement of the difference between the actual situation and some desired situation. Thus a closed signal loop always connects the higher power output of the servo to the low power input. Under some circumstances an over-riding amount of the high power output may take control of the input and the system "runs away." In the equine-human system mentioned previously, this might take place literally when some characteristic of the load, say a couple of tin cans on the end of a rope, provided an element that excited the prime mover. Then the system becomes highly regenerative and the output tends toward infinity.

SERVO APPLIED TO STEERING A SHIP

Another example of a servomechanism at work is the steering of a ship. This is a particularly good illustration because events take place so slowly that the sequence of operations is readily apparent, and also it is a system in which the mass of the controlled object rather than friction is the overwhelming factor. When a force is applied to move the mass, an opposing force of equal strength must be applied later on to stop it.

To see how these various phases of control action take place, consider the simple act of making a moderate turn with a large steamship. At first, this appears trivial: the wheel is turned and the ship turns in response. However, it is not so trivial; several things must happen after the pilot decides he wants the ship to take up a new course, and before she actually settles out on that course.

The Human Steersman as a Servo Link

A large steamship of ten thousand tons or so, is steaming up the Narrows into New York Harbor and at a channel turn must change course some 15 degrees. Usually a quartermaster is at the wheel. The harbor pilot is beside him smoking his pipe and wondering if the Staten Island ferry will charge out of the slip before he gets past. The captain is behind the pilot keeping an eye on everything in general. As the channel buoy appears on the port bow the pilot calls out to change course. The quartermaster acknowledges with "Port 15 degrees, Sir!" and gives the wheel a couple of turns to port.

Nothing much happens, however, except that a pointer on a dial on the top of the steering stand moves from zero-center to maybe ten degrees left. This is the rudder order indicator, and shows the amount of rudder called for by the wheel. Down in the bowels of the ship the steam steering gear starts cranking away, and hauls the twenty or thirty tons of rudder out to the angle called for. Usually there is an electrical or mechanical repeatback from the rudder to the steering stand, and the rudder angle indicator over the pilot house window now moves over to match the rudder order. The steady sidewise pressure of the rudder on the stern gradually builds up a turning momentum in the ship and she starts to swing.

On the bridge the swing of the ship is first noted by a ticking from the gyro-compass repeater as it records the changes. When the ship is within a few degrees of the new course, the quartermaster will turn the wheel back toward center. However, the pressure of the rudder has given the ship, all ten thousand tons of it, an angular velocity of several degrees per minute, and this means the ship has an angular momentum of a good many thousand ton-feet squared per second. This angular momentum must be dissipated before the ship will steady on the new course. The quartermaster therefore turns the wheel through center and orders the rudder out on the other side to apply "meeting helm." Then as the ship swings in on the new course, he gradually reduces the rudder angle, and if he is skillful, he will bring the rudder angle to zero as the ship reaches the new heading with its turning momentum just cancelled out.

The ship's head is now on the new heading, but she isn't going that way yet. Before the turn started, the ship, all ten thousand tons of her, was coming up the channel on one course at 12 or 15 knots. She will continue on that course for some little time, until the linear momentum is absorbed by the now sidewise motion through the water.

Some may say that the foregoing example does not illustrate a servomechanism because of the human steersman. This is quite true, if one limits servomechanisms to machines only. However, the underlying theory of a closed loop servomechanism that governs the response of the *system* is still valid even though there is a biomechanical link in the control loop. It is true that the steersman cannot be classified as a linear element nor is he essentially noise free. Nevertheless, he is a link in a closed loop servomechanism. The response of the entire system can be studied by including his characteristics in the system; particularly his sensitivity (how far he turns the wheel for a given compass deviation) and his lag (how long it takes him to note that a deviation has occurred). These are important parameters in the design of any control system operated by a human, and servo theory is a powerful method for including the human factor into the design of such equipment.

The Automatic Steering System

Many ships now have entirely mechanized stering systems, familiarly known as the Metal Mike® automatic pilot. Until recently these systems were relatively simple servomechanism, which measured the displacement of the ship's head from the desired course by means of a pickoff of some type on either a magnetic compass or a gyro-compass. Then the rudder angle was made proportional to the error from course, by having the course error signal from the pickoff operate relays to run the steering engine until a rudder angle indicator showed a rudder angle proportional to error from course. This repeatback from the rudder could be obtained in a variety of ways. One means used a mechanical connection from the rudder stock to the compass binnacle, so that the pickoff itself was rotated by the rudder.

In such a system the rudder applies a turning force proportional to deviation from course giving more rudder angle with larger deviations and vice versa. Such a system, however, does not take into account the rate of turn or turning momentum of the vessel and therefore cannot apply "meeting helm" to dissipate

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SERVOMECHANISMS

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the turning momentum. If it were not for the more or less streamlined shape of the vessel's hull, which resists turning and absorbs the turning momentum in water turbulence, such a system could not be operated without oscillations or hunting (a continuous yawing back and forth across the course). However, the Metal Mike pilot in its primitive form was several orders better under most conditions than the human pilot, steering a straighter course with less rudder motion than the quartermaster could. It was found that the use of the Metal Mike pilot had a sizeable effect on the rate at which the coal pile disappeared into the furnaces. Each time the rudder is put over, it increases the drag of the ship in the water as is well known by anyone who has sailed a small sailboat in a race. Steering the ship with the least possible amount of rudder motion gives the least drag, and therefore, the best fuel efficiency. It was found that Metal Mike was no luxury; he easily paid his way.

The simple-minded Metal Mike described above could steer a reasonably good course up to a point, but when an attempt was made to increase his sensitivity so that he would steer a tighter course, beyond the point where sufficient damping could be obtained from the hydrodynamics of the ship's hull, he would break into uncontrollable oscillations, swinging back and forth across the course. To obtain better steering it was found necessary to take into account the *rate* at which the ship turns, as well as how far she is off heading.

Measuring the turning rate of a ship is no easy matter: the rate of turn is slow, the ship yaws with the seas, and the roll is also coupled into the turn or yaw. However, if the ship is provided with a gyro-compass, there is a fairly ready means of determining its turning rate. In the gyro-compass there is the gyroscopic wheel itself, which through its ballistic coupling to gravity, is constrained to keep its axle pointing north. This gyroscopic wheel is hung in a delicate gimbal suspension, which incorporates a follow-up motor that serves to keep the gimbal always aligned with the wheel so that the wheel is thereby isolated from any disturbing influences due to the motion of the ship. Thus, when the ship turns, this follow-up servo will drive the suspension oppositely to the direction the ship is turning. Hence, the speed with which this compass follow-up motor runs is proportional to the rate at which the ship is turning, and a generator coupled to this motor will produce a voltage proportional to the rate of turn of the ship.

This signal voltage can be applied in place of the steering signal, so that, if the ship swings or yaws, the rudder will always move so as to oppose the swing. Thus, if the ship swings to port, the generator on the gyro-compass would send a rate signal to the steering engine to move the rudder to starboard. As the swing of the ship stopped, the signal from the compass generator would cease, and the steering engine would return the rudder to center. Such a control would have no sense of heading, but it would counteract any swing or turn of the ship. If now the heading signal is added to the rate signal, the rate signal will tend to oppose the ship's overshoot (due to its turning momentum). For instance, if in returning to course the turning rate of the ship is too great, the heading signal would decrease to zero in strict proportionality, but the rate signal from the compass generator would not. When the heading signal became less than the rate signal, the resultant would change sign and cause the rudder to swing out oppositely and oppose the turn giving "meeting helm" and thus stopping the turn right on course.

Such a control permits the amount of rudder applied for a given error to be increased, and the action of the control in applying opposing rudder to meet the swing of the ship in a seaway becomes very similar to that of an expert steersman applying "meeting helm" when coming to a new course.

Finally, it should be noted that the steering of a ship is not a linear process. The torque applied to the ship by the rudder is *not* proportional to rudder angle. It is greatest for intermediate angles, becoming mostly drag with little turning effect when hard over.

The force of the rudder is also a marked function of the ship's speed, as well as the direction of the ship's motion through the water. When the ship is skidding on a turn, the neutral position of the rudder may be displaced several degrees to one side. It has been suggested that a measure of the ship's speed as well as a measure of its relative motion through the water be added to the control system.

In recent years the availability of analogue computers has made it possible to study the action of various types of ship steering systems in the laboratory; and much improvement in the operation of such steering systems is being made by such methods as adding non-linear elements to the repeatback from the rudder to the heading control to compensate for the non-linear action of the rudder itself.

SERVO APPLICATIONS TO FLIGHT CONTROL

The steering of a ship is an illustration of one type of servo in which the direction, or heading of a moving craft is controlled so that the craft will move in a desired *direction*. The type of control presupposes that a craft will move generally in the direction of its longitudinal axis. The characteristics of such a control are determined largely by the dynamics of the body being controlled; its inertia, the friction effects of the medium in which it moves, etc. The next step in the control of vehicles is the control of the track of the vehicle so that it is constrained to move along a definite prescribed path. An example of such a control system is the automatic approach control in which an aircraft is constrained to follow the path defined by an instrument landing system.

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1957-1958

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SERVOMECHANISMS

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In such a system, the actual mass of the airplane loses its predominant place in importance, since it is the position of the craft relative to the axis of the landing system that is being controlled, and changes in this parameter are determined largely by the speed and heading of the craft. Generally, transient changes in heading can be considered instantaneous relative to the time it takes the aircraft to move across the field.

In this particular application, the deviation of the aircraft from the axis of the radio beam of the landing system is measured and indicated by the instrument landing system receiver. A control signal from the receiver is applied to the turn control of the automatic pilot to turn the aircraft toward the beam by an amount proportional to the deviation, so that the aircraft seeks to make its track coincide with the axis of the radio beam.

An all-important characteristic of this type of control is that the error information upon which the system operates is the deviation of the aircraft from the beam, whereas the quantity that is controlled is the heading of the aircraft, and there is not necessarily any sensible relation between the two. This brings certain complicating factors into the operation of the system.

Lateral Deviation Problems

The coupling between the deviation from the axis which produces the control signal, and the heading, which changes in response to the control, is through the angle that the track of the craft makes with the desired course, i.e., the rate at which it travels across the beam. If the craft is moving parallel to the axis of the landing system at the time the control is turned on, then its track will subside to the axis of the landing system. If it is heading in any other direction, the track will subside to a course parallel to the axis of the landing system but displaced from it. The displacement distance corresponds exactly to the amount of turn, or heading change, put in by the control.

This is an unsatisfactory condition, because the aircraft must land on the runway, and not in the ditch alongside of it, and the dimensions of the runway, in width at least, are very small relative to the distances covered by the craft in the approach. As a result, the relative accuracy of control must be very high and the allowable deviation from the beam must be very small, at least at the point of contact. Therefore, for a control of this type to be satisfactory, the exact heading of the runway, or the beam, must be known in the aircraft with a high order of accuracy prior to the start of the approach. In addition, if wind is blowing across the course, the aircraft will drift to the side until the deviation from course builds up to an amount that will turn the craft, by means of the control system, so that it holds a "crab" angle with the course just sufficient to counteract the wind, from when the craft will follow a track parallel to the axis of the landing system but displayed from it just far enough to maintain the proper crab angle.

To eliminate this type of displacement from course, due to unknown crosswinds, errors in knowledge of runway headings, etc., an additional factor may be added to the control system. In addition to the change in heading proportional to deviation from course, the aircraft is also made to turn at a *rate* proportional to the displacement from course. Now, if there is a cross wind, so that the track tends to settle parallel with the desired track, the remaining displacement necessary to establish the crab angle will then cause the heading to change further, causing the craft to crab further into the wind and thereby pull into the course.

If the craft is flying on a heading to the right of the desired course when the control is turned on, that part of the control which changes the heading of the craft an amount proportional to *deviation* from course, will turn the craft to the left. The size of the angle to the left then *decreases* as the craft approaches the course; i.e., the heading has a rate of turn to the right. That part of the control that turns the craft at a *rate* proportional to deviation from course will cause the craft to turn at some rate to the left. At some angle with the course, these two effects will cancel, and the rate of turn will fall substantially to zero. The track of the craft then subsides asymptotically to the beam axis with the proper crab angle to remain on the beam.

This then is a control system which is able to cancel "unbalances" in the system, such as cross winds, or unbalances in the aircraft controls, and does not require that the runway heading be known in the aircraft, provided the point at which the aircraft enters the beam is far enough out for the control to have sufficient time to pull the craft into the center of the beam before it gets to the point of contact.

However, this system has certain other pecularities because the rate of turn of the aircraft is being controlled. One of the most distressing is if the deviation from course is large, the maximum rate of turn put in when the craft is moving perpendicular to the desired course may be less than the rate of turn put in by the rate control. Then there is no stable course, and the craft will follow a more or less circular path to the side of the desired track, without ever finding it. Hence, if this system is used, it must not be turned on outside of a certain distance either side of the landing beam, or other means must be provided to prevent circling to one side of this desired course.

The two types of control signals must be properly proportioned. If the part which makes the rate of turn proportional to deviation is made too large, the track will be a damped oscillation across the course; if too small, an unnecessarily long distance will be required before the track converges into the beam.

Altitude Deviation Controls

Much the same sort of control system is used to fix the altitude at which an aircraft flies. In such a system, the primary attitude or angle of attack (how sharply

the wings cut the air) is fixed by means of a closed servo loop. A gyroscope establishes a horizontal plane, and some sort of signal pickoff measures the deviation of the fore and aft axis of the airplane from the horizontal. The output of the signal pickup is then applied to an amplifier and servomotor to move the elevator controls. If the aircraft is out of trim, so that the attack angle held by the control system is not correct for constant altitude or level flight, the airplane will climb or dive.

To maintain the aircraft at constant altitude, in spite of unbalances in trim, an additional control signal proportional to deviation about some set altitude is obtained from an altimeter. The altitude for zero signal is set by means of a knob on the instrument. This signal is then added to the horizontal signal to bias the elevator control so as to increase the angle of attack if below the set altitude, and decrease it if above. With this control the character of the system is changed so that an unbalance or bias in the system, instead of causing a continuing climb or dive, causes the system to settle out a fixed amount above or below the altitude to which the altimeter pickoff is set.

When making an instrument-controlled approach to a landing the rate of descent along the glide path is held fixed by replacing the altimeter signal with the glide path signal, so that the elevation of the aircraft is stabilized about the glide path. Here it is essential that any bias in the system be removed before contact with the ground. A few feet of offset could be important, particularly if it is a matter of clearing a fence along the edge of the field. To insure this, a further control is added which makes the rate of change of pitch angle (angle of attack) proportional to deviation from the glide slope, so that any bias in the system is removed before contact with the runway. In this case, circling when far off course is not a serious factor, since aircraft are not normally flown on a course perpendicular to the glide slope.

UNFORESEEN PROBLEMS OCCUR

Speaking of aircraft control systems, it was brought rather forcibly to the writer's attention some years ago that the most disturbing part of designing and operating these systems is not the design of the basic system, but the anomalies which crop up. In 1940 the servo amplifiers of an automatic pilot were being developed which operated from synchro pickoffs to actuate servo power units that did the actual pulling on the control cables. These power amplifiers served to amplify the signals from the instruments and at the same time differentiated the error signals to obtain a measure of the rate the attitude was changing. In addition, signals from several different instruments were added to provide various control combinations such as: coordinated turns, bank-constant altitude control, and automatic approach control.

At the time I knew very little about airplanes, having never been up in one. After some time in the laboratory constructing a set of experimental amplifiers and associated gear. I found myself in the unusual position of flying over Long Island in a Lockheed Hudson bomber, guiding it by this assemblage of experimental equipment, without ever having been at the controls of an aircraft myself. I decided to learn what the actual controls of an aircraft felt like, and got into the co-piolt's seat, with the system running on the automatic pilot. Taking a firm grip on the wheel, I switched off the power of the servos and proceeded to "fly the airplane myself. It shortly became apparent that to a rank neophyte, keeping an aircraft level on two axes and going in a straight line on the third all at the same time, required a simultaneous divisibility of attention and order of concentration somewhat more than I possessed, regardless of how nonchalantly it is handled by a seasoned pilot. First we fell off on one wing and then while concentrating on getting level again, the nose came up and we climbed. While getting the nose down, we were off on the other wing. And then putting some balance in those two we were going in a circle. After about ten minutes of staggering around the sky, I came to the conclusion that the automatic pilot I had assembled could do five things at once better than I could, so with a momentary burst of superhuman concentration, I got the thing entered on all three axes simultaneously, and snapped on the servo power control..

Unfortunately, I had failed to note that while performing our Brownian motions through the sky, we had also climbed about 50 feet. The altitude control, however, didn't forget. It recognized the situation immediately, and ordered full down elevators. The automatic pilot jerked the wheel out of my hands, slammed it full forward, and we promptly started down, heading for an outside loop. My assistant, back in the cabin, rose off the floor and plastered himself against the overhead, and the pilot, being tied to his seat, let out an almighty grunt as his safety belt bit into his middle. He yanked the emergency disconnect on the autopilot controls and leveled us out. Then he headed for the airport.

When we got back on the ground, it was a considerable period before they would let me near an airplane again. For some reason the airplane people objected to young engineers who tried to make their equipment fly an outside loop without warning anybody. On my part, I couldn't understand how the flight testing could do much good, if the equipment was expected to be perfect before it was tried out. This is an argument which has never been settled.

In final designs of Sperry automatic pilots the altimeter has had a servo incorporated within it, which automatically keeps the altimeter signal pickoff centered when it is not connected to the autopilot, so that whenever the altitude control is switched off the system is automatically aligned, and gross errors such as described cannot happen.

This is characteristic of servo design problems. The things that are the most difficult are usually not in the basic design of the servo itself. Instead, the troubles concern ancillary effects, which occur at various non-

(Continued on page 69)

MEN AND METALS

(Continued from page 25)

separated the Bronze Age from the widespread use of iron. In fact archeologists variously date the beginning of the Iron Age within the period 4000 to 1300 B.C.

Neither iron nor steel was produced in large amounts or in articles heavier than one or two men could lift until far into the Christian Era. The European invasion of the Americas succeeded in large part because the invaders had what the natives lacked – iron and steel weapons and armor. In the race over the years for the development of better weapons and armaments, iron and steel have played a major part.

Perhaps iron's greatest gift to the human race is simply that it lifted the burden off the backs of men. Man used it to create machinery to do for him what he could not do for himself.

The search for improved metals and more versatile alloys continues at an ever increasing pace. More than three-fourths of the known chemical elements are metals. It is with these 75 metals, and with the large number of possible alloy combinations both with other metals and with non-metals, that the Science of Metals concerns itself today. Not only have the old and more commonly known metals and alloys been improved and adapted to modern scientific and industrial demands, but a large number of entirely new metallic materials have been developed. A brief glimpse at only a few of these new faces in the metallurgical world might well include the following:

Beryllium – used to harden and stiffen copper.

Cesium – used in photoelectric cells and for removing traces of gas in electronic tubes.

Columbium – a constituent of electrodes in electronic tubes.

Gallium – a backing for special optical mirrors.

Germanium – used for some types of transistor tubes.

Indium – component of special bearing alloys.

Iridium – contacts on voltage regulators.

Osmium – electrical contacts.

Palladium – a catalyst for hydrogenation reactions.

Rhodium – searchlight reflectors, alloy thermocouples.

Ruthenium – jewelry, alloyed with platinum for electrical contacts.

Tantalum – grid supports, cathodes, filaments, and getter cups in electronic tubes.

Thorium – used in x-ray tubes.

Titanium – used in aircraft, armaments.

Zirconium – structural component in nuclear reactors.

New frontiers of the Science of Metals are opening so widely and at such an accelerating rate that no one can predict their extent or effect on the economy and culture of the world.

Each metal is distinct from every other because its atoms are unique. Not all of the metals are in common use; some are very scarce and costly to obtain. In looking at the future of metals, it is evident that more must be learned about their properties and those of their alloys so that they may be used more selectively. Consider, for example, the search for outstanding properties of metals heated to incandescence. In this regard the radiation from superheated molten zirconium is so intense that it is the basis of a new concentrated arc lamp. In fact a crater of molten zirconium only 0.003 inches in diameter has a brilliance equal to one-sixteenth that of an equal area on the sun.

The day may not be far away when much of the effort now devoted to studies of "smashing the atom" will be translated into investigations of "synthesis of atoms." The building of atoms may one day provide a variety of alloys with properties as yet unobtainable (or not even imagined) in existing materials.

What astronomers now see near the limit of their telescopes and the physicist measure in their studies of cosmic rays suggests that matter is being created as well as annihilated in the cosmic realms of far-off space. The story of metals is a part of the great development of science in its never-ending search for truth. The awesome job of annihilation lies behind in the nuclear bomb, but an even greater task – creation – beckons in the future. The Science of Metals will play a key role in the creative engineering of tomorrow.

SILICONES

(Continued from page 52)

with silicone (Class H) insulation. The list price for 12 new 75 H.P. motors was $24,840. The cost of rewinding the old ones with silicone insulation cost $7,425. That is a saving of $17,415. Without any change in the installation, motors originally rated at 50 H.P. now can carry peak loads of 86.5 H.P.

Performance of the kind outlined has resulted in a growing demand for new equipment made with silicone insulation. Many types of this kind of machines are available from most of the leading manufacturers of electrical equipment.

Only in the past few years has a large step been taken in the electrical world–that of silicone insulation. With the ever-growing trend toward automation and increased mass production, the development of an excellent insulation is a fortunate thing. At Dow Corning the work is still going on to improve their products. As long as there is a desire for progress, American industry will help make our world a little better.

Visitor: "Can you tell me the name of this school?"

Young man: "Sorry, mister, I'm just a football player here."

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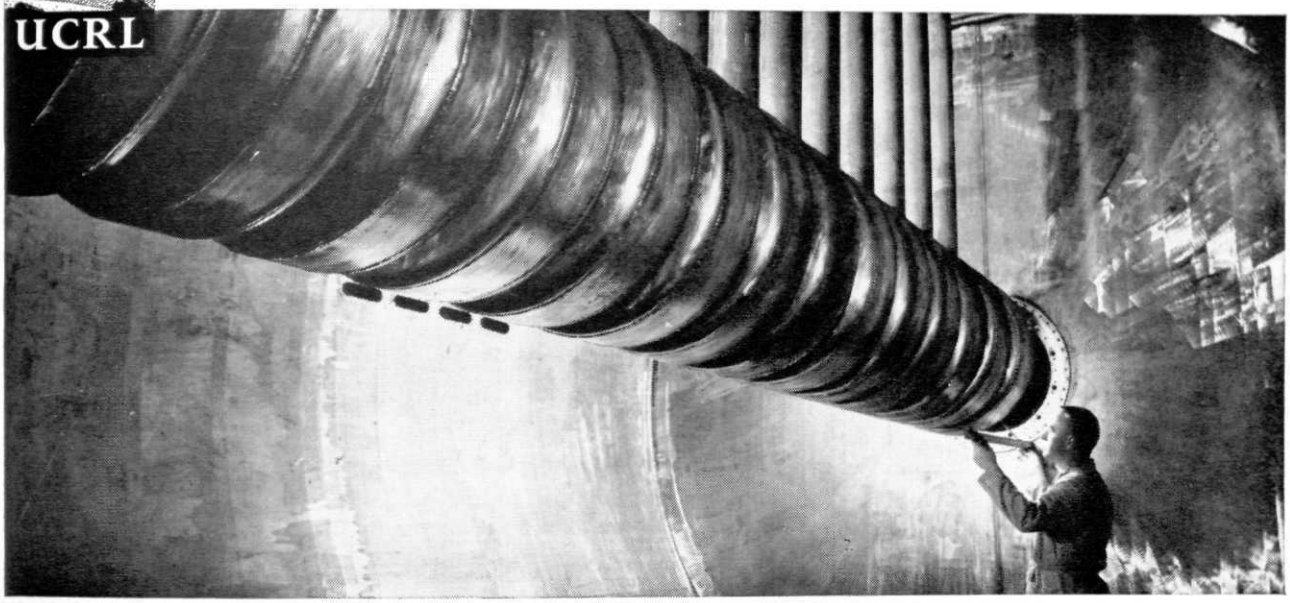

At UCRL's Livermore, California, site—interior view of drift tubes in high-current linear accelerator designed to deliver 250 ma of 3.6 Mev protons or 7.8 Mev deuterons

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For UCRL is directed and staffed by some of America's most outstanding scientists and engineers. This group offers pioneering knowledge in nuclear research—today's most expansive facilities in that field...and wide-open opportunities to do what has never been done before.

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If you are a **PHYSICIST** or **MATHEMATICIAN** you may be involved in such fields of theoretical and experimental physics as weapons design, nuclear rockets, nuclear emulsions, scientific photography (including work in the new field of shock hydrodynamics), reaction history, critical assembly, nuclear physics, high current linear accelerator research, and the controlled release of thermonuclear energy.

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*City*_____ *Zone*____ *State*_____

THE PHOTON

Lo, the poor Photon,
It's miserable existence
Due to Lorentz's equations
And Einstein's insistence
That it must be born
And live and Die
In a state so peculiar,
Irrational as π*!*
Its mass at rest
Is nothing, you see,
But is proportional to nu
When $V = c$.
Now c is constant
Of relative persistence
Despite a natural
Intellectual resistance
To Einstein's theory
And all its brilliance.
So the photon is bored
By its constant speed,
Through the fabulous ether
Which it doesn't need,
Till it strikes one day
An atomic oscillator
And disappears in a flash
Of Photo-Beta.

JERRY DANIELS—*Grad Student*
Dept. Physics, U. of M.

Dear Ruth:

I just read in the paper that students who don't smoke make much higher grades than those who do. This is something for you to think about.

Love, Father.

Dear Father:

I have thought about it. But truthfully I would rather make a B and have the enjoyment of smoking; in fact I would rather smoke and drink and have a C. Furthermore, I would rather smoke, drink and neck and make a D.

Love, Ruth.

Dear Ruth:

I'll break your neck if you flunk anything.

Love, Father.

Can't Win All of 'Em

(Continued from page 31)

stand; neither am I a match to the worthy and able opposing attorney in crossing my words with his, nonetheless, I beg your indulgence to hear me out. It's a matter of two extremely important facts in this case that were, perhaps unintentionally misconstrued and, therefore, put incompetently before you.

"Mr. Schlegel, as able as he is, has offered for an argument something I did not say. And, too, he has also overstressed a point which is not even relatively important in this case. First, ladies and gentlemen, I want you to note that I did not say that the on-coming car was 1,000 feet away from me. He asked me how long the block was. I told him 'I would very roughly guess it to be 1,000 feet,' I am not and I was not positive about the length of the block because I did not measure it. Now then, this 'very roughly' could well mean 500 feet. I have also said that the car traveling at an excessive speed was well within the block when I saw it coming. Here is another fact for you to keep in mind. My car was standing still about 100 feet from the intersection of Mechanic and Taylor Streets. And when the on-coming car was well within the block, it could have easily been 200 feet from Mechanic and Larkin intersection. In that case, the distance between my car and Miss Wistful's car could have been not more than 200 feet. Cars traveling between 30 and 40 miles an hour, do well over 50 feet in each second. So you see, ladies and gentlemen, I had only about three seconds to take my car out of the traffic. Three seconds is not enough even for the best of experts to pull a car from zero velocity to that of 60 feet per second in order to get out of the way of an on-coming car that is doing more than fifty feet every second.

"Secondly, this business of showing colored toy cars on the black board proves nothing. A fast moving car does not behave like a crawling baby on the floor. It does not go around the obstacle like the baby does around the bassinet. I am certain that, at one time or another, you have driven your own cars and made a sharp turn trying to miss something that was in your way. You must have noted in such instances that when you swing your front wheels to the right, the front end of your car goes the way you want it to go; but the rear continues in the line of your original motion. This is the reason many cars get turned over on sharp turns. The well known 'Moment of Inertia,' a law of nature, operates all objects in motion that way. Any competent engineer would tell you that. The reason Miss Wistful's car didn't turn over on the quick turn to the right was that my car stopped it. If she had watched the traffic and turned her wheel sooner, there would have been no collision. Now she would not be pleading with you to have me pay the bill for her own negligence.

"Good people of the jury, kindly add these two corrections to what my trustworthy counselor said and you will have a complete picture of what happened on August seventh, nineteen fifty-five at Mechanic and Taylor intersection. Looking at it you will undoubtedly arrive in your minds at a just and equitable conclusion. I thank you."

The judge gave the jury instructions and the jury filed out to the adjacent room for the deliberation. In the meantime my attorney wandered to the plaintiff's attorney, obviously ignoring me. Mr. Funk exchanged cordial remarks with Mr. Schlegel and was introduced to the lovely Miss Wistful. I sat subdued and alone waiting for the verdict while my counselor engaged in lively conversation with Miss Wistful.

Finally came the anticipated knock. Court Clerk opened the door and the jury filed in. Before resuming their respective seats, they, for a brief moment, stood rigid, like small statues, with only their eyes alive. Judge Kahgegab ordered, "Mr. Foreman, please read the jury's verdict."

A man of about forty-five, tall, shapely, well-dressed, and the possessor of luxuriant, almost white hair read, "We the jury . . . find the defendant not guilty of negligence placed upon him and therefore hold him not responsible for the repair bills which the plaintiff asks this court to order him to pay."

Mr. Schlegel's face turned as dark as the autumn clouds. Miss Wistful's expression changed not at all. She showed apparent indifference to the outcome. Mr. Funk all of a sudden made an about face, grabbed my hand, squeezed and pumped it hard and said, "We did better this time, didn't we?"

Next moment he turned around and looked to where he left my pretty opponent. Then and there dropping me like a pair of shorts, all swelled up he went to her and sputtered, "you can't win all of 'em." Her green eyes gave him a warm smile, while he lingered in conversation with her, the judge pounded the gavel three times and then announced, "The Court declares the case is closed." Gazing at the two from his elevated chair, he smiled wryly, as did I, not only because justice had been done, but because obviously the case was not closed insofar as Mr. Funk and Miss Wistful was concerned.

"I'm feeling a little out of place with all these people smiling at us," holding her eyes on him, Miss Wistful mildly complained.

"You look a little out of place," Mr. Funk agreed kindly. "But time cures all ills. A dozen years from now it won't be so noticeable."

When the echo of the last gavel blow died down, the two left the room side by side, and discovered that they were bound in the same direction.

Judge: "So your name is Sarah Ingersoll. Are you by any chance related to the famous Ingersoll who makes the dollar watch?"

Sarah: "Well, suh, not exactly. You see, the name is the same, but the movement is different."

Student Authors Page

MEL MAYNARD

Interviewing Dean Ryder, was the first assignment given Mel Maynard, freshman, for the Spartan Engineer.

A major in journalism, she thought it would be of interest to write for the Engineer so as to have a broader knowledge of fields other than journalism.

A resident of South Campbell, Mel is originally from Royal Oak, Mich. During high school, she worked on the school paper four years and for a while had her own feature column in the city newspaper.

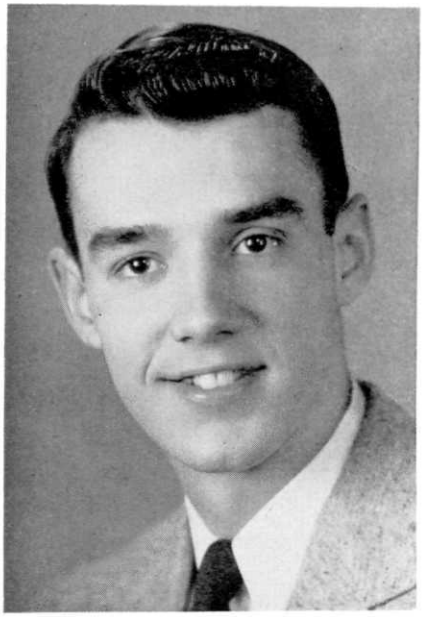
Patrick Miller, Maple City senior, is author of the JETS story which is connected with the Junior Engineering Technical Society. It is his first story for the Spartan Engineer.

Before coming to Michigan State University, Pat attended junior college in Traverse City. He is majoring in mathematics.

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

Besides writing "Silicones are Working for You," Herbert Horsley, Midland, Michigan junior, is also interested in music. He produced the musical "Good News" in the MSU Auditorium last year.

Herb is majoring in journalism and plans to go into advertising. He worked at Dow Corning for three years.



HERBERT HORSLEY

Coed: "What position does your brother play on the team?"

Sister: "A sort of crouched, bent position."

My checkbook informs me the balance is small.

The bigger the summer, the harder the fall.

M.E. Student: "Could you help me with this problem?"

M.E. Professor: "I could, but I don't think it would be quite right."

M.E. Student: "Well go ahead and take a shot at it anyway."

Thermo Prof.: "Who's smoking in the back of the room?"

M.E.: "No one – that's just the fog we're in."

A young divinity student whose father was a bishop admitted that he had used profanity.

"It was like this," he said to his father. "The ball had been passed to me . . . a long pass . . . and I caught it tight under my arm. There were only two men between me and the goal line. Interference took care of one and I dodged the other. I was within two yards of the goal post and I looked down and the ball wasn't under my arm. It just wasn't there, father. And I couldn't help saying, 'Where the hell is that ball?' "

"Well, where the hell was it?" cried the bishop impatiently.

A man caught in a snowdrift looked up and saw a St. Bernard coming toward him, with the usual keg of brandy under the dog's chin. "Well," exclaimed the man, "here comes man's best friend – and look at the big dog too."

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**Inside back cover
***Back cover

SERVOMECHANISMS

(Continued from page 59)

linear boundaries of the system, and which often are unexpectedly violent in their results. A rather minute disturbance in the control system, greatly amplified, can release the full power of a high energy servo at the wrong time with disastrous results.

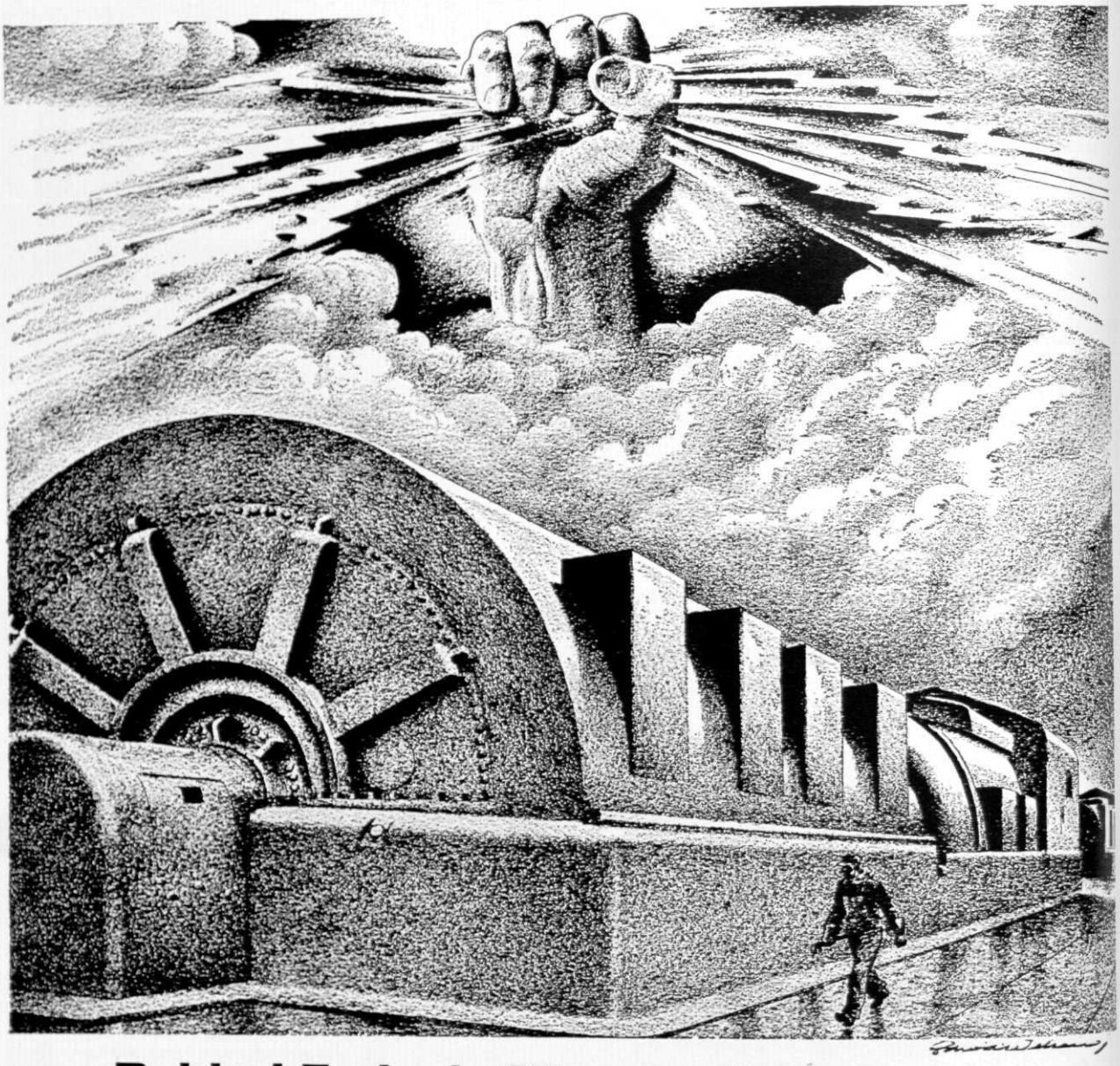
CONCLUSION

We have examined the application of servomechanisms to a few examples with which the author has had some experience. The total number of different kinds of applications now being made is extremely large and grows every day. But perhaps even more important is the application of servo theory to obtain a better understanding of long established systems. For instance, some efforts have recently been made to analyze an economic system on the basis of servo theory with the idea of determining what controls could be applied to damp its oscillations, and maximize its output.

In the field of biology there is growing evidence that muscular control is a servo system; for instance, in reaching to pick up an object, the eye senses the difference between what is and what is desired, and the brain sends an appropriate nerve impulse to the muscles tending to reduce the difference. This system shows many of the outward characteristics which servomechanisms possess; notably a tendency to oscillate, if the gain is made too high. For instance, when concentrating on a delicate operation, a tremor often appears in the hands, that is not normally present. There is good evidence that this is due to an increase in system sensitivity (concentration in the task), to the point of incipient oscillation of the muscular servo system. This is further borne out by the fact that such tremors can be damped by relaxing a bit.

Many other fascinating possibilities appear. In the field of atomic research, there is the problem of performing chemical analyses on substances that are too hot for the operator to even approach, let alone manipulate. The solution of this problem is to arrange a compound servomechanism for manipulating the instruments, and repeating back the pressures, felt by the instruments, the hands of the operator through servo links running in the opposite direction. This entire process is being observed via a television link and sound communication channel so that sight, sound, and feel, can be made at a distance.

But from this we can speculate further. Consider a servo of this type; with the output devices reduced tremendously in scale to where they can be manipulated under a microscope, and the microscopic forces of the output multiplied by the repeatback servos to where they can be felt by the operator. It then becomes possible to perform extremely delicate operations under the microscope; and if carried far enough, one could think of rearranging atoms in a molecule under an electron miscroscope to make special compounds.



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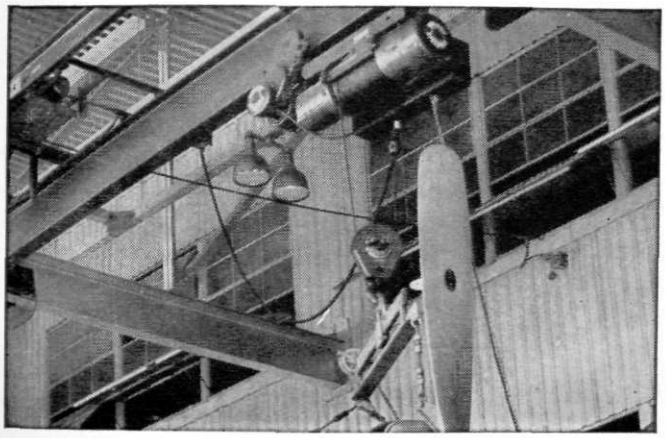
Another page for **YOUR BEARING NOTEBOOK**

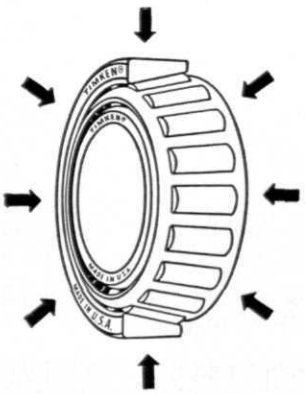
How to keep cranes flying



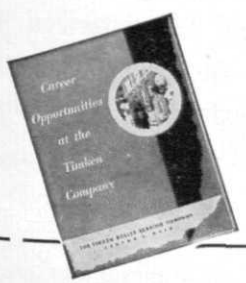
When engineers designed the overhead cranes for the world's largest line maintenance hangar, they faced the problem of taking the enormous thrust and radial loads imposed by swinging aircraft engines. To assure dependability, keep the cranes on the job, and keep the engines moving, they specified Timken® tapered roller bearings.

Tapered design lets Timken® bearings take both radial and thrust loads

Because of their tapered design, Timken bearings can take radial or thrust loads or any combination. And because the load is carried along a full line of contact between rollers and races, Timken bearings have extra load-carrying capacity.



Want to learn more about bearings or job opportunities?



Some 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.

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TAPERED ROLLER BEARINGS

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

NEW DEVELOPMENTS

(Continued from page 40)

the metallizing processes because of their greater resistance to heat and chemical stability. In many cases, the underlying metal actually can be melted without causing coating failure.

The technique of application is similar to that required for the metallizing processes. "Flame Spray Ceramics" are sintered layers of refractory and chemically inert materials, such as aluminum oxide or zirconium oxide.

The spray coatings do not require that the metal or other base be heated unduly—as opposed to ordinary ceramic coatings, which require heating both metal and ceramic to high temperatures.

Since the two basic "Flame Spray Ceramic" coatings —aluminum oxide and zirconium oxide—are stable metal oxides, they cannot oxidize further.

The alumina coating is harder than tool steel and unusually adherent in thicknesses up to about 10 mils. If applied more heavily, residual stresses may cause coating failure on sudden heating or cooling.

The coating appears to be extremely effective for protecting metals, such as steel and even aluminum, against high temperature erosion such as that encountered in rocket nozzles.

The hardness of the coating suggests its use for protecting soft metals—aluminum, die-cast alloys, or mild steel, for instance—against erosion and abrasion in pump impellers and housing, fan blades and turbines, and piping subject to cavitation.

The alumina coating is electrically insulative, and Bradstreet anticipates its use in the manufacture of high-temperature process equipment. The coating is poorly wetted by certain molten metals, and preliminary tests show it to act as a satisfactory permanent mold coating for aluminum casting. In this last respect, the zirconia coating should be even better, since it is more refractory and inert than alumina. Although the zirconia coating is somewhat softer and more difficult to apply, its resistance to corrosion and heat is outstanding.

The coating will find use in rockets, flame ducts, burner equipment, and as a liner for troughs, feeders, molds, and other foundry equipment.

Like all sprayed coatings, "Flame Spray Ceramics" have a residual porosity of about 10 to 15 per cent and alone do not provide perfect protection against chemical corrosion of the underlying material.

However, various additives to the two basic coatings improve their protective action, and this can be improved further by overcoating with recently developed "Solution Ceramics," or by co-spraying with soft metals.

Big Jump in Use of "Throw-Away" Tooling

According to a study just completed by an independent technical research organization, industry is leaning strongly toward the gradual abandonment of cutting tools that have to be sharpened. A survey shows that "throw-away" tools will shortly reach the startling total of 40% of all single-point tools used in metalworking. The present figure is 15 percent.

Chief reasons for the trend appear to be the several indirect cost reductions which throw-away tooling makes possible. Maintenance of extensive and costly tool grinding facilities becomes less necessary. Operators skilled in tool grinding are also getting harder to find and are costly to train. In addition, the throw-away tools require no elaborate setting up on machines. As a result, machine downtime for tool changes is greatly reduced, thus producing major overall economies—particularly on automated or semi-automated production lines.

The survey shows that industry is even more interested in the idea of adapting the throw-away principle on a broad scale to milling cutters and other more complex tools, such as boring tools. This is due to the desire to eliminate grinding—which is even more complex and costly on milling and multi-diameter cutters than on single point tools.

In throw-away tooling, the responsibility for maintenance of tool accuracy "on the job" is passed on to the manufacturers of carbide tooling. Since carbide manufacturers can make the "throw-away" inserts on a mass production scale, they can effectively use high precision automatic equipment to assure a high degree of accuracy on the inserts despite their low cost.

The industries covered by the survey include manufacturers of ordnance, fabricated metal products, machinery – both electrical and non-electrical – and transportation equipment including airplanes, automobiles, etc. Analyses were also made to determine extent of present and future use according to size of plant.

New Reversing Roughing Mill to Use Card Programming and Transistorized Memory Storage for Automatic Operation

A new reversing roughing mill now being completed for Jones and Laughlin Steel Corporation's Aliquippa Works is expected to be the steel industry's first completely automatic card-programmed rolling mill. Its control system will permit an operator to initiate a detailed rolling schedule simply by pressing a push button. By selecting the proper card from several pre-punched for each schedule, it will be possible to attain a definite set of reductions while allowing for variations in temperature and composition among individual slabs.

When in operation in late 1956, the card programming control system will be given the schedule for any set of rolling operations in the form of pre-punched

(Continued on page 75)

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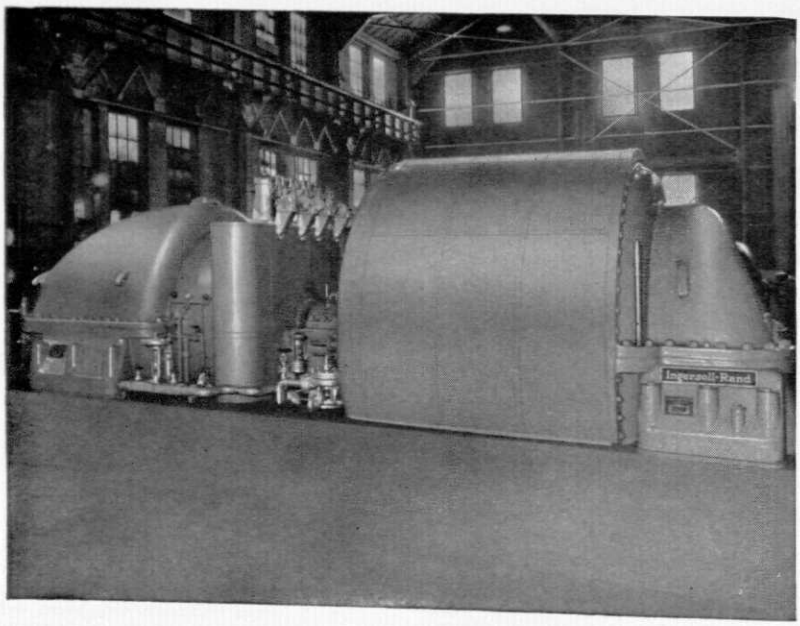
HAND-OPERATED plungers in hollowed-out tree stumps provided a crude but workable source of compressed air for this primitive African iron foundry — marking an early step in the mechanization which permitted man's evolution from the stone age to the iron age.

TODAY *it's the* TURBO-BLOWER...

another history-making development by Ingersoll-Rand



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COMPRESSORS • BLOWERS • GAS & DIESEL ENGINES • PUMPS • VACUUM EQUIPMENT • AIR & ELECTRIC TOOLS • MINING & CONSTRUCTION EQUIPMENT

(Continued from page 72)

IBM cards. These cards can be prepared for practically every slab and strip size and grade of steel so that proper drafts and speeds will produce a product of high uniformity at a high production rate. Each card will include all the requirements of a given schedule: mill screw-down opening, edger adjustment opening mill speed, and edger speed. Also included will be a notation to indicate when the last pass has been completed.

After a stack of punched cards is placed in the IBM card reader, the card applying to the first schedule is read and all information is transferred to a transistorized memory storage element. The mill is then ready to roll the entering slab. Automatic operation takes place when the first pass is initiated by the operator's pressing the pass-advance push button.

As the slab approaches, the control equipment acts through magnetic amplifier output units to preset roll openings and speeds. After one pass, reversing is brought about by sensing devices that read the position of the slab and reverse the rolls after a brief period of slowdown. After all but the final pass, roll openings and mill speeds are readjusted in accordance with the schedule filed in the memory storage element. When the final pass is completed, an indicator light automatically signals the operator at the crop shear that the strip is ready to enter the finishing mill.

The mill will then be preset for the next schedule by pressing the schedule advance push button. Again, a punched card is read by the card reader, its information is transferred to the memory storage element, and the mill is made ready for the schedule required for the next slab.

When completed, the new roughing mill will feed a six-stand continuous hot strip mill. Main horizontal rolls of the roughing mill are 42 inches in diameter and 44 inches wide. Each edger roll is 24 inches in diameter.

The "Sun Sleuth" and Paint

A "sun sleuth" that has kept its automatic eye glued on the sun continuously for two years at Miami, may help unravel the mystery of what some of the sun's rays do to auto finishes. Called a Spectroheliometer, the device recently tracked the sun from dawn to dusk for 8,104 hours, recording the amount and intensity of certain parts of the sun's light that are known to have a weathering effect on paints, lacquers and enamels.

It automatically transfers the "evidence" on graph paper for researchers to study. Data from hundreds of feet of graph lines are still incomplete, but researchers have uncovered some incidental intelligence. For example, the Spectroheliometer indicates the Miami Chamber of Commerce may claim one point in favor of its sunshine. The instrument reports it five times brighter or more intense than Detroit sunshine. Also, a so-called solar "twinkle" appears in Detroit's industrial atmosphere, apparently caused by invisible puffs of smoke floating through the air.

Developed in 1952 the "sun sleuth" underwent a year's trial near Detroit before it was shipped to the Florida Test Field near Miami. So far as researchers know, the instrument has produced the first continuous spectral record of the sun's daily behavior. It was used at Miami to find out first how much sunlight falls on the Florida Test Field in a year. This gave researchers a measurement yardstick for indoor laboratory tests with a so-called "Little Florida" device in which paint samples are exposed to artificial sunlight from a 1,200-watt high pressure mercury vapor lamp.

By knowing how much sunlight drenched Miami annually, researchers could expose paint to similar amounts of intense laboratory "sunlight." In a period of weeks they hope they may duplicate many months of outdoor exposure at Miami, and any speed-up of testing tempo is a research bonus.

Meantime, while the Spectroheliometer was in service, chemical researchers put new auto finish sample panels on exposure racks each month at Miami. This was done to find out how much paint weathering varied from month to month. The amount of weathering on each new panel each month is being correlated with the Spectroheliometer's reports of varying intensities and amounts of the sun's radiation, rain or shine.

Later, a research project was set up to determine how much sunlight varies in amount and intensity from sunrise to sunset through the four seasons of the year. This indicated that at Miami's latitude a paint sample panel in a fixed position took its worst "beating" from the sun either during spring or fall. Meanwhile, studies of all this accumulated information are under way—part of an overall effort to make automotive finishes even more durable than they are today.

The instrument follows the sun's path in the same manner that astronomical telescopes follow paths of the stars. It picks up the sunlight and passes it through a spectrograph. This breaks the light into a color band stretching from the "red" to the "blue" light of the sun's spectrum.

Thermopiles convert five of the various light bands into electrical signals that are amplified approximately 100,000 times so that both amount and energy intensity of each band can be recorded on graph paper.

Introduction of "Lumonics"

New York—Using the same type of radio signal that transmits sound to radio and television receivers, a new multi-purpose lamp has been introduced. The lamp transforms radio impulses into light so brilliant that it is brighter than any incandescent lamp ever devised.

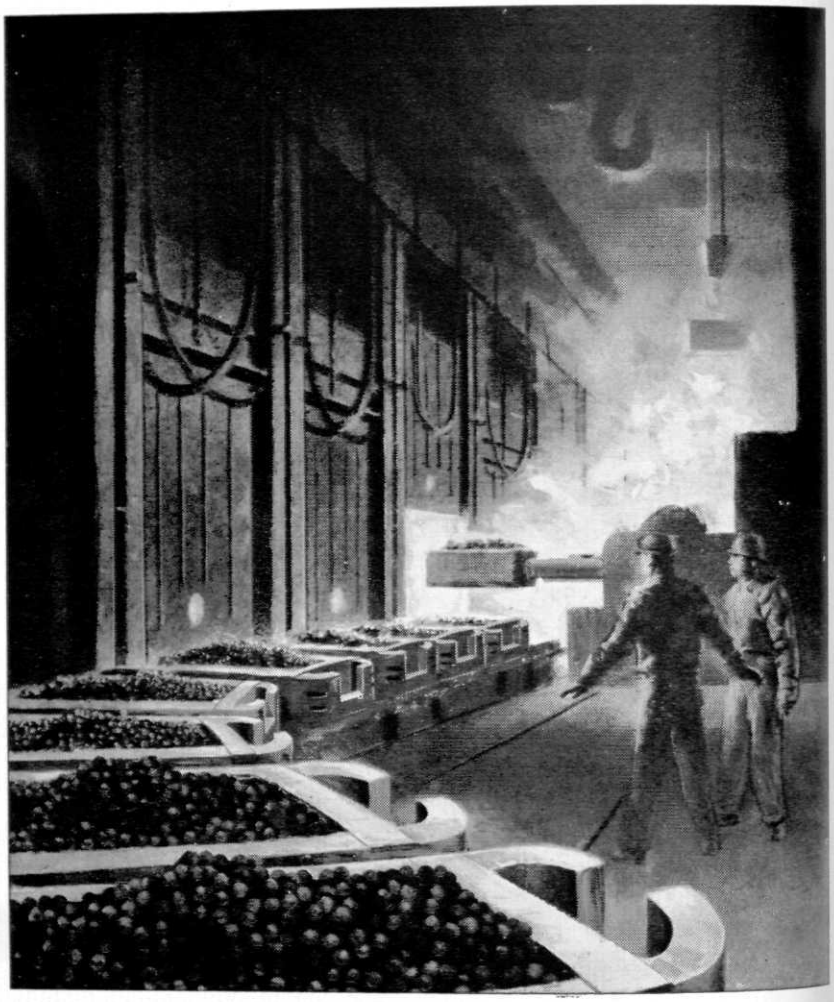
The lamp is not connected by wires to the source of its activating energy. Known as the RF (Radio

(Continued on page 78)

Inco Nickel Progress Report

How Inco's more-from-the-ore research program is expanding North America's natural resources

Once the iron in Nickel-containing pyrrhotite went to slag heaps.



Now this high-grade iron ore—product of Inco research—goes to steel mills. Here you see it being fed into open hearth furnaces.

Now Inco saves iron in Nickel ore from the slag heap

ALSO RECOVERS NICKEL

There's iron in Nickel ore.

But for years, this iron was of no commercial value. No one could find a way to recover it.

Recently, after years of research, International Nickel pioneered a new extraction process.

Saves the iron—

Nickel is recovered, too!

This new Inco process not only recovers iron ore from pyrrhotite *economically;* it is the highest grade iron ore (68% iron) now produced in quantity in North America. It also recovers the Nickel in the ore.

For its pioneering new process, International Nickel has built a $19,000,000 recovery plant. Modern and streamlined, this plant is only the first unit of the new Inco Iron Ore operation. It is expected to add hundreds of thousands of tons a year to this continent's high-grade iron resources.

More from the ore

That's one of the prime objectives of International Nickel's expansion program. As in the case of iron ore, this has enabled Inco to expand the free world's natural resources. Today, International Nickel gets fourteen different elements from its Nickel ores.

• • •

"Mining For Nickel"

Inco's new full-color, sound film! 16mm prints loaned to engineering classes and student technical societies. The International Nickel Co., Inc., Dept. 127e, New York 5, N. Y.

INCO TRADE MARK

International Nickel

Producers of Inco Nickel, Nickel Alloys, Copper, Cobalt, Iron Ore, Tellurium, Selenium and Platinum, Palladium and Other Precious Metals

To the *creative* engineer...

AiResearch two stage lightweight gas turbine compressor provides pneumatic power for aircraft main engine starting and serves as auxiliary power source for a variety of ground and in-flight services.

The rapid scientific advance of our modern civilization is the result of new ideas from creative minds that are focused on the future. Our engineers not only have ideas but have the ability to engineer them into products.

That's why The Garrett Corporation has grown in both size and reputation to leadership in its areas of operation. That's why we are seeking more creative engineers to help us maintain and extend our leadership. If you fall in that category, you'll find working with us fulfilling in stimulation, achievement and financial rewards. In addition, financial assistance and encouragement will help you continue your education in the graduate schools of fine neighboring universities.

All modern U.S. and many foreign aircraft are Garrett equipped. We have pioneered such fields as refrigeration systems, pneumatic valves and controls, temperature controls, cabin air compressors, turbine motors, gas turbine engines, cabin pressure controls, heat transfer, electro-mechanical equipment, electronic computers and controls.

We are seeking engineers in all categories to help us advance our knowledge in these and other fields. Send resume of education and experience today to: Mr. G. D. Bradley

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AIRESEARCH INDUSTRIAL • REX • AERO ENGINEERING • AIR CRUISERS • AIRESEARCH AVIATION SERVICE

NEW DEVELOPMENTS

(Continued from page 75)

Frequency) lamp, it was originally designed by engineers, in cooperation with the Motion Picture Research Council in Hollywood, to overcome a number of motion picture printing problems. The RF lamp can also be used in color television tube processing, medical research, computers, film projectors and many other fields. The RF lamp also permits radar images to be projected on to a screen. This has found immediate application in an air-traffic radar device presently being produced under military supervision.

In this fast moving jet age there is no longer time to plot the location of planes on a large board as has been the practice. Planes now move so fast danger of collision can occur during the time the aircraft are being plotted. With the RF lamp, the radar targets can be projected directly on a ten-foot square screen and the movement of the planes observed immediately. Not only does this mean more safety for the flying public, but the application opens up many useful applications for the military.

This same principle is being applied in medical research. For example, with the use of RF illumination, scientists will be able to project microscope images of tissues on a large screen to determine whether cancer cells are present. The excellent uniformity and brilliance of RF illumination permits more perfect images than were previously possible.

The lamp represents a union of lighting and electronics. It opens the door to an entirely new field which might be termed "lumonics." In the case of the RF lamp, the energy is concentrated into a small disc about 5/16 of an inch in diameter, causing it to incandesce brilliantly.

The RF lamp, which is heated by induction, uses for the light-emitting source a disc of refractory material. Because the refractory material can be heated to a much higher temperature than the tungsten filaments of incandescent lamps, a great increase in light is attained. Also, because of the higher temperature, the light has a higher content of blue than does the incandescent lamp and provides more light emission in the visible range. With the use of a disc, as contrasted with the usual tungsten wire filament, the light from the lamp can be focused directly without complicated optics.

The RF energy is carried to the RF lamp by means of a copper coil wound around the outside of the lamp from a radio frequency oscillator. A DC voltage source is used and the brightness of the lamp can be controlled by varying the voltage. A water line can be connected to the oscillator to cool the lamp and coil.

Wash Day on the Railroads

Every day could be wash day somewhere on the railroads if a revolutionary new theory proves economically feasible.

The theory points to washing rails—with a detergent possibly—to help eliminate one of the railroads' oldest and most expensive problems—slipping of locomotive wheels.

The theory holds that slipping is caused by an extremely thin, practically invisible layer of oil approximately one molecule thick, which spreads itself over the running band of a rail at the onset of rain or when there is dew. Despite its thinness, this "monomolecular layer" can withstand pressures so high (up to 75,000 pounds per square inch) that locomotive wheel loads ordinary used will not break through it.

Suitable rail cleaning holds the promise of fair weather adhesion around the clock every day of the year. If a practical cleansing method can be perfected, the savings to the railroads will be tremendous.

From the earliest days of locomotives pulling trains, the slipping of locomotive wheels has been a problem. Slippery rail conditions often result in stalled trains, overspeeded traction motors, delay, and expense.

At many places on railroad track, accumulations of journal oil can be observed outside the wear band. When the rails become moist or damp, the oil spreads over the rail, pushing the water off. The result is a thin film of oil which causes slipping and often stalls crack trains traveling on grades.

Journal oil, used in the bearings of freight cars, contains some percentage of animal oils which spread rapidly over a polished surface in the presence of a small amount of water. Oxidized mineral oils seem to exhibit the same characteristics as animal oils or fish oils and spread over a polished surface in the presence of moisture.

One drop of oil in the presence of moisture has the ability to cover a surface of five square meters. If tracks were not interrupted by rail joints, this one drop would spread along the polished running part of the rail (5/8 inch wide) to form a slippery film for a distance of two miles.

If the source from which the film spreads is removed, the presence of moisture will no longer cause slipping. Most people have experienced the oil-spreading phenomenon in driving a car on an oil-dripped highway on a rainy day. When the rain first starts, the road is extremely slick. But after the rain has been falling for a while, it isn't nearly as slippery. The steady rain has washed away most of the oil film.

It has been known since the earliest experience with railroads that rails which looked perfectly satisfactory would, with the introduction of moisture, lose adhesion. Even before the turn of the century it was observed that if rain continued, adhesion would be

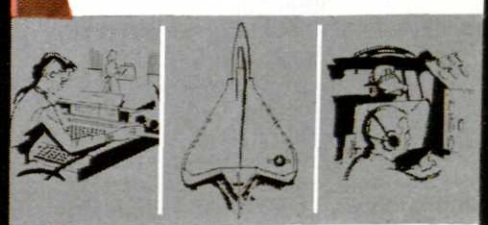
(Continued on page 81)

NPC Die Castings

ALUMINUM
ZINC
MAGNESIUM

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

Assurance of performance in virtually all industries



Excellent Tool-Making Facilities

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

NEW PRODUCTS CORPORATION

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

(Continued from page 78)

restored, but no satisfactory explanation of this was offered.

Cleaning methods now under investigation, in addition to water, include detergents, solvents, open flame, and ultraviolet light. If a suitable cleansing agent is found, much of the sand currently used on locomotives to improve traction on wet days can be eliminated, with the added benefit of a reduction in the drag of the train.

VINYL PLASTIC WALLPAPER

Wallpaper with a vinyl plastic finish promises to foil junior in his attempts to draw a modern-day Rembrandt on your living room walls. The wallpaper is easily cleaned with soap, water and a fine bristle brush if the dirt is especially heavy. Dry cleaner or other chemical bleaches may be used to remove stubborn stains.

The wallpaper is completely saturated with vinyl plastic, which encases every particle of color. This gives a protective shield which renders the wallpaper impervious to penetration by dirt, ink spots, crayon marks, grease spatterings and other stains. Since these marks are stopped at the surface, they can be whisked off with ease.

It can be washed as often as necessary. The plastic resists the effects of soaps and other alkaline cleaning solutions, and the surface does not come off with repeated washings. Special detergents may be used on the wallpaper providing they do not contain any abrasive material. The use of abrasives must be avoided to protect the plastic surface from scratches. Wallpaper cleaner may also be used if you prefer it for ordinary dust and dirt.

Unlike many plastic coated wallpaper products which have a gloss or sheen, this has a beautiful matte finish which is a characteristic of the finest wallpapers obtainable. A certain few have special color effects which are enhanced by a special satiny lustre. It comes in soft pastel tints or in deep decorators' tones and in a wide range of designs for every room of the home.

This wallpaper can be hung like ordinary wallpaper. No special tools or adhesives are needed. It is precision-trimmed with electronic accuracy at the factory, eliminating messy trimming. This makes it much easier work for Mr. and Mrs. Do-It-Yourself if they want to do a professional job.

IMPROVED TRANSISTORS

Transistors recently developed can be used in television, radar, short-wave radio, and other electronic devices where high-frequency requirements have previously called for bulkier vacuum tubes.

A revolutionary new method of producing the crystal "hearts" of such transistors has been developed. When made by a new "meltback" process, the tiny devices can operate efficiently at frequencies five times higher than those of ordinary transistors, and at such high frequencies the new devices show greatly improved power-amplification characteristics.

"Meltback" significantly improves the control of impurities in the thin layers of germanium or silicon crystals from which transistors are made. With this greatly improved control of impurities, crystals can be successfully produced in layers thin enough to meet the requirements of high-frequency operation. Before development of this process, even the best commercially available transistors were not useful for many applications above the standard radio frequencies. Gain characteristics have also improved.

(Continued on Page 86)

"It's quite simple," explained one of the seniors in EE, "to hook up an electric power circuit. We merely fasten leads to the terminals and pull the switch. If the motor runs, we take our readings. If it smokes, we sneak it back and get another one."

° ° °

OHM ON THE RANGE

Opus 314 – In Three Phase Time
Oh give me an ohm
Where the impedances roam,
Where the fields are not fluxing all day,
Where you'll never see
A field without phi,
And the flux is not leaking away.
Ohm, ohm on the range,
Where the flux is not charging all day;
Where never is seen
A shunt field machine
With the armature running away.

° ° °

Pilot to tower, pilot to tower: "Plane out of gas; am one thousand feet and thirty miles over ocean. What shall I do?"

Tower to pilot, tower to pilot: "Repeat after me—'Our Father who are in heaven——'."

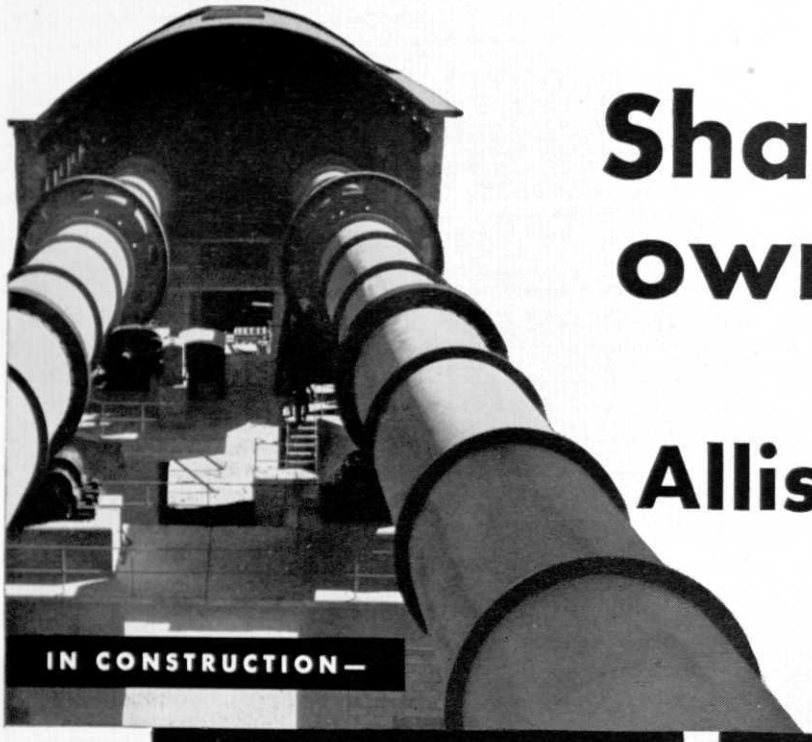
° ° °

Salesman: "Sir, I have here something that's guaranteed to make you the life of the party, allow you to win friends and influence people, help you to forge ahead in the business world, and in general make life a more pleasant and invigorating experience."

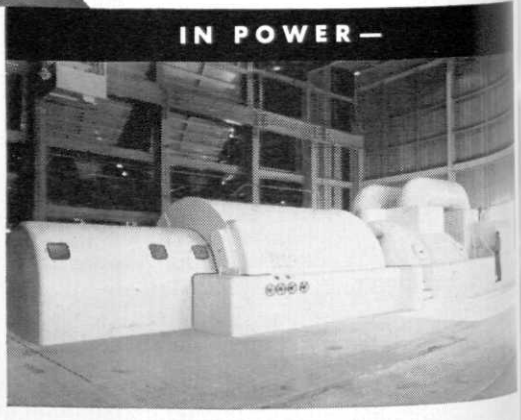
Engineer: "I'll take a quart."

° ° °

Lives there a man with soul so dead
Who to himself has never said
To hell with these studies,
I'm going to bed.



Shape your own future at Allis-Chalmers



• Grow with the world's basic industries! Here at Allis-Chalmers is a range of product applications from earth moving to atomic energy . . . a choice of training assignments...plus professional development and advancement.

Allis-Chalmers Graduate Training Course allows you to develop skill through application of theoretical knowledge. For example:

THERMODYNAMICS—steam turbines, internal combustion engines

ELECTRICITY—transformers, motors, generators

HYDRAULICS—hydraulic turbines, centrifugal pumps

—and many more make up a course designed to develop industrial leaders.

Whatever your engineering goal, there's a place for you at Allis-Chalmers. Find out more from the A-C representative visiting your campus, or write Allis-Chalmers, Graduate Training Section, Milwaukee 1, Wisconsin.

Facts of the Course

The Course—Offers maximum of 24 months' training. Established in 1904. Recognized as a model for industry since that time.

Optional Program—You plan your own program and may revise it as your interests change. Competent counselors are always available.

Objectives—Program is designed to put the right man in the right job and develop men of management caliber.

Results—Many members of Allis-Chalmers management team are graduates of this program.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

5044

I love the ENGINEER
I think it's swell
And every month
I run pell mell
To get my copy
And read each line.
The stories and features
I think are fine
I laugh at the jokes
I read all the ads
I note all the news
And take up all the fads.
When I praise it
I scorn those who laugh
I'm really most loyal
I'm on the staff.

* * *

Their joint account's retarded
By one persistent flaw;
He's fast on the deposit,
But she's quicker on the draw.

* * *

If it's true that women dress to express themselves, some have very little to say.

* * *

YOUTH – When you can be a college track star during the day – but can't go to the corner drug store at night without the family car.

* * *

Bars are something which, if you go into too many of, you are apt to come out singing a few of, and maybe land behind some of.

* * *

Pity the minister who bought an old used car, and then didn't have the vocabulary to run it.

* * *

One lecturer on this campus was so boring in one of his classes that two empty seats got up and walked out.

NEW DEVELOPMENTS

(Continued from page 81)

ELECTRONIC CLOCK

Setting a new trend for time-pieces of the future, the first electronic clock is being introduced by General Electric. The new clock involves unique engineering design, keeping accurate time without a cord or direct electric attachment.

The clock picks up electric impulses floating in the air. It is kept in accurately synchronized time by these impulses, rather than by being plugged into an outlet. It is claimed that no other electric appliance on the market today operates in the manner or makes use of such a cordless electric principle.

WORLD'S LARGEST STEAM TURBINE GENERATOR

The largest steam turbine-generator in the world has been ordered for the River Rouge plant of The Detroit Edison Company.

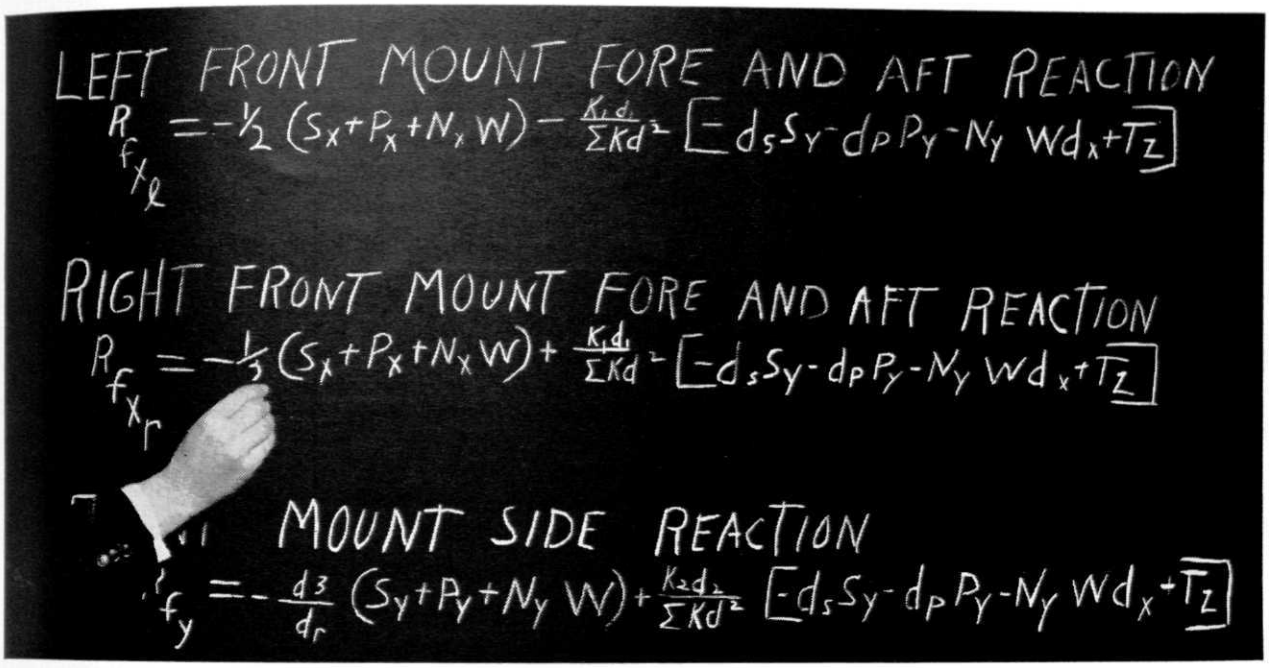
The new unit, one of the most economical ever designed and built, will produce a kilowatt hour of electricty for less than three-quarters of a pound of coal. This coal consumption per kilowatt hour is approximately 30% less than the national average.

The new unit will have a capacity of 300,000 kw and will be capable of supplying the electrical requirements of an industrial city of one-half million people.

The cross-compound turbine will be designed for an initial pressure of 2400 psig and an exhaust press of 1 in. Hg absolute. Initial temperature of 1050° F. and reheat temperature, 1000° F. Both high and intermediate pressure turbrines will be on the 3600-rpm shaft. The high speed generator, which will be rated in excess of 200,000 kva, will have supercharged cooling aplied to both stator and rotor conductors.

A preacher recently announced that there are 726 sins.

He is being besieged with requests for the list, mostly from college students who think they're missing something.



GRADUATE TRAINING AT ALLISON PICKS UP WHERE CAMPUS LEAVES OFF

With the completion of your academic training, you're basically qualified to start your career in engineering.

What then?

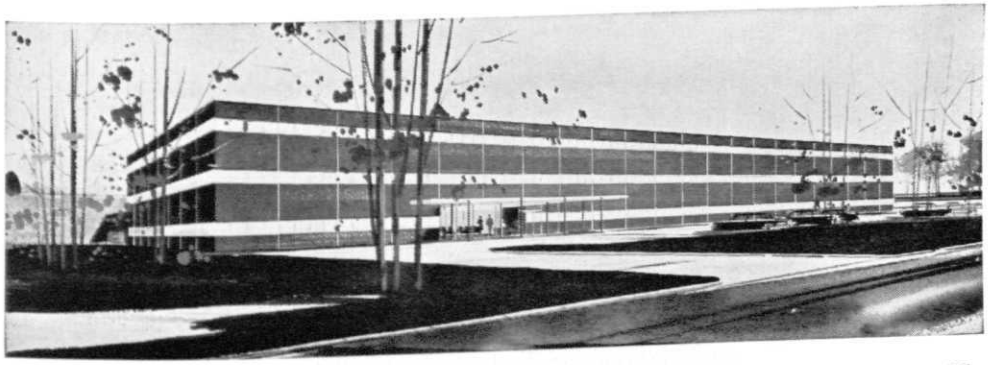
If you plan to go ahead and further your education to prepare for greater things later on you'll be interested in the Allison Training Programs.

Starting your engineering career at Allison, you are given the opportunity to continue learning while you work alongside top-level engineers in the aircraft engine industry.

Should you want to work toward an advanced degree, you can, for we have arrangements with an outstanding engineering school which conducts classes within the plant. You get your Master's degree in engineering while you continue to work and earn.

A variety of refresher courses at college level and other specialized, non-credit courses are always available at Allison. Lectures on curent problems and practices are conducted by prominent university men, consultants and Allison's own specialists in their respective fields.

We'd like to tell you more about the many benefits, advantages and unlimited opportunities awaiting you at Allison. Write for full information: Personnel Dept., College Relations, Allison Division, General Motors Corporation, Indianapolis 6, Indiana.



OUR ENGINEERS WORK HERE

This is our new Administration Building, hub of the new Allison engineering Research and Development Center in Indianapolis.

SIDETRACKED

STOLEN BY FRANK W. BRUTT

Girls are like newspapers. They all have forms, they always have the last word, back numbers are not in demand, they have great influence, you can't believe everything they say, they're thinner than they used to be, they get along by advertising, and every man should have one of his own and not try to borrow his neighbors."

° ° °

Rules for handling women electrically:
If she talks too long – Interrupter.
If she wants to be an angel – Transformer.
If she meets you half way – Receiver.
If she gets excited – Controller.
If she gets up in the air – Condenser.
If she is hungry – Feeder.
If she sings inharmoneously – Tuner.
If she is wrong – Rectifier.
If she is too fat – Reducer.
If she gossips too much – Regulator.
If she wants to get married – Resistor.

° ° °

People are like steamboats – they toot loudest when they are in a fog.

° ° °

C.E.: "She's like an auto radiator."
M.E.: "How's that?"
C.E.: "She'll freeze up on you if you don't keep her filled with alcohol."

° ° °

"Shay lady, you're the homeliest woman I ever saw."
"Well, you're the drunkest man I ever saw."
"I know lady, but I'll get over it in the morning."

"I can't marry him, Mother, he's an atheist and does not believe there is a Hell."
"Marry him anyway, my dear, and between the two of us we'll convince him."

° ° °

A cynic is a person who, when he smells flowers, looks around for a coffin.

° ° °

Oh, Engineers, with hairy ears designing dams and ditches,
Controlling floods and blowing suds and never reaching riches,
When you want fun your tastes don't run to graphs and mathematics,
But to the "Pub" and "Clover Club" and ball-room acrobatics.
You make surveys of waterways, and plan for irrigation
But H_2O to gin that's sloe you add in moderation.
With stress and strains you ascertain the ways to make frames rigid,
Then spend the night till broad daylight in making dames less frigid
Oh, Engineers have hairy ears, I find them most endearing,
But awfully odd, because by God, they don't like engineering.

° ° °

First old maid: "I hate to think of my youth."
Second old maid: "Why? What happened?"
First old maid: "Nothing!"

° ° °

Famous last words: "Hell, he won't ask us that."

° ° °

One thing about sport cars: If you flood the carburetor, you can just put the car over your shoulder and burp it.

° ° °

Soph. – I failed my Physics exam.
Jr. – But I thought you had the answers written on your cuff.
Soph. – Yeah, but by mistake I put on my Calculus shirt.

PHOTOGRAPHY AT WORK—No. 24 in a Kodak Series

They're coming in for a first landing at a "new" airport

American Airlines uses wide-screen color slides to familiarize pilots with every detail in approaching an airport that is new to them

BEFORE an American Airlines' pilot sets his aircraft and passengers down at a new airport, the field and surrounding territory are as familiar as though he'd come in many times before.

As part of American Airlines' comprehensive airport familiarization program, he has seen the field from many directions, many heights. He has gone over the approach to each runway—correlated what he has seen with the radio and instrument aids.

All this is done through color slide films shown on a wide screen to simulate actual vision from the cockpit. American makes one for each airport added to its system. As a matter of fact, American uses similar slide films to train many of its staff—flight engineers, stewardesses, maintenance employees, cargo handlers, line personnel and ticket agents. It means greater efficiency and money saved.

Photography works in many ways to save money and improve operations for all kinds of businesses, large and small. In research, in development, in production, in sales, it saves time and cuts costs.

Behind the many photographic products becoming increasingly valuable today and those planned for tomorrow lie intriguing and challenging opportunities at Kodak in research, design and production.

If you are interested in these opportunities in science and engineering—whether you are a recent graduate or a qualified returning serviceman, write to the Business and Technical Personnel Dept.

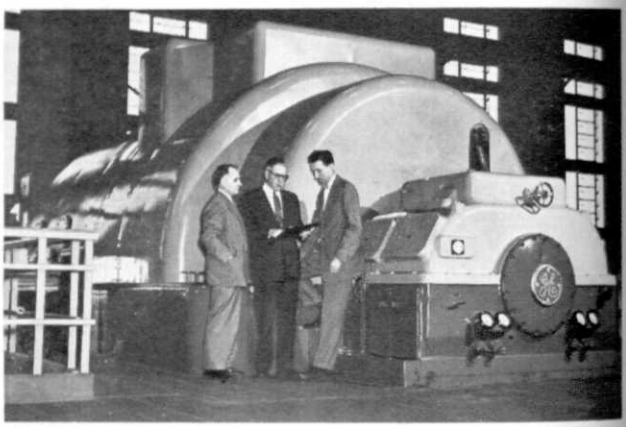
EASTMAN KODAK COMPANY, Rochester 4, N. Y.

Kodak
TRADE MARK

At General Electric . . .

Here's how your engineering background fits you for the broad field of Technical Marketing

IN PRODUCT SPECIALIZATION complete knowledge of certain product lines assures their proper application to best serve the customer's requirements.



IN SALES ENGINEERING lies the prime responsibility for the integration of all sales and engineering activities between General Electric and the customer.

IN HEADQUARTERS MARKETING product planning, marketing research, and sales direction all contribute to successful marketing of General Electric products.

IN APPLICATION ENGINEERING electrical and mechanical components are engineered into the customer's product, power system, or manufacturing process.

IN INSTALLATION AND SERVICE ENGINEERING customer satisfaction is assured by proper installation and service of equipment supplied by General Electric.

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Technical Marketing Program
Building 2 Section 956-8
General Electric Company, Schenectady 5, New York

Please send me your descriptive bulletin on the Technical Marketing Program, GEZ-5158.

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College_____ Degree & Year_____

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