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FEBRUARY

1960

The Wisconsin

engineer

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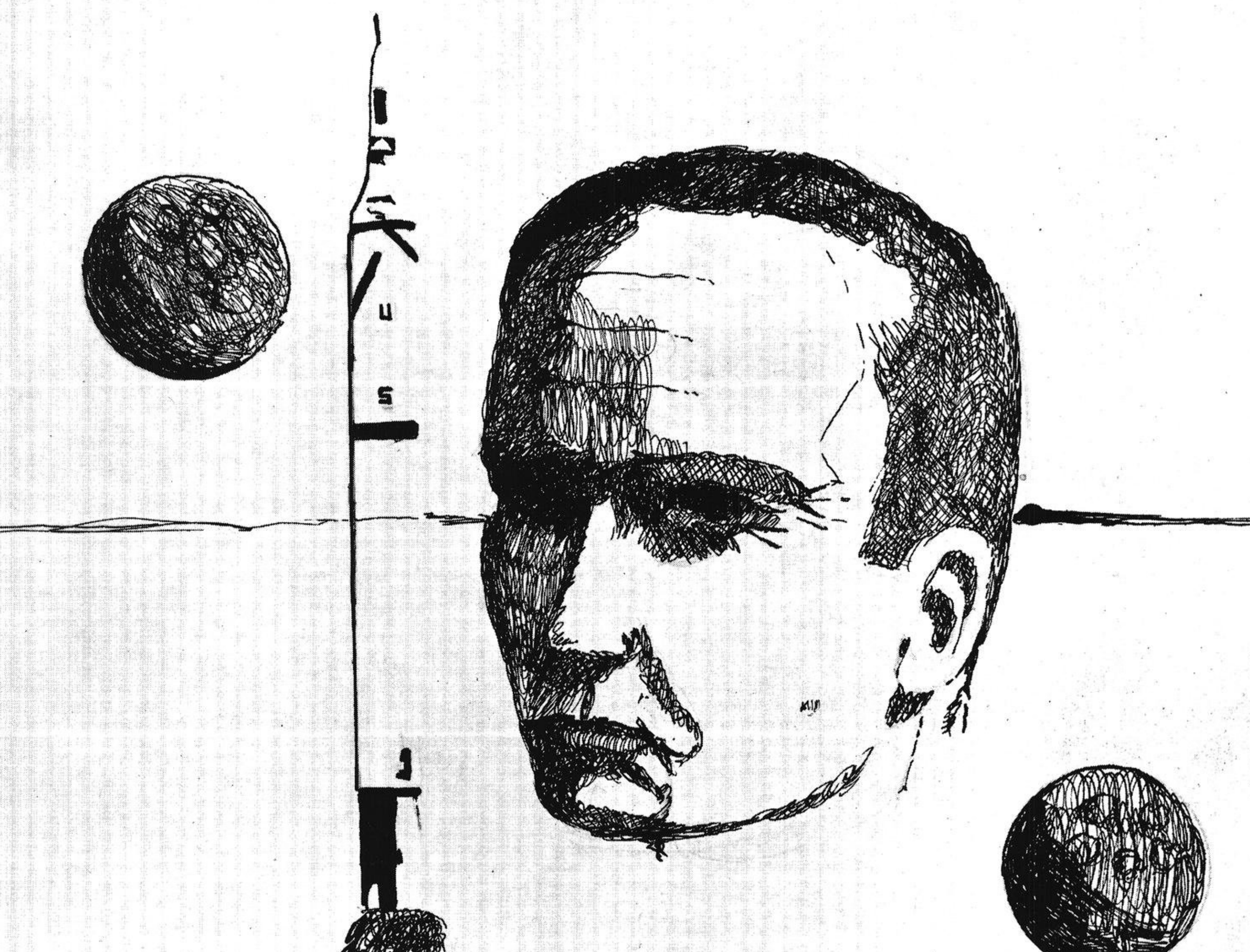

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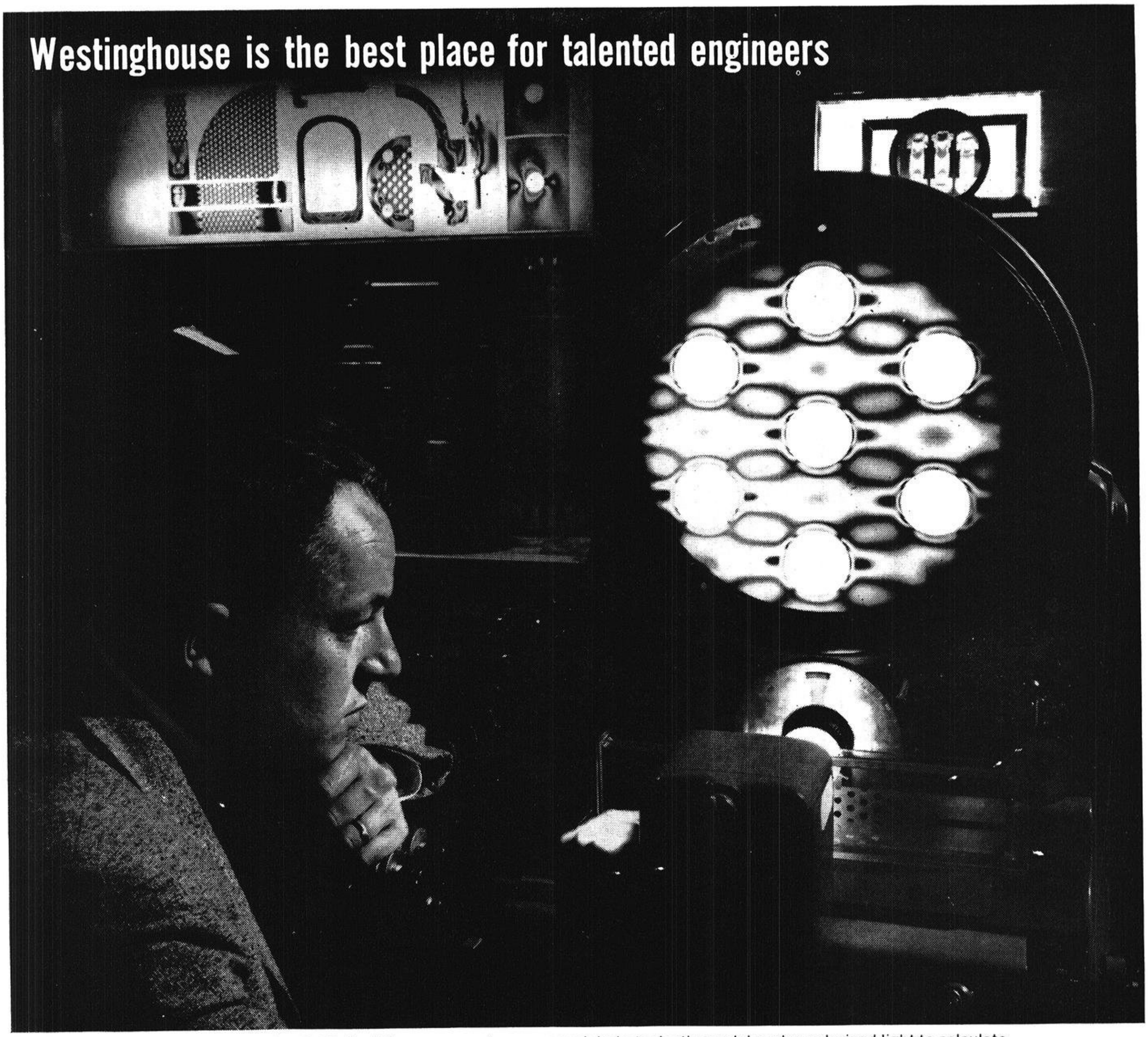

Westinghouse scientist Robert Sampson analyzes a special photoelastic model under polarized light to calculate the stresses which would be built up in an atomic reactor component now in the design stage.

If your design must resist severe stress and shock, the Mechanics Lab can help you

Engineers at Westinghouse can count on the Mechanics Lab for expert advice and help on problems involving static or dynamic mechanics. If an engineer's design must withstand the shock of a missile blast, or the stress in an atomic reactor, the men in the Mechanics Lab will analyze it for him and point out ways to improve it.

This laboratory supplements the work of engineers in all departments at Westinghouse. Its typical activities include studies of flow and combustion, heat transfer, lubrication, stress, and vibration . . . studies aimed at solving today's specific problems, as well as building a store of knowledge for tomorrow.

The young engineer at Westinghouse isn't expected to know all the answers . . . our work is often too advanced for that. Instead, his abilities and knowledge are backed up by specialists like those in the Mechanics Laboratory.

If you have ambition and ability, you can have a rewarding career with Westinghouse. Our broad product line, decentralized operations, and diversified technical assistance provide hundreds of challenging opportunities for talented engineers.

Want more information? Write today to Mr. L. H. Noggle, Westinghouse Educational Department, Ardmore & Brinton Roads, Pittsburgh 21, Pennsylvania.

YOU CAN BE SURE...IF IT'S

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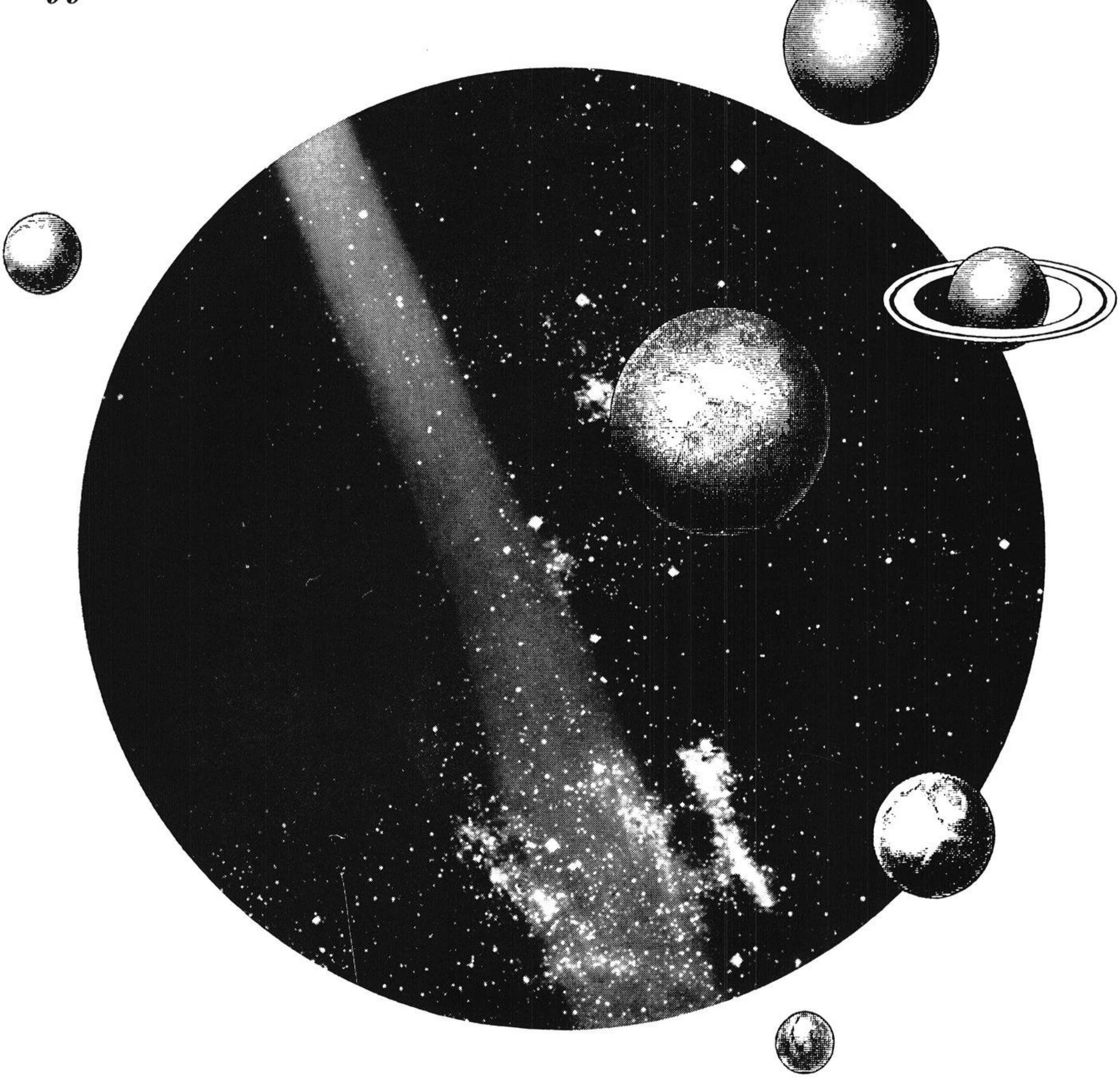

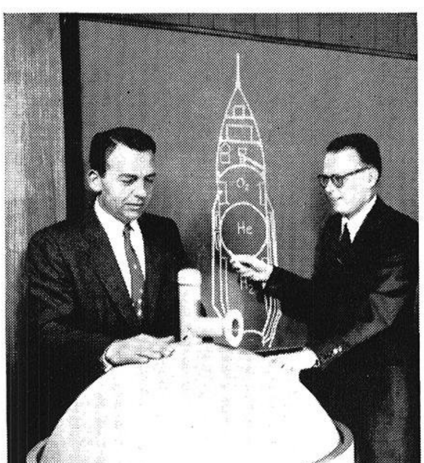

Each 6,000,000 pound thrust rocket ship now being planned for manned interplanetary exploration will gulp as much propellant as the entire capacity of a 170 passenger DC-8 Jetliner in less than 4 seconds! It will consume 1,140 tons in the rocket's approximately 2 minutes of burning time. Required to carry this vast quantity of propellant will be tanks tall as 8 story buildings, strong enough to withstand tremendous G forces, yet of minimum weight. Douglas is especially qualified to build giant-sized space ships of this type because of familiarity with every structural and environmental problem involved. This has been gained through 18 years of experience in producing missile and space systems. We are seeking qualified engineers and scientists to aid us in these and other projects. Write to C. C. LaVene, Box P-600, Douglas Aircraft Company, Santa Monica, California.

Dr. Henry Ponsford, Chief, Structures Section, discusses valve and fuel flow requirements for space vehicles with Donald W. Douglas, Jr., President of **DOUGLAS**

MISSILE AND SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ DC-8 JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND SUPPORT EQUIPMENT

CAMPUS COMEDY

"DEAR SIR: I WANT TO THANK YOUR COMPANY FOR YOUR GENEROUS OFFER, HOWEVER, MY FRIENDS AND NEIGHBORS HAVE PERSUADED ME TO ACCEPT ANOTHER POSITION TEMPORARILY, AND SO....."

Volume 64 FEBRUARY, 1960 Number 5

WISCONSIN ENGINEER

The Student Engineer's Magazine

FOUNDED 1896

Features

Departments

Cover

Moon, Mars, Venus, these and others are within man's reach in the near future. The means of travel may be the rocket ship or may be a new device, as yet unknown to man. But no matter what the destination is or what the means of travel are, there will always be human problems in space flight.

In this issue's cover by artist Kendall Fortney, the planets are within man's grasp, the rocket is ready to take off, but the problems facing man are still there.

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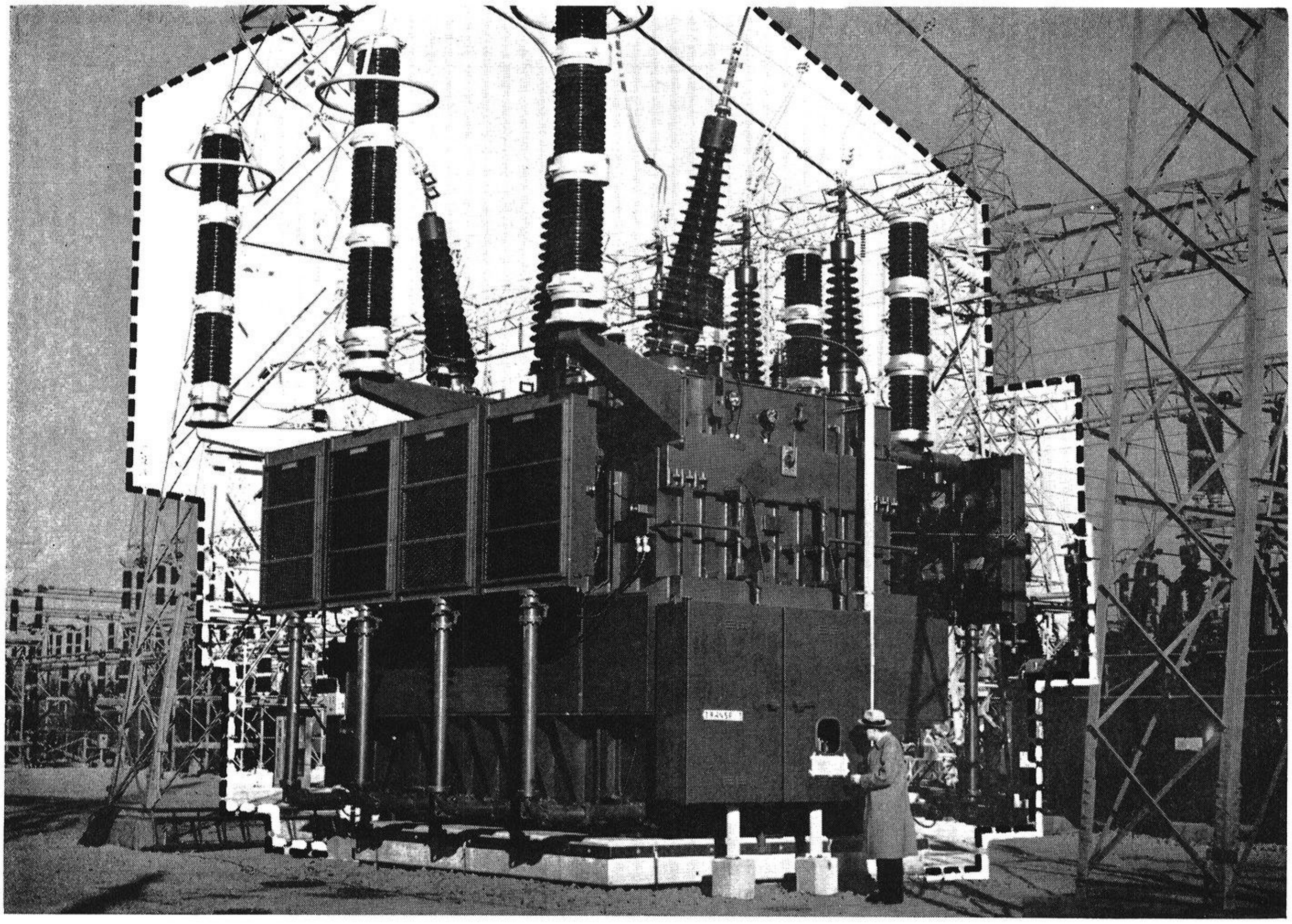


290,000 KVA AUTO TRANSFORMER SERVES 460,000 KVA LOAD

Wisconsin Electric Power Company engineers' specifications for the new 230/138 kv transformer at the Company's Bluemound Substation were reduced from the 460,000 kva (shown in outline) to 290,000 kva as the result of imaginative thinking.

POWER is ENGINEERED for economy, reliability

Wisconsin Electric Power Company engineers needed a transformer to carry a load of 460,000 kva. The unit was to be part of Wisconsin's first 230 kv transmission system from the new 275,000 kilowatt generating unit at Oak Creek. An auto transformer was the obvious choice over a conventional two winding unit. But Company engineers also considered these three factors: (1) the ambient temperature expected in the Milwaukee area; (2) the daily and hourly variation in load expected for the next 15 years, and (3) the use of supplemental cooling equipment. The result was the 290,000 kva unit above. It is able to carry 460,000 kva of load without sacrificing reliability or shortening transformer life.

The electrical engineer plays a vital role in design and development work at Wisconsin Electric Power Company. Progress in power with us may be your key to the future.

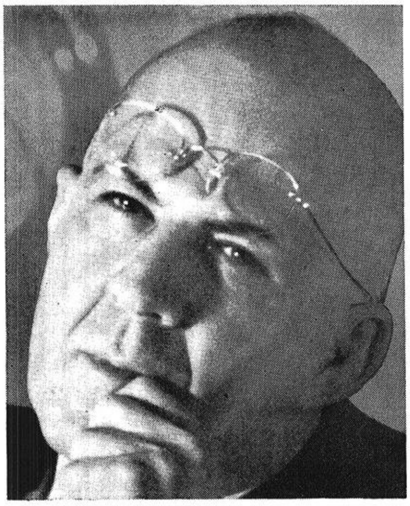
WISCONSIN ELECTRIC POWER COMPANY SYSTEM

Wisconsin Electric Power Co.
Milwaukee, Wis.

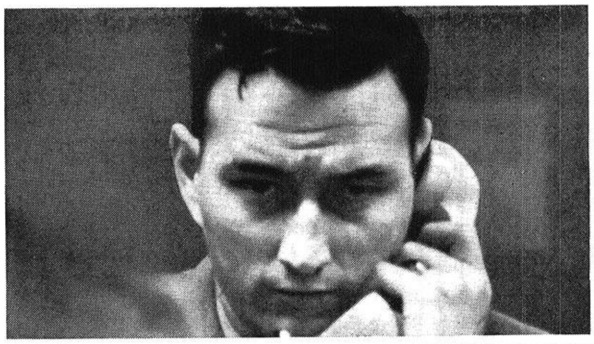
Wisconsin Michigan Power Co.
Appleton, Wis.

Wisconsin Natural Gas Co.
Racine, Wis.

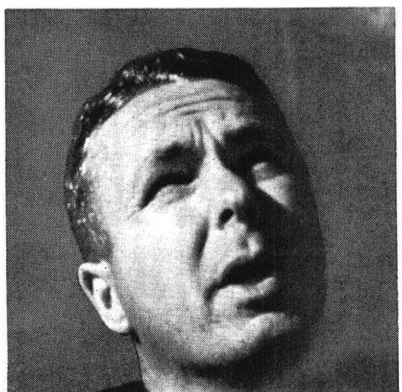
THESE MEN HAVE ONE THING IN COMMON ...BESIDES SUCCESS



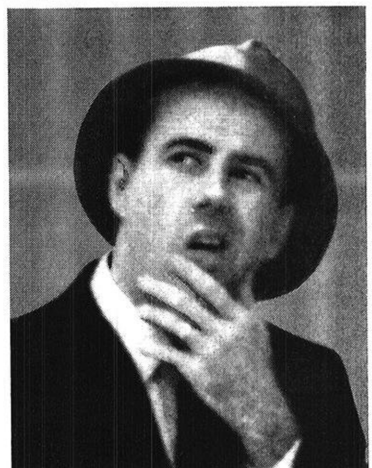
KENT R. VAN HORN, Director of Research, Ph.D., Yale University



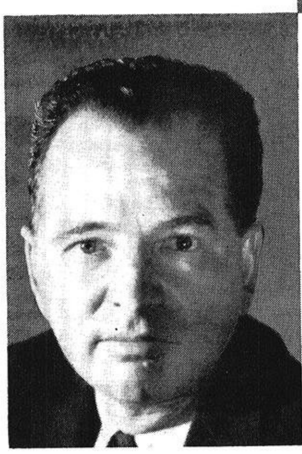
HARRY SUMNER, Sales Engineer, B.S. in Business Administration, University of South Carolina



RICHARD C. WILSON, Assistant Manager of Distribution, B.S. in Aeronautical Engineering, University of Kansas



LAWRENCE M. DUNN, Manager of Automotive Engineering Sales, B.S. in Mechanical Engineering, Iowa State University



THOMAS R. GAUTHIER, Cleveland Works, Chief Metallurgist, B.S. in Chemical Engineering, Iowa State University

GUSTAV O. HOGLUND, Division Chief of Alcoa Process Development Laboratories, B.S. in Aeronautical Engineering, University of Michigan

These men have a faith. An abiding faith. It's in the future of a metal. Aluminum.

They all are department heads at Aluminum Company of America. They all started with Alcoa as young men fresh out of college. They all have prospered as Alcoa has prospered.

They all have received their promotions on merit . . . the same merit which has contributed signally to Alcoa's status as the Twentieth Century's outstanding corporate success story.

Today, the prospects for a new employee at Alcoa are even brighter, even more challenging than they were when these men first went to work. This is because the prospects for Alcoa and for aluminum are brighter.

If a dynamic future in this kind of corporate environment interests you, contact your placement officer to arrange an interview. For more details, write for our free booklet, *A Career For You With Alcoa.* Write Aluminum Company of America, 810 Alcoa Building, Pittsburgh 19, Pa.

Your Guide to the Best in Aluminum Value

ALCOA ALUMINUM
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FOLLOW THE LEADER is no game with Delco. Long a leader in automotive radio engineering and production, Delco Radio Division of General Motors has charted a similar path in the missile and allied electronic fields. Especially, we are conducting aggressive programs in semiconductor material research, and device development to further expand facilities and leadership in these areas. Frankly, the applications we see for semiconductors are staggering, as are those for other Space Age Devices: Computors . . . Static Inverters . . . Thermoelectric Generators . . . Power Supplies.

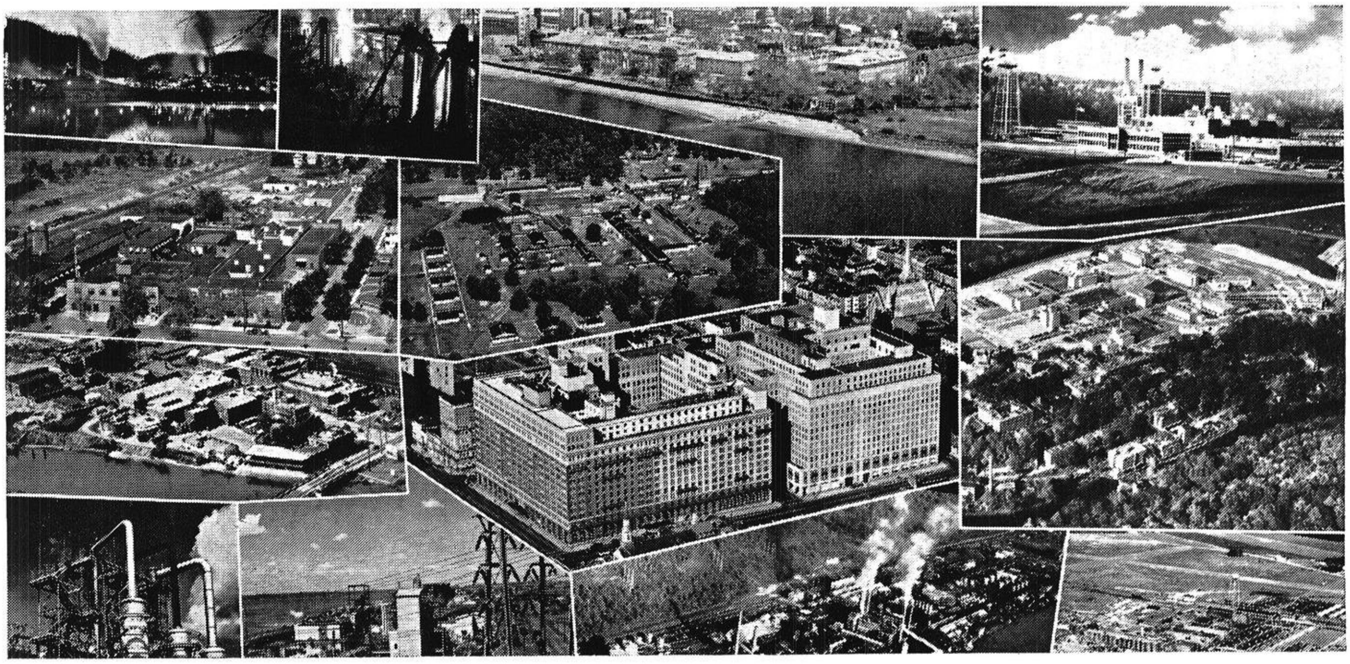
However, leadership is not self-sustaining. It requires periodic infusions of new ideas and new talent—aggressive new talent. We invite you to follow the leader—DELCO—to an exciting, profitable future.

If you're interested in becoming a part of this challenging DELCO, GM team, write to Mr. Carl Longshore, Supervisor—Salaried Employment, for additional information—or talk to our representative when he visits your campus.

DELCO RADIO DIVISION OF GENERAL MOTORS

KOKOMO, INDIANA

Summer jobs often lead to rewarding careers at Du Pont



THIS SUMMER...

ON-THE-JOB TECHNICAL TRAINING AT DU PONT

Pictured are a few of the many Du Pont plants and laboratories across the country where selected technical students roll up their sleeves during summer vacation and put their college training to practical use.

Most of the assignments are similar to work the employees are likely to do after graduation. Next summer, for example, a chemical engineering student may go to work on a catalyst recovery project. A mechanical engineering trainee may become engrossed in a challenging hydraulic study. A promising young chemist may tackle a problem in organic chemistry.

In short, each man is given a regular plant or laboratory assignment commensurate with his education to date. And, as with permanent employees, the student's training is personalized and tailored to fit his background and interests . . . even to the location he prefers, as far as practical.

This program has proved of benefit both to students and to Du Pont. It gives students an opportunity to increase technical knowledge and to learn how to put college training to use in industry. It gives Du Pont a chance to observe men who will soon be graduating in science and engineering. Many of these summer associations are stepping stones to rewarding careers with this company.

Juniors, seniors and graduate students will be given technical assignments. Opportunities are in chemical, mechanical, electrical and metallurgical engineering; also in physics and mathematics. Candidates should write at once to E. I. du Pont de Nemours & Co. (Inc.), 2420 Nemours Building, Wilmington 98, Delaware. Openings are, of course, limited.

There are opportunities also for men who have completed their freshman and sophomore years, as laboratory assistants or vacation relief operators. They should apply direct to the Du Pont plant or laboratory location of their choice.

DU PONT
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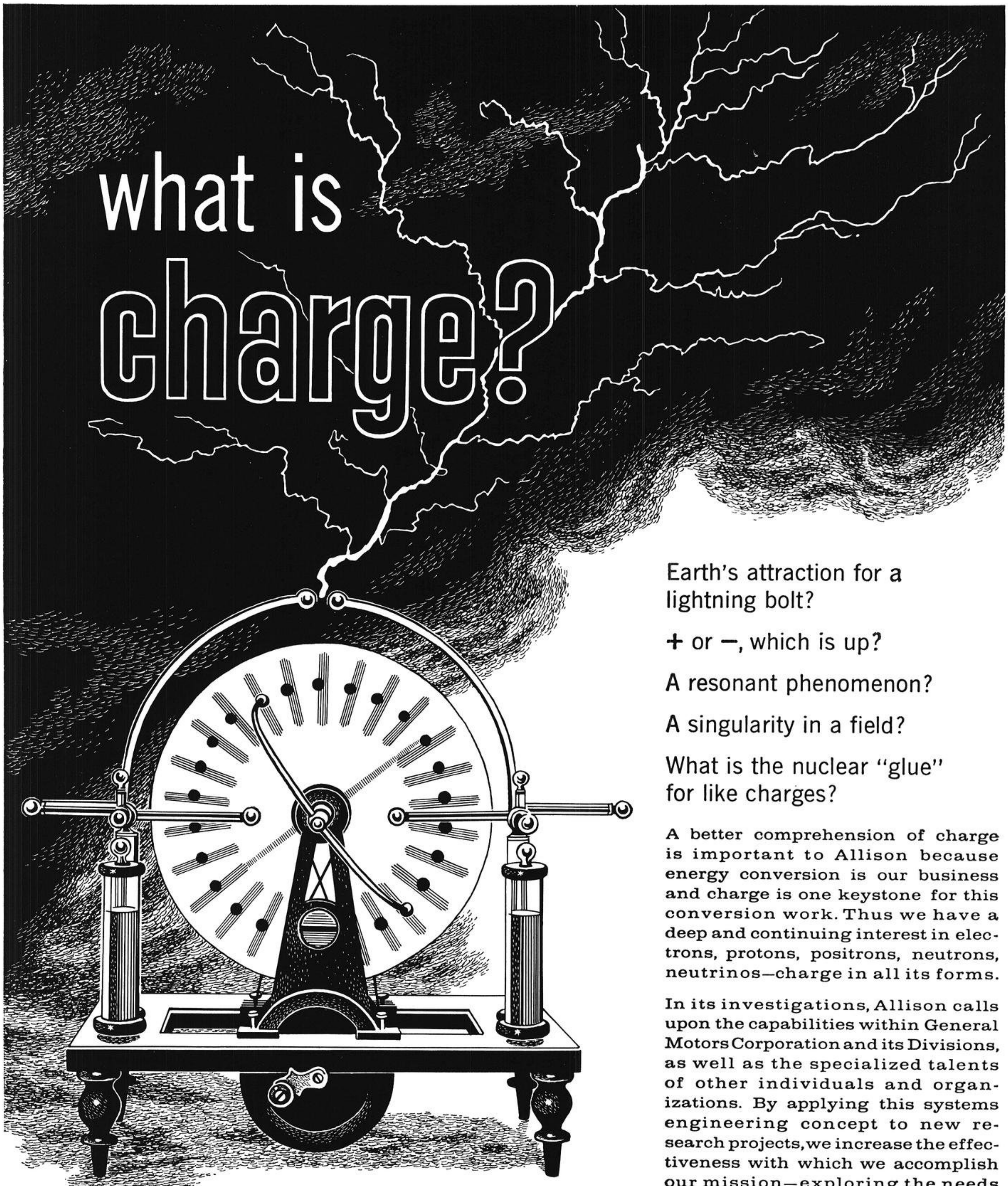
BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*



Earth's attraction for a lightning bolt?

+ or −, which is up?

A resonant phenomenon?

A singularity in a field?

What is the nuclear "glue" for like charges?

A better comprehension of charge is important to Allison because energy conversion is our business and charge is one keystone for this conversion work. Thus we have a deep and continuing interest in electrons, protons, positrons, neutrons, neutrinos—charge in all its forms.

In its investigations, Allison calls upon the capabilities within General Motors Corporation and its Divisions, as well as the specialized talents of other individuals and organizations. By applying this systems engineering concept to new research projects, we increase the effectiveness with which we accomplish our mission—exploring the needs of advanced propulsion and weapons systems.

Want to know about YOUR opportunities on the Allison Engineering Team? Write: Mr. R. C. Smith, College Relations, Personnel Dept.

Energy conversion is our business

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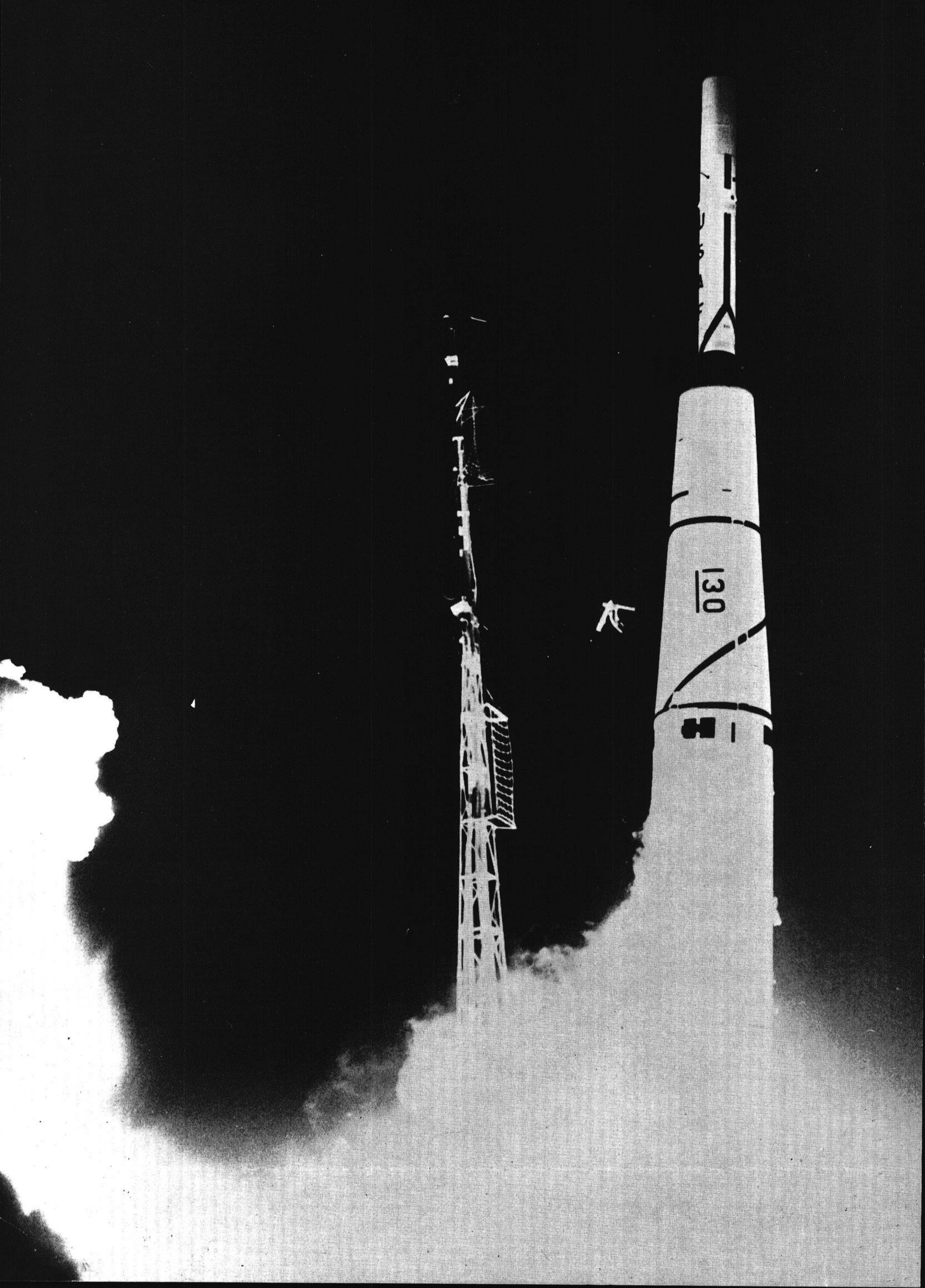
Division of General Motors, Indianapolis, Indiana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Rambling WITH THE EDITOR

Social Regulations May Change

In my rambling this month I would like to discuss some aspects of a problem with which University officials are now being confronted. For many years a few aspects of social regulations have remained tuned to a mid-Victorian social code which is as outdated as hula-hoops and Hadacol. The University Student Life and Interests committee is contemplating changes in present regulations to adjust them to reality.

A proposal by a committee of students representing the Wisconsin Student Association, Interfraternity Council, Pan Hellenic Council, Associated Women Students, Lakeshore Halls Association, the Graduate Club, and independent students has been presented to SLIC and is being carefully studied for possible inclusion in the Student Handbook. The first part of this proposal is designed to define precisely what conduct the University expects of its students. The feeling is that since we follow the civil code in its many aspects of moral and social behavior, a statement that this policy should be followed will establish it as a standard of conduct.

The second part of this committee proposal deals with specific change in regulations concerning chaperonage of social events. The committee in effect advises that chaperones not be required at apartment parties but that chaperones still be required when women visit organized men's living units. While we all recognize the fact that apartment parties have been going on against university regulations, it is not because many are violating the rule that the committee recommends change. To confuse what is right with what is most widely accepted is not the criteria upon which their arguments are based. A major point is that in the vast majority of apartment parties the social and moral codes which we live by are not violated. There is little reason to punish all for the actions of a small minority. Another point is that since this and any rule which is widely ignored leads to a disregard of other rules, the removal of this regulation would lead to more respect for other University rules.

In the case of permitting women to visit men in their rooms in organized living units, there may be reasons for granting this permission. But, many male students feel that it would be an infringement on their privacy to dress and talk as they pleased in their rooms, while the problem of using community showers and lavatory facilities while women were present in a house would remain. These problems would not exist in self contained apartment living units.

One of the issues which the committee has not included in their official report is the rule that prohibits a graduate student resident counselor to chaperone fraternity parties, while housemothers may. It is inconceivable to me, after these housefellows are carefully screened for leadership abilities and high moral standards that they be designated unfit to chaperone a house social event after 8:00 p.m.

The Student Life and Interests Committee has a reputation for being very slow in its decisions. While they are not fast acting nor do they make snap decisions, this is natural in that they are bringing about the change slowly to be sure they are correct in their final action.

Yes, there is a need for review and revision of social regulations. I am sure that SLIC, upon the advice of the student governmental groups, will deem it necessary to take action soon to maintain the University of Wisconsin's fine tradition for student freedom and responsibility.

Donald D. Roeber
Editor

"Five , . four . . three . . two . . one . . fire." These words are heard often at proving grounds around the world as new and more powerful rockets are thrust into the sky to probe the secrets of space. Man may be in one of these vehicles to outer space if the human problems in space flight can be solved.
—Photo Courtesy of Douglas Aircraft

Human Factors in Space Flight

by Kenneth Pfrang

Man is taking great steps in the direction of space flight, but his greatest obstacle is man himself.

HUMAN CAPACITIES

Temperature Variation of Space

MAN has to live under almost ideal conditions, otherwise he can not survive. One of these conditions is the variation in the temperature that he can tolerate. His range is about 150° Fahrenheit. The temperature range that he may have to face in space may amount to several thousand degrees Fahrenheit, depending upon his position in relation to his surroundings. In order to overcome this handicap, the space cabin will have to be either heated or cooled to provide comfort and insure survival.

Oxygen and Hypoxia

Air pressure also has an effect on temperature control. As one travels into space, the atmosphere changes very rapidly. By the time a space vehicle reaches the 34,000 foot level, three-fourths of the total air mass and approximately 90–95 per cent of all the water vapor has been left behind. The temperature decreases at a constant rate of two degrees per thousand feet until a temperature of –55° Centigrade is reached. Almost all weather occurs in the troposphere. Here there is turbulence, icing, and winds that reach velocities as high as 200 miles per hour. The stratosphere, on the other hand, is characterized by having a temperature of at least –55° Centigrade, little or no water vapor, no turbulence, possibly some horizontal winds, but no major vertical disturbances. What, then, are some of the problems rising from these conditions?

Of great importance is the problem of decreasing partial pressure of oxygen with decreasing atmospheric pressure and increasing altitude. At ambient pressures up to 10,000 feet, man can perform reasonably well if he does not stay at that level for more than 4 or 5 hours. Above this level it is important that pilots, crew members, and passengers inhale supplementary oxygen in order to maintain efficiency and to prevent performance deterioration. A condition, known as "hypoxia," results when the partial pressure of oxygen drops below 2 pounds per square inch. The physical and mental capacity of an individual is controlled by the partial pressure of the available oxygen. Hypoxia overtakes one with no warning or pain. There is a gradual decrease in mental ability, and effective physical activity results in fatigue, drowsiness, and sluggishness. Coordination and visual acuteness are decreased. Man loses his most precious asset the ability to analyze and evaluate clearly. An extended period at this altitude will increase the severity of these conditions and produce other more serious and disastrous consequences: nausea, headache, collapse, coma, and finally death.

Altitude	Time of Useful Consciousness
22,000 Feet	7–10 Minutes
25,000 Feet	3– 5 Minutes
30,000 Feet	1 Minute or Less
35,000 Feet	20 Seconds
Above 35,000 Feet	9–12 Seconds

As in other things, there is an individual variation in the amount and extent of disability accompanying a given degree of hypoxia. Adding other factors, such as exercise, carbon monoxide, alcohol, excessive use of tobacco, and heat and cold, compound the dangers.

While pressurization and oxygen systems minimize the danger of hypoxia, there is the danger and hazard of the sudden loss of pressure from the cabin. It is possible to descend to lower altitudes, but even with supplementary oxygen survival is not possible unless the oxygen is delivered under a positive pressure, and even then the human can tolerate only so much positive pressure without counter-pressure.

Psychological

It is a well known fact that when man has long periods of leisure he becomes bored and restless. Repetition of operations plus the unchanging view will also cause extreme boredom. This very thing may happen to the space traveler because he will have little variation during his journey. To overcome this problem, a play and relaxation room will have to be built in the space cabin.

If the space man travels alone he may become extremely lonely. This will have to be overcome by direct contact with the earth and by various other medias like phonograph records or movies. If his loneliness is allowed to continue, the space man is liable to lose his motivation for making the journey, which could be disastrous if he did not watch the operation of the space ship very closely. The result would probably be the loss of his life and all the scientific data that he had recorded. All this can be avoided by surrounding the space man with a healthy and cheerful cabin environment.

CABIN ENVIRONMENT

Temperature and humidity in the space cabin can be controlled by air-conditioning units if a power source and a heat sink are available. The temperature in the cabin will depend on the effectiveness of the air-conditioning system, the thermal insulation, the thermal log, the time of exposure to the sun and earth, and the surface cover of the vehicle. The amount of heat produced by man in the cabin cannot be ignored. Considering that 1 calorie is approximately 4 British thermal units (BTU's), the average 175 pound man using 3,000 calories would give off 12,000 BTU's per day. The total of 3,000 calories per day would include sleep, moderate work, leisure, and programmed exercise. If the heat given off in a day by a crew member were allowed to accumulate, the temperature of a 400 cubic feet space cabin would increase from 12° to 32° Fahrenheit, depending on the activity of the spaceman. At this rate it would not take very long and he would be roasted to death.

Oxygen Variation

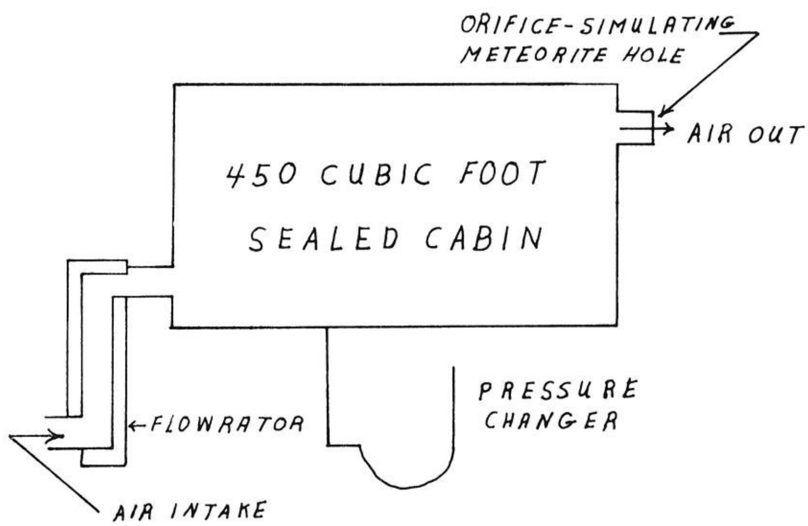
Man can survive for weeks without food, days without water, but only minutes without oxygen. The oxygen is needed by the body cells to support the combustion of food to produce energy. The lack of oxygen results in hypoxia. The 21 per cent oxygen at sea level exerts a pressure of 160 millimeters of mercury and saturates about 95 per cent of the blood. Any increase in altitude produces a corresponding decrease in oxygen pressure which results in a lower oxygen saturation of the blood.

In space flight the amount of oxygen needed depends on the oxygen consumption rate and the duration of the flight. The average man of 175 pounds, using 3,000 calories per day, uses one cubic foot of oxygen per hour or about two pounds per day. As oxygen is consumed, carbon dioxide is liberated. The average 175 pound man would liberate 0.9 cubic feet of carbon dioxide per hour for each cubic foot of oxygen used. At this rate approximately 2.5 pounds of carbon dioxide would have to be removed from the cabin atmosphere per day.

Oxygen originally stored on the space ship could be used to supply the needed oxygen for trips lasting a few months, but flights lasting for one year or more would require a system for converting carbon dioxide back to oxygen. On the earth this is done by photosynthesis, which is the natural way of converting carbon dioxide to oxygen.

Carbon Dioxide

Carbon dioxide will probably have to be removed chemically in the space cabin. This can be done by using the oxide of an alkali metal. Lithium oxide is the most economical carbon dioxide absorber in terms of weight; 700 grams per man per day for carbon dioxide, and 840 grams per man per day for carbon dioxide and water. Lithium oxide reacts with carbon dioxide to form lithium carbonate. The regeneration of lithium carbonate back to the oxide is not considered practical because of the large amount of heat necessary for the conversion. Calcium oxide appears to be a more promising carbon dioxide absorbent since it can be regenerated.



Decompression test set-up. Altitudes of 63,850 feet can be simulated.

Cabin Properties

The space cabin will have to be sealed and separated from the main power unit so heat, noise, and other damaging effects do not reach the crew. The living and working facilities will be determined by the size of the ship and the crew. Up to this point an adequate cabin to serve for space travel has not been built.

(Continued on page 48)

Opposed—Piston Diesel Engine

by Charles Nelson me'60

Its development, design and operation

THE opposed-piston diesel engine was designed to meet Navy specifications of low weight per horsepower and low overall weight in a compact package. This was done just prior to World War II and the O-P engine was used in Navy submarines all during the war. After the war, basically the same engine was sold to industry in locomotives, tug boats, and stationary power systems. It is currently being used in these and many other installations.

GENERAL DESIGN AND CONSTRUCTION

The O-P diesel engine consists of two pistons in each cylinder which work toward each other. The upper and lower pistons drive separate crankshafts which are interconnected by a vertical drive shaft. This eliminates the need for cylinder heads and valves. The engine is two-cycle and the necessary compressed air is supplied by a positive displacement blower driven by the upper crankshaft. Air is admitted to the cylinder by ports in the upper portion of the cylinder and the exhaust gases flow out ports in the lower part of the cylinder.

The cycle begins when the pistons, moving together, have covered the exhaust and inlet ports and compress the air in the cylinder. As the pistons approach the inner dead center, fuel is injected and combustion takes place producing the power stroke. The pistons are now moving apart with the lower crankshaft twelve degrees ahead of the upper crankshaft. With this arrangement, the exhaust port is first uncovered by the lower piston, allowing the exhaust gases to escape. Then the upper piston uncovers the intake port and compressed air from the blower removes what gases are left in the cylinder. The exhaust port is then covered by the lower piston and the cylinder charged with fresh air. The intake port is then covered and compression takes place, repeating the cycle.

Cylinder Block

The main structural part of the engine is the cylinder block. It is made from flame-cut, steel sections that are placed in jigs and welded. The block is then sand-blasted, stress-relieved, and magnaflux tested at all vital points.

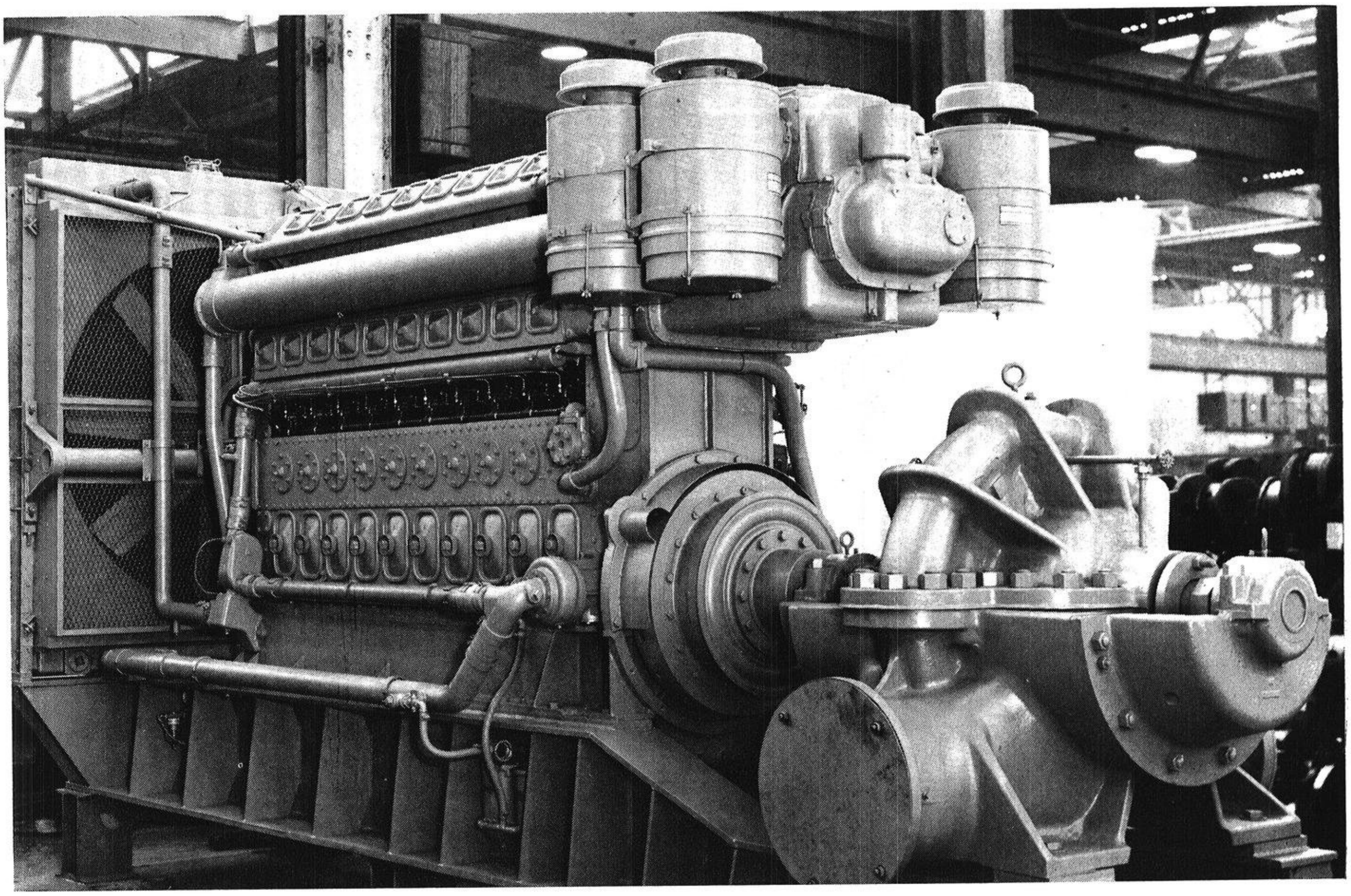
The four horizontal plates are line-bored to take the cylinder liners. The vertical members form the upper and lower crankshaft bearing saddles, camshaft bearing bores and, with the horizontal plates, form compartments for the intake and exhaust manifolds.

Crankshafts—Vertical Drive

The O-P engine, due to its design, needs two crankshafts together with a vertical drive. But due to the timing action required by the O-P diesel engine, the lower crankshaft leads the upper crankshaft by twelve degrees. Therefore, at full engine load, about 80 percent of the total power of the engine is delivered to the lower crankshaft. The power delivered to the upper crankshaft is partially taken by the blower, while the remaining power is transmitted to the vertical drive and then to the lower crankshaft.

The crankshafts are made of high-strength alloy cast iron and are cored for lightness. The main bearings are made of a wear-resistant aluminum alloy and the bearing caps are made of forged steel.

Torsional dampers are used when needed on the crankshafts to eliminate torsional vibrations. Vertical drive torsional flexibility is



A 10 cylinder $5\frac{1}{4}$x$7\frac{1}{4}$ opposed piston engine.

provided by the flexibility of the shaft itself.

Cylinder Liners

The cylinder of the O-P engine is made up of an assembly of the liner and an outer jacket over the combustion space. The liner is made from high strength cast iron and is also chrome plated. The jacket is made of steel for added strength around the combustion area. The upper part of the liner is cooled by the incoming air while the lower part is cooled by water which then goes through the finned center portion of the liner, cooling the combustion area.

Intake and exhaust ports are located around the entire liner circumference. These ports are slanted to give the incoming air more turbulence and provide a better air-fuel mixture. Holes are provided midway of the liner for the fuel injector nozzles and air start.

Pistons and Connecting Rods

The pistons are made from a close-grained cast iron. The concave ends of the two pistons form the combustion chamber as they come together midway in each cylinder. A removable piston pin insert supports the piston pin. This permits a perfectly cylindrical external surface of the piston which adds to its strength. The piston is cooled by the spray of lubricating oil from the connecting rod on the dome of the piston which then flows between the piston insert and inner piston wall.

The connecting rods are drop-forged from high strength steel and are drilled to supply lubricating oil to the piston. A hollow, full floating piston pin is used with bushings and bearings made from a wear-resistant aluminum alloy.

Blower

Since the O-P engine operates on the two-cycle principle, scavenging air is needed to clear the exhaust gases from the cylinder. A positive displacement blower of the Roots type is used in the engine, and is driven by the upper crankshaft. The lobes of the blower are made in a spiral to deliver the air at constant velocity. When operating the engine at partial load, blower output is reduced by an air by-pass valve which minimizes blower power requirements.

During the power stroke, the lower piston uncovers the exhaust port before the upper piston uncovers the intake port. Thus, most of the exhaust gases escape before the scavenging air enters the cylinder. During the compression stroke, the inlet port remains open after the exhaust port is closed. This allows the scavenging air to completely fill the cylinder with fresh air for combustion. This is called positive uniflow scavenging, or air flowing in one direction.

Fuel System

The fuel oil is first drawn from an oil tank by a gear-type pump and delivered through a filter to the fuel supply header on the engine. From there the oil is delivered to the injection pumps located on both sides of the engine. A pres-

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Summer Training For You

Four Wisconsin engineering students present their views on the merits of summer work in industry.

POLYGON Board is beginning a program of increasing the amount of information available on summer industrial experience for student engineers. Accompanying the early spring correspondence of the Engineering Placement Office with the companies who are interested in hiring engineers, will be an information form from Polygon Board. This form contains such questions as company name, services or products, and types of engineers wanted for summer employment. The companies will be requested to complete the form and return it to the Board. The information received will be copied and distributed to the department which it concerns.

In order to give the readers of the *Wisconsin Engineer* some advance information about summer industrial experience four University of Wisconsin student engineers have written the following resumés of their experience.

A Summer . . . In Engineering?

By ROBERT B. OLSON

Two years ago, the question faced me as to what I should do during the summer. The financial picture was such that I could ill afford summer school and I knew that I would have to concentrate on earning some money for the next school-year.

This, I believe, is a common problem with many sophomores and juniors in engineering. The next problem to consider was: Shall I work in my hometown at the place that I worked throughout high school, being able to live at home and consequently save money, or attempt to get a summer job in industry where I might not be able to live at home. This would afford me valuable experience in industry, but at the same time, I might not be able to save quite as much. This problem is one that you have to decide for yourself. I chose to work in a summer engineering training program to help me gain further knowledge of industry and help me plan a specific field in engineering to pursue. At the outset, I must say that I am quite prejudiced on this question and will strongly recommend to any undergraduate engineer that, if the opportunity presents itself, and if he can possibly swing it financially, that he take a summer job in a summer engineering training program. Too many students underestimate the value of the training they will receive, to say nothing of establishing definite industrial contacts and future recommendations. Almost all summer engineering programs carry no obligation with them such as definitely returning to that company for permanent employment. This should, however, be definitely clarified before accepting any summer position. Most companies run their summer program under the premise of letting the student get a good look at their company and the industry as a whole. Also, be resigned to the fact that they are looking

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An Introduction to Commercial Heat Treating

By BOB ONAN

The past two summers were my introduction to industry and to commercial heat treating, a major phase of metallurgical engineering. I was an employe of Metal Treating Inc., a heat treating shop in Milwaukee. The company does a great deal of precision heat treatment such as tool and die work, gears and shafts.

My experiences were of two types: engineering and personnel. Engineering experiences covered a wide range. I was assigned work on furnaces used for hardening, tempering, annealing, carburizing, and carbo-nitriding steels. Starting as a helper to the man in charge of the furnace, I learned from him how the furnace operated, how to control it, what kind of steel could be heat treated in it and how to heat treat those steels. When the furnace operator went on vacation, I was often given charge of the furnace.

The manager also put me to work in the inspection department. All heat treated work is checked for hardness and surface finish before it is delivered to the customers. I operated several different Rockwell machines and a Brinnell hardness tester, learned the art of hardness determination by filing and how to determine a particular steel composition by observing its spark pattern.

Straightening steel after heat treatment is a very important operation, especially where dies and shafts are concerned. The straightener is the highest paid man in a heat treat shop and his work is very much of an art. I was able to assist the straightener at his work and could observe the immense amount of skill required to straighten steel pieces to within ± 0.001 inch.

The plant metallurgist taught me a great deal about atmosphere heat treatment, quenching media, steel microstructures, problems with heat treating particular steels and shapes, carburizing methods, and many of the tricks that only years of experience in heat treating could reveal.

(Continued on page 54)

A Summer Training at Giddings & Lewis

By ROBERT DOUGHERTY

So you've chosen your field? It is satisfying to know exactly what you want and to strive in that direction. If you fall in this category you are a rare and lucky person. It is more probable that you have chosen your field from the context of the engineering college bulletin, the advice of your advisor or fellow engineers, or from professional magazines. It is just as likely that you are a Sophomore or Junior who is plodding along taking the required courses giving no thought to any ultimate specialization simply because you have no basis for such considerations. The way to investigate the many applications of Electrical Engineering with a mind to choosing a field, and specifically what is involved in this field, is practical experience. The means available to students to become exposed to Electrical Engineering in practice is to obtain a summer job in industry.

Most sizeable corporations sponsor some sort of training program for students and many smaller companys are happy to hire students for the summer on informal programs designed to educate. I was fortunate to be employed in the Electrical Research Department of the Giddings & Lewis Machine Tool Company and was amazed at my own ignorance of the progress in electronics. The chores assigned to me were menial but interesting. There were wires to solder in multi-conductor plugs and panels to wire. However, the opportunities to observe Electrical Engineering in action were endless. There was an array of electrical controls there ranging from a simple push button start switch to the room full of panels needed to operate a magnetic tape controlled machine tool. In research, there were tests running on components from a Nixie Light to an electrical memory system designed there. I worked with engineers on these projects and many others, some of which I shall describe briefly. My main function there was simple wiring jobs such as the multi-conductor plug previously mentioned. I also partially

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Chemstrand and Bell Laboratories

By JOHN V. OLSZEWSKI

Summer employment in industry is a vital part of the engineering student's education. In addition to providing valuable experience in industry, it can go a long way to prevent the student from getting a wrong start after graduation. My own summer experience has covered two summers. The first summer was with Chemstrand Corporation which makes the synthetic fibers. The second summer, I worked for the Bell Telephone Laboratories which carries on the research and development for the Bell System and also does much government work in the communications field. From these two work experiences, I have come away with some impressions which I hope will interest you, as an engineering student, in summer engineering work.

The most important benefit, I feel, a student can derive from summer work, is to "find himself." The student can crystallize his likes and dislikes about research, development, or production. He can see whether or not he likes heavy industry, consumer industry, government work, or service engineering in another branch of engineering. It is well worth the investment of three months to find out if you are suited for the work you have been planning to do. If you had made a good choice, you have three months experience in your field and possibly an "in" with that particular company when you graduate. If you made a bad choice and are not interested in your work, you have lost nothing in experience and you will be so much the wiser the next time you interview.

A secondary benefit gained from summer work is an appreciation of how a company does operate, how an engineer fits into that company, the local company politics, and the idea of competition and economy that influences every company decision, to name just a few. Although much of this information will pertain to the particular company, it will add to your experience and

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Isotope Power and Light Units

by Thomas J. Spicher me'60

The nuclear power unit is the answer to man's requirements for a small and light unit to power earth satellites.

THE recent launching of many earth satellites has aroused most of the general public to a greater interest in the technological fields. Space vehicles must necessarily have sub-miniature components in order to decrease the weights of the payload to a practical figure.

Lightweight, long-lasting power units have suddenly become very important. The most promising type of power unit at this time is nuclear powered. Several usable nuclear power sources have been announced to the general public.

Lightweight light units are also being produced with nuclear reactions. These units are self-contained and require no wiring.

Nuclear batteries consist of a radioactive element and an energy converter. The converter determines the efficiency and practical power level of the unit. Radioactive isotopes have high internal energies. This energy is emitted in the form of minute particles usually referred to as rays. The energy content of a certain amount of radio-active material is determined by the amount, half-life, and type of particle emitted.

The amount is measured in "Curies." One curie is that quantity of an isotope that will have a 3.7 x 10^{10} disintegrations per second. Half-life means that period of time required for a given isotope to disintegrate to one half of its original energy. The three particles that may be emitted are alpha particles, beta particles, and gamma rays. The alpha particle is a helium atom nucleus. Alpha particles are positively charged and have velocities from 10,000 to 20,000 miles per second. Because they are in short supply, are very expensive to obtain and have very little penetrating power, they do not currently have much value in the power field. The beta particles are electrons with velocities approaching that of light; these rays have good penetrating powers. The beta producing isotopes are in ample supply and have long half-lifes. The gamma rays have no electrical charge and are extremely hazardous.

TYPES OF CONVERTERS

From the previous description of the rays available, the beta rays obviously are the best choice for power sources. Beta rays in combination with alpha rays would also be very useful, but gamma rays in a source would require much heavy shielding to reduce the hazard. Exposure to large quantities of gamma rays would result in large amounts of tissue deteriorating and might be fatal.

Direct Use of the Beta Ray

The most obvious utilization of a beta source is to direct the electrons through the circuit desired. The efficiency of this type of cell is less than two per cent.

The Thermo-Couple Conjunction

A second method of harnessing the isotope power is by use of thermo-couple conjunctions. When one end of a conductor, or semiconductor, is heated, electrons leave that end more freely than from the other. These electrons tend to travel toward the cold end. Until an equilibrium is reached, this reaction causes an electric current to exist. This is known as the Seebeck effect. A battery of this type could be assembled.

For maximum efficiency the thermo-couples could be made of pairs of P and N type semi-conductors. Each pair of thermocouples could be connected to produce the total battery output. An N type semi-conductor has a current flowing from the hot end to the cold end and the P type has a cold to hot flow.

This type of battery is not constant voltage producing, the voltage will decrease with time. It is not harmed by short circuiting, should be relatively free of vibration damage, and is best suited for continuous maximum current production.

A General Electric battery of this type weighing 25 pounds, using radioactive gold or cerium could supply 100 watts for a year in space environs. As heat resistant materials are developed, the maximum ambient temperature at which the battery will operate could be extended quite high. The lower ambient temperature is nearly absolute zero.

In February, 1959, the Martin Company and Minnesota Mining and Manufacturing Company announced the statistics on a nuclear battery, the result of their joint effort in the nuclear battery field. This nuclear battery is cylindrically shaped, 4.5 inches in diameter and 5.5 inches high. It weighs five pounds and has produced five watts continuously for 140 days with an efficiency of 10 to 12 per cent. The prototype contained 3000 curies in 2/3 gram of Polonium 210. The instrument cost was $15,000 and the fuel cost $10,000 per curie. An estimate of $200 was given for a mass produced instrument cost. A cheaper fuel could be used to lower the fuel cost. The power output of this nuclear battery over a 280 day period would be equivalent to that of 1450 pounds of standard batteries.

The Contact-Potential Cell

If a cell is made of two dissimilar materials, separated by an ionized gas, a current will flow from the less active to the more active material. The gas ionization can be provided by nuclear irradiation. The amount of current varies with the amount of radioactive material used. The open circuit voltage varies with the contact potential difference of the electrodes. If the external impedance is less than the internal impedance, the cell will produce a constant current. This type of cell will always produce a constant voltage, consequently it will be very useful as a reference voltage. Temperature has very little effect on this type. If high accuracy is required, the temperature cell correction is a linear function of 0.00021 volts per degree Fahrenheit. Recent results show that the cell can be constructed to eliminate all temperature caused voltage changes.

The Air Force had a type "E" nuclear battery developed on the contact potential difference basis. This battery is used as a voltage reference source in airborne electrical equipment. It contains ten milli-curies of Strontium 90 for its energy source. The electrodes are aluminum and lead dioxide separated by argon.

The Solid Dielectric Cell

Each cell of a solid dielectric battery is basically a capacitor in which an electrically insulated electrode is in contact with the radioactive substance. This isotope coated electrode serves as one plate and a metal case serves as the other. The particles from the radioactive source travel through the dielectric to the case. This creates a potential difference with values up to about three kilo-volts. This high voltage is accompanied by a low amp reading of 10 to 1000 $\mu\mu$ amps (10^{-11} to 10^{-9} amps).

Patterson, Moos Division of Universal Winding Company developed a cell of the solid dielectric type using Strontium 90. Some of their later findings have shown Krypton 85 to be a suitable and cheaper element to use in this type cell. The krypton can be used in its gaseous form to make the cell safe in case of accidental breakage. If broken open, the krypton would disperse harmlessly into the atmosphere. A cell built with Krypton 85 would cost $5.00 to $6.00 in quantity. It is very reliable and can withstand temperatures from –65° to 200° Fahrenheit. The shelf life is the same as the half-life of the krypton or about ten years. The cell produced by Patterson, Moos is 1-7/16 x 7/16 inches and weighs 22 grams. Even though the current produced is small the batteries could be used for such items as Geiger counters, self-powered transistor systems, timing circuits, and control circuits.

Applications

Most devices are designed to fit a need. In the case of the nuclear batteries the commercial uses are developing as the battery cost decreases and the power output increases. The majority of the batteries have been designed to fit a military use, mostly for space vehicles. Any reduction in weight for power units will benefit the aircraft companies so they seem to be the most direct beneficiaries of the search for better isotope utilization. Mining organizations will also benefit by not having to wire areas with explosive gases present. Since cost is one of the governing factors in limiting the use of isotope power, the following table is given to show comparative cost figures.

Material	Power Watts/Curie	Cost Dollars/Curie
Polonium 210	1.67×10^{-3}	10,000
Strontion 90	1.25×10^{-3}	500
Tritium, H^3	0.03×10^{-3}	100
Krypton 85	1.10×10^{-3}	50

ISOTOPE LIGHTING UNITS

Isotopes can provide a self-contained, wireless, and dependable light source. The light is independent of temperature extremes and requires no external excitation. The isotope can be used as a coating, gas, or solid. The light is produced by exposing a phosphor to the alpha or beta particles emitted by the isotope. The result is a long lasting, very reliable light. The brightness of the light will decrease to one half of its original brightness in one half-life of the material used.

Applications

The military forces have found many uses for the isotope-phosphor lighting, including:

1. Ammunition identification,
2. Personnel identification,
3. Unit identification in combat situations,
4. Signaling system, and
5. Emergency lighting.

Railroad companies are testing self-contained units for warning

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Magnesium Alloys for Elevated Temperatures

by Roger D. Cannell, me'60

By combining magnesium's light weight with the high temperature characteristics present in thorium, an ideal alloy for modern space use is obtained

IF ALL the magnesium in the sea was to be extracted today, it would cover the earth's land area to a depth of six feet. Magnesium has a specific gravity of 1.74, thus making it the world's lightest metal.

The outbreak of World War II brought about a tremendous increase in the demand for magnesium and its alloys. They were used mainly in aircraft in such applications as sand cast wheels and engine parts where their good strength-weight ratio and good fatigue characteristics were important considerations. Some castings and forgings were also in use in airframe structural parts. Formed sheets were utilized for wings, empennage, and fuselage parts.

These magnesium-aluminum-zinc alloys were important during World War II when aircraft operating temperatures were below 300° Fahrenheit. However, today's aircraft operate at temperatures above 300° Fahrenheit and here the properties of the Mg-Al-Zn alloys drop off significantly. Magnesium-rare earth and magnesium-thorium alloys have been developed to operate at temperatures above 300° Fahrenheit.

MECHANICAL PROPERTIES

Ultimate Tensile Strength

Although the ultimate tensile strength is not too important when considering a material for design, the information is given to show the superiority of the thorium alloy HK31A over the Mg-Al-Zn alloy AZ31A and also to compare it with two aluminum alloys.

Tensile Yield Strength

HK31 has a higher yield strength than AZ31A above 375° Fahrenheit, but it is lower than 2024 aluminum over all temperature ranges. So far it would seem to indicate that 2024 aluminum has better properties that HK31A. However, when stiffness and resistance to buckling are taken into account, the disadvantages of 2024 aluminum show up.

Creep Strength

In an application such as a missile, an excessive elongation of a part might cause a malfunction. Therefore, the missile would not accomplish its mission.

A plot of creep strength shows that at 300° F. the thorium containing alloys have about four times the creep strength that aluminum containing alloys do. When temperature ranges of 500° to 700° F. are reached the thorium alloys still maintain from 3,000 to 10,000 psi creep strength. This is important in applications where temperatures up to 700° F. are reached.

Modulus of Elasticity

A comparison of the modulus-of-elasticity values of HK31A and AZ31A shows the superiority of HK31A over AZ31A. The modulus of elasticity is of primary importance in designing for stiffness and resistance to buckling. Both of these properties are proportional to the modulus of elasticity.

Buckling Resistance Characteristics

The buckling strength of a column is proportional to the parameter ET^2; where E equals Young's modulus and T equals sheet thickness.

On the basis of equal thickness the strength in buckling of the magnesium is only about two-thirds of that of aluminum.

However, on the basis of equal weight the magnesium sheet is about 60 per cent stronger than the aluminum sheet through all temperature ranges up to 600° F. This greater strength in buckling of magnesium is of real importance in designing aircraft skin structures.

Stiffness Characteristics

Relative stiffness in a member is proportional to EI. Where E equals Young's modulus and I equals the moment of inertia of the cross section of the piece.

Compared on the basis of rigidity of magnesium-thorium alloys at room and elevated temperature, magnesium is approximately:

Twice as rigid as aluminum
Seven times as rigid as titanium
Sixteen times as rigid as stainless steel

For these examples, width of beam is constant and depth of beam is variable. Relative stiffness versus weight is of the same magnitude of importance today as strength-weight was in design a few years ago when operating temperatures were predominately below 160° F.

FABRICATION AND FORMING CHARACTERISTICS

When considering only machining characteristics, HK31A does not differ from other magnesium alloys; that is, it can be machined readily by almost any type of machining operation. Differences are found, however, in other methods of fabrication.

Sheet Fabrication

Hughes Aircraft Company conducted tests on the sheet fabrication properties of HK31A. They thought that there would be no difficulties encountered with the usual forming methods, provided a slightly higher temperature than that of AZ31 was used.

From the AZ31 forming temperature of 350° F. they had gone to 550° F. but had made nothing but scrap parts. They tried higher forming temperatures. The limitations on their dieheaters would not allow them to get much above 600° F. However, at this temperature they were able to form some satisfactory parts. They have obtained dies that will operate up to 750° F. but none of the results of tests at this temperature are available. Nevertheless, they feel that this temperature will improve forming characteristics of sheet material.

Castings

Magnesium-rare earth alloys in castings generally find their greatest use in applications operating between 350° and 500° F. In this range, they possess good general properties. They can be cast satisfactorily and the castings in use have a good service record. Applications in this temperature range have been primarily on aircraft and missiles.

Magnesium-thorium alloys in sand castings show promise of filling needs of applications up to, and in some cases above 700° F. HK31A is particularly good for short time elevated temperature use where high stresses are encountered. HZ32A is preferred where long time, lower stress properties are important, as its creep resistance is greater over extended periods of time. These castings are subject to very little microporosity. Operating at 700° F., the magnesium-thorium castings find their applications on aircraft and missiles.

Forgings

If a part made by precision forging is to compete with parts machined from bar stock or plate, it must be forgable to such close tolerances that little or no subsequent machining is required. Hughes Aircraft Company ran forging tests on HK31 to see if this were feasible. The results of this test is as follows.

HK31 forging stock was forged between flat dies with the intention of flattening it out to ⅛ thickness. At a forging temperature of 640° F. the edges cracked. Less cracking resulted when a temperature of 800° F. was used, but the best forgings were obtained at 900° F. Hughes decided that at a forging temperature of 900° F. satisfactory forgings could be made, but upon running further tests concluded that the cost of forgings would probably be too high to compete with similarly machined parts.

Joining

Two methods of joining magnesium alloys are used; welding and riveting. Welding is the more important of the two.

Magnesium-thorium alloys are readily welded, but they require about 10 per cent more welding than the other magnesium alloys. At room temperature the weld efficiency ranges from 70 to 80 per cent and at elevated temperatures, above 400° F., the weld efficiency is 100 per cent. A significant characteristic of the welds of thorium containing alloys is the fact that they do not require stress relieving.

Riveting is commonly used to join magnesium. It provides a wide variety of joints with consistently good strengths and high efficiency.

Joints that are welded or riveted are subject to corrosion. A discussion of the protective coatings used on these contacting surfaces follows.

CHEMICAL PROPERTIES AND PROTECTIVE COATINGS

Magnesium surfaces in contact, or magnesium surfaces in contact with other metals provide a great source of corrosion unless adequately protected. While protection is required for satisfactory performance of magnesium itself, the metal to metal contacts are probably the most important in assembly protection. The protection required varies with the severity of the corrosive environment and the metal with which the magnesium is coupled.

Corrosion between various magnesium alloys is negligible. However, Dow Chemical Co. recommends that, for good assembly practice, magnesium surfaces in contact be given one or more coats of chromate pigmented primer. Dow also states that galvanic corrosion between magnesium and dissimilar metals can be prevented by employing the following steps alone or in combination:

1. Protect the dissimilar metal as well as the magnesium.

2. Use dissimilar metals that are compatible with magnesium.
3. Separate the dissimilar metals from each other so that any corroding medium cannot complete on electrical circuit.

Non-absorbent tapes or sealing compound may be used in joints. Fasteners or other hardware that are in contact with magnesium can be zinc or cadmium plated. Any steel that joins magnesium must be zinc or cadmium plated or completely primed prior to assembly and then joined with a gasket between the contacting edges.

Finishing treatment of exposed magnesium surfaces is done primarily for protective purposes and usually consists of a chemical treatment followed by proper priming and painting. Dow No. 17 Anodize and HAE anodize are used on the magnesium-thorium alloys because these treatments are stable to the melting point of the alloys. Paints that are applied over Dow No. 17 or HAE consists of silicones, silicon alkyds, or epoxy phenolics.

Although the thorium containing alloys have properties that are desirable for some high temperature applications, the radioactivity of thorium presents some problems.

RADIOACTIVITY AND TOXICITY

The radioactivity of thorium alloys has been overlooked by some and overemphasized by others. The Dow Chemical Company has conducted many tests in connection with grinding, welding, and storage of the material and have recommended keeping exposure within safe limits by:

1. Following normal dust control precautions to avoid fire hazard in grinding.
2. Using local exhaust systems in welding.
3. Limiting the size of indoor storage racks to 1000 cubic feet.
4. Maintaining suitable aisle widths in storage areas.

The Los Angeles County Health Department in conjunction with Hughes Aircraft Company conducted an investigation of Hughes facilities. They had been exposed to thorium alloys through grinding, welding, chemical processing, and storage. Their findings tend to verify Dows results, except that a high concentration af alpha, beta, and gamma emitters were found in the coating removed during heat treating and aging.

After analyzing the results of the investigation, Hughes concluded that the Dow recommendations would provide adequate protection provided a suitable means of collecting wastes such as metal turnings and grinding dust was used. Hughes is continuing their investigation until all doubt of the ill effects of radioactivity on personnel and equipment is removed.

THE END

SCIENCE HIGHLIGHTS

Donald Norris ee'60

THIS month's column features an article on a new type of paint which may find widespread application in rocket motors as well as other high temperature surfaces. Other items of interest are the production of microminiature lamps and a TV picture freezer which can hold a picture for as long as ten minutes. Another article discusses the "gasoline bricks" used by the Russians during their exploration of the Antarctica.

NEW COATING MAY HELP SOLVE ROCKET PROBLEMS

"Thermo-lag," a revolutionary new product has been selected after exhaustive tests by the National Aeronautical and Space Administration for use on test capsules for the man-in-space program. Numerous applications of Thermo-lag presently under advanced testing include the Minute-Man inter-continental ballistic missile, the Polaris submarine-launched ballistic missile, the Samos satellite, and the X-7 hyper-velocity research vehicle.

Thermo-lag is the name given to a revolutionary new family of compounds applied like paint that reduce and control the temperature of materials or instruments subjected to intense heat. It works on a completely different principle from any other material currently in use for this purpose.

It dissipates heat by vaporizing in the same manner that dry ice vaporizes. It is this process, known as sublimation, which makes Thermo-lag so effective and so different from any other available process or material.

Sublimation is the name used to describe the phenomenon of evaporation of a solid directly into a gas. The phenomenon takes place at a certain temperature which remains steady regardless of the rate of heating encountered. With Thermo-lag, this temperature can be accurately predetermined over a wide range of values.

Consequently, Thermo-lag can be prepared not only to provide protection from heat, but to keep the temperature of the object being protected at a specified temperature. It can also be tailored to meet virtually any anticipated heat control condition.

Although Thermo-lag has many commercial possibilities, it was developed primarily to keep the structures of missiles and space craft relatively cool while they are being exposed to a heat environment of thousands of degrees. It additionally is a means of greatly reducing the weight of rocket motors, either by permitting the use of less metal or by making it practical to use lighter structural materials while maintaining the same structural strength. While many techniques have been developed for this purpose, they have all proved to be relatively too costly, too heavy, or too difficult to apply.

Unlike other similar materials, Thermo-lag requires no adhesive or bonding material but bonds itself molecularly to the material to which it is applied. Since it is simply sprayed or brushed on, it can be applied to any shape structure and requires no expensive molds or forms. Tests so far indicate that it can be applied to virtually any material.

Thermo-lag is being used as a protective coating on the man-in-space Little Joe capsules now being tested by NASA at their Wallop's Island test station. It has also been used on their Cajun research vehicle. Tests are under way at the McDonnell Aircraft Company to investigate the use of Thermo-lag as a protective coating on the Project Mercury man-carrying capsule.

MICROMINIATURE LAMP IN PRODUCTION

The smallest incandescent lamp ever produced on an assembly line has recently been placed into production. The lamp is small enough to pass through the eye of a darning needle. The new microminiature lamp, called the Mite-T-Lite, has immediate applications in transistorized circuits in missiles, computers, and electronic systems. The development of techniques making mass production of the lamp possible represents a significant step forward in the trend towards microminiaturization. These production techniques open new horizons in providing the smallest possible incandescent light source at the lowest possible price.

It is expected that immediate additional applications will be found in airborne electronic systems, high speed punch-card and tape readout devices, compact matrix displays, photoelectric logic systems, other microminiature circuits, and in the jewelry and decorative arts fields.

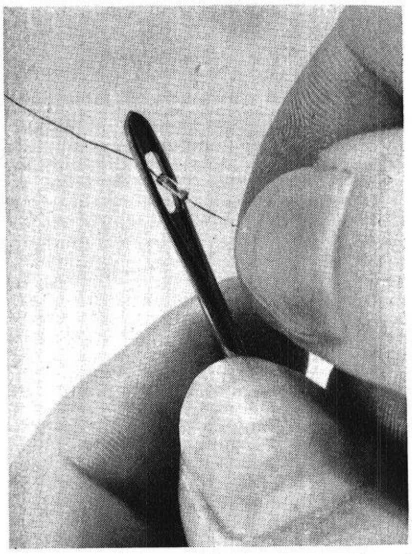
The body of the lamp is cylindrical with a nominal diameter of 0.040 inches. Nominal body length is 0.125 inches. The lamp leads are platinum with a diameter of 0.005 inches. The filament is 0.00025 inch tungsten wire of approximately 30 turns. The diminutive lamp can be seen in a normally illuminated room. Its light output is in the order of 100 millilumens at 1.5 volts input. The efficiency of the lamp is approximately 1.5 lumens per watt.

The very low current and voltage requirements of the lamp immediately suggest uses in indicating devices in portable equipment operating from batteries. Because it can be operated directly from the output of a transistor, the Mite-T-Lite will be used in many display devices consisting of a matrix of many lamps for such purposes as computer readout displays and arrays for animation. The lamp's compactness permits its use as an indicator device in push buttons and other visual signals.

The lamp's tiny filament is less than one-tenth the diameter of a human hair and the light source has low thermal inertia and can be modulated at a rate of more than 100 times per second. This characteristic will allow the lamp to be used in signalling devices incorporating photo tubes and photo diodes.

GLYCERINE HAS ROLE IN I.G.Y.

Detailed information on the famous "gasoline bricks" carried by the Russians on their International Geophysical Year Expedition to Antarctica shows glycerine to be one of the ingredients in their formulation. Developed at the Institute of Fuels of the U.S.S.R.'s Academy of Sciences, the bricks, bright yellow in color, are a highly concentrated solid emulsion consisting of 95 per cent gasoline



The world's smallest mass produced incandescent lamp passes through needle eye.

trapped in honeycomb-like cells. The emulsion material, a distilled water solution of glycerine, ammonium chloride, casein, and polyvinyl alcohol, is combined with the gasoline by mechanical and ultrasonic-wave agitation for 5–6 minutes. After addition of a 20 per cent formaldehyde solution to further increase the viscosity, the mixture is allowed to thicken. It is then pressed into long strands, cut to the desired briquet shapes and dried. Before use, the bricks are transformed back to liquid with a specially designed machine that breaks up the solid and squeezes the gasoline from the honeycomb cells of the emulsion. The Russians report that gasoline losses are less than three per cent.

PICTURE FREEZER FOR TV EDITING

A video picture freezer which instantly stops TV picture action and holds the frozen image on its screen for as long as ten minutes is now available. The new storage monitor is equipped with a five-inch Tonotron tube, which can display a continuous television picture, and "freeze" the action at any desired time.

The storage monitor has a varied range of applications, including:

1. Video tape editing. The monitor can be used as a key unit in the design of advanced video tape editing systems.

2. Surveillance. Closed-circuit TV surveillance in industrial plant protection, as a deterrent against shoplifting, and as an aid in general law enforcement.

3. Sports. Quick determination of pertinent actions in sporting events by providing an instant frozen picture of race finishes, winners, accidents, and rules infractions.

4. Teaching. Closed-circuit "on the scene" TV classroom instruction. Ideal for capturing pertinent moments in medical and dental operations and demonstrations, thus permitting elaboration by the lecturer.

5. Fluoroscopy. Capable of storing images where short-burst fluoroscopic X-ray techniques are used, further aiding in reducing patient irradiation dosage. Image available for immediate examination.

The storage monitor can be connected directly to a closed circuit television camera, video tape recorder, or other video signal source. The device will monitor the picture until the store switch is manually or automatically actuated. This instantly freezes the action, until normal picture action is again started by using the monitor switch.

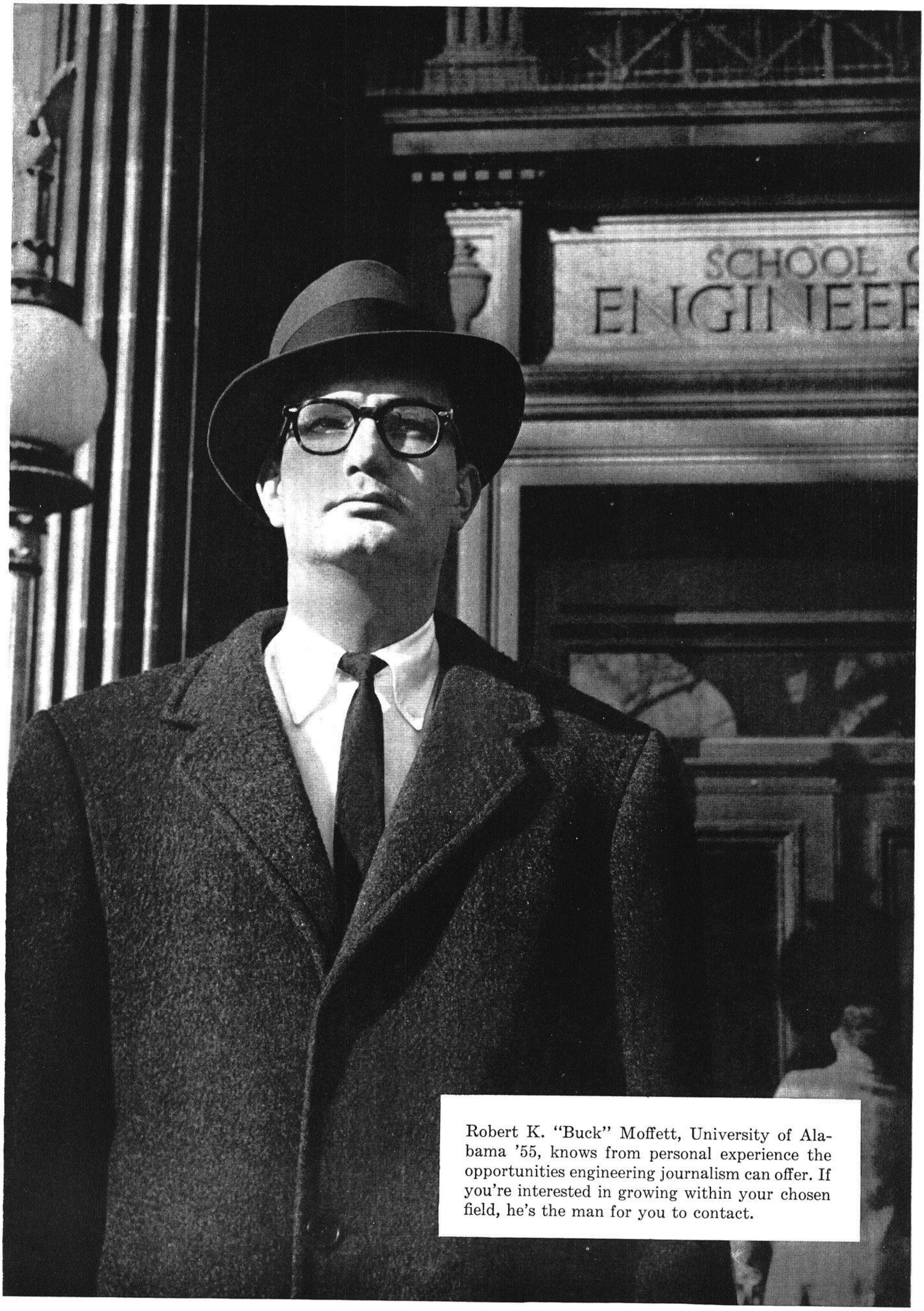
INSULATION TO 'PAINT OUT' ELECTRIC ARCS

A new insulation that can simply be painted or sprayed on electrical equipment subject to high-voltage discharges that cause the rapid breakdown of conventional insulating materials has recently been developed. The new insulation dries to form a smooth and attractive painted surface and, at the same time, gives standard insulating materials as much as 300 times more resistance to breakdown by electrical arcing or "tracking."

Tracking occurs when electricity skips across the surface of electrical insulation, causing a short circuit. This is a serious problem in power-handling electrical apparatus and is most acute when moisture or dust contaminate the surface of an insulating material.

These contaminants are the origin of tiny individual electric arcs which cause hot spots on the surface of the insulation. Under this heat and electrical pressure, ordinary insulating materials tend to 'unlink.' That is, their large complex molecules break down into simpler ones, finally depositing car-

(Continued on page 63)



Robert K. "Buck" Moffett, University of Alabama '55, knows from personal experience the opportunities engineering journalism can offer. If you're interested in growing within your chosen field, he's the man for you to contact.

"we need...

men who can write . . . or learn to write; cover fast-breaking news around the world; develop into editors running top business and engineering magazines."

ROBERT K. MOFFETT
Assistant to the Editorial Director
McGraw-Hill Publishing Company

"Buck" Moffett is looking for engineering graduates who can come up as fast in business and technical journalism as he did himself.

Buck was trained on *Business Week*, *Factory*, and *Fleet Owner*, handling everything from rewrite to field assignments. With experienced McGraw-Hill editors to show him how, he rose rapidly from trainee to assistant editor to associate editor to managing editor of *Fleet Owner*.

Now Assistant to the Editorial Director of McGraw-Hill, he's looking for engineering graduates who want to rise to the top of their industry—in publishing.

This is no job for the engineer who wants to spend his life in a corner on one part of one project. You work with the new . . . the experimental . . . the significant.

It will be up to you to interpret today's advanced developments for thousands of readers. Whichever McGraw-Hill magazine you're assigned to, an industry will be looking to you for the word on the latest in that field—and what it may mean.

In line with this, you may also be interested in the McGraw-Hill Tuition Refund Plan. All of our editors have the opportunity to continue their education in their chosen fields. The company pays half the cost. Physics, economics, aerodynamics—whichever will help you go the furthest in your career.

Is writing experience required? It helps, but if you like to write—and engineering is your profession—that's the main thing.

Buck Moffett will cover as many colleges as he can in person. Ask your placement director when he'll be at yours. If he hasn't been able to get your campus on his itinerary, write direct. Tell us about your background, college record, outside activities and why you would be interested in a career in engineering journalism.

Write to: Assistant to the Editorial Director, McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York 36, New York.

McGraw-Hill
PUBLICATIONS

MCGRAW-HILL PUBLISHING COMPANY, INC., 330 WEST 42nd STREET, NEW YORK 36, N.Y.

Happy Birthday

Meet Helen Berghoff, our addition to important birthdays in February. Sharing the month with names like Lincoln and Washington, she admits, is fun, but we refuse admission to these pages to ex-presidents.

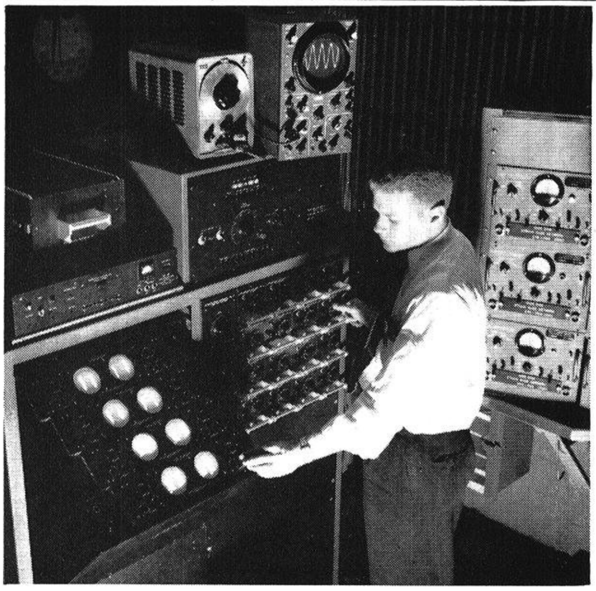
Helen is a senior English major whom we met in the middle of the English Renaissance (English 160) and questioned about appearing here. Following an interchange of questions, answers and promises, came a valuable shooting session.

Helen likes to travel. "I've been to Europe," she said with an I'd-like-to-go-again smile. Classical music, good books and sports car driving are other hobbies.

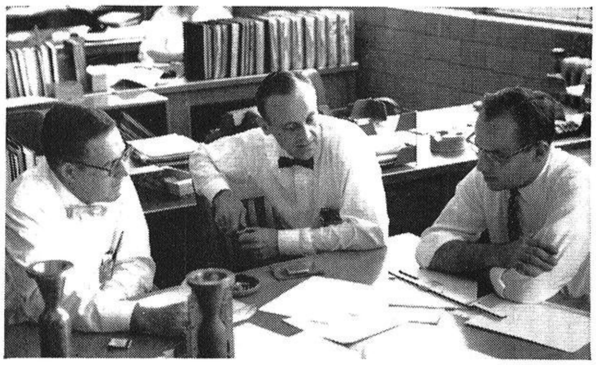
With a look to the future (while serving on an informal Coke taste test panel at the Brathaus during our interview) she noted that she would like to get a job after graduation as a personal social secretary to an important person. In a position like this she could have fun, make money, and travel. To this, we can only add our wishes for success.

—Photos by Peter N. Gold

engineers



Automatic systems developed by instrumentation engineers allow rapid simultaneous recording of data from many information points.



Frequent informal discussions among analytical engineers assure continuous exchange of ideas on related research projects.

Under the close supervision of an engineer, final adjustments are made on a rig for testing an advanced liquid metal system.

and what they d

The field has never been broader
The challenge has never been greater

Engineers at Pratt & Whitney Aircraft today are concerned with the development of all forms of flight propulsion systems—air breathing, rocket, nuclear and other advanced types for propulsion in space. Many of these systems are so entirely new in concept that their design and development, and allied research programs, require technical personnel not previously associated with the development of aircraft engines. Where the company was once primarily interested in graduates with degrees in mechanical and aeronautical engineering, it now also requires men with degrees in electrical, chemical, and nuclear engineering, and in physics, chemistry, and metallurgy.

Included in a wide range of engineering activities open to technically trained graduates at all levels are these four basic fields:

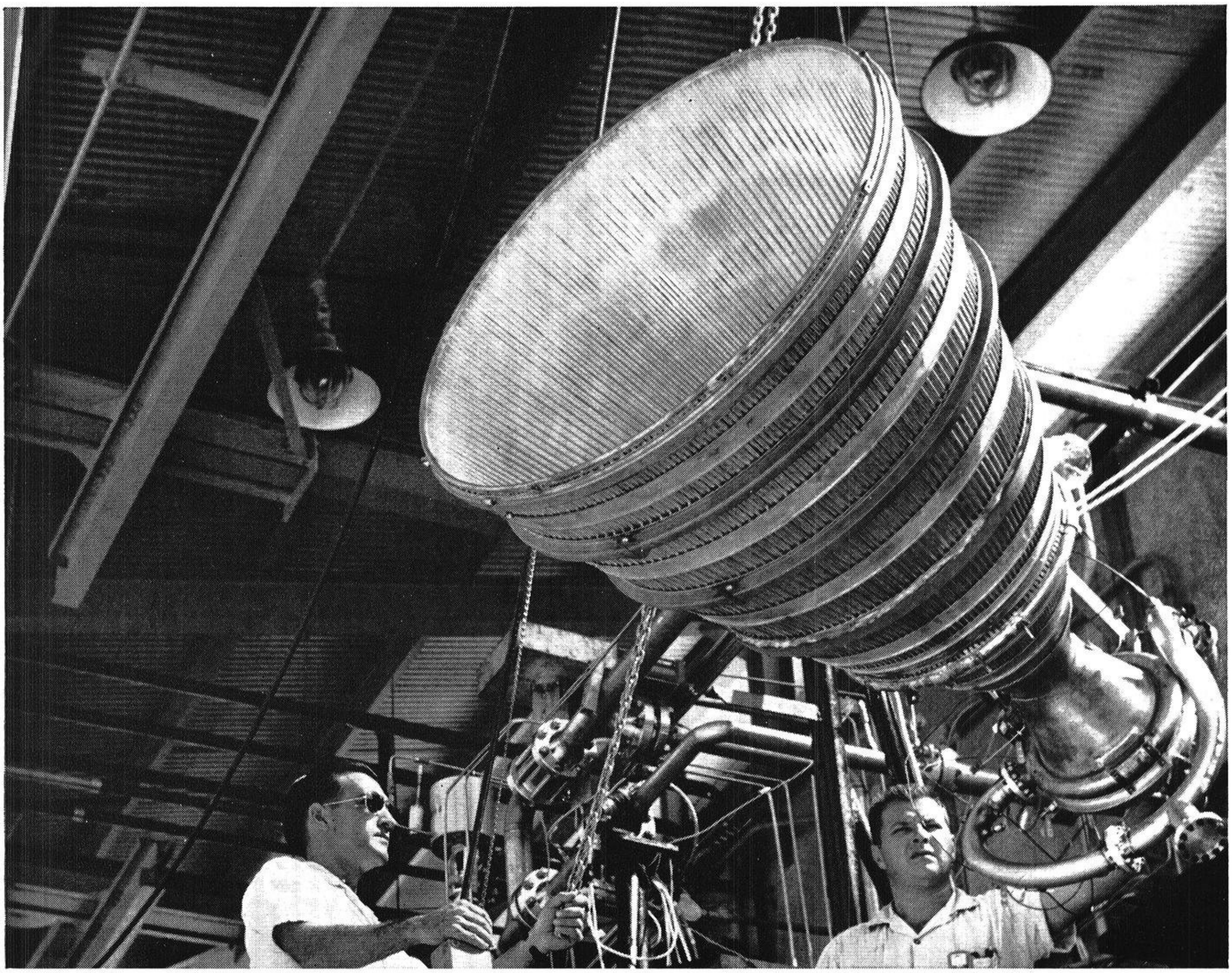
ANALYTICAL ENGINEERING Men engaged in this activity are concerned with fundamental investigations in the fields of science or engineering related to the conception of new products. They carry out detailed analyses of advanced flight and space systems and interpret results in terms of practical design applications. They provide basic information which is essential in determining the types of systems that have development potential.

DESIGN ENGINEERING The prime requisite here is an active interest in the application of aerodynamics, thermodynamics, stress analysis, and principles of machine design to the creation of new flight propulsion systems. Men engaged in this activity at P&WA establish the specific performance and structural requirements of the new product and design it as a complete working mechanism.

EXPERIMENTAL ENGINEERING Here men supervise and coordinate fabrication, assembly and laboratory testing of experimental apparatus, system components, and development engines. They devise test rigs and laboratory setups, specify instrumentation and direct execution of the actual test programs. Responsibility in this phase of the development program also includes analysis of test data, reporting of results and recommendations for future effort.

MATERIALS ENGINEERING Men active in this field at P&WA investigate metals, alloys and other materials under various environmental conditions to determine their usefulness as applied to advanced flight propulsion systems. They devise material testing methods and design special test equipment. They are also responsible for the determination of new fabrication techniques and causes of failures or manufacturing difficulties.

...t Pratt & Whitney Aircraft...



Exhaustive testing of full-scale rocket engine thrust chambers is carried on at the Florida Research and Development Center.

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

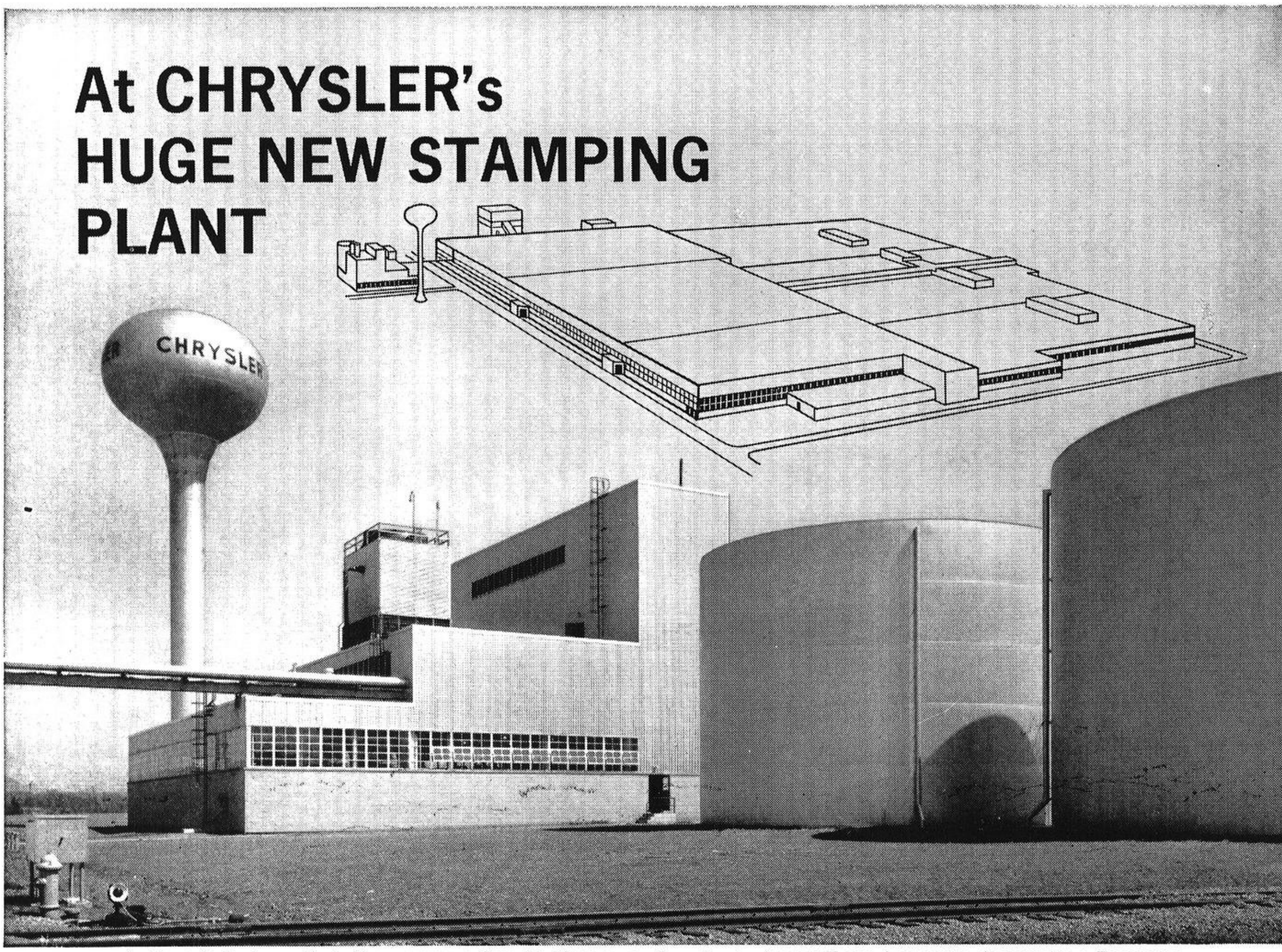
PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

CONNECTICUT OPERATIONS — East Hartford

FLORIDA RESEARCH AND DEVELOPMENT CENTER — Palm Beach County, Florida

At CHRYSLER's HUGE NEW STAMPING PLANT



Architect & Engineer: F. A. FAIRBROTHER & GEO. H. MIEHLS • *Consultants:* ALBERT KAHN ASSOCIATED ARCHITECTS & ENGINEERS
Mechanical Contractor: THE STANLEY CARTER CO.

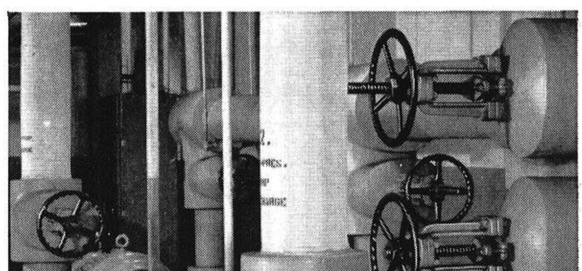
JENKINS VALVES assure reliable, economical control of Production's Lifelines

Cited as one of the nation's "Top Ten Plants of the Year", Chrysler Corporation's stamping plant at Twinsburg, Ohio, is a 34-acre model of building and manufacturing efficiency.

Go into the power plant and you will find Jenkins Valves everywhere, controlling "production's lifelines" that supply 150,000 pounds of steam per hour . . . 30 million cubic feet of air per day . . . 7500 gallons of cooling water per minute. Jenkins Valves got the job because "every effort was made to install the finest mechanical and electrical equipment . . . and to insure minimum costs by eliminating excessive upkeep and equipment with a short life span".

It is a highly significant fact that all building experts and operating engineers agree *"there's nothing better than Jenkins Valves"*. Many will always insist on JENKINS for critical services, and will prefer them for general use. After all, Jenkins Valves cost no more!

When you are buying or specifying valves, remember that the best valves are the best assurance of economical service. Jenkins Bros., 100 Park Ave., New York 17.



In the ultra-modern boiler house shown above, all general service valves controlling pipelines are JENKINS

JENKINS VALVES

LOOK FOR THE JENKINS DIAMOND

JENKINS SINCE 1864

Jenkins Bros

Sold Through Leading Distributors Everywhere

HE MAKES HIS ENGINE STALL

...so yours won't!

Charles Domke has one of the world's most unusual jobs. He *tries* to have engine trouble!

He's a Project Automotive Engineer at Standard Oil. In all kinds of weather—hot, cold, wet, dry, low barometer, high barometer—he goes driving. First thing you know, he'll stop and change fuel, put in a different blend of gasoline to see what happens. If it stalls, he doesn't call a tow truck. He just puts in another blend of gasoline.

You might say he *makes* his engine stall...so yours won't!

What Mr. Domke and other automotive engineers learn from these constant experiments is used to give you gasoline that is blended especially for the region of the country in which you live and also for the season.

It may surprise you to learn that *12 or more seasonal changes* are made in Standard gasoline every year! It is adjusted for temperature, humidity, altitude and other factors that affect gasoline performance in your area.

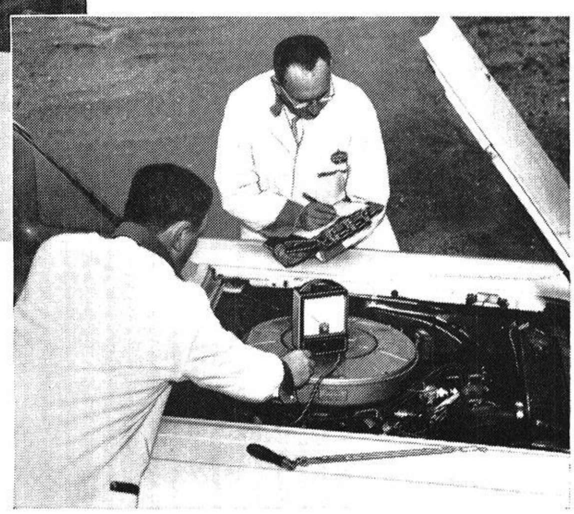
A pioneer in petroleum research, Standard Oil is famous for its "firsts" in petroleum progress. Since our first research laboratory opened 70 years ago, our scientists have been responsible for many major petroleum advances—from making a barrel of oil yield more gasoline to discovering a way to get more oil out of the earth.

Charles Domke and other scientists at Standard Oil and its affiliated companies are searching continually for ways to make oil products serve you better...to make petroleum *more useful to more people than ever before!*

What makes a company a good citizen?

For a company, good citizenship is more than obeying the law and paying taxes. It is looking ahead, planning for the future, making improvements. America has grown to greatness on research conducted by private business for the benefit of all.

Charles Domke (right) is one of the few men we know who takes a positive delight in having his engine stall in sub-zero weather. He and Mechanic Verland Stout change gasoline blends frequently. When the engine stalls, they try another blend. Their objective, of course, is to find the perfect gasoline under various climatic and road conditions—and the true test is on the road itself!



The gasoline that performs best in icy conditions will cause engine difficulty in hot weather. Standard gasoline formulas are changed twelve times a year to assure peak performance in every season. Mixtures also differ from one geographical location to another in order to offer customers more gasoline value for their dollar.

STANDARD

STANDARD OIL COMPANY

THE SIGN OF PROGRESS... THROUGH RESEARCH

ENGINE EARS

by Bob Helm, ce'61

LONG LIVE ST. PAT!!

ST. PATRICK'S day has been tradition for many years at the University and it appears that it will continue to remain for many more. It all started when the Engineers were housed in Science hall across the hill from the Lawyers. When the rivalry first started it was the equivalent of today's "water fight," although much better organized.

The "shysters" were the target of many engineers jokes and pranks. In 1934, the engineers padlocked the law school and affixed signs to the windows and doors informing of the official padlocking. The sign on the front door read as follows:

Know all min by these prisints, that

WHEREAS: The shyster inmates of this here asylum unjustly dubbed themselves as my cohorts, and

WHEREAS: The aforementioned inmates have conducted themselves in a verra stinkin manner, and

WHEREAS: The aforesaid inmates have dared to molest and attempt to degrade my faithful followers the ENGINEERS; the time for decisive action on my part has therefore become imperative. *Now, therefore,* I, Saint Patrick, an Engineer, do hereby padlock this asylum for an indefinite period.

In testimony whereof I have set me mark and caused to be affixed me great seal, this twentieth day of March, in the year of our Lord 1934. (To which was affixed the great seal of St. Patrick, and "Erin Go Bragh," University of Wisconsin.)

The pranks were followed by a St. Patrick's day parade with a large band and upwards of twenty floats. St. Pat himself reigned over the parade. He led the parade in a "Regal Hack" and was guarded by three fellow engineers. St. Pat's top hat became a prime target for the large numbers of egg throwers in the crowds lining the streets.

Prizes were given by the local merchants for the best floats. The engineering society's and independent organizations entered the contest.

The parade was climaxed by the kissing of the blarney stone. This was followed by a mass egg fight and general riot.

Since the engineers have moved to the lower campus the action has subsided and St. Pat's Day has taken a new form.

Today, the energy of the engineers has been directed in a different manner. The St. Pat's activities actually started when Polygon board began planning the events early this school year. The first visible evidence of the festivities in store is seen in the beards being grown by student engineers. The beard judging contest wil be held on Thursday night, March 10, at which time semi-finalists will be selected in each of the five categories: bushiest beard, most colorful beard, longest beard, most Lincoln-like beard, and most devilish beard. The final judging will be at the St. Pat's dance on Saturday evening, March 12.

A basketball tournament between the engineering societies with the all-star team from these teams meeting the lawyers in a classic battle of honor highlites the week's activities. The engineers won last year by an overwhelming score.

The climatic ending of the week's festivities comes on Saturday night when St. Pat is crowned at the annual dance.

AIEE–IRE NEWS

The fourth meeting of the year of the AIEE–IRE chapter was held in Exhibit Hall of the Wisconsin Center Building. The main topic of business was the election of two new representatives to Polygon Board. Elected were Bob Daugh-

(Continued on page 38)

Engine Ears

(Continued from page 36)

erty for the IRE and Don Sanford for the AIEE. Beer and pizza was served the seventy members who were present.

Do not forget the paper competition to be held here next spring. Karel Olson, chairman of the contest suggests that old papers be checked for ideas. It is definitely not too early to be starting your paper.

KHK NEWS

New officers of KHK were elected December 7. Carl Much is the new president of the fraternity.

During Helpweek, the pledges and actives industriously worked on the house. The entire building was cleaned. The basement feeling the greatest improvement. Tables and benches were sanded and refinished. The posts were covered with paneling as part of the pledge project. The week ended with the biannual initiation banquet.

Roger Breihan proved to be one of the most able toastmasters on campus. He kept the 45 actives, new initiates, and honoraries in good spirits with his hilarious comments and jokes. Dr. Richard Greiner was the guest of honor. He is our newest honorary member. Professor Wayne B. Swift in his well known humorous manner gave an interesting talk on the development of the university curricula. Included with the rest of the pledges party antics was the able participation of the number one participant, Bob Daugherty. He cleverly prepared and recited a new version of *The Night Before Christmas* directed at the idiosyncracies of some of the well known actives.

Eight men were initiated: Bob Daugherty, Beetles Bailey, Ken Scribner, John Kruse, Bob Mikulsky, Newton Parekh, Tom Maruca, and Don Laughlin.

We would like to pay tribute to the graduating seniors of the first semester as they are an outstanding group—reaffirmed by not only their work in the fraternity but in many other engineering activities on campus. They are: Al Spangler, President; Mike Stanke, Vice President; Gene Flath, Recording Secretary; Don Martell, Treasurer; O. J. Ziemelis, Rushing Chairman; Fred Herman, Neil Beneditz, and Larry Dietrich.

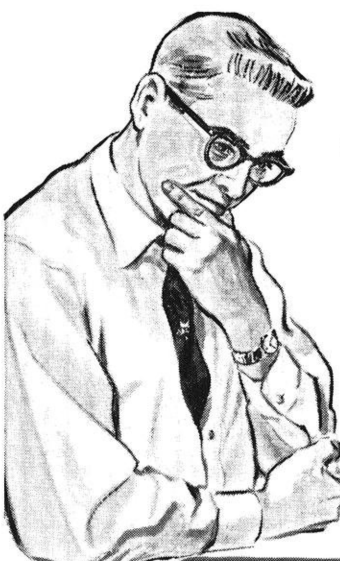
MINING AND METALLURGY CLUB

Professor Philip G. Fox, of the University of Wisconsin's Commerce Department, was the guest speaker at a recent meeting of the Mining and Metallurgy Club. Professor Fox, a statistics and ethics professor, spoke on the probability of winning in various games of chance. Based on his recent article, "A Prime for Chumps," Professor Fox's discussion elaborated on and supplemented the article.

Following the talk, a short business meeting considered the forthcoming excursions, meetings, and sponsorship of a St. Pat's queen candidate by the Club.

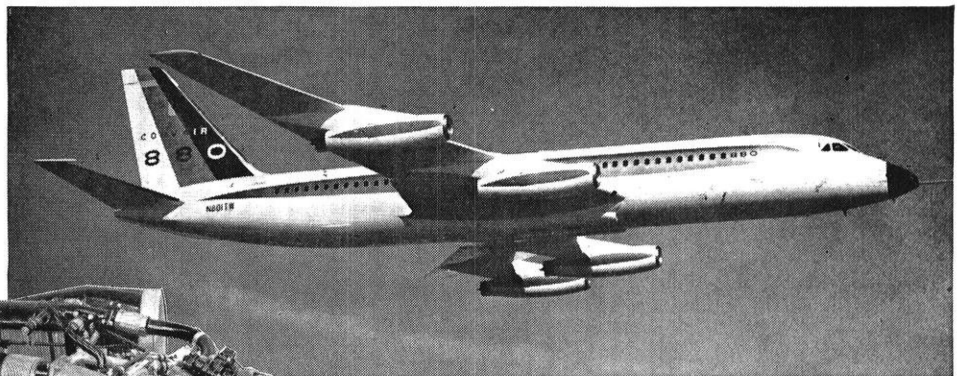
Election of new officers for the coming year will be the main feature of the January meeting.

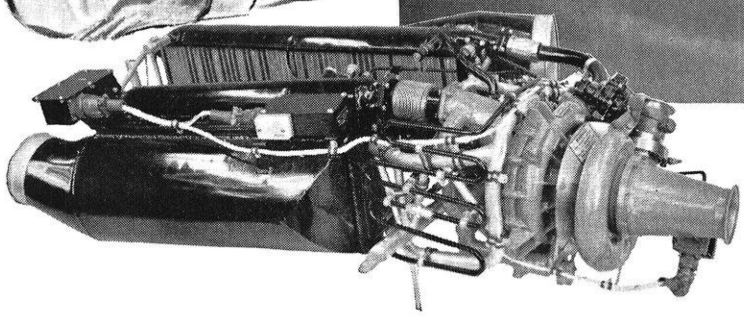
THE END

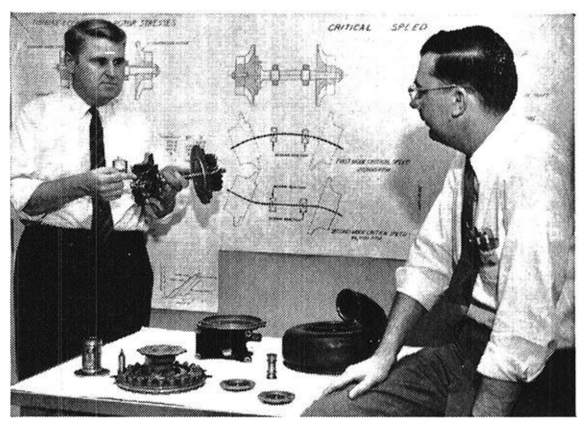


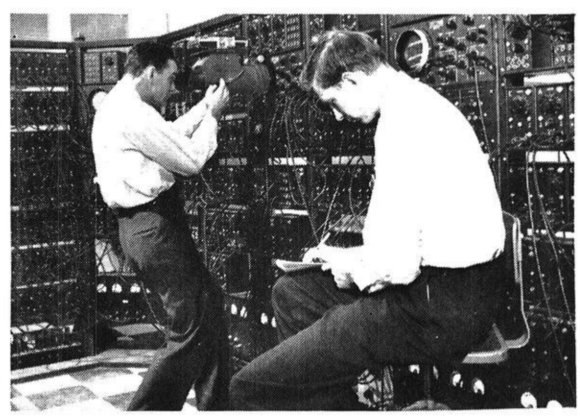
Student Frank G. pictures himself on a typical Hamilton Standard

engineering assignment: environmental control system for Convair 880









ENGINEERING EXCELLENCE of Hamilton Standard equipment is reflected by the selection of its air conditioning and pressurization system for the new Convair 880 jet. Frank G. readily sees the variety of engineering applications involved and learns that he would, as an engineer, participate in its development in one of the following groups:

DESIGN ENGINEERING—Where the engineer, using technical skills in *aerodynamics, thermodynamics, heat transfer, vibration, servo mechanisms* and *electronics*, creates a working concept of the product to meet rigid specifications of performance, weight, size, reliability, cost and safety. Engineers shown at right are discussing stress analysis problems of the turbo compressor rotor system.

ANALYSIS ENGINEERING—Where the engineer, acting as a consultant in applied research, derives and evaluates data on *performance, structures, vibration* and *reliability*. In addition, Frank G. finds that close liaison is maintained with project and design engineers, who incorporate this information in the development of the product. Such machines as the Philbrick Analog Computer, shown at right, facilitate compilation of technical data.

PROJECT ENGINEERING—Where the engineer's prime responsibility is coordinating all activity from design through qualification testing. Frank G. discovers this means "shirt sleeve" work at laboratory test facilities, verifying product specifications with analysis and design groups, working with experimental technicians and contact with customers and vendors. Electronic temperature control pictured at right, was developed by our autonomous Broad Brook Electronics Department.

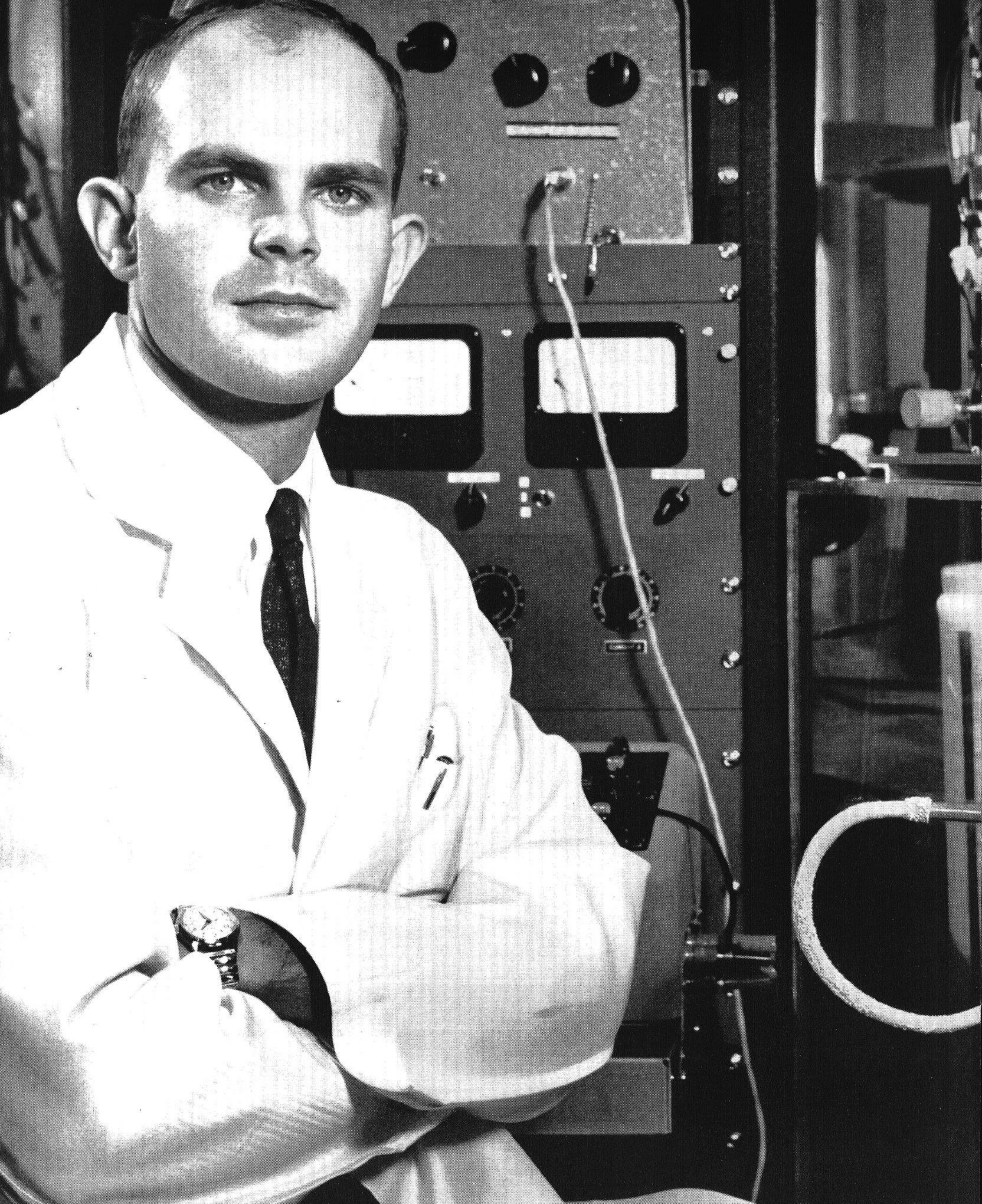
For full color and illustrated brochure "Engineering for You and Your Future" write R. J. Harding, Administrator—College Relations

HAMILTON STANDARD

A DIVISION OF

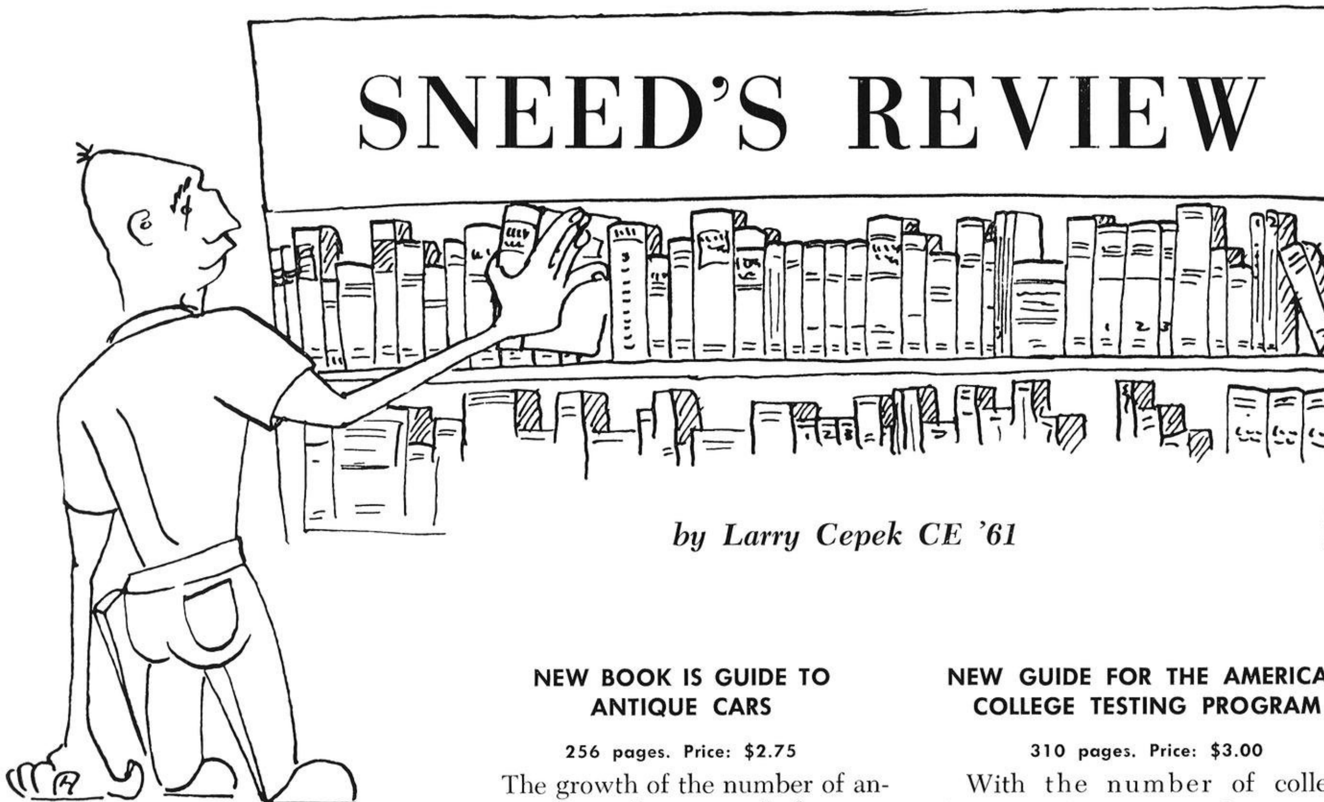
UNITED AIRCRAFT CORP.

BRADLEY FIELD ROAD, WINDSOR LOCKS, CONN.



D. J. Dumin (E.E. '57) earned his degree at Johns Hopkins. An Associate Engineer at IBM, he is doing original work in the design and testing of thin film circuits. Two of his ideas in this field have been filed upon for patents.

SNEED'S REVIEW



by Larry Cepek CE '61

NEW GUIDE CONTAINS MANY NEW INCOME TAX TIPS

By S. J. Lasser

28 pages. Price: $1.00

The new "Arco 1960 Income Tax Guide" by S. Jay Lasser, C. P. A., prepared specifically for the filing of 1959 tax returns takes the American taxpayer through his tax form step-by-step, and shows him how to make the greatest savings on every and any item.

This is the sixth and latest issue of a tax manual which has solidly established itself on the basis of its clarity and thoroughness in presenting valuable information. Information that can become complex and involved without proper explanation, or that may escape the taxpayer completely.

By dealing with only the laws applicable to this year's taxes and eliminating the kind of technical jargon which is useless and confusing to the taxpayer, "The Arco 1960 Income Tax Guide" makes possible a relatively painless payment of taxes. Additional features include tax tips and record keeping for 1960 returns; a complete list of important tax saving possibilities; and sample filled out forms for guidance and illustrations.

NEW BOOK IS GUIDE TO ANTIQUE CARS

256 pages. Price: $2.75

The growth of the number of antique car collectors and the general wide-spread interest in the "vintage car" has been phenomenal.

This amazing growth of interest has prompted the preparation of "The Vintage Motor Car Pocketbook." While it was compiled in England under the editorial supervision of Cecil Clutton, Paul Bird, and Anthony Harding, the scope of this new book is world-wide in presenting photographs and detailed descriptions of the world's most famous "vintage" automobiles. All in all, more than 400 classic models are included with specifications and photographs of most. While there have been many detailed books on the subject of "vintage cars," there has never been one that is so comprehensive as well as so compact. This handy book will slide in and fit comfortably in any pocket, making it ideal as a reference tool for the collector or the spectator at vintage car rallies or the antique auto fair that has grown so popular in the past few years.

The true enthusiast will savor the notes on the battle fought by the "vintage car" against weight, which in the end sounded its death knell almost as much as economic conditions. It is, in part, the interweaving of these two influences that make the study of "vintage cars" so fascinating and enjoyable.

NEW GUIDE FOR THE AMERICAN COLLEGE TESTING PROGRAM

310 pages. Price: $3.00

With the number of college freshmen due to jump from a record enrollment of 711,000 this year to 1,267,000 by 1969, the American College Testing Program is a sorely needed qualifying system for the beginning college student. The ACT is designed to service the remaining 88% of the colleges in the United States that do not now belong to any student selection board.

A new book, "How To Pass High on the American College Testing Program Exams," has been issued to assist the high school senior in entering the college of his choice when the ACT is the method of selection. This new book offers sample examination questions with answers to all phases of the ACT exam: English Usage, Mathematics, Literature and Reading Interpretation, Art and Music, Social Studies, and Natural Sciences.

In addition, the student is shown the ABC's of psychological examinations and sample College Entrance Board Scholastic Aptitude and Achievement Tests. General study sections are provided for all parts of the basic ACT examination: Mathematics, Reading, Natural Science, Social Studies, and Vocabulary Practice and word lists.

(Continued on page 48)

IT'S LITERALLY ALL AROUND YOU!

The word *space* commonly represents the outer, airless regions of the universe. But there is quite another kind of "space" close at hand, a kind that will always challenge the genius of man.

This space can easily be measured. It is the space-dimension of cities and the distance between them . . . the kind of space found between mainland and off-shore oil rig, between a tiny, otherwise inaccessible clearing and its supply base, between the site of a mountain crash and a waiting ambulance—above all, Sikorsky is concerned with the precious "spaceway" that currently exists between all earthbound places.

Our engineering efforts are directed toward a variety of VTOL and STOL aircraft configurations. Among earlier Sikorsky designs are some of the most versatile airborne vehicles now in existence; on our boards today are the vehicles that can prove to be tomorrow's most versatile means of transportation.

Here, then, is a space age challenge to be met with the finest and most practical engineering talent. Here, perhaps, is the kind of challenge *you* can meet.

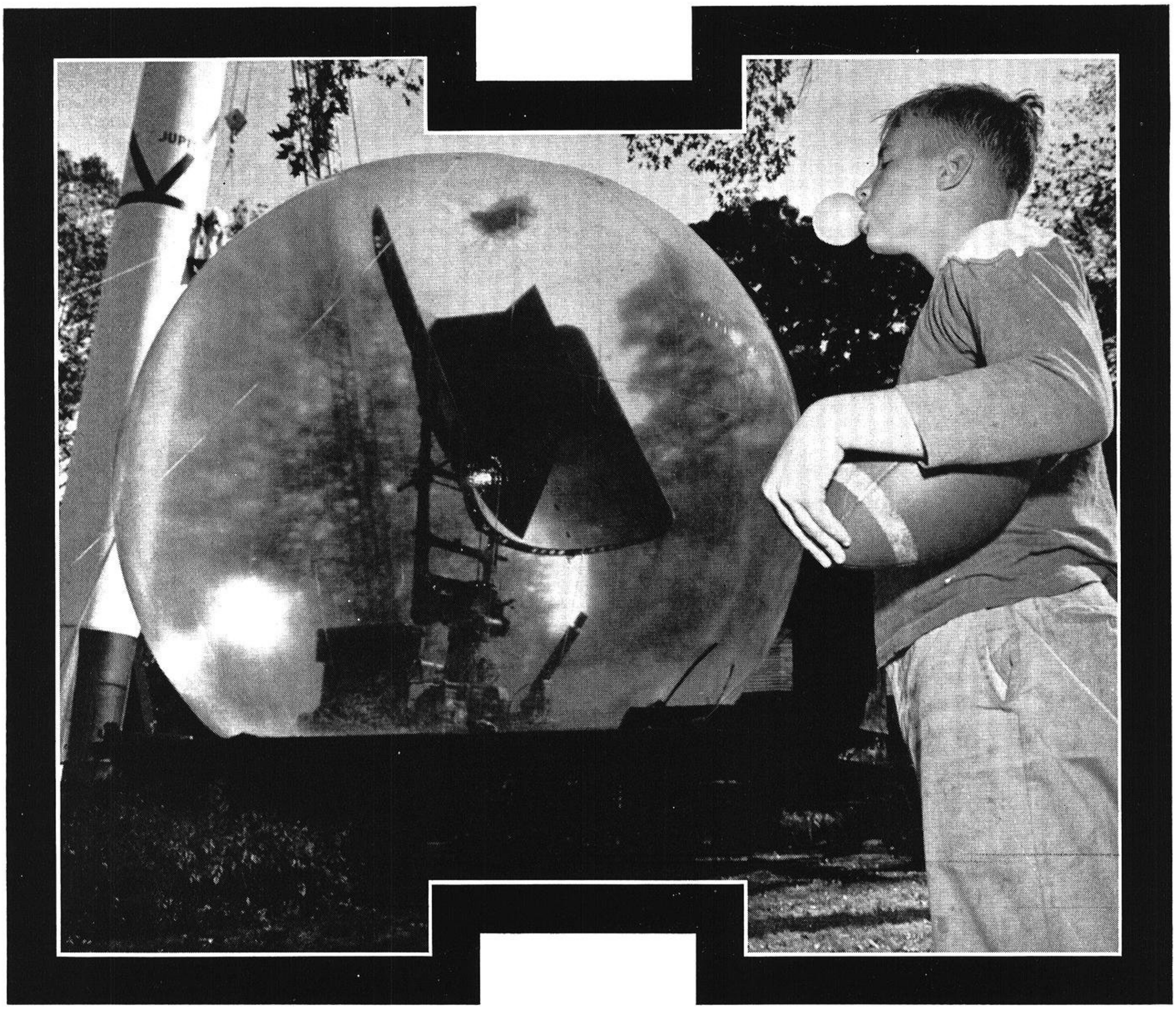
SIKORSKY AIRCRAFT

One of the Divisions of United Aircraft Corporation

STRATFORD, CONNECTICUT

For information about careers with us, please address Mr. Richard L. Auten, Personnel Department.

A new dimension in



bubble blowing

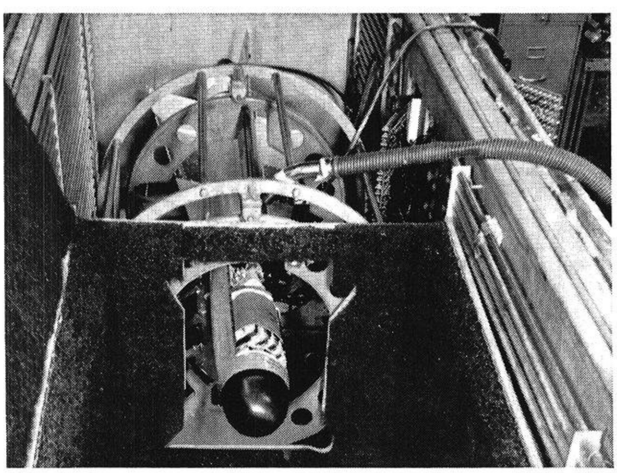
This plastic bubble protects the antenna of a radically new aerial three-dimensional radar defense system.

Sensitive to the inadequacies of conventional radar systems, engineers at Hughes in Fullerton devised a radar antenna whose pointing direction is made sensitive to the frequency of the electromagnetic energy applied to the antenna. This advanced technique allows simultaneous detection of range, bearing and altitude...with a single antenna.

Hughes engineers combined this radar antenna with "vest-pocket sized" data processors to co-ordinate antiaircraft missile firing. These unique data processing systems provide:

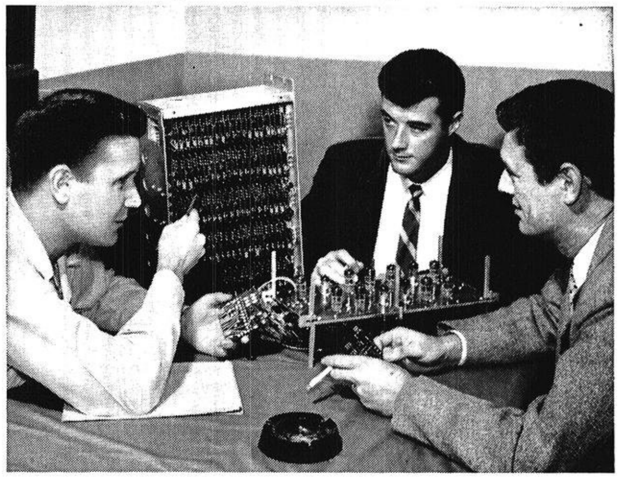
1. Speed—Complex electronic missile firing data was designed to travel through the system in milliseconds, assuring "up-to-date" pinpoint positioning of hostile aircraft.
2. Mobility—Hughes engineers "ruggedized" and miniaturized the system so that it could be mounted into standard army trucks which could be deployed to meet almost any combat problem—even in rugged terrain.
3. Reliability — By using digital data transmission techniques, Hughes engineers have greatly reduced any possibility of error.

Result: the most advanced electronics defense system in operation!



Falcon air-to-air guided missiles, shown in an environmental strato chamber are being developed and manufactured by Hughes engineers in Tucson, Arizona.

Reliability of the advanced Hughes systems can be insured only with the equally advanced test equipment designed by Hughes El Segundo engineers.



Other Hughes projects provide similarly stimulating outlets for creative talents. Current areas of Research and Development include advanced airborne electronics systems, advanced data processing systems, electronic display systems, molecular electronics, space vehicles, nuclear electronics, electroluminescence, ballistic missiles...and many more. Hughes Products, the commercial activity of Hughes, has assignments open for imaginative engineers to perform research in semiconductor materials and electron tubes.

Whatever your field of interest, you'll find Hughes diversity of advanced projects makes Hughes an ideal place for you to grow...both professionally and personally.

ELECTRICAL ENGINEERS AND PHYSICISTS

Members of our staff will conduct

CAMPUS INTERVIEWS

MARCH 30 and 31, 1960

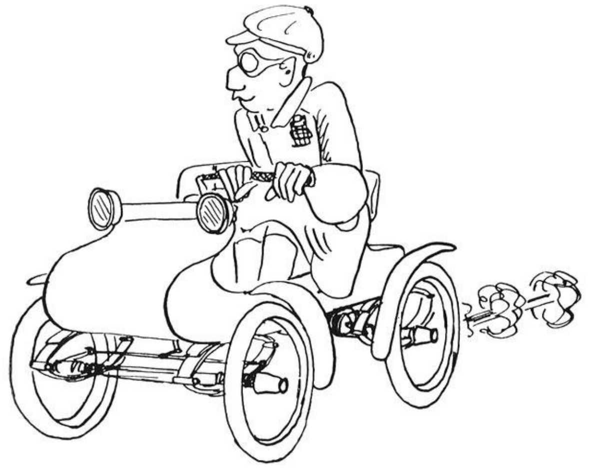
For interview appointment or informational literature consult your College Placement Director.

HUGHES

The West's leader in advanced ELECTRONICS

HUGHES AIRCRAFT COMPANY

Culver City, El Segundo, Fullerton, Newport Beach, Malibu and Los Angeles, California
Tucson, Arizona



THE ENGINEER OF YESTERYEAR

by Floyd Gelhaus, EE '61

LET'S PAY HOMAGE TO ST. PAT

IN 1929 St. Pat's day went something like this. "Led by a color guard bearing the banner of St. Pat, the Irish Free State, and the United States of America, the annual parade of the followers of St. Pat swept down State Street, around the Square and back Langdon Street to the Lower Campus accompanied by the sprightly music of St. Pat's own band, the patter of raindrops, the acclaim of the assembled multitude, and the jeers of those few supporters of the ignoble art of shystering who dared brave the wrath of the engineers . . . At the lower campus, after the parade, came the climax of the occasion. All worthy followers of St. Pat were knighted in the Royal Order of St. Pat after performing the sacred rite of kissing the Blarney Stone. And once again the engineers had ruled supreme. May St. Pat reign forever." Let's pay homage to St. Pat by becoming members of his Guard. Cut out the 'ERIN GO BRAGH' and mail it to the *Wisconsin Engineer*, so that in 1960 the army of knights of the Guard is again at full force. DO IT NOW!

THE UNIVERSITY CLASS-BELL SYSTEM

G. GILBERT BOTHUM

February 1915

The system of bells in the University buildings by which the assembly and dismissal of classes are regulated is seldom considered by the large majority of the people who are accustomed to hear the signals. It is sufficient to know that the bells rarely fail to ring at the scheduled time, and that all the bells throughout the entire system ring simultaneously. A brief description of the way the impulses are sent out and transmitted may correct any erroneous impressions regarding this important factor of the routine of the University.

Since the accuracy of the time of classes must be rigidly preserved it is quite natural that the "heart" of the system should be located where such accuracy can be most easily obtained and maintained. For this purpose the Washburn Observatory was selected as the central station, since the time as indicated by star observation can be directly transferred to the signal system. Here is located the clock which operates the bells, and the necessary equipment for starting the signals upon their journeys to the respective buildings.

The bell clock, or motor clock as it is called, consists of an ordinary time piece similar in appearance to those used in school rooms, but of a quality that insures uniformity in running. It is mounted upon the wall by brackets in an accessible position and upon the back of the case is fastened a hinged cover which encloses the mechanism for sending out the impulses. This device consists of an aluminum wheel about six inches in diameter directly connected with the driving shaft of the clock, which revolves once an hour. Lying in a plane just back of this aluminum wheel, and geared directly to it, is a wheel made of brass which carries insulated fiber inserts upon which in turn are mounted metallic contacts. This latter wheel makes one revolution in twenty-four hours and by the double system of insulated contacts allows for the difference of class time in the afternoon from that in the morning. Bronze spring fingers bear upon the contacts as the disk moves around, and by the time the afternoon periods have begun the springs have moved off the contact employed in the morning, and another set of springs have moved upon the second contact strip, that used in the afternoon.

Upon the aluminum wheel are mounted two fiber blocks at a distance of sixty degrees apart, corresponding to an interval of ten minutes in time. The outer ends of these blocks are beveled in the direction of rotation of the wheel, and upon the edges opposite the bevels are mounted metallic strips, grounded to the wheel, which can be adjusted slightly by small set screws. Two bronze spring fingers or contacts are mounted upon the base holding this mechanism at diametrically opposed points. As the aluminum wheel turns, these contacts bear upon the beveled surfaces of the blocks, and at the proper time the finger slips off the edge of the block and down on to the end of the metallic strip. Here the contact is made for a definite time (about six seconds), after which the finger slips off the strip and breaks the circuit.

Thus two distinct contacts are necessary for a completion of the circuit; in the morning one of the strips on the brass disk and one of the spring contacts at the periphery of the aluminum disk is used, and in the afternoon the other strip on the brass disk and the diametrically opposed spring contact at the aluminum disk. It is necessary that these contacts be strong enough to insure a steady passage of the current through them, and yet not bear heavily enough upon the wheels to cause the clock to stop.

In series with these clock contacts, and located in the basement of the Observatory, is a four fork relay to moderate resistance. This relay is operated by six dry batteries of a large size, as it is desirable to have the contacts on the forks firm and sure. The contacts made through these forks close the circuits which lead from the Observatory to the various buildings, and each of the circuits is operated with twenty dry cells of the type mentioned above. Each circuit is equipped with a knife switch located conveniently with reference to the relay, and the following convenience for testing added to the circuit. A small, double pole, single contact, high resistance relay is connected to the contacts of the knife switch, and when the latter is open and it is wished to test the circuit for its life, the arm of the large relay is actuated, making the contact. If the circuit in question is alive the arm of the relay will click, indicating the passage of current. There are three distinct circuits closed by the arm of the large relay operated by the clock contacts.

What may seem to be a complicated system is in reality a very simple one, one in which trouble can be readily located, but one which requires considerable care and watchfulness. In the whole service to the twenty-four buildings, there are employed one hundred seventy-one bells and two hundred sixty cells of battery, all of which must be constantly watched for indications of inefficient action. Adjustment to the correct time is easily made by comparison with the standard clock of the Observatory.

CAMP RANDALL YESTERDAY AND TODAY

December 1917

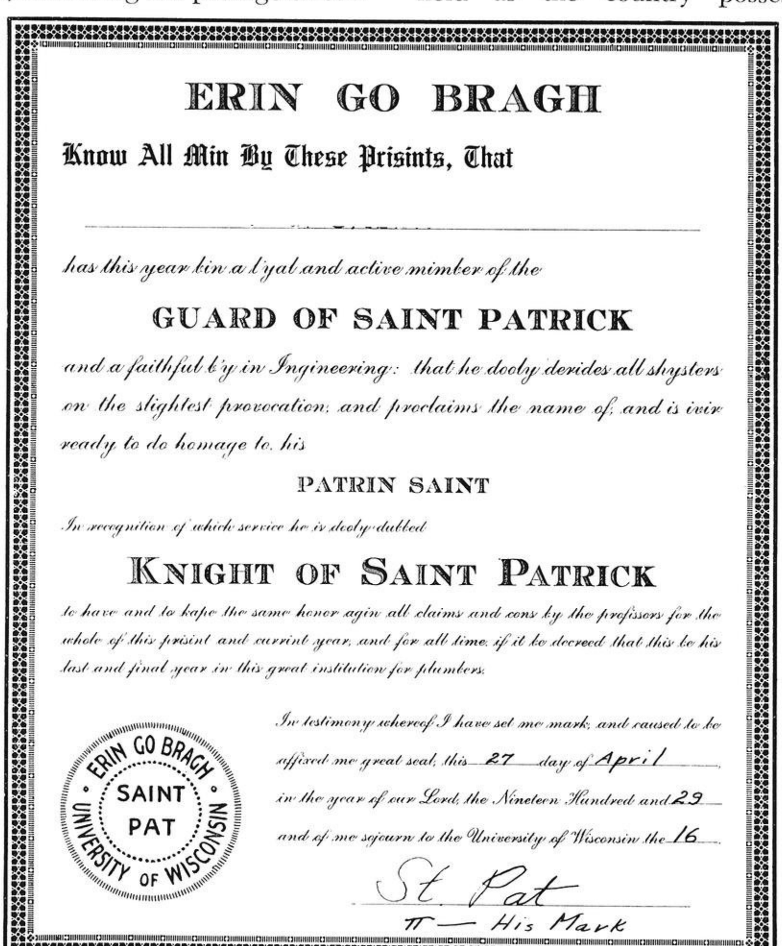
A new athletic field and concrete stadium now grace historic Camp Randall. The project though far from being complete, when finished according to the present plans will be as fine an athletic field as the country possesses. Coach T. E. Jones, Director of Athletics, declares that the field at present is better than any other one in the United States. Camp Randall is the finest spot in Wisconsin for an athletic field, both because of its history and its situation. It is located south of the main University grounds in a position yielding an unsurpassed view of the University buildings. Its history is as absorbing as that of any spot in the vicinity, and it is no wonder that so many people are tied to it by bonds of recollection.

The tract of land now known as Camp Randall originally belonged to the Wisconsin Agricultural Society. There they held the state fairs and horse races. The old straightaway and grandstand were in about the same positions that the contemplated track and the stadium respectively occupy at present. When the Civil War broke out, a place for mustering in, training and mustering out of troops was desired. The Wisconsin State Agricultural Society offered its grounds for this purpose, and the camp was immediately named after the governor at that time—Alexander W. Randall. The old stables and stands were immediately utilized, and new buildings were erected, for about 8,000 men were in camp there at one period. The place was the center of all activity in Madison during the war. Another camp was located near Milwaukee, but the majority of Wisconsin's troops had been at Camp Randall at one time or other.

After the war, many meetings were held at the historic camp. The state fairs were held there for quite a time until the grounds at Milwaukee were purchased. In 1893, the State Legislature bought the entire tract and presented it to the University of Wisconsin for athletic purposes. The tract was immediately used for track athletics, but it was not until about 1895 that football was played there.

EXPENSES

Grading and drainage	$ 8,473.00
Concrete	11,555.00
Wooden seats	1,925.00
Moving grandstand and bleachers	1,700.00
Sodding, turnstiles, architect's fees and general expenses	7,112.00
	$30,765.00



ERIN GO BRAGH

Know All Min By These Prisints, That

has this year bin a l'yal and active mimber of the

GUARD OF SAINT PATRICK

and a faithful b'y in Ingineering: that he dooly derides all shysters on the slightest provocation; and proclaims the name of, and is ivir ready to do homage to, his

PATRIN SAINT

In recognition of which service he is dooly dubbed

KNIGHT OF SAINT PATRICK

to have and to kape the same honor agin all claims and cons by the professors for the whole of this prisint and currint year, and for all time if it be decreed that this be his last and final year in this great institution for plumbers.

In testimony whereof I have set me mark, and caused to be affixed me great seal, this 27 day of April, in the year of our Lord, the Nineteen Hundred and 29 and of me sojourn to the University of Wisconsin the 16.

ERIN GO BRAGH · SAINT PAT · UNIVERSITY OF WISCONSIN

St. Pat

π — His Mark

Join the Guard (See adjoining article).

Space Flight

(Continued from page 15)

DECOMPRESSION

Meteorites

Any body in space is exposed to the possible collision with meteoritic particles. Meteorites weigh from a few milligrams to many tons. A large meteor could completely destroy a space vehicle, but that possibility is extremely unlikely. The latest estimates show that a near earth satellite of radius 20 inches and skin thickness 0.5 millimeter will be punctured on the average of once in 5 days.

The designing of a safe space cabin must take into consideration the probability of a meteoritic caused decompression. A Mr. F. L. Whipple, suggests a "meteor bumper" which would reduce the number of meteoritic punctures by a fraction of 10 to 100 times by exploding the meteoritic particles far enough away from the surface of the cabin skin so that only the vapor touches the cabin wall and this over a large area.

Sickness

Danger of decompression includes hypoxia, physical injury by being blown toward the opening, and decompression sickness. Without pressurization the human body will react according to the laws of physics. Boyle's law for expanding trapped gases, Henry's law for solubility of gases, and Dalton's law of partial pressures and resultant oxygen deficiency. When one considers that the body gases are wet gases, the problems are even greater. The nitrogen, dissolved in the tissues and blood stream under atmospheric pressure, comes out of solution with decrease in pressure according to Henry's law; and these bubble formations, as long as they form outside the circulating blood, will produce considerable pain. This pain may produce collapse if it is very severe.

Another condition referred to as the "chokes" results from the same mechanism as the nitrogen bubble formation. The sensation of not being able to breath, accompanied by a racking, hacking cough with deep, burning pain, results from the "chokes." Immediate descent and 100 per cent oxygen is needed. However, successful cabin pressurization will minimize these problems.

Delay of Decompression

During decompression the time it takes the cabin oxygen partial pressure to decrease sufficiently to prevent hypoxia is more important than the total time of decompression. A space cabin of 500 cubic feet volume, with a pressure of 14.7 pounds per square inch and 21 per cent oxygen content would decompress to a vacuum in 600 seconds if punctured by a one inch meteorite. It takes only two minutes to reach a pressure equivalent of the altitude at 40,000 feet. This gives the crew only two minutes to react to the emergency before hypoxia overcomes them. It is possible to extend the time of reaction by releasing compressed air into the cabin, but this would require 22¼ pounds of compressed air per minute.

The weight of compressed air needed to delay decompression can be reduced by increasing the oxygen concentration. At sea level 21 per cent oxygen is sufficient to saturate 95 per cent of the blood, but at 35,000 feet not even 100 per cent oxygen is enough to maintain 95 per cent blood saturation; so, hypoxia results. Compressed air with varying concentrations of oxygen could be used to offset the effects of hypoxia, but then the increased fire hazard must be taken into account.

COSMIC RADIATION

Cosmic rays are originated outside of the earth. Protons, nuclei of hydrogen atoms, constitute the major part of primary cosmic radiation. The remainder of the main beam consists of alpha particles and the nuclei of heavier atoms (those whose atomic number is above helium). Cosmic radiation can be thought of as a representative chemical sample of universal matter, i.e., atoms of elements stripped of all electrons and accelerated to high energy. The average cosmic rays have energy of about six billion electron volts (Bev), with others as high as 81 Bev. Cosmic rays have a tremendous penetrating power; passing through the entire atmosphere of the earth is equal to penetrating 37 inches of lead. Therefore, mass shielding of a space cabin against cosmic rays will not be known until the data is compiled from biological specimens sent into outer space for extended periods of time.

WEIGHTLESSNESS

Experiments in a jet aircraft flying a parabolic arc have been able to achieve only one minute of weightlessness. The problems of zero gravity appear to be mostly psychological, involving orientation and impairment of coordination. On the ground man uses three senses: eyes, ears, and proprioceptors to maintain balance. The last two senses would not be expected to function in a useful manner during the weightless state. Therefore, the eyes will have to furnish the space man with clues to spatial orientation. The interior design of the cabin will provide subjective orientation in the cabin while the instruments provide objective orientation. Again, all the necessary information will not be known until experimental test flights are flown.

THE END

Sneed's Review

(Continued from page 42)

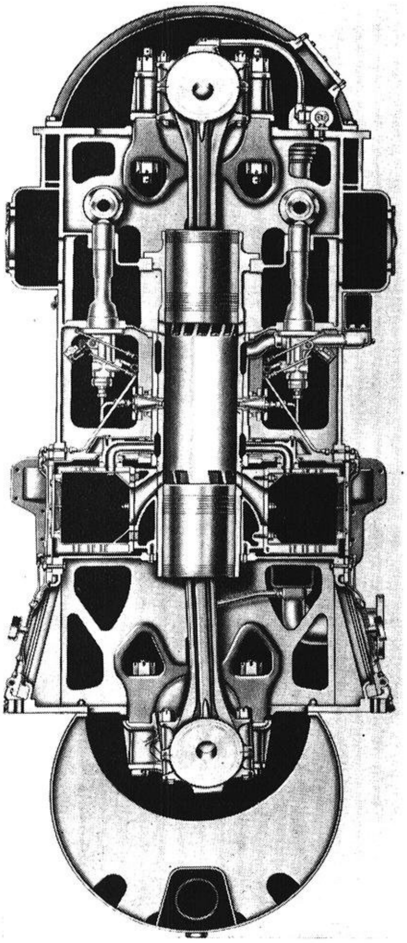
DRINKING AND INTOXICATION

Edited by Raymond G. McCarthy, Yale University, Price $7.50

In some ancient cultures, as well as in certain contemporary primitive cultures, both drinking and intoxication have been accepted as part of religious ritual or as customs carrying full social approval. Today, millions of people continue to use alcohol for widely divergent purposes and in correspondingly varying amounts.

Why has alcohol played so important a role in man's life for so long?

The present volume seeks to examine the practice of social drinking in an effort to understand better its motivation and its results.



Trasverse section of 8⅛″ bore commercial engine.

sure of 15 pounds per square inch is maintained in the header to insure complete filling of the injection pumps. Excess fuel not used by the injection pumps is returned to the tank. The injection pump then delivers a measured quantity of fuel to the pintle-type nozzles at high pressures.

Two injection pumps are used for each cylinder, one on each side of the engine. These pumps are operated by camshafts which are driven by a silent chain from the upper crankshaft. The plunger stroke of the injector is constant and always admits an equal amount of fuel from the supply system. The amount of fuel delivered to the nozzles depends on the position of the helix on the plunger, relative to the port in the pump barrel. When the plunger is in its highest position, the fuel port is uncovered and the pump barrel fills with fuel. The port is then covered on the downstroke by the helix, and the fuel is delivered to the nozzle until the circular groove on the plunger uncovers the port. To stop the engine, the plunger is moved to keep the port uncovered during the entire stroke, by-passing all of the fuel. The rotary position of the plunger is controlled by the governor through the linkage to the control rack of the injection pumps.

Dual Fuel Modification. For permanent installations, dual fuel systems can be very satisfactory where a cheap gas supply is available. Engines equipped to operate on dual fuel can operate on fuel oil, or gas and pilot fuel oil. The pilot fuel oil is needed to ignite the gas. These engines, so equipped, can operate on whichever fuel is available and most economical. During gas operation, the gas enters the cylinder through gas admission valves actuated by the camshaft. Pilot fuel is supplied from each injection pump, and injected into the cylinder to ignite the gas. If the gas supply pressure drops, a control valve shuts off the gas supply and the engine automatically goes back to full diesel fuel operation.

Spark Ignition Modification. The O-P diesel engine can also be converted to a full gas engine. This would be done where a steady gas fuel is available. Extra savings can be had with the gas engine by the elimination of the pilot fuel oil.

The spark ignition engine is basically the same as the dual fuel engine except for the elimination of the fuel oil injection system and the addition of a high tension electrical system which is used to ignite the gas fuel.

GOVERNOR

The governor used on the O-P model 38D8-⅛ diesel engine is the Woodward isochronous hydraulic governor. An isochronous governer is one that can maintain zero speed change from full load to no load. The main job of the governor is to maintain a steady engine speed under varying loads. The governor does this by detecting any speed change of the engine and making the correcting rack change of the injector pumps.

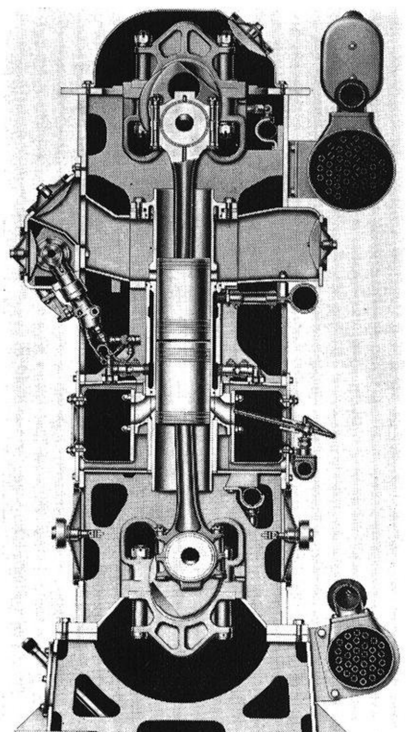
The governor also has protection against engine lubricating oil pressure failure by automatic shutdown of the engine if the lubricating oil pressure drops. Manual adjustment of load limit, speed setting, and speed drop can be made on the governor with the engine running. A reversible synchronizing motor is used to control speed from the switchboard on the electric generating sets. Speed control for locomotive engines can be controlled either electrically or pneumatically from the cab.

OTHER DESIGN DETAILS

Exhaust System. The exhaust system is made of water jacketed passages built into the engine frame on each side of the engine. The exhaust gases leave the cylinder through the exhaust ports being pushed out by the scavenging air of the blower, into the exhaust manifolds and through the nozzles to the muffler.

Lubrication System. A full pressure lubrication system is used to lubricate the engine and also cool the pistons. Oil is delivered through upper and lower headers to each main bearing, through the crankshaft to the connecting rod, then to the tops of the pistons for cooling. The oil then drains back to the oil sump. Pressure oil is also delivered to the camshaft, blower, and vertical drive shaft. The lube oil pump, together with the water pump, is built into the engine.

Starting System. For stationary installations, an air start system is



Cross section of 5¼″ bore diesel engine.

usually provided. This consists of air, under high pressure, flowing into each cylinder according to the firing order when starting the engine. The air is controlled by valves actuated by the air start distributor which is driven by the upper crank shaft. A single lever is used to start and stop the engine with its START, RUN, and STOP positions.

Locomotive engines are started by using the main generator as a starter which is turned over by batteries. Usually a sixty-four volt system is used for this purpose.

FURTHER DEVELOPMENTS OF THE O-P ENGINE

The original design of the O-P engine had an eight inch bore and a ten inch stroke. This was soon changed to $8\frac{1}{8}$ x 10, the same as that manufactured today in the 38D-$8\frac{1}{8}$ models. After World War II, Fairbanks Morse and Company developed a smaller engine along the same basic design of the 38D8-$\frac{1}{8}$ but with a smaller bore and stroke. This smaller design has a $5\frac{1}{4}$ inch bore and a $7\frac{1}{4}$ inch stroke and turns over at 1200 revolutions per minute compared to 720 revolutions per minute for the larger engine. The engine is built with 4, 5, 6, 7, 8, and 10 cylinders with 75 horsepower per cylinder for continuous service.

Another recent development has been a supercharged modification of the $8\frac{1}{8}$ x 10 model. This was done by using a turbo-charger driven by a turbine in the exhaust system. This modification allows the engine to turn over at 900 revolutions per minute and develop up to 340 horsepower per cylinder as compared to the non supercharged model running at 720 revolutions per minute and rated at 160 horsepower per cylinder.

ADVANTAGES AND DISADVANTAGES OF THE DESIGN

One of the main advantages of the opposed piston design is the elimination of cylinder heads and valves. This can be very important from a maintenance standpoint. Another point in its favor is the compactness of the design and relative light weight per horsepower. This is possible in part due to the use of a welded steel cylinder block. Another advantage of the design is the range of horsepower offered in the O-P line. Engines available range from four to ten cylinders with 75 horsepower per cylinder at 1200 revolutions per minute in the 38F5-$\frac{1}{4}$ models. For the 38D8-$\frac{1}{8}$ model, engines are available with 5 to 12 cylinders with 160 to 320 horsepower per cylinder, depending on whether the engine is supercharged or not. All of these engines can use parts that are interchangeable with each other except for the frame, crankshaft, and blowers. Dual fuel and spark ignition modifications are also available for these engines.

Although the O-P diesel has about 40 percent fewer parts than the equivalent conventional diesel engine, one of the drawbacks of the design is that two crankshafts are required plus the vertical drive to interconnect them. This can be a disadvantage when overhauling the engine, such as changing a cylinder liner. Both the upper and lower pistons can be removed through the lower crank case, but it would be simpler to remove the upper crankshaft for the upper pistons. The head room needed to remove a cylinder liner is eight feet seven inches measured from the base. This could be a handicap in a tugboat or fishing boat.

RANGE OF SERVICE

The O-P diesel is used in municipal power stations to provide complete electric service for many cities and it is also used as an emergency power supply for other communities. It is used to pump water, for municipal use, or flood control. The O-P engine is also used for a portable generating set that is used in the oil fields and for many other uses.

In the mobile field, the O-P engine is used in marine service. During World War II, the entire production of the O-P engine was used in the Navy's submarines. Today, the engine is used in tug boats, fishing boats, and others. The engine is also used in the locomotives manufactured by Fairbanks Morse and Company. A 1200 horsepower engine is used in the switcher locomotives. Engine sizes of 1600, 2000, and 2400 horsepower are used in their road locomotives.

Summer Engineering

(Continued from page 18)

you over for possible future permanent employment. By no means do they expect you to come up with a startling, world-shaking discovery —only a sincere and diligent devotion to the job that has been assigned to you. Simply do the very best that you can with the tools that you have acquired through experience and education.

To perhaps clarify the following discussion, I might first explain the type of work that I have done for the past two summers.

During the summer of 1958, I was employed by E. I. DuPont De Nemours & Co., Inc. They have an excellent summer training program for engineers as one might well expect from the size of the company. I worked in the Technical Section of Mechanical Research and Development. I was given the project for the summer of experimenting and attempting to utilize a different type of windup pattern or method for their cellophane. I was given the use of a windup machine on which I could run tests and from there, the responsibility was essentially mine. Of course, I worked under a regular engineer who was fairly familiar with the process. First, I consulted reports from their library and found what had been done previously, got ideas from other engineers and from my suprior, and began running tests. Failures resulted, and sometimes results were noted. All these were taken into consideration when changing my setup for a subsequent run. Formal management reviews were held periodically at which time the "wheels" of the company sat in and listened to your latest progress and offered ideas, constructive criticism, etc. Also, for the summer student, they held weekly seminars conducted by DuPont management dealing with different phases of the DuPont Company, general industrial problems, etc. These were always followed by question and answer periods which always proved extremely beneficial and interesting.

At the end of the summer, I wrote a report on the progress of my project during the summer. This was quite detailed, clearly indicating the failures, where success was experienced, and also any recommendations for further tests.

The summer of 1959 was spent with Scott Paper Company in Chester, Pennsylvania, in the heart of the industrial East coast, just South of Philadelphia and just North of Wilmington, Delaware. Here, I was employed in the Design Section of Mechanical Research. I was again given a project for the summer, but more basic in nature than my previous summer. This involved a type of research and design work rather than testing or developing something that had already been designed basically. The overall program was quite similar to the DuPont program so I will not go into detail anymore than to say that this, also, was a project given to me with the responsibility pretty much mine. It included research as to what had been done in the past, management reviews periodically, and a report at the end of the summer. Seminar sessions were also included which were led by the vice-presidents of the company, and again, very informative. A unique part of this program included one day spent in either the industrial sales or retail sales field. I spent my day in the industrial field and surprisingly, learned much in that short time of the technical knowledge needed for a man in this type of a position.

These experiences that I have had were invaluable to me. The application of the "book learning" here at the U. W. proved to be very beneficial to me along with getting an inside look at how industry operates and how the engineer performs so that the industry does operate. One problem which I formerly faced was what specific field in engineering am I going to enter? These summer experiences have helped immeasurably in determining the answer to this question. Because of this, I was, and am able to plan my courses accordingly for my senior year, and ultimately, graduate school.

Any undergraduate who has the opportunity to spend a summer in an engineering training program should not bypass the opportunity of getting into bull-sessions with the higher-ups in the organization. Many interesting and informative viewpoints can be obtained with much food for thought as to what field you are best suited for and most interested in and also learn much about industry. I have found these informal and spontaneous discussions to be one of the strongest reasons behind my advocating summer engineering work. The information gained from the other engineers and men in management is spoken from experience, and as the saying goes—this is the best teacher.

Aside from the experience gained during your 40 hours spent each week at work, the experience of living away from home and away from school is also unique. You run into all sorts of situations, each quite interesting. You may prefer to live in a private room, or you may have the opportunity, as I did, of living in an apartment with other summer engineering students. If nothing else, we learned to whip up a half-decent meal and had the opportunity to see much of the eastern part of the country. Also, discussing and comparing each other's engineering curriculum proved very interesting. My roommates were from the University of Michigan and the University of North Carolina.

Whether or not YOU are interested in summer engineering work is up to you, but you should be if you are in engineering. Unfortunately, many companies do not offer this type of work. I strongly recommend that you look into the situation thoroughly by checking into the Placement Office for information concerning companies offering summer work. Talk to your professors and to fellow students who have participated in these programs. They proved invaluable to me and you owe it to yourself to check all possibilities before making any decision relative to your summers while still an undergraduate engineer.

Heat Treating

(Continued from page 19)

The personnel side of my experience was rewarding. I worked with all types of people: foremen, shipping room people, furnace operators, general workmen, customers, management, and a top notch metallurgist. Each of these people taught me a great deal. Most of all I have learned to respect each and all of them because every one of them has an important place in the heat treating business. A company exists to produce and make a profit; in heat treating it is the production of perfectly heat treated work which is so important and every man does his part to help complete the production operation. I was fortunate that all of these people took time to answer my innumerable questions, show me how to do things and to patiently suffer with my ignorance.

Being able to do almost every existing job in the shop was one of the big advantages of working in a moderate size organization. Another advantage was the closeness to the employees, knowing they would answer my questions and help me when I needed help.

My work in school has become so much more meaningful as a result of seeing the science and skill of metallurgy come alive in the form of brine quenching a piece of cherry-red hot steel and feeling the shiver of the piece as it transforms to martensite which, in simple terms, means it is hardening.

Summer industrial experience is not difficult to obtain, but it will take a certain amount of effort. Now is the time to start thinking about the coming summer. The Polygon Board with its summer employment program and the engineering placement office are working to increase the possibility of summer employment in your field. If you are interested keep your eyes on the Polygon and Placement Office bulletin boards as well as attending your professional society meetings where you will be hearing a lot more about summer employment.

Good luck with your summer employment. It is a rewarding experience and one you will draw from all your life.

Chemstrand & Bell Labs

(Continued from page 19)

form a basis for future comparisons. The supervisor, the engineer with which the student works, and the other people in his department provide the student with an insight into the company which no literature can provide. These personal contacts are the essence of the student's experience in industry.

Aside from the advantages of summer work, there are two points which I consider important when interviewing for this work. First, approach the interview as though it was an interview for permanent employment. To be of any value, the student should approach the interview with his present goals firmly in mind. Second, find out as much as possible about your specific job. Some companies require little actual work from the student, but try to have him spend his time in a number of different areas or departments to give him a broad view of the engineering work and possibly help him find a special interest. Other companies will give the student a project, consistent with his ability, on which he will spend most of his time. In this company the student will spend less time with the different areas, but by the end of the summer, he will have completed the project and made a constructive engineering contribution to the company. Neither alternative is necessarily better than the other, but they both exist and the student will probably favor one over the other.

It is interesting to note that while I am in mechanical engineering, I worked for Chemstrand, a chemical firm, and Bell Labs, predominantly in the communications business. This points out the need for mechanical engineers in all types of industries. It is well worth the mechanical engineering student's time to look into the opportunities in all the industries.

You can see that summer engineering work can be a valuable supplement to your undergraduate training. If your circumstances permit, consider an engineering job next summer.

Giddings & Lewis

(Continued from page 19)

rewired a paper-tape reader which had to be suited to a certain application. Another assignment was assisting engineers in setting up and testing a "dial in" positioning device, a two axis positioning system, used on a small horizontal boring mill. The coordinates were dialed in at the control panel and the machine components (table and head) traversed to these coordinates with jig bore accuracy. This system was also supplemented by tape control. I was given a sine-cosine transformer panel to assemble and wire completely. This panel was designed to test discriminators used to demodulate the signal from feedback resolvers. In conjunction with this panel, I also assisted in the assembly, wiring, and testing of the discriminators. At the same time, there were other operations to observe. There were technicians and engineers trouble shooting the myriad of panels in the "director," a device used to transfer the signals from punched paper-tape to magentic-tape. There was usually an engineer in the shop experimenting with a new circuit using a maze of clip leads and components. Other students more advanced in Electrical Engineering were given projects of their own. Tom Corth, a Wisconsin Junior, designed a control console containing the operating buttons, speed and feed selectors, and indicators. A Marquette Senior worked on the electric control for a hydraulic shifting device.

Here I have described a research department. There are also design engineers, sales engineers, service engineers, and others. Design engineers made use of the circuits and components proven in research. Some packaged the components with compactness and accessibility in mind, while others were assigned to advertising and descriptive literature. One engineer who was working on a memory system, which drew a few milliamps of current, had majored in power transmission. Another electrical engineer was working out the sequence of operations of a machine that was completely automatic. This machine, with a paper-tape brain, had to be capable of all the considerations of an operator.

The variety of jobs open to electrical engineers in today's industry is tremendous. The best way to become aware of the range of opportunities available is to observe them first hand and choose your field accordingly.

THE END

William Whewell...on mind and matter

"...these metaphysical discussions are not to be put in opposition to the study of facts; but are to be stimulated, nourished and directed by a constant recourse to experiment and observation. The cultivation of ideas is to be conducted as having for its object the connexion of facts; never to be pursued as a mere exercise of the subtlety of the mind, striving to build up a world of its own, and neglecting that which exists about us. For although man may in this way please himself, and admire the creations of his own brain, he can never, by this course, hit upon the real scheme of nature. With his ideas unfolded by education, sharpened by controversy, rectified by metaphysics, he may *understand* the natural world, but he cannot *invent* it. At every step, he must try the value of the advances he has made in thought by applying his thoughts to things."

—Philosophy of the Inductive Sciences, 1847

THE RAND CORPORATION, SANTA MONICA, CALIFORNIA

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

Problem: To find a job that will utilize your engineering training to the fullest possible extent, and reward you for a job well done.

Solution: Find a company that has a reputation for being the leader in its field. A company whose continued expansion is built on creative engineering of new products, new processes. A company with this background relies on its engineers for progress and rewards them accordingly.

At LINDE, the creative engineer will find this and more. As you probably know, LINDE is a major supplier of industrial gases to industry . . . you're probably familiar with them in welding; steel companies use them in refining metals; and they're essential to thousands of chemical processes. LINDE is also famous for its contribution in welding equipment, and its leadership in cryogenic (ultra-low-temperature) technology, and other new and fascinating products and processes.

A LINDE engineer, as a result of this progressive company thinking, enjoys several important advantages. Primarily, he works in a professional atmosphere, where highly specialized technicians are used to relieve him of bench work, drafting, and other detail work. And the engineer at all times enjoys privacy that is so greatly desired in engineering today.

But all these are discussed in a booklet that should be in your possession before you decide. Why not write for a copy today . . . no obligation. Ask for "Look to LINDE for Your Future." Address: Mr. J. J. Rostosky, Manager — Recruiting, Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, New York.

A LEADER FOR OVER 50 YEARS

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UNION CARBIDE

STRIPPED GEARS

by Todd S. Deutsch

"A sense of humor is the oil of life's engine. Without it the machinery creaks, squeaks, and groans. No lot is so hard, no aspect of things so grim, but that it relaxes before a hearty laugh."—TSD

Betcha Didn't Know—

. . . That girls hate quitters almost as bad as beginners.

. . . A tarnished woman is by no means dull.

. . . Your girl may have nice lines, but watch out for the fine print.

. . . The height of salesmanship would be selling two horse-show tickets to a street sweeper.

. . . That a well informed man is a fellow whose views are the same as yours.

* * *

An American school teacher on her vacation rented one of those little foreign cars, with the engine in the rear, for her tour through Europe. All went well until she stalled one day and lifted the hood to see what was the matter. As she stood there, staring down in bewilderment, another school teacher drove up in a similar auto to see what was the matter.

"I've lost the whole motor," the first school teacher wailed.

"You're in luck," the other reassured her. "Fortunately I seem to have an extra in my trunk!"

According to the dictionary, one of the definitions of embargo is "any hindrance or restraint. . . ." Therefore, wouldn't embargo be a good trade name for brassiere?—Now, to prove that you agreed too readily, reverse spelling and pronunciation.

* * *

Girls are like newspapers. They have all forms; they always have the last word; back numbers are not in demand; they have great influence; sometimes they even change the times; you can't believe everything they say; and every man should have his own and not try to borrow his neighbor's.

* * *

Boss: "How come you're only carrying one sack when the others are carrying two?"

Workman: "Well, I suppose they're too lazy to make two trips like I do."

* * *

Salesman: "This slide rule is something you'll really need. It will do half your work for you."

Up and Coming Freshman Engineer: "Fine, I'll take two."

Thought of the Month—

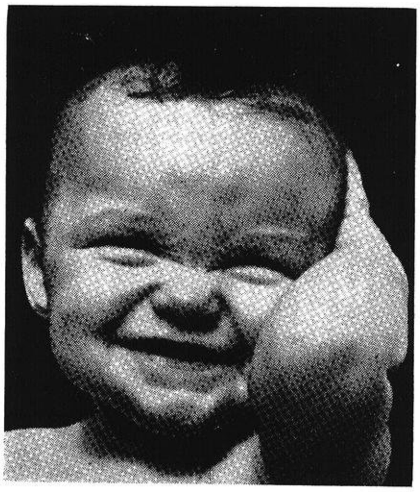
Any fool can criticize, condemn, and complain—and most fools do!
—Dale Carnegie

* * *

Two morons each had a horse, but they couldn't decide which one belonged to whom. So they cut the mane off one to differentiate, but it soon grew back. Next, they cut the tail off one, and it also grew back. Finally, they measured them and found the black one was 4 inches taller than the white one.

* * *

SNEEEDLY, Jr.



"So what, the second week of classes, and I'm only a month behind in my work!"

Rumor has it that one of the E.E. professors is writing a text on AC–DC motors. Since it deals with some hot circuits, he plans to call it "FOREVER AMPERE."

* * *

"No," said the man at the wheel, "I can't complain of back seat driving."

"What kind of car do you drive?"

"A hearse."

* * *

Coed: "Oh, Professor, whatever do you think of me now that I've kissed you?"

Professor: "You'll pass."

* * *

Several days after his father died, little Wilbur was stopped on the street by a neighbor.

"And what were your poor father's last words?" asked the neighbor.

"He didn't have any," Wilbur answered. "Mama was with him to the very end."

* * *

Our engineer friend defined a pink elephant as a beast of bourbon.

* * *

Engineers are continually surprised to find that girls with the most streamlined shapes offer the most resistance.

* * *

She'll love it if you tell her that time stands still when you look in her eyes. But, just try telling her that her face would stop a clock.

* * *

The dean of women at a very well known university recently began a speech to the students with these memorable words:

The president of the University and I have decided to stop petting on campus. . . .

* * *

Dean of Women: "Didn't you read the letter I sent you?"

Co-ed: "Yes, Ma'am. I read it inside and outside. On the inside it said, 'You are requested to leave college,' and on the outside it said, 'Return in five days,' so here I am."

* * *

She: "I see by the paper where nine professors and a student were killed in an airplane crash."

He: "Poor Chap."

Take Heed Engineers

"A little kissing now and then, makes husbands out of single men!"

* * *

Professor: "This exam will be conducted on the honor system. Please take seats three seats apart, in alternate rows."

* * *

Housewife: "Gretchen, I suspect my husband of having a love affair with his secretary."

Maid: "I don't believe it. You're just saying that to make me jealous."

Isotope Power

(Continued from page 21)

lamps. The warning lamps consist of a phosphor core surrounded by Krypton 85 gas in a glass enclosed unit. They are visible at over 1500 feet and would cut maintenance to one change of gas every ten years.

The radio isotopes could be used in exit markers, ship deck markers, and markers for keyholes, light switches, and control switches. The mining industries have been testing isotope powered lamps for use in explosive atmospheres. The following table has been prepared to compare the isotope light source with conventional lighting systems.

Selection factor	Self-liminous coatings vs.	Conventional lighting
Equipment space	Very little	Wires, bulbs in quantity
Maintenance	Almost none	Constant, bulbs can burn out
Reliability	High	Uncertain
Temperature limits	None for practical purposes	Batteries often fail due to extremes
Life	2 to 5000 years depending on isotope used	Short
Operational hazards	Little radiation danger if properly shielded	None to personnel, sparking hazard in explosive atmospheres
Cost	Original is high Maintenance low	Initial cost low Maintenance high
Availabilty	Limited by AEC allocations	No restrictions

Limitations

The major objection to isotope use is the radiation hazard. To reduce this hazard a lead, plastic, or glass shielding must be used. A thickness of 3/8 inch is sufficient to safely shield the gamma radiation of Strontium 90, the most dangerous commonly used isotope. A solid paint made of tritium is claimed to have no radiological danger. However, a formal Atomic Energy Commission test must be performed to insure that adequate safety standards are being followed before the unshieled paint can be used. Several colors are available, depending on the kind of phosphor used. Some of these are red, yellow, blue, and green. The most commonly used colors are blue-green and yellow-green. These are the colors commonly found on radium treated watch and clock faces. Radium is seldom considered now because it causes the phosphor to deteriorate too rapidly and results in a loss of brightness in a short time.

THE END

Science Highlights

(Continued from page 27)

bon which can conduct electricity and form a continuous path for an electrical discharge. The electricity then tracks across the surface, chars the insulation, and shorts out the apparatus.

The new insulation stops this tracking. It bonds itself to other basic insulating materials to form a new surface with outstanding physical, chemical, and electrical behavior. It will find wide use in electrical apparatus in which organic insulation may be subjected to open arcs or to environments that lead to tracking.

Engineers described the insulation as a resin of the "epoxy" type. Epoxy resins are a family of plastics well known for their stability, their resistance to moisture absorption, and their ability to adhere to almost anything. The adhesive properties of such resins are responsible for the close bonding the new insulation has to all kinds of existing insulating surfaces.

The experimental tests of this new coating material have been so promising that it is now being incorporated into a complete new Limitrak insulation system for power-switching equipment that handles up to 3000 amperes of current at 15,000 volts. Equally interesting is its usefulness in modernizing electrical apparatus already in service. When painted on existing equipment, it brings to less-modern insulation a better-than-new resistance to tracking and moisture absorption at a fraction of the cost of replacing it.

THE END

So You Think You're SMART!

by Sneedly, PhD '84

I HAVE a sad, heart-rending story to tell you this month. Since September a couth, kempt, hardworking, and handsome young man has labored mightily for endless hours to bring you this brain stirring intellectual column. As an added inducement, he has offered the staggering sum of ten dollars to the first person sending the correct answers to his intriguing problems. And each month, his fragile heart has been broken by the infinitesimal response to his brilliant work.

I, Sneedly, am the unhappy, dejected young man. Please help me! Make me feel that I am reaching you, the vast intelligent readership of the "Engineer." Wipe the tears from your eyes! Send me the answers to the following problems, and I, with joy in my heart, will send ten dollars to you via the fastest dog team available.

1. Here is a question from the ancient philosophers to test your ability in logic. If half of 5 were 3, what would a third of ten be?

2. A number of chickens and horses are standing in a barn. The total number of heads and wings equals the number of feet. What percentage of the total number of animals are horses?

3. A locomôtive watering tank is to be located alongside a straight section of railroad and supplied with water from two wells located on the same side of the railroad and located respectively 1 mile and 3 miles from the track. The distance between lines drawn through the two wells perpendicular to the railroad is 3 miles. What is the minimum total length of pipe required to connect the two wells to separate inlets on the watering tank?

The answers to January's problems are:

1. Only two recent years have simple square roots: 1849, whose square root is 43, and 1936, whose square root is 44. The sum of these roots is 87 which was gramp's age when he died. The young man is 87 –65 or 22.

2. Since Hotberg is equidistant from Punkton and Mainfield, and since Mainfield is also equidistant from all the towns, Hotberg, Punkton, and Mainfield make an equilateral triangle, whose angles are therefore 60°. But this makes the triangle joining Hotberg, Junkville, and Mainfield isosceles. Since the angle of this triangle at Mainfield is 120° (180°–60°), the other angles must be 30° each. But this makes the triangle joining Hotberg, Punkton, and Junkville a right triangle, with its right angle at Hotberg. With the hypotenuse 40 miles and one side 20 miles, the other side must be about 34.6 miles.

3. There must be 7 women, each paying 29¢. This is because there are no numbers, other than 7 and 29, that will make 203 and since the price of each article is more than 10¢, there cannot have been 29 women, each buying a 7¢ article.

Send any questions, solutions, or fan mail to

SNEEDLY
c/o The Wisconsin Engineer
Mechanical Engineering Bldg.
Madison, Wisconsin

One of a series

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

Technical Training Programs at General Electric

Q. Why does your company have training programs, Mr. Abbott?

A. Tomorrow's many positions of major responsibility will necessarily be filled by young men who have developed their potentials early in their careers. General Electric training programs simply help speed up this development process.

In addition, training programs provide graduates with the blocks of broad experience on which later success in a specialization can be built.

Furthermore, career opportunities and interests are brought into sharp focus after intensive working exposures to several fields. General Electric then gains the valuable contributions of men who have made early, well-considered decisions on career goals and who are confidently working toward those objectives.

Q. What kinds of technical training programs does your company conduct?

A. General Electric conducts a number of training programs. The G-E programs which attract the great majority of engineering graduates are Engineering and Science, Manufacturing, and Technical Marketing.

Q. How long does the Engineering and Science Program last?

A. That depends on which of several avenues you decide to take. Many graduates complete the training program during their first year with General Electric. Each Program member has three or four responsible work assignments at one or more of 61 different plant locations.

Some graduates elect to take the Advanced Engineering Program, supplementing their work assignments with challenging Company-conducted study courses which cover the application of engineering, science, and mathematics to industrial problems. If the Program member has an analytical bent coupled with a deep interest in mathematics and physics, he may continue through a second and third year of the Advanced Engineering Program.

Then there is the two-year Creative Engineering Program for those graduates who have completed their first-year assignments and who are interested in learning creative techniques for solving engineering problems.

Another avenue of training for the qualified graduate is the Honors Program, which enables a man to earn his Master's degree within three or four semesters at selected colleges and universities. The Company pays for his tuition and books, and his work schedule allows him to earn 75 percent of full salary while he is going to school. This program is similar to a research assistantship at a college or university.

Q. Just how will the Manufacturing Training Program help prepare me for a career in manufacturing?

A. The three-year Manufacturing Program consists of three orientation assignments and three development assignments in the areas of manufacturing engineering, quality control, materials management, plant engineering, and manufacturing operations. These assignments provide you with broad, fundamental manufacturing knowledge and with specialized knowledge in your particular field of interest.

The practical, on-the-job experience offered by this rotational program is supplemented by participation in a manufacturing studies curriculum covering all phases of manufacturing.

Q. What kind of training would I get on your Technical Marketing Program?

A. The one-year Technical Marketing Program is conducted for those graduates who want to use their engineering knowledge in dealing with customers. After completing orientation assignments in engineering, manufacturing, and marketing, the Program member may specialize in one of the four marketing areas: application engineering, headquarters marketing, sales engineering, or installation and service engineering.

In addition to on-the-job assignments, related courses of study help the Program member prepare for early assumption of major responsibility.

Q. How can I decide which training program I would like best, Mr. Abbott?

A. Well, selecting a training program is a decision which you alone can make. You made a similar decision when you selected your college major, and now you are focusing your interests only a little more sharply. The beauty of training programs is that they enable you to keep your career selection relatively broad until you have examined at first hand a number of specializations.

Furthermore, transfers from one General Electric training program to another are possible for the Program member whose interests clearly develop in one of the other fields.

Personalized Career Planning is General Electric's term for the selection, placement, and professional development of engineers and scientists. If you would like a Personalized Career Planning folder which describes in more detail the Company's training programs for technical graduates, write to Mr. Abbott at Section 959-13, General Electric Company, Schenectady 5, N. Y.

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