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ENGINEER

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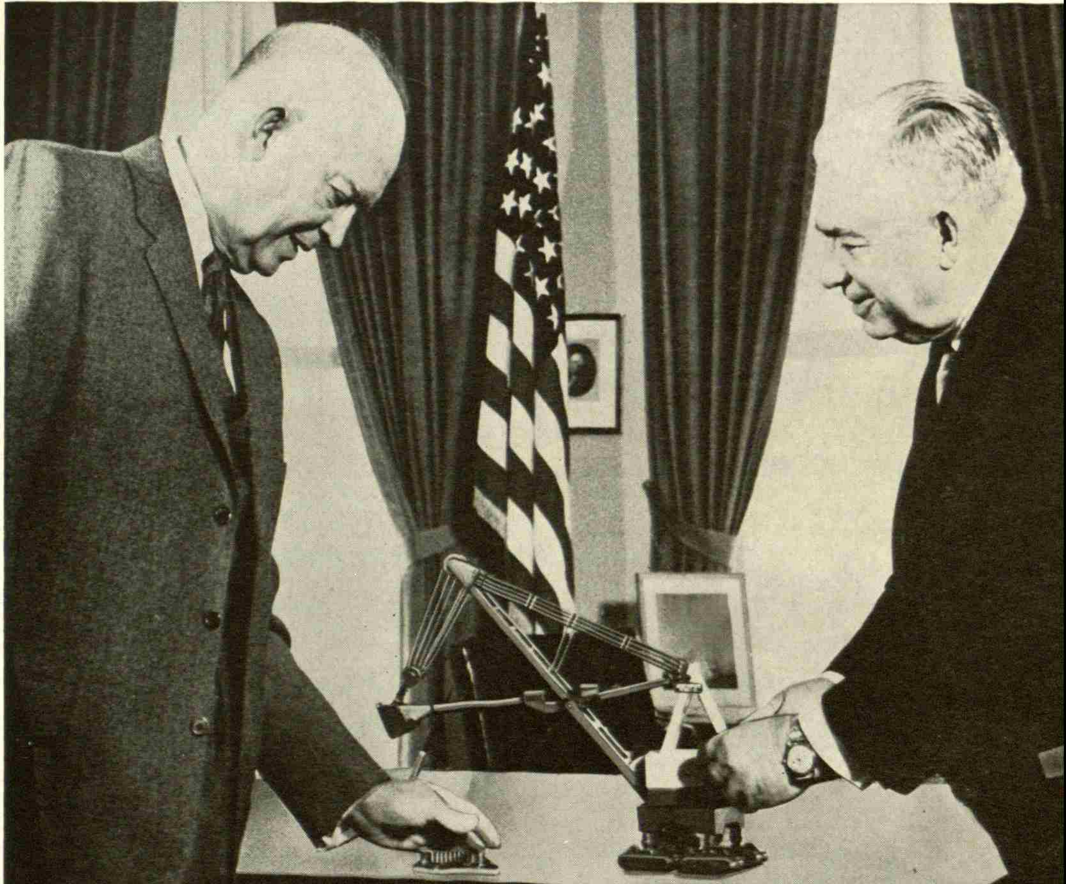
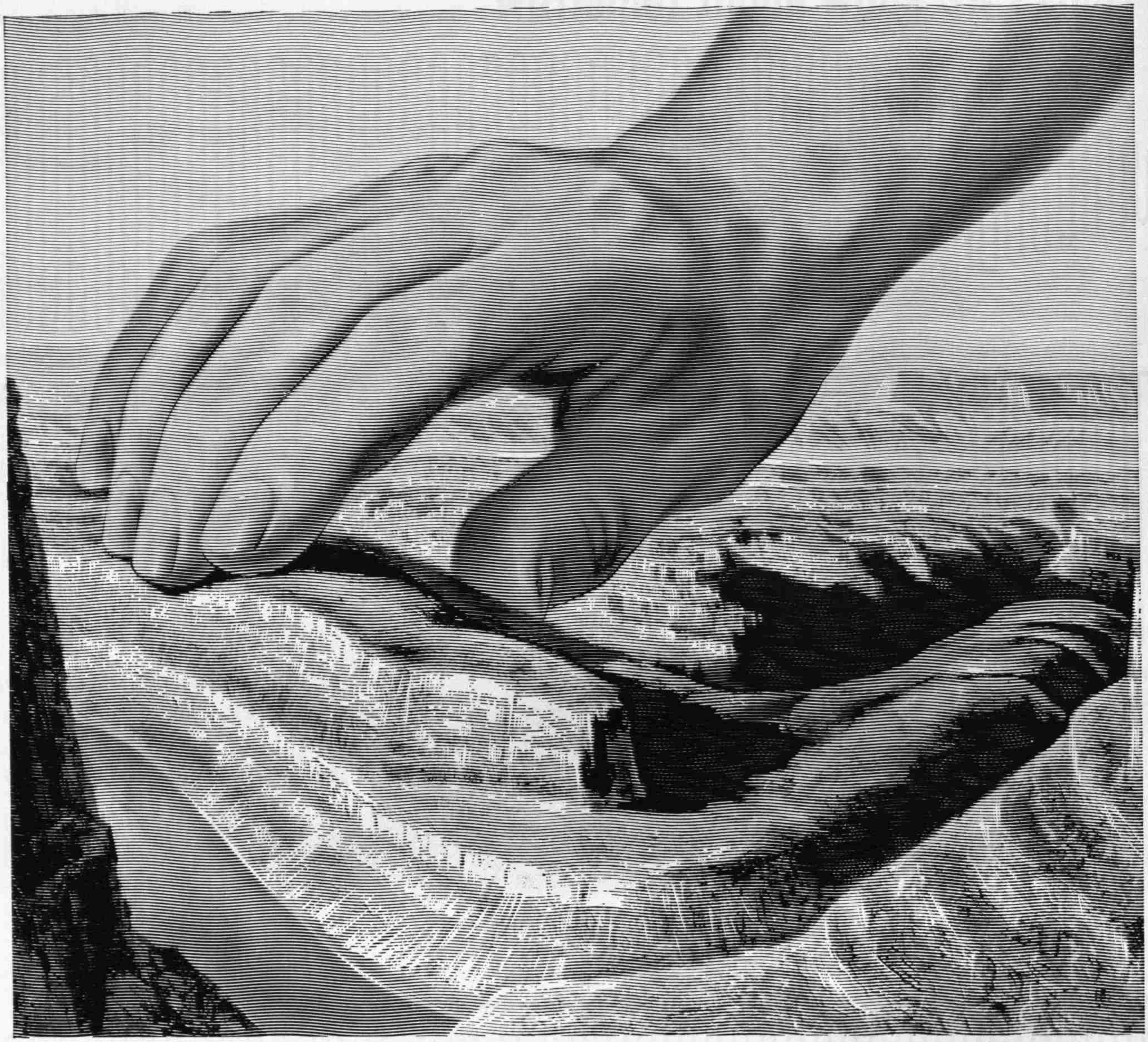


President Eisenhower receiving model of world's largest shovel

- see story on page 6



. . . a hand in things to come

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Spartan Engineer

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Dean's Letter

The lengthening and lowering of automobiles has been a trend in recent years. Conscious that they overshot their market, the manufacturers are now moving back to shorter and smaller cars. Some trends, such as these, may be of short time duration and easily discernible; others take years to develop and are not apparent except to those in positions of opportunity.

Engineering education has its trends too, usually of such long duration as not to be apparent to a particular student. In the early days, engineering training could be satisfactorily obtained through practical experience, but since World War I the self-made practitioner has almost disappeared, and the Bachelor's degree has come to be the normal path into the engineering profession.

With the rise of research and development as a part of engineering activity since World War II, a trend toward the graduate degree level has developed. As the engineering field has become more complex and scientifically based, many of our engineering employers have learned to appreciate the special abilities of the holder of a Master of Science or Doctor of Philosophy degree, and are actively seeking many more of these men than are available each year.

It should also be pointed out that many very good men, holders of only the B.S., find themselves handicapped and unable to advance to levels of which they believe themselves capable, when faced with many of today's problems, and with the competition from the holders of graduate degrees. We should recognize this, too, as a long term trend, a movement toward the day when the B.S. degree will only be a pause on the path to advanced degrees in the engineering profession.

May I again repeat that which I have said to many of you—any student who will stand in the upper half of his class on graduation should give serious thought to continuation of his education beyond the Bachelor's level. In the broadly scientific and fiercely competitive world of the future it will pay off, measured either by standards of satisfaction and achievement, or by economic ones.

With an advanced degree all doors will be open—with only the B.S. some door may be shut in your future!

All of you, from freshmen to senior, are invited to discuss the subject with your department head or with me.

J. D. Ryder

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Editor's Corner

We are literally engaged in a fight for survival. Whether or not we want to admit it, we have entered into direct competition with Russia. Day by day this competition inevitably creeps into every area of our daily existence.

One of the most crucial areas of competition is the struggle for technological supremacy in science and engineering. Already the Soviets have wrested the lead from us in many areas of nuclear and space development, despite protests to the contrary.

In 1950, when the difference in political ideologies and increasing international competition between the United States and Russia became apparent, we had approximately 100,000 more trained engineers than the Soviets had.

Today, the U.S.S.R. not only has more trained engineers than the U.S., but continues to pull away by an ever-widening margin. The Soviet Union is currently graduating 90,000 engineers annually—double the number of U.S. engineering graduates.

A recent survey by the Engineering Manpower Commission estimates a fifty percent increase in the need for engineers in U.S. industry in 1966. Yet educators tell us that each year as many as 200,000 of our nation's most talented high school graduates do not go on to college and that freshman engineering enrollments are decreasing.

This tremendous waste of talent is due mainly to a lack of financial means to pay for a college education. The realization of this untenable situation has prompted the establishment of a considerable number of scholarship foundations. Such non-profit organizations have been of tremendous help to large numbers of students. But even the financial resources of these groups are inadequate to cope with the problem single-handedly.

We, as a nation, cannot rest on our laurels; we must move ahead to stay ahead. We *must* produce more engineers and scientists if we are to win this fight for survival.

What can you do to aid in the fight? As a student, you may not be in a position to do much, but in the future, as a citizen and a parent, you can help considerably. You can make an individual contribution by supporting science and engineering interest among our youth, by encouraging them to take science and mathematics courses in high school, by seeing to it that the local high schools provide the proper guidance and training for college, by encouraging the pursuit of a science or engineering career, and finally by financial assistance.

The need is there. The decision is yours.

R. V. P.

Dow means an attitude toward
research, resources, results

RESEARCH. "Find the truth of a matter first, then adapt that truth to the industrial needs of the day." This is the attitude of the research staff of The Dow Chemical Company. In new and expanded facilities across the United States, in Canada, and overseas, Dow research continues to embody this philosophy on which the company was built. It is noteworthy in the history of Dow that parallel to the steady growth of the company has been a steady increase in the number of research personnel. With this attitude toward research, Dow will continue to find and invent new and better processes and products, and at the same time to offer the research-minded person an ideal atmosphere for development.

RESOURCES. When someone told Herbert H. Dow that there wasn't enough bromine available in the earth, he made his now famous statement, "We'll have to mine it out of the ocean, then." This is characteristic of the Dow attitude toward *resources*. It is true that the chief raw materials for virtually all the Dow products are sea water, brine, petroleum, coal, and oyster shells. It is also true that the Dow attitude toward resources has led to an extremely broad and beneficial exploitation of these common materials. Dow thoroughness in the handling of all resources has led to the industry axiom, "If it's Dow, it's backed by complete technology."

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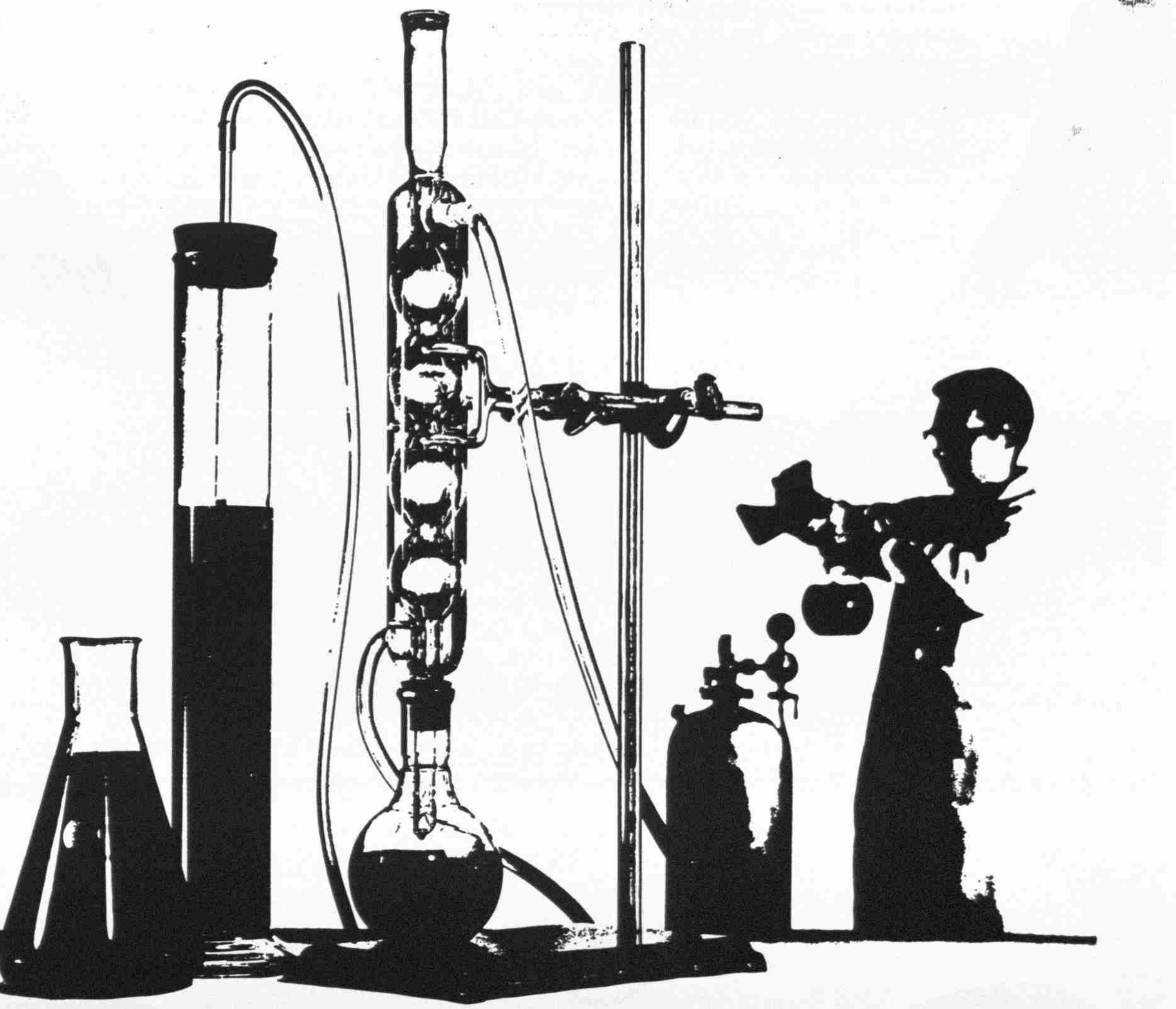

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FUEL

Power source with twice the efficiency of a steam turbine

IN the near future, there may be an era in which electrical power will be generated with an efficiency that will make today's methods of power generation seem very inefficient. The device that will make this possible is the high temperature fuel cell.

You may ask, "What is a fuel cell and how does it operate?" Basically, a fuel cell is an electrochemical device which converts the free energy of a chemical reaction into electrical energy. It does this by consuming an inexpensive fuel and an oxidant which are fed continuously into the system.

Consider Fig. 1, which pictures the simplest type of fuel cell. This type of fuel cell is called an oxygen concentration cell and it consists of a sandwich of a cathode, an eletrolyte and an anode. Oxygen molecules are introduced to the system at the porous cathode. They diffuse through the cathode and form oxygen ions by picking up four electrons. A potential difference is created by the difference in concentrations of oxygen at the cathode and anode. When the ions diffuse through the electrolyte, a positive charge is left at the cathode and the anode becomes negatively charged.

If a load is connected across the cathode and anode a current will flow in the external circuit. This current will continue to flow as long as there is a vacuum or a fuel to react with the oxygen to produce a difference in oxygen concentration between the anode and cathode.

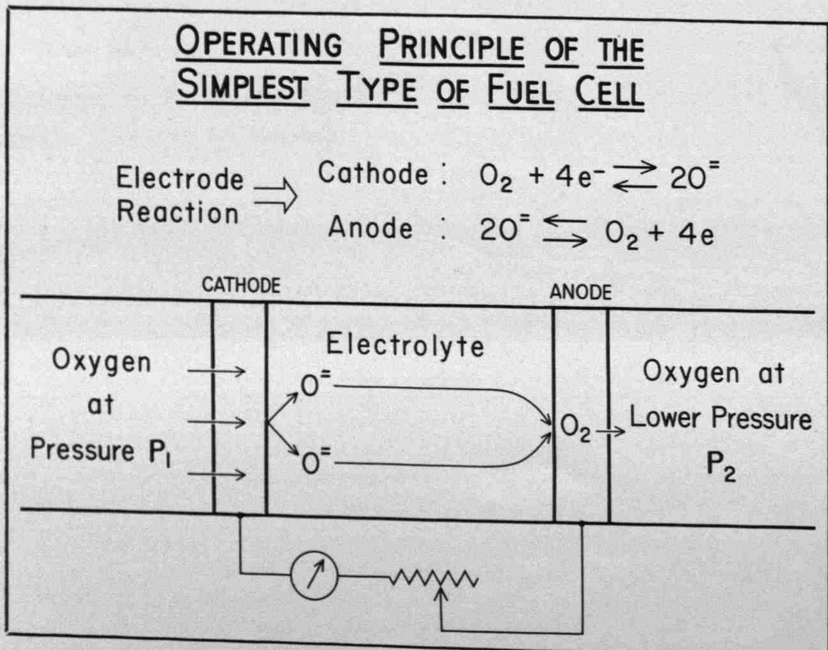


Figure 1

There are many types of fuel cells being developed in the laboratories around the world. A few of the many types are listed in Fig. 2. These fuel cells vary in the type of electrolyte used, nature of the cell reaction, temperature of operation and the direct or indirect use of the cell reactants. All of the fuel cells are subject to catalyst problems because a catalyst is needed to speed the electrode reactions.

Note that all the cells operating below 250 degrees centigrade use hydrogen or some other type of special fuel. The hydrogen-oxygen type fuel cells have the best operating characterists, but hydrogen is a high cost fuel. To improve the economy of present fuel cells, a cheaper source of hydrogen would have to be found.

A different approach to this problem involves the design of high temperature fuel cells which use the inexpensive fossil fuels. Most research devices of this type have used molten salt electrolytes. One of the advantages of the high temperature fuel cell is that the electrode reactions of fuel such as natural gas or coal occur much faster at higher temperatures. This gives a better long range potential by reducing the catalyst problem.

However, operation at higher temperatures induces some very severe requirements upon the components of

CELLS

by DON ANDERSON, E.E.

the fuel cell system. These components must be made of a low cost, highly corrosion resistant material that will retain its conductivity for sustained periods of time at high temperatures. Special ceramics, fused salts, and metal alloys are presently being studied to determine specific physical and chemical requirements that will enable operation at high temperatures.

In present experimental units, the size of the furnace and containers for the fuel cell overshadows the size of the cell itself. It is expected that the size of the furnace can be reduced by substituting for the electrolyte sandwich a series of stacked plates. The heat generated by this type of cell would be sufficient to maintain the high temperature required for operation. Such a high temperature fuel cell might be built as a small mobile unit or as a large central power source because the efficiency would be independent of size over a few kilowatts of power. This type of fuel cell could and would operate on some of the cheapest fuels available today.

Some of the unique characteristics of the fuel cell that offer advantages in electric power generation are silent operation and efficiency independent of the size of the cell over a wide range of power output. Fuel cells are low voltage, direct current devices, which makes them readily adaptable for use in electrochemical industries. The fuel cell does not operate on the heat cycle which limits the efficiency of steam turbine generators and other heat engines. Theoretically, a fuel cell should be able to produce over twice as much energy from the fossil fuels as the most efficient steam turbine of today.

The efficiency of fuel cells is usually defined as the ratio of electrical energy output to the heat of combustion of the fuel for a direct comparison with heat engines. On this basis fuel cells can theoretically operate at efficiencies as high as 70 to 90 percent, compared to a maximum of 42 percent for today's most modern central station plants.

The efficiency noted above is not the complete picture because efficiency is also a function of the load on the system, efficiency decreasing as the load increases. To use fuel cells economically, a compromise has to be reached between efficiency and cost. The ideal fuel cell would use cheap fuels, be made of low cost materials, operate at high efficiency and have high power output per unit of volume and weight.

On the basis of estimated power per unit volume at 50 to 80 percent efficiency and present trends in fuel costs, it appears that the high temperature cells might become competitive with conventional large scale power sources in ten to twenty years if the critical research is completed. For economical large scale power generation, fuel cells that use cheap fuel such as coal or natural gas must be developed. To use such fuels, cells operating at temperatures of 500 degrees C. and above appear to have the most promise.

Fuel	Electrolyte	Operating Temp.	Estimated KW/ft^3 (cell only)
Hydrogen and oxygen	Aqueous alkaline 50 atm.	200-240°C	2 - 4
Hydrogen and oxygen	Solid ion exchange membrane 1 atm.	Ambient to 50°C	3 - 1.5
Hydrogen and air	Aqueous alkaline 1-5 atm.	50-80°C	.2 - 1
Hydrogen and air Carbonaceous materials and air	Aqueous chemical intermediates (redox) 1 atm.	Ambient to 80°C	.2 - 2
Carbonaceous gases	Molten salt 1 atm.	500-850°C	1 - 4

Figure 2

Laboratories in Space

USAF scientists pave the way for manned space flight

by JOHN THORNTON, E.E.

TO the average reader, the use of rockets containing animals for experiments in space medicine seems to be a relatively new field. Actually, USAF scientists of the Aerospace Medical Division experimented with mice and monkeys as early as 1950.

Soon after World War II, with the coming of jet fighters and supersonic, rocket-powered research aircraft, scientists realized that man was the weak link in their experiments. Just as any sensitive mechanism needs protection from vibration, temperature, and pressure to operate correctly, the pilot of a modern plane or rocket needs adequate protection in order to survive on the fringes of space.

The Aerospace scientists were primarily concerned with the problem of bailout from high-altitude, supersonic aircraft.

Rockets are ideal vehicles for studies of this nature. Under power, an Aerobee sounding rocket reached speeds of 2000 mi./hr. After burnout of the main engine, while coasting to its peak altitude, a rocket decelerates at 1 "g" because of lack of air resistance. During this short period, a "year gravity" state is produced, and any objects not anchored to the airframe will hang suspended in space.

During a four year period, three Aerobee rockets containing mice and monkeys were flown from Holloman Air Force Base.

Two basic types of study were conducted. The first consisted of physiological observations of the pulse rates and respiratory rhythms of several rhesus monkeys.

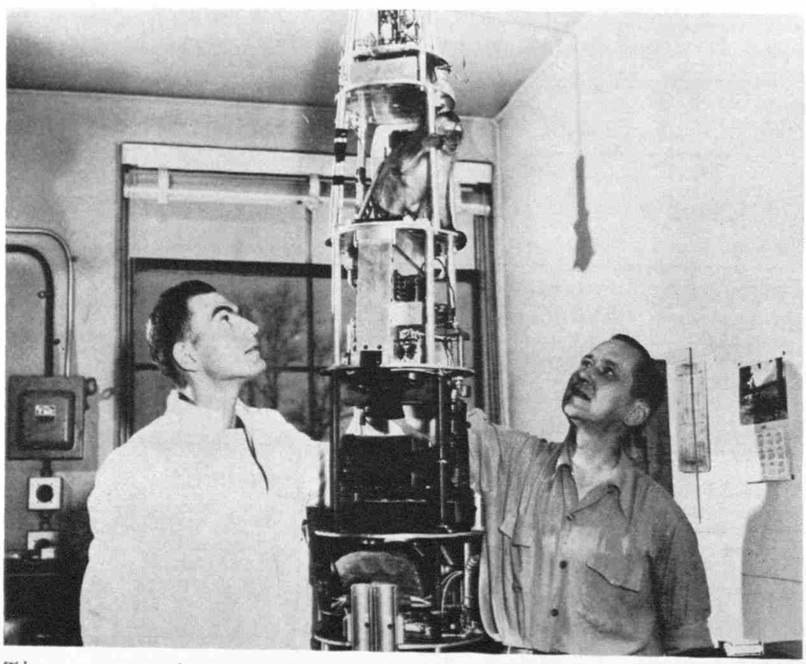
The monkeys, after being anesthesized, were securely strapped to a sponge rubber bed. The purpose of these beds was to prevent the monkeys from struggling and to protect them from the shock of the opening of the parachute.

Various electrodes and needles were inserted into the monkey's legs and chests in order to obtain electrocardiograph data. A special rubber face mask, fitted with thermocouples, measured the rate of respiration.

In Aerobee III, two monkeys were used. One was placed in an upright position while the other was lying prone. The object was to determine whether directional effects of the rocket's acceleration on various parts of the body made any changes in the respiration rate. The monkey in the upright position was connected to an electrocardiograph which recorded the heartbeat. The second monkey had small electrodes inserted into his body which were connected to a transducer. These signals were fed into frequency modulated oscillators and then to an FM transmitter mounted in the tip of the nose cone. These signals were picked up and recorded at Holloman Air Force Base, eighty miles away.

The Aerobee nose cone also carried a complete air purification system consisting of a fan and an eight hour oxygen supply. A small can containing soda lime was used to absorb carbon dioxide and water vapor. Once the parachute had lowered the nose cone safely to the ground, this system provided air until the cone was recovered.

The second study was of mice under weightless conditions. A cylindrical drum six inches in diameter was free to rotate on an axle mounted across the main axis of the rocket. The drums were divided into two small compartments with plastic fronts. A small paddle was mounted



The nose cone of Aerobee III with the skin stripped away. The monkey, at top, is in the compartment in which he rode into the upper atmosphere.
(USAF photo)

in one compartment of each drum. An electric motor drove the drums at various speeds. A sixteen mm gun camera took movies of the two mice during the three minute "zero gravity" condition and parachute descent. By using three accelerometers to measure the roll, pitch, and yaw of the rocket, scientists were able to determine the exact amount of gravity, if any, which affected the experiment.

The rockets used in these experiments were the standard Aerobee high-altitude research rockets manufactured by Aerojet General Corp. Aerobee is a fin stabilized rocket of low cost, using nitric acid as the oxidizer and aniline as the fuel. The main part of the rocket is eighteen feet long and fifteen inches in diameter. Loaded, the rocket weighs about 1050 pounds, but it is capable of sending a payload of 150 pounds a distance of seventy-five miles.

The Aerobee's main engine gave 2600 pounds of thrust for forty-five seconds. Besides the main engine, a booster giving 18,000 pounds thrust for 2.5 seconds was used to increase the takeoff acceleration to fifteen g's, giving the rocket more stability.

Both nose cones for the second and third Aerobees were specially designed for biological experiments. Each had a complete eight channel telemetering system for transmitting data. The mounting of instrumentation as well as the mice and monkeys required compact packing.

When the rocket reached maximum altitude, the nose cone was separated from the engine and fuel tanks. After falling approximately thirty seconds, a drag chute popped open, slowing the nose cone to the speed at which the main parachute could open.

The results of the experiments using anesthesized monkeys showed the possibility of manned space flight. The monkeys' pulse rates and respiration rates were not disturbed to any great extent by the effects of the rocket flight. During the flight, the internal temperature of the nose cone rose about 59°F (15°C), but this didn't seem to affect the passengers at all.

When subjected to "zero gravity" conditions, the mouse in the compartment without a paddle thrashed wildly, losing his orientation. The second mouse clung to his paddle, apparently undisturbed. It was proven later that a small gravitational force of 1/20 g existed due to the rolling of the rocket about its main axis, but the experiment was considered a success. Once the chute had opened, both mice resumed normal activity.

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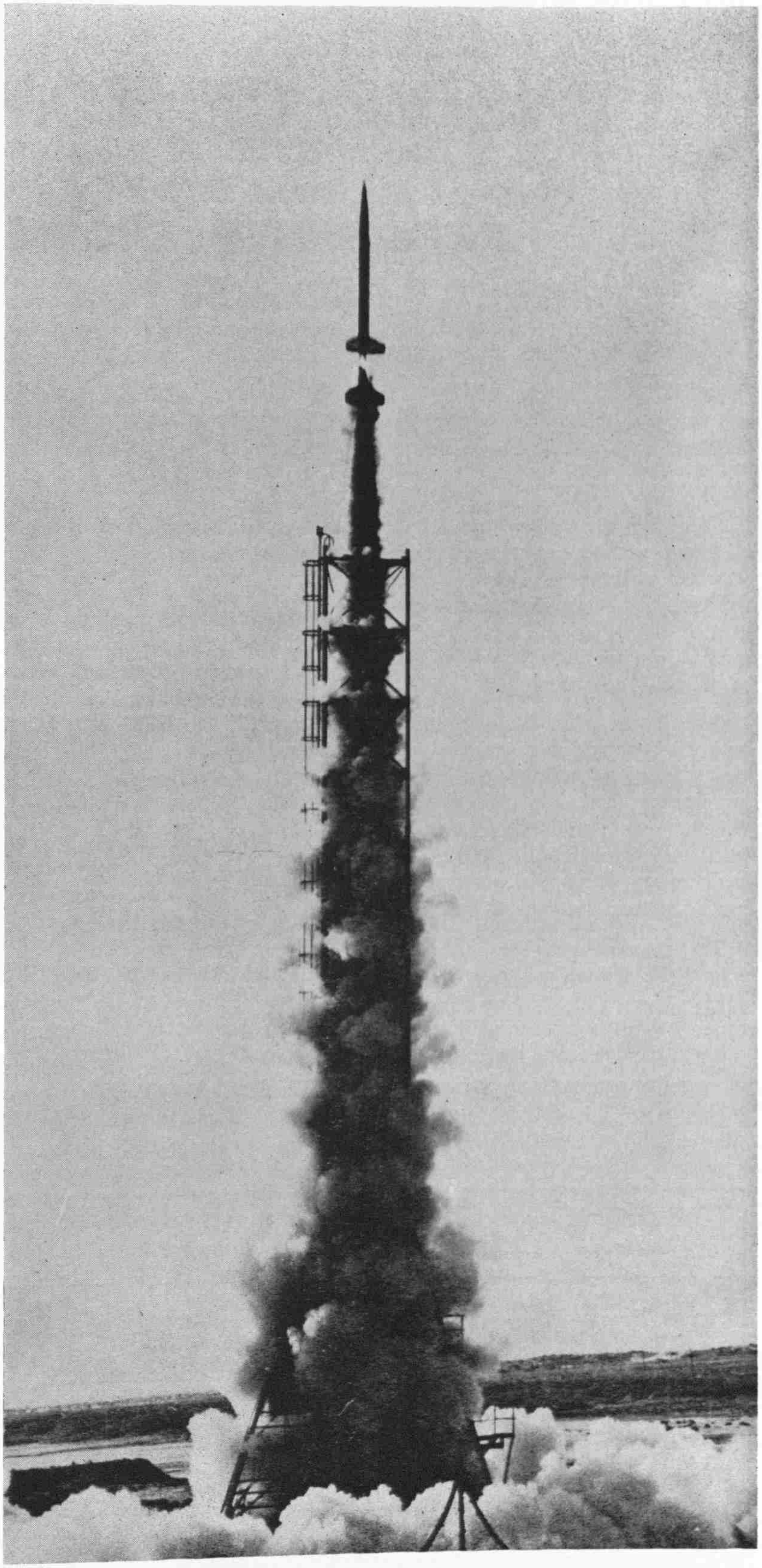


Aerobee III roars aloft from Holloman Air Force Base, carrying mice and monkeys to an altitude of 200,000 ft. in 1952. (USAF photo)

ENGINE OF TOMORROW

FREE PISTON ENGINE SHOWS GREAT PROMISE FOR THE FUTURE

by PAUL BUTLER, M.E.

The "engine of tomorrow"—what is it and what does it promise? Researchers working with what is called the "free piston engine" have tagged it with this title—full of hope, but promising some difficulties that may be solved—"tomorrow."

Investigators have been impressed with the engine's high thermal efficiency, excellent torque, low exhaust temperature, and few moving parts. On the other hand, they have had problems with starting and low efficiency when idling and when operating under part load conditions.

The common gasoline engine has several disadvantages which hinder further development. The maximum force which the crankshaft bearings can withstand severely limits the range of possible compression ratios. The problems of knocking at high compression, low thermal efficiency, poor torque, and expensive fuel are also inhibitive.

In contrast, the free piston engine has no crankshaft, and therefore is practically unlimited in compression ratio. The use of direct fuel injection in the free piston engine eliminates the problem of knocking. It has high thermal efficiency, excellent torque, and can run on anything from peanut oil to high octane gasoline.

The other engine presently being developed is the gas turbine. This has the disadvantage of low efficiency, especially under part load conditions, and it requires expensive alloys for turbine blades. Because of the low exhaust temperature of the free piston engine, this latter disadvantage is eliminated.

The free piston engine is basically an opposed piston, two stroke diesel engine without a crankshaft or connecting rods. The free piston engine itself does not produce mechanical power. It simply generates hot, high pressure gases which are passed through a turbine to produce power.

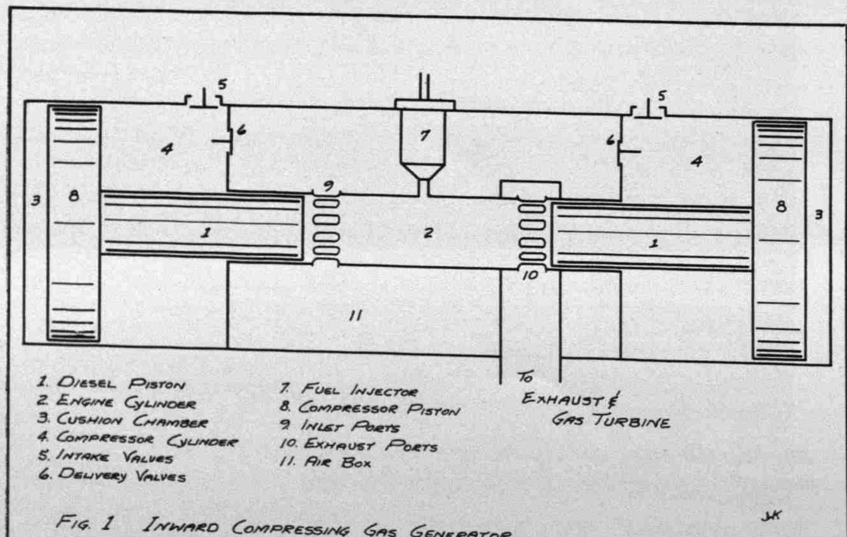


FIG. 1 INWARD COMPRESSING GAS GENERATOR

The free piston engine has two horizontal pistons with a combustion chamber between them, as shown in Figure 1. When the engine fires, the pistons (1, 1) are thrust outward, compressing air in the cushion or bounce chamber (3).

As the pistons separate they uncover first the exhaust ports (10) and then the intake ports (9). Pressurized air rushes in from the air box (11) through the intake ports, clearing the chamber of exhaust gases and bringing in fresh air for the next cycle. On the outward stroke the inlet valves (5) open and admit air into the compression chamber (4).

When the pistons reach the end of the outward stroke, the compressed air in the bounce chamber acts as a spring to force the pistons together. On the inward stroke the air in the compression chamber is compressed and forced under pressure through the delivery valves (6) into the air box. At the same time the air in the combustion chamber is greatly compressed.

Because of the high temperature produced in compressing the air to about one-fortieth of its original volume, spontaneous combustion occurs when fuel is injected into the cylinder as the pistons reach the end of the inward stroke. This starts the cycle over again.

As the exhaust gases, considerably cooled and diluted by the pressurized fresh air used to clear the cylinder, leave the combustion chamber they pass into a collection chamber, which eliminate the pulsations of the engine in the flow of the gases. From the collector the gases pass through a turbine which utilizes the hot, pressurized gases to produce mechanical energy.

Because the exhaust gases have been mixed with fresh cool air and have expanded within the cylinder before passing to the turbine, they enter the turbine at about 900 degrees F, compared with 1800 degrees F for a gas turbine engine. This permits the use of cheap and easily obtained alloys, and an afterburner to increase power for short periods of acceleration can be added without damage to the turbine. Part of the power produced by the gas turbine engine must be used to drive the compression turbine, but all the power generated by the turbine of a free piston engine can be utilized to do work.

The compression ratio of a free piston engine varies between 35 to 1 and 50 to 1, depending on the amount of fuel being burned. This high compression results in high thermal efficiency, as high as 45%, which, combined with a turbine efficiency of 80%, gives an overall efficiency of 36%. The average efficiency of a gasoline engine is 25%.

The high temperature produced by the compression makes it possible to burn almost any kind of clean burning fuel in the free piston engine. The low cost of fuel, combined with high thermal efficiency, makes the free piston engine very economical to operate.

Since the speed of the engine is independent of the speed of the turbine, approximately the same amount of power is produced at all vehicle speeds. In fact, the torque produced is greater at low turbine speeds, which makes the engine very useful for tractors, trucks, and buses because they require power and acceleration at low speeds.

The independence of the engine and the turbine also results in better response and more flexibility than either the gasoline engine or the gas turbine. This results in better performance and allows the engine to be placed anywhere while the turbine is placed at the point of power application, with only a small tube for the hot gases connecting the engine to the turbine.

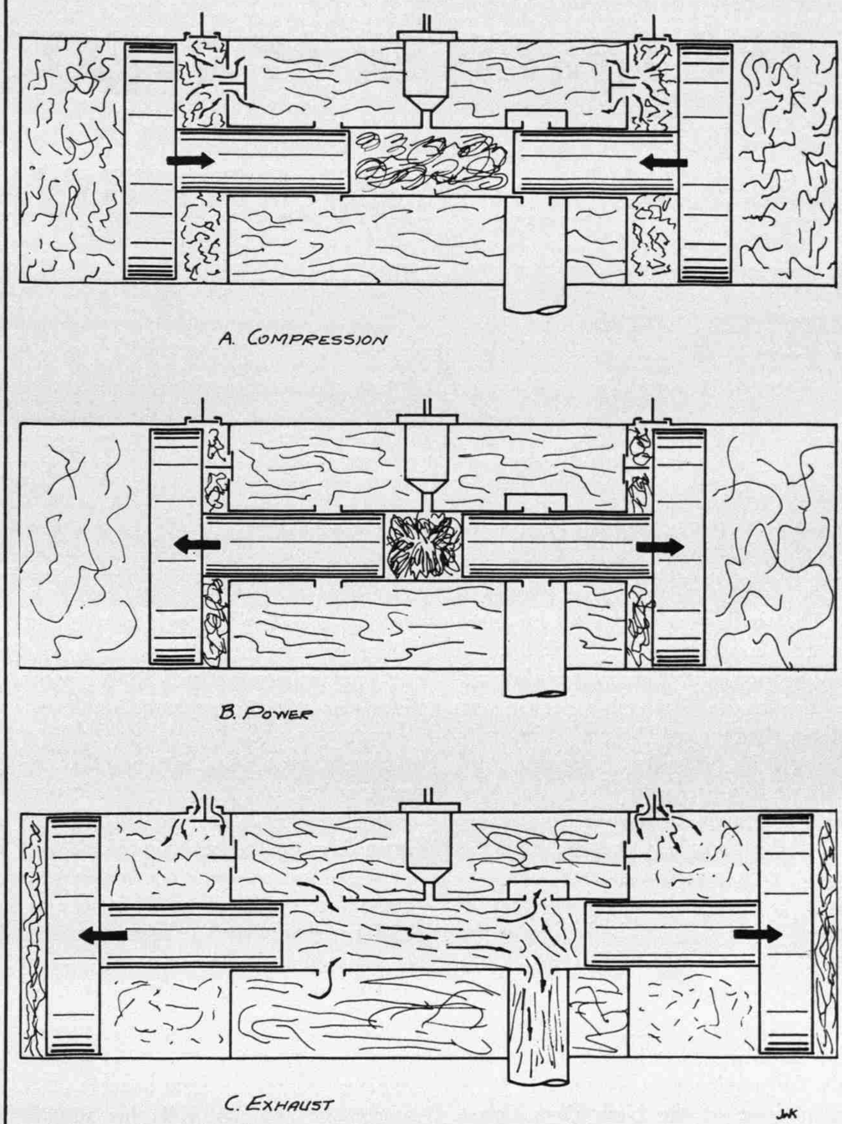


Fig. 2 The Cycle

The engine is mechanically very simple, requiring few moving parts and few precision tooled elements. Only the pistons, the injector, the valves, and the synchronizing linkage move and therefore only these parts and the surfaces they contact require machining.

Two or more engines can be used to supply gases to one turbine and thus double the power output. Output can also be varied considerably by changing the fuel, since the energy produced is directly related to the heating value of the fuel.

However, serious difficulties must be ironed out before the free piston engine can be widely applied. Many different methods have been tried for starting the engine but none of them have proved to be completely satisfactory. Some starting procedures are too complicated or too expensive, others are not dependable.

Much of the development has been devoted to improving the engine's part load efficiency, and although considerable improvement has resulted, this facet of the engine's performance is still unsatisfactory.

The contest between the free piston engine and the gas turbine will probably be decided by metallurgists. If a cheap, high-temperature alloy for turbine blades is developed, the gas turbine will probably win. With present day materials, the free piston engine has the advantage.

In order to replace the established powerplant, the challenger must not only perform as well as the present

(Continued on page 46)

THE ENGINEER IN QUEST OF PROFESSIONAL STATUS

by DR. DANIEL H. KRUGER
LABOR AND INDUSTRIAL RELATIONS CENTER
MICHIGAN STATE UNIVERSITY

The dramatic changes taking place in the engineering function and in engineering education are well known. In the decade ahead, it is certain that other changes will occur. The new changes in processes, techniques and defense requirements have had and will continue to have their impact on the engineering profession. As a result, new terminology has been created. The curricula of the engineering schools have been revised to meet the needs of the mid-twentieth century engineer.

The changes taking place are vividly portrayed by looking over the ads for engineering personnel. In a recent issue of the *New York Times* there appeared ads for the following: Supervisor of Analysis, Ionospheric Training Specialists Operations, Research Scientists, Analog and Digital Computer Design, Aerodynamicist Electronics Production Engineer, Microwave Specialist, Reliability Engineers, Rocket Engineer, Missile Range Instrumentation. The list could be extended.

These ads make interesting reading. They show the kinds of engineering skills currently in demand. They reveal the price tag for such skills. They also point out the changing nature of the engineering profession. These ads were placed by *large* firms who *employ* many engineers. Most engineers today are employees. They work in some company under some manager or supervisor. Their salaries and conditions of employment are laid down by rules which are determined by their employers.

This is indeed a significant change. Once upon a time, the working unit of engineers was small. Their work involved a high degree of independence in day-to-day decisions. They themselves set their fees or other remuneration, they regulated their own hours and conditions of employment according to market conditions and personal inclinations. They were in a sense, free practitioners. Today the individual who wants to be an engineer is dependent, for the most part, upon an employer of engineering personnel.

The market place has become a dominant force in the life of the engineer because it is the market place where the engineer sells his service. The employer-employee relationship becomes most important. In this kind of relationship, the engineer seeks status and recognition.

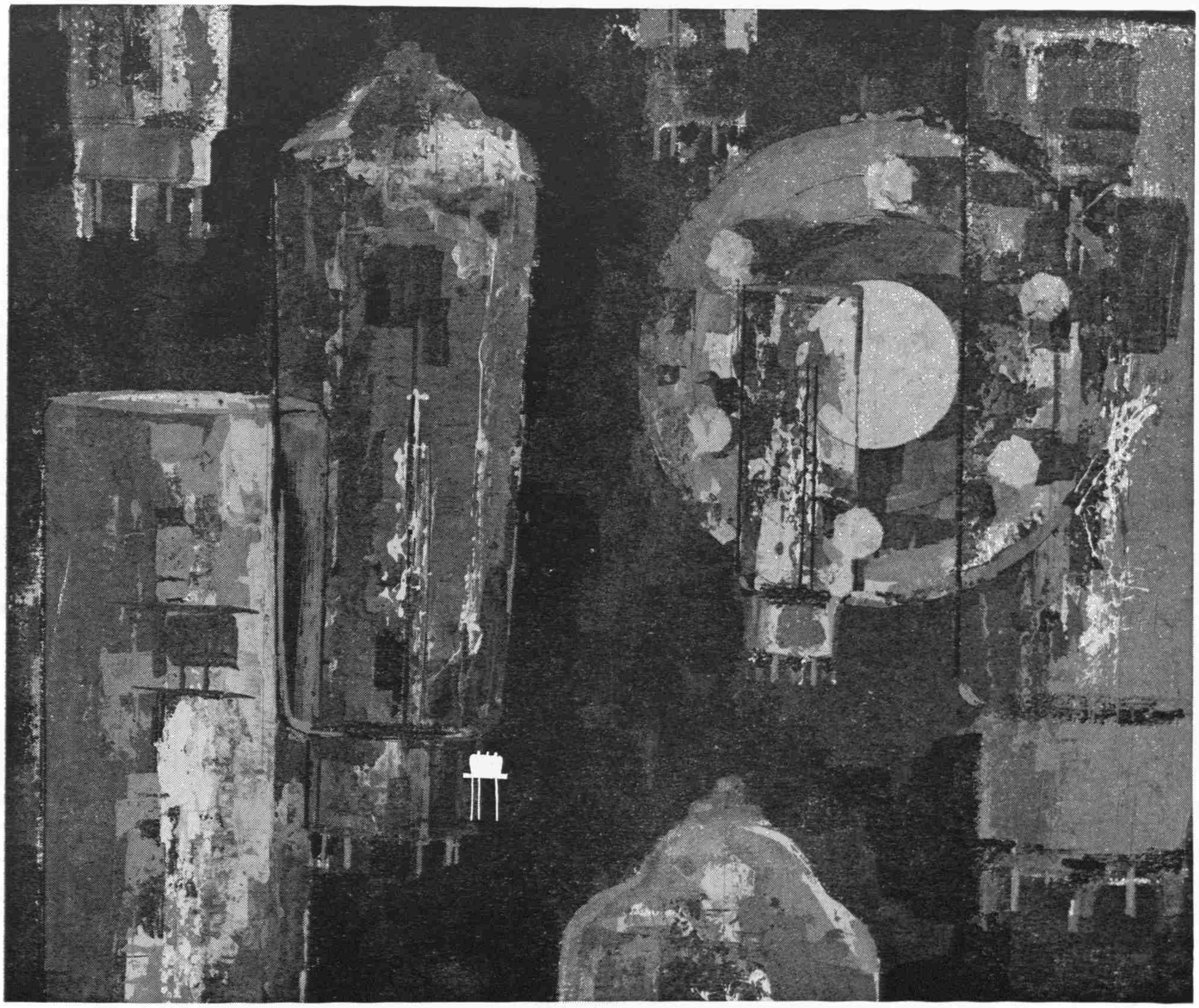
What can be said about the status of the engineer in the decade ahead? There is much discussion these days concerning the professional status of the engineer. The term profession has been widely used and abused by many groups. For example, a football player signs a contract to play professional football. By being paid to play, he becomes a professional. Other examples are just as ludicrous. There are many definitions, criteria and characteristics of professionals depending on the source used. It is not my intent to add another set of definitions or criteria to the already growing list. It seems that all kinds of groups seek status, recognition and prestige by affixing the term professional to their job title. The avidness with which the term is used has been explained, in part, as a cultural phenomenon of the United States.

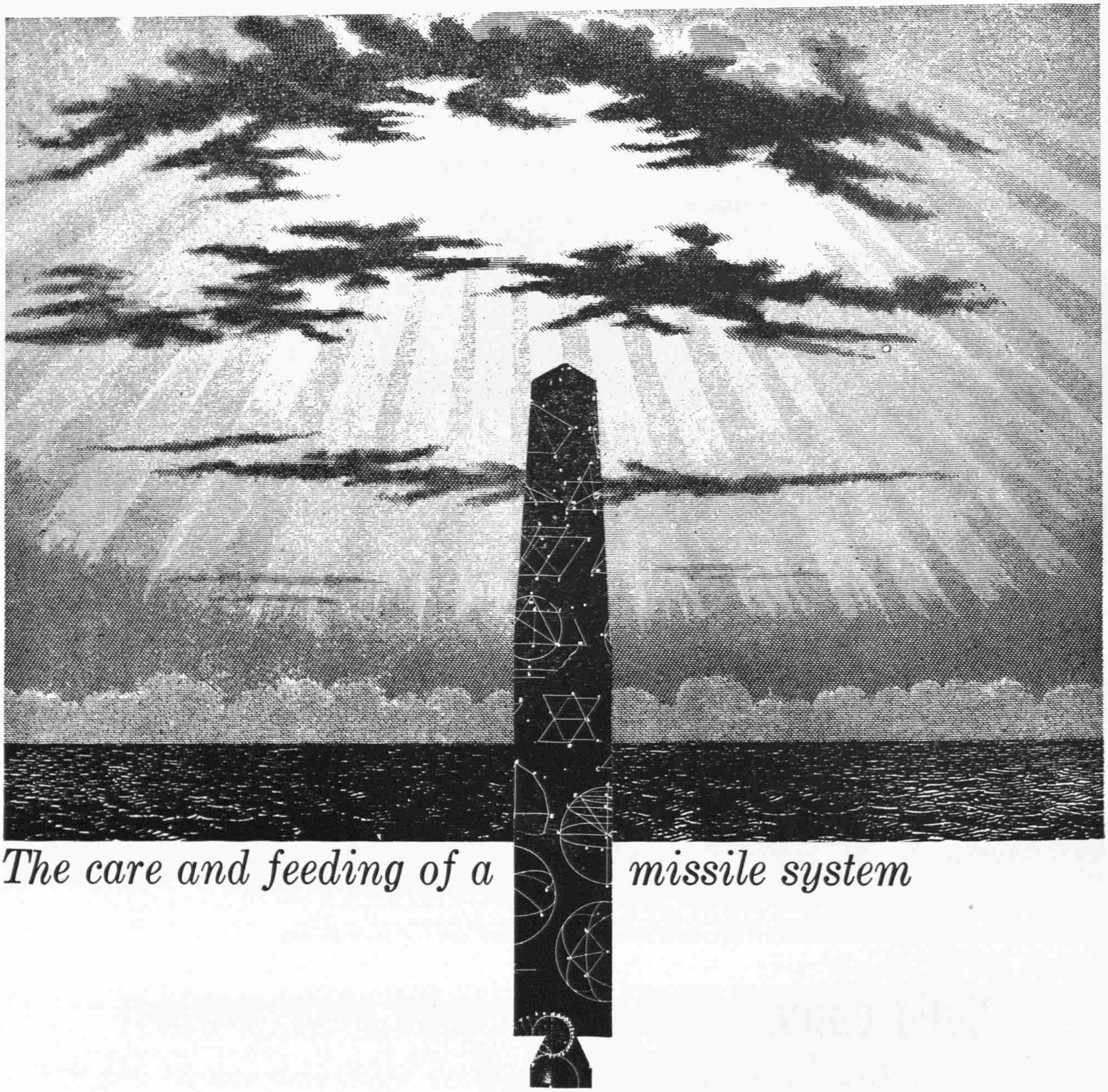
It seems that status has become all important. Many popular books have been written on the subject of the status seekers. Status can take many forms. There is status in the work place, in where one resides, in the kind of clothes one wears, where he purchases them, the kind of car he drives, etc. The available evidence suggests that the engineer seeks status in the work place.

How does the engineer obtain professional status in the work place? Is status related to job duties? Is it related to earnings? Is it related to emoluments? Is it related to education? Is it related to job assignment? Is it borrowed directly from the nature of the service performed? Is it a function of proficiency on the job? Is he a professional just because he says he is or lays claim to it?

Certainly the engineer can't claim professional status on job duties alone. Some engineers are just technicians who in the discharge of their duties perform highly routine functions. Claim cannot be made on earnings because the professional engineer is pledged "to place service before profits." Emoluments alone do not make for professional status. Educational background standing by itself is not a basis. There are some engineers who have not kept pace with changes in their field of specialization. For these the learning process ended with graduation. They have not participated in

(Continued on page 46)



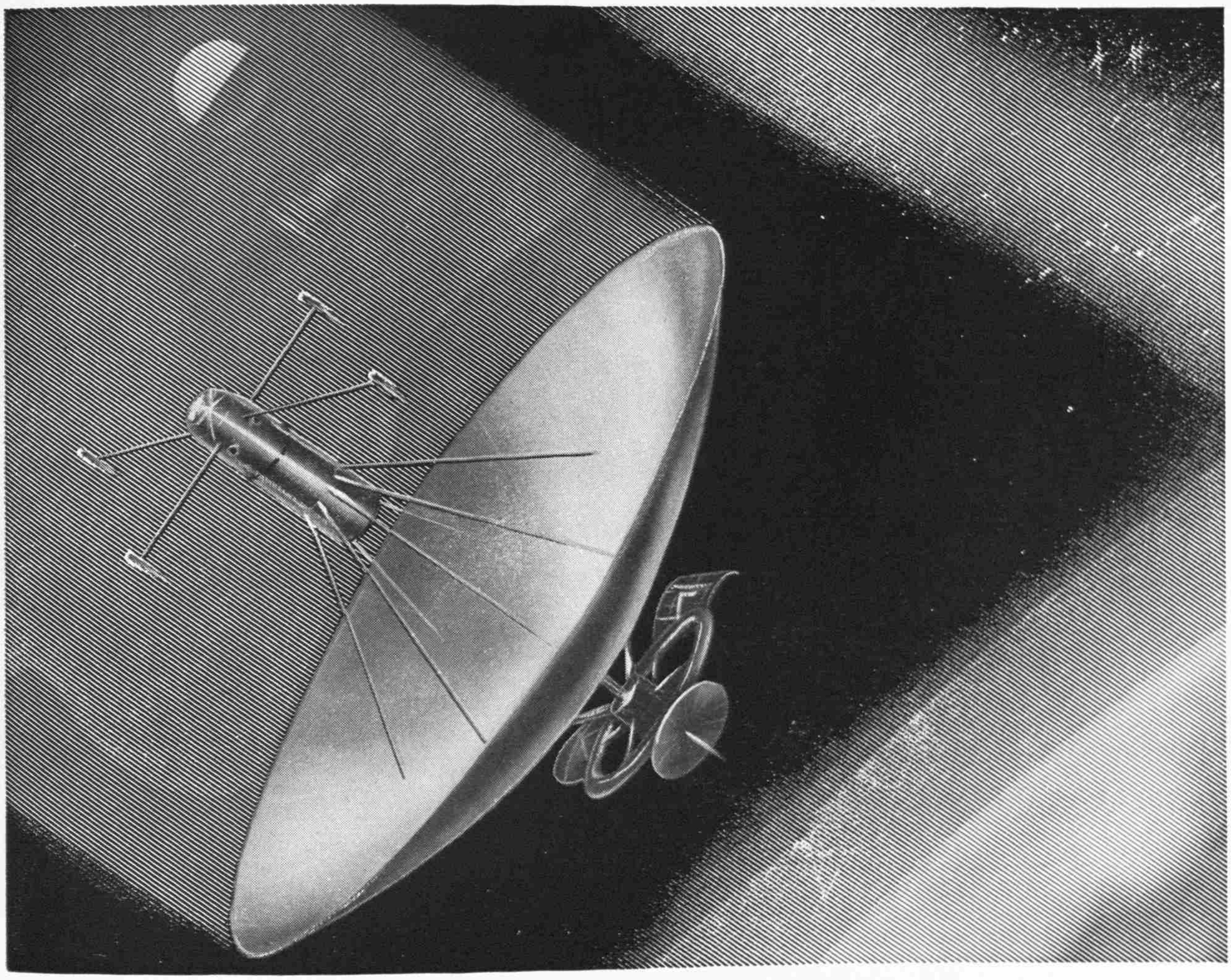


The care and feeding of a missile system

It takes more than pressing a button to send a giant rocket on its way. Actually, almost as many man-hours go into the design and construction of the support equipment as into the missile itself. A leading factor in the reliability of Douglas missile systems is the company's practice of including all the necessary ground handling units, plus detailed procedures for system utilization and crew training. This complete job allows Douglas missiles like THOR, Nike HERCULES, Nike AJAX and others to move quickly from test to operational status and perform with outstanding dependability. Douglas is seeking qualified engineers and scientists for the design of missiles, space systems and their supporting equipment. Write to C. C. LaVene, Box 600-X, Douglas Aircraft Company, Santa Monica, California.

Alfred J. Carah, Chief Design Engineer, discusses the ground installation requirements for a series of THOR-boosted space probes with Donald W. Douglas, Jr., President of DOUGLAS

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



Advanced power conversion systems for space vehicles utilizing energy of the sun or heat from a nuclear reactor are now being developed by Garrett's AiResearch divisions. Under evaluation are dynamic and static systems which convert heat into a continuous electrical power supply for space flight missions of extended duration. Component and material developments for these systems are being advanced in the fields of liquid metals, heat transfer, nonmechanical and turboelectric energy conversion, turbomachinery, alternators and controls.

Besides solar and nuclear power systems for space applications, other product areas at Garrett include small gas turbine engines, environmental systems for advanced flight vehicles, cryogenic fluid systems and controls, pneumatic valves and controls and missile accessory power units.

This diversification of project areas enables the engineer at Garrett to specialize or diversify according to his interest, not only making work more interesting but increasing the opportunities for responsibility and advancement.

An orientation program lasting several months is available for the newly graduated engineer, working on assignments with highly experienced engineers in laboratory, preliminary design and development projects. In this way his most profitable areas of interest can be found.

For further information about a career with The Garrett Corporation, write to Mr. G. D. Bradley in Los Angeles.

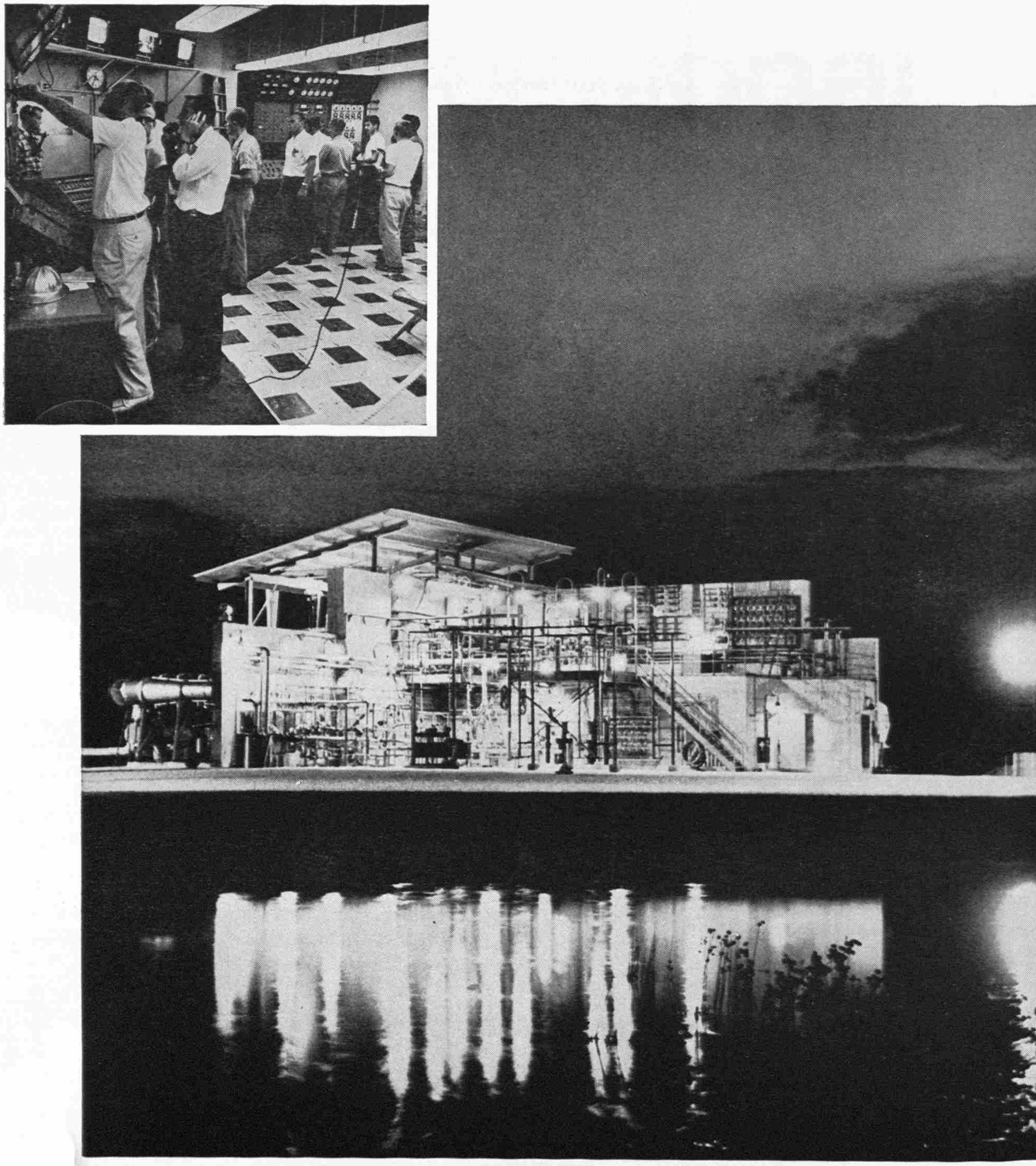
THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems and Components for: AIRCRAFT, MISSILE, SPACECRAFT, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

What would YOU do
as an engineer



Development testing of liquid hydrogen-fueled rockets is c
ried out in specially built test stands like this at Prat
Whitney Aircraft's Florida Research and Development Cen
Every phase of an experimental engine test may be control
by engineers from a remote blockhouse (inset), with clos
circuit television providing a means for visual observati

ratt & Whitney Aircraft?

Regardless of your specialty, you would work in a favorable engineering atmosphere.

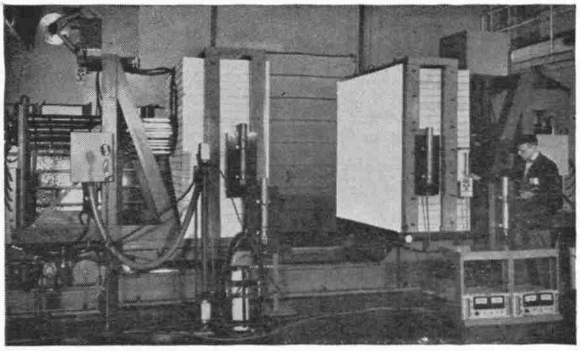
Back in 1925, when Pratt & Whitney Aircraft was designing and developing the first of its family of history-making powerplants, an attitude was born—a recognition that *engineering excellence* was the key to success.

That attitude, that recognition of the prime importance of technical superiority is still predominant at P&WA today.

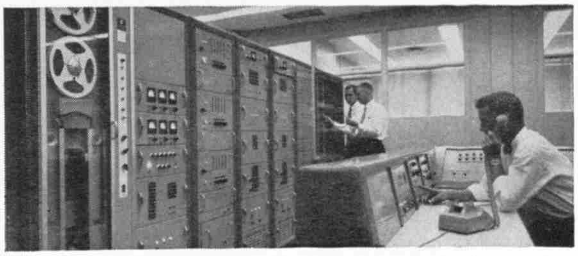
The field, of course, is broader now, the challenge greater. No longer are the company's requirements confined to graduates with degrees in mechanical and aeronautical engineering. Pratt & Whitney Aircraft today is concerned with the development of all forms of flight propulsion systems for the aerospace medium—air breathing, rocket, nuclear and other advanced types. Some are entirely new in concept. To carry out analytical, design, experimental or materials engineering assignments, men with degrees in mechanical, aeronautical, electrical, chemical and nuclear engineering are needed, along with those holding degrees in physics, chemistry and metallurgy.

Specifically, what would *you* do?—*your own engineering talent* provides the best answer. And Pratt & Whitney Aircraft provides the atmosphere in which that talent can flourish.

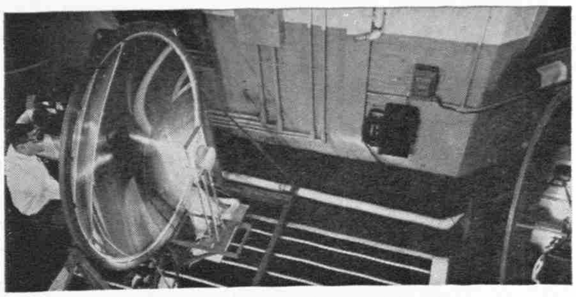
For further information regarding an engineering career at Pratt & Whitney Aircraft, consult your college placement officer or write to Mr. R. P. Azinger, Engineering Department, Pratt & Whitney Aircraft, East Hartford 8, Connecticut.



At P&WA's Connecticut Aircraft Nuclear Engine Laboratory (CANEL) many technical talents are focused on the development of nuclear propulsion systems for future air and space vehicles. With this live mock-up of a reactor, nuclear scientists and engineers can determine critical mass, material reactivity coefficients, control effectiveness and other reactor parameters.



Representative of electronic aids functioning for P&WA engineers is this on-site data recording center which can provide automatically recorded and computed data simultaneously with the testing of an engine. This equipment is capable of recording 1,200 different values per second.



Studies of solar energy collection and liquid and vapor power cycles typify P&WA's research in advanced space auxiliary power systems. Analytical and Experimental Engineers work together in such programs to establish and test basic concepts.

PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

CONNECTICUT OPERATIONS — East Hartford

FLORIDA RESEARCH AND DEVELOPMENT CENTER — Palm Beach County, Florida

WHAT'S NEW

NEW MATH HEAD

Dr. Charles P. Wells has assumed direction of the department of mathematics here at MSU. He succeeds Dr. J. Sutherland Frame who has headed the department for the past seventeen years.

Dr. Frame has stepped down at his own request to spend more time in writing and research.

Dr. Wells has been a member of the mathematics faculty since 1938. He is co-author of a book "Differential Equations" and has done post-doctoral study and research at Brown University and California Institute of Technology.

At MSU he has been connected with various mathematical research projects for the government.

PLENTY OF JOBS

Virtually all of this year's engineering graduates are assured of jobs. Demand continues highest for chemical engineers, as during the past three years. Graduates in business, commerce, and the arts are about ten percent below engineers in definite commitments.

Source:

Engineering Manpower Commission.

AIRBORNE TV

Television signals will be beamed at five million mid-west students from the world's first flying classroom this fall. The programs will originate from Purdue University, transmitted from a specially equipped DC-6 orbiting overhead.

Programs will supplement efforts of teachers in 17,000 locations covering parts of Illinois, Indiana, Kentucky, Michigan, Ohio and Wisconsin. All education levels from grade school through college are included.

"COMPACTRON"

A significant new development in the history of controlling electron flow was unveiled by General Electric late in June. The device is called a "Compactron" and consists of a packaged combination of electronic functions.

The "Compactron" eventually is expected to be widely used in entertainment electronic equipment such as radios, television receivers, and high-fidelity in place of transistors and ordinary tubes.

An example of the versatility of "Compactrons" lies in the fact that two of these devices can provide all the functions in a table radio that now are provided by five tubes or seven transistors.

Similarly, twelve "Compactrons" will provide all the electron flow control functions in a television receiver which now requires about seventeen tubes or twenty-five transistors. Further, automobile radios which combine the best qualities of both tubes and transistors eventually can be built with two "Compactrons" instead of four tubes.

DISCOVERY STARTLING

Sound waves can be used to measure more accurately the rates of fast chemical reactions, it has been found by a physicist at the University of California, Los Angeles.

One way of measuring very fast reaction rates, those that occur in one-millionth of a second, is through sound waves, whose velocities change with the time of reactions.

Using a complex apparatus, U.C.L.A. research physicist Harvey Blend has developed a method for detecting very small changes in sound wave length and velocity, which in turn allows him to measure reaction rates more accurately.

Through a combination of optical, acoustical and electronic techniques, Mr. Blend has been able to measure changes in wave length of two thousand five hundredths of an inch, and changes in frequency of one cycle in a million. These measurements, taken together, represent a new high in accuracy.

In his apparatus, which he largely designed himself, Mr. Blend used two transducers to generate and receive sound waves. He sent his waves in short bursts to eliminate the echoes which had clouded measurements of earlier researchers.

"WINDOW" ENGINE

A single-cylinder overhead valve engine with a quartz-topped piston may give new information about the burning of air and fuel in high compression auto engines.

Already it has made possible a series of high-speed color photos of combustion at compression ratios as high as 10.7-to-1, offering researchers a more realistic view than they could get before, and combustion occurring under both load and full throttle engine conditions.

Earlier "window" engines, L-head designs with quartz heads, never could be operated above 7-to-1 ratio, while today's valve-in-head engines range from 8-to-1 to 10.5-to-1.

Basic difference between the new "window" engine and its predecessors is that high-speed photos are taken through the transparent top of its piston rather than through a quartz "window" in its head—from the bottom upwards instead of the top downwards.

NEW SOUND

The first experimental effort to correlate satellite instrumentation by broadcasting a standardized timing code or clock signals over National Bureau of Standards Radio Station WWV is underway as a cooperative effort by NBS Boulder Laboratories, the Electronic Engineering Company of California, and Convair Astronautics.

Listeners to WWV are now hearing a new sound in addition to the precision once-per-second ticks. During the third minute of ten five-minute periods a buzzing sound interrupts the ticking and—too fast for the human ear to decode—indicates the day-of-the-year, hour-of-the-day, minutes, and seconds. During this one-minute period this timing information is read out sixty consecutive times.

Scientists and engineers at satellite instrumentation sites within the effective range of WWV can put the timing signal on their oscillographs and tell time to an accuracy of one milli-second or a thousandth of a second. WWV is used by missile test ranges and satellite tracking stations to synchronize their timing systems. These are in operation 24 hours per day to correlate the data received from telemetering receivers, tracking radars, special cameras, and to correlate data from the equipment operated during the launching phases.

(Continued on page 54)

Northrop is an analog for progress where engineers – and ideas – grow to reach their maximum potential. It takes a lot of engineer to measure up to Northrop's creative engineering challenges.

To convert our sophisticated requirements into producible and reliable systems calls for intellectual stature, disciplined imagination, and an explorer's venturesome curiosity.

Northrop is rich in advanced projects to grow on. If you want to associate yourself with an organization that is producing tomorrow's technological headlines today, stand up and be measured. Send us a card or letter today with your name, address, and area of special interest.

NORTHROP CORPORATION, P.O. BOX 1525, BEVERLY HILLS, CALIF.

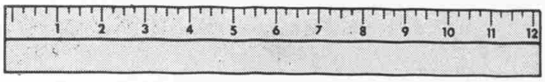
DIVISIONS: NORAIR / RADIOPLANE / NORTRONICS

Fudge Factors

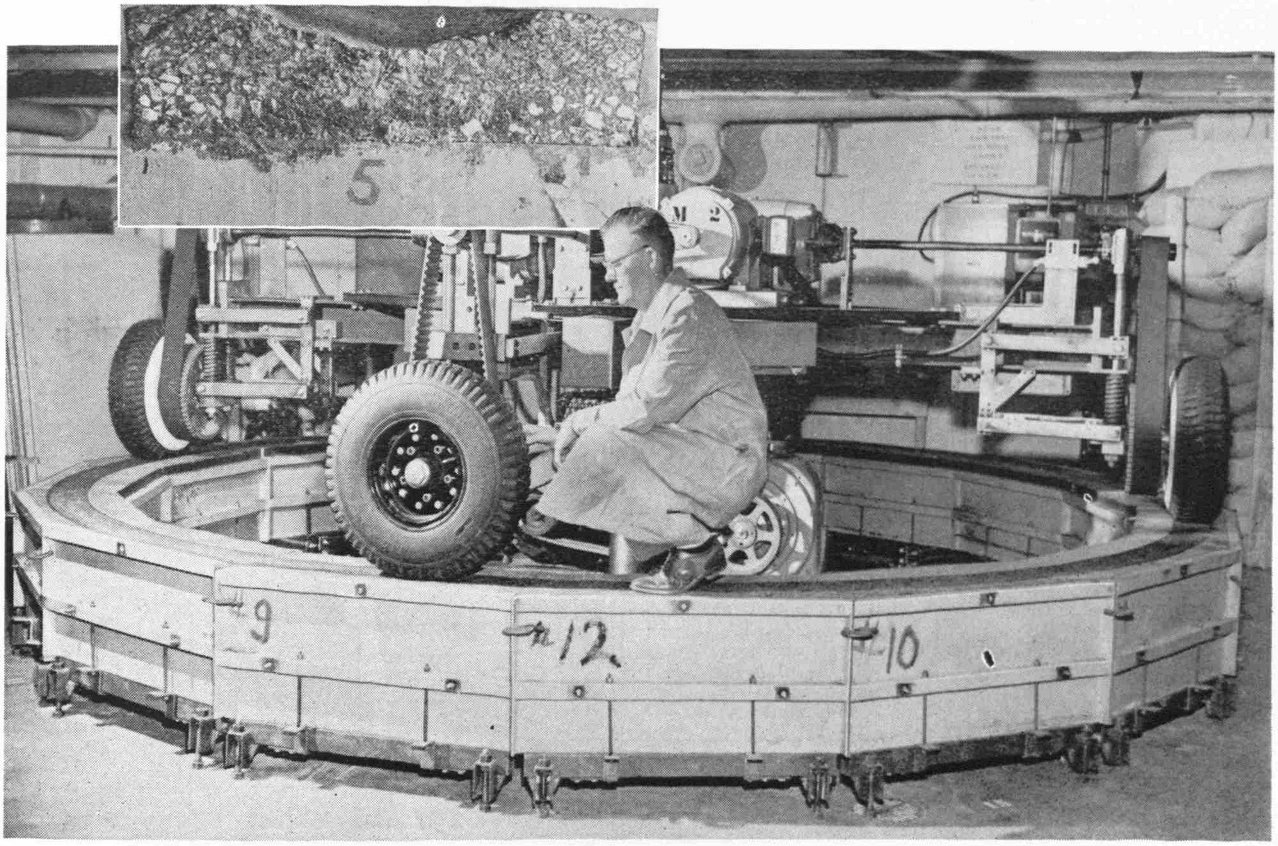
MULTIPLY	BY	TO OBTAIN
Abamperes	10	amperes.
Abamperes	3×10^{10}	statamperes.
abamperes per sq. cm.	64.52	amperes per sq. inch.
abampere-turns	10	ampere-turns
abampere-turns	12.57	gilberts
abampere-turns per cm.	25.40	ampere-turns per inch
abcoulombs	10	coulombs.
abcoulombs	3×10^{10}	statcoulombs
abcoulombs per sq. cm.	64.52	coulombs per sq. inch.
abfarads	10^{9}	farads
abfarads	10^{15}	microfarads.
abfarads	9×10^{20}	statfarads.
abhenries	10^{-9}	henries
abhenries	10^{-6}	millihenries.
abhenries	$1/9\times10^{-20}$	stathenries.
abmhos per cm. cube	1.662×10^{2}	mhos per mil foot.
abmhos per cm. cube	10^{3}	megmhos per cm. cube.
abohms	10^{-15}	megohms
abohms	10^{-3}	microhoms.
abohms	10^{-9}	ohms.
abohms	$1/9\times10^{-20}$	statohms.
abohms per cm. cube	10^{-3}	microhms per cm. cube.
abohms per cm. cube	6.015×10^{-3}	ohms per mil foot.
abvolts	$1/3\times10^{-10}$	statvolts.
abvolts	10^{-8}	volts.
acres	43,560	square feet.
acres	4047	square meters.
acres	1.562×10^{-3}	square miles.
acres	5645.38	square varas.
acres	4840	square yards.
acre-feet	43,560	cubic-feet.
acre-feet	3.259×10^{5}	gallons.
amperes	1/10	abamperes.
amperes	3×10^{9}	statamperes.
amperes per sq. cm.	6.452	amperes per sq. inch.
amperes per sq inch	0.01550	abamperes per sq. cm.
amperes per sq inch	0.1550	amperes per sq. cm.
amperes per sq inch	4.650×10^{8}	statamperes per sq. cm.
ampere-turns	1/10	abampere-turns.
ampere-turns	1.257	gilberts.
ampere-turns per cm.	2.540	ampere-turns per in.
ampere-turns per inch	0.03937	abampere-turns per cm.
ampere-turns per inch	0.3937	ampere-turns per cm.
ampere-turns per inch	0.4950	gilberts per cm.
areas	0.02471	acres.
areas	100	square meters.
atmospheres	76.0	cms. of mercury.
atmospheres	29.92	inches of mercury.
atmospheres	33.90	feet of water.
atmospheres	10,333	kgs. per sq. meter.
atmospheres	14.70	pounds per sq. inch.
atmospheres	1.058	tons per sq. foot.
Bars	9.870×10^{-7}	atmospheres.
Bars	1	dynes per sq. cm.
Bars	0.01020	kgs. per square meter
Bars	2.089×10^{-3}	pounds per sq. foot.
Bars	1.450×10^{-5}	pounds per sq. inch.
board-feet	144 sq. in.x1 in.	cubic inches.
British thermal units	0.2530	kilogram-calories.
British thermal units	777.5	foot-pounds.
British thermal units	3.927×10^{-4}	horse-power-hours.
British thermal units	1054	joules.
British thermal units	107.5	kilogram-meters.
British thermal units	2.928×10^{-4}	kilowatt-hours.
B.t.u. per min	12.96	foot-pounds per sec.
B.t.u. per min	0.02356	horse-power.
B.t.u. per min	0.01757	kilowatts.
B.t.u. per min	17.57	watts.
B.t.u. per sq. ft. per min	0.1220	watts per square inch.
bushels	1.244	cubic feet.
bushels	2150	cubic inches.
bushels	0.03524	cubic meters.
bushels	4	pecks.
bushels	64	pints (dry).
bushels	32	quarts (dry)
Centares	1	square meters.
centigrams	0.01	grams.
centiliters	0.01	liters.
centimeters	0.3937	inches.
centimeters	0.01	meters.
centimeters	393.7	mils.
centimeters	10	millimeters.
centimeter-dynes	1.020×10^{-3}	centimeter-grams.
centimeter-dynes	1.020×10^{-8}	meter-kilograms.
centimeter-dynes	7.376×10^{-8}	pound-feet.

MULTIPLY	BY	TO OBTAIN
centimeter-grams	980.7	centimeter-dynes.
centimeter-grams	10^{-5}	meter-kilograms.
centimeter-grams	7.233×10^{-5}	pound-feet.
centimeters of mercury	0.01316	atmospheres.
centimeters of mercury	0.4461	feet of water.
centimeters of mercury	136.0	kgs. per square meter.
centimeters of mercury	27.85	pounds per sq. foot.
centimeters of mercury	0.1934	pounds per sq. inch.
centimeters per second	1.969	feet per minute.
centimeters per second	0.03281	feet per second.
centimeters per second	0.036	kilometers per hour.
centimeters per second	0.6	meters per minute.
centimeters per second	0.02237	miles per hour.
centimeters per second	3.728×10^{-4}	miles per minute.
cms. per sec. per sec.	0.03281	feet per sec. per sec.
cms. per sec. per sec.	0.036	kms. per hour per sec
cms. per sec. per sec.	0.02237	miles per hour per sec
circular mils	5.067×10^{-6}	square centimeters.
circular mils	7.854×10^{-7}	square inches.
circular mils	0.7854	square mils.
cord-feet	4 ft.x4 ft.x1 ft.	cubic feet.
cords	8 ft.x4 ft.x4 ft.	cubic feet.
coulombs	1/10	abcoulombs.
coulombs	3×10^{9}	statcoulombs.
coulombs per sq. inch	0.01550	abcoulombs per sq. cm
coulombs per sq inch	0.1550	coulombs per sq. cm.
coulombs per sq. inch	4.650×10^{8}	statcouls. per sq. cm.
cubic centimeters	3.531×10^{-5}	cubic feet.
cubic centimeters	6.102×10^{-2}	cubic inches.
cubic centimeters	10^{-6}	cubic meters.
cubic centimeters	1.308×10^{-6}	cubic yards.
cubic centimeters	2.642×10^{-4}	gallons.
cubic centimeters	10^{-3}	liters.
cubic centimeters	2.113×10^{-3}	pints (liq.).
cubic centimeters	1.057×10^{-3}	quarts (liq.).
cubic feet	2.832×10^{4}	cubic cms.
cubic feet	1728	cubic inches.
cubic feet	0.02832	cubic meters.
cubic feet	0.03704	cubic yards.
cubic feet	7.481	gallons.
cubic feet	28.32	liters.
cubic feet	59.84	pints (liq.).
cubic feet	29.92	quarts (liq.).
cubic feet per minute	472.0	cubic cms. per sec.
cubic feet per minute	0.1247	gallons per sec.
cubic feet per minute	0.4720	liters per second
cubic feet per minute	62.4	lbs. of water per min.
cubic inches	16.39	cubic centimeters.
cubic inches	5.787×10^{-4}	cubic feet.
cubic inches	1.639×10^{-5}	cubic meters.
cubic inches	2.143×10^{-5}	cubic yards.
cubic inches	4.329×10^{-3}	gallons.
cubic inches	1.639×10^{-2}	liters.
cubic inches	0.03463	pints (liq.).
cubic inches	0.01732	quarts (liq.).
cubic meters	10^{6}	cubic centimeters
cubic meters	35.31	cubic feet.
cubic meters	61,023	cubic inches.
cubic meters	1.308	cubic yards.
cubic meters	264.2	gallons.
cubic meters	10^{3}	liters.
cubic meters	2113	pints (liq.).
cubic meters.	1057	quarts (liq.).
cubic yards	7.646×10^{5}	cubic centimeters.
cubic yards	27	cubic feet.
cubic yards	46,656	cubic inches.
cubic yards	0.7646	cubic meters.
cubic yards	202.0	gallons.
cubic yards	764.6	liters.
cubic yards	1616	pints (liq.).
cubic yards	807.9	quarts (liq.).
cubic yards per minute	0.45	cubic feet per second.
cubic yards per minute	3.367	gallons per second.
cubic yards per minute	12.74	liters per second.
Days	24	hours.
Days	1440	minutes.
Days	86,400	seconds.
decigrams	0.1	grams.
deciliters	0.1	liters.
decimeters	0.1	meters.
degrees (angle)	60	minutes.
degrees (angle)	0.01745	radians.
degrees (angle)	3600	seconds.
degrees per second	0.01745	radians per second.
degrees per second	0.1667	revolutions per min.
degrees per second	0.002778	revolutions per sec.
dekagrams	10	grams.
dekaliters	10	liters.
dekameters	10	meters.
dollars (U.S.)	5.182	francs (French).
dollars (U.S.)	4.20	marks (German).
dollars (U.S.)	0.2055	pounds sterling (Brit.)
dollars (U.S.)	4.11	shillings (British)
drams	1.772	grams.
drams	0.0625	ounces.
dynes	1.020×10^{-3}	grams.
dynes	7.233×10^{-5}	poundals.

(Continued on page 38)



ONLY 12 INCHES WIDE...



Tom Speer, Senior Engineering Research Supervisor at Standard Oil, inspects one of the 12 sections in a new miniature road tester. Under simulated weather conditions, four wheels whirl around to reveal wear patterns and other vital information. (INSET) Ruler shows wear pattern after strip has taken pounding from tires during rain, freeze, thaw and heat.

...THIS 'ROAD' CARRIES
WORLD'S HEAVIEST TRAFFIC!

Say good-bye to washboard pavements and chuck holes—their doom may be sealed!

Key weapon in the war on costly road damage is a new miniature highway developed in the Standard Oil research laboratories in Whiting, Indiana. It is only 12 inches wide and 44 feet in circumference, but it carries heavier loads than any highway in the world. This Tom Thumb turnpike will eventually lead to methods of building longer-lasting, smoother, safer highways...at far less cost to taxpayers.

Four wheels whirling around hour after hour can give it any degree of traffic intensity desired. Pressure that corresponds to the weight of the heaviest trucks can be applied to the wheels. To simulate actual traffic, the wheels are placed on braking and acceleration 90 per cent of the time. Automated electronic equipment can quickly change "road conditions" from desert dry to cloudburst drenched. "Road conditions", too, can be changed from freezing to thawing.

Within weeks, the new test-tube roadway can determine what happens to roads during years of use in all kinds of weather. It can pretest paving formulas and techniques, and may show how to eliminate washboard pavement and chuck holes. Savings in highway research alone may run into millions of dollars. Even larger savings in auto and road repairs and possibly in gasoline taxes are in sight.

This test-tube roadway is just one of the many exciting developments at Standard. Every day, scientific research, pure and applied, points the way to new or improved products. This work holds great challenge and satisfaction for young men who are interested in scientific and technical careers.

STANDARD OIL COMPANY

910 SOUTH MICHIGAN AVENUE, CHICAGO 80, ILLINOIS

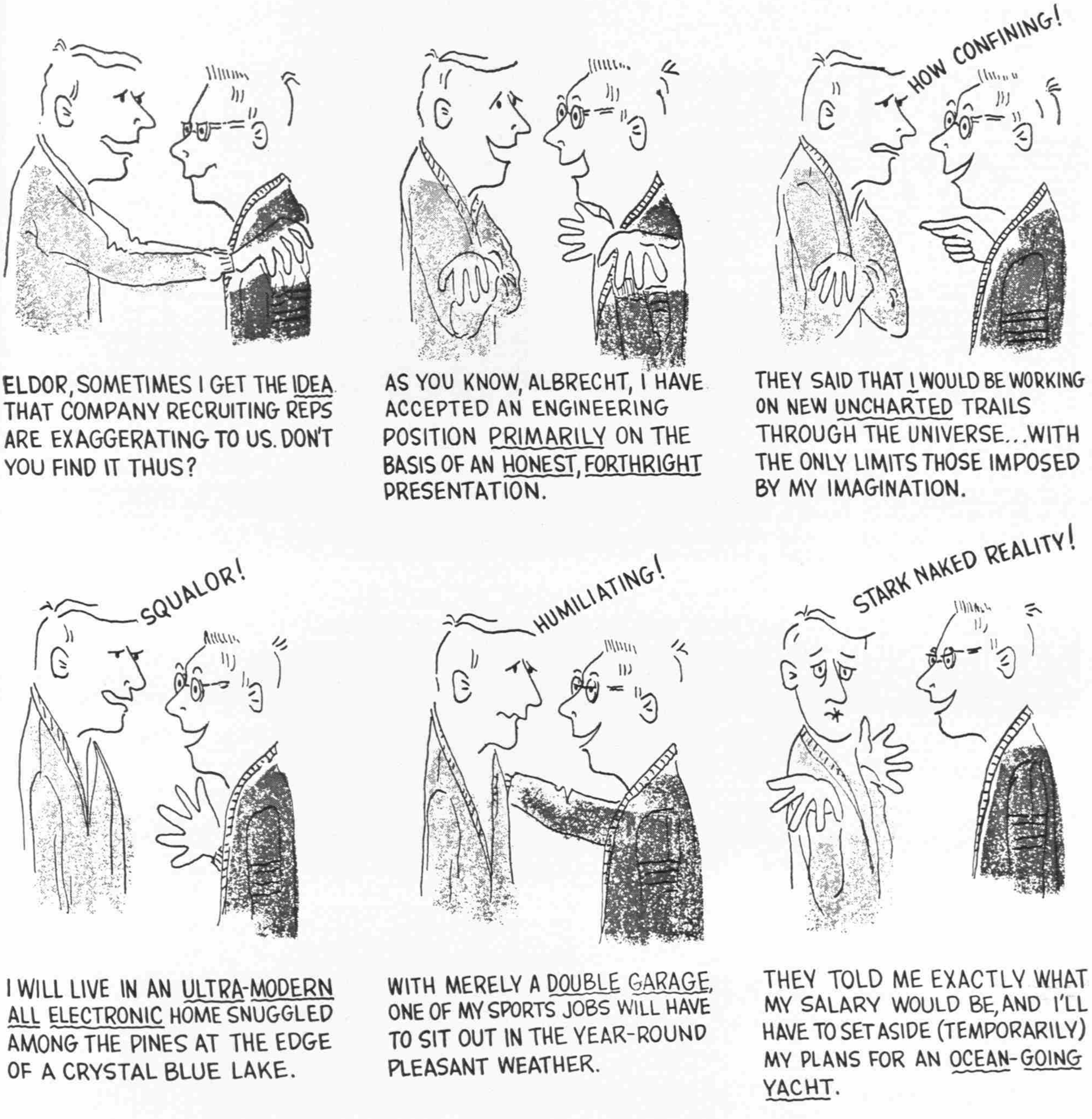
STANDARD

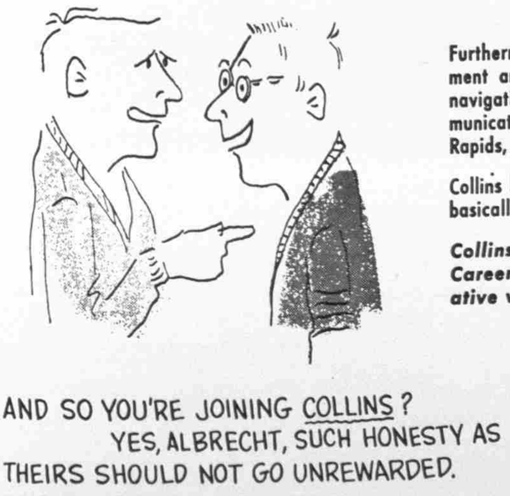
THE SIGN OF PROGRESS... THROUGH RESEARCH

(Continued from page 36)

MULTIPLY	BY	TO OBTAIN
dynes	2.248×10^{-6}	pounds.
dynes per square cm.	1	bars.
Ergs	9.486×10^{-11}	British thermal units.
Ergs	1	dyne-centimeters.
Ergs	7.376×10^{-8}	foot-pounds.
Ergs	1.020×10^{-3}	gram-centimeters.
Ergs	10^{-7}	joules.
Ergs	$2{,}390\times10^{-11}$	kilogram-calories.
Ergs	1.020×10^{-8}	kilogram-meters.
ergs per second	5.692×10^{-9}	B.t. units per minute.
ergs per second	4.426×10^{-6}	foot-pounds per min.
ergs per second	7.376×10^{-8}	foot-pounds per sec.
ergs per second	1.341×10^{-10}	horse-power.
ergs per second	1.434×10^{-9}	kg.-calories per min.
ergs per second	10^{-10}	kilowatts.
Farads	10^{-9}	abfarads.
Farads	10^{6}	microfarads.
Farads	9×10^{-11}	statfarads.
fathoms	6	feet.
feet	30.48	centimeters.
feet	12	inches.
feet	0.3048	meters.
feet	.36	varas.
feet	1/3	yards.
feet of water	0.02950	atmospheres.
feet of water	0.8826	inches of mercury.
feet of water	304.8	kgs. per square meter.
feet of water	62.43	pounds per sq. ft.
feet of water	0.4335	pounds per sq. inch.
feet per minute	0.5080	centimeters per sec.
feet per minute	0.01667	feet per sec.
feet per minute	0.01829	kilometers per hour.
feet per minute	0.3048	meters per minute.
feet per minute	0.01136	miles per hour.
feet per second	30.48	centimeters per sec.
feet per second	1.097	kilometers per hour.
feet per second	0.5921	knots per hour.
feet per second	18.29	meters per minute.
feet per second	0.6818	miles per hour.
feet per second	0.01136	miles per minute.
feet per 100 feet	1	per cent grade.
feet per sec. per sec.	30.48	cms. per sec. per sec.
feet per sec. per sec.	1.097	kms. per hr. per sec.
feet per sec. per sec.	0.3048	meters per sec. per sec.
feet per sec. per sec.	0.6818	miles per hr. per sec.
foot-pounds	1.286×10^{-3}	British thermal units.
foot-pounds	1.356×10^{7}	ergs.
foot-pounds	5.050×10^{-7}	horse-power-hours.
foot-pounds	1.356	joules.
foot-pounds	3.241×10^{-4}	kilogram-calories.
foot-pounds	0.1383	kilogram-meters
foot-pounds	3.766×10^{-7}	kilowatt-hours.
foot-pounds per minute	1.286×10^{-3}	B.t. units per minute.
foot-pounds per minute	0.01667	foot-pounds per sec.
foot-pounds per minute	3.300×10^{-5}	horse-power.
foot-pounds per minute	3.241×10^{-4}	kg.-calories per minute.
foot-pounds per minute	2.260×10^{-5}	kilowatts.
foot-pounds per second	7.717×10^{-2}	B.t. units per minute.
foot-pounds per second	1.818×10^{-3}	horse-power.
foot-pounds per second	1.945×10^{-2}	kg.-calories per min.
foot-pounds per second	1.356×10^{-3}	kilowatts.
francs (French)	0.193	dollars (U.S.).
francs (French)	0.811	marks (German).
francs (French)	0.03865	pounds sterling (Brit.).
furlongs	40	rods.
Gallons	3785	cubic centimeters.
Gallons	0.1337	cubic feet.
Gallons	231	cubic inches.
Gallons	3.785×10^{-3}	cubic meters.
Gallons	4.951×10^{-3}	cubic yards.
Gallons	3.785	liters.
Gallons	8	pints (liq.).
Gallons	4	quarts (liq.).
gallons per minute	2.228×10^{-3}	cubic feet per second.
gallons per minute	0.06308	liters per second.
gausses	6.452	lines per square inch.
gilberts	0.07958	abampere-turns.
gilberts	0.7958	ampere-turns.
gilberts per centimeter	2.021	ampere-turns per inch.
gills	0.1183	liters.
gills	0.25	pints (liq.).
grains (troy)	1	grains (av.).
grains (troy)	0.06480	grams.
grains (troy)	0.04167	pennyweights (troy).
grams	980.7	dynes.
grams	15.43	grains (troy).
grams	10^{-3}	kilograms.
grams	10^{3}	milligrams.
grams	0.03527	ounces.
grams	0.03215	ounces (troy).
grams	0.07093	poundals.
grams	2.205×10^{-3}	pounds.
gram-calories	3.968×10^{-3}	British thermal units.
gram-centimeters	9.302×10^{-8}	British thermal units.
gram-centimeters	980.7	ergs.
gram-centimeters	7.233×10^{-5}	foot-pounds.
gram-centimeters	9.807×10^{-5}	joules.
gram-centimeters	2.344×10^{-8}	kilogram-calories.
gram-centimeters	10^{-5}	kilogram-meters.
grams per cm.	5.600×10^{-3}	pounds per inch.
grams per cu. cm.	62.43	pounds per cubic foot.
grams per cu. cm.	0.03613	pounds per cubic inch.
grams per cu. cm.	3.405×10^{-7}	pounds per mil-foot.
Hectares	2.471	acres.
Hectares	$1{,}076\times10^{5}$	square feet.
hectograms	100	grams.
hectoliters	100	liters.
hectometers	100	meters.
hectowatts	100	watts.
hemispheres (sol. angle)	0.5	sphere.
hemispheres (sol. angle)	4	spherical right angles.
hemispheres (sol. angle)	6.283	steradians.
henries	10^{9}	abhenries.
henries	10^{3}	millihenries.
henries	$1/9\times10^{-11}$	stathenries.
horse-power	42.44	B.t. units per min.
horse-power	33,000	foot-pounds per min.
horse-power	550	foot-pounds per sec.
horse-power	1.014	horse-power (metric)
horse-power	10.70	kg.-calories per min.
horse-power	0.7457	kilowatts.
horse-power	745.7	watts.
horse-power (boiler)	33,520	B.t.u. per hour.
horse-power (boiler)	9.804	kilowatts.
horse-power-hours	2547	British thermal units.
horse-power-hours	1.98×10^{6}	foot-pounds.
horse-power-hours	2.684×10^{6}	joules.
horse-power-hours	641.7	kilogram-calories.
horse-power-hours	2.737×10^{5}	kilogram-meters.
horse-power-hours	0.7457	kilowatt-hours.
hours	60	minutes.
hours	3600	seconds.
Inches	2.540	centimeters.
Inches	10^{3}	mils.
Inches	.03	varas.
Inches of mercury	0.03342	atmospheres.
Inches of mercury	1.133	feet of water.
Inches of mercury	345.3	kgs. per square meter.
Inches of mercury	70.73	pounds per square ft.
Inches of mercury	0.4912	pounds per square in.
Inches of water	0.002458	atmospheres.
Inches of water	0.07355	inches of mercury.
Inches of water	25.40	kgs. per square meter.
Inches of water	0.5781	ounces per square in.
Inches of water	5.204	pounds per square ft.
Inches of water	0.03613	pounds per square in.
Joules	9.486×10^{-4}	British thermal units.
Joules	10^{7}	ergs.
Joules	0.7376	foot-pounds.
Joules	2.390×10^{-4}	kilogram-calories.
Joules	0.1020	kilogram-meters
Joules	2.778×10^{-4}	watt-hours.
Kilograms	980.665	dynes.
Kilograms	10^{3}	grams.
Kilograms	70.93	poundals.
Kilograms	2.2046	pounds.
Kilograms	1.102×10^{-3}	tons (short).
kilogram-calories	3.968	British thermal units.
kilogram-calories	3086	foot-pounds.
kilogram-calories	1.558×10^{-3}	horse-power-hours.
kilogram-calories	4183	joules.
kilogram-calories	426.6	kilogram meters.
kilogram-calories	1.162×10^{-3}	kilowatt-hours.
kg.-calories per min.	51.43	foot-pounds per sec.
kg.-calories per min.	0.09351	horse-power.
kg.-calories per min.	0.06972	kilowatts.
kgs.-cms. squared	2.373×10^{-3}	pounds-feet squared.
kgs.-cms. squared	0.3417	pounds-inches squared.
kilogram-meters	9.302×10^{-3}	British thermal units.
kilogram-meters	9.807×10^{7}	ergs.
kilogram-meters	7.233	foot-pounds.
kilogram-meters	9.807	joules.
kilogram-meters	2.344×10^{-3}	kilogram-calories.
kilogram-meters	2.724×10^{-6}	kilowatt-hours.
kgs. per cubic meter	10^{-3}	grams per cubic cm.
kgs. per cubic meter	0.06243	pounds per cubic foot.
kgs. per cubic meter	3.613×10^{-5}	pounds per cubic inch.
kgs. per cubic meter	3.405×10^{-10}	pounds per mil. foot.
kgs. per meter	0.6720	pounds per foot.
kgs. per square meter	9.678×10^{-5}	atmospheres.
kgs. per square meter	98.07	bars.
kgs. per square meter	3.281×10^{-3}	feet of water.
kgs. per square meter	2.896×10^{-3}	inches of mercury.
kgs. per square meter	0.2048	pounds per square ft.
kgs. per square meter	1.422×10^{-3}	pounds per square in.
kgs. per sq. millimeter	10^{6}	kgs. per square meter.
kilolines	10^{3}	maxwells.
kiloliters	10^{3}	liters.
kilometers	10^{5}	centimeters.
kilometers	3281	feet.
kilometers	10^{3}	meters.

(Continued on page 40)





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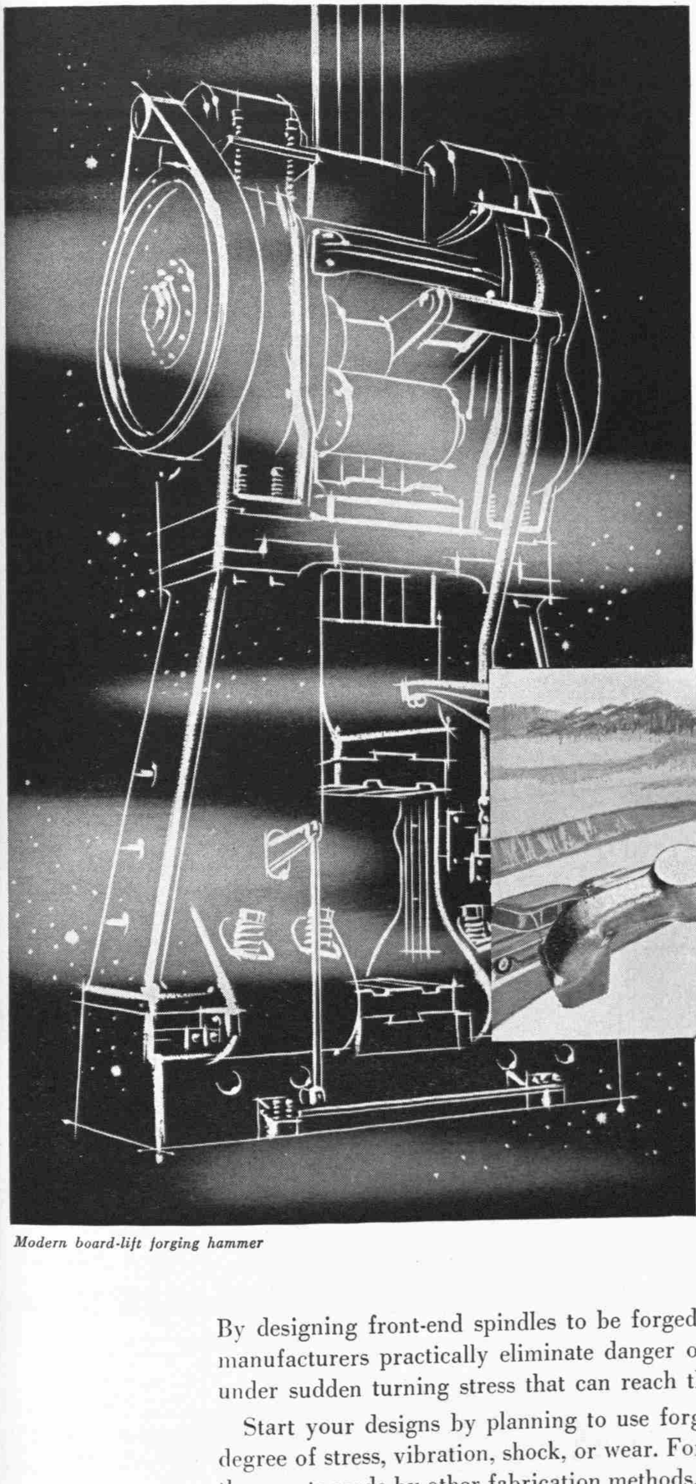
(Continued from page 38)

MULTIPLY	BY	TO OBTAIN
kilometers	0.6214	miles.
kilometers	1093.6	yards.
kilometers per hour	27.78	centimeters per sec.
kilometers per hour	54.68	feet per minute.
kilometers per hour	0.9113	feet per second.
kilometers per hour	0.5396	knots per hour.
kilometers per hour	16.67	meters per minute.
kilometers per hour	0.6214	miles per hour.
kms. per hour per sec.	27.78	cms. per sec. per sec.
kms. per hour per sec.	0.9113	ft. per sec. per sec.
kms. per hour per sec.	0.2778	meters per sec. per sec.
kms. per hour per sec.	0.6214	miles per hr. per sec.
kilometers per min.	60	kilometers per hour.
kilowatts	56.92	B.t.u. units per min.
kilowatts	4.425×10^{4}	foot-pounds per min.
kilowatts	737.6	foot-pounds per sec.
kilowatts	1.341	horse-power.
kilowatts	14.34	kg.-calories per min.
kilowatts	10^{3}	watts.
kilowatt-hours	3415	British thermal units.
kilowatt-hours	2.655×10^{6}	foot-pounds.
kilowatt-hours	1.341	horse-power-hours.
kilowatt-hours	3.6×10^{6}	joules.
kilowatt-hours	860.5	kilogram-calories.
kilowatt-hours	3.671×10^{5}	kilogram-meters.
knots	6080	feet.
knots	1.853	kilometers.
knots	1.152	miles.
knots	2027	yards.
knots per hour	51.48	centimeters per sec.
knots per hour	1.689	feet per sec.
knots per hour	1.853	kilometers per hour.
knots per hour	1.152	miles per hour.
Lines per square cm.	1	gausses.
lines per square inch	0.1550	gausses.
links (engineer's)	12	inches.
links (suveyor's)	7.92	inches.
liters	10^{3}	cubic centimeters.
liters	0.03531	cubic feet.
liters	61.02	cubic inches.
liters	10^{-3}	cubic meters.
liters	1.308×10^{-3}	cubic yards.
liters	0.2642	gallons
liters	2.113	pints (liq.).
liters	1.057	quarts (liq.).
liters per minute	5.855×10^{-4}	cubic feet per second.
liters per minute	4.403×10^{-3}	gallons per second.
$\log^{10} N$	2.303	$\log_{10} N$ or $\ln N$.
$\log_{10} N$ or $\ln N$	0.4343	$\log_{10} N$.
lumens per sq. ft.	1	foot-candles.
Marks (German)	0.238	dollars (U.S.).
Marks (German)	1.233	francs (French).
Marks (German)	0.04890	pounds sterling (Brit.).
maxwells	10^{-3}	kilolines.
megalines	10^{6}	maxwells.
megmhos per cm. cube	10^{-3}	abmhos per cm. cube.
megmhos per cm. cube	2.540	megmhos per in. cube.
megmhos per cm. cube	0.1662	mhos per mil foot.
megmhos per inch cube	0.3937	megmhos per cm. cube.
megohms	10^{6}	ohms.
meters	100	centimeters.
meters	3.2808	feet.
meters	39.37	inches.
meters	10^{-3}	kilometers.
meters	10^{3}	millimeters.
meters	1.0936	yards.
meter-kilograms	9.807×10^{7}	centimeter-dynes.
meter-kilograms	10^{5}	centimeter-grams.
meter-kilograms	7.233	pound-feet.
meters per minute	1.667	centimeters per sec.
meters per minute	3.281	feet per minute.
meters per minute	0.05468	feet per second.
meters per minute	0.06	kilometers per hour.
meters per minute	0.03728	miles per hour.
meters per second	1968	feet per minute.
meters per second	3.284	feet per second.
meters per second	3.0	kilometers per hour.
meters per second	0.06	kilometers per min.
meters per second	2.237	miles per hour.
meters per second	0.03728	miles per minute.
meters per sec. per sec.	3.281	feet per sec. per sec.
meters per sec. per sec.	3.6	kms. per hour per sec.
meters per sec. per sec.	2.237	miles per hour per sec.
mhos per mil foot	6.015×10^{-3}	abmhos per cm. cube.
mhos per mil foot	6.015	megmhos per cm. cube.
mhos per mil foot	15.28	megmhos per in. cube.
microfarads	10^{-15}	abfarads.
microfarads	10^{-6}	farads.
microfarads	9×10^{5}	statfarads.
micrograms	10^{-6}	grams.
microliters	10^{-6}	liters.
microhms	10^{3}	abohms.
microhms	10^{-12}	megohms.
microhms	10^{-6}	ohms.
microhms	$1/9 \times 10^{-17}$	statohms.
microhms per cm. cube	10^{3}	abohms per cm. cube.
microhms per cm. cube	0.3937	microhms p. in. cube.

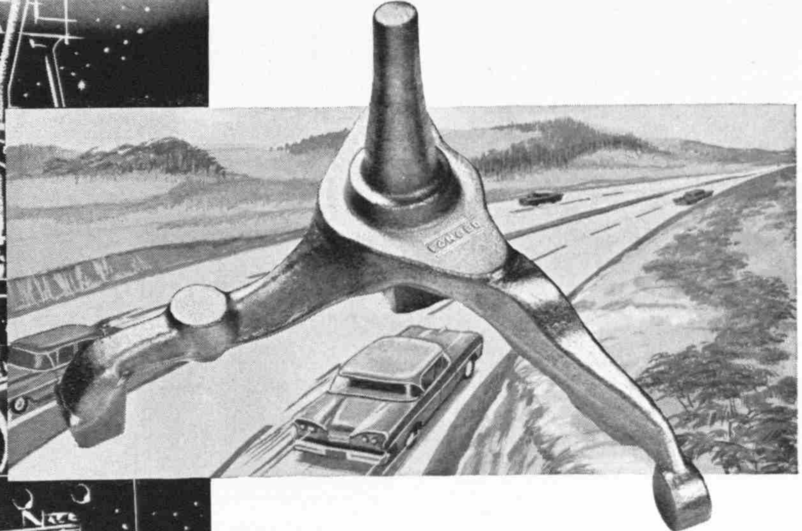
MULTIPLY	BY	TO OBTAIN
microhms per cm. cube	6.015	ohms per mil foot.
microhms per inch cube	2.540	microhoms p. cm. cube.
microns	10^{-6}	meters.
miles	1.609×10^{5}	centimeters.
miles	5280	feet.
miles	1.6093	kilometers.
miles	1760	yards.
miles	1900.8	varas.
miles per hour	44.70	centimeters per sec.
miles per hour	88	feet per minute.
miles per hour	1.467	feet per second.
miles per hour	1.6093	kilometers per hour.
miles per hour	0.8684	knots per hour.
miles per hour	26.82	meters per minute.
miles per hour per sec.	44.70	cms. per sec. per sec.
miles per hour per sec.	1.467	feet per sec. per sec.
miles per hour per sec.	1.6093	kms. per hour per sec.
miles per hour per sec.	0.4470	M. per sec. per sec.
miles per minute	2682	centimeters per sec.
miles per minute	88	feet per second.
miles per minute	1.6093	kilometers per min.
miles per minute	0.8684	knots per minute.
miles per minute	60	miles per hour.
milligrams	10^{-3}	grams.
millihenries	10^{6}	abhenries.
millihenries	10^{-3}	henries.
millihenries	$1/9 \times 10^{-14}$	stathenries.
milliliters	10^{-3}	liters.
millimeters	0.1	centimeters.
millimeters	0.03937	inches.
millimeters	39.37	mils.
mils	0.002540	centimeters.
mils	10^{-3}	inches.
miner's inches	1.5	cubic feet per min.
minutes (angle)	2.909×10^{-4}	radians.
minutes (angle)	60	seconds (angle).
months	30.42	days.
months	730	hours.
months	43,800	minutes.
months	2.628×10^{6}	seconds.
myriagrams	10	kilograms.
myriameters	10	kilometers.
myriawatts	10	kilowatts.
Ohms	10^{9}	abohms.
Ohms	10^{-6}	megohms.
Ohms	10^{6}	microhms.
Ohms	$1/9 \times 10^{-11}$	statohms.
ohms per mil foot	166.2	abohms per cm. cube.
ohms per mil foot	0.1662	microhms per cm. cube.
ohms per mil foot	0.06524	microhms per in. cube.
ounces	8	drams.
ounces	437.5	grains.
ounces	28.35	grams.
ounces	0.0625	pounds.
ounces (fluid)	1.805	cubic inches.
ounces (fluid)	0.02957	liters.
ounces (troy)	480	grains (troy).
ounces (troy)	31.10	grams.
ounces (troy)	20	pennyweights (troy).
ounces (troy)	0.08333	pounds (troy).
ounces per square inch	0.0625	pounds per sq. inch.
Pennyweights (troy)	24	grains (troy).
Pennyweights (troy)	1.555	grams.
Pennyweights (troy)	0.05	ounces (troy).
perches (masonry)	24.75	cubic feet.
pints (dry)	33.60	cubic inches.
pints (liquid)	28.87	cubic inches.
poundals	13,826	dynes.
poundals	14.10	grams.
poundals	0.03108	pounds.
pounds	444,823	dynes.
pounds	7000	grains.
pounds	453.6	grams.
pounds	16	ounces.
pounds	32.17	poundals.
pounds (troy)	0.8229	pounds (av.).
pound-feet	1.356×10^{7}	centimeter-dynes.
pound-feet	13,825	centimeter-grams.
pound-feet	0.1383	meter-kilograms.
pounds-feet squared	421.3	kgs.-cms. squared.
pounds-feet squared	144	pounds-ins. squared.
pounds-inches squared	2.926	kgs.-cms. squared.
pounds-inches squared	6.945×10^{-3}	pounds-feet squared.
pounds of water	0.01602	cubic feet.
pounds of water	27.68	cubic inches.
pounds of water	0.1198	gallons.
pounds of water per min.	2669×10^{-4}	cubic feet per sec.
pounds per cubic foot	0.01602	grams per cubic cm.
pounds per cubic foot	16.02	kgs. per cubic meter.
pounds per cubic foot	5.787×10^{-4}	pounds per cubic inch.
pounds per cubic foot	5.456×10^{-9}	pounds per mil foot.
pounds per cubic inch	27.68	grams per cubic cm.
pounds per cubic inch	2.768×10^{4}	kgs. per cubic meter.
pounds per cubic inch	1728	pounds per cubic foot.
pounds per cubic inch	9.425×10^{-6}	pounds per mil foot.
pounds per foot	1.488	kgs. per meter.
pounds per inch	178.6	grams per cm.

(Continued on page 42)

SHOCK-STRENGTH of steering spindle soars by designing it to be forged



Modern board-lift forging hammer



By designing front-end spindles to be forged, automobile and truck manufacturers practically eliminate danger of failure of these vital parts, even under sudden turning stress that can reach thousands of foot-pounds.

Start your designs by planning to use forgings everywhere there's a high degree of stress, vibration, shock, or wear. Forged parts withstand them all better than parts made by other fabrication methods. And forgings have no hidden voids to be uncovered after costly machining hours have been invested . . . the hammer blows or high pressures of the forging process compact the *better* forging metal, make it *even better.*

Write for literature on the design, specification, and procurement of forgings.

When it's a vital part, design it to be FORGED

Drop Forging Association • Cleveland 13, Ohio

Names of sponsoring companies on request to this magazine.

(Continued from page 40)

MULTIPLY	BY	TO OBTAIN
pounds per mil foot	2.306×10^{6}	grams per cubic cm.
pounds per square foot	0.01602	feet of water.
pounds per square foot	4.882	kgs. per square meter.
pounds per square foot	6.944×10^{-3}	pounds per sq. inch.
pounds per square inch	0.06804	atmospheres.
pounds per square inch	2.307	feet of water.
pounds per square inch	2.036	inches of mercury.
pounds per square inch	703.1	kgs. per square meter.
pounds per square inch	144	pounds per sq. foot.
Quadrants (angle)	90	degrees.
Quadrants (angle)	5400	minutes.
Quadrants (angle)	1.571	radians.
quarts (dry)	67.20	cubic inches.
quarts (liq.)	57.75	cubic inches.
quintals	100	pounds.
quires	25	sheets.
Radians	57.30	degrees.
Radians	3438	minutes.
Radians	0.637	quadrants.
radians per second	57.30	degrees per second.
radians per second	0.1592	revolutions per second.
radians per second	9.549	revolutions per min.
radians per sec. per sec.	573.0	revs. per min. per min.
radians per sec. per sec.	9.549	revs. per min. per sec.
radians per sec. per sec.	0.1592	revs. per sec. per sec.
reams	500	sheets.
revolutions	360	degrees.
revolutions	4	quadrants.
revolutions	6.283	radians.
revolutions per minute	6	degrees per second.
revolutions per minute	0.1047	radians per second.
revolutions per minute	0.01667	revolutions per sec.
revs. per min. per min.	1.745×10^{-3}	rads. per sec. per sec.
revs. per min. per min.	0.01667	revs. per min. per sec.
revs. per min. per min.	2.778×10^{-4}	revs. per sec. per sec.
revolutions per second	360	degrees per second.
revolutions per second	6.283	radians per second.
revolutions per second	60	revs. per min.
revs. per sec. per sec.	6.283	rads. per sec. per sec.
revs. per sec. per sec.	3600	revs. per min. per min.
revs. per sec. per sec.	60	revs. per min. per sec.
rods	16.5	feet.
Seconds (angle)	4.848×10^{-6}	radians.
spheres (solid angle)	12.57	steradians.
spherical right angles	0.25	hemispheres.
spherical right angles	0.125	spheres.
spherical right angles	1.571	steradians.
square centimeters	1.973×10^{5}	circular mils.
square centimeters	1.076×10^{-3}	square feet.
square centimeters	0.1550	square inches.
square centimeters	10^{-6}	square meters.
square centimeters	100	square millimeters.
sq. cms.-cms. sqd.	0.02402	sq. inches-inches sqd.
square feet	2.296×10^{-5}	acres.
square feet	929.0	square centimeters.
square feet	144	square inches.
square feet	0.09290	square meters.
square feet	3.587×10^{-8}	square miles.
square feet	.1296	square varas.
square feet	1/9	square yards.
sq. feet-feet sqd.	2.074×10^{4}	sq. inches-inches sqd.
square inches	1.273×10^{6}	circular mils.
square inches	6.452	square centimeters.
square inches	6.944×10^{-3}	square feet.
square inches	10^{6}	square mils.
square inches	645.2	square millimeters.
sq. inches-inches sqd.	41.62	sq. cms.-cms. sqd.
sq. inches-inches sqd.	4.823×10^{-5}	sq. ft.-feet sqd.
square kilometers	247.1	acres.
square kilometers	10.76×10^{6}	square feet.
square kilometers	10^{6}	square meters.
square kilometers	0.3861	square miles.
square kilometers	1.196×10^{6}	square yards.
square meters	2.471×10^{-4}	acres.
square meters	10.764	square feet.
square meters	3.861×10^{-7}	square miles.
square meters	1.196	square yards.
square miles	640	acres.
square miles	27.88×10^{6}	square feet.
square miles	2.590	square kilometers.
square miles	3,613,040.45	square varas.
square miles	3.098×10^{6}	square yards.
square millimeters	1.973×10^{3}	circular mils.

MULTIPLY	BY	TO OBTAIN
square millimeters	0.01	square centimeters.
square millimeters	1.550×10^{-3}	square inches.
square mils	1.273	circular mils.
square mils	6.452×10^{-6}	square centimeters.
square mils	10^{-6}	square inches.
square varas	.0001771	acres.
square varas	7.716049	square feet.
square varas	.0000002765	square miles.
square varas	.857339	square yards.
square yards	2.066×10^{-4}	acres.
square yards	9	square feet.
square yards	0.8361	square meters.
square yards	3.228×10^{-7}	square miles.
square yards	1.1664	square varas.
statamperes	$1/3 \times 10^{-10}$	abamperes.
statamperes	$1/3 \times 10^{-9}$	amperes.
statcoulombs	$1/3 \times 10^{-10}$	abcoulombs.
statcoulombs	$1/3 \times 10^{-9}$	coulombs.
statfarads	$1/9 \times 10^{-20}$	abfarads.
statfarads	$1/9 \times 10^{-11}$	farads.
statfarads	$1/9 \times 10^{-5}$	microfarads.
stathenries	9×10^{20}	abhenries.
stathenries	9×10^{11}	henries.
stathenries	9×10^{14}	millihenries.
statohms	9×10^{20}	abohms.
statohms	9×10^{5}	megohms.
statohms	9×10^{17}	microhms.
statohms	9×10^{11}	ohms.
statvolts	3×10^{10}	abvolts.
statvolts	300	volts.
steradians	0.1592	hemispheres.
steradians	0.07958	spheres.
steradians	0.6366	spherical right angles.
steres	10^{3}	liters.
Temp. (degs. C.) +273	1	abs. temp. (degs. C.).
Temp. (degs. C.) +17.8	1.8	temp. (degs Fahr.).
temp (degs. F.) +460	1	abs. temp. (degs. F.).
temp. (degs. F.) —32	5/9	temp. (degs. Cent.).
tons (long)	1016	kilograms.
tons (long)	2240	pounds.
tons (metric)	10^{3}	kilograms.
tons (metric)	2205	pounds.
tons (short)	907.2	kilograms.
tons (short)	2000	pounds.
tons (short) per sq. ft.	9765	kgs. per square meter.
tons (short) per sq. ft.	13.89	pounds per sq. inch.
tons (short) per sq. in.	1.406×10^{6}	kgs. per square meter.
tons (short) per sq. in.	2000	pounds per sq inch.
Varas	2.7777	feet.
Varas	33.3333	inches.
Varas	.000526	miles.
Varas	.9259	yards.
volts	10^{8}	abvolts.
volts	1/300	statvolts.
volts per inch	3.937×10^{7}	abvolts per cm.
volts per inch	1.312×10^{-3}	statvolts per cm.
Watts	0.05692	B.t.u. units per min.
Watts	10^{7}	ergs per second.
Watts	44.26	foot-pounds per min.
Watts	0.7376	foot-pounds per sec.
Watts	1.341×10^{-3}	horse-power.
Watts	0.01434	kg.-calories per min.
Watts	10^{-3}	kilowatts.
watt-hours	3.415	British thermal units.
watt-hours	2655	foot-pounds.
watt-hours	1.341×10^{-3}	horse-power-hours.
watt-hours	0.8605	kilogram-calories.
watt-hours	367.1	kilogram-meters.
watt-hours	10^{-3}	kilowatt-hours.
webers	10^{8}	maxwells.
weeks	168	hours.
weeks	10,080	minutes.
weeks	604,800	seconds.
Yards	91.44	centimeters.
Yards	3	feet.
Yards	36	inches.
Yards	0.9144	meters.
Yards	1.08	varas.
years (common)	365	days.
years (common)	8760	hours.
years (leap)	366	days.
years (leap)	8784	hours.

These conversion factors first appeared in the November '54 and January '55 issues of the CITY COLLEGE VECTOR.

ALUMNI NEWS

Lowell Brigham ('59) is employed by General Electric as an applications engineer. He is residing at 3 Virginia Ave., Endwell, New York.

* * *

Edwin Buehler ('59) is working at Oldsmobile. He is living at 4568 S. Hagadorn, East Lansing, Michigan.

* * *

Robert Buonodono ('59) is working with Flood Control problems in Los Angeles. His address is 280 Puente Ave., Covina, Calif.

* * *

James Burns ('59) is an associate engineer for Rocket Dyne and is working on the design and test of rocket components and engines. He is residing at 6936 Garden Grove, Reseda, Calif.

* * *

Robert Cadwallader ('59) is employed by Fisher Body Technical Center. Bob is living at 17580 Pennington, Detroit.

* * *

John Campbell ('59) is working in acoustical engineering at the General Motors Proving Ground. He is residing at 2350 S. Milford Rd., Milford, Michigan.

* * *

Richard Carpenter ('59) is a process engineer for Olin-Mathieson Nuclear Fuel Division. He works on cores for nuclear reactors. He lives at 849 Ridge Road, Hamden, Conn.

* * *

Richard Carroll ('59) is an electrical engineer for Collins Radio Company and is working with space navigation. Dick is living at 361 30th St., S.E., Cedar Rapids, Iowa.

* * *

Thomas Case ('59) is now working as a Foreign Sales Engineer Trainee for The Worthington Corporation. He and his wife Barbara reside at 2809 Woodworth Place, Hazel Crest, Ill.

* * *

Patrick Caskey ('59) is employed as a project engineer for Sundstrand Aviation in Rockford, Illinois. His address is 2421 11th Street.

* * *

Howard Cervantes ('59) is working in the Bell Telephone laboratories in Murray Hill, N. J. His address is Bldg. 1, Apt. 12A, 100 Franklin St., Morristown, New Jersey.

* * *

V. H. Christenson ('59) is employed by Chrysler Missile in Warren, Michigan. He is living at 1540 Lapeer Rd., Lake Orion, Michigan.

Ernest Hart ('14) is president of the Food Machinery and Chemical Corp. in New York City. His address is 4000 Howell Parkway, Medina, N. Y.

* * *

Carl Nilson ('14) is project engineer for the Army Ordnance's Tank-Automotive Command in Center Line, Mich. He lives at 1329 Audubon, Grosse Pointe 30, Michigan.

* * *

Claude B. Milroy ('16) is district bridge engineer for the Michigan State Highway Department at Jackson. His address is 970 Northwood St., Ann Arbor, Michigan.

* * *

L. S. Plee ('18) is supervisor of research and statistics for the Michigan Public Service Commission. He has been a state employee for 35 years. His address is 1813 Drexel Rd., Lansing 15, Michigan.

* * *

Robert L. Wirt ('25) is senior design engineer for the Niagara Mohawk Power Corporation in Buffalo, N. Y. His address is 29 Lakeside Crescent, Lancaster, N. Y.

* * *

Robert Deam ('59) is working for the Chicago Bureau of Engineering. His address is 6134 North Kenmore, Chicago.

* * *

John Decker ('59) is a project engineer for Western Electric. He is residing at 1514 West 99th Street, Chicago.

* * *

John DeFoe ('59) is working in testing and research for the Michigan State Highway Department. He is living at 628 West Walnut, Hastings, Michigan.

* * *

Herbert Dellapenta ('59) is working for General Electric. His address is 53 Kelly Ave., Endicott, N. Y.

* * *

Raymond Delong ('59) is an assistant engineer for Burroughs Corporation, Plymouth, Michigan. He is living at 2471 Ogden Drive, Orchard Lake, Michigan.

* * *

Wayne Denniston ('59) is working for the St. Joseph Health Department. He is living at RR #1, Box 88, Centreville, Michigan.

* * *

William F. Eaton ('30) and his wife Margaret write from 128 Meadow Lane, Grosse Pointe Farms 36, Michigan.

Donald Churchill ('58) is living at 421 Haslett St., East Lansing, Michigan. He is doing research for the Agricultural Engineering Department at Michigan State.

* * *

Anthony Cipolla ('59) is working for the General Chemical Corporation at Claymont, Delaware. His address is 100 N. Clayton Ave., Wilmington, Delaware.

* * *

Ronald Clarke ('59) is an associate engineer for Convair Astronautics. He is residing at 2029½ Norena Blvd., San Diego 10, Calif.

* * *

James Clock ('59) is an aircraft structural analysis engineer for North American Aviation. His address is 3359-C, East Broad St., Columbus 13, Ohio.

* * *

James Coon ('59) is employed by Boeing Aircraft, Seattle, Washington. He is living at 3236A 113th, S.E., Bellevue, Washington.

* * *

Eugene D. Cox ('59) is working for Bendix-Pacific Division of Bendix Aviation. He is working in the area of transistor circuit design. Gene's address is Apt. 20, 1235 N. Harper, Los Angeles 46, Calif.

* * *

Gayle Crabb ('59) is a civil engineer for the U. S. Army Corps of Engineers. He is living at 1303 Minneapolis, Sault Ste. Marie, Michigan.

* * *

Ronald Cruthers ('59) is working for U. S. Naval Avionics Facility. He is living at 8810 Pendleton Pike, Indianapolis 26, Indiana.

* * *

Thomas J. Culhane ('59) is living at 230 Clifford Ave., Lansing, Michigan. He is employed by Motor Wheel.

* * *

Robert Daly ('59) is employed by Bendix, Pacific, Inc., and is living at 11009½ Hartsook St., N. Hollywood, California.

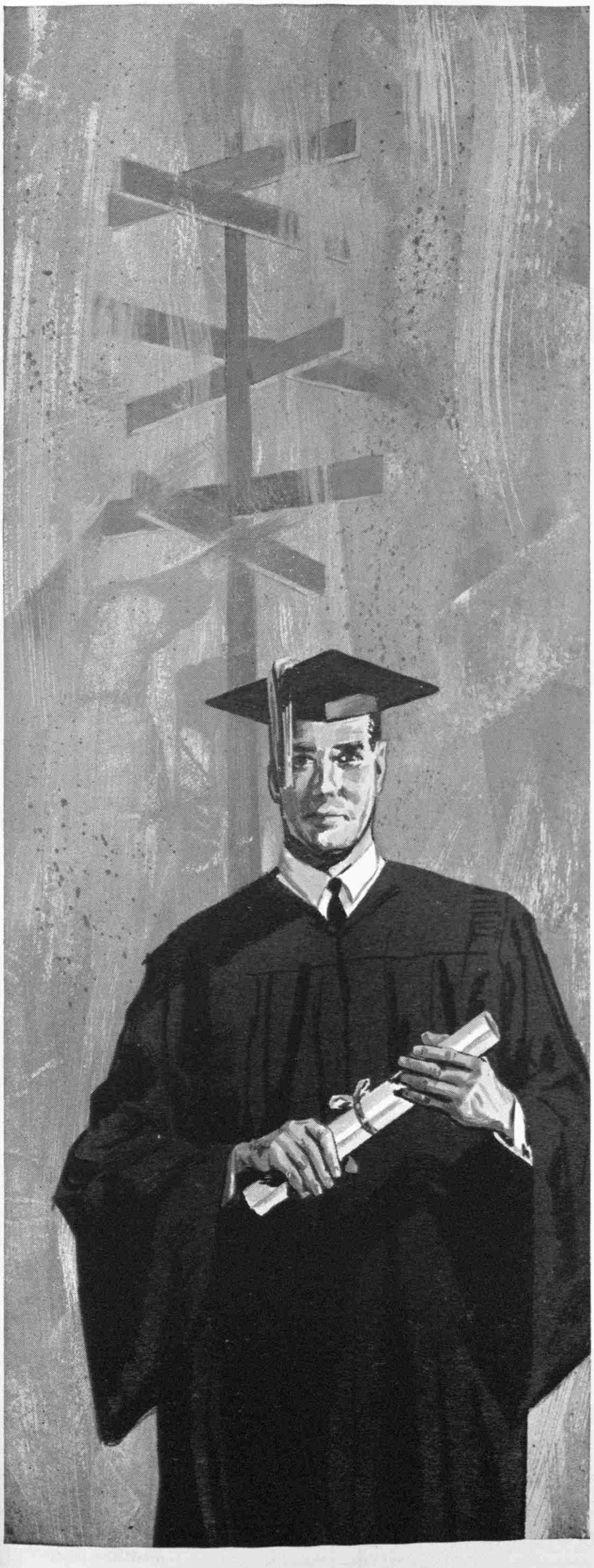
* * *

Gerald Davies ('59) is working for Boeing Aircraft Corporation. His address is 9227-9th Ave., S.W., Seattle 66, Washington.

* * *

Charles Davis ('59) is continuing his education at the University of Illinois. His address is Electrical Engineering Department, University of Illinois, Urbana, Illinois.

(Continued on page 55)



For the man who likes to make his own career decisions

The Allis-Chalmers Graduate Training Course is based on freedom of opportunity. You will have up to two years of practical training to find the right spot for yourself. At the same time, you enjoy a steady income. You can accept a permanent position at any time — whenever you can show you are ready.

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Types of jobs: Research • Design • Development • Manufacturing • Application • Sales • Service.

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Freedom of Opportunity opens the doors to challenging and interesting careers. Among them is our Nuclear Power Division, with an engineering staff in Washington, D. C., a new research and development center in Greendale, Wis., and an important research effort at Princeton University involving power from the hydrogen atom. For details on the opportunities available, write to Allis-Chalmers, Graduate Training Section, Milwaukee 1, Wisconsin.

A-1192

ALLIS-CHALMERS

ENGINE OF TOMORROW

(Continued from page 23)

engines, but must surpass them in some category to make the expensive changeover profitable.

To replace the gasoline engine an engine must be cheaper to build, more compact, more economical to operate, and better performing. Potentially the free piston engine has these qualities, but it will require years of development to realize its great potential.

PROFESSIONAL STATUS

(Continued from page 24)

any kind of self-development program. They have not availed themselves of the opportunities designed to keep them properly informed.

Experience likewise cannot solely serve as the basis for claiming professional status. What kind of experience counts? There are wide variations in the work experiences of the engineers. Professional status is rather an elusive item. An event told by a training coordinator of a large west coast employer indicated that status, at least to some engineers, is a state of mind.

In this company the manufacturing division maintained a laboratory which was used to test the items produced. There were fifty engineers working in this laboratory. Although the laboratory was a part of the manufacturing division, the engineering personnel were in the engineering division of the company. Last summer the engineering personnel in the laboratory were transferred to the manufacturing division because of the nature of their job assignments. There was no change in salary, no change in physical place of employment, no change in equipment used. The only visible change which occurred was a change in the first prefix of their identification badge numbers. The personnel in the manufacturing division bore the prefix number 3, while the engineering personnel had the prefix number 7. Thus the only change was from 7 to 3. The training coordinator told me that 25 of the engineers resigned shortly after the transfer was announced. His explanation was that the engineers in this laboratory had lost status because of their transfer from the engineering division to the manufacturing division.

(Continued on page 48)

Earth's attraction for an apple?

Free fall in relativistic space?

A complex meson field?

Built-in return power for project Mercury?

How is it related to binding energy?

Gravity is both a bane and a boon to man's efforts—and a thorough understanding of it is of great significance in the completion of Allison's energy conversion mission.

Gravity conditions our thinking on advanced assignments. For example, in outer space there is a disorientation of conventional design. The fact that large accelerations can be obtained with low thrust forces has taken us into the new field of electrical propulsion, ion and magnetohydrodynamic rockets.

In our inquiries, we supplement our own resources by calling on many talents and capabilities: General Motors Corporation, its Divisions, other individuals and organizations. By applying this systems engineering concept to new projects, we increase the effectiveness with which we accomplish our mission—exploring the needs of advanced propulsion and weapons systems.

Energy conversion is our business

ALLISON

Division of General Motors, Indianapolis 6, Indiana

PROFESSIONAL STATUS

(Continued from page 46)

The problems of status and recognition as revealed in the story above do not lend themselves to easy solution. They cannot be solved just by having canons of ethics and 61 rules of conduct. These may be printed in attractive form; the words are well chosen. They "mean exactly what they say—that there is no concealed, hidden, or obscure intent." These rules are important guidelines and serve a useful purpose. As Heermance once wrote—a united expression of what is best for the common good becomes a strong force for progress.

Status and recognition involve, however, at least two persons, one to claim it and the other to honor the claim. The engineer may claim professional status and recognition but full and complete honoring of the claim has been slow in coming. At first glance there appears to be several reasons for the slow honoring of the claim. One relates to the individual engineer and the other to the employers of engineers.

Some of the shortcomings of the individual engineer in laying claim for professional status and recognition have already been noted. It can be summarized in a brief phrase—he is just not entitled to the claim. His individual actions do not merit his claim being taken seriously. It would do well to remember the biblical injunction—"By ye actions, ye shall be judged." Indeed individual engineers are judged and the "actions" do not measure up to the expectations of employers who are being called upon to honor the claim.

Employers, on the other hand, have attitudes and concepts about engineers. To a very large measure the employers' attitudes and policies control the actual extent of the individual engineer's success in attaining professional status and recognition. For the most part it is the employer of engineering personnel who writes the job description.

The heart of the status problem is found in the employment relationship. The Subcommittee of the Employment Practices Committee of the National Society of Professional Engineers has developed its *Criteria For Professional Employment of Engineers*. These "rules of the road" are for "those who conscientiously desire to serve their own best interests by recognizing and treating engineers as full professionals in every sense of the word." While these are helpful they do not appear to address themselves to the nature of the employment relationship.

There is much misunderstanding and confused thinking about this relationship. The employee-employer relationship *inevitably* generates problems. The more employees, the more problems and the more complex are the problems. Someone manages and someone is managed. In other words, someone gives instructions and someone carries out these instructions. In the management process, employees will experience at some time or another, feelings of irritation, dissatisfaction, ill treatment, etc. For one brief example, the engineer is assigned to a job which doesn't comport with his notion of what a professional should be doing.

Since there is this relationship, these are essential differences of interest between those who are employed and those who employ. The employer is conscious of costs; he seeks to make a profit. The employee on the other hand wants more money (and, engineers are no exception). The employer wants greater freedom in running his business while the employee wants greater freedom as an individual. It is highly unrealistic to say that there are no differences in interest. While the engineer may be "company minded" he is also concerned with his own interests. At times there will be a conflict in interests and these conflicts must be resolved if a mutual satisfactory working relationship is to be maintained.

It must be noted that human relations and communication techniques will not resolve all the real differences of interest. Would the attitude of the engineers in the story related above have been any different if they were told about being transferred to the manufacturing division and explained the reasons for the transfer? I doubt it. This is not to say that a sound human relations program is unimportant. They can be very useful, but they will not eliminate the differences of interest which grow out of the very nature of the employee-employer relationship.

(Continued on page 54)


U.S. ARMY

ONCE upon a time when t equals zero, there lived in a small cavity in a dielectic medium, a poor struggling dipole by the name of Eddy Current. He was deeply in love with a beautiful coil by the name of Ann Ion, the daughter of an influential force in the town, Cat Ion.

Eddy's first contact with her came at a time t equals a. As he passed by a beauty parlor on his periodic orbit, he saw her having a standing wave induced in her filaments. He made a fine sight in his beautiful doublet and it was a case of mutual polarization.

"YOU SHOCK ME"

By a coincidence they met at a dissipation function of the following night. After a few oscillations to the strains of a number (n) played by Mo Mentum and his Incadescent Tuning Forks, the couple diffused into the field outside.

"Gauss, Ann," he said, "You're acute angle; I am d (termined) that U shall marry for K sphere that I shall never be happy without you."

"Oh, Eddy," she replied, "Don't be so obtuse. Integrate out here in the alpha rays tonight?"

"Ann, are you trying to damp my osculation? Can't you see I'm in a state of hysteresis over you?"

HE CAN'T RESISTOR

"Now, Eddy, be a discrete particle. What will father say?" Alas, there was also in this cavity a mean dipole who was resolved to marry the beautiful Ann, using coercive force if necessary. Hearing these murmurings of love, he went Pi-i'd with fury, and crept stealthily upon the couple with velocity u, his joules drooling with the vestial erg that moved him.

"What the infra red are you doing here you flat-footed vial villian?" demanded Eddy. The situation grew tensor.

THE VECTOR!

Schmidt advanced to choke the beautiful coil: Eddy offered resistance R; His capacity C for absorbing the charge Q was low, and Schmidt suffered little lost work content in knocking him out to infinity with a severe blow on his megative charge. Eddy made a quick comeback with acceleration a, stripping off Schmidt's outer electrons. This so upset the villian's equilibrium that he was converted into cosmic radiation and vanished into the realms of space, leaving Eddy the resultant vector in the combat.

"Our love will not be transient," said Eddy as he formed a closed circle around her.

"Darling, we will raise a one parameter family of second infinitesimals," murmured Ann happily.

And as time t approached infinity, they lived happily ever after.

Editor's note: This is taken from the Houston Ire Section publication, who took it from the Kansas City IRE section publication, who couldn't remember where they got it.

MINUTE BIOGRAPHY

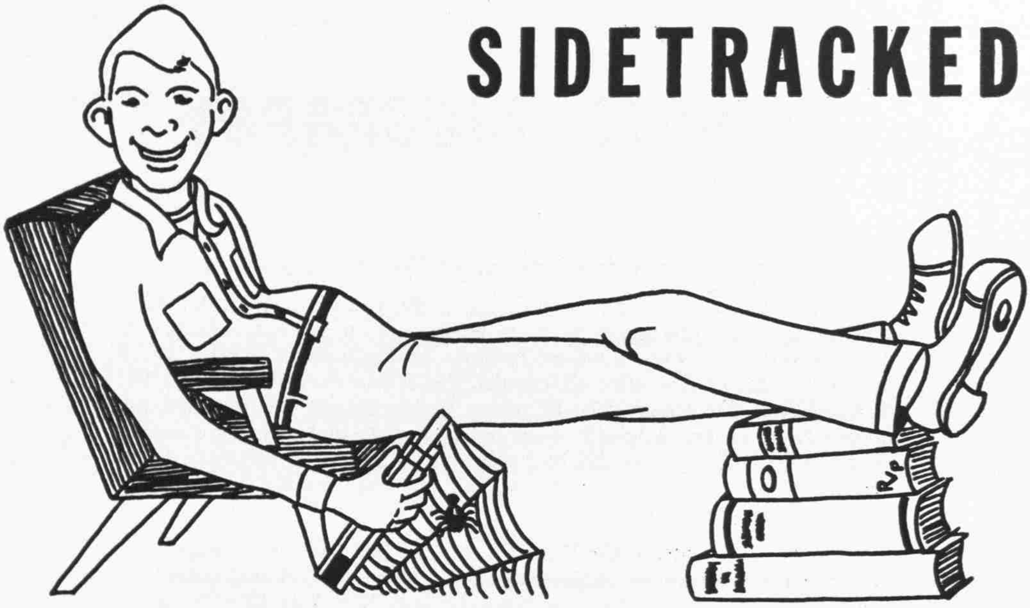
Joseph A. Strelzoff—Professor of Electrical Engineering

Dr. Strelzoff was born on June 21, 1899 in Southeast Russia. After graduating from high school in 1916, he was one of 500 out of 3200 students selected to enter Kharkov Institute of Technology. World War I interrupted his studies after six months, and it wasn't until 1919 that Dr. Strelzoff had the opportunity to return to his studies. He attended the university at Liege, Belgium, receiving a Mechanical Engineering degree at the end of three years and two years later a degree in Electrical Engineering. While in attendance he worked part-time for the Construction Electriques de Belgeque.

Dr. Strelzoff entered the United States in 1929, and, until his entrance to Cornell University in 1931, worked for Stone & Webster, consulting engineers in Boston and later for Gibson-Hill in New York City. It was at this time that Dr. Strelzoff received the Bull Earl Fellowship at Cornell. Dr. & Mrs. Strelzoff were married in 1931. While at Cornell he received his Master of Science in Electrical Engineering in 1932 and his Ph.D. in 1934. From 1934 to 1942 Dr. Strelzoff taught at various schools and joined the teaching staff at Michigan State University in 1942.

Among his numerous hobbies, Dr. Strelzoff listens to opera, reads history, square dances and loves to take long walks. He walks to school every day. Mrs. Strelzoff reveals that until they had their dishwasher installed, her husband washed the dishes every night. Although he has many hobbies, Dr. Strelzoff says his most rewarding hobby is teaching.

SIDETRACKED



Things men like to hear a girl say:

1. "No, I've never seen the golf course at night."
2. "Why bother, there's no one home here."
3. "You don't think this bathing suit is too tight do you?"
4. "Let's go dutch!"
5. "Chaperone? What chaperone?"
6. "No, it really doesn't make any difference whether I get back at all tonight."
7. "My, but I'm cold!"
8. "Yes!"

* * *

It was C.E.'s first date with the Coed.

"No, thank you, I don't smoke."

"Let's go down and sip a beer or two."

"I'd rather not. I never touch liquor."

"Well, let's go down to the stadium for a while."

"No, I'd rather go out and do something new—something exciting."

"O.K. Let's go down to the dairy building and milk hell out of a couple of cows."

"May I have this dance?"

"I'm sorry, I never dance with a child," said she, with an amused smile.

"Oh, a thousand pardons," said he. "I didn't know about your condition."

* * *

The ferocious lion ate a bull. Afterward he felt so wonderful he roared and roared. A hunter heard him roar and shot him.

Moral: When you are full of bull, you had better keep your mouth shut!

* * *

A Texan, newly arrived in England, was playing poker with a couple of the natives. He was pleasantly surprised upon picking up an early hand to see four aces in it.

"I'll wager a pound," said the Britisher on his right.

"Ah don't know how y'all measure your money," drawled the Texan, "but ah reckon ah'll have to raise you about a ton."

* * *

It's tough to find
For love or money
A joke that's clean
And also funny.

The EE's Lament

Through the smoke and ozone fumes the student slowly rises.
His hair is singed, his face is black, his partner he despises.
He shakes his head and says to him, with words so softly spoken,
"The last thing that you said to me was, 'Sure, the switch is open.' "

* * *

Thermometers—Something else graduated with degrees without having brains.

* * *

A farmer who had earlier given two tramps a job chopping wood decided to check on how they were doing. He found one tramp leaning on his ax, watching the other execute a series of flip-flops and somersaults.

"Gosh," said the farmer, "I didn't know your friend was an acrobat."

"Neither did I," admitted the tramp, "till I cracked him on the shin with this ax."

* * *

Senior Engineer: "We're coming to a tunnel. Are you afraid?"

Co-ed: "Not if you take that cigar out of your mouth."

PROFESSIONAL STATUS

(Continued from page 48)

Since these differences do exist, neither employers nor employees can be trusted to protect adequately the interests of the other. The employers do have power and they exercise authority. Employers often develop policies on the basis of "knowing better what's good for you than you do for yourself." Often policies are introduced with the best of intentions but their application causes friction. Then, too, no group of employees, no matter how idealistic they are, can adequately protect the employer's interest.

In this kind of situation what can the professional engineer do to obtain status? It must be remembered that status and dignity are not given; they must be earned. Occupational competency is a must. Engineers must turn in a creditable performance on the job. In other words, the place to begin is with the individual engineer.

Since most engineers are employees, the employer must be educated so as to establish a clear understanding of employment conditions necessary to meet professional employee expectations. The Engineer-in-Industry Sub-Committee of the Employment Practices Committee has formulated certain criteria for employers of engineers. The criteria include recruitment policies, indoctrination, technical development of the individual, company practices, personnel practices, working conditions, etc. The important question is how to get employers to adopt and to put into practice these criteria.

As was pointed out the best of intention can and does produce frictions and irritations. A number of management practices contribute to engineer dissatisfaction and poor morale. For example, the improper use of engineering talent, haphazard salary administration, work assignment, incompetent supervision are but a few of the areas of friction. In the decade ahead these areas will become more aggravated unless remedial action is taken.

The shortage of certain types of engineering skills has and will continue to produce frictions. Employers give the special treatment to the engineer whom they have pirated away from another firm. Usually these special talent engineers have been brought in at high (or higher) salaries. This policy of "red carpet" treatment may be carried to the point where older engineering employees of less potential develop a chronic case of low morale.

This suggests that while there is a machine and equipment obsolescence there is also the problem of aging and obsolescense in respect to engineering talent. Of course, this condition could be remedied by an educational program plus sufficient will to action by the engineer. With the ever increasing tempo of change, there are also engineers who fall behind in their knowledge of fundamentals which underlie new developments. Employers need to develop educational and training programs which will permit engineers to keep their skills up-to-date. Their investment in engineering talent could be enhanced if proper use were made of these persons.

The employer's attitude and actions are another aspect in the engineers quest for status. The professional societies have a role to play in fostering a healthy professional climate for employed engineers. There is more to be done than establishing standards of ethical conduct or pressuring for more stringent registration laws. Professional societies have a responsibility to promote better salaries and working conditions. To accomplish this may require the development of new institutional arrangements. Professional societies have got to stop talking about raising the professional status of engineers and start doing more than uttering platitudes and cliches. A professional society must be strong and active if it is to assist in enhancing professional status. To be strong, the engineers must support their societies. This means more than sending in the annual dues.

The problems and prospects of raising the status of engineers in the decade ahead are replete with many formidable barriers. The profession of engineering is a heterogeneous complex. The profession speaks with many voices. Perhaps one approach would be to de-emphasize the status question. There are already too many groups in the grips of the "status panic." Perhaps more can be gained by concentrating on occupational competency. Status may well come through creditable workmanship.

But this is only the starting place. Raising the professional status requires both individual and collective action. The individual engineer can work towards improving his own status but by the nature of the employment relationship he can only do so much. He must have the backing of a strong professional society vitally interested in improving "professional treatment," "personal treatment" and "financial treatment." This is the age of collective action in which individuals band together to advance their interests.

Professional societies have got to bring their thinking up-to-date. They all too frequently resort to what Professor Galbraith has termed conventional wisdom—"ideas which are esteemed at any time for their acceptability." The articulation of conventional wisdom is in the words of Galbraith "a religious rite." Professional societies devote a good bit of their time to articulating conventional wisdom. But the enemy of conventional wisdom is not ideas but the march of events. There are dramatic changes taking place in the engineering profession and in the market place where the skills of the engineer are being utilized. These changes are making the conventional wisdom of the moment obsolescent. In time the changes become fatal to these once acceptable ideas. The fatal blow is delivered when the ideas have lost their relationship to the real world. The position of the engineer in America in the 1960's will turn on the adaptation of new ideas to meet new changes.

WHAT'S NEW

(Continued from page 32)

AUTOMATION PLUS

A contract to develop an all-electronic Alpha-Numeric Recognition Device for identifying typed or printed envelope addresses has been awarded to Philco Corporation's Research Division by the U.S. Post Office Department in Washington, D. C.

The system will be able to read envelope addresses by separate recognition of all 26 alphabetic and 10 numeric characters, without the use of special symbols or of magnetic ink. It is planned that this machine will be integrated with letter-sorting machines developed by the Post Office Department to further the automation of mail-handling in post offices.

Electronic scanning techniques will be used for locating addresses on envelopes. The contract requires the capability of recognizing typed or printed addresses which can be sorted to as many as 50 different addresses. A high processing rate is promised, with a character analysis capability of identifying one thousand alpha-numeric characters per second.

FEWER ENGINEERS

For the second consecutive year, enrollment in America's accredited engineering colleges has dropped.

In the fall of 1959, 240,063 students registered in engineering; in 1958 there were 249,950, and in the fall of 1957 the total was 257,777.

Under the influence of high enrollments in the mid-1950's, the number of engineering graduates continues to rise; in the year ending in June, 1959, 41,132 degrees were given in various fields of engineering. But a study of recent enrollments would indicate that there will be fewer engineering graduates within the next one or two years, according to the American Society for Engineering Education.

Total engineering enrollment in the fall of 1959 was down 4% from 1958 and 6.9% from 1957, according to the survey. A decrease in undergraduate enrollment first reported in 1958 continued in 1959 with a 5.7% drop during the year. These engineering enrollment decreases came at a time when total college enrollments were rising—in all, by 10.9% during the two-year period. In 1959 engineering students accounted for only 7.1% of all college students, compared with the high of 8.4% in 1957.

ALUMNI NEWS

(Continued from page 44)

Lloyd H. Harrington ('30) is an engineer for the western division of Consumers Power Company in Grand Rapids, Mich. His address is 3838 Clyde Park Ave.

* * *

R. Clark Dawes ('31) is in his 20th year as a member of the Grove City (Pa.) College staff and his second as chairman of the engineering department. His address is 801 Superior St.

* * *

Stan Slezak ('39) is a designer for General Electric in Schenectady, N. Y. His address is Rt. 2, Amsterdam, N. Y.

* * *

Fred E. Satchell ('44) is chief chemical engineer for Brunswick, Balke Collender Company in Muskegon, Mich. His address is 1107 Hendrick Road.

* * *

E. W. Baldwin ('11) is retired and living in New Oxford, Pa.

Hugh C. Forsberg ('45) is an engineer at the University of California's Los Alamos Scientific Laboratory at Los Alamos, New Mexico.

* * *

Gale D. Sharpe ('47) has been appointed office manager of Anderson Chemical Company, Weston, Mich.

* * *

Thomas A. Zechin ('47) writes from 23125 Norcrest Dr., St. Clair Shores, Michigan. A daughter, Nancy Louise, was born March 15, 1959.

* * *

John Foster ('48) is director of products development for the J. L. Clark Manufacturing Company in Rockford, Ill. He and his wife Juliette live at 1607 Cynthia Drive.

* * *

Edward A. Lau ('49) is vice president of Precision Controls Company in Dexter, Mich. His address is 17547 Stahelin, Detroit 19, Michigan.

* * *

Jack B. Ridenour ('48) is a development engineer for Oldsmobile. He lives at 2201 Quentin Ave., Lansing.

* * *

Richard Howell ('49) writes from College Park Apts. 6-C, Camp Hill, Pa. A son was born in April.

* * *

John R. Kelley ('50) is an engineer for Federal Electric Corporation in Paramus, N. J. He lives at 161 Linden Ave., Emerson, N. J.

Uno W. Filpus ('51) is an engineer for Consumers Power Company in Traverse City. He has four sons. His address is 922 Avenue D, Traverse City, Michigan.

* * *

Dayton A. Hunt ('52) was married in July and is working for the Schenectady Varnish Company. His address there is 2165C Daisy Lane.

* * *

Floyd H. Valentine ('09) has been elected secretary of the Cleveland Consulting Engineers Association. He lives at 3019 Edgehill Rd., Cleveland Heights 18, Ohio.

* * *

James A. Smith ('12) is retired and living in Rochester, N. Y., at 4 Beverly Heights.

* * *

R. R. Havens ('15) is living in St. Petersburg, Florida, at 6021 Burlington Ave.

* * *

Herman C. Zierleyn ('15) is retired. His home is at 119 Maple Terrace, Spring Lake, Mich.

* * *

A. H. Nichol ('17) has retired from management in the power specialties field after 40 years. He now is associated with an Oldsmobile dealer in Lancaster, Ohio. His address there is Rt. 3, Baltimore Rd., Lancaster.

(Continued on page 58)

SPACE LAB. (Continued from page 21)

AEROBEE ROCKET EXPERIMENTS OF THE AEROSPACE MEDICAL DIVISION DURING 1951-52

Aerobee No.	Date of Firing	Peak Altitude (miles)	Animals Carried
I	4-18-51	38	1 monkey 1 mouse
II	9-20-51	40	1 monkey 2 mice
III	5-21-52	38	2 monkeys 2 mice

Except for the monkey in Aeorbee I, all mice and monkeys were recovered safely. However, after surviving a wild ride into the ionosphere, the monkey flown in Aerobee II died from heat exposure on the way to the laboratory. The mice were used in hereditary experiments to determine whether cosmic radiation would have any effect on reproduction.

These tests, while not conclusive, indicate that man can survive and function in the hostile environment of space. Although it will probably be a while yet before an astronaut is shot into orbit, these early tests and more recent ones involving orbital rockets are laying the groundwork for future, successful, manned space flight.

19 Ways to Flunk Any Course

Learn now that society will provide for you. Just because you are you. Just because you are paying for an education doesn't mean you have to get your money's worth. Don't be ridiculous. "If the learner hasn't learned," it isn't your fault, surely.

1. *GENERAL ATTITUDE*—The B.B.A. degree is valuable. Successful grads have made it so. It is valuable because they produced. Let them keep up the good work, but don't prepare to rob them of their glory, to increase the value.

2. *BE YOUTHFUL*—Be young while you can. Why discard those good old high school days—and ways? Don't grow up until you just have to. People will always be understanding and appreciative of your adolescence.

3. *DRESS*—Be yourself, dress naturally. Those business people can be very stuffy about sartorial matters. On that first job, they'll probably start you off as a porter anyway, so why not look like one?

4. *AROMATICS*—The pungency of the locker room can be carried with you. A gamey "athletic" odor is a great personal asset—in class and out, in business and out—and fast. Carry your own atmosphere—be "aromatic."

5. *RELAX, ENJOY IT*—A stiff posture restricts absorption. Spread yourself figuratively. Chairs in front, occupied or not, are fine for parking feet, thus facilitating relaxation.

6. *MENTAL EFFORT*—Some say that brain cells, like liquor bottles, can not be used twice. Save them, coddle them, spare them—in class and out. The mind(?) you save may be your own.

7. *DON'T ANTICIPATE*—Who knows what might happen tomorrow—or for that matter next week, when the paper is due? Don't do it ahead of time—nothing might happen. Then you'd have no excuse.

8. *ACCURACY*—Is for the birds. A misplaced decimal point is embarrassing but not critical. You can always do it right when and if you get a job (on the basis of your excellent school record, of course).

9. *DON'T WRITE, TELEGRAPH*—Legibility went out with long underwear. None of the really big wheels like Napoleon, Hitler, or even Confucius—could write good English.

10. *SPELLING*—Why bring that up? Phonetics are out, "word picture" didn't work, so your generation just can't spell. Everyone understands and is sorry. You are unique—now don't go and spoil it.

11. *LATE PAPERS*—Promptness here is a sign of servility. Be independent. Be different. A few days late shouldn't matter, especially if you use a good standard explanation.

12. *BE LATE*—A "fashionable" entrance, after everyone else is seated, and the class is moving along—this calls attention to one, definitely. You can also be so ignorant about what has gone before and get the spotlight again.

13. *ATTEND IRREGULARLY*—That's the stuff. Always being there is dreadfully boring. After all, one meeting is like another and the instructor gets tired of your face, too.

14. *BE CONVERSATIONAL*—Talk it up. If the old buzzard doesn't make it interesting, it surely can't be interesting to your neighbor, can it? Competition is good for business, so why not for business educators?

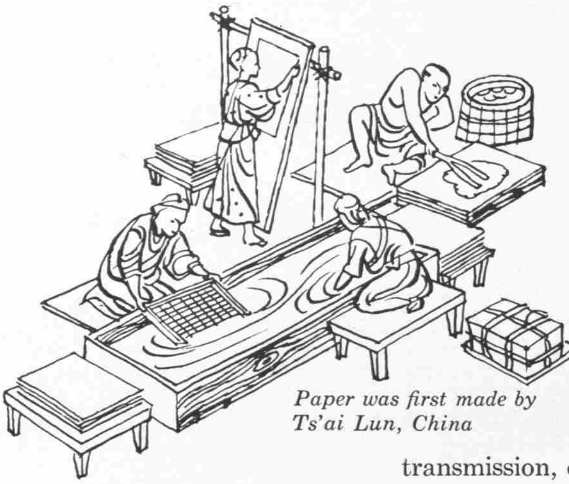
15. *PREPARATION*—A dangerous habit. Here again, let's don't anticipate. A heavy snow might make the work useless. And—the instructor might resent having you come to class one day knowing what he is talking about.

16. *(BUT OTHERWISE) CLAM UP*—Don't ever venture an opinion, don't defend a point; let some other jerk stick his neck out. Remember it may be better to remain silent and be thought ignorant—than to open one's mouth and remove all doubt.

17. *ON YOUR MARK*—Don't get left at the post when the bell rings. A rustling of papers and plopping of books indicates alertness on your part to the hour of parting and reminds the Professor accordingly.

18. *REPETITION*—A powerful force. If the files show that someone did a good paper on the topic last year, why should such a gem be discarded? The instructor will never recognize it if your pal was at U. of M.

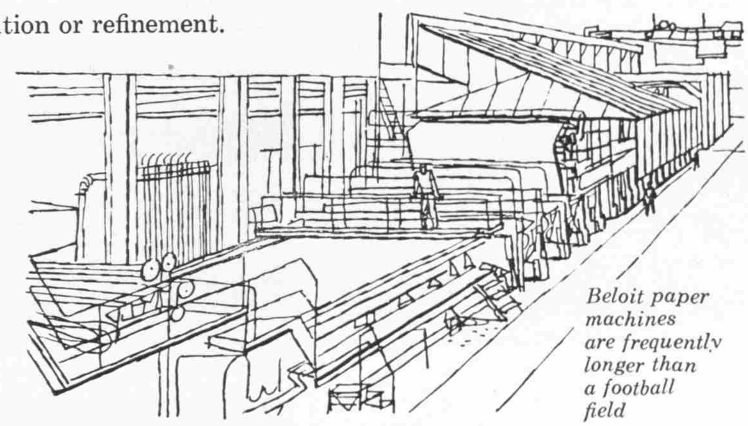
19. *PLAGIARISM*—If in preparing a paper you find that some author has said it better than you can; and a long time ago—don't dull initiative. Let him have his way—in your paper, too. It should be flattering to him.



Paper was first made by Ts'ai Lun, China

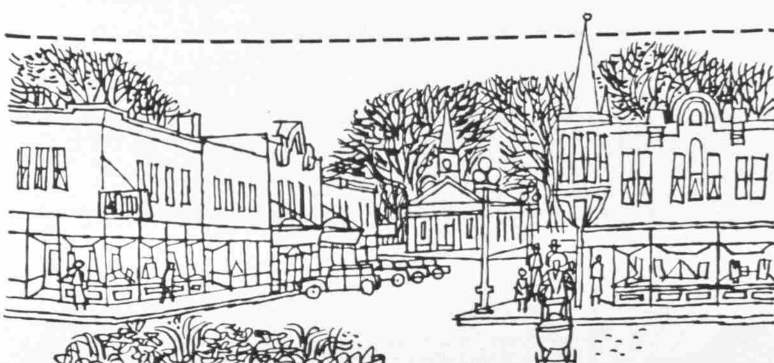
What's going on here? Papermaking!—but you needn't know a single *thing* about the process—that is, to *start* with. What *we* want to know is, can you demonstrate engineering proficiency in any of these fields: mechanical engineering, electrical engineering (with mechanical interests), vibration, fluids, balance, noise control in sound levels, power transmission, chemistry of papermaking, machine design, controls, structures, thermodynamics, lubrication, stress, and instrumentation?

If engineering is your field, you may find a real challenge at Beloit Iron Works—where the *world's largest papermaking machines* are designed and built. In the papermaking field, there is scarcely a branch in which Beloit hasn't broken a record or introduced an engineering innovation or refinement. Beloit engineering—since 1858—has set standards for paper-making around the world. Beloit also manufactures machines and equipment in Pennsylvania, Massachusetts, England, Japan, Italy. As for the community, Beloit, Wisconsin, is a place of pleasant dwellings and modern shopping facilities. It's also the home of Beloit College. It's located in the heart of the Midwest's lake and recreational region. Let us tell you more.

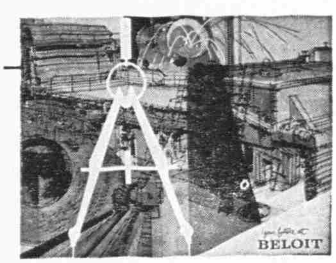


Beloit paper machines are frequently longer than a football field

send for brochure: "Your Future at Beloit."



Beloit, Wisconsin, is a college town



For interview appointment date consult your College Placement Director—or send for brochure:

Beloit Iron Works, Personnel Division,
Beloit, Wisconsin

Please send me illustrated "Beloit" brochure

Name____________________

School____________________ Date of graduation

Address____________________

City________ Zone____ State________

ALUMNI NOTES

(Continued from page 55)

Leonard S. Plee ('18) is supervisor of research and statistics with the Michigan Public Service Commission. He lives in Lansing at 1813 Drexel Rd., and extends a cordial invitation to alumni to visit him.

* * *

Thomas A. Steel ('21) is president of the Leitelt Iron Works and Leitelt Elevator Company in Grand Rapids. He and his wife Dorothy live at 1543 Mackinaw Road, S.E., Grand Rapids, Michigan.

* * *

Forest B. Crampton ('23) completed his 30th year this summer with Marsh & McLennan, national insurance brokers. His address is 14855 Coyle Ave., Detroit 27.

* * *

Ralph E. Decker ('27) is right of way clearance agent for the California Division of Highways in Los Angeles. He lives in San Gabriel at 338 N. Arroyo Drive.

* * *

Charles Blattner ('58) is an employee of Commonwealth Associates, Inc., and is currently working on Project Matterhorn in Princeton, N. J. His address is Laurelton House, Rt. 3, Princeton, N. J.

* * *

Peter Chiarenza ('58) works as a systems engineer at the Martin Company in Baltimore, Md. His address is 830 Argonne Dr., Apt. 9, Baltimore 18, Maryland.

* * *

Donald F. Colby ('58) is a technical sales representative with Rohm & Haas Company. He and his wife Dorothy live at 38 Glenbrook Drive, Prospect Heights, Ill. They have three children, a girl and two boys.

* * *

Mark DeBono ('58) and his wife Joan live at 247 Park Avenue, East Orange, N. J. A daughter, Lori Ann, was born in July.

* * *

Donald E. Janke ('58) is serving two years with the Army at Fort Bliss, Texas.

* * *

A. S. Armstrong ('06) retired in 1958 after fifty years with the same company. He lives at 307 S. 16th St., Quincy, Ill.

* * *

Arthur Pulling ('10) is a retired engineer living at 16214 Fielding Ave., Detroit.

* * *

John J. Harris ('12) writes from 3231 Jamaica, Corpus Christi, Texas.

ADVERTISER'S INDEX

One of a series*

Interview with General Electric's Charles F. Savage
Consultant—Engineering Professional Relations

How Professional Societies Help Develop Young Engineers

Q. Mr. Savage, should young engineers join professional engineering societies?

A. By all means. Once engineers have graduated from college they are immediately "on the outside looking in," so to speak, of a new social circle to which they must earn their right to belong. Joining a professional or technical society represents a good entree.

Q. How do these societies help young engineers?

A. The members of these societies—mature, knowledgeable men—have an obligation to instruct those who follow after them. Engineers and scientists—as professional people—are custodians of a specialized body or fund of knowledge to which they have three definite responsibilities. The first is to *generate* new knowledge and add to this total fund. The second is to *utilize* this fund of knowledge in service to society. The third is to *teach* this knowledge to others, including young engineers.

Q. Specifically, what benefits accrue from belonging to these groups?

A. There are many. For the young engineer, affiliation serves the practical purpose of exposing his work to appraisal by other scientists and engineers. Most important, however, technical societies enable young engineers to learn of work crucial to their own. These organizations are a prime source of ideas—meeting colleagues and talking with them, reading reports, attending meetings and lectures. And, for the young engineer, recognition of his accomplishments by associates and organizations generally heads the list of his aspirations. He derives satisfaction from knowing that he has been identified in his field.

Q. What contribution is the young engineer expected to make as an active member of technical and professional societies?

A. First of all, he should become active in helping promote the objectives of a society by preparing and presenting timely, well-conceived technical papers. He should also become active in organizational administration. This is self-development at work, for such efforts can enhance the personal stature and reputation of the individual. And, I might add that professional development is a continuous process, starting prior to entering college and progressing beyond retirement. Professional aspirations may change but learning covers a person's entire life span. And, of course, there are dues to be paid. The amount is graduated in terms of professional stature gained and should always be considered as a personal investment in his future.

Q. How do you go about joining professional groups?

A. While still in school, join student chapters of societies right on campus. Once an engineer is out working in industry, he should contact local chapters of technical and professional societies, or find out about them from fellow engineers.

Q. Does General Electric encourage participation in technical and professional societies?

A. It certainly does. General Electric progress is built upon creative ideas and innovations. The Company goes to great lengths to establish a climate and incentive to yield these results. One way to get ideas is to encourage employees to join professional societies. Why? Because General Electric shares in recognition accorded any of its individual employees, as well as the common pool of knowledge that these engineers build up. It can't help but profit by encouraging such association, which sparks and stimulates contributions.

Right now, sizeable numbers of General Electric employees, at all levels in the Company, belong to engineering societies, hold responsible offices, serve on working committees and handle important assignments. Many are recognized for their outstanding contributions by honor and medal awards.

These general observations emphasize that General Electric does encourage participation. In indication of the importance of this view, the Company usually defrays a portion of the expense accrued by the men involved in supporting the activities of these various organizations. Remember, our goal is to see every man advance to the full limit of his capabilities. Encouraging him to join Professional Societies is one way to help him do so.

Mr. Savage has copies of the booklet "Your First 5 Years" published by the Engineers' Council for Professional Development which you may have for the asking. Simply write to Mr. C. F. Savage, Section 959-12, General Electric Co., Schenectady 5, N. Y.

***LOOK FOR** other interviews discussing: Salary • Why Companies have Training Programs • How to Get the Job You Want.

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