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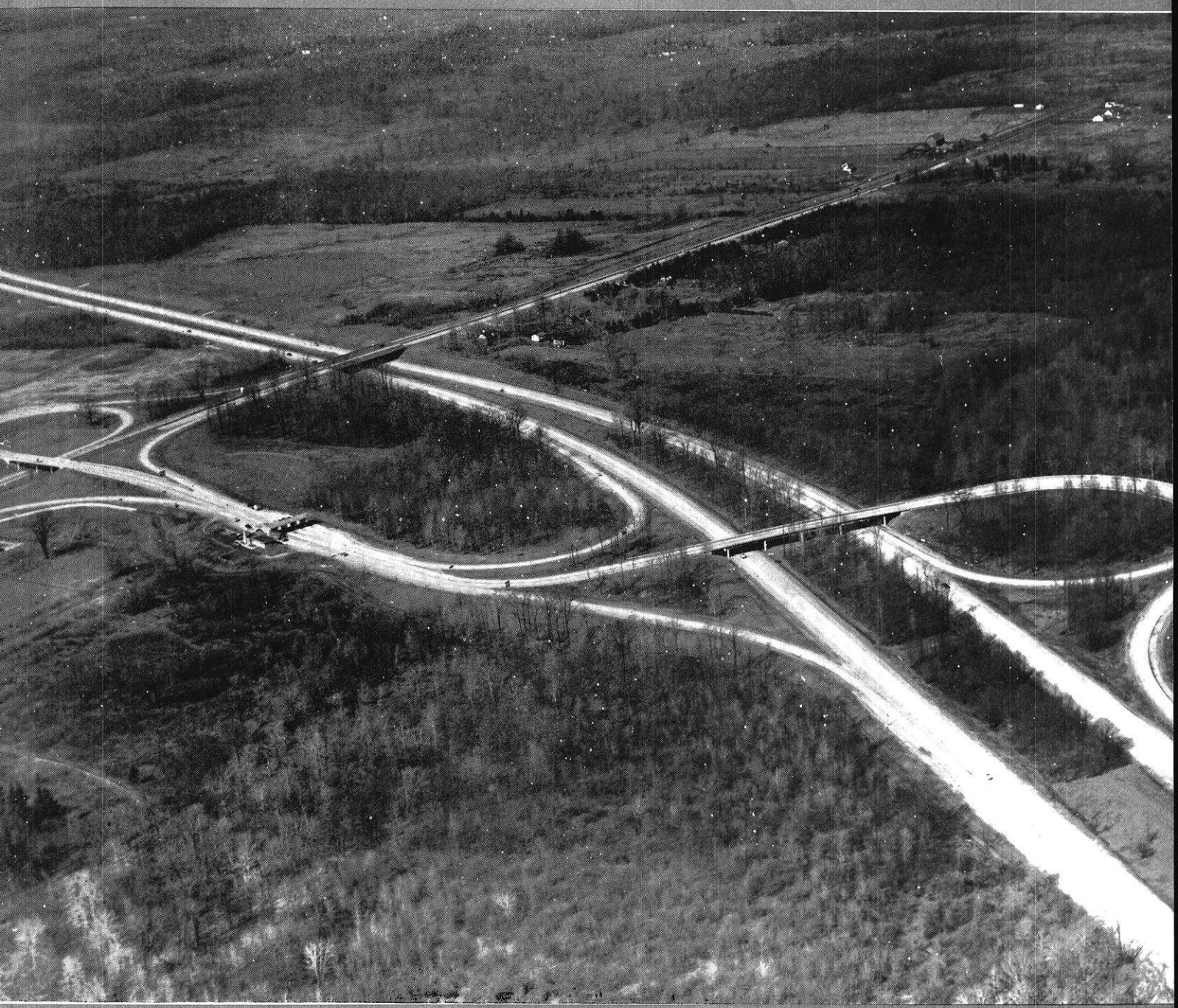
JANUARY
1959
The Wisconsin
25¢

engineer



Highways of Tomorrow

IN THIS ISSUE

Modern Diesels

Cation Captivators

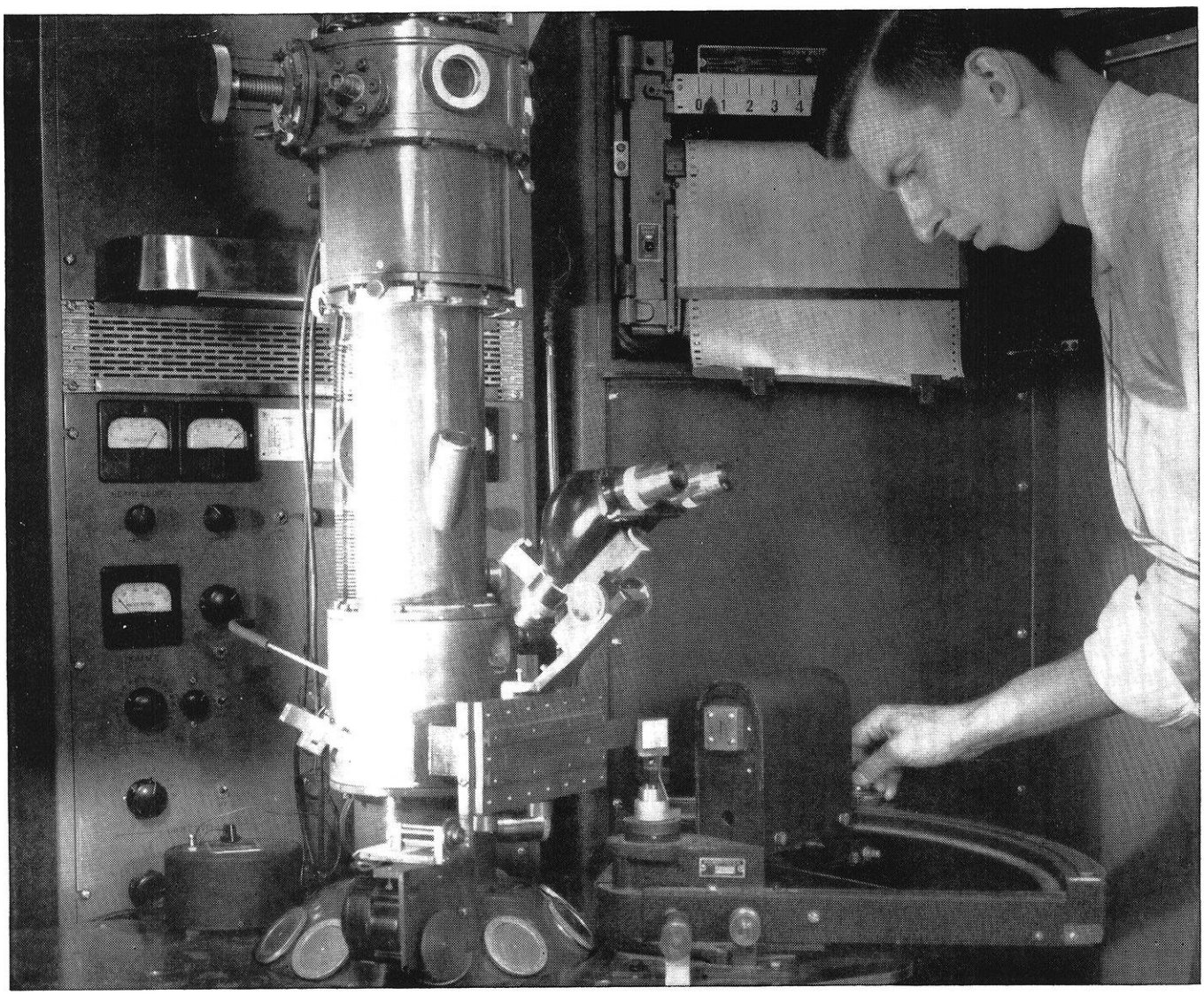
Auto Gas Turbines

Want to see a pinhead—
47 feet wide?

The head of a pin would appear about 47 feet wide if examined under this instrument. It's an electron probe microanalyzer—the first to be used industrially in this country. U. S. Steel research teams use it to get a better look at the microstructure of new types of steel. In this way, they gather more information about the factors affecting steel quality and performance.

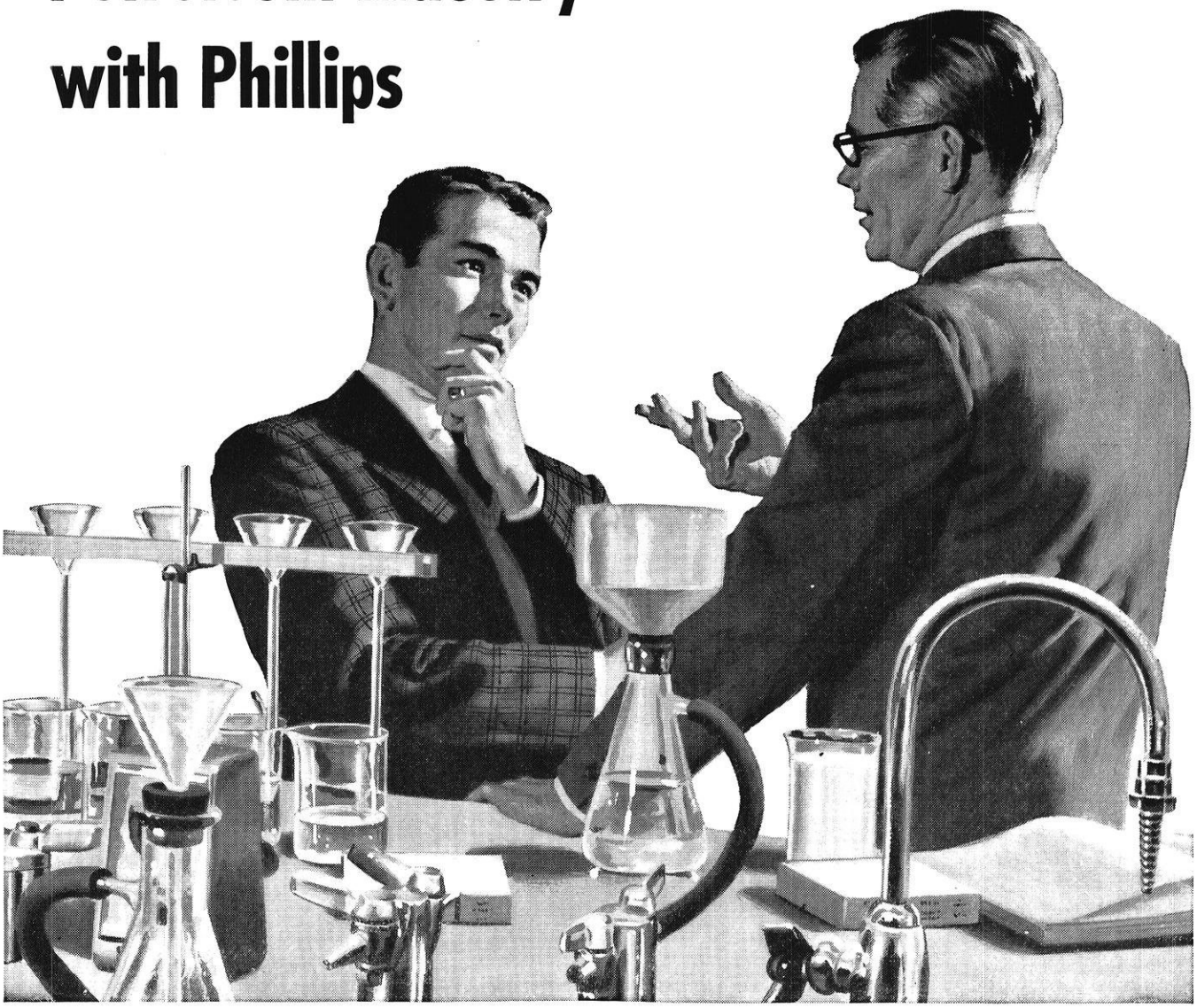
Research like this is typical of U. S. Steel's leadership in the production of better steels for the wonder products of tomorrow.

USS is a registered trademark



USS United States Steel

Opportunities in the Petroleum Industry with Phillips



What would you like to do? Help design a fractionation unit? Develop a new fertilizer? Perhaps construct a new polyethylene reactor . . . or work on an improved octane number system?

Petroleum chemistry is important at Phillips . . . but so are gasoline refining, uranium processing, pipe line design, oil geology and exploration, research and the dozens of other activities which are essential to Phillips broad and diversified operations. The wide selection of possibilities available in these various specialties enables you to choose a career that matches your education and interests.

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Phillips 66

D. R. McKeithan, Director
Technical Manpower Division
PHILLIPS PETROLEUM COMPANY
Bartlesville, Oklahoma

"I think Dudley has the wrong idea about our engineering school."

THE WISCONSIN ENGINEER??

"Hey! I'm over here."

Volume 63 JANUARY 1959 Number 4

WISCONSIN ENGINEER

The Student Engineer's Magazine
FOUNDED 1896

Features

Departments

Cover

The Cleveland interchange on the Ohio Turnpike is a good example of the safety being built into modern roadways. See story page 10.

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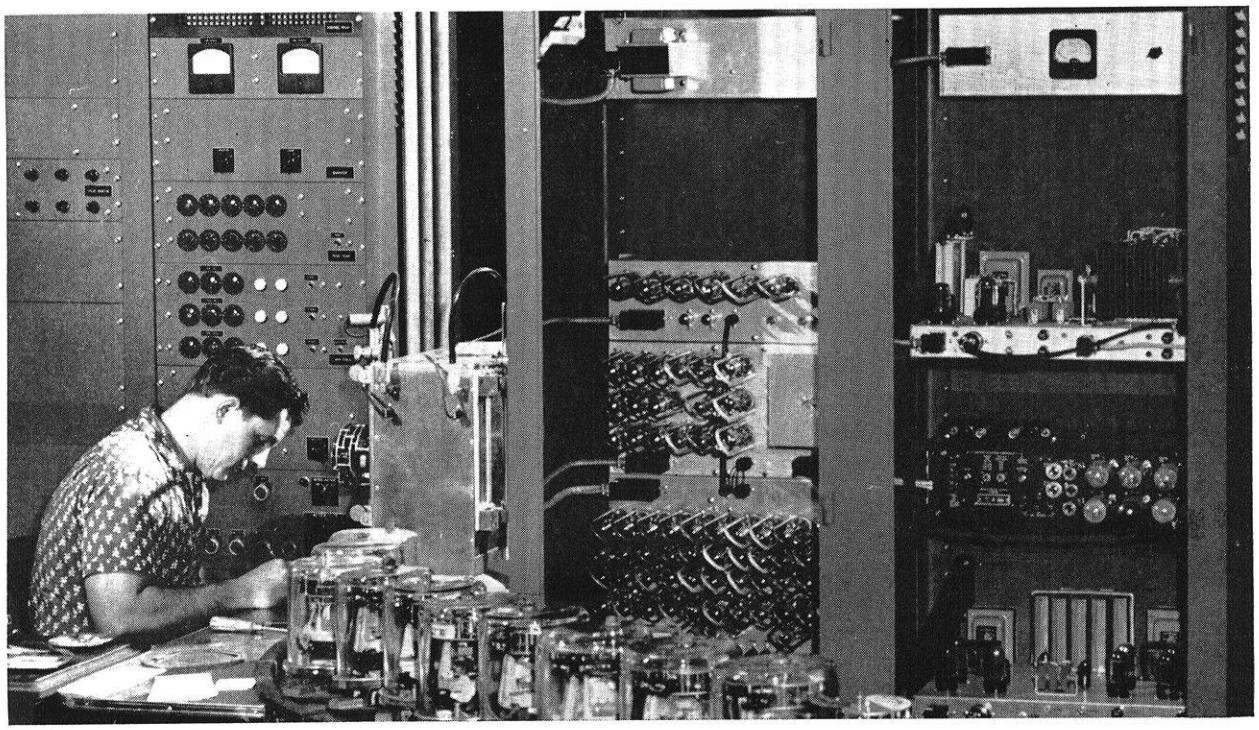
It takes imagination...



It takes *engineering imagination* to design and develop practical applications for the many recent technological advances. Applying the principles of multiplier and divider circuits, as found in digital computers, to the determination of accuracy in watthour meters — our engineers have designed and built an automatic error computer. Use of this computer has increased individual production in testing of watthour meters to approximately 250 units per day. The installation is one example of the dividends resulting from Wisconsin Electric Power Company's policy of performing its own design and development work.

We're looking for men with qualities like these!

This policy also results in *dividends* for the young engineer. Even with skill, foresight, imagination and judgment, a person must find a receptive environment to enable him to exercise and develop these qualities. At Wisconsin Electric Power Company you will find such an environment. You will have a chance to use your engineering skills in a wide variety of fields — electrical, mechanical, civil, chemical, statistical, research, sales, administrative, etc.

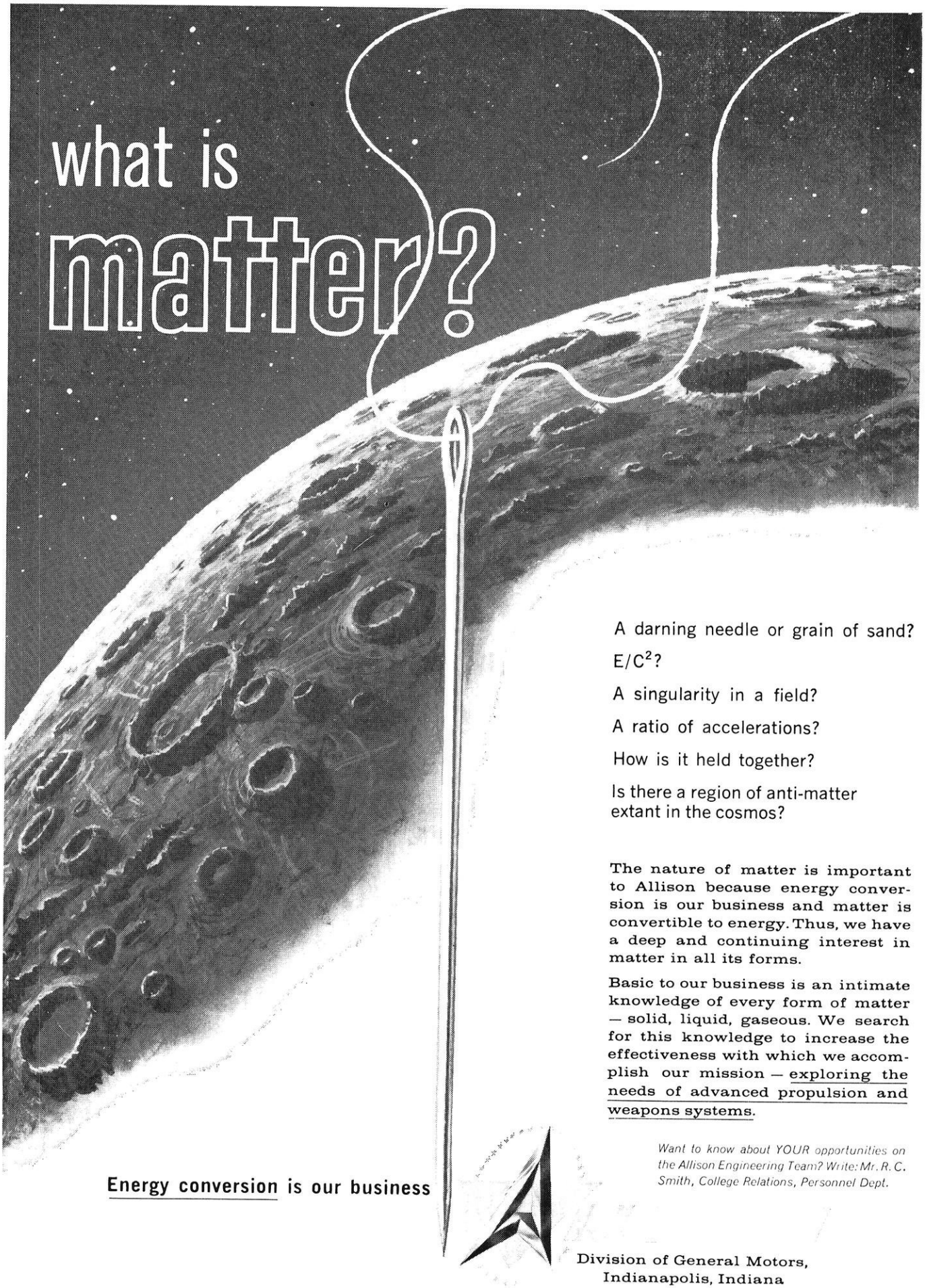
Demands for our services are so great that our current expansion program anticipates the doubling of our facilities within a 10 year period. We invite you to grow with us. Whatever your work may be, it will be worthy of achievement and will bring with it the material rewards which accompany success.

WISCONSIN ELECTRIC POWER COMPANY SYSTEM

Wisconsin Electric Power Co.
Milwaukee, Wis.

Wisconsin Michigan Power Co.
Appleton, Wis.

Wisconsin Natural Gas Co.
Racine, Wis.



A darning needle or grain of sand?

E/C^2?

A singularity in a field?

A ratio of accelerations?

How is it held together?

Is there a region of anti-matter extant in the cosmos?

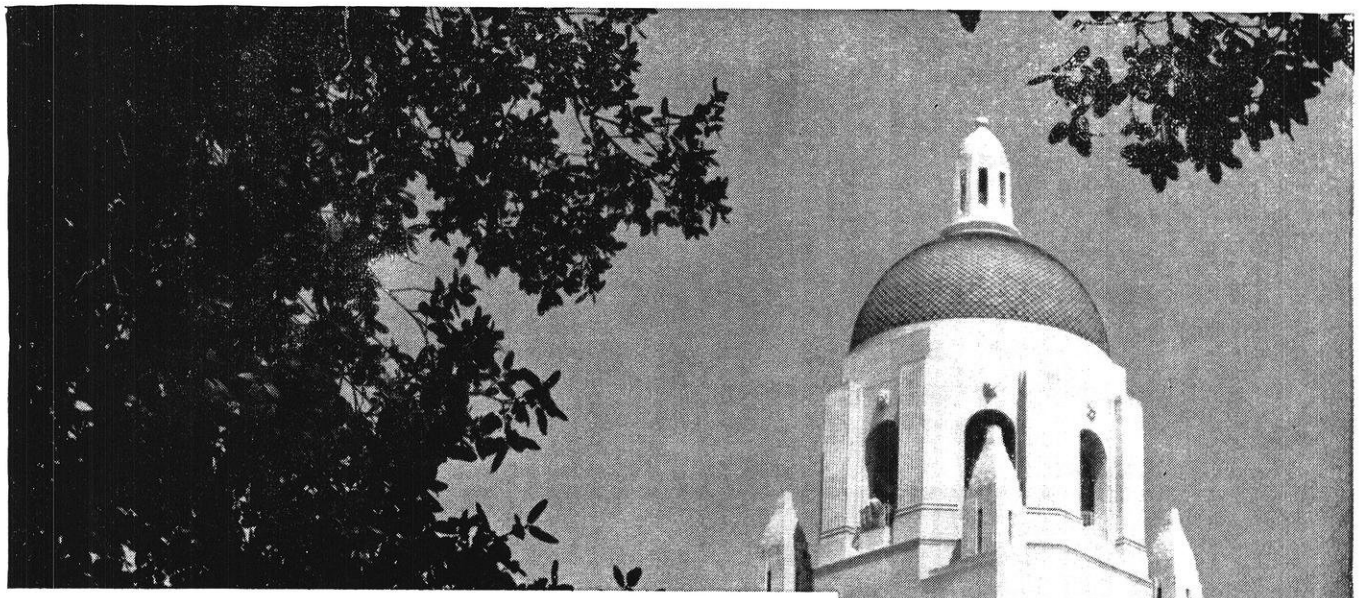
The nature of matter is important to Allison because energy conversion is our business and matter is convertible to energy. Thus, we have a deep and continuing interest in matter in all its forms.

Basic to our business is an intimate knowledge of every form of matter — solid, liquid, gaseous. We search for this knowledge to increase the effectiveness with which we accomplish our mission — exploring the needs of advanced propulsion and weapons systems.

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

Energy conversion is our business

Division of General Motors, Indianapolis, Indiana



Why Lockheed –

Lockheed's leadership in aircraft is continuing in missiles. The Missile Systems Division is one of the largest in the industry and its reputation is attested by the number of high-priority, long-term projects it holds: the Polaris IRBM, Earth Satellite, Kingfisher (Q-5) and the X-7. To carry out such complex projects, the frontiers of technology in all areas must be expanded. Lockheed's laboratories at Sunnyvale and Palo Alto, California, provide the most advanced equipment for research and development, including complete test facilities and one of the most up-to-date computing centers in the nation. Employee benefits are among the best in the industry.

For those who qualify and desire to continue their education, the Graduate Study Program enables them to obtain M.S. or Ph.D degrees at Stanford or the University of California, while employed in their chosen fields at Lockheed.

Lockheed Missile Systems Division was recently honored at the first National Missile Industry Conference as "the organization that contributed most in the past year to the development of the art of missiles and astronautics."

For additional information, write Mr. R. C. Beverstock, College Relations Director, Lockheed Missile Systems Division, Sunnyvale , California.

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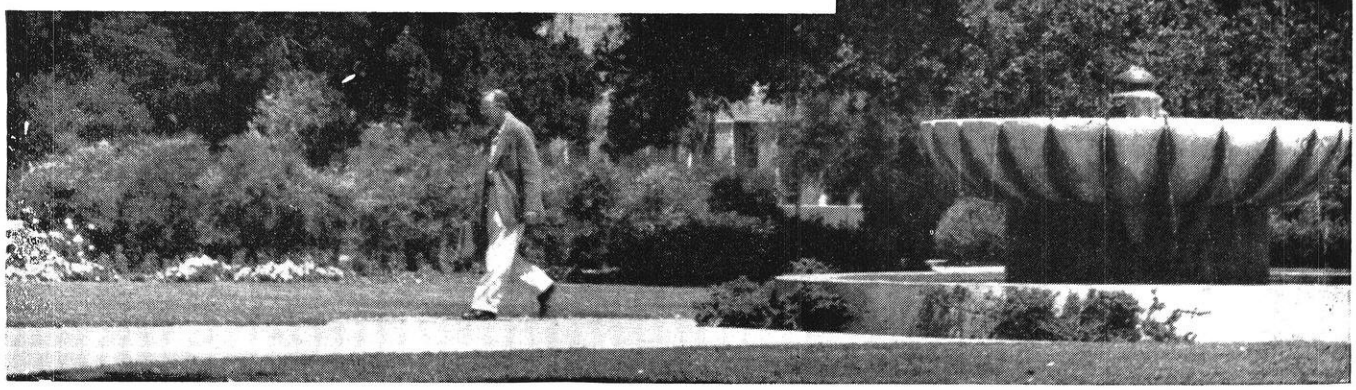


1959

MAY YOU FIND

NINETEEN FIFTYNINE

A FULL YEAR

OF HAPPINESS

AND SUCCESS

1959

Rambling WITH THE EDITOR

Perhaps a little known fact is the alarmingly high percentage of senior engineering students who drop from school and never receive a degree. Figures for the University of Wisconsin are not readily available at this writing, but, for the nation in 1957, about 15 per cent of seniors in engineering "fell by the wayside" for some reason or another.

A few months ago President John T. Rettaliata of Illinois Institute of Technology delivered an address to the board of trustees of that school on this subject. An excerpt from a news release covering that address is reprinted below and is entered as guest editorial material this month.

"In his report to the board at the Chicago Club, he said the number of seniors receiving degrees has been heading downward since 1951.

'This is a loss the nation can ill afford, particularly in engineering and science,' Rettaliata said, for our very survival in future years will depend upon our scientific and technological competence.'

The educator attributed the loss of senior students to lack of funds, changes in curriculum, inadequacy of grades and the attraction of favorable job opportunities in industry. To remedy the situation, he called for 'a strengthening of high school programs to challenge the minds of students and create in them the ability to think and the desire to learn.'

However, he emphasized that 'America should not imitate the Russian education system which tends to create an intellectual elite.

'Our goal at all levels must be to educate properly in both quality and quantity.

'There are many indications pointing to a long-term, strong demand for engineers. It is also a hopeful sign that more of the nation's youth are indicating an interest in engineering.'

In discussing the sputnik scare, Rettaliata said, 'Science has not failed America. We have proved that we have the know-how, but it will not be enough to be second best in an age of intercontinental missiles and nuclear weapons.'

Citing the importance of encouraging scientific and technological talents, he warned that 'we must not neglect other fields of learning which contribute to the development of the broadly-educated people needed to deal with the complex world of today.

'We must strive to produce graduates who have broad concepts and understanding of their social, as well as professional, responsibilities.'

We concur with President Rettaliata, but, for the solution to the problem of "dropping" seniors, it would seem that, since the students have finished three years of college in a demanding curriculum, there should perhaps also be "a strengthening of *college* programs to challenge the minds of students and create in them the ability to think and the desire to learn." Perhaps the drudgery of the curriculum, the great number of required courses that are taught and received with the attitude "Oh, well, we have to go through with this mess, but I'm sure nothing much will be gained by it," as well as the tremendous demands placed on one's time are somewhat to blame for some fellows finally giving up on the whole affair and maybe the educators should concentrate on the University level as well as the high school indoctrination.

—Photo Courtesy Illinois Tollway

A model of a planned highway, interchange.

Highways for Tomorrow

by Ed Allen

In a determined effort to eliminate the highway accident problem and to provide a network of highways for defense, plans have been made for a national system of super-roads.

BY 1975, at a cost of 27.75 billion dollars, the entire nation will be crisscrossed by a network of 41,000 miles of "superroads" to be known as the National System of Interstate and Defense Highways. The system will connect 42 state capitals and 90 percent of all cities of 50,000 or more population, bringing to motorists in every state quicker, easier, safer, and less costly travel.

Standards for the 41,000 mile Interstate System were adopted last July, a month after passage of the legislation which set into motion the huge 13-year highway program. These standards state that Interstate System roads and streets must be designed for the volumes and weights of traffic expected in 1975.

How does a highway engineer design a road for 17 years hence? The adopted standards tell him

many of the minimum features a road must have to qualify for Federal Funds. These minimum features are calculated to give the safest, sturdiest, and most convenient roadways ever built. Although the purpose of the system is partly military, the individual motorist has been kept in mind.

On Interstate System highways, a motorist will be able to drive from coast to coast without a stoplight. There will be no intersections with side roads. Connecting highways will be brought into the main highway by means of interchanges, and railroads and major highways will cross above or beneath the traffic stream on overpasses or underpasses.

Interstate System highways will in general be two separate, one-way roads, divided by median strips at least 36 feet wide, except in cities and mountainous terrain. Headlight glare will be greatly reduced and head-on collisions almost impossible. Rural sections will have hard shoulders at least ten feet wide, for safe off-the-road emergency stops in any weather.

Except in mountainous terrain, the Interstate System will have no hills steeper than a shallow grade. Curves will be gentle and the highways built on wide right-of-way so that the driver will have safe sight distance at all times. All but a few thousand miles of the network will be divided highway, four or more lanes wide. Passing will be no problem.

Interstate System highways are being designed for speeds of 70 miles per hour in flat land, 60 mph in rolling country, and 50 mph in mountainous areas and in cities. They will cut hours from driving time. For example, in December of 1956, a New York Times reporter and his wife traveled from the heart of Manhattan to the Chicago Loop, a distance of 857 miles, in 15 1/2 hours, utilizing the New Jersey, Pennsylvania, Ohio, and Indiana Turnpikes, highways approximating present Interstate System standards. They never exceeded speed limits and stopped five times for food, gasoline, and rest. Yet they made the trip 3 1/2 hours faster than some trains, and 30 minutes faster than a crack New York–Chicago streamliner!

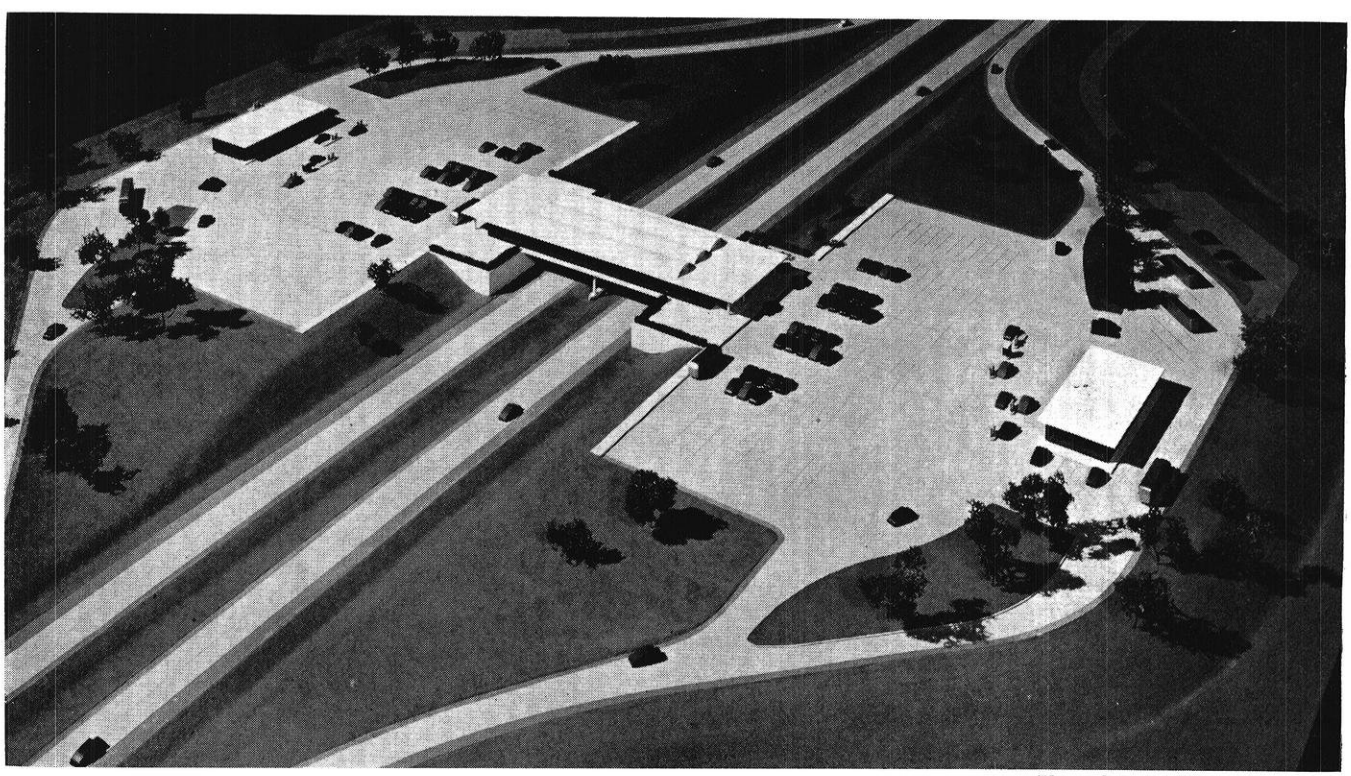
This trip indicates time savings possible on roads of Interstate system design. Average speed for the first 842 miles of the journey, including stops, was about 57 miles per hour. For 800 miles they encountered not one traffic light or crossroad. The last 15 miles, in contrast, were driven over city streets, at an average of 20 miles per hour.

Motorists will save money as well as time on these roads—at least one cent per mile. This saving will result from reduced gasoline consumption, reduced mechanical and tire wear, and lower insurance rates.

Far more important than savings of time and money is the saving in human lives to result from completion of the Interstate System. The Automotive Safety Foundation estimates conservatively that the design standards adopted for the network will save at least 3,500 lives and decrease injuries by more than 100,000 *each year.*

One of the most important safety features of these highways is the little-known "Control of access." This means control over the number and location of entrances to the main highway. A study conducted by the United States Bureau of Public Roads showed that where access to the highway was fully controlled, accident deaths aver-

(Continued on page 42)



—Photo Courtesy Illinois Tollway

Under construction are five "over-the-tollway" restaurants to serve Illinois' 187-mile tollway. The unique restaurants give diners an overhead view of the traffic flowing beneath them, cut land and construction costs, and are more efficient to operate than conventional "twin" restaurants.

Cation Captivators

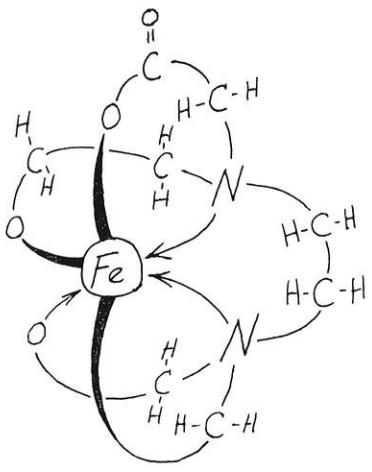
by John Holms Che'59

Metal ions often cause considerable trouble in a process. The addition of a cation captivator or sequestering agent "masks" the activity of the ion in the reaction and renders the ion harmless.

CATION captivators, or so called sequestering agents, are becoming increasingly important to the chemical industry. These agents are used to alter or mask the chemical or biological activity of metal ions in numerous types of reactions. A trace of calcium in the diet may be a wonderful and needed thing, but the same amount of calcium in your shampoo would be noticed as a curd at the bottom of the bottle. A few parts per million of certain dissolved ions can cause soap to turn rancid, inactivate enzymes, promote clouding of wines, even embrittle rubber. The chemical industry finds sequestering agents indispensable in a host of processes: preparation of soap, purification of water, analytical work, pharmaceuticals, and ion exchange processes are but a few.

Sequestering agents are classified as organic and inorganic. The organic agents of importance are the amino acids and the hydroxy carboxilic acids, while phosphates are the most widely used inorganic sequestering agents. Citric, malic, lactic and tartaric acids are of the hydroxy carboxilic acid type and occur commonly in nature. Salts of ethylene diamino tetraacetic acid (EDTA) and its related compounds are of the amino acid type and are the most commonly used of the organic agents. Condensed polyphosphates are the most widely used inorganic sequestering agents.

When a metal ion is causing trouble in a process, it must be inactivated. An easy way to do this is by the addition of a sequestering agent. Used in small amounts, they counteract even trace impurities by capturing the metal ions in stable, soluble complexes, which no longer are able to interfere with the process.



EDTA sequestering Fe. Note the chelaterings gripping the iron ion.

The term "chelation" is often used to describe the reaction of EDTA with metal ions. Chelation is the formation of a stable ring structure with a metal ion so that it no longer has properties of a metal ion. EDTA works well because the atoms are spaced at convenient distances and angles to form a most stable chelate ring. The molecule of EDTA has six atoms which can attract a metal ion. This property allows it to grip a metal ion in one or more chelate rings at a time. A newly developed product, "Perma Kleers," forms water soluble chelates which are said to be more stable than those of EDTA.

Since trace metals catalyze the oxidation and deterioration of mineral oil and gasoline, oil soluble chelating agents have been developed. These agents function in oil much like EDTA does in water solution.

The exact mechanisms by which the hydroxy carboxilic acids se-

quester an ion are not thoroughly understood. They may undertake a chelate type reaction, such as EDTA undergoes to complex the metal ions. The polyphosphates complex metals into soluble ions which usually vary in composition and complexity.

To better understand the reaction of these agents with a metal ion, a general equation is presented.

$Ac + M_u^+ \rightleftharpoons Cm + M_s^+$

Ac is the complexing agent, M_u^+ is the unwanted metal ion, Cm is the resulting metal complex, and M_s^+ is the non-harmful metal ion.

Aids Soap Industry

The soap industry is the largest user of sequestering agents. The addition of a sequestering agent to a soap renders harmless the ions, which would ordinarily form a curd with the soap. Products like Surf and Tide are effective detergents because of the large proportion of sequestrants in their composition. Other desirable properties of soap which are obtainable with sequestering are longer shelf life, improved water softening, and easier solublizing of protein and grease. EDTA can dissolve insoluble salts of metals as well as prevent their precipitation. This makes it useful for decontaminating radioactive films which are insoluble to ordinary soap and water. Also, "Calgon", a chemical polyphosphate, improves the efficiency of commercial soap by removing radioactive contamination.

The polyphosphates find a wide use as sequestering agents for water conditioning. They not only capture the metal ions present, but also potentiate the detergent action of soap used with the treated water. A sequestering process is usually used only as a final step in water conditioning because of the high unit cost of material.

Because of a chelating agent's property of being able to grasp one metal and not another, they are one of the finest tools of the chemical analyst. The analyst can use chelating agents like forceps to pick a specific ion out of a complex mixture. A chelation process is characterized by an abrupt change in metal ion concentration, usually called an end point. This abrupt change can easily be detected by established visual and instrumental techniques. In general, sequestering agents comprise the greatest part of the hundreds of organic reagents used for metal analysis.

Selective chelation in an ion exchange column has become an important method for recovering rare earths from their ores. A large group of ions with similar properties can easily be separated.

The electrochemical industry recently has increased its use of agents such as gluconic acid to complex impurities in plating and cleaning baths. Also, similar agents are now being used as a reservoir of metal ions to control the concentration of various plating solutions. A process for removing rust with an EDTA compound has recently been patented by people in the electrochemical industry.

Not as evident, but as important a use of these compounds is in the pharmaceutical and food industries. Many medicinal uses have been found for sequestering agents, such as decalcifying bones, dissolving kidney stones, removing heavy metals (such as lead and plutonium) from the body, and as an anticoagulant and stabilizer of whole blood. A chelating agent is used in antibiotics because of the catalytic deterioration caused by trace ions. California wines utilize a sequestering agent (Fessler's compound) to prevent the clouding of wine by metal ions. Foods are made more palatable and have longer shelf life when they contain sequestering agents.

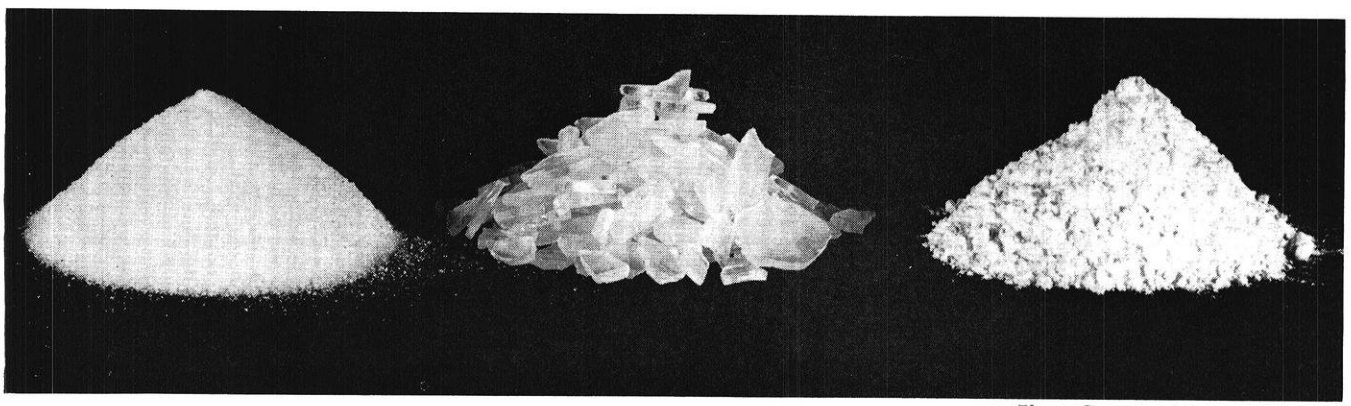
The clothes you wear every day have met with sequestering agents in such processes as dying, mercerizing, and sanforizing.

Automobile tires are protected from embrittlement with certain sequestering agents. The deterioration of crude rubber and latex is caused by small amounts of manganese, copper and iron which can be inactivated with the application of the proper chelating agent.

Some of the newer uses of these compounds range from home permanent neutralizers to transparent wrapping clarifiers to a stabilizer for some of the more advanced rocket fuels.

From the chemist's laboratory to the home and in every-day products you use, the field of sequestration finds application. If a metal ion is causing trouble in any new process, a cation captivator will probably be the best remedy.

THE END



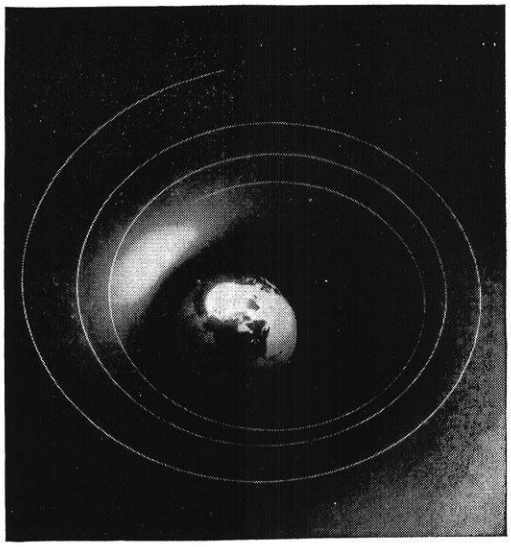
—Photo Courtesy Calgon Company

Powdered calgon for textile, paper and leather processing, water conditioning, compounding with other chemicals.

Calgon glass for threshold treatment, scale prevention, corrosion control and water conditioning.

Crushed calgon for textile, paper and leather processing, water conditioning, compounding with other chemicals.

For Peaceful Purposes and the Benefit of All Mankind The National Aeronautics and Space Administration Announces its Authorization by the Congress of the United States



To Direct and Implement U.S. Research Efforts In Aeronautics and the Exploration of Space

"The aeronautical and space activities of the United States shall be conducted so as to contribute materially to one or more of the following objectives:

(1) The expansion of human knowledge of phenomena in the atmosphere and space;

(2) The improvement of the usefulness, performance, speed, safety, and efficiency of aeronautical and space vehicles;

(3) The development and operation of vehicles capable of carrying instruments, equipment, supplies and living organisms through space;

(4) The establishment of long-range studies of the potential benefits to be gained from, the opportunities for, and the problems involved in the utilization of aeronautical and space activities for peaceful and scientific purposes;

(5) The preservation of the role of the United States as a leader in aeronautical and space science and technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere;

(6) The making available to agencies directly concerned with national defense of discoveries that have military value or significance, and the furnishing by such agencies, to the civilian agency established to direct and control nonmilitary aeronautical and space activities, of information as to discoveries which have value or significance to that agency;

(7) Cooperation by the United States with other nations and groups of nations in work done pursuant to this Act and in the peaceful application of the results thereof; and

(8) The most effective utilization of the scientific and engineering resources of the United States, with close cooperation among all interested agencies of the United States in order to avoid unnecessary duplication of effort, facilities, and equipment..."*

The excitement, the importance, and the scope of the National Aeronautics and Space Administration are apparent, we believe, from our enabling act. Career opportunities at NASA are as unlimited as the scope of the organization itself.

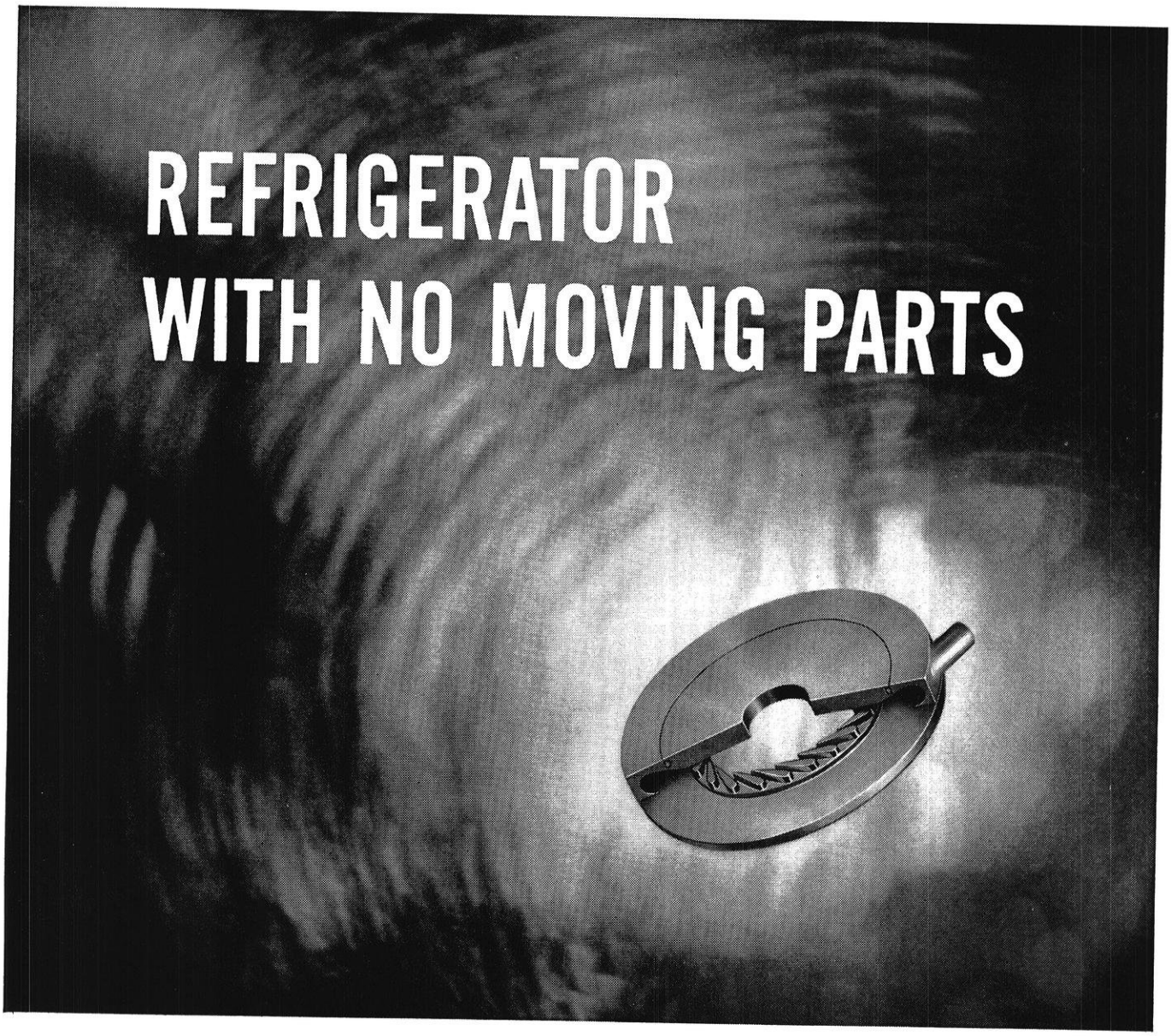
Please address your inquiry to the Personnel Director of any of the following NASA research centers. Your inquiry will be answered immediately, and will be treated in the strictest confidence.

Langley Research Center, Hampton, Virginia
Ames Research Center, Mountain View, California
Lewis Research Center, Cleveland, Ohio
High-Speed Flight Station, Edwards, California

*Quoted from the National Aeronautics and Space Act of 1958.

(Positions are filled in accordance with Aeronautical Research Scientist Announcement 61B)

NASA National Aeronautics and Space Administration



The vortex tube is a refrigerating machine with no moving parts. Compressed air enters the vortex chamber pictured here and spins rapidly down an attached tube. Pressure and temperature differences build up, forcing cold air out one end and hot air out the other. Requiring no maintenance, a large vortex tube developed by AiResearch scientists and engineers can be permanently sealed in nuclear reactors, and has many uses in industries with spot cooling problems.

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This Can Be You...A

Carroll W. Boyce, B.S. in Business and Engineering Administration, M.I.T., today is a key managing Editor of FACTORY Magazine

Assistant Editor; Associate Editor for editorial plans; Special Projects Editor. These steps up the ladder have brought Carroll to his present position of executive responsibility on McGraw-Hill's FACTORY MANAGEMENT AND MAINTENANCE.

Carroll Boyce is the author of numerous articles; guest lecturer at Graduate Schools of Engineering and professional societies, Consultant to the Administrator, National Production Authority; member, American Society of Mechanical Engineers, the National Press Club and other leading organizations.

"During my four years at M.I.T.," relates Carroll, "I was an editor of the Tech Engineering News. I discovered that I enjoyed both writing and engineering, so I decided to combine the two. Knowing that McGraw-Hill is the largest publisher of business magazines, I wrote a letter to the Personnel Department. In a way, it was probably the most important letter of my life. I was hired!

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Top Engineer-Journalist

What's in a brain? Carroll (standing) gets an advanced briefing on the latest developments in the Univac Electronic Computer from Charles Katz of Remington Rand.

From Air To Sea

by Roger G. Bensman

The diesel engine finds use in almost all types of power production from aircraft to automotive to marine application.

IN THIS present day world, diesel engines play an important role. They have applications for power production in the marine, stationary, motor vehicle, and aircraft fields.

From its conception up to the present, the diesel has enjoyed a high degree of refinement. As such, only those people directly connected with the field are familiar with the many details of design and operation.

Description of Operation

Since Diesel engines are made in varying sizes and horsepower, no attempt will be made to show a diesel model. Instead, the discussion includes descriptions of events in the cylinder itself, since these events are the same in all diesel engines, independent of the size, number of cylinders, output, or speed.

The diesel is an internal combustion engine which depends upon high pressures for ignition of its air-fuel mixture. It differs significantly from the internal combustion gasoline engine because its fuel is ignited by compression in place of a spark plug.

In the usual four-stroke cylinder, there are four working strokes during two complete revolutions of the crank shaft. (See figure 1.) These are, respectively,

1. Induction.
2. Compression.
3. Combustion and expansion.
4. Exhaust.

In part A, of figure 1, the piston is shown desending on its induction stroke; pure air only is drawn into the cylinder. It will be observed that the inlet valve is open, while the exhaust valve is closed. The valves shown are of the overhead type, and can be operated by an overhead cam shaft, or by push rods and rocker-arms, as in modern gasoline engines.

The next stroke of the piston is the compression, shown in B. During this stroke, both the inlet and exhaust valves remain closed and the air previously drawn into the cylinder during the suction stroke is compressed as the piston ascends. The compression employed in modern internal combustion engines corresponds to pressures ranging from 450 to 650 psi. Compression ratios range from 11:1 to 18:1 in modern engines.

As the air is compressed in the cylinder, its temperature increases until, near the end of the compression stroke, it becomes sufficiently high to ignite any liquid fuel that may be injected into the cylinder. This temperature is about 400 to 450 degrees F.

In part C, figure 1, the piston is shown near the top of its compression stroke, the fuel valve being open and liquid hydrocarbon fuel, such as Diesel oil, is sprayed into the combustion head under higher pressures than those existing in the cylinder itself. This fuel then ignites, being burned with the oxygen of the highly compressed air.

During the fuel injection period, the piston reaches the end of its compression stroke and commences to return on its third consecutive stroke, the expansion stroke. During this stroke, D, the hot products of combustion, consisting principally of carbon dioxide, together with the nitrogen left from the air compressed, expand, forcing the piston downwards. This is the only working stroke of the cycle.

During the expansion stroke, the pressure falls from its maximum combustion value, down to about 60 psi near the end of the stroke. The exhaust valve then begins to open slightly before the piston has reached its lowest point of travel, and the exhaust gases are swept out on the following upward stroke of the piston, as shown in E. The exhaust valve remains open throughout the whole of this stroke, and closes at the top of the stroke.

Combustion

Of greatest importance in the design of a high speed diesel is completeness of combustion. This problem overshadows other purely mechanical details, such as lightness and strength of framing, balancing of crankshaft, and lubrication. Without a reasonable combustion efficiency, the power developed per gallon of fuel would be low, thereby eliminating the advantage possessed by the theoretical diesel.

Combustion efficiency is desirable for a second reason. If a large charge of fuel, injected into the cylinder, is not completely burned, the unburned portion will settle on the cylinder walls and piston, leaving a sticky mass of carbon. This carbon will fill the space between a piston ring and its groove, binding the ring so that it no longer seals the piston against blow-by. Other portions of the carbon settle on the exhaust valve seat and cause the valve to leak. This reduces compression to a point where the air temperature does not reach a high enough value during compression to ignite the next fuel charge.

From both an efficiency and mechanical standpoint, complete combustion is a requirement if a diesel is to be successful.

Fuel Preparation and Combustion

When a charge of fuel oil is injected into an engine cylinder, there are several steps in the combustion of the fuel and air.

1. Atomization. This divides the oil charge into as many fine particles as possible. This allows each fuel particle to find an oxygen particle.
2. Dispersion. Fuel oil particles must be uniformly dispersed through the chamber. Fuel spread (dispersion) and penetration are controlled by nozzle design, injector-pump pressure, and air turbulence in the cylinder.
3. Heating. The oil particles must be heated up to a temperature high enough to permit self-ignition where oil meets oxygen.
4. Ingition. This occurs shortly after the first oil particle enters the cylinder. The time interval is the ignition lag, and it varies with oil type, compression temperature, and other engine characteristics.
5. Burning. The oil then burns as fast as it enters the cylinder.

Due to the importance of oil-spray diffusion, the idea of air movement in the cylinder has been extensively developed. Air movement is obtained by three methods.

1. Entrance swirl. Incoming air is given a curvilinear path.
2. Piston swirl. The piston is given a concave head, which causes swirling action, and hence, better mixing.
3. Turbulance chamber. This is a chamber above the cylinder, usually in the head casing, in which air and fuel meet at high velocities.
4. Pre-combustion chamber. When the piston completes its compression stroke, some of the cylinder charge of air is forced into the pre-combustion chamber, but about 65% remains in the cylinder. This cuts pre-ignition and stabilizes pressure.

Fuel Injection Nozzles

The performance of diesel engines depends upon the condition of the nozzles. If the valves are faulty, anything including pre-ignition, late burning, or faulty pressure will result.

All fuel spray valves may be divided into three classes.

Mechanically operated needle valves. Some diesels employ needle valves of this type. The valve is a needle which, when lifted by the cam mechanism, uncovers the orifice into the cylinder. The oil is forced through the orifice by the high pressure in the fuel header piping (from 4000 to 6000 psi.)

Atomization of the oil depends upon the velocity of the oil, which is close to 800 fps.

Open spray valves. This valve employs a pump to push oil through it and into the firing chamber. The nozzle can be provided with a check valve to prevent cylinder gases from blowing back into the oil pipe line.

Differential spring loaded valves. This type of valve consists of a spray valve with a spring loaded shut-off device. The valve provides excellent oil control.

Fuel Injection Pumps

Two basic methods of fuel injection are found on high speed diesel:

Impulse injection (jerk-pump). In the jerk-pump system, sharp nosed cam rotates under the foot of the plunger working in the barrel filled with oil, with a tube leading to the nozzle at the engine cylinder. The rotation of the cam shaft at half engine speed brings the raised portion of the cam into contact with the pump plunger at a high velocity. The effect on the plunger is similar to the result to a lever if given a sharp jerk, consequently, the term "jerk-pump." The motion given to the pump plunger raises the oil high enough to overcome spring pressure at the nozzle, and forces oil into the engine cylinder.

Hydraulic (common rail). In this case, there are two principle types of injection.

1. Variable valve lift with constant fuel pressure.
2. Constant valve lift with variable pressure.

In both, injection is through a mechanically controlled valve, using fuel stored under pressure in a receiver.

When the former system is employed, the fuel pressure must be kept constant under all conditions, any excess of delivery, as when running light, being by-passed.

In the second case, the fuel pressure varies with the engine load, the fuel valve lift being constant. The advantage of this method is that only one pump is required, even for a multiple cylinder engine, so that if for any reason there is a variation in the pump supply, it will affect all the cylinders to the same extent.

Governors

An engine is able to deliver power in proportion to the amount of fuel introduced in the cylinders. At a decrease in the load carried by the engine, the amount of fuel injected in each cycle, if not changed, will be more than sufficient to deliver the power needed under the new condition. As a consequence, the engine would speed up and explode. Conversely, at an increase in load, the engine would slow down and stop, for not enough fuel would

(Continued next page)

be introduced into the cylinder to meet the increased load. The amount of fuel injected, then, must be regulated in accordance with the load. This is commonly accomplished by one of three types of governors:

1. Jahns.
2. Flyball.
3. Inertial-Centriugal.

The Jahns governor. The two weights A are guided in a radial straight line perpendicular to the spindle, by three rolls C on the lower surface sustaining the weights, and two rolls not shown on the sides, resisting the force of inertia, which would tend to keep the weight revolving at the same rate as the engine. Therefore, the governor increases or decreases its speed by an infinitesimal amount. The centrifugal force of each weight act directly upon its spring so that all lever points are entirely free from any centrifugal or spring force. The amount of fuel injected is controlled by the change in the length of springs.

The Jahns governor possesses the following qualities:

a. Great sensitivity.
b. Large capacity.
c. High efficiency.

The Flyball governor. This denign embodies the principal of two weights suspended from a central shaft by means of two links or arms. The shaft is connected by some means to the crankshaft. Its rotation causes the weights to revolve in a horizontal plane at a distance below the point of suspension, depending upon the engine speed in rpm. At an increase in engine speed, the balls fly outward and upward. This changes the position of a lever by which the fuel pump is controlled.

The Inertial-centrifugal governor. This is fitted on the engine crankshaft. The design combines inertia and centrifugal action. Two weight arms J are pivoted at V. at the outer ends the weights are connected by links X and Y to a cam on the engine shaft. This can control the time at which the fuel pump's by-pass valve closes and also the amount of fuel reaching the engine cylinder.

At any engine speed the weights move outward, swinging from the pivots V until the resistance of the springs V equals the centrifugal force developed by the weights. At a change in speed, say, an increase, the weights move outward to a new position, but momentarily the inertia of the weights offset the tendency to move. The governor thus does not move at minute variation in speed, which makes for decided stability.

The three governors mentioned represent the general types in use. Engineers should appreciate that governors seldom give trouble as long as the parts are reasonably oiled and the pins are well-fitted in their bushings.

Air Filtration

Dust, grit, or any foreign matter carried into an oil engine during the suction stroke or scavenging period is one of the main causes of fouled valves and piston ring wear. Air filters are particularly advisable in power plants where dust and grit are present. In such places from .1 to 5.0 grains per 1000 feet of air can be found. This amount going through a 300hp engine, for example, gives some conception of the amount of abrasive matter which will ultimately enter the engine. Filtration requirements may be listed as follows:

1. Minimum of air resistance.
2. High efficiency.
3. Ease of cleaning.
4. Compactness.
5. Moderate cost.

Commercial air filters may be divided into three classes:

1. Dry.
2. Impingement.
3. Oil bath.

Dry filter. A typical filter is a star-shaped wire frame covered with felt. It is provided with a cylindrical hood having louvres for air admission, the hood being fastened with a thumb nut to the suction pipe. Such units are built for capacities from 15–250 cfm and can be assembled in special boxes holding 2–20 units, then giving a capacity up to 5000cfm, sufficient for a 1700 hp engine.

Impingement filters are generally used on large diesel engines. They consist of a frame fastened to a box through which air is drawn into the engines. One or more of the box-walls may be replaced by such frames containing steel wool.

For a capacity of about 150cfm intended for use on a single-cylinder, four-cycle engine, such a unit will occupy a rectangular space about 22 x 22 x 14 inches.

Oil bath filters have received the widest application, especially for the higher speed engines. The filter, of which several designs are available, consists of a tank containing oil and an upper compartment containing steel wool.

When the cleaner is in operation, the dust-laden air enters through the center inlet whose lower end is submerged below the oil level. As the air enters, the oil is forced upward into the screen element which separates the oil from the air and returns it to the oil reservoir. The sudden reversal of air flow direction removes a large portion of the dust, which is blown to the bottom of the cup.

Super-Charging

Super-charging means charging the engine with air at a higher-than-atmospheric pressure. The pressure generally varies from 2–5 psi; in some cases it may reach 10 or even 30psi. There are two methods commonly used:

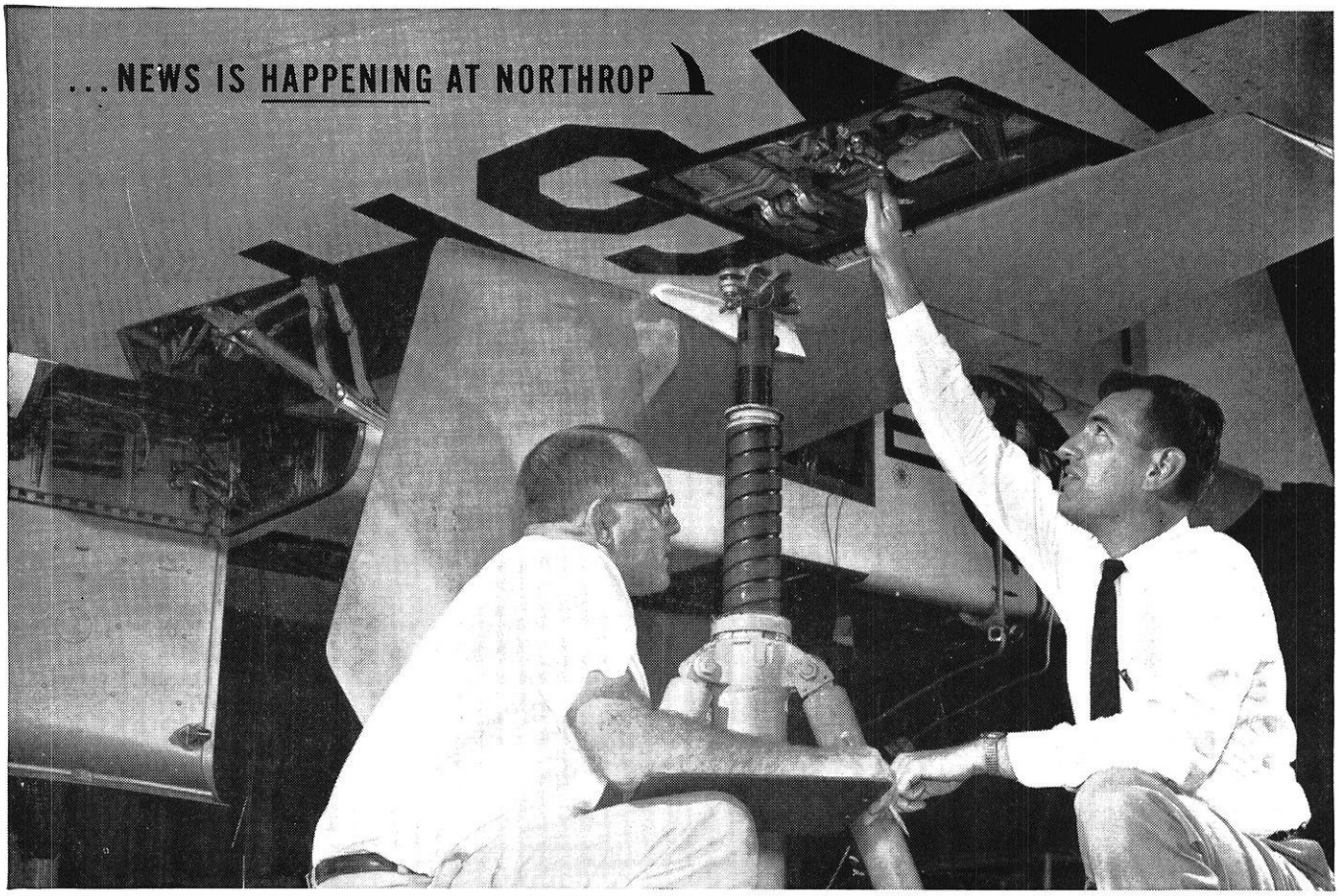
1. Positive displacement (Roots type).
2. Centrifugal blower.

Roots Type. This is primarily used on electro-motive engines and many small engines. The action of the blower is the same, regardless of whether a four-or two-cycle engine is used.

One inherent characteristic of this blower is of special importance. Regardless of speed changes, this type of blower delivers air in proportion to the operation speed so that the volume of air matches the engine need at any speed.

Centrifugal Blower. As this is less commonly used, only a short reference will be made here. The *principle is simple Air* rotated in a whirling squirrel-cage is blown into the cylinder. Pressures similar to the Roots type may be attained.

Refinements in diesels have made many variations of these general ideas fact. Probelms in engine efficiency, speed governors, air filtration, and supercharging form a crucial part of modern diesel engine design. **THE END**



On the right, shown following through on pre-flight checkout: Hydraulics Design Engineer Curt Coderre, at 28, responsible for vital systems of the USAF T-38.

Curt (BSME, UCLA, '53) joined Northrop Division during the summer between his junior and senior years, stayed on to become a Northrop 5-year man.

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Automotive Use of The Gas Turbine

by Donald H. Himmel

Many difficult problems are encountered in adapting a gas turbine to road vehicles. The advantages of the gas turbine, however, have led to extended research and development for automotive purposes.

THE idea of a gas turbine was recognized as early as 1790, but it was not until the early 1900's that a successful gas turbine was produced. The long lag between 1790 and 1905 was due to a combination of two factors: the inability to design a high efficiency compressor and the lack of materials suitable for use at high temperatures.

The first gas turbine of modern times using continuous combustion and capable of running under its own power came in 1905. This turbine, which had a thermal efficiency of only 3 or 4%, was developed in France by Lemale and Armengoue. The first commercially successful gas turbine developing shaft power was the Brown Boveri industrial turbine of 1938. It had a thermal efficiency of about 18% at full load. In 1950 the Rover Company of England demonstrated a turbine-driven automobile.

The two contributions which gave the real advancement to gas turbine development were: (1) the theoretical work of Prandtl in Germany leading to the improvement of the turbine compressor efficiency, and (2) the discovery of vitallium as a turbine blade material having adequate strength at high temperature and lending itself to the lost-wax process of precision casting.

Principles of Operation

The gas turbine can be analyzed as another form of the internal-combustion engine working on some of the same basic thermodynamic principles as the reciprocating engine, but using a mechanical arrangement which is quite different. The reciprocating engine uses a piston which acts alternately as a compressor and as an expansion chamber converting heat into work in the form of mechanical power. The turbine, on the other hand, has a separate rotary compressor, usually driven by a turbine wheel (equivalent to the expansion chamber in the reciprocating engine), which supplies the power for both the compressor and the shaft.

The piston engine deals with expansion of high-pressure, high-temperature gases in relatively small volumes, while the turbine operates on large volumes of low-pressure, lower-temperature gases. The reciprocating internal combustion engine is subjected intermittently to pressures of 2000 psi and temperatures of 4500° F, while the turbine is subjected continuously to pressures of 200 psi and temperatures of 1500° F. Because of this continuous temperature, being only about one-third that of the internal-combustion engine, very expensive materials are needed.

The constant-pressure cycle of the simple gas turbine is illustrated in Figure 1. Air is received at the compressor inlet under the conditions prevailing at 1. The compressor compresses the pure air adiabatically from 1 to 2. The air is then heated in the combustor between the points 2 and 3 at constant pressure. The combustion gases expand adiabatically in the turbine from 3 to 4 and are then exhausted into the atmosphere along line 4–0.

The three basic components of the gas turbine are the combustor, the compressor, and the turbine. A brief description of the various types of these components will be given:

1. Two types of combustors may be used in gas turbines. In one, the fuel is sprayed into the air as a fine mist and burned in an atomized form in the combustor. With the other type, called a vaporizer, a fuel pump discharges fuel into a hot tube through which part of the combustion air is flowing. The hot tube and the hot air flowing through it evaporate the fuel and a rich fuel-air mixture is provided

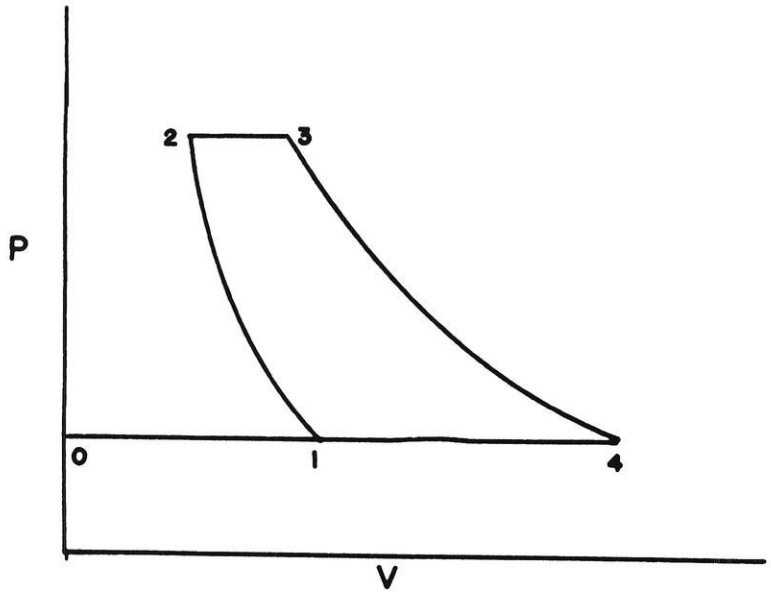

Fig. 1.

in the combustion zone. Here it is mixed with additional air and burned to final combustion products.

2. Compressors are also of two types. The centrifugal type, usually having only a single stage, works on the same principle as the centrifugal water pump. The axial type is always multistage and is used predominantly in aircraft turbines.

3. Two types of turbines, namely, axial and radial, are used in gas turbines. The axial type is predominantly used in aircraft where a high power output is needed. They are, like axial compressors, always multistage. The radial type turbine, which is usually single stage, closely resembles the centrifugal compressor, but with the gas flowing inward rather than outward.

A gas turbine operating on a simple cycle can have added to it a number of components, all of which contribute to increase the overall efficiency of the plant. The three most important of these components are the regenerator, the intercooler, and the reheater.

The regenerator, Figure 2, is a heat exchanger in which the discharge of air from the compressor picks up heat from the exhaust of the turbine, thus reducing the amount of heat required to be added in the combustion chamber.

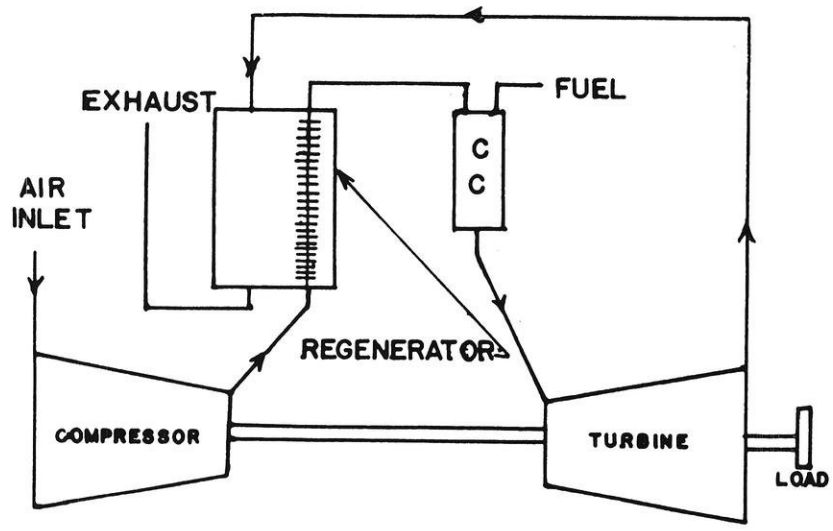

Fig. 2.

A regenerator is the source of many problems when used on turbines adapted for ground vehicles. In order to compete with the fuel economy of the piston engine the regenerator needs to have an efficiency of about 85%. Regenerators of this efficiency become extremely costly and bulky to install in automotive equipment. The Chrysler gas turbine installed in a Plymouth, however, is quite effective and still is installed within the hood limits of the present piston engine. This particular gas turbine averaged 14.9 miles per gallon on a coast to coast run made in 1954.

If the compressor of the gas turbine is divided into two stages, a low pressure stage and a high pressure stage, the overall efficiency of the compressor can be improved by inserting an intercooler, Figure 3, between the low pressure discharge and the high-pressure inlet. This reduces the power required to compress the air and leaves more of the turbine output available for useful work.

In Figure 4 a two-stage turbine is shown. Here a high pressure turbine discharges into a second combustion chamber (reheater) in which additional fuel is burned to supply added energy to the low pressure or second stage of the turbine. This is a practical means of providing peak power for short periods, using a given size of powerplant. Also, this means that the turbine can be made to develop more power without exceeding the original maximum gas temperature. It should be understood that any combination of these components may be used in any one gas turbine.

In current applications of gas turbines to road vehicles the most advanced method consists of a single-stage centrifugal compressor driven by a compressor turbine. A second turbine (power turbine), in series with the first one, but having no mechanical connection with it, develops the power that is supplied to the wheels. With this arrangement of the turbine wheels, they act as a torque converter and eliminate the need for an automatic transmission. In order to reduce cost and size, the intercooler and reheater are usually eliminated in vehicle use. The regenerator, although also bulky and costly, is a

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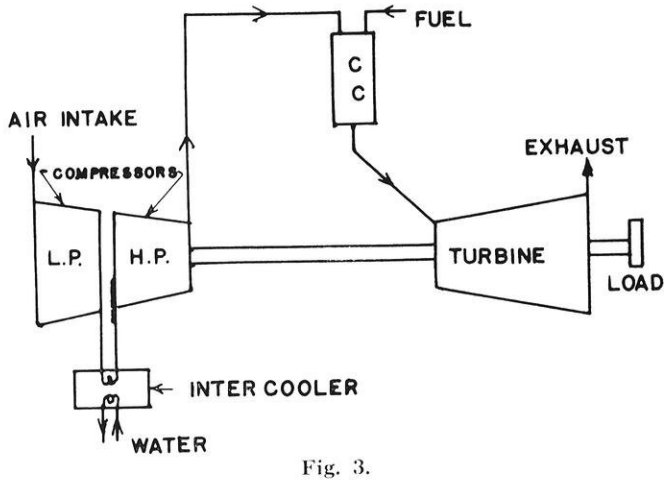

Fig. 3.

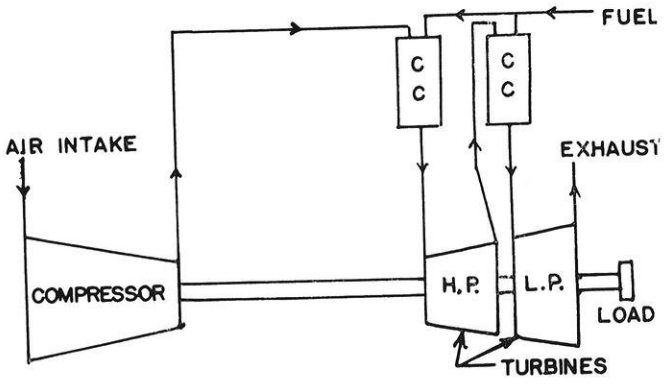

Fig. 4.

necessity in order to compete with the fuel economy of the piston engine. Because a gas turbine runs at very high speeds (as high as 50,000 RPM's) a reduction gear is needed when this powerplant is adapted for vehicle use. The fuel pump, generator, regenerator, and electric starter as well as the drive shaft operate off this reduction.

Manufacture and Costs

At present, the high cost of materials is one of the most significant problems of the gas turbine. The material must carry high stresses continuously at high temperature and without creep. It is not only necessary to consider the stress the material can handle but the length of time over which it can safely carry it. The combination of all these properties results in excessively high-cost critical materials. The experimental gas turbines of the past were made with aircraft metals known as austenetic high temperature forging and casting alloys. These alloys cost as much as four dollars per lb., while the maximum allowable cost for production turbines should be below one dollar per lb. as applied to the most expensive material entering their manufacture. However, continued research is being done to find low cost alloys to withstand high temperatures and stresses. It appears probable that ductile and workable, simple iron-aluminum alloys with about 10% aluminum can be economically produced in sheet form for very high temperature, low stress parts of combustor cans. High nitrogen manganese austenitic steels appear to be cheap and adequate for turbine blades.

Fabrication facilities have been developed which may permit high volume production in the near future. Only two years ago the forging of a specific hot turbine wheel for an automotive unit cost almost two-hundred dollars after inspection and testing. Today the same wheel can be produced in quantity by precision casting and welding methods for approximately twenty dollars. Developing materials of lower cost and devising fabricating facilities for the mass production of the gas turbine engine provide a great challenge in the future.

Advantages and Disadvantages of the Gas Turbine

A gas turbine is important in its field since it rivals the conventional piston engines of today in its efficiency. There are many known methods of improving the cycle efficiency still further. Figure 5 shows the increase of fuel consumption of Chrysler's present gas turbine as compared with their first one. In Figure 6 the fuel consumption of the gas turbine is compared with the piston engine. It is not good enough yet, but getting closer to the optimum.

The gas turbine has a torque curve that is much better suited for a ground vehicle.

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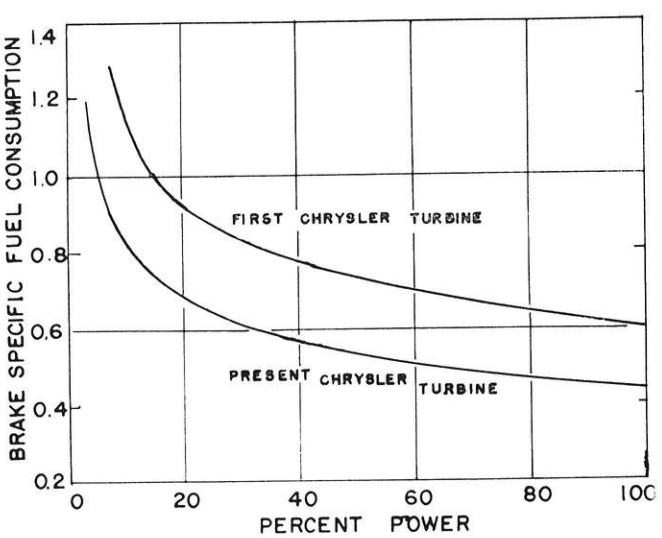


Fig. 5.

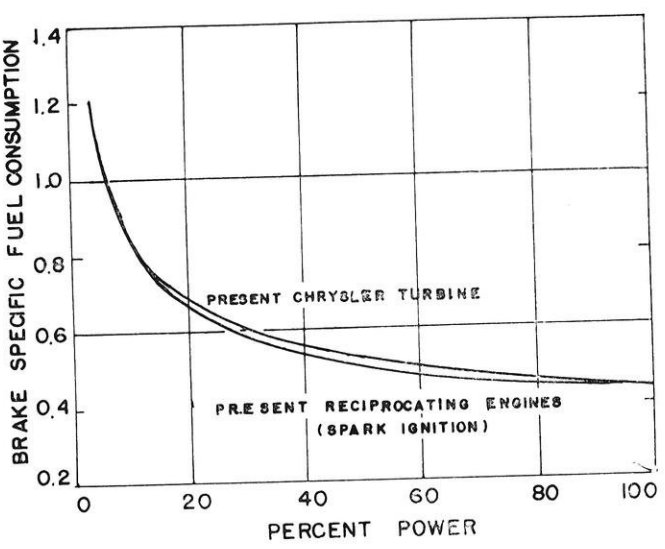
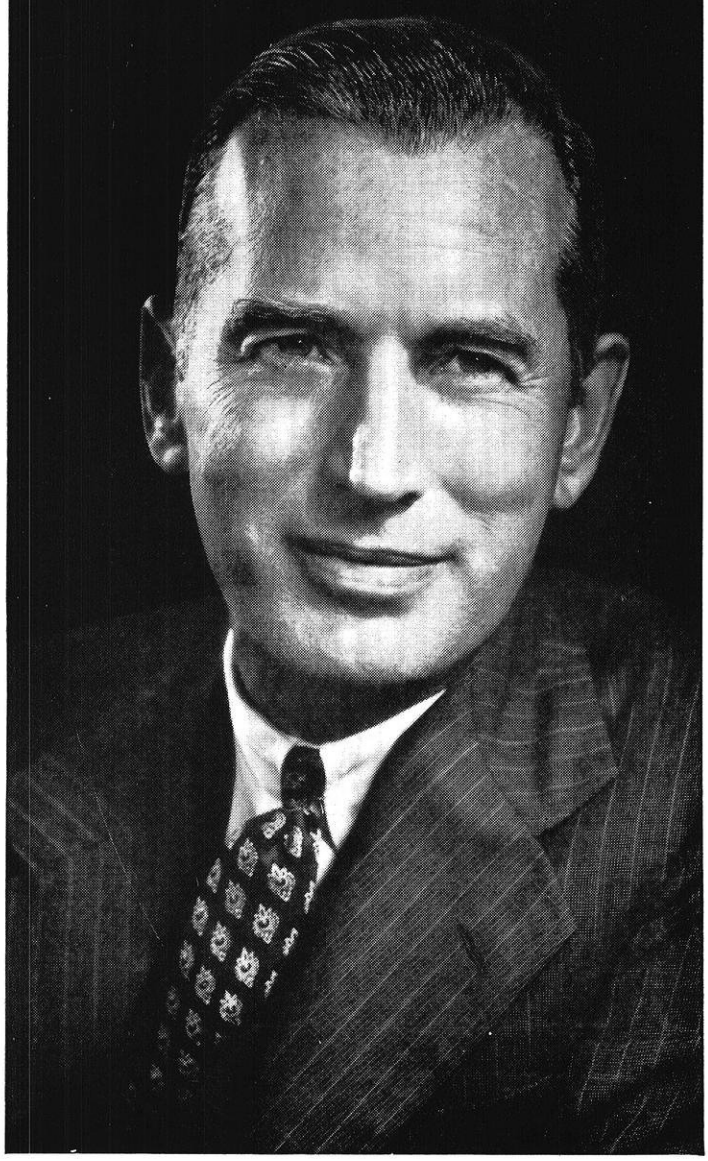


Fig. 6.

"Organizations do not make men— it is men who make organizations"

CRAWFORD H. GREENEWALT, PRESIDENT
E. I. DU PONT DE NEMOURS & CO. (INC.)



"It is what men bring with them in the way of character and adaptability and fresh ideas that enriches the organizational bloodstream and insures corporate longevity." This is the observation of Crawford H. Greenewalt, President of the Du Pont Company.

In a lecture given in the past year at Columbia University, Mr. Greenewalt outlined his views on the role of the individual in the organization. "The Du Pont Company's success over the last 150 years," he pointed out, "has come about in large part through devoted allegiance to two major themes . . .

"First, the realization that an enterprise will succeed only to the extent that all individuals associated with it can be encouraged to exercise their highest talents in their own particular way.

"Second, the provision of maximum incentives for achievement, particularly in associating the fortunes of the individual to that of the corporation.

"Men are not interchangeable parts, like pinion gears or carburetors. Individuals differ in approach and method, and, to perform to best advantage, they must never be fettered to approaches and methods not their own."

"Conformity" obviously takes a back seat here. As Mr. Greenewalt comments, "We conform as is necessary to good manners, good relationships and the highest use of individual talent. And bear in mind that these are strictures on behavior, not on creative thought."

If you find this kind of atmosphere challenging it will pay you to explore career opportunities with Du Pont.

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SCIENCE HIGHLIGHTS

Jim Mueller me'59

JUST A MATTER OF YEARS

UNVEIL PLANS FOR "MOON BUILDING"

Plans for a permanent "moon building" to house living quarters for moon explorers, laboratories for scientific research, maintenance shops for space vehicles and stations for earth-moon communications have been announced by the Wonder Building Corporation of America, Chicago.

A detailed 5 by 6 foot scale model of the structure—a cigar shaped corrugated metal cylinder covered by a protective metal "meteoric shield"—was recently unveiled to military and federal government officials at a presentation in Washington, D.C.

Because of the present lack of knowledge and great divergence of opinion concerning the moon's surface, the moon building has been designed for the worst condition anticipated—a sea of dust upon which the building would float, anchored by heavy weights suspended by cables from the body of the structure. If the moon's surface proves to be sufficiently solid, it could then provide normal support for the building.

In actual size, the moon building would be 340 feet long, 160 feet wide, and 65 feet high. Including air lock and plastic observation bubble, it would measure 520 feet in length. The building would be fabricated of aluminum alloys which combine high strength and low weight with ease of fabrication. Aluminum also provides a good reflecting surface which aids cooling problems.

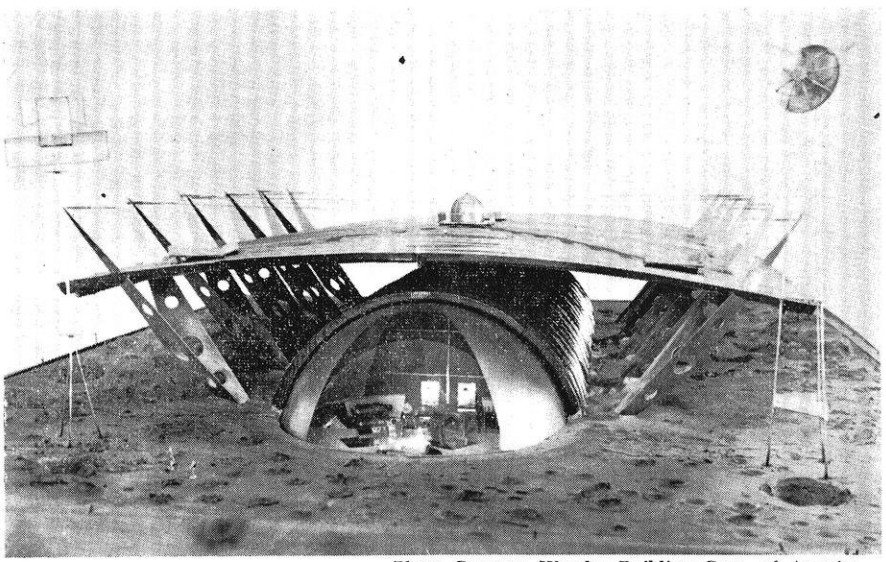
Above and separated from the roof of the building is a slightly curved umbrella-shaped protective meteoric shield, designed to ward off the gnatlike rain of interplanetary meteoric dust which descends with great velocity on the barren surface of the moon. The shield would be 460 feet long, 380 feet wide, and 83 feet high.

The entire shell of the building, and the protective barrier, would be fabricated of pre-engineered metal sheets secured by simple nut and bolt fasteners and welded structural connections. A unique "Truss-Skin" design developed by the Wonder Building firm provides completely useable interiors, without internal supports of any kind.

With space at a premium inside the moon building, the trussless concept would eliminate space wasted by ordinary structural supports, while the pre-engineered design would permit quick erection with minimum labor and tools.

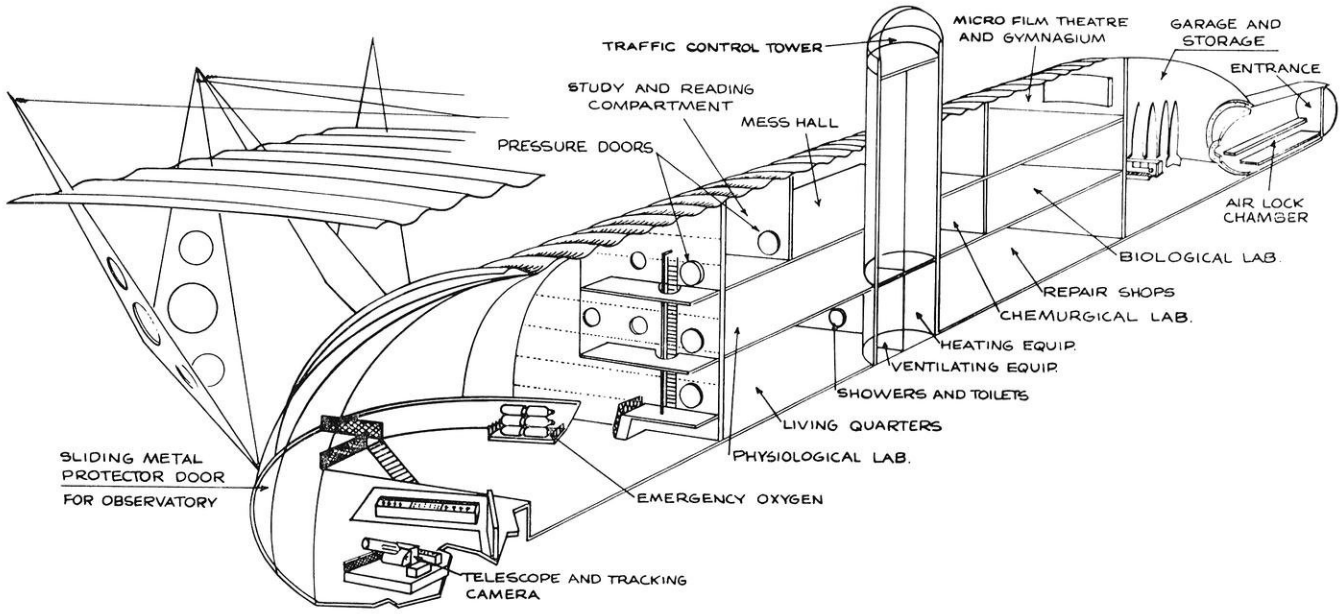
Inside the moon building are:

Living quarters, including rooms for sleeping, cooking, eating, and recreation.



—Photo Courtesy Wonder Building Corp. of America

Model of "moon building" designed and engineered as a permanent structure to house living quarters for moon explorers, laboratories for scientific research, maintenance shops for space vehicles and stations for earth-moon communications.



—Photo Courtesy Wonder Building Corp. of America

Cut-away drawing of interior of moon building shows compartments for research, space for living quarters, observatories, etc. Entrance is made at one end of building (right) where air lock chamber is located. Pressure doors separate main areas from each other, prevent loss of internal pressure throughout building in case of accidental puncture by meteor penetrating overhead protective shield.

Physics, chemistry and biological laboratories.

A control tower for communication, meteorological studies, earth observations, astronomical observations, and traffic control.

Air conditioning, heating, power, and refrigeration plants, oxygen producing units, extreme-temperature regulating devices, water supply and sewage processing plants.

Machine shop and equipment maintenance areas.

Entrance to the moon building is made through an air-lock at one end, adjacent to which would be constructed a rocket landing area. Complete internal pressurization of the hermetically-sealed building provides an air pressure of at least 10 pounds per square inch, close to earth's normal atmospheric pressure of 14.7 pounds, the same as pressure used in high altitude airliners.

Special refrigerating and heating plants cope with the extreme temperatures and tremendous temperature gradients which abound on the moon. Day and night on the moon are about two weeks long, with temperatures at lunar midday reaching 214 degrees F; at sunset, 32 degrees F, and at midnight, —243 degrees F.

There are no windows in the moon building, since ultraviolet radiation, normally absorbed by the earth's atmosphere, would be sufficiently intense to render panes of glass or plastic useless through discoloration. Metal shutters protect the plastic observation bubbles.

Wonder Building Corporation of America, which undertook development of the moon building in October, 1957, following launching of the first Russian sputnik, is one of the nation's major manufacturers of pre-engineered metal buildings. The firm's long experience in pre-fabrication techniques led to their interest in designing the moon building, a structure which would necessarily have to be transported in small sections, with no single piece larger than the load-carrying capacity of future moon rockets.

Dr. Rinehart estimated that man could establish a building on the moon in ten years.

WORLD'S BEST LIGHTED OFFICE

In the new space General Electric engineers have created as nearly as possible the "optimum total office environment which workers may some day enjoy."

The new demonstration facility introduces several important advances in lighting combined with other systems of comfort control. Most important of these are:

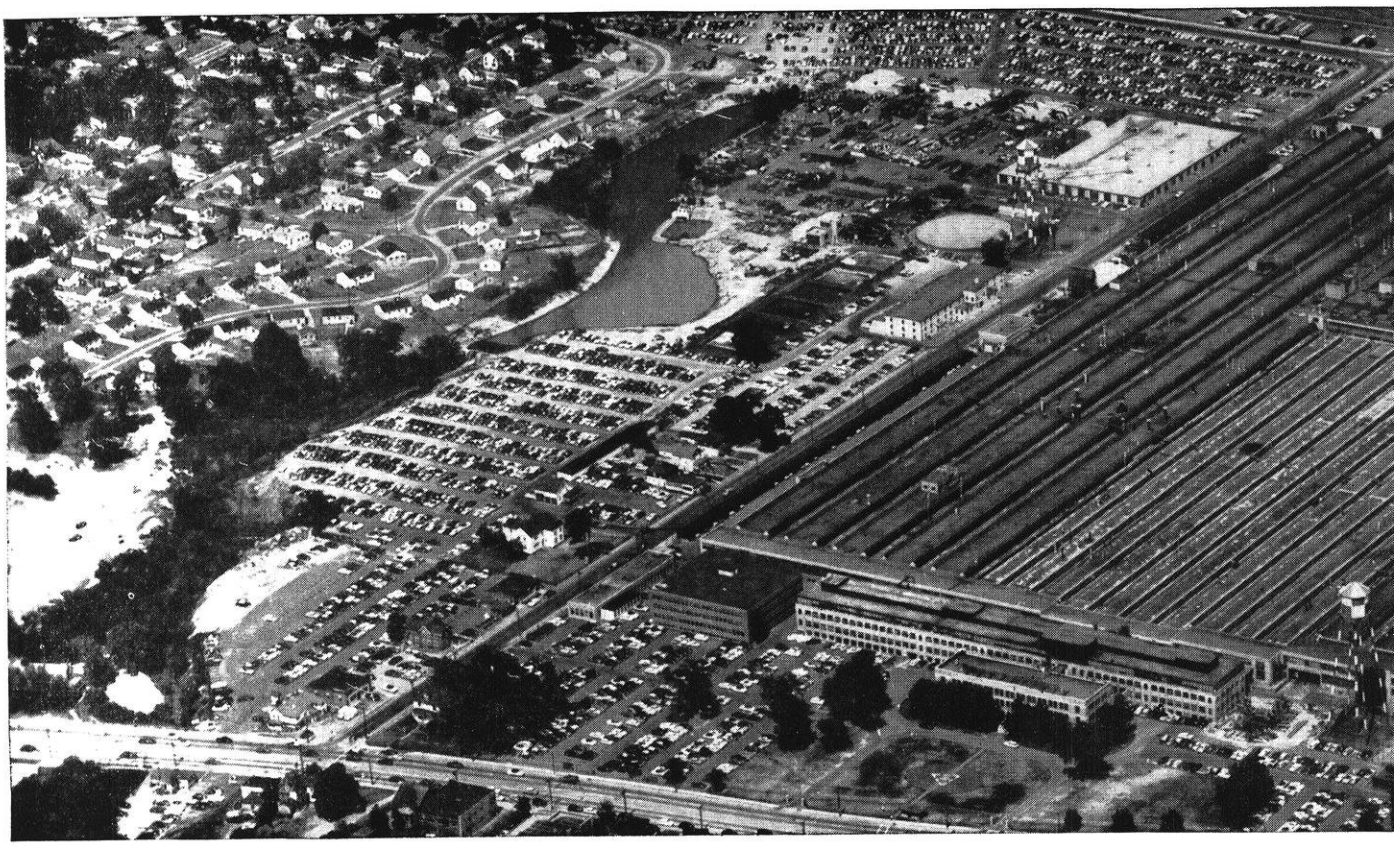
Comfortable lighting levels up to nearly 1000 footcandles, 10 to 20 times the average illumination existing in offices today;

A new system of ventilating the lighting system which will virtually cut in half its load upon the air-conditioning system, and which materially can reduce heating requirements for the space; and

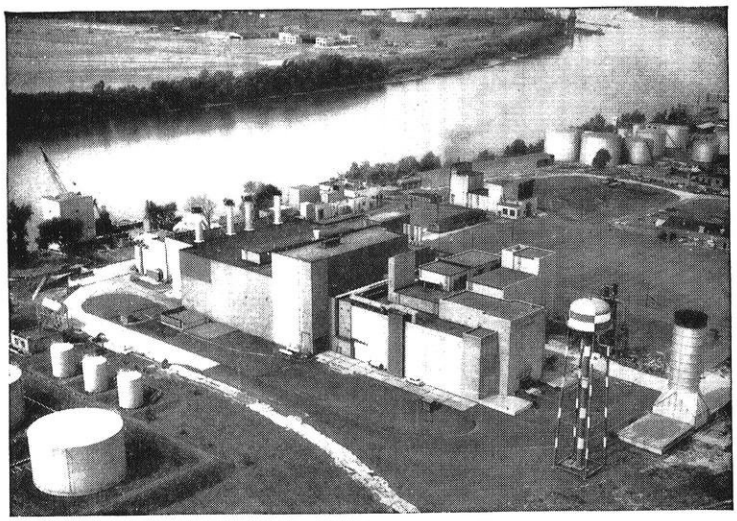
A radically different new type of plastic louver designed by G–E engineers which marks a major advance in creating comfortable higher level lighting systems.

Design of the environmental control system was largely the creation of the G–E department's Robert T. Dorsey, supervisor of commercial lighting applications, and Will S. Fisher, office lighting specialist. They worked closely with architect Wilbur Riddle of the Institute design group to integrate plans for the room with the systems which would control and stimulate its environment.

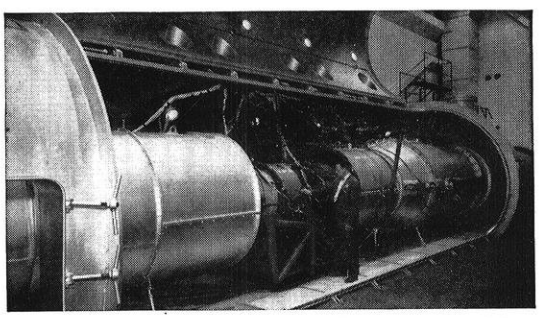
(Continued on page 48)



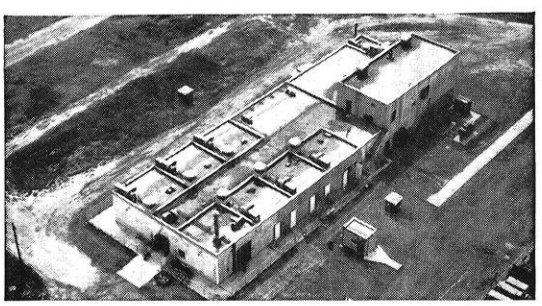
CONNECTICUT



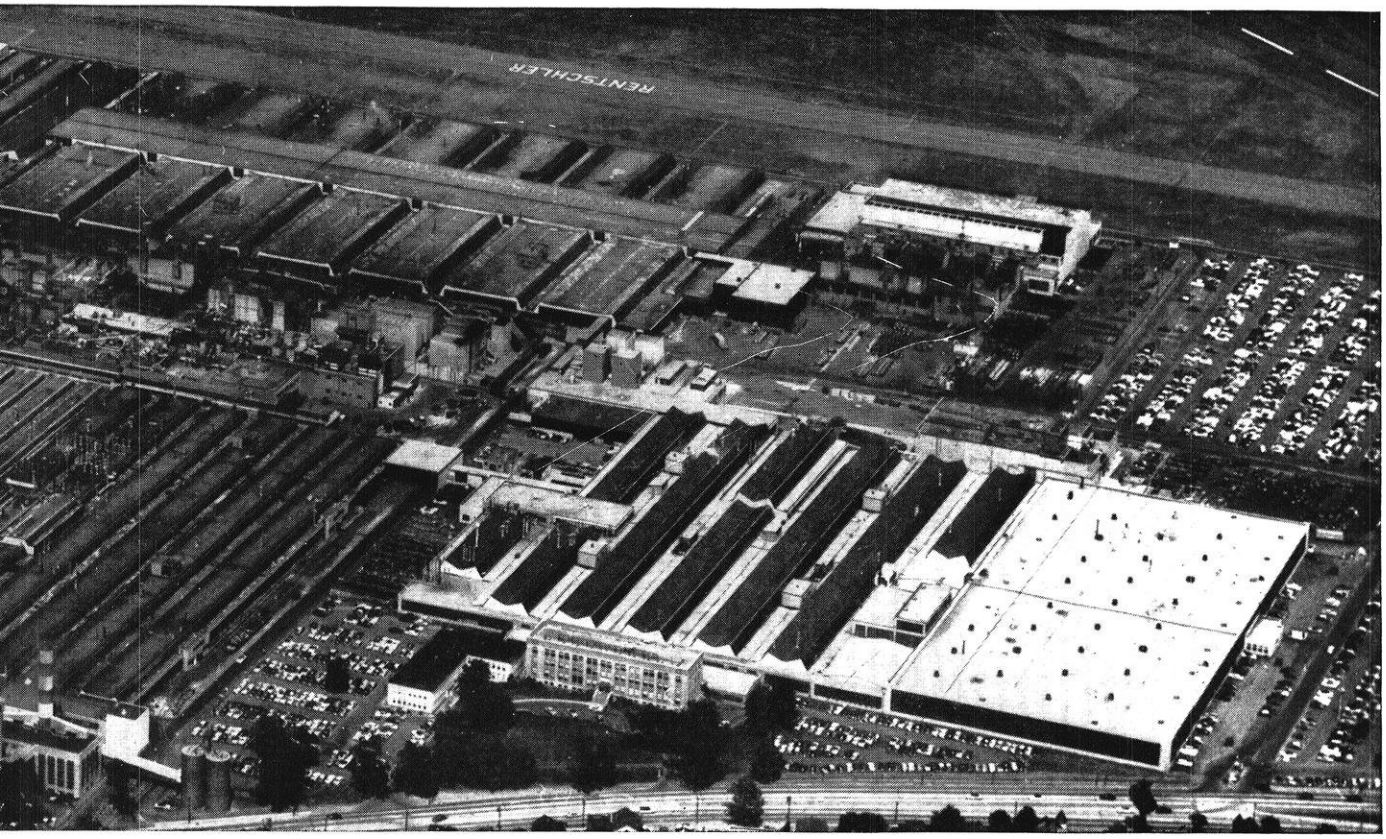
The Willgoos Turbine Engine Test Facility is the world's most extensive privately owned turbine development laboratory. Designed and built specifically to test full-scale experimental engines and components in environments simulating conditions at extreme altitudes and speeds, it is currently undergoing expansions that will greatly increase its capacity for development testing of the most advanced forms of air breathing systems.



In chambers like this at the Willgoos Turbine Engine Test Facility full-scale engines may be tested in environments which simulate conditions from sea level to 100,000 feet. Mach 3 conditions can also be simulated here.



In the new Fuel Systems Laboratory engineers can minutely analyze the effects of extreme environmental conditions on components of fuel systems — conditions such as those encountered in advanced types of flight vehicles operating at high Mach numbers and high altitudes. Fuel for these tests can be supplied at any temperature from −65°F to +500°F.



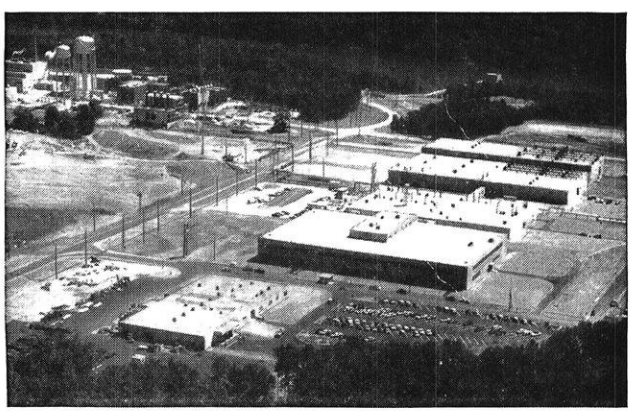
OPERATIONS

Unmatched Engineering Facilities for Developing Advanced Flight Propulsion Systems

Operations at Pratt & Whitney Aircraft are essentially those of an engineering and development organization. As such, an engineering atmosphere dominates the work being done, much of which directly involves laboratory experimentation.

In the past three decades, expansion at Pratt & Whitney Aircraft has been almost tenfold. In recent years, greatest emphasis has been on extending engineering facilities to meet the needs of advanced research and development programs in flight propulsion.

Among the Connecticut P & W A facilities are many that are unequaled in the industry. Thus today, Pratt & Whitney Aircraft is better prepared than ever to continue development of the world's best aircraft powerplants . . . to probe the propulsion future . . . to build and test greatly advanced propulsion systems for coming generations of flight vehicles – in whatever form they take.



The Connecticut Aircraft Nuclear Engine Laboratory, operated by Pratt & Whitney Aircraft, is situated on a 1,200-acre tract near Middletown. The Laboratory was specially built for the development of nuclear flight propulsion systems.

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

PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

CONNECTICUT OPERATIONS — East Hartford

FLORIDA RESEARCH AND DEVELOPMENT CENTER — United, Florida

Lubrication of enclosed parts can now be inspected without disassembly. Standard Oil scientists have developed the instrument system shown here which measures the presence or absence of the required lubricant on concealed parts by checking the ability of the entire assembly to cut down radiation passed through it.

How to "see" without looking

At a final inspection station how would you make sure that enclosed parts were properly lubricated? Until recently, if you really wanted to know, you had to remove the housing, disassemble the mechanism—a costly, time-consuming process—and take a look.

But now Standard Oil research has solved the problem with a new instrument system that does away with disassembly. It passes radiation through the assembly and measures the amount that gets through. Inspectors can tell whether or not the proper level of lubricant is present without looking inside.

This remarkable device is just one of hundreds of ways in which Standard has helped industry solve problems connected with lubrication. It was developed by a team of Standard Oil scientists and engineers who saw the need for a new approach to an old problem.

Such creative thinking is the product of the atmosphere in which Standard Oil scientists work. They have the time, the equipment and the opportunity to contribute to the progress of their industry and their country. That is why so many young scientists have chosen to build satisfying careers with Standard Oil.

STANDARD OIL COMPANY

910 SOUTH MICHIGAN AVENUE, CHICAGO 80, ILLINOIS

STANDARD

THE SIGN OF PROGRESS...
THROUGH RESEARCH

QUESTIONS WISCONSIN STUDENTS ASK MOST OFTEN

about today's opportunities at Alcoa

1. What are the opportunities for a graduate with my degree?

Alcoa has openings for graduates with most types of degrees each year. Opportunities exist in engineering, production, research, development and sales for Mechanical, Metallurgical, Electrical, Industrial, Chemical and Civil Engineering graduates and for Chemists for research.

2. Where will I be located if I am employed by Alcoa?

Assignments for new Engineering and Production employees are at one of 30 Alcoa operating locations. New Sales Engineering and Sales Administration employees, after their six-month training program, go to one of Alcoa's 72 sales offices. Sales Development and Process Development employees work either at New Kensington, Pa., or Cleveland, Ohio. Research employees are assigned to one of Alcoa's five research locations.

3. What type of training program does Alcoa offer?

The training program varies with the type of job. Some are formal programs where concentrated attention is given groups of new men. Other training for individuals is more specialized.

4. What is the starting salary at Alcoa?

Alcoa pay is based on initial allowance for a basic four-year degree. Additional credit is given for advanced educational training, length of military service and amount and type of previous work experience. Future salary progress depends entirely on individual merit.

5. If I am hired, will Alcoa pay moving expenses?

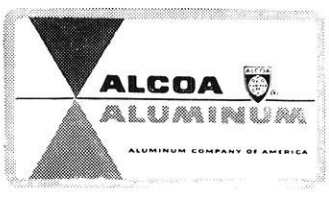
Yes. Alcoa will pay transportation and moving expenses for you and your family to your first and all subsequent assignments.

6. How does Alcoa insure personal recognition for its people?

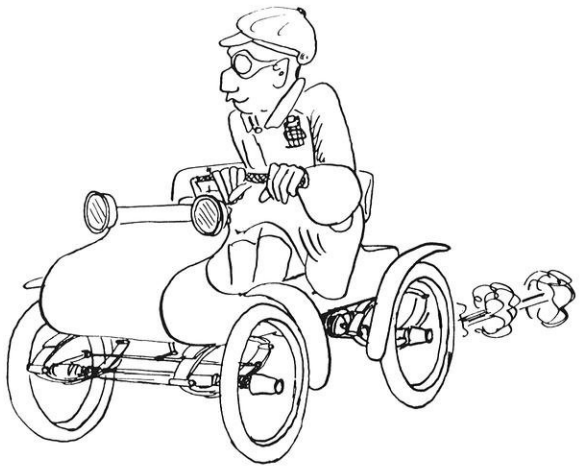
Alcoa's personnel policies call for regular performance appraisals, individual opportunity for advanced management training, confidential and individual salary consideration and promotion from within the company.

7. How do I apply for a position with Alcoa?

Contact your placement officer to arrange an interview. If you would like more details immediately, write Manager, College Recruitment, 809 Alcoa Building, Pittsburgh 19, Pa., for the newly revised booklet, *A Career For You With Alcoa.*



Your Guide to the Best in Aluminum Value



THE ENGINEER OF YESTERYEAR

by John Nichols ee'60

PHOTOGRAPHY IN COLORS

May, 1889

PROF. R. W. Wood has a new method of photographing in natural colors. He produces the colors by diffraction. The production of the first finished picture is a somewhat tedious, though not difficult, process. However, once the first picture is made, duplicates can be printed from it as easily as ordinary photographs are made.

The pictures are on glass and are not only colorless but almost invisible when viewed in ordinary light. However, when placed in a viewing apparatus consisting of a convex lens on a light frame, they show the colors of nature with great brilliancy. Prof. Wood says, "The finished picture is simply a diffraction grating of variable spacing. In other words, it is a transparent film of gelatine with very fine parallel and equi-distant lines on it, about 2,000 to the inch on the average. The colors depend solely on the spacing between the lines and are pure spectrum colors or mixtures of such.

"I feel confident that the present process of making these pictures can be simplified and believe that it will be possible to expose a plate in the camera under three color filters, on the surface of which diffraction gratings have been imvelop it at once into a colored photograph."

WIND MILLS FOR ELECTRICAL PURPOSES

October, 1897

Ever since the invention of machinery for the production of electricity attempts have been made to use wind mills for motive power. But until lately the intermittent nature of the wind has prevented the use of wind mills as generators for current in any type of work requiring steady current.

Now, with the invention and perfection of accumulators the possibility of lighting isolated places by electricity furnished by wind power has been tried in various parts of the country and has given very encouraging results. Disregarding the expense of storage cells we are able to store any quantity of electrical energy and get a high return, even though considerable time lapses between the time of storing and using.

Previously wind mills have been operated with no governors. It has been possible to charge batteries with these irregular running mills. However a modern wind mill equipped with a governor can drive a dynamo almost as steadily as if the motive power were a steam engine.

THE NORTHWESTERN LIMITED

April, 1898

This handsome new train recently put into daily service between Chicago and the Twin Cities contains all the conveniences and modern improvements that could possibly add to the safety and comfort of the traveling public.

The cars were built by the Wagner Company. Taken as a whole they embody in their make-up every modern safety appliance and every device conducive to the highest degree of comfort and convenience.

Suspended from the ceiling of each room is an ornamental chandelier supplied with both electricity and gas. Also in each room are electric reading lights and electric bells for summoning attendants.

The dining car is finished in oak, one end being divided into apartments. The platforms of the train are completely enclosed with broad plate glass vestibules which contribute not only to the elegant appearance of the exterior, but also afford passengers a safe and comfortable passageway from one car to another.

Special attention has been given the matter of lighting this new train. Both electricity and Pintsch gas are available, the latter being used only in case of an accident to the electrical apparatus. The electrical equipment is located in the front end of the express car and consists of a Westinghouse six-pole, compound wound dynamo connected directly to a 35 hp Westinghouse steam engine. The average load on the dynamo is 150 amperes at 110 volts. Steam is supplied to this unit from the train engine at an average pressure of 100 pounds. The front end of the car serves as the switchboard which contains a portable Weston ammeter and voltmeter, field rheostat, and a double-pole, double throw switch for the main circuit. Sixty-five lights are used in each of the standard sleeping and compartment cars, the average load for the train being the equivalent of about 250 sixteen candle power lamps.

REGULATION OF INTERNAL COMBUSTION ENGINES

July, 1897

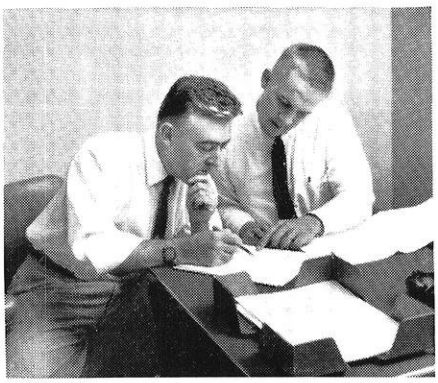
Regulation of speed in the internal combustion engine is effected

(Continued on page 43)

WILLIAM F. BLOOMFIELD, B.S.I.E., LEHIGH, '53, SAYS:

"Join me for a day at work?"

Bill is Plant Service Supervisor for New Jersey Bell Telephone Company at Dover. He joined the telephone company after graduation, has held many jobs to gain valuable experience. Now he has three foremen and 32 craft people working for him. "It's a challenging job and keeps me hopping," says Bill. "See for yourself."

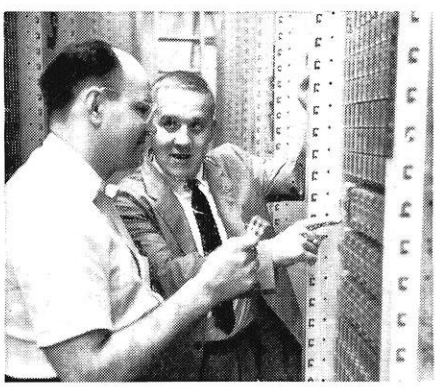


"8:30 a.m. With my test bureau foreman, I plan work schedules for the coming week. Maintaining equitable schedules and being ready for emergencies is imperative for good morale and service."

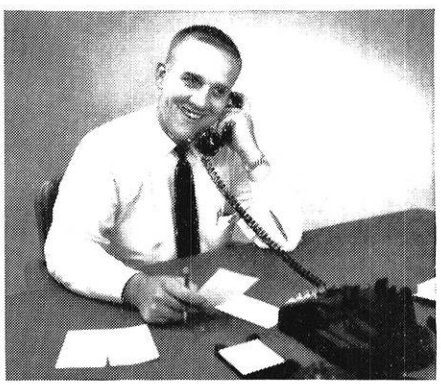
"9:10 a.m. The State Police at Andover have reported trouble with a mobile radio telephone. I discuss it with the test deskman. Naturally, we send a repairman out pronto to take care of it."

"11:00 a.m. As soon as things are lined up at the office, I drive out to check on the mobile radio repair job. The repairman has found the trouble — and together we run a test on the equipment."

"1:30 p.m. After lunch, I look in on a PBX and room-phone installation at an out-of-town motel. The installation supervisor, foreman and I discuss plans for running cable in from the highway."



"2:45 p.m. Next, I drive over to the central office at Denville, which is cutting over 7000 local telephones to dial service tomorrow night. I go over final arrangements with the supervisor."



"4:00 p.m. When I get back to my office, I find there are several phone messages to answer. As soon as I get them out of the way, I'll check over tomorrow's work schedule — then call it a day."

"Well, that's my job. You can see there's nothing monotonous about it. I'm responsible for keeping 50,000 subscriber lines over a 260-square-mile area in A-1 operating order. It's a big responsibility—but I love it."

Bill Bloomfield is moving ahead, like many young engineers in supervisory positions in the Bell Telephone Companies. There may be opportunities for *you*, too. Talk with the Bell interviewer when he visits your campus and get the whole story.

BELL TELEPHONE COMPANIES

ENGINE EARS

by Tom Corth, ee'60

UW EXPOSITION OFFERS ENGINEERING COMPETITION

The Engineering Exposition, which will be held on April 10, 11, and 12, of 1959, offers all engineers —seniors, juniors, sophomores, and freshmen—an excellent opportunity to participate in the University of Wisconsin's greatest display of engineering. The exhibits are created and displayed by both students and industry. The student-run part of the exhibition is made up of exhibits showing some feat of engineering. Cash prizes are awarded to various categories of student exhibits. The exhibit committees are tentatively planning for forty industrial displays and eighty student displays.

The break-down on exhibits classifications and prizes is as follows: Individual Student—$25 first place, $15 second place, and $10 third place; Student Organization—$50, $30, and $20; Graduate Student—$15 and $10; Student Group—$50, $30, and $20; and Craftsmanship—$15 and $10. The judges for this award competition will be three prominent persons who are well acquainted with the practice of engineering.

The registration is easy. Determine exactly what your exhibit will consist of and then register the exhibit. This registration is primarily to avoid duplication of displays—a type of patenting process to insure the students the chance to benefit from their own ideas. After the exhibit is registered, it needs only to be built. Equipment can be obtained from any of the engineering colleges by permission of the department custodians.

The Exposition Committee stresses early registration and construction of exhibits although exhibits will be accepted up to March 15, 1959. The displays showing early progress will be used for newspaper and television publicity. For any further questions on exhibits contact Ken Lewandowski, Student Exhibits Chairman, Alpine 5–0585.

RESEARCH SCIENTIST EXAMINATION

The U.S. Civil Service Commission is making an intensified nationwide search for more than 200 of the most inquisitive-minded college seniors and recent graduates in the country. In addition to curiosity, the persons sought must have imagination, resourcefulness, and a high potential for research work in engineering or the physical sciences. Eleven of the top government research laboratories located in and around Washington, D.C., are among the Federal agencies seeking the new men. The men selected for these positions will be paid a starting salary of $5,430 a year and have the opportunity to set their sights on the highest-level research positions in the Federal Government. In addition, the selected men will be working with some of the nation's top scientists and will be given the opportunity for further training to help them along the career ladder. For complete information and application forms see Mr. J. A. Marks, Engineering Placement Director, 262 Mechanical Engineering Building.

EXPOSITION CHAIRMEN SELECTED

General Chairman Tom Pitterle, ME 3, expressed the purpose of the coming Engineering Exposition as bringing the achievements of engineering to the attention of the public and acquainting them with the latest industrial trends and developments. The various chairmen working with Tom are Ken Lewandowski, EE 4, Student Exhibits; Carl Christensen, EE 3, Industrial Exhibits; Bill Fagerstrom, ME 2, Publicity; John Nichols, Min E 3, Program; Arlyn Albrecht, CE 4, Incidentals; and Jerry Jennings, ME 3, Finance.

AIEE–IRE NEWS

The third joint meeting of the year was held on Wednesday, December 3, in the Plaza Room of the Memorial Union. The main topic of business was the election of two new representatives to the Polygon Board. Elected were Dan Donahoo for the IRE and Don Martell for the AIEE. A very interesting talk about satellites and their application to meteorology was given by Dr. Suomi, assisted by Professor Swift. There was enough beer and pizza on hand to satisfy the seventy members who were present.

The Engineering Exposition Committee, headed by Don Hardin, is working on exhibits to be entered by the AIEE–IRE group. At present two separate exhibits are being planned. One is on stereophonic sound; the other, on satellites. Individual exhibits are also encouraged. Let's make this Exposition the best one yet!

Don't forget the paper competition to be held here next spring. It is definitely not too early to be starting your paper.

NEWS FROM TRIANGLE

December proved to be a very busy month for the members of Triangle, not only because of the Christmas vacation with its rash of pre-vacation hour exams, but also because of some very successful rushing activities.

One of the most important events was a Smoker held on December 3, with Professor Paul Grogan speaking on "Using the Gears Between the Ears." This proved to be a very entertaining and enlightening subject.

At the Regional Chapter Administration Forums, held during December, the Wisconsin Chapter of Triangle was awarded the National Scholarship Improvement Plaque.

ASCE RESEARCH FELLOWSHIP

A new Fellowship Grant in the field of civil engineering has just been announced by the American Society of Civil Engineers. The grant will be made annually in the amount of $5000. Applicants must be members of the Society in any grade of membership, be citizens of the United States, and have been graduated from an accredited curriculum. The selection for the award will be based on transcripts of scholastic records, ability to conceive and explore original ideas, and a description of proposed research and its objectives, including a statement from the institution at which the research will be done.

Applications in specified forms will be received to March 15, 1959. For complete information write to William H. Wisely, Executive Secretary, American Society of Civil Engineers, 33 West 39th Street, New York 18, New York.

A DOZEN WAYS TO KILL AN ORGANIZATION

1. Don't go to any of the meetings.
2. But if you go, go late.
3. If the weather doesn't suit you, don't think of going.
4. If you do attend, find fault with the work of the officers and members.
5. Never accept an office. It is much easier to criticize than to do things.
6. Get sore if you are not appointed on a committee. Should you be appointed, don't attend any of the meetings.
7. If asked to give your opinion on some matter, tell the chairman you have nothing to say. After the meeting is over, tell everyone how it should be done.
8. Do nothing more than is absolutely necessary. When others roll up their sleeves and unselfishly use their ability to help matters along, howl that the organization is run by a clique.
9. Hold back your dues as long as possible, or don't pay them at all.
10. Make no effort to get new members for the club.
11. Don't be sociable either within or outside the organization.
12. If you should get a good idea, smother it at once.—Taken from the Ladies' Auxiliary Veterans of Foreign Wars National Bulletin.

A.S.M.E.

The last official meeting of the first semester of the Student Section of the American Society of Mechanical Engineers was held on December 3, 1958. Following the business meeting, Tom Pitterle, general chairman of the 1959 Engineering Exposition showed movies of the last exposition and gave a talk concerning the exposition and the society's and individual student's role in it.

The Membership Committee, under the direction of Dave Minshall, was extremely successful this fall. The results of the drive were a total of 225 members, the largest ever in the society.

The Movie Committee, headed by Dave Perry, is sponsoring free movies every Thursday noon at 12:05 in Room 105 in the Mechanical Engineering Building. These movies last from 20 to 45 minutes. They are generally technical movies, geared specifically for Mechanical Engineers, however, everyone is welcome.

The Special Projects Committee is currently working on the possibility of field trips and buying mechanical engineering handbooks for the members.

The A.S.M.E. Promotions Committee is presently concerned with St. Pat's Dance and Exposition promotions. Specifically, a banquet is being planned for all A.S.M.E. members to be held prior to the St. Pat's Dance.

Several ideas have been considered by the Exposition Exhibit Committee and a final decision concerning the society's exhibit will be made shortly.

A joint Student Section–Senior Section dinner meeting was held December 11, at the Cuba Club. The speaker was Mr. A. Amorsi, technical director of Atomic Power Development Associates Inc., who spoke on "The Enrico Fermi Atomic Energy Power Plant."

Other A.S.M.E. sponsored events include many A.S.M.E. paper contests, both technical and non-technical, and a speech contest held in the spring. The local winners of these contests will receive cash prizes along with expense paid trips to the A.S.M.E. Regional and/or National contests to compete further. The A.S.M.E. spring regional conference will be held at the University of South Dakota and all interested members are welcome to attend. Anyone interested in these contests should contact any of the officers or come to the next meeting for details which will be held on Wednesday, February 11, in Tripp Commons, the Union, at 8:00 P.M.

The Officers of the Student Section are:

Bob Olson, *President*
Sally Trieloff, *Vice-President*
Fred Lowe, *Recording Secretary*
Lalit Sarin, *Corresponding Secretary*
Dick Dahnke, *Treasurer*
Bill Fagerstrom, *Polygon Representative,* and
Dave Perry, *Polygon Representative.*

(Continued on next page)

NEW ENGINEERING STAFF MEMBERS

Eight new senior staff members have been added to the faculty of the University of Wisconsin's College of Engineering this fall to help take care of the increased teaching-research load, it was reported today by the college's Dean Kurt F. Wendt.

The new staff members are: Dr. Miklos Hetenyi, visiting professor, and Dr. William S. Clouser and Dr. Millard W. Johnson, both assistant professors, all in engineering mechanics; Dr. Max W. Carbon, professor, and William A. Moy, assistant professor, both in mechanical engineering; Dr. Franz H. Vitovec, associate professor of metallurgy; Dr. Edwin J. Crosby, assistant professor of chemical engineering; and Dr. Donald Dietmeyer, assistant professor of electrical engineering.

In addition, several instructors have been added, Dean Wendt said.

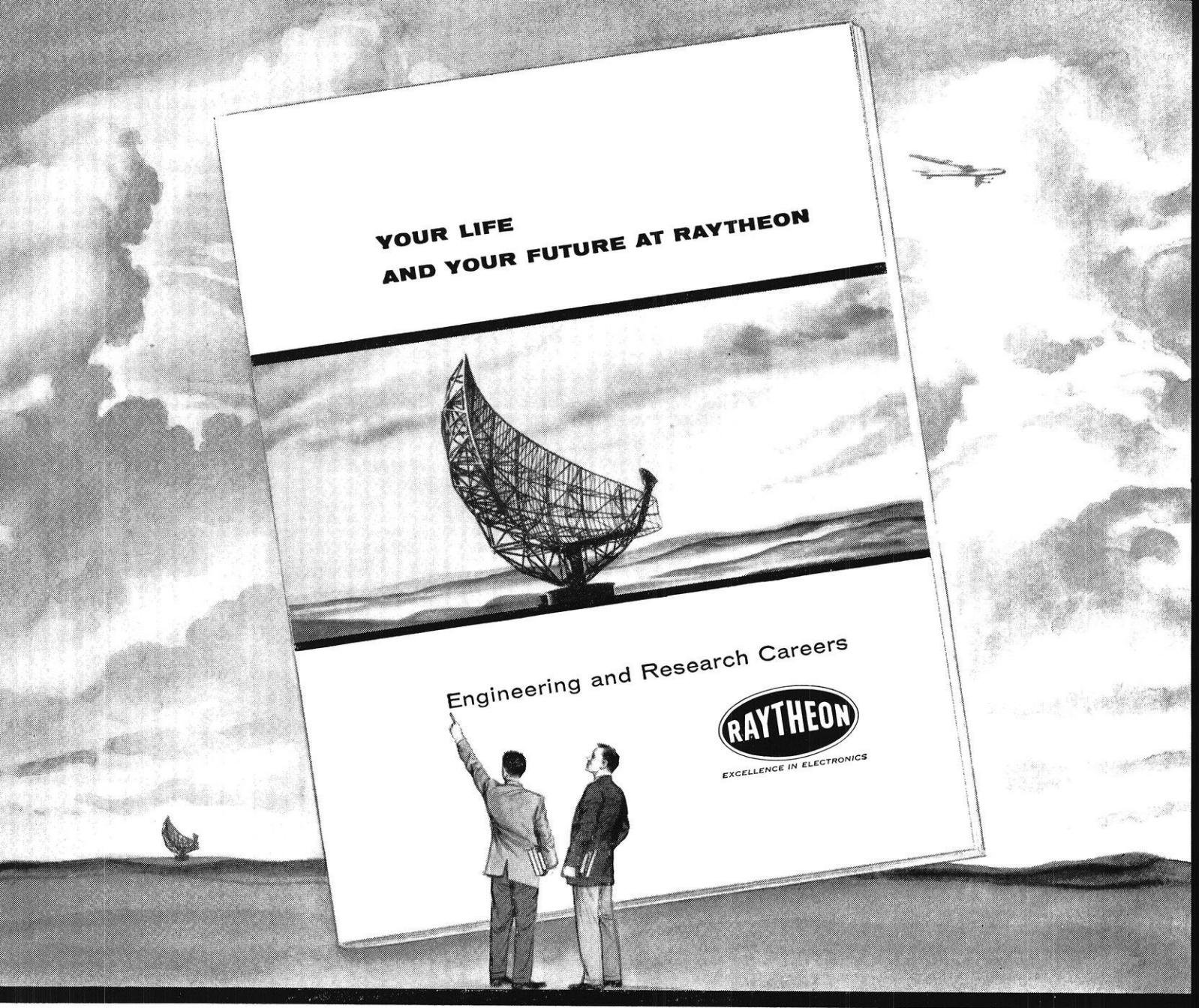
Two of the new senior faculty members received all or part of their higher education in foreign countries. Dr. Hetenyi did his undergraduate work in Budapest, Hungary, and Dr. Vitovec received both his undergraduate and graduate training in Vienna, Austria.

Hetenyi did his graduate work at Illinois and Michigan universities, receiving his Ph.D. from Michigan in 1936. He was awarded the Hollan Prize by the Hungarian Society of Engineers and Architects and was cited in 1953 as a distinguished alumnus of the University of Michigan. He served as research engineer in charge of the Experimental Stress Laboratory at Westinghouse Electric Corp., until 1946, when he joined the Northwestern University faculty as professor of theoretical and applied mechanics.

As visiting professor in mechanics at Wisconsin this year, Prof. Hetenyi will devote most of his time to work for the Army Mathematics Center on the campus, but will also participate in the graduate program in engineering mechanics.

Vitovec received his first degree in mechanical engineering and his Doctor of Technical Science degree in physical metallurgy in Aus-

(Continued on page 40)



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Development and Design Program — prospects for you in the practical application of research to the manufacture of new electronic products and components.

Manufacturing Techniques Program — latest production processes outlined for you who are inclined toward supervision and management positions.

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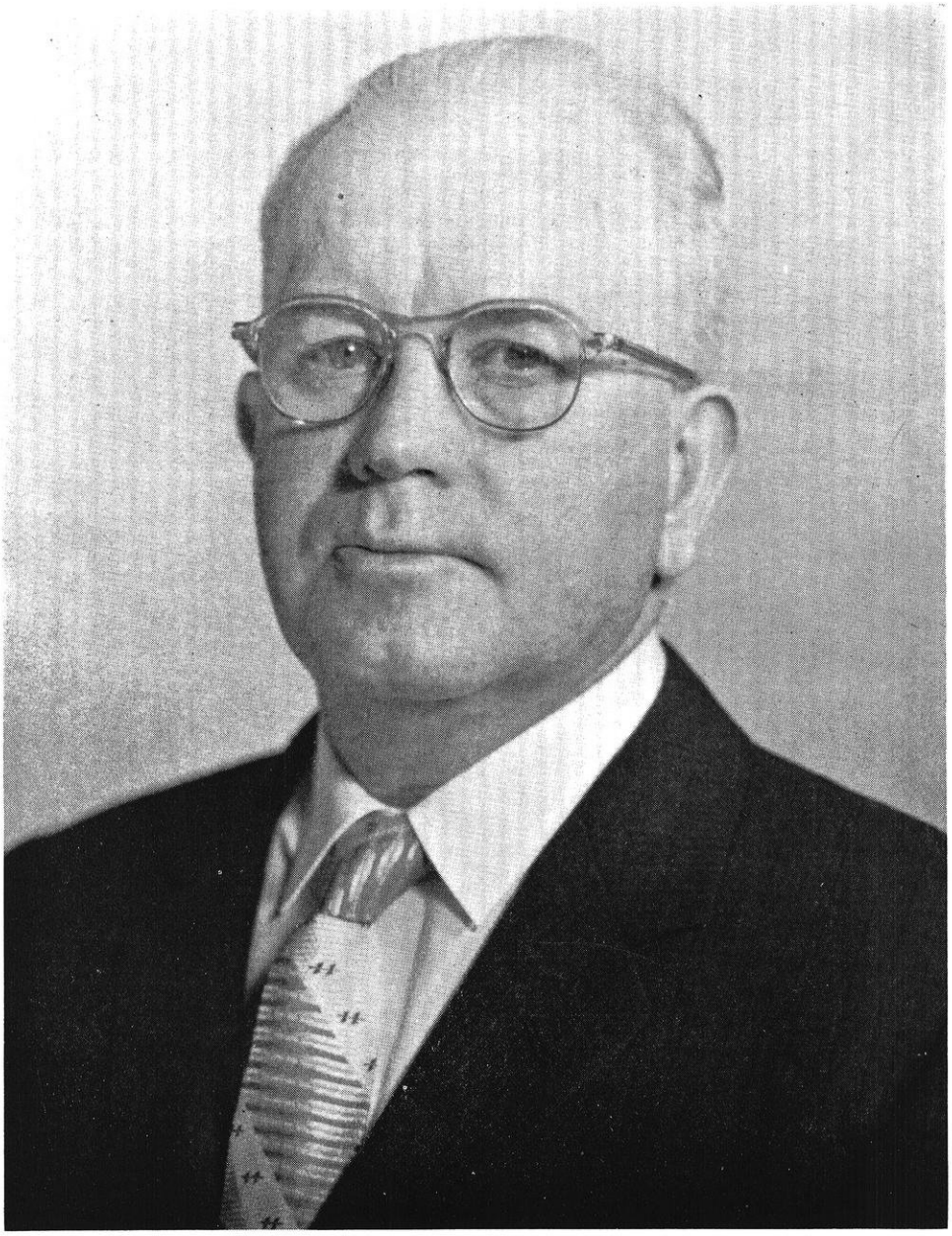


Andrew B. Esser, President, Western Chapter, WSPE

Born at Marshfield, Wisconsin, on April 20, 1907, Andrew Esser attended grade and high schools at Marshfield. Entering the University of Wisconsin Engineering School, he graduated with a Bachelor of Science degree in Electrical Engineering in 1933. He was a member of Kappa Eta Kappa.

Mr. Esser was employed by the Wisconsin Emergency Relief Administration as a Works Project Engineer of Trempealeau County in 1934 and later as Director of Employment with the La Crosse District Office of the Works Progress Administration until 1937.

He then joined The Trane Company of La Crosse as a field and service engineer until 1941 when he joined the U.S. Army Signal Corps. He was discharged with the rank of Captain in 1946.

He rejoined The Trane Company at that time and is presently a research and test engineer in their new research center.

He is married to the former Ethel O'Connor of Verona, and they have three sons and one daughter. His primary hobby is amateur radio. He is a member of the Knights of Columbus.

Wisconsin Society of Professional Engineers

by Darell Meyer ee'61

JUST THE FACTS, PLEASE

The National Society of Professional Engineers is to be commended for its recent action asking all communications media to "weigh the facts" before running "engineer shortage" stories. NSPE calls publicity concerning engineer shortage a disservice to the nation and to the profession, when it is not based on sound analysis.

This is so true. Reporting any situation inaccurately is a disservice. But it should not be inferred from NSPE's perfectly proper stand that stories on engineering manpower ought not be published. What NSPE is saying, in effect, is that engineer shortage should not be proclaimed unless engineer shortage, or prospect of it, is a fact. NSPE would agree, it is assumed, that engineer surplus ought not be proclaimed either, unless it exists.

To be realistic, it must be admitted that stories about the engineering manpower situation are bound to be published. The subject simply has come to be of interest to mass media.

The real point to be made, then, is that those who do publish such stories ought to seek their information at the best source of all the facts on the subject: the Engineering Manpower Commission of Engineers Joint Council. This organization has been gathering the facts on engineering manpower since it was set up in 1950. It could have prevented many a poor analysis leading to misleading shortage or surplus stories published in mass media—if only it had been their source.

ENGINEERS' CREED

As a professional engineer, I dedicate my professional knowledge and skill to the advancement and betterment of human welfare.

I PLEDGE

To give the utmost of performance, to participate in none but honest enterprise, to live and work according to the laws of and the highest standards of professional conduct. To place service before profit, the honor and standing of the profession before personal advantage, and the public welfare above all other considerations. In humility and with need for Divine Guidance, I make this pledge.

MEETING DATES

The meeting dates of the Southwest Chapter of W.S.P.E. are as follows:

January 22, 1959
February 26, 1959
March 19, 1959
April 23, 1959
May 21, 1959

The meeting dates of the Northwest Chapter W.S.P.E. All meetings are on the first Wednesday of the month:

January 7, 1959
February 4, 1959
March 4, 1959
April 8, 1959
May 6, 1959
June 3, 1959

APPLICATIONS FOR MEMBER AND AFFILIATE MEMBER—NOVEMBER 1, 1958

Name and Position	Address	Reg. No.	Sponsor
NORTHWEST			
Donald R. Franzmann, P.E. Sales Representative Northern States Power Co.	100 N. Barstow St. Eau Claire, Wis.	E-4605	W. E. Hestekin, P.E.
Charles H. S. Charlson, E.T. Ensign U. S. Navy	USS Boston (CAG-1) F.P.O. New York, N. Y.	ET-1921	M. R. Charlson, P.E.
WISCONSIN VALLEY			
Robert W. Mortenson, P.E. Mechanical Engineer Nekoosa-Edwards Paper Co.	731 Wisconsin River Dr. Port Edwards, Wis.	E-2179	A. R. Dent, P.E.
Robert A. Kennedy, E.T. Chemical Engineer Owens Ill. Glass Co.	604 E. Park Ave. Tomahawk, Wis.	ET-1844	R. L. Fitze, P.E.
OUT-OF-STATE			
Robert E. Hattis, P.E. Chm. of the Board Robert E. Hattis Engrs. Inc.	510 Ridge Ave. Evanston, Ill.	E-6477	H. A. Kallsen, P.E.
SOUTHWEST			
R. H. Richardson, P.E. Electrical Engineer Wis. Highway Comm.	714-21st Avenue Monroe, Wis.	E-4167	Reinstatement
MILWAUKEE			
Chester P. Surprise, P.E. Field Engineer Johnson Service Co.	7224 W. Appleton Ave. Apt. 5 Milwaukee 16, Wis.	E-5580	J. R. Meyer, P.E. Harry Gute, P.E.
Total—Members 5 Affiliates 2			

(Continued on next page)

THE PRESIDENT SALUTES ENGINEERS

NATIONAL ENGINEERS WEEK

"The observance of National Engineers Week provides an opportunity to recognize the vital work our engineers perform in maintaining American superiority in technology. I am heartened by the sense of urgency and public responsibility displayed by American scientists and engineers, and by their determination to be of service to the Nation.

The priority given by engineers and scientists to education is a strong example to us all. Their efforts to alert young people to the importance of careers in science and engineering help to enlarge the basic resources of American intellectual talent. It is only by education that we can guarantee the future supply of leadership in all field of endeavor."

Dwight D. Eisenhower

Dr. Clark A. Dunn, P.E., President
National Society of Professional Engineers
2029 K Street, N.W.
Washington 6, D. C.

Campus News

(Continued from page 36)

tria. He served as special lecturer and research associate at the Institute for Research and Testing of Materials in Vienna, and he was awarded a prize by the city of Vienna as an outstanding young scientist in 1952. He has been on the faculty of the University of Minnesota since 1955 and has conducted research for the U.S. Air Force.

Carbon is in charge of UW's nuclear engineering study and research program. He received all of his engineering degrees from Purdue University. He served in U. S. Army Ordnance during World War II. After receiving his Ph.D. in engineering from Purdue in 1949, he joined the nuclear engineering staff of the General Electric Co., at its Richland, Wash., plant.

He served as thermodynamics specialist, pile engineer, chief of the heat transfer unit, and chief of the contact engineering unit during 1950–55. He came to the UW from the Avco Manufacturing Corp., research and advanced development division, at Lawrence, Mass.

Moy is a graduate of the University of Minnesota, receiving both his bachelor's and master's degrees in industrial engineering. He has been associated with the Toro Manufacturing Co., Minneapolis, the Minnesota Mining and Manufacturing Co., St. Paul, and the Procter and Gamble Manufacturing Co., St. Louis, Mo.

Both Clouser and Johnson were formerly UW students, the former receiving his Ph.D. in engineering at Wisconsin last August, the latter receiving both his bachelor's and master's degrees in engineering at UW. Johnson completed his graduate studies at the Massachusetts Institute of Technology where he received his Ph.D. in 1957.

Clouser did his undergraduate work in engineering at the University of New Mexico and then worked at the Los Alamos Scientific Laboratory for several years before coming to Wisconsin. Both Clouser and Johnson are doing teaching and research in engineering mechanics.

(Continued on page 42)

STRAIGHT TALK TO ENGINEERS

from Donald W. Douglas, Jr.

President, Douglas Aircraft Company

The "Space Age" isn't going to become a fact by itself. We engineers have to make it happen. Here's what Douglas is doing about it:

We've formed a top level engineering council to bring all our knowledge and experience to bear on the new problems relating to extreme high speeds and altitudes and to outer space.

This council is composed of the heads of our six major engineering divisions and is chairmanned by our senior engineering vice president. It will map out the most important goals in aviation and mobilize the scientific and engineering resources required to achieve them.

If you would like to become a part of our stimulating future, we'll welcome hearing from you.

Write to Mr. C. C. LaVene
Douglas Aircraft Company, Box P-600
Santa Monica, California.

Highways for Tomorrow

(Continued from page 11)

aged 2.8 per hundred million vehicle miles. Where access was uncontrolled, the rate was 8.0. Similar studies of urban expressways showed them to be five times as safe as streets where access was not controlled. The purpose of the Interstate system is to insure the swift and safe movement of a great volume of vehicles. The standards adopted for the network will prevent the build-up of a large number of roadside businesses with direct entrances to the traffic stream, if this were not done, uninterrupted travel would be impossible, the highways would become quickly obsolete, and the huge public investment in the roads would be lost.

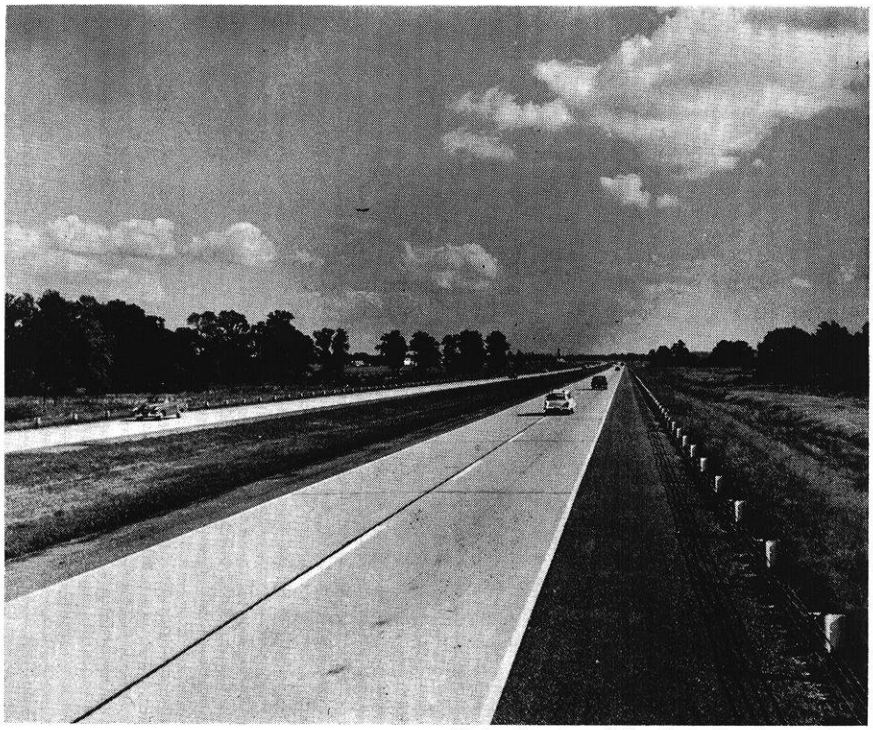
The geometrical design of this system of highways will not be unfamiliar to most of us, but the structural design of the roadbeds is more complex. Both concrete and asphalt pavements are under consideration, so we shall briefly examine the characteristics of each type. In both materials modern methods have resulted in pavements far superior to the older types.

Modern concrete is a smooth, durable pavement which will last many years under heavy loads. It has high skid resistance and good night visibility. It is virtually unaffected by temperature and moisture if properly laid.

Concrete has suffered two big drawbacks in the past—uncontrolled expansion and contraction, and breaking up under heavy loads. Modern concrete roads are bothered by neither of these.

Concrete roads are now laid in continuous slabs. After the concrete has set, tiny expansion joints are sawed into the pavement at regular intervals. This takes care of expansion and contraction, but still eliminates the old "bumpity-bump" tar-filled expansion joints.

Modern concrete roads are designed to carry 1 1/2 to 2 times the present maximum load limit, and are expected to last fifty years or more, even under heaviest traffic. Nine inch pavements are being laid in Kansas, Indiana, New York, Ohio, and other states. Arkansas, Illinois, and Texas are laying ten inch thick concrete roadways to carry tomorrow's loads.



—Photo Courtesy Ohio Turnpike Commission

Each of the travel roadways of the Ohio Turnpike is 24 feet wide and consists of two 12-foot lanes. The two roadways are separated by a center strip which has a minimum width of 56 feet, consisting of 40 feet of grass mall and the two 8-foot paved inside shoulders. The center strip is depressed to a maximum of five feet to assist in drainage and snow removal and to help out-of-control vehicles on one roadway from getting across into the opposite roadway. The paved outside shoulders are each 10 feet wide.

Present-day asphalt is likewise very smooth, flexible, durable, and offers sharp visibility of road markings at night. It is flexible enough to virtually eliminate expansion problems if properly laid. Initial cost is usually substantially lower than that of concrete, even for a turnpike-type pavement structure totalling twenty or more inches thick with subgrade development. It is easy to use for repair and maintenance, and is often used for resurfacing old concrete roadways. Maintenance costs are roughly equal with those of concrete. Skid resistance is slightly better on the best asphalt roads. It is smooth and glares less in the daytime.

Good examples of high-types asphalt paving are the New Jersey Turnpike, the Maine Turnpike, the Garden State Parkway (N.J.), the Massachusetts Turnpike, the Kansas Turnpike, and the Sunshine State Parkway (Fla.), along with many others. The New York, Ohio, Pennsylanvia, and Indiana Turnpikes offer excellent examples of concrete's worth. Which type of pavement the layman will prefer is likely to be dependent on whose literature he reads, as both pavements have many advantages.

The Federal Government will pay 90% of the cost of these superhighways, and the individual states will maintain them. The system will be completed in 15 years, but some branches are opening already. Perhaps you will drive on one soon.

THE END

Campus News

(Continued from page 40)

Crosby received bachelor of science degrees in both mathematics and chemical engineering at Michigan State University. He came to the UW to do his graduate work in chemical engineering, receiving his master's degree in 1952 and his Ph.D. in 1955, when he joined the staff of the Du Pont Experiment Station in Delaware. Before joining the UW chemical engineering staff, he completed a one-year Fulbright appointment to the Royal Technical University of Denmark in Copenhagen.

Dietmeyer completed the requirements last summer for his Ph.D. in electrical engineering at Wisconsin.

THE END

The Engineer of Yesteryear

(Continued from page 32)

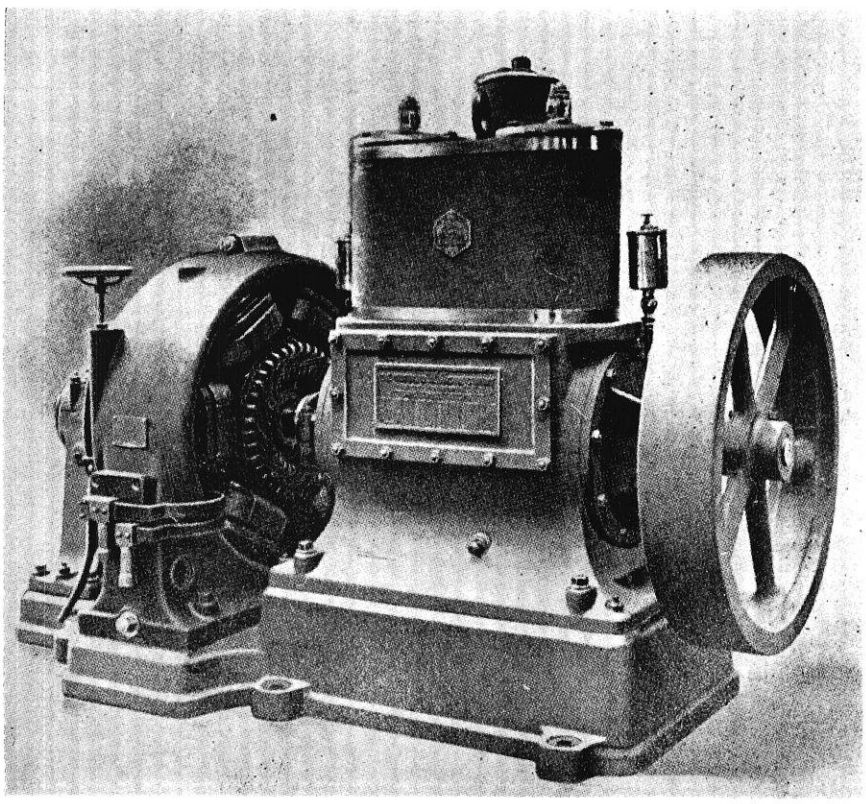
in a great variety of ways. The methods of governing in most common use are the following: cutting out entirely charges of oil, vapor, or gas; varying the quantity of oil, vapor, or gas; and varying the quantity of the explosive mixture.

The first method is usually carried out by some hit-and-miss device which, when the speed is above normal, fails to open the gas valve, the oil injector, the pump, or whatever means is employed to let the gas, oil, or vapor into the cylinder, or the exhaust valve is held open or shut. In those engines using an oil injector, the injector is operated by a knife edge. When the speed is unduly increased, the governor weights fly out and the knife edge is drawn to one side so that it misses the rod of the injector. No oil enters and only pure air is drawn into the cylinder. With this method, the work imposed upon the knife edge is small. This method is open to the objection that with almost any mixing device a slight quantity of the oil or vapor remains in the pipes leading to the cylinder. In case the oil is cut off and air is allowed to enter through the same channel, this is wasted when an explosion is missed. This loss, however, is about made up for by the air acting as a scavenger charge to cleanse the cylinder of burned products so that the next explosion produces more work.

When the exhaust valve is operated on to remain closed, the knife edge is used to move the valve, and, being deflected to one side by the governor, misses the valve stem. In this case the work on the knife edge is severe and it does not act with the certainty of the above method. The pressure remaining in the cylinder prevents the admission valve from opening and no charge is taken into the cylinder. The burned charge is compressed and expanded until the speed falls and the exhaust valve again opens. This method is open to the objection that a continued radiation of heat takes place through the walls and the work of expansion of the residue is not equal to the work necessary to compress it, resulting in a loss of economy.

The method which has found most favor is to have the exhaust valve pushed open positively, the knife edge interposing behind the exhaust valve when the speed increases, holding the valve open. The exhaust is then sucked into and expelled from the cylinder until the speed again falls below normal. There being no great suction, the admission valve does not open.

For ordinary work with slight fluctuations of speed, the method of governing by cutting out the explosion entirely, either by cutting off the mixture or by holding the valves open, is good, economical, and can be used easily in engines of moderate speeds. However, if a more constant speed is necessary, regulation may be achieved by a method only recently used experimentally; *i.e.*, that of varying the quantity of oil, vapor, or gas.



A Westinghouse engine and generator set.

PREPARATION OF METALLIC LITHIUM

May, 1899

To the present time, metallic lithium has been obtained by electrolyzing lithium chloride in the molten state. The reason for this metal not being obtained from aqueous solutions by electrolysis is that it reacts with water, forming hydrogen and lithium hydroxide. It is evident that if a solvent for a lithium salt could be found with which lithium does not react, the metal could be deposited from the solution by electrolysis, provided the solution proved to be an electrolyte.

Pyridine is a solvent of this kind. It will dissolve lithium chloride and form a solution that conducts electricity. The electrical conductivity of such solutions is slight as compared with that of aqueous solutions.

A concentrated solution of lithium chloride in pyridine is placed in a beaker containing a carbon plate as the anode and a bright metal plate as the cathode. With a difference of potential of 14 volts a current of 0.2 to 0.3 amperes per 100 sq. cm. of cathode area will soon deposit a dense, well adhering silver, white coating of metallic lithium. The deposit thus obtained possesses all of the well known physical and chemical properties of the metal. **THE END**

Gas Turbines

(Continued from page 24)

The turbine type engine is more durable, chiefly because it has less than a fifth as many major moving parts. The coast to coast trip made by a Plymouth equipped with a gas turbine was marred by only two incidents: the failure of a reduction gear bearing due to loss of oil caused by cracking of an oil line in the reduction gear housing, and the fatigue failure of a casting in the intake environment. The Chrysler Corporation claims they have had more trouble with newly designed reciprocating engines on their first cross-country runs.

Other advantages gained from the gas turbine are:

1. No mechanical vibrations.
2. Its weight is between one-half to two-thirds that of a piston engine.
3. It can operate on a wide range of fuels.

It is highly probable that within a few years the advantages will outweigh the disadvantages. Two drawbacks, beside high cost of materials, are acceleration lag and lack of engine braking. Substantial progress has been made in overcoming both of these deficiencies. There is apparently no reason why a solution to these problems should not be satisfactorily reached.

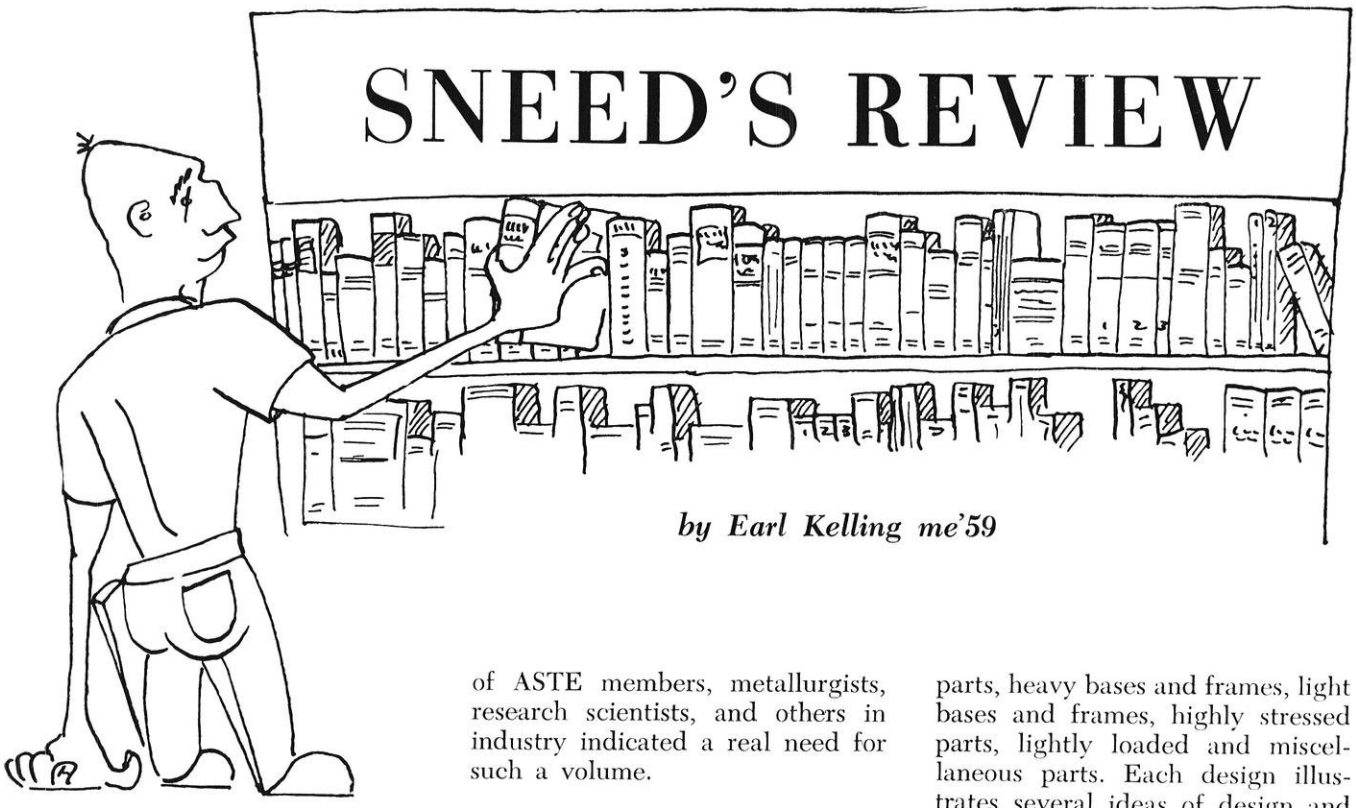
Conclusions

Because of the extensive research done in the last 10 years, the gas turbine has come a long way. Many of its basic problems have been ironed out. Its efficiency is ever increasing. In order to make a more perfect powerplant, thousands of engineers are working full time to solve the problems that remain.

It is the author's opinion that the gas turbine will replace the reciprocating engine within the next ten years. Many automotive engineers believe that the turbine will be produced for a good many years in limited production. It is doubtful that this type of production will continue for more than one year. The turbine will become too expensive if not manufactured in full scale production.

THE END

SNEED'S REVIEW



by Earl Kelling me'59

TOOLING FOR METAL POWDER PARTS

Published by the American Society of Tool Engineers
ASTE Member Price, $6.00
Non-Member Price, $7.50

This 253 page volume is a comprehensive reference work covering the relatively new process of making metal parts by compressing metal powders into finished or nearly finished form. Written by George H. DeGroat, Associate Editor, American Machinist, under the supervision of the ASTE National Technical Publications Committee, the book is a practical treatment on modern practice in the process planning, tool design, equipment and operations involved in producing structural parts from various metal powders. The book covers such subjects as: planning and economics for the metal powder process, design of structural metal powder parts, production of powders, preparation of powders, briquetting presses and practice, briquetting tools, sintering structural parts, and finishing operations.

Calling the book "a sharp new tool for the forward-thinking tool engineer," Mr. Conrad said the Society decided to develop all available information on the process into a reference manual after a survey of ASTE members, metallurgists, research scientists, and others in industry indicated a real need for such a volume.

ARC WELDING IN MACHINERY DESIGN AND MANUFACTURE

Published by the James F. Lincoln Arc Welding Foundation, Cleveland 17, Ohio
224 pages, $2.00

The James F. Lincoln Arc Welding Foundation has published a new book to help designers and manufactures of machinery of all types find answers to their questions in using welded steel construction to lower costs and improve performance. This book offers a source of ideas for the efficient use of steel in machinery. It provides a broad review of current practice in design and manufacture as reported to the Lincoln Foundation in its continuing series of machine design competitions.

Part I of the book outlines how to approach the problems of welded design and provides a series of check lists and suggestions with which designers and production men can guide their efforts to take full advantage of properties of steel and the cost reduction potential of welding. These lists point out how the production process of welding influences design decisions and the importance of designing for welding.

Part II of the book contains a brief review of 73 welded designs of a wide variety of machines. The book classifies the designs as to basic type of component: rotating parts, heavy bases and frames, light bases and frames, highly stressed parts, lightly loaded and miscellaneous parts. Each design illustrates several ideas of design and construction which have achieved lower costs and better performance. Ideas are illustrated with pictures and drawings and explained briefly to indicate their general application and significance. The designs are indexed for reference both as to type of machinery and as to type of design or manufacturing problem involved. A sample of machine types covered includes: construction, mining, electrical, farming, machine tool, pumping, processing, and textile. Some of the problems reviewed are appearance, assembly, breakage, corrosion, finishing, flexibility, impact, machinery, precision, rigidity, and vibration.

This book, published on a nonprofit basis, should be a valuable reference file of ideas for men who design machinery or who plan and execute the production of machinery.

MANAGEMENT FOR ENGINEERS

By Roger C. Heimer

Published by McGraw–Hill Book Company, 330 West 42nd St., New York 36, N. Y.
453 pages, $6.75

The engineer engulfed hour by hour in problems which have precise mathematical answers is frequently not conversant with the economic, social, psychological, and political complexities of manage-

(Continued on page 54)

Hermann von Helmholtz...on immortality

"...what arouses our moral feeling at the thought of a future cessation of all living creation on earth, remote as this may be, is above all the question whether all life is but an aimless sport, which will ultimately fall prey to destruction by brute force. In the light of Darwin's great thoughts we begin to see that not only pleasure and joy, but also pain, struggle, and death, are the powerful means by which nature has built up her finer and more perfect forms of life. And we men know that in our intelligence, our civic order, and our morality we are living on the inheritance which our forefathers gathered for us through labor, struggle, and sacrifice; we also know that what we acquire will in like manner ennoble the lives of our descendants. Thus the individual, who works for the ideals of humanity, even if in a modest position and in a limited sphere of activity, can bear without fear the thought that the thread of his own consciousness will one day break."

—Über die Entstehung des Planetensystems, 1871

Science Highlights

(Continued from page 27)

Special demonstration equipment was used in the room to show that "good office lighting does not cost; it pays." Annual costs of workers, equipment, and their productivity showed that an office, relighted from the present average to today's minimum standard level (100 foot-candles), need only increase worker efficiency one and one-half per cent in order to pay for itself and begin earning a profit. In actual practice efficiency gains up to five per cent or more are typical for lighting improvements of this order. Even higher gains could be expected in installations which more closely approach the optimum levels in this room.

Although the room provides many times the illumination found in better-lighted offices today, lighting engineers know that the human performance of office seeing tasks is best at these levels.

The office contains two different and complete lighting systems. Each of these alone would outstrip most of today's modern offices in the lighting level it provides.

The biggest punch of light comes from recessed fixtures eight feet long and two feet wide, each of which hold four of the new G–E Power-Groove lamps. With their unusual "dimpled" shape, Power-Groove lamps give two and a half times as much light per foot as do ordinary fluorescent tubes. This fixture has the highest generated quantity of light for its area of any recessed fixture yet. Because of its high lumen loading, none of the commonly used light-controlling materials were satisfactory.

This made necessary the development of the new louver, which is an injection-molded, vacuum-metallized "egg-crate" type. Its parabolically curved sides form a wedge-shaped louver wall. Not available commercially at present, the louver was developed experimentally by G–E lighting engineers.

Special emphasis was put on creating a pleasant surrounding for occupants of the office. Important to such an atmosphere is the lighting of walls and other vertical surfaces. Four different wall surfaces are used in the area. Fluorescent or filament lighting techniques are demonstrated with wood paneling, draperies, painted surfaces, and a self-luminous wall.

Visitors will be allowed to adjust the battery of dimmers which control the flexible lighting systems. Thus the office will help accumulate additional data on the lighting preferences of people for different office tasks. Studies up to now indicate that people prefer much higher levels even for easy office tasks than they now enjoy in the best-lighted offices.

Groups of more than 50 have already used the area experimentally as a work space and for discussion sessions. These groups have found that the lighting, air-conditioning, and acoustical controls keep the room comfortable over extended periods.

TINY DEVICE HELPS COMPUTERS "THINK" FASTER

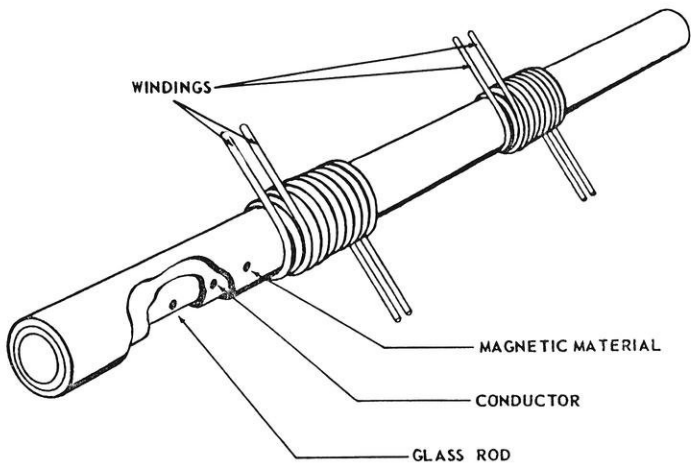
A magnetic device the size of a pin promises to increase the "thinking" speed of future electronic computers 10 to 20 times and make possible new missile and satellite advances.

The device, a glass rod with a magnetic coating, serves as both a switching and information storage element. Top speed of the device is as yet unknown. However, research models have exhibited switching speeds as fast as 4 millimicroseconds.

The new component was developed at The National Cash Register Company's Electronics Division.

Thousands of the rods could be linked electrically within a small space to solve problems with "unprecedented speed." The rod element can be used both in word-ordered and coincident current memory circuits. In contrast with present memory devices, which are costly to produce, the rod lends itself to less expensive mass-production techniques, both in fabrication and testing.

The rod will make it possible to navigate a missile or satellite with smaller power sources and increase the useful range of these vehicles.



Construction of NCR magnetic rod.

Only 20 thousandths of a watt is required to store a "bit" of information on the rod. Five thousand rods could operate simultaneously on the energy needed to light a single 100-watt bulb.

The new component will also enable missiles and space vehicles to navigate more dependably in the extremely high temperatures encountered during flight. The magnetic rod operates reliably at temperatures 300 degrees Fahrenheit higher than conventional components.

In the laboratory the rod has been operated in the coincident current mode from −100°C to +200°C. In the word-ordered mode this temperature range can be extended upward. The rod has been switched continuously at a 5 megacycle repetition rate without adverse heating effects. The hysteresis loop on the rod's magnetic coating is extremely square, showing ratios of better than 0.95.

The new component also is expected to find many applications in the field of commercial data-processing systems. By handling information much faster than existing switching and memory units rod networks will reduce the amount of equipment needed to handle a problem.

Since the rod can serve both as a logical switch and a storage element it permits a reduction in the number of semiconductors required in a computer. While some transistors will still be required, all switching will be performed by the rods themselves. As a result, the number of active components in a computer can be substantially reduced and reliability improved.

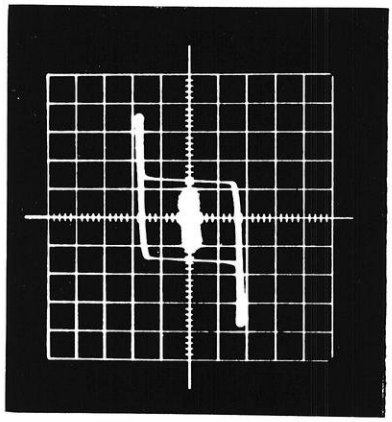
The compact size of the rod also cuts the space required for storing information. For example, a rod memory system the size of a cigarette package could store 8,000 bits of information.

It is possible to wind ten bit-positions per linear inch along the rod without mutual interference. These windings of very fine wire are placed on the rod in a solenoid-like manner with successive windings superimposed. At present, packing density is 1,000 bits per cubic inch, although this is not an electrical limit. Improved techniques in solenoid windings will make even greater compactness possible.

A single magnetic element for a coincident current memory requiring two inputs, an inhibit winding and a sense winding would consist of four separate single-layer concentric solenoids over the rod. Memory matrices each consisting of many solenoids can be stacked and simultaneously threaded with the rod.

The rod is about 15 thousandths of an inch in diameter. It is given a magnetic coating by an electrochemical process. The length of the rod can be varied, depending on the storage capacity desired. Small windings of wire around the rod store the information.

Typical applications of the rod now being investigated are: (1) a high-speed memory with one-microsecond cycle time, (2) shift registers and counters which work in the range of two to five megacycles and (3) multi-propositional logical applications. Using a system of inhibit logic, a laboratory switching model of the rod handles as many as 30 different propositions.



NCR's square hystersis loop for its new computer "rod."

COOLING LOADS OF REFRIGERATED TRAILERS

A method for determining the cooling load of refrigerated trailers is currently under study at the National Bureau of Standards. The objective of this project is the development of a standard laboratory rating method that will adequately simulate the heat transfer conditions under which trailers are actually operated on the road.

Work on the project is now well under way. Cooling loads of typical trailers have been compared in the laboratory and on the road, methods are being devised to simulate the effects of solar radiation and wind pressure, and air and moisture transfer processes through trailer walls are being investigated. Results so far indicate that any laboratory method must include a means for simulating the air leakage that occurs on the road; significant reductions in cooling load would be realized if air leakage could be eliminated.

At present there is no standard method in common use to accurately determine the cooling load of a refrigerated trailer. An accurate method would enable the trailer manufacturer to establish a rating for each of his models; and the purchaser, knowing this rating, the product load contributed by the commodity being carried, the length of haul, and certain environmental conditions, could then select the most economical and efficient refrigerating equipment for his needs. The method under development promises to provide the manufacturer with a reliable technique for determining these ratings.

Equipment and Procedure

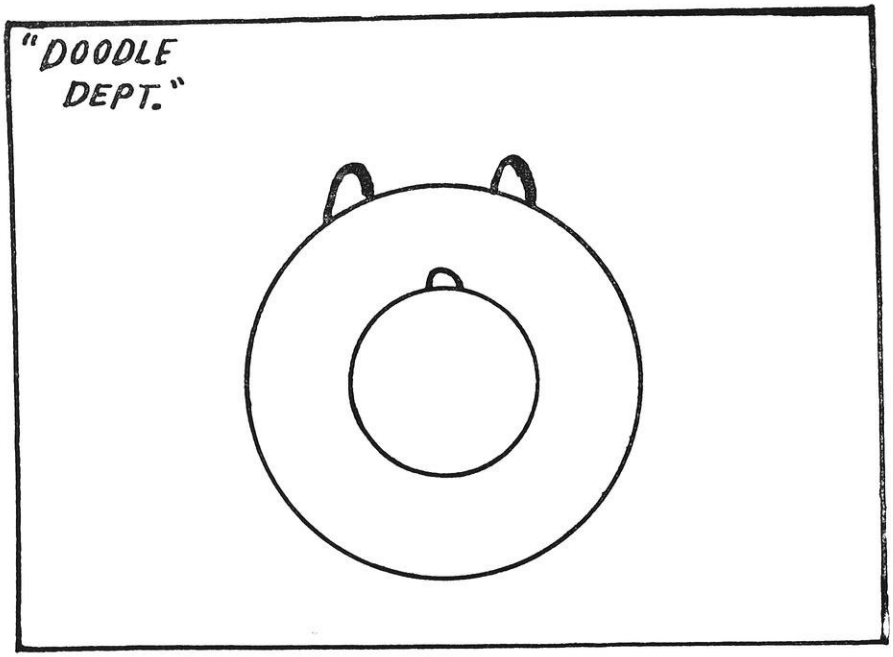
Three 35-ft refrigerated semi-trailers were chosen for the laboratory and road tests. The laboratory consisted of an insulated structure specially equipped with humidity and temperature control facilities. The trailers were placed inside this building, on three calibrated platform scales to determine the weight gain caused by condensation of infiltrated moisture. An adjoining room was equipped with suitable controls and instruments. Outside the test structure was installed a prototype comparison heat-sink apparatus. This consisted of sectionalized, semi-portable, refrigerating equipment which included three motor-driven two-speed compressors with water-cooled condensers, two brine chillers, and a metered heat comparator.

A refrigeration coil with an integral blower was placed inside the trailer at approximately the same height above the floor as in typical trailer-refrigerating units. When needed, an electric space heater was used to counteract the excess cooling capacity of the refrigerating units.

Thermocouples were installed inside and outside the trailer near the walls to measure the average interior and ambient temperatures. Several large fans circulated the air around the trailer to promote uniform ambient temperature and humidity within the test structure. Controls and equipment were set and adjusted to maintain the selected standard test conditions—0°F inside the trailer and 100°F and 50 percent relative humidity outside the trailer.

The laboratory tests of each trailer were made to determine the cooling load and simultaneous gain in weight due to the accumulation of water or ice under the standard test conditions. Chilled brine was circulated at a constant rate through the cooling coil inside the trailer and around an electric heater immersed in the brine circuit outside the trailer. The temperature rises produced in the brine by the heat absorbed inside

(Continued on page 52)



A bald-headed fat man, seen from the top of a building!

SMILE!!

The Twenty-third Psalm of an Engineer's Sweetheart

Verily I say unto you, marry not an engineer.

For an engineer is a strange being, and is possessed of many evils.

Yea, he speaketh eternally in parables which he calleth formulae.

And he wieldeth a big stick which he calleth a slide rule.

And he hath only one bible, a handbook.

He thinketh only of stresses and strains and without end of thermodynamics.

He showeth always a serious aspect and seemeth not to know how to smile.

And he picketh his seat in a car by the springs therein and not by the damsels.

Neither does he know a waterfall except by its horsepower,

Nor a sunset except that he must turn on the lights

Nor a damsel except by her live weight

Always he carrieth his books with him, and he entertains his sweetheart by steam tables.

Verily, though his damsel expecteth chocolates when he calleth She opened the package to disclose samples of iron ore.

Yea, he holdeth her hand, but only to measure the friction thereof,

And he kisseth her only to test the viscosity of her lips.

For in his eyes there shineth a faraway look that is neither love

Nor longing—rather a vain attempt to recall a formula.

There is but one key to his heart and that is Cum Laude,

And when his damsel writeth of love and signeth with crosses,

He taketh these symbols not for kisses, but rather for unknown quantities.

Even as a boy he pulleth a girl's hair but to test its elasticity

But as a man he discovereth different devises, for he counteth

The vibrations of her heartstrings; and he seeketh ever to pursue his scientific investigations.

Even his own heart fluttering he counteth as a vision

Of beauty and inscribeth his passion as a formula,

And his marriage is a simultaneous equation

Involving two unknowns and yielding diverse results.

Verily, I say unto you,
marry not an Engineer.

Science Highlights

(Continued from page 49)

the trailer and by the electric heater were measured as well as the power used by the electric heater. By equating the ratios of the two temperature rises and the two heat energy sources, the unknown cooling load of the trailer could be determined.

For the road tests, carried out at 50 mph average road speed, a tractor was altered to carry a two-stage gasoline-engine-driven refrigerating system and an electric generator, also gasoline-engine-driven. Controls and instrumentation for measuring the cooling load of the trailers were mounted inside the cab. The cooling load was determined by observing the rate of chilled brine circulation through the cooling coil, the temperature rise of the brine inside the trailer, and the electric energy dissipated inside the trailer by fans and other equipment.

Test Results

Comparison of laboratory and road tests shows that the heat gain of a refrigerated trailer was significantly greater during road operation than under stationary laboratory conditions for the same ambient temperature and humidity. This increase ranged from about 20 to 30 percent for the three trailers at ambient conditions of 100° F dry bulb temperature and 50 percent relative humidity (R.H.). Since these ambient conditions were attained during the road tests, this comparison is based on extrapolation of the observed data to the standard laboratory test conditions. The extrapolated heat gain values of the three trailers for these conditions ranged from 9000 Btu/hr to 12,600 Btu/hr for a road speed of 50 mph.

The increase in heat gain on the road was due principally to air leakage into the trailer construction under the impact pressure of the air against the front of the trailer. Additional small increases were caused by solar radiation and the movement of air, heated by the engine, under the floor of the trailer.

The air leakage and ice accumulation in the trailers were not negligible even under stationary conditions in the laboratory. The weight gain rates caused by ice accumulation averaged 0.32, 0.54 and 0.98 lb/hr for the three trailers during the laboratory tests. By assuming that the leakage air entered the trailer walls at ambient conditions of temperature and humidity and left the trailer body saturated at 0°F the air leakage rate and the heat transferred to the cooling unit by the air leakage was computed for each trailer from the rate of weight gain. On this basis the minimum air leakage rates in the laboratory were 235, 395, and 715 cu ft/hr and the corresponding values of heat transfer caused by the air leakage were 740, 1250, and 2270 Btu/hr.

If the heat transmission rate per degree temperature difference on the road, exclusive of heat transferred by air leakage, were assumed to be the same as in the laboratory, the air leakage could be deduced for the road tests. This procedure results in minimum air leakage rates for the road tests of 970, 860, and 1590 cu ft/hr and corresponding heat transfer rates of 3070, 2730, and 5030 Btu/hr caused by air leakage at the standard test conditions. On this basis, the heat gain due to air leakage ranged from 32 to 69 percent of the transmission heat gain. These percentages indicate that significant reductions in cooling load could be achieved by eliminating air leakage in trailer bodies.

The effects of solar radiation on a trailer are largely mullified by the rapid air motion over the vehicle at 50 mph. In a typical test at this road speed in bright sunshine, incident solar radiation raised the surface temperature of the roof and one side of the trailer about 7.5°F above ambient air temperature. On a weighted-average basis this corresponds to approximately three degrees rise in temperature for the entire exterior surface. When the trailer was sitting still, the sun sometimes raised the roof temperature by as much as 25 degrees.

The underside of the trailer warmed up as much as 15 degrees above ambient temperature during road operation, principally by waste heat from the tractor engine. This rise would not cause a very large increase in over-all heat gain of the trailer unless chilled air were circulated around and under the load.

At 50 mph, impact air pressures up to 1.25 in. water gage (W.G.) occurred on the nose of a trailer where it was not shielded by the tractor, although the average pressure over the entire front end of the trailer was probably considerably below this value. The static pressures in the cargo space, in the insulation space, and over most of the exterior skin surface (excluding the nose) were about equal and ranged from 0.2 to 0.4 in. W.G. below the pressure of the undisturbed atmosphere as measured ahead of the vehicle. The leakage air probably entered the trailer body primarily on the nose of the trailer and left the body over the remainder of the surface. Most of the moisture in the ambient air was deposited as ice in the insulation space. The air exchange between the insulation space and the outdoors was probably several times greater than between the cargo and outdoors.

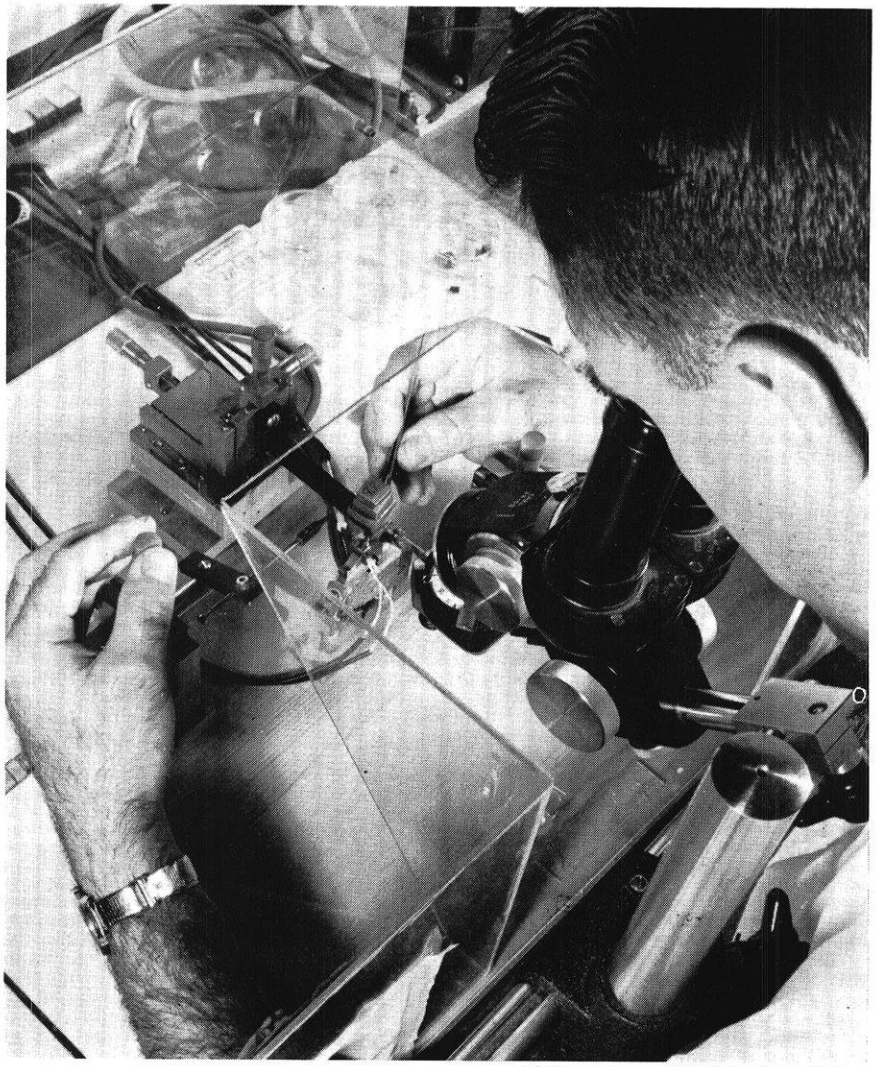
The results suggest that smaller refrigerating units could be used if air leakage could be eliminated; alternatively, less insulation would be required if air leakage were significantly reduced. Moreover, if moisture could be kept out of the insulation spaces, deterioration of trailer bodies would proceed more slowly.

COMPRESSION BONDING FOR TRANSISTORS

Compression bonding of leads to the metallized germanium surfaces of high frequency transistors provides a lead structure which can withstand 100,000g in a centrifuge and very high shocks.

Compression bonding is a technique recently developed at Bell Laboratories for attaching leads to semiconductors. A combination of heat and pressure is employed to form the bond, but neither is sufficient to cause damage to the semiconductor. When properly formed, bonds made in this fashion can be stronger than the lead itself.

This bonding process is highly satisfactory where very small leads (0.0004″ in diameter) must be attached to small areas (0.001 inch



—Photo Courtesy Bell Telephone Labs

Compression bonding of gold leads to a high-frequency transistor is being carried out by T. B. Light of Bell Telephone Laboratories.

by 0.006 inch), as in high-frequency transistors. The areas are previously treated with evaporated and alloyed metallic films from 1500 to 3000 angstroms thick. Annealed gold has been found to be satisfactory as lead material.

To form the bond, the wire is pressed on the desired area with a tool shaped as a half cylinder. A force sufficient to produce about an 85% deformation of the wire is employed. The temperature is held within the annealing range of the lead material (about 300°C for gold) during the process, and the bond is formed in a non-oxidizing atmosphere. Under these conditions, a bond can be formed in a second or two which is stronger than the lead material itself.

This bonding technique, combined with a suitable configuration which minimizes lead length, when applied to diffused-base germanium transistors with alpha cut-off frequencies in the 500–1000 mc range, results in a very rugged structure which will withstand 100,000g in a centrifuge, and very high shocks.

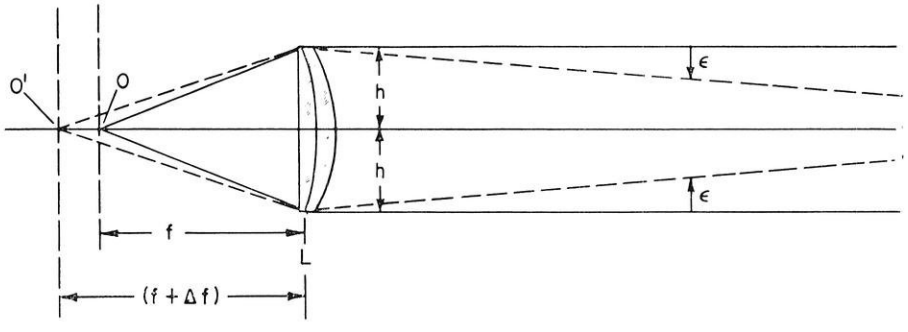
APPARATUS FACILITATES LENS TESTING

An apparatus devised by Dr. F. E. Washer of the National Bureau of Standards measures spherical and chromatic aberrations in lenses with a high degree of accuracy. The equipment is proving very useful for the rapid testing of high-precision lenses such as those used in airplane cameras and in telescopes. With the aid of an optical T-bench equipped with nodal slides, a visual testing method is made possible. Outstanding features of the method are its simplicity, reliability, and versatility.

By longitudinal spherical aberration is meant the variation in focal length for different annular zones of a lens. In other words, the focus for each zone occurs at a different place along the lens' optical axis. In order that corrections may be made for the resulting out-of-focus effects, accurate data must be obtained on the focal lengths of the various annular zones. These data are also important in lens design because they yield valuable information on expected performance and show the direction to be taken in improving the design.

When a light source is placed at the back focus of an annular zone of a lens with a longitudinal spherical aberration, the light from that zone emerges from the front of the lens at an angle to the lens axis. By isolating small areas along the lens diameter, it is possible to measure this angular deviation, ϵ, for each zone. From these measurements the change in focus from zone to zone

(Continued on next page)



The change in focus from zone to zone can be seen in this diagram.

can be readily determined by the approximate formula

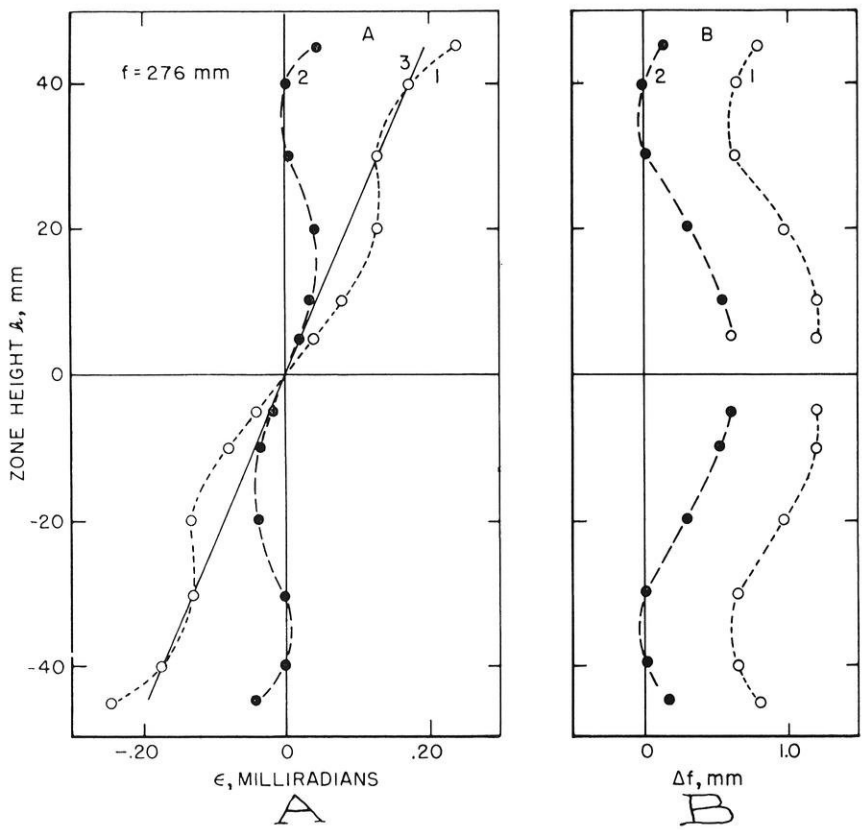
$$\triangle f = \frac{\epsilon}{h} f^2$$

where $\triangle f$ is the variation of focus or longitudinal spherical aberration; ϵ is the measured angular deviation; h is the zone height (distance from lens axis); and f is the equivalent focal length of the lens.

The testing apparatus consists of two optical benches mounted on a strong metal table at right angles to each other in the form of a T. The cross bench carries a nodal slide with the viewing telescope, and a movable slide on which a pentaprism is mounted. The perpendicular bench carries a nodal slide that supports the lens under test, and a movable slide to which the reticle and light source are attached. The pentaprism is used to direct the light emerging from the lens under test to the telescope. The size of the telescope's aperture is limited as required by diaphragms with openings of from 1 to 10 mm.

When the slide with the pentaprism is moved along the cross bench, each annular zone along the lens diameter is isolated, and the angle ϵ, separating successive beams from the central beam, can be measured by the micrometers mounted on the telescope. Values for the longitudinal spherical aberration $\triangle f$ can then be computed for each zone height h. By plotting the values of $\triangle f$ as abscissae against h as ordinate, the typical spherical aberration curve is formed.

Information is obtained on longitudinal chromatic aberration by first determining the longitudinal spherical aberration for a series of color filters. This is done by placing each filter in the light path between the light source and the illuminated reticle, and then by plotting the $\triangle f$ versus h curves from the data derived for each color. The separation of these curves along the axis of abscissae is a measure of the longitudinal chromatic aberration.



IDENTIFICATION LIGHT FOR JET AIRCRAFT

A tiny but powerful wing-tip identification lamp for super-sonic jet aircraft, has been announced by General Electric's Miniature Lamp Department.

Designated as the aircraft wing-tip identification lamp #1958, it is a 150-watt, 28-volt tubular quartz lamp, 2¼ inches long and ½ inch in diameter, with a rated life of 300 hours.

The tremendous speed and closing rate of the newer jet aircraft necessitated the development of this new lamp having greatly increased light output. Yet the increasingly thinner wings and stabilizers of jets required a smaller light source. Existing lamps of the light output required would not fit into the wing tips.

Producing as much light as two ordinary 100-watt household lamp bulbs, the new lamp is approximately two-thirds the length of a cigarette and about twice the diameter. It is the most compact commercially available tungsten filament lamp of comparable wattage in the world.

Although the light output from most lamp bulbs decreases with burning, the new lamp maintains practically 100 per cent light output until the end of life. This feature is not now available in any other light source of similar wattage. **THE END**

Sneed's Review

(Continued from page 45)

ment. But these subjective concerns greatly affect and often completely dominate the decisions of business management and are therefore given studied attention in this new book. The author points out that such decisions must be based upon subjective as well as objective factors. This book will acquaint the reader with the day-by-day workings of a business firm both as an economic institution and as a coordinate organization made up of individual participants.

Scope of the book—

Takes a practical look at the impact of costs, standards, materials, methods, taxes, insurance, power, equipment, labor, and ethics; and shows the relationship between them and engineering considerations.

Describes the fundamentals of business cost considerations.

Shows how both cash and credit are made to work in behalf of the over-all business purpose.

Acquaints the reader with basic record keeping for corporate financial transactions.

Contains the meat of depreciation accountancy. **THE END**

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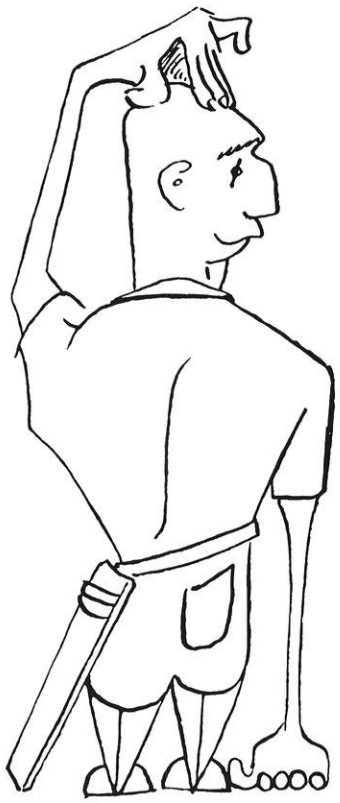


So You Think You're SMART!

by Sneedly bs'60

NOW seems to be that time of the year again when all collegians throw away the rules and regulations of normal existence to study for finals. The girls are not signing out for overnights and the Engineers falling into bed at 2 or 3 a.m. are exhausted from their last effort to pass; *i.e.*, the courses, not the beer mug.

Some of you Engineers will also take the Engineer-in-Training examination and certainly many of you will be working on your projects for the Engineering Exposition. By the way, if you haven't as yet planned anything, take a look at the prizes and contrive something as soon as you can. Remember, April 10, 11, and 12, are the dates of our exposition, so let's back it all the way.

But wait! Sneedly also has some problems for you to solve. So trim your beard later, put everything else aside for a while, and see if you can't win yourself 10 dollars. Remember, the earliest postmarked correct solution wins.

1. An ME had constructed a vehicle and decided to take it for a trial run. Driving to a nearby town he found that he averaged 10 mph. Coming back he was going downhill and averaged 15 mph. What was his average speed?

2. In the square below there are 9 digits so arranged that the number in the second row is twice the number in the first row, and the number in the bottom row is three times the number in the top row. Find the three other ways of arranging the digits producing the same result.

1	9	2
3	8	4
5	7	6

3. Professor Lewandowski was spending an evening with his friends, Mr. and Mrs. Mueller, playing cards. The professor lost the first game, which resulted in doubling the money that both Mr. and Mrs. Mueller had laid on the table. The second game was lost by Mrs. Mueller, which doubled the money then held by her husband and the professor. Curiously enough, the third game was lost by Mr. Mueller, and had the effect of doubling the money then held by his wife and the professor. It was then found that each person had exactly the same money, but the professor had lost 5 dollars in the course of play.

How much money did the professor have in the beginning?

Sneedly was very happy to receive so many correct solutions from all parts of the state as well as the campus itself. Here are the answers to the thought twisters of December.

The first problem could have been done a number of ways and does not need any detailed explanation. It was just a matter of manipulating the numbers to obtain the correct solution.

The answer to the second problem is 26 minutes until 6 o'clock.

The third problem can be set up several ways. Thinking this problem through correctly and using the conversion from acres to square feet should render the answer of 28 miles.

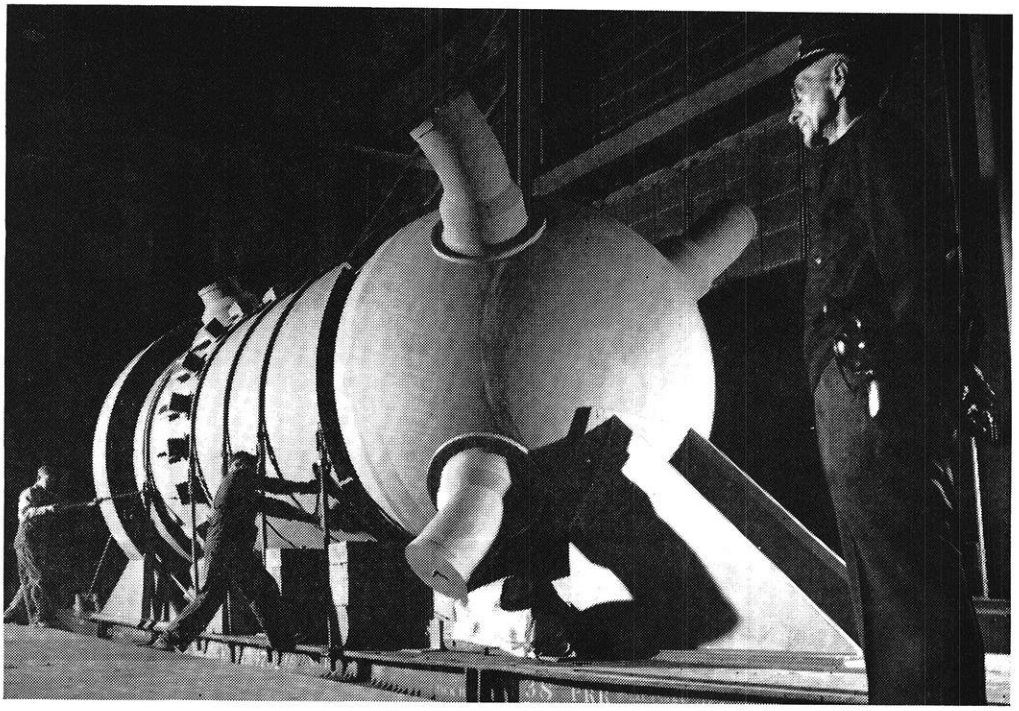
The fourth and additional problem is a number theory problem which can also be solved by a trial and error method. Regardless of the method used, the answers should be:

2 men, 30 women, 68 children
5 men, 25 women, 70 children
8 men, 20 women, 72 children
11 men, 15 women, 74 children
14 men, 10 women, 76 children
17 men, 5 women, 78 children
20 men, 0 women, 80 children

The belated Christmas presents were earned by James J. Marcou for the first three and John L. Rivard for the fourth. Good work fellows!

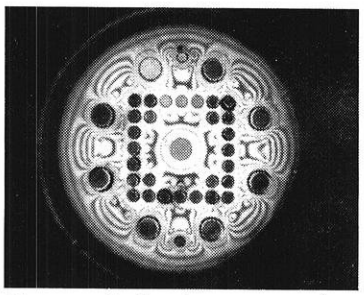
SNEEDLY
% The Wisconsin Engineer
Mechanical Engineering Bldg.
Madison, Wisconsin

PHOTOGRAPHY AT WORK—No. 25 in a Kodak Series

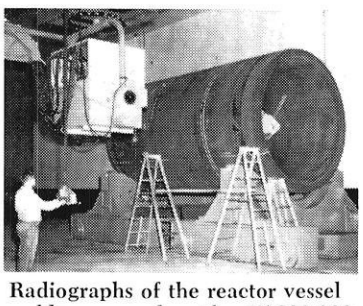


Nuclear reactor vessel for Shippingport, Pa. power plant designed by Westinghouse Electric Co. under contract with the A.E.C. for operation by Duquesne Light Company.

Where atoms turn into horsepower



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



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

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

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

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

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

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One of a series

General Electric interviews Dr. Richard Folsom, President of Rensselaer Polytechnic Institute, to explore . . .

Teaching— A Career Opportunity For the Engineer

Leading educators, statesmen and industrialists throughout the country are greatly concerned with the current shortage of high-caliber graduates who are seriously considering a career in the field of science or engineering education. Consequently, General Electric has taken this opportunity to explore, with one of America's eminent educators, the opportunities and rewards teaching offers the scientific or engineering student.

Q. Is there in fact a current and continuing need for educators in technical colleges and universities?

A. Colleges and universities providing scientific and engineering educational opportunities are hard pressed at the present moment to obtain the services of a sufficient number of well-qualified teachers to adequately carry out their programs. Projected statistical studies show that this critical need could extend over the next 15 or 20 years.

Q. Why is this need not being met?

A. There are probably three main reasons. These might be classed under conditions of financial return, prestige associated with the position, and lack of knowledge and understanding on the part of the college student of the advantages and rewards teaching as a career can afford.

Q. What steps have been taken to make education a more attractive field to engineering students?

A. Steps are being taken in all areas. For example, we have seen a great deal in the newspapers relating educators' salaries to the importance of the job they are doing. Indications are that these efforts are beginning to bear fruit. Greater professional stature is being achieved as the general public understands that the youth of our nation is the most valuable natural resource that we possess . . . and that those associated with the education of this youth have one of the most important assignments in our country today.

Q. Aside from salary, what rewards can a career in education offer as opposed to careers in government or industry?

A. The principal rewards might be freedom to pursue your own ideas within the general framework of the school, in teaching, research and consulting activities. As colleges and universities are normally organized, a man has three months in the summer time to engage in activities of his own choice. In addition, the educator is in direct contact with students and he has the satisfaction of seeing these students develop under his direction . . . to see them take important positions in local and national affairs.

Q. What preparation should an engineering student undertake for a teaching career?

A. In college, the engineering student should obtain a basic understanding of science, engineering science, humanities and social sciences with some applications in one or more professional engineering areas. He should have frequent career discussions with faculty members and his dean. During graduate work, a desirable activity, the student should have an opportunity to do some teaching.

Q. Must an engineering student obtain advanced degrees before he can teach?

A. It is not absolutely necessary. On the other hand, without advanced degrees, advancement in the academic world would be extremely difficult.

Q. How valuable do you feel industrial experience is to an engineering or scientific educator?

A. Industrial experience for a science educator is desirable; however, with a senior engineering educator, industrial experience is a "must". An ideal engineering educator should have had enough industrial experience so that he understands the problems and responsibilities in carrying a project from its formative stages to successful completion, including not only the technical aspects, but the economic and personal relationships also.

Q. What do you consider to be the optimum method by which an educator can obtain industrial experience?

A. There are many methods. After completion of graduate school, perhaps the most beneficial is a limited but intensive work period in industry. Consulting during an academic year or summer is a helpful activity and is desirable for older members of the staff. Younger educators usually need experience in "living with the job" rather than providing consultant's advice to the responsible individual.

Q. Based on your experience, what personal characteristics are possessed by successful professors?

A. Primarily, successful professors have an excellent and growing knowledge of their subjects, are interested in people, and transmit enthusiasm. They have an ability to explain and impart information with ease. They generate ideas and carry them out because they are devoted to developing their fields of knowledge. They desire personal freedom and action.

For further information on challenging career opportunities in the field of science and engineering education, write to: Mr. W. Leighton Collins, Secretary, American Society for Engineering Education, University of Illinois, Urbana, Ill.

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