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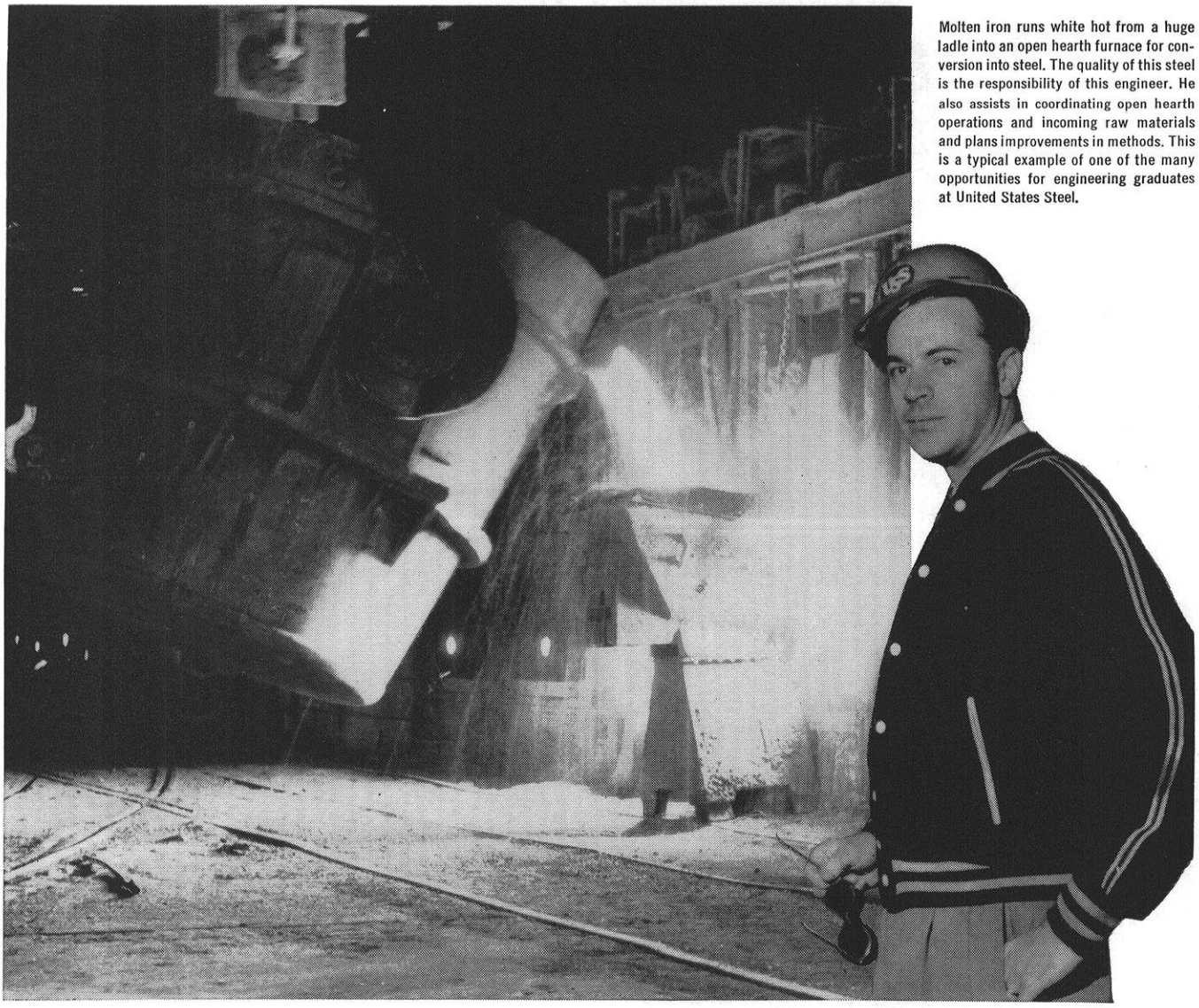
NOVEMBER
1957

The Wisconsin engineer

25¢



Molten iron runs white hot from a huge ladle into an open hearth furnace for conversion into steel. The quality of this steel is the responsibility of this engineer. He also assists in coordinating open hearth operations and incoming raw materials and plans improvements in methods. This is a typical example of one of the many opportunities for engineering graduates at United States Steel.

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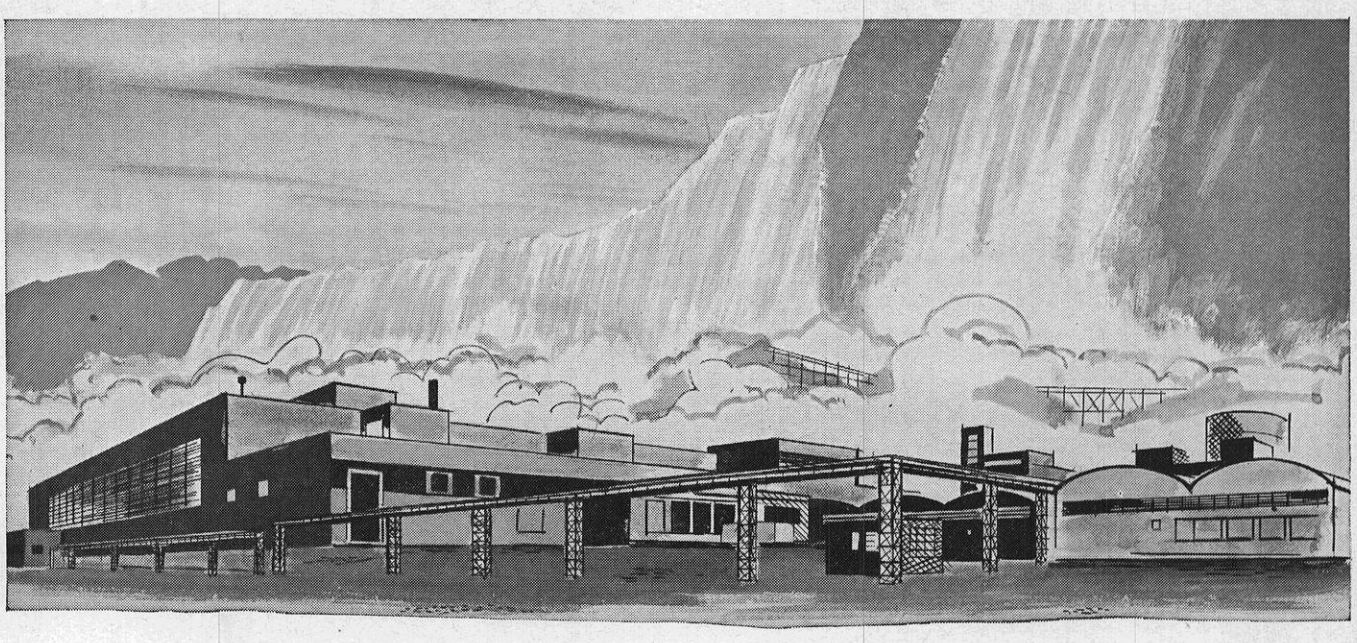

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Volume 62 NOVEMBER 1957 Number 2

WISCONSIN ENGINEER

The Student Engineer's Magazine

FOUNDED 1896

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Hoover Dam—monument to the civil engineer.

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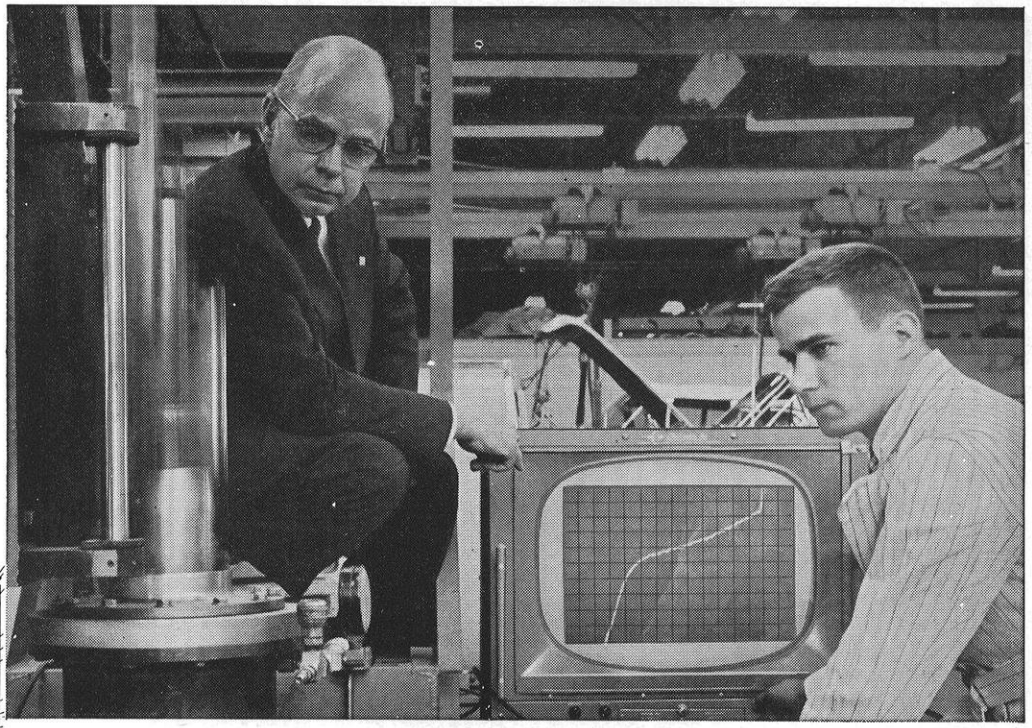

SUSPENSION STORY—Chuck Steger, M.E. '52, probing dynamic properties of new Air Spring developed by Von Polhemus (l.). A nationally recognized authority on suspension systems, Mr. Polhemus directs Structure and Suspension Development Group of GM's Engineering Staff, helps guide Chuck in his professional career.

Because *engineering* is a *profession* at GM —we offer you a career—not a job

ONE REASON engineering standards at General Motors are so high is that General Motors recognizes engineering as a profession. And the men who engineer the many different products made by GM are respected for the profession they practice.

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And you are also encouraged to take an active role in your community's affairs—because a truly professional man is a good citizen as well as a good engineer.

All this is for a reason—and a good one.

Many of the men who will fill the key positions at GM in the future are the young engineers joining GM today. This is not theory, it is fact. For 14 of our 33 Vice-Presidents are engineers, 23 of our 42 Division General Managers are engineers, too.

Today we are looking for young engineers—such as you—who may fill these positions tomorrow. The rewards—both professional and financial—are substantial. If you feel you have the ability, write us. It could be the most important letter of your life.

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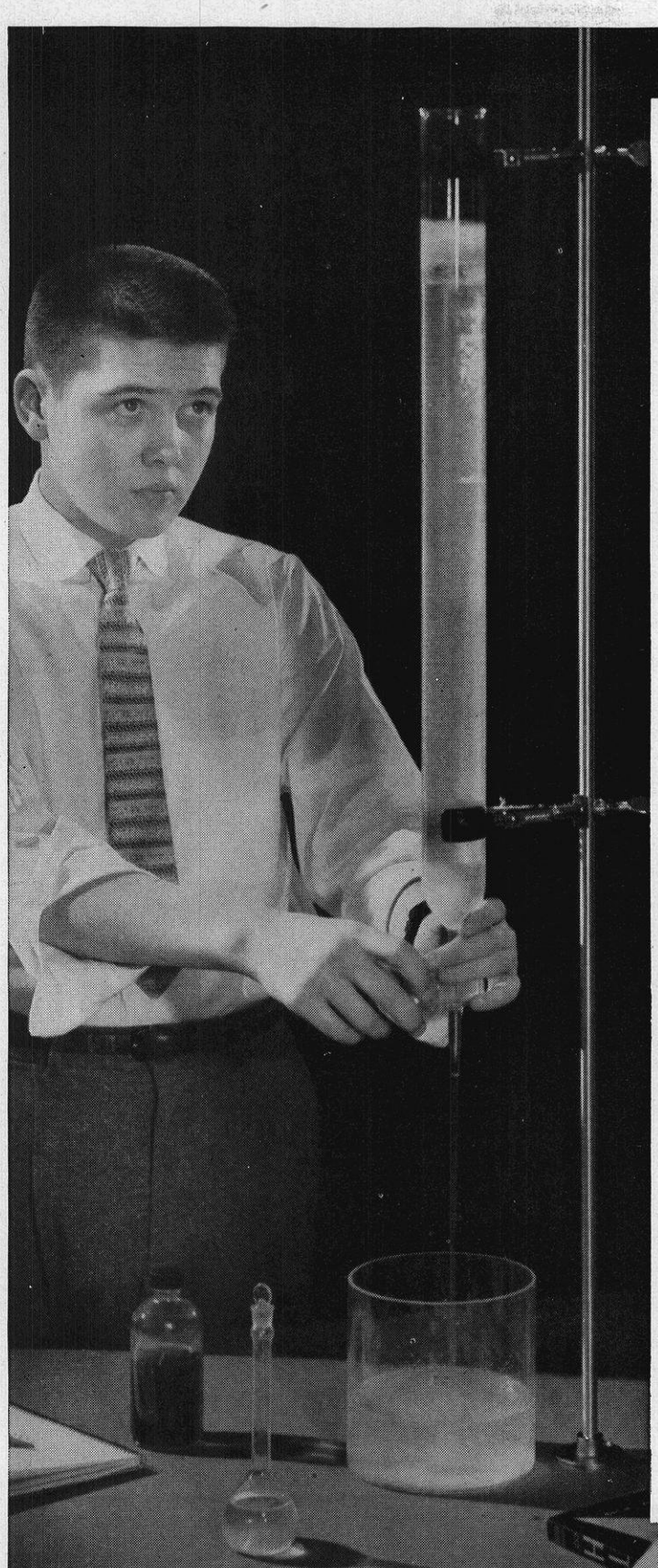

How does a chemist happen?

"New ideas," Henry Thoreau wrote, "come into the world . . . with a flash and an explosion and perhaps somebody's castle roof perforated." Many a budding young chemist has introduced his parents to chemistry in similar fashion. But the real making of a chemist takes place in quiet, unspectacular little ways.

There is the challenge of a teacher who asks two new questions for every one he answers.

There is the mental sweat and labor of working out a quantitative analysis—and the glowing pride of being *right,* to the fourth decimal place.

There is the romance of chemistry written wordlessly in the twinkle of an aging professor's eye.

There is memorizing and mixing . . . calculating and titrating and cramming. Hour upon unending hour of them.

But the hours, the days, the years of work and study silently dissolve in that magic moment when a new idea strikes . . . in that moment when all that *has* been done is forgotten, when all that seems important is to learn if this new thing that has never been done, *can* be done.

In that fleeting moment, the student becomes a scientist and begins for the first time to use chemistry to help people gain a little more comfort, a little extra convenience, a little better health.

It is many such moments that make a career in the chemical industry exciting, challenging, and very, very satisfying. Write for a copy of our booklet which shows how you can achieve this type of satisfaction at Koppers. Koppers Company, Inc., Pittsburgh 19, Pennsylvania.

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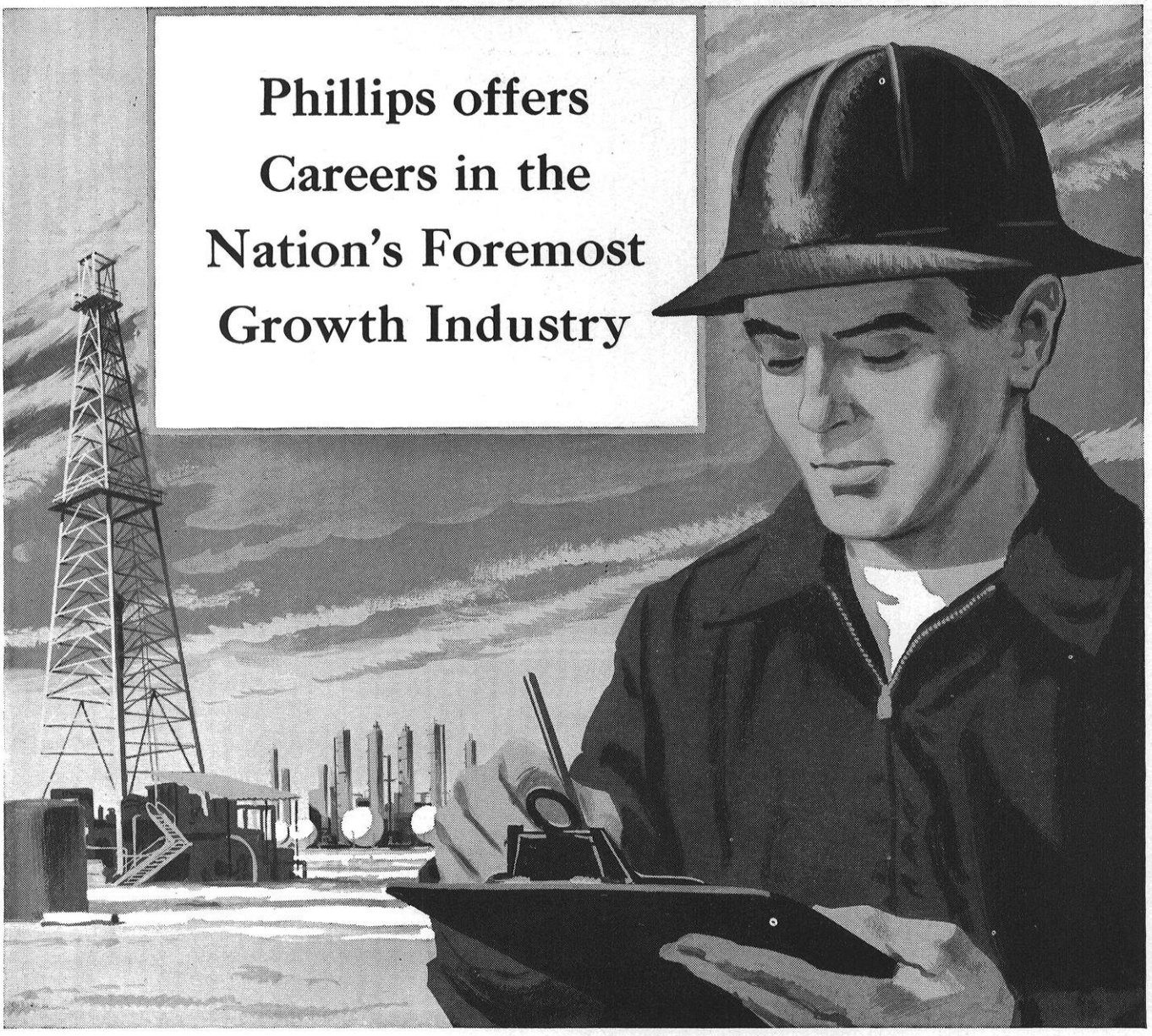

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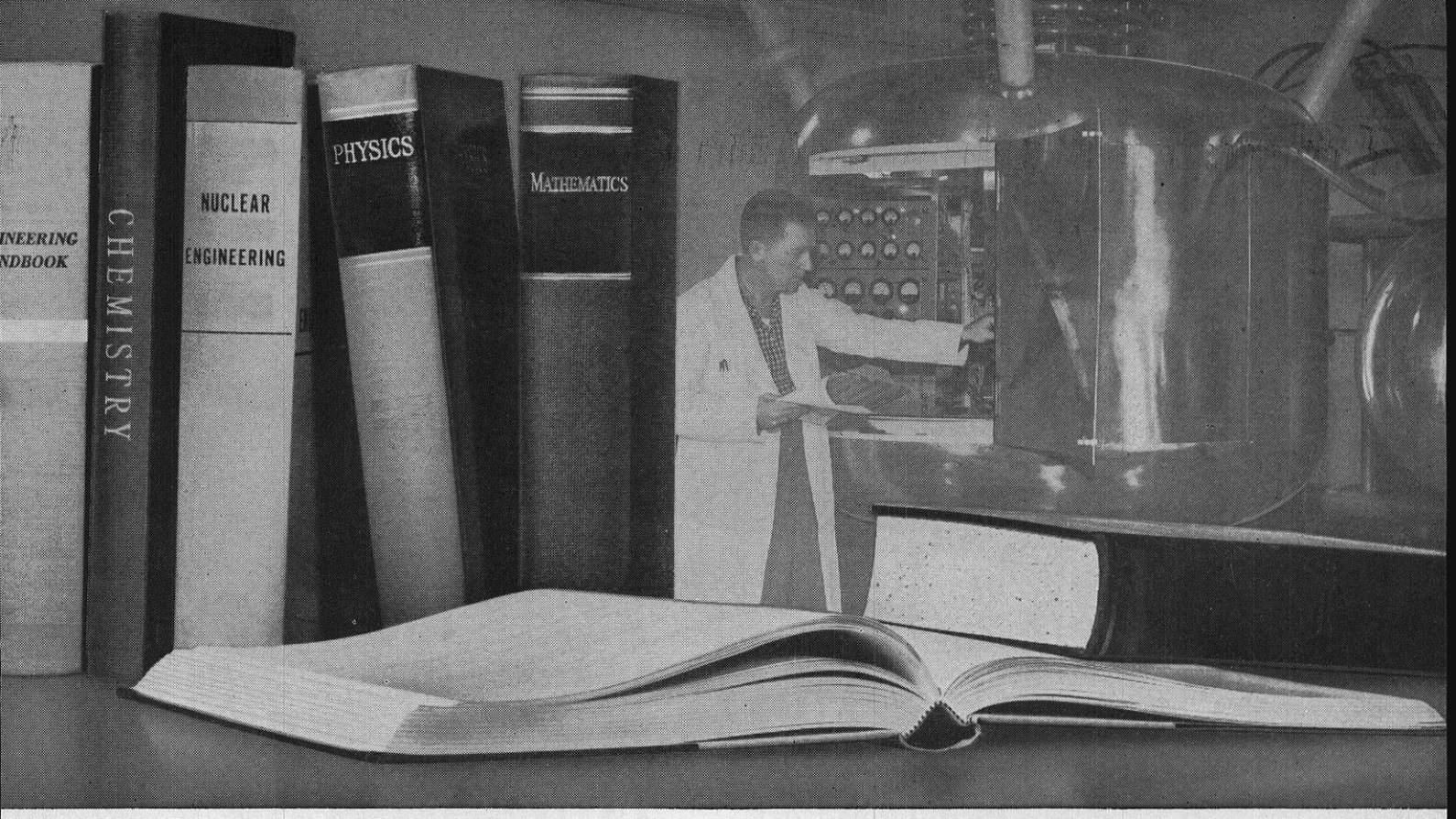

graduate study opportunity...

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The Center, operated by the University of New Mexico, offers graduate programs in the fields of nuclear, mechanical and electrical engineering, chemistry, physics and mathematics.

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- Instruction is by recognized leaders in their scientific fields from the laboratory staff and from the University of New Mexico
- Classes are held in the evening, a few minutes from your Los Alamos residence
- One-half of your tuition is paid by the Laboratory
- Unique laboratory facilities and equipment are available
- Los Alamos technical library, among the nation's most complete, is open 24 hours each day for study and research.

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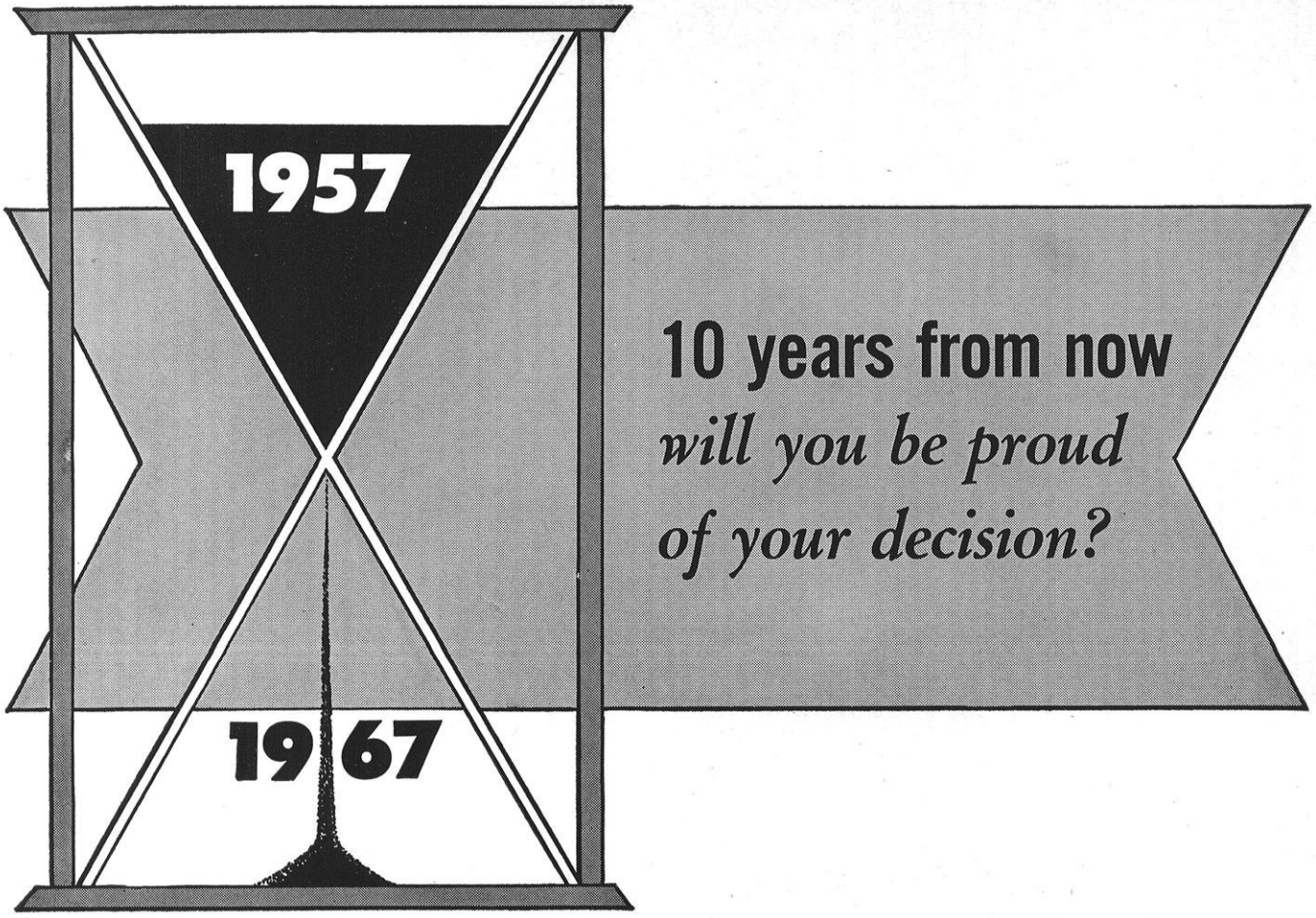

The right decision now, at the launching of your career, can do much to influence your success.

Pittsburgh Plate Glass Company has a host of fine young men who are holding responsible positions in the PPG organization. Ten years ago, many of them were faced with the same decision that now faces you: "Which company shall I select?"

They chose PPG because it offers unlimited opportunity. PPG has never stopped expanding or growing in its 73 years of existence. Its markets are constantly increasing. PPG's management is progressive. It seeks men who can grow with the company . . . men who can take over responsibilities. In PPG, it isn't necessary to wait for a man's retirement or death before you move up in the ranks. Opportunities are opening up all the time in all of its important divisions: Paint, Glass, Chemicals, Brushes, Fiber Glass.

This is your year of decision. We invite you to look into Pittsburgh Plate Glass Company. To help you become better acquainted with PPG, we suggest you get a copy right away of the booklet entitled, "Toward New Horizons with Pittsburgh Plate." Ask your placement officer for a copy or write directly to the Pittsburgh Plate Glass Company, General Personnel Director, One Gateway Center, Pittsburgh 22, Pennsylvania.

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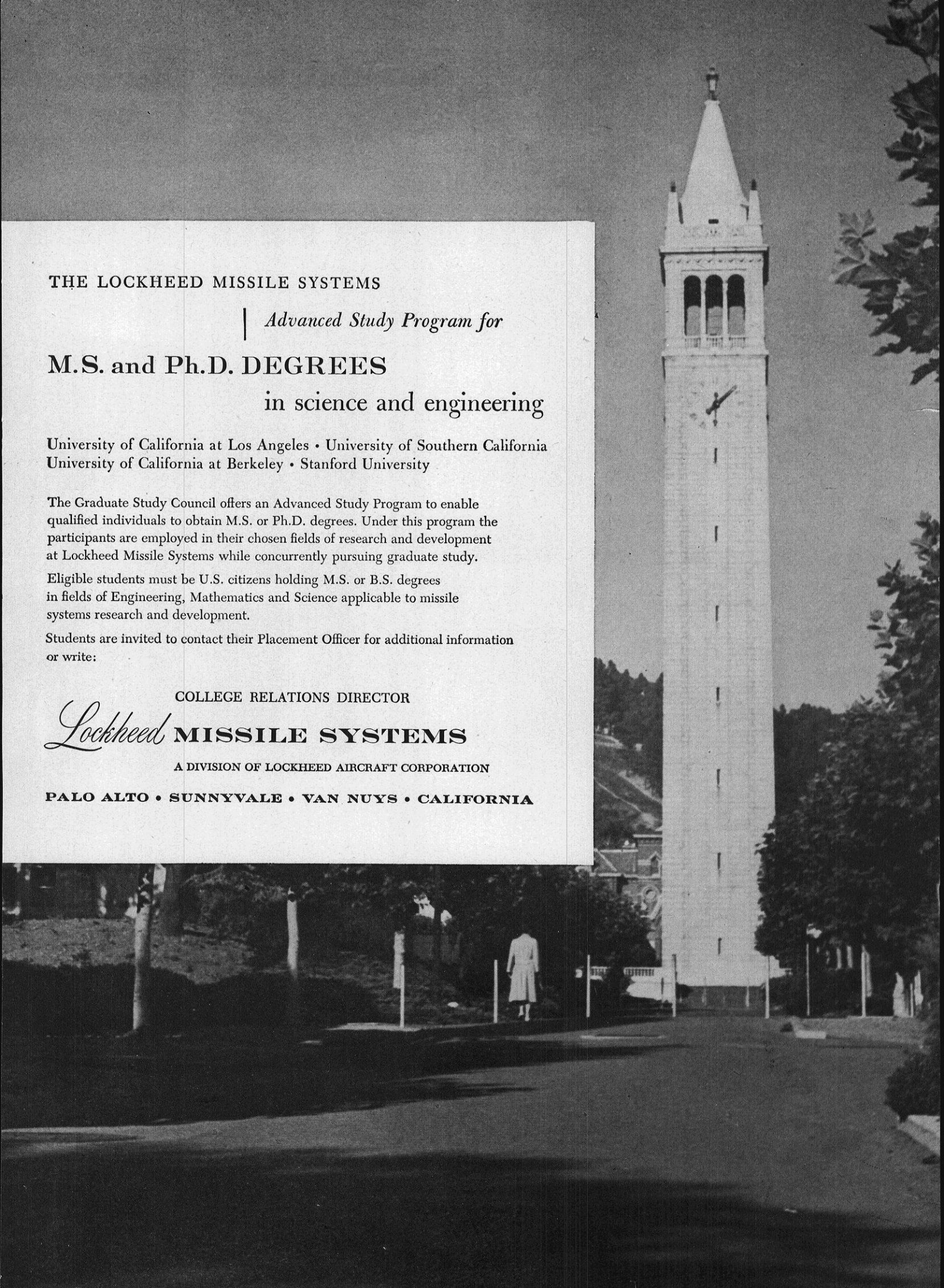

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Eligible students must be U.S. citizens holding M.S. or B.S. degrees in fields of Engineering, Mathematics and Science applicable to missile systems research and development.

Students are invited to contact their Placement Officer for additional information or write:

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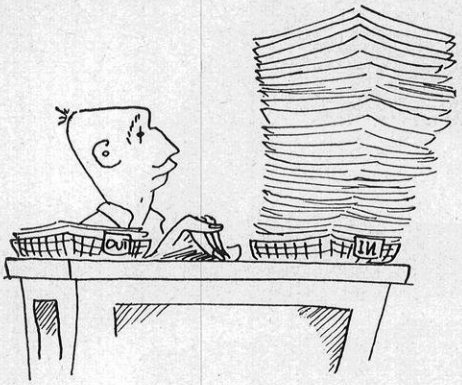

Rambling WITH THE EDITOR

For the last several weeks, various reports have been heard about the possibility of another student newspaper, the *Wisconsin Herald,* on the University of Wisconsin campus. Feeling paternal toward any future comrade in journalism, the *Engineer* decided to find out just what reports were true, and whether publication could be expected in the near future.

Upon contact with a member of the *Herald's* future staff, we were told that:

"The *Wisconsin Herald* is conceived as a dynamic and stimulating newspaper, written for student interest. The 16-page tabloid size paper will come out six days a week and until October 1, 1958 the newspaper will be distributed free to students and all interested. An initial circulation of about 16,000 copies is anticipated.

"At the University of Wisconsin the *Herald* will fill an urgent need for a daily paper of quality journalism. It will differ in three large respects from the existing campus paper, the *Daily Cardinal,*:

1. It will cover national, international and state news in addition to campus and university activity.

2. It will be published by a student editorial staff that is paid. The attraction of salaries will draw the most able journalists enrolled, and will allow the paper to operate on a professional basis.

3. The publishing corporation which will put out the *Herald* is a body independent of the university, operating outside its control. The corporation will be non-stock, non-profit, and will sell memberships to all interested.

"'One of the purpose of the Herald will be to further the "Wisconsin Idea" by explaining the work of the university affecting citizens throughout the state in such fields as agriculture, engineering, meteorology, etc. Once the Herald is established its originators contemplate building it into a state-wide publication."

The initial publication date of the *Herald* is February 10, 1958, and the Engineer will be looking forward to the first issue. If it lives up to its expressed expectations, the *Herald* will be a welcome addition to the family of publications that now serve as a training ground for University of Wisconsin students. Good luck, *Wisconsin Herald,* and welcome aboard.

← **Large ingots are drop forged into shape at metals manufacturing plant, Blairsville, Pa.—Courtesy Westinghouse.**

Hundreds do it every day, without ever leaving the company. Confined by an unimaginative management, they sink to the level of pencil pushers . . . or slip-stick artists, losing the value of their intensive academic training. But the youthful engineer does not have to suffer this fate. Selecting the right company . . . with thought to its reputation for leadership, initiative, and atmosphere . . . makes the difference.

Linde Company is world renowned for its progressive development in many fields . . . in atmospheric gases and acetylene, welding and flame processes and equipment, synthetic crystals and adsorbents to name a few. This leadership has only been won through the creative powers and initiative of LINDE engineers and scientists. And, these men have received individual recognition of their achievements.

You can find out more about career opportunities at LINDE, in research, development, production, sales, and staff positions, from your Placement Officer. A booklet, "Look to LINDE for your future," is available by addressing Mr. P. I. Emch, Central Recruiting Office, Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

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Linde UNION CARBIDE

Dr. M. A. Biondi (Massachusetts Institute of Technology, B. S. '44, Ph. D. '49) measuring ultra-microwave transmission through superconductors. This experiment is a joint effort of a group of Westinghouse scientists aimed at obtaining a better understanding of the nature of superconductivity.

Westinghouse Scientists Probe Secrets of Superconductivity, using...

The Coldest Cold

Temperatures within a fraction of a degree of absolute zero are produced routinely by Westinghouse scientists in their search for more knowledge of the important phenomena of superconductivity. These phenomena rank with the nature of nuclear forces as one of the most fundamental problems facing the theoretical physicist. When superconductivity is completely understood, its principles could well revolutionize the electrical and electronic industries.

The basic principles of superconductivity have eluded an explanation since 1911 when the first example of the complete disappearance of electrical resistance in metal was discovered. Today scientists at the Westinghouse Research Laboratories in Pittsburgh, are making significant contributions to the field by their low-temperature research.

Superconductivity occurs in certain metals, alloys and compounds which, below characteristic transition temperatures, completely lose their electrical resistance. While in this superconducting state, they are perfectly diamagnetic, i.e. will completely exclude magnetic flux when placed in a magnetic field.

While this fundamental research is being conducted by theoretical physicists in search of knowledge and understanding of first principles, from even the terse description above of superconductivity, the imagination begins to run wild with engineering applications. An electronic computer using superconductivity memory elements will switch 10,000 times faster than conventional computer elements, will store 10 times as much information per unit space as ordinary computers. If the conditions can be fulfilled to make a substance superconductive in temperature regions other than that around absolute zero, design of every electrical or electronic product will be radically changed. Imagine considering the commonest electrical design problem without having to take into account electrical resistance!

While these exciting considerations whet the imagination, they are not the primary object of the low-temperature research going on at Westinghouse. This and many other research projects are being conducted to discover new phenomena and new knowledge of the universe. It is done on the belief that all research is an investment in tomorrow.

To the young, creative engineer this means exciting opportunities for graduate engineers in these exciting fields:

ATOMIC POWER	RADAR
AUTOMATION	SEMICONDUCTORS
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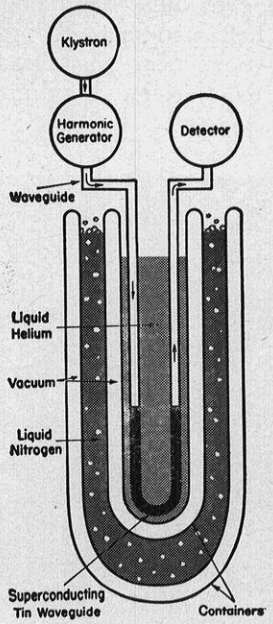
. . . and dozens of others



Highly simplified diagram of the apparatus used to study the absorption of millimeter wavelength microwaves in superconducting tin waveguide. Studies of this type have shown the existence of a gap in the energy levels of superconductors. These studies have thus provided key information in solving the puzzle of superconductivity.

For more information on Westinghouse research in the field of superconductors and low-temperature studies, or information on job opportunities, write Mr. J. H. Savage, Westinghouse Electric Corp., P.O. Box 2278, Pittsburgh 30, Pa.

Westinghouse

FIRST WITH THE FUTURE

ENGINEERING AND PEOPLE NEAR THE DEAD SEA

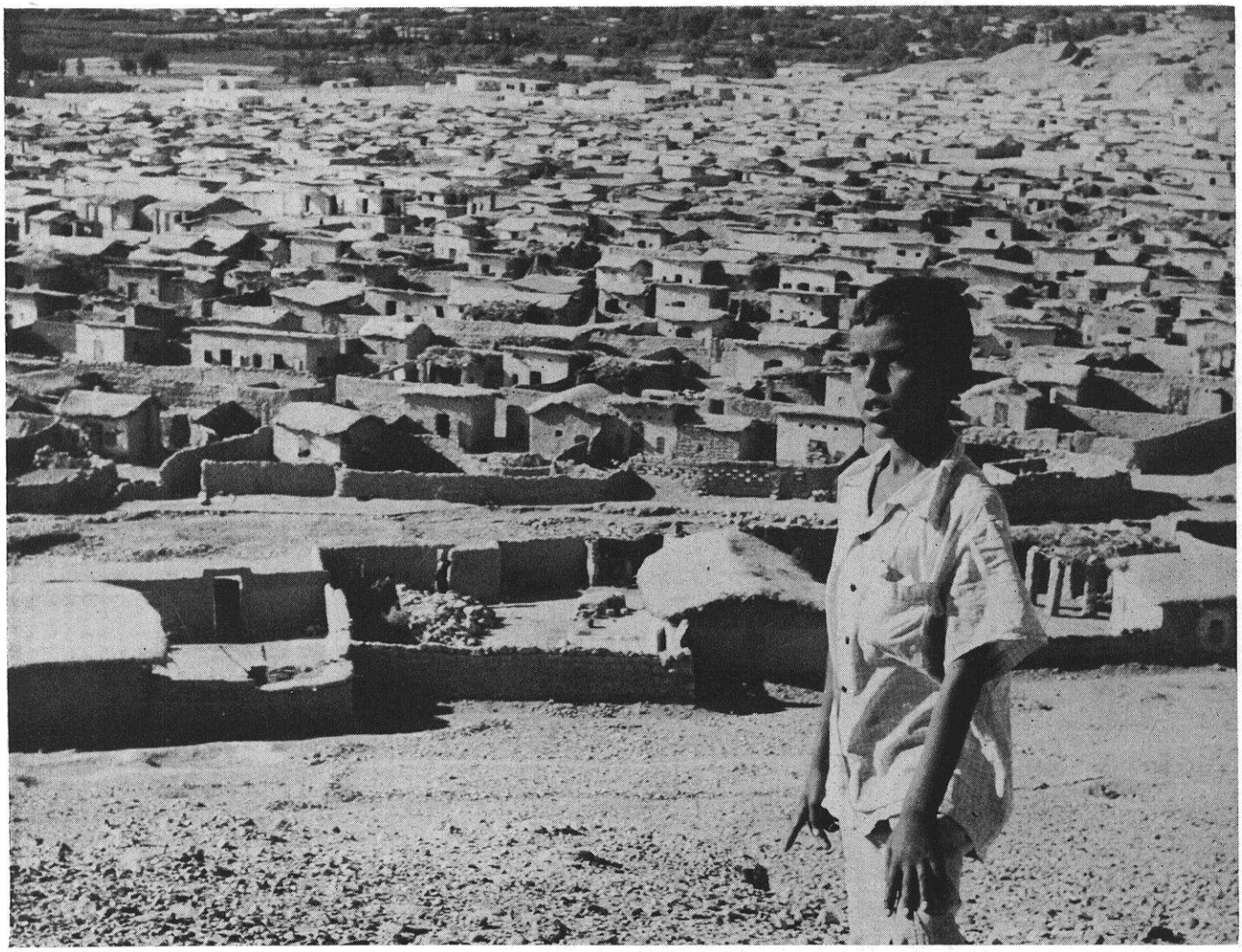
by Frederick S. Walz

A University of Wisconsin student traveled to the Middle East this summer and here reports on what he saw. He gives a picture of the help and advancement that modern engineering can give to a desolate land and the people it must support.

ENGINEERING and people are very closely related, and this fact is demonstrated dramatically by the achievements of limited, even amateurish, engineering to help people in the Jericho, Jordan area near the Dead Sea which is thirteen hundred feet below sea-level.

Ten years ago, this land was virtually uninhabited and arid. Of course there was the small city of Jericho and its outlying fields and orchards, irrigated by the waters from spring-fed Elijah's Pool, but this was hardly adequate for the influx of about fifty thousand Arab refugees migrated there from their homeland (now Israel) during the Arab-Israeli war of 1948. Nonetheless, with the aid of the Arab Development Society and the International Y. M. C. A., this land is bearing fruit, both in terms of crops, and in terms of young men qualified to earn a living.

Labib Nasir, son of the Episcopal



The Old—An Arab refugee boy looks into the future. Behind him lie the mud huts that are home to him and his people.

The New—This ultra-modern architecture marks the home of the Gaza Vocational Training Center. It is supported by UNRWA and the Egyptian government.

rector of Jäffa, was trained in social sciences, not engineering, yet his instinct for the latter was of great value in the laying out of the Aqabat Jeber Refugee Camp near Jericho. The land was a wilderness, so Labib Nasir and his associates from the Jerusalem Y. M. C. A. looked for surface water in the desert. They settled on this site near Elijah's Pool, and used their eyes to lay out the camp which is more orderly than some only half its size. That was in the summer of 1949. Before arrangements for living could be made, the winter came and about thirty thousand Arab refugees descended from the mountains where they had spent their first homeless summer, and occupied all of the available tents.

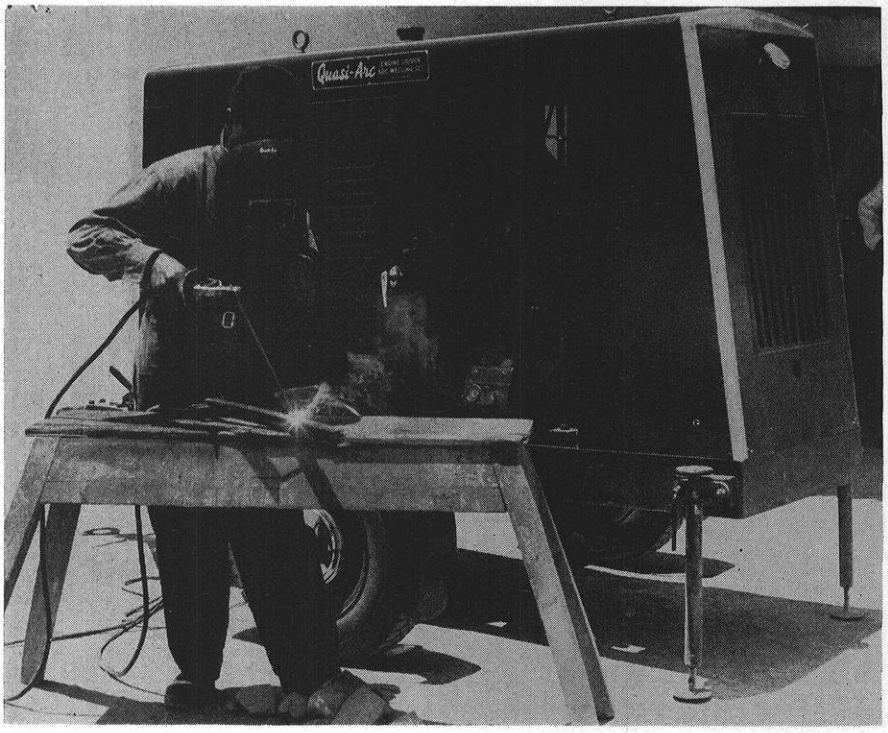
Another amateur engineer is Musa El Alami, a law graduate of Cambridge University. Formerly Advocate General of the Palestine Mandate, the Arab-Israeli war made him, too, a refugee. Eager to help his fellow refugees, he looked for unsettled land that might be developed, and quickly found it.

In the memory of man, there had never been any type of agriculture in a stretch of acreage by the north shore of the bitter-salt Dead Sea, where it never rains, but where he had good reason to believe, despite discouraging reports from the Point Four and the United Nations "experts", that there was fresh water under that very salty ground. If there was, he reasoned, this land could be made to produce crops. So, in August, 1949, with the backing of the Arab Development Society, he brought unemployed refugees from the nearby Aqabat Jeber Refugee Camp to drill for water on a section of the four thousand arid acres that had been given to them, by the Council of Ministers of the Hashemite Kingdom of Jordan.

That was in June. By January of the following year, their persistent hard labor was rewarded by fresh water from the first well flowing abundantly to the surface. A simple system of irrigation leeched much of the salt out of the soil in addition to the first year's planting of salt absorbent crops.

In successive years, a great variety of fruit trees, grains, and vegetables have flourished in the subtropical heat under the cloudless skies in the mineral-rich, salt-free, soil that is left. This combination of circumstances brings harvests of all crops earlier than in surrounding countries, permitting advanced prices for out-of-season produce.

(Continued next page)



The New—Arc welding is important. Oil is transported in welded pipes and the art must be learned by the students.

Within three years of the first flow of water, the Society had reclaimed and made cultivable over eight thousand acres. With the aid of twenty-five wells; forest trees, banana trees, citrus trees, vines, palm trees, cotton, potatoes, and vegetables of all kinds had been planted; pump houses, concrete water channels and pipes, asphalt macadamised roads, sixty-five houses, and a first rate sewerage system had been built; and electricity and running water had been installed in all of the sixty-five houses.

The crop that Musa El Alami is proudest of is his group of budding junior amateur engineers. When he was searching through Aqabat Jeber Refugee Camp for drillers, farmers, and builders, he became aware of seven orphaned boys whose lot was even more desperate than that of the children in the uprooted families. He took them in as his "nephews" whose number has now grown to 160. In the resulting "boys' town", the young Arabs learn not only farming, although that is an essential part of the training of each one, but also a craft of some sort which will suit them for later life in a normal community.

The objective of the Arab Development Society, of which this amounts to the junior department, is to produce farmers (fallaheen), who are better equipped with agricultural knowledge and experience, who know about machine farming and new methods of cultivation, and who are also literate and educated so that they may follow up their studies in later life. A second objective is to train skilled craftsmen and artisans so that this country, which has too few such people, may prosper as it never has before.

As a means to accomplish these ends, the Society has set up a curriculum of work and training which involves the following for the boys: full elementary course of study, comparable to that of the Jordanian Government's, to the age of twelve to fourteen years; gardening which is designed to teach them to love the soil and to work with their hands and physical training and drill.

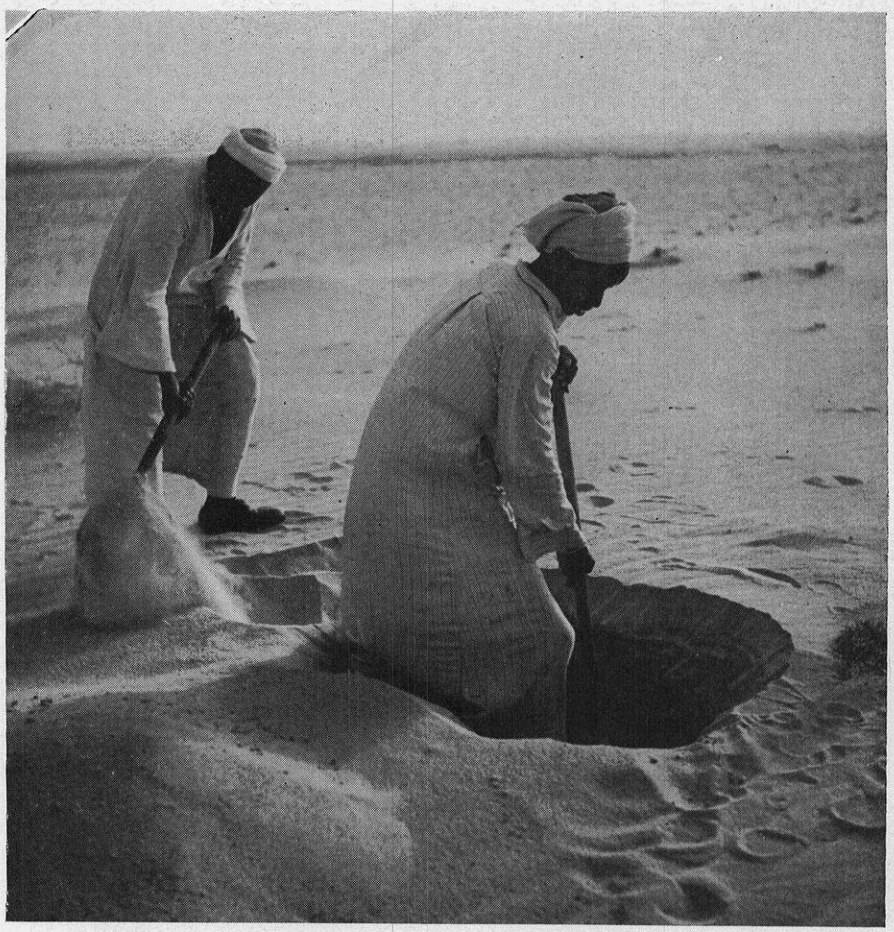
The meetings of the various boys' committees, necessary because the whole community is run under democratic principles; and fun and recreation, including a dip in the community pool now and then, round out the program.

The main source of income of the Society at Jericho is the sale of their pre-season agricultural products, and they are many, but there is also

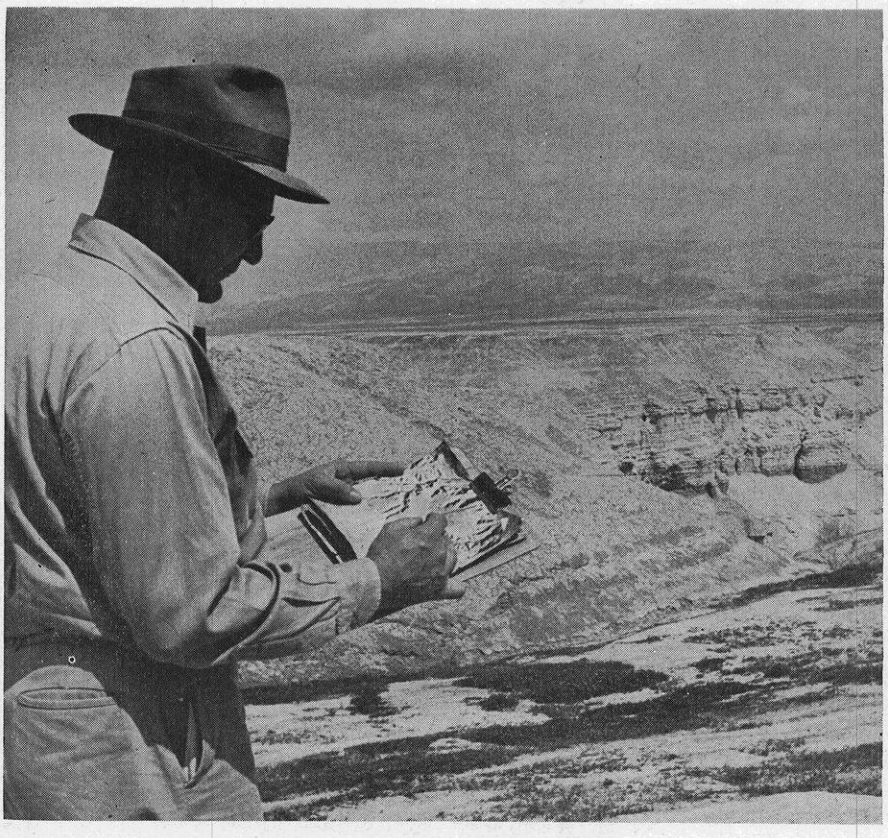
The New—Metal working is an important part of the YMCA's work at Aqabat Jeber Camp. Here students watch a lathe demonstration.

the large flock of chickens, which is cared for in the most modern manner with periodic injections against infection and a scientifically prepared diet. They lay enough eggs regularly, including out of season, to make one of the most dependable sources of income to the Society the sale of eggs on the Beyrouth, Lebanon market. There is a Jordanian export tax, called by the workers at the Society's project the "eggsit" tax, on all shipments of eggs out of the country, so this acreage is giving income to the government which once called it "dead and waste".

The banana trees are now bearing fruit abundantly, and when I was there this summer, the first grape harvest was being gathered. The citrus fruits, always in demand, especially in warm climates; and the potatoes and vegetables from this center are all able to command the same higher out-of-season price, so the project is now completely self-supporting as far as running expenses are concerned, for the 160 boys and the refugee men who are hired from Aqabat Jeber camp. However, there is not enough money for expansion of the boys center, or for the opening of a girls' center which is their present dream.



The Old—Two Arab workers spend day after day digging down into the desert in a desperate search for water.



The Old—A point-4 expert makes an on-the-spot study of the reclamation possibilities of the old unchanging landscape of the Middle East.

The Rockefeller Foundation has built them a beautiful modern administration building where there is also enough space for meetings of all the residents for educational movies, evening recreation, meetings to discuss the running of the camp, and, what is of paramount importance to Musa El Alami, for programs of a religious importance.

The camp is built on the Palestine-born, Western-nurtured concept of democracy, and each living unit has a representative to their parliament which governs the community. This representative is changed every three months to allow each boy the experience, and in this way self-government, self-reliance, and self-discipline are encouraged. The boys work together very well, and prizes are awarded at specific times of the year for those houses showing the greatest improvement in the grounds, the one in the best order, and the one with the best conduct of its members of the last period.

Not far from them on the edge

(Continued on page 44)

NEW SOUNDS THROUGH ELECTRONICS

by Erland Johnson

The science of electronics has produced circuits that are seemingly as intelligent as their creators. Even the time honored instruments of music are being challenged by "new sounds through electronics."

THE progress of electronics has been phenomenal within the last few decades and especially so in the last decade. One of the principal causes of this growth is the development of speed and accuracy in the manufacture of electronic circuit components.

This was the result of the greatly increasing need of high quality components in commercial and military applications. As a result tremendous amounts of research in circuit design theory have produced networks with almost any type of characteristic. With these developments comes the possibilities for new musical instruments to supplement or replace those that have evolved through many centuries.

Electronics appears to be the answer to many limitations of conventional instruments. These instruments are limited to certain frequency ranges. The intensity ranges are limited, since intensities that are either too high or low give an unpleasant quality to the sound produced.

Each instrument is very limited in the variation of tone colors or sound waveforms that may be produced. This is evidenced by the usual ease of recognition of the type of instrument being played. Because of the tremendous size of some pipe organs they cannot be readily transferred to new locations. Electronics makes possible miniaturization as well as large ranges of variations of the characteristics of musical instruments.

The first electronic musical instruments were built in the 1920's with the idea of obtaining new sounds and playing techniques or of attempting to simulate conventional musical instruments. Apparently the musicians believed that only the conventional instrument could produce true musical sound as the electronic instruments did not become popular.

Those producing new sounds definately did not satisfy the musician's criteria and those which attempted to simulate conventional instruments produced relatively poor imitations and could quite easily be detected as "electronic." This latter features seemed to excite bitter controversy between the musician and the engineer. It is only within the last few years that this battle has abated to a few isolated sputterings.

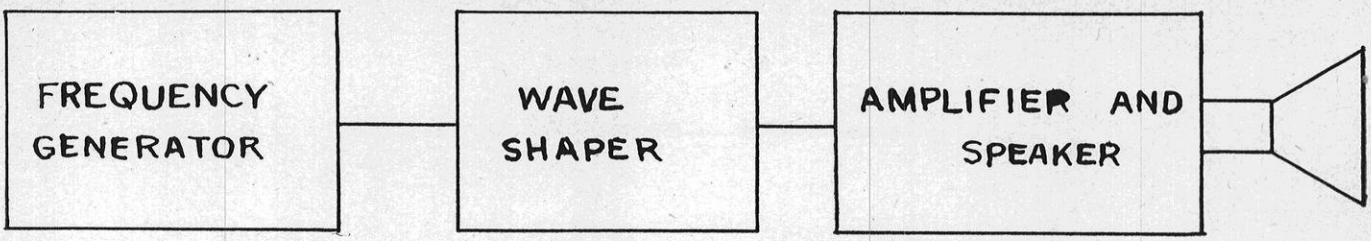
The only electronic instrument that has truly become popular is the electronic organ, producing new musical sounds and simulating the pipe organ and other conventional instruments. Other electronic instruments which are gaining considerable favor are electric pianos, carillons, bells, and other percussive instruments. Because of the difficulty of imitating percussive sounds with their peculiar transient characteristics, this type of instrument is just coming into prominence.

It seems that in the psychological makeup of most human beings a change to something new is generally gradual. The "Spike Jones" types of musical caricature seems to be gaining widespread acceptance for even symphony orchestras have succumbed.

Various new types of musical instruments have been and still are being invented, but interest in most of them has been short lived. A radical change appeared in the Theremin which was designed to avoid "resistance" to being played which conventional instruments offer . . . Every conceivable means of controlling pitch and intensity was tried . . . A well known conductor predicted in 1929 that in a few years the conventional instruments with their limitations and unnecessary playing difficulties would have disappeared completely! These have been long years.

The electronic musical instrument has certain requirements that must be met for successful musical sound production. As implied in the preceding discussion it should be possible simulations indistinguishable from the sound of conventional musical instruments, as well as pleasing new sounds. To accomplish this the frequency spectrum produced must be variable over a wide range.

Since the transient characteristics of musical sounds are almost as important as the steady-state characteristics, it is necessary that the rise and decay characteristics be variable. To more closely simulate traditional instruments, the frequency spectrum should also be variable during the transient state.



The three units of an electronic musical instrument containing the various functions of sound production.

However, it is impossible to exactly simulate the inharmonic content of the transient spectrum by electrical means. Usually an imitation of the rise and decay characteristics will be satisfactory since the ear is easily fooled.

To provide sufficient playing ranges the frequency and intensity ranges should at least cover that of any sound source. "It is essential that every octave be exactly in tune, but within the octave very slight departures are permissible. Experience has shown that frequency errors of 0.1% are just tolerable".

It is very desirable that these instruments be designed for extreme ease of playing and of controlling the waveform characteristics. The greater the ease of performing on the instrument, the greater is the extent to which the musician may employ the capabilities of the instrument.

The electronic musical instrument can be divided into three units containing the various functions of sound production. The frequency generator is the basic unit around which the rest of the electronic circuits are designed. The output waveform of the generator may be either a pure sine wave or a complex wave containing a series of harmonics.

If the waveform is a sine wave, then the waveforms of the fundamentals of higher frequency which are exactly or approximate harmonics may be added in certain proportions by the wave shaper to produce the desired complex waveform. If the generated waveform is a complex wave, filter and resonant circuits in the wave shaper are used to subtrace all or part of certain harmonics to produce the desired waveform.

Following the wave shaper is the amplifier and speaker system, which amplifies and transforms the voltage waveform into acoustical energy. Since the final two units are subordinate to the frequency generator this topic will be concerned only with the generators that have been and are utilized in commercial instruments.

Some electronic instruments are designed to sound one frequency at a time, but because of this limitation they have not become very popular. This is a very real limitation as the versatility of the instrument is much less than that of a multiple frequency instrument.

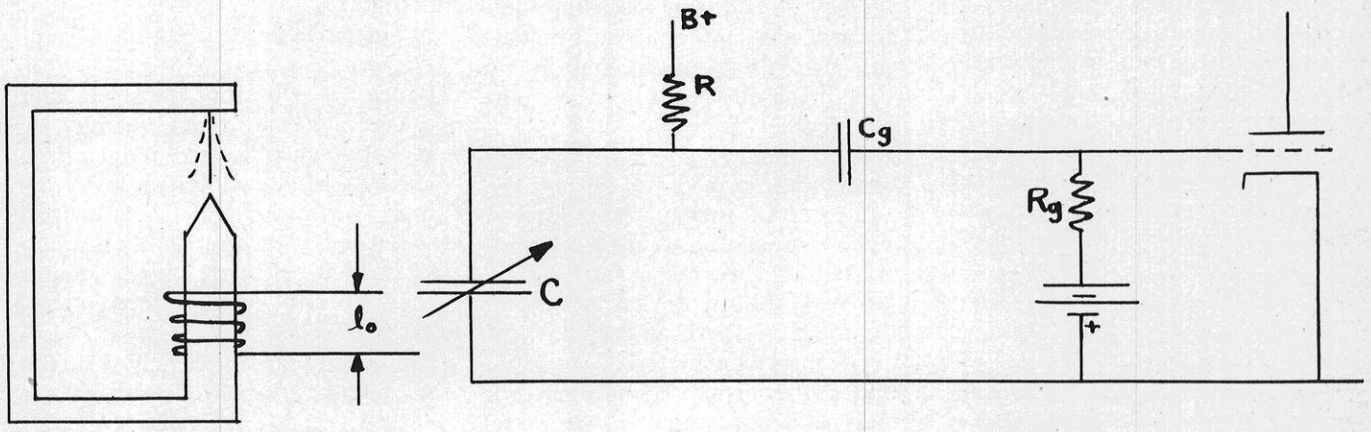
The "singing arc" was probably the first electronic instrument, but it never did materialize into a practical form. Its operation is essentially that of a relaxation oscillator in which a certain potential must be built up across a spark gap before the air will break down.

Oscillating neon lamps were also tried with limited success, as it was extremely difficult to obtain satisfactory frequency stability. The circuits were relaxation oscillators, as is illustrated by the Trautonium. So great was this variation between the neon tubes used that "some of the early Trautonium performers treated their neon tubes as fondly as a clarinet player cares for his pet reed". The substitution of a thyraton provided greater reliability of operation. The instrument had a quite limited range.

The Solovox has a vacuum tube oscillator with five frequency dividers which are really synchronized oscillators to provide five octaves of frequencies. The Clavioline is a similar instrument, but it uses only a multivibrator with a variable resistance and capacitance to provide the five octave frequency range. The Univox is similar in operation to the Clavioline except that much truer synthesized tones can be obtained from the sawtooth waveform.

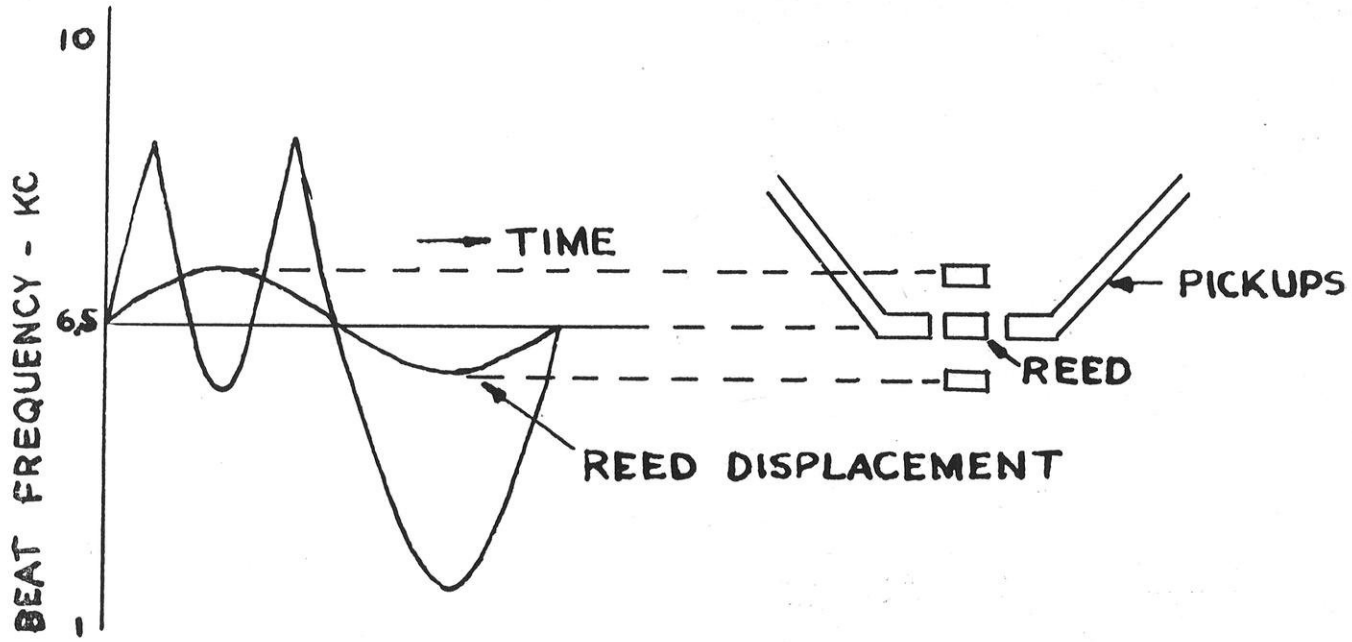
The Martenot uses the hetero-

(Continued next page)



Vibrating device.

Circuit of electrostatic pickup.



Proper positioning of vibrating reed produces a wave form with a long series of precise harmonics.

dyne note produced between two radio frequency oscillators and not the principle of fixed oscillating circuits. The variation of one oscillator frequency is done through a closely coupled circuit in which the capacitance is variable." Its only usefulness is that any frequency may be generated within the limits of audibility since the almost pure sine wave output does not provide much possibility of waveform variation.

An instrument using the same operating principle of obtaining the audio frequency by beating two radio frequencies, but requiring a radically different playing technique is the Theremin. The frequency of one oscillator is varied by the change in hand capacitance as the hand is moved in the vicinity of the control antenna. The volume is controlled similarly by the other hand.

Vibrating strings and bars or reeds in conjunction with either electromagnetic or electrostatic pickup devices have been used for frequency generation. In this type of generator the frequency is determined by the physical properties of the vibrating systems. The fundamental frequency of the ideal string is

$$f_o = \tfrac{1}{2}\sqrt{\frac{T}{ML}}$$

where L is the length, T the tension and M the total mass of the string. The fundamental frequency of a clamped-end bar or reed is

$$f_o = \frac{.56}{L^2}\sqrt{\frac{EK^2}{P}}$$

where E is Young's modulus, K the radius of gyration and P the density of the bar or reed.

In most instruments the physical sound sources, such as vibrating reeds or strings, are coupled to the air by some type of "sounding board" which vibrates in unison with the sound source and moves a much greater volume of air than the sound source can. This apparent amplification of the sound is due to the greater rate of sound energy dissipation. The only energy supplied to the system being that given to the vibrators by the performer. If this coupling to the air is eliminated the only energy dissipated will be that directly due to the string and the decay rate of sound energy will then be considerably decreased. With an electronic amplifier it is a simple matter to maintain the vibrations indefinitely by a feedback of a portion of the output signal.

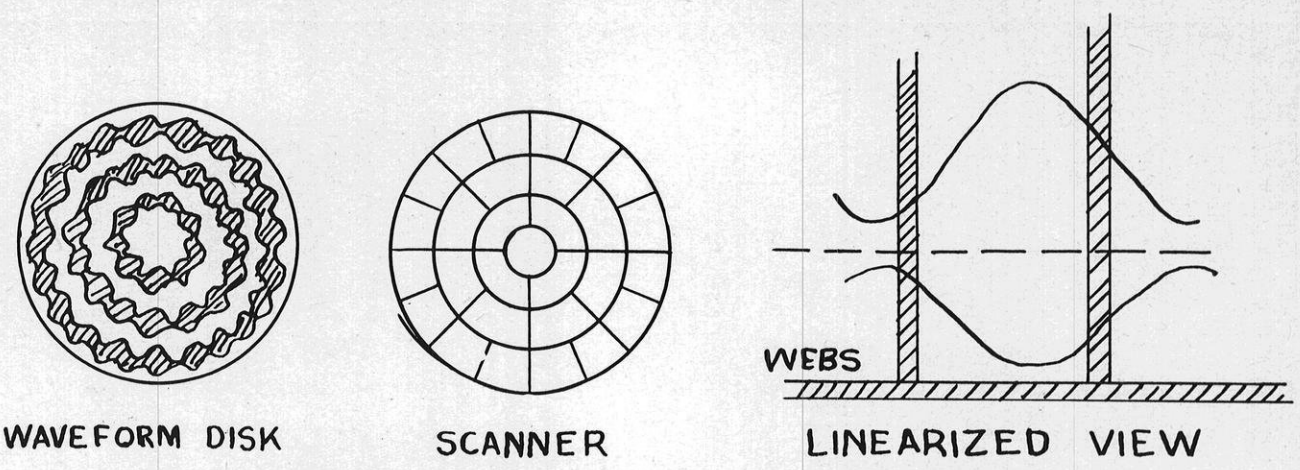
In frequency generators containing vibrating reeds or strings the electrostatic pickup has proved much more useful than the electromagnet pickup.

The vibrating device is part of the magnetic path and hence must be of magnetic material. As it vibrates, the air gap changes accordingly and consequently varies the reluctance of the magnetic circuit. The change in flux in the circuit will then be proportional to the change in reluctance. This changing flux will induce a voltage in the pickup coil proportional to the change in the air gap and thus the frequency of e_o will be determined by that of the vibrating device.

The magnet exerts a damping effect on the reed or wire which distorts the normal deflection pattern of the vibrating system. Because of the nonlinear effect of high hysteresis in the steel an additional distortion is produced in the generated waveform. Combined with fringing effects the resultant waveform will be a distortion of the ideal waveform.

An electronic piano called the "Clavier" had short steel rods with electromagnetic pickups. However, the absence of high harmonics prevented it from being a true simulation and so it did not become popular.

The variable capacitator, C, represents the varying capacitance between the vibrating electrode and a fixed electrode in an electrostatic pickup. When C varies there is a corresponding voltage drop in the high resistance R. This voltage variation is transmitted through C_g which is many times greater than C, and corresponding variations in bias occur across R_g. If the current in C is negligible, the potential variations across R_g are proportional to $\frac{\Delta C}{C}$. The changes



Compton Electrone scanning method using electrostatic frequency generators.

in capacitance follow the wire or reed movement exactly, so the vibrating condition of the wire at the point of the pickup is reproduced in replica. The high voltage is usually applied to the reed or wire and the magnitude of the output signal may then be adjusted by changing the voltage on the capacitor, C, or by changing the average gap distance between the wire and the pickup.

The frequency spectrum of a vibrating wire is an approximately true harmonic series. Because of the stiffness of the wire the frequencies of the spectrum are given by

$$f_n = n f_o' (1 + Bn^2)$$

where f_n is the frequency of the n^{th} harmonic, $f_o' = f_o (1 + a + a^2)$ where f_o is defined by equation (1), and

$$a = \frac{r}{2f_o L^2}\sqrt{\frac{E}{P}} = \text{constant for a}$$

wire of fixed length, r is the radius of the wire, and $B = \frac{1}{8}\pi^2 a^2 (1 + a + a^2) = \text{constant}$. Thus the harmonics are increased in frequency by a small quantity proportional to the harmonic number squared. The frequencies existing in the frequency spectrum of a clamped-end bar or reed are inharmonic and unpleasant. These frequencies produced are in order 6.267 f_o, 17.55 f_o, and 34.39 f_o.

Because of the series of frequencies produced by the vibrating wire or reed, the nodal points along the wire or reed are different for each frequency. Thus by placing the pickup at the nodal point for any frequency, that frequency will not appear at the output. If the pickup is at the point of maximum deflection the frequency will have its maximum output. Thus by proper positioning of the pickup various frequency spectrums may be obtained.

This effect was exploited by the Electrone which was a piano with string-to-air coupling almost eliminated. Electrostatic pickups were placed at various positions along the string. The output was fed into preamplifiers and on into a phasing network where the frequencies may buck or aid the other to provide certain waveforms.

The frequency spectrum of the reed may be varied by shaping the reed to obtain an approximate harmonic series. The Wurlitzer organ utilizes this principle of shaped reeds in its frequency generator. The movement of the free end of these reeds is not sinusoidal, but is slightly flat-topped and so aids in forming the harmonic series.

Many unsuccessful attempts have been made to simulate piano and other percussive sounds by reproducing the decay envelope. But these are new sounds because the harmonics in the actual decay have different decay rates and also intermodulate and beat during the decay, making exact synthesis impossible.

Wurlitzer has marketed an electronic piano which uses small steel reeds and produces an excellent piano tone when these reeds are struck. This is accomplished by eliminating all overtones and then by proper positioning of the vibrating reed producing a waveform with a long series of precise harmonics. The overtones are eliminated by striking the reed at one nodal point and placing the pickup at the other. Because the reed over-

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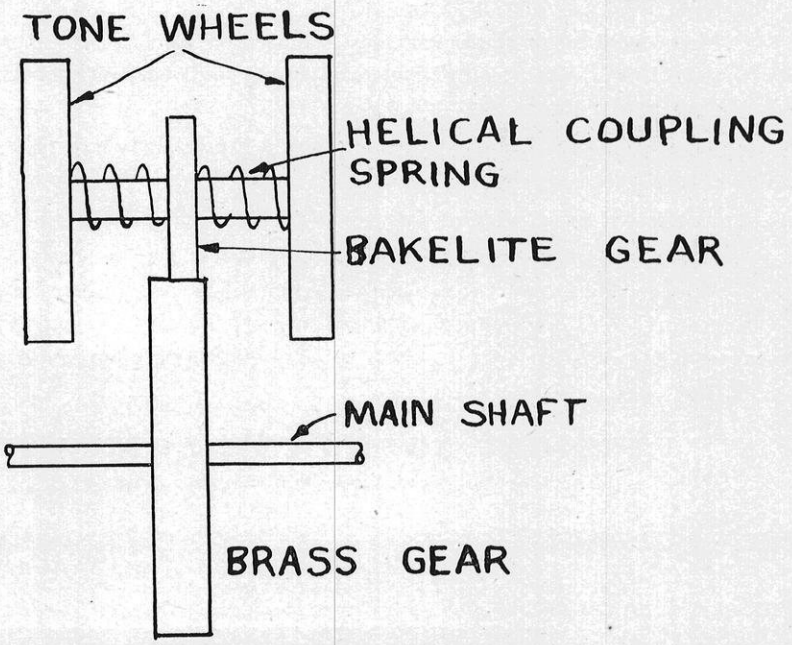
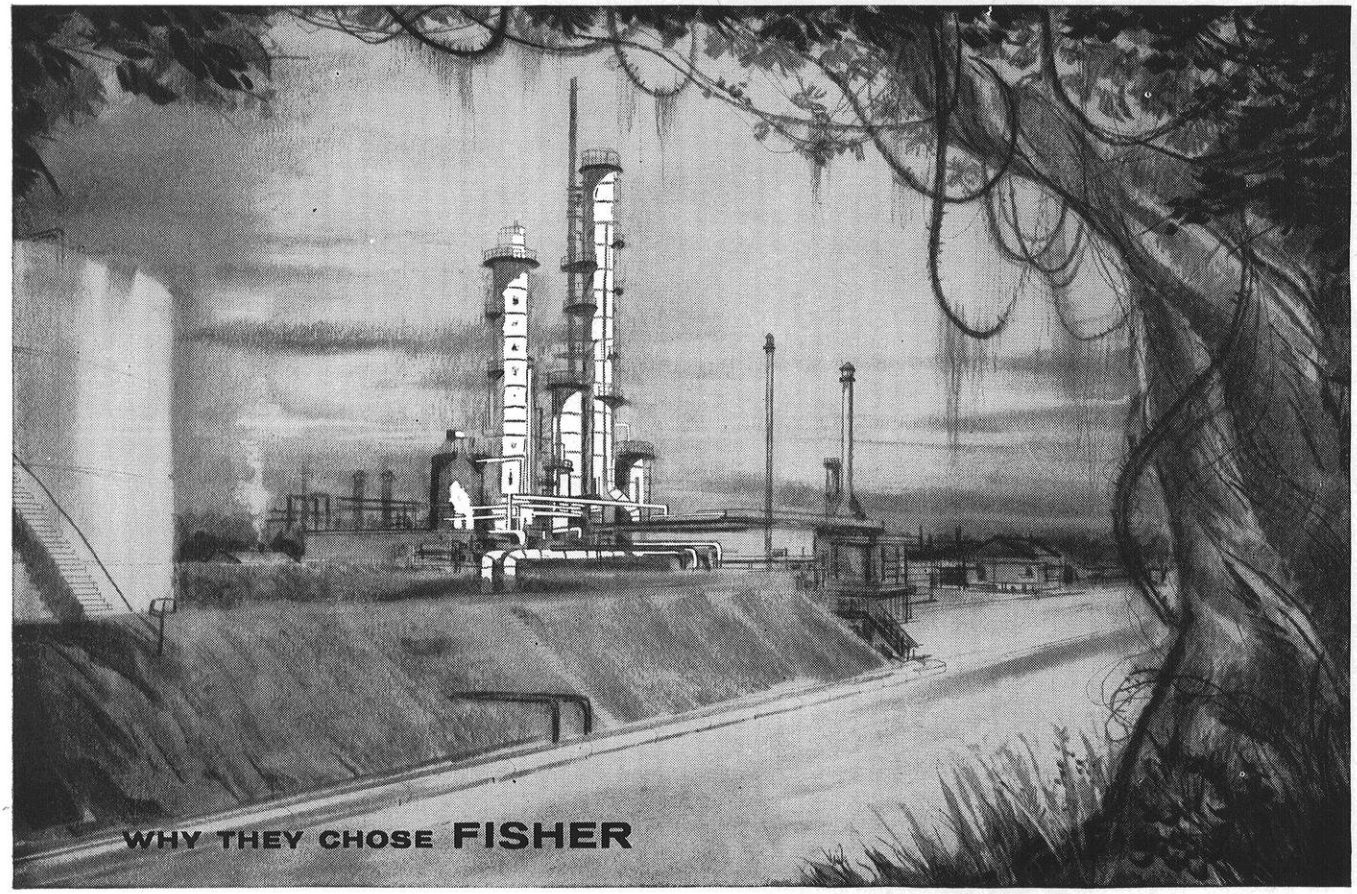


Electromagnetic rotary type frequency generator.



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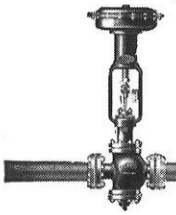

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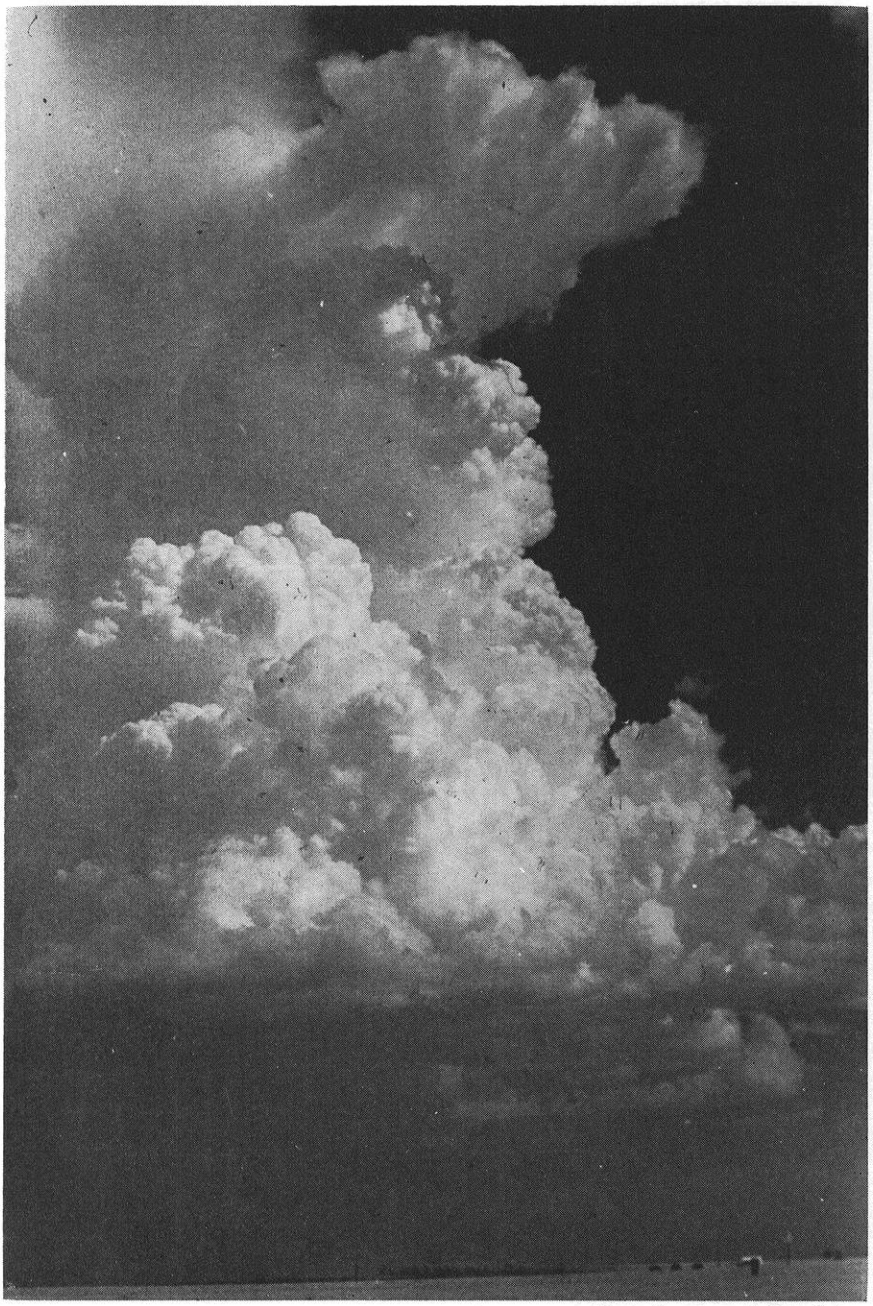
DETROIT EDISON

"THUNDERSTORMS"

An explanation of the development of storms and associated phenomena—lightning and thunder

by James D. Allain



—Photo Courtesy of Pete Kuhn

THE sun radiates heat by short waves which are of such a nature that they do not heat the atmosphere while passing through it. The short waves strike the earth which absorbs the heat energy emitted by them. Because the earth is heated and at a higher temperature than the surrounding air a transfer of heat by conduction between the earth and water vapor in the air results.

Air in contact with the earth is also heated by radiation of long waves emitted by the earth and absorbed by the water vapor. The atmosphere is thus indirectly heated by the sun, and directly heated by the earth, which converts the energy of the sun into energy that can be absorbed by the atmosphere.

Water vapors has as its primary source the oceans which cover approximately three-quarters of the earth's surface. By winds and diffusion, the water vapor evaporated from these bodies of water through solar heating is carried in over the land. Other sources of atmospheric moisture are moist land surfaces, vegetation, and minor bodies of water.

The surface air after being heated by conduction and radiation expands in volume and is consequently decreased in density. Because it is lighter, is is carried up and replaced by cooler heavier air which flows in at the surface. A convectional circulation system of warm and cool air takes place until the temperature of the earth and

← **A cumulonimbus "anvil head" towering 40,000 ft.**

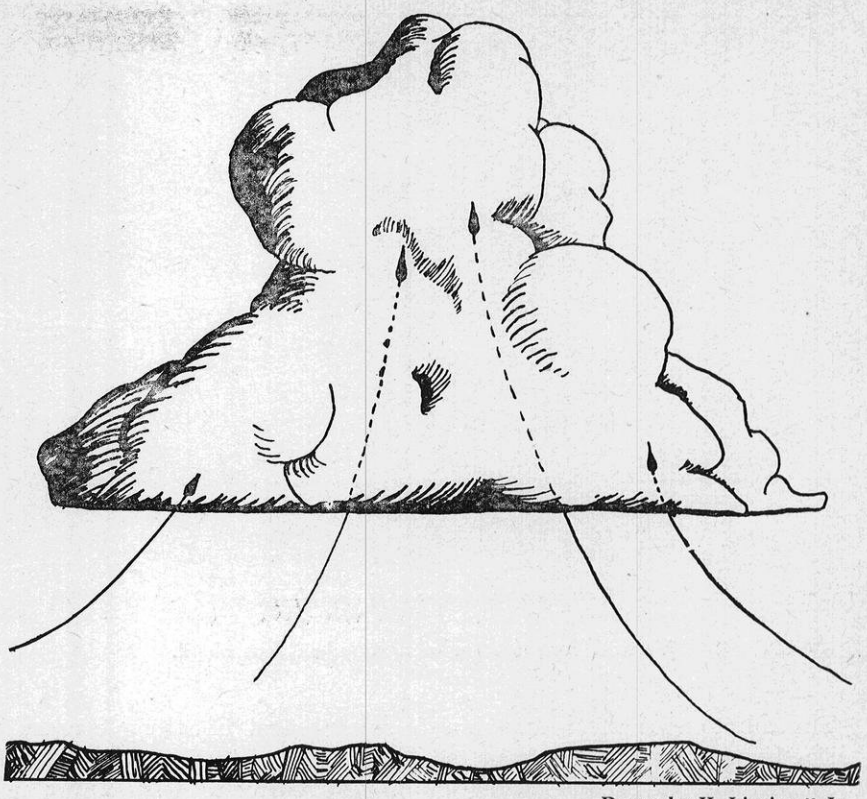
contact air are the same. The warm surface air is like a cork that is held under water; it is unstable and inclined to rise.

Warm air can hold more water vapor than cold air for a given volume. Since the temperature of the atmosphere decreases with an increase in altitude, a height will be reached at which the water vapor will condense. This condensation takes place because the warm air as it rises is gradually cooled, and hence becomes saturated with vapor. Because the air cannot contain additional vapor it settles out in the form of small water droplets which we see as a cloud. Convectional currents support the cloud at the base, which forms at the condensation level. If the rising air is less than 75 percent humid the cloud thickness will range between 2,000 and 5,000 feet. Clouds of this type, known as cumulus clouds, are associated with good weather since no precipitation falls.

Most thunderclouds or cumulo-nimbus clouds are alike in structure regardless of the method of formation. They are all overgrown cumulus clouds often developing a length of 60 miles and a width of 20 miles with vertical dimensions of 2½ to 5 miles.

Warm moist unstable air is necessary for the development of the cumulo-nimbus cloud. Normally the relative humidity of the air must exceed 75 per cent. An adequate supply of water vapor in the air is necessary to release additional heat to the atmosphere through latent heat of vaporization. Latent heat of vaporization is given off when water vapor is cooled to a liquid. The heat given off is equivalent to approximately 607 calories per gram of water vapor condensed at the same temperature. This additional heat renders the air unstable by producing new convectional currents.

Strong upward drafts are formed which carry the saturated air and condensed vapor through the center of the cloud to the freezing level. At the freezing level the condensation freezes and releases the heat of fusion. The heat of fusion of water is equivalent to 80 calories per gram at a temperature of 32 degrees Fahrenheit. This new supply of energy sets up turbulent air currents which reach altitudes of 20,000 feet or more.



—Drawn by H. Lippincott Jr.

Fig. 1.—The cumulus, or first stage in the development of a thunderstorm.

Due to the extreme low temperature at this altitude the air becomes dense, mushrooms out, and falls to the earth. Thus the cumulo-nimbus cloud is characterized by "chimneys" of vigorously ascending warm air and compensating areas of cooler downdrafts.

Most storms tend to move with the general flow of air and weather from west to east. The air in front of the storm is rushing nearly upward; and just to the rear it rushes downward. This produces the rapidly rotating roller cloud extending the width of the storm cloud, just below and in the forward part of the cloud.

This roller or squall cloud is the most violent part of the storm. The air within it frequently reaches velocities from 200 to 400 miles an hour. It can be seen as a long rolling black cloud with a whitish-gray front as the storm approaches. The sudden gusts and wind shifts attending the passage of this part are particularly dangerous to aircraft and sailing vessels. Following the passage of the roller cloud the heavy showers of the storm set in and are characteristic of the whole central area of the storm.

Rainfall in thunderstorms is likely to be more vigorous while it lasts, but of shorter duration than ordinary rainfall. This downpour type of rain is due to the rapid ascent and high humidity of the air in thunderstorms. Condensation takes place in the ascending current as soon as the temperature of the air is reduced to the dew point. The drops of water do not immediately fall out, but are carried upward by the rising air.

Small drops of water fall very slowly and can be carried upward by a relatively slight ascending current, but large drops require a more intense upward current. The largest drops about 4 millimeters in diameter, require an upward current of 25 feet per second. When larger drops than these are formed, they are unstable and break up into smaller drops.

In a thunderstorm the ascending current is not steady, but blows in a succession of gusts and lulls. The drops of water rise and fall intermittently sometimes forming larger drops and then breaking up again into smaller drops. The drops which get to the edge of the ascending current fall to the ground, giving the heavy rain of the thunderstorm.

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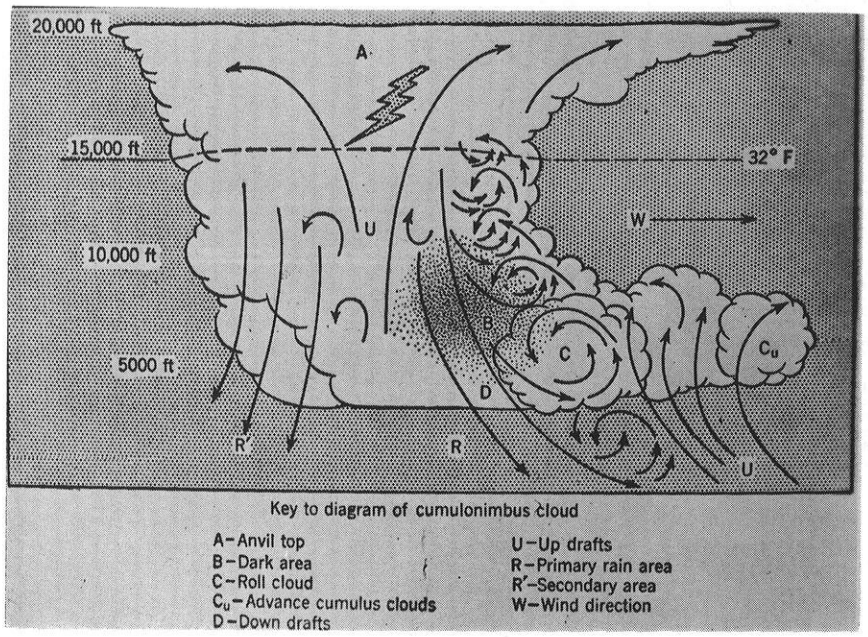

Vertical cross section of a cumulonimbus cloud.

The duration of the heavy rain varies from a few minutes to more than an hour but usually averages 25 minutes. The vigorous nature of the thundershower, together with the fact that it occurs frequently during the growing season, has important economic consequences.

Occasionally hail, the most destructive form of precipitation, is developed in very intense thunderstorms. When convection is violent, and air currents are ascending at the rate of 25 to 30 miles per hour, rain drops are carried up into regions of extreme could. They mix with snow and form globules of ice.

Moving downward, this ice is covered with a layer of water and is then shot upward again, and the film of water freezes. This process may continue until the hailstone, formed of concentric layers of clear ice and snow, like the layers of an onion, reaches considerable size. When the upward moving air currents weaken, the hailstones fall to earth.

Lightning is a huge electric spark caused by the discharge of electricity between clouds or between a cloud and the earth. By dragging ones feet on a rug and touching someone, a tiny electric spark and faint cracking sound can be generated. The cracking sound is thunder and the electric spark is lightning.

Lightning results from the splitting up of large raindrops, and the development of strong charges of static electricity in rapidly ascending air currents. As raindrops in a storm grow larger and larger they eventually reach such a size that they loose cohesion and begin to break up. The larger portions of the drops remain near the base of the cloud in the region of the rapidly ascending currents. The smaller particles and water vapor are carried upward and outward into other portions of the cloud.

The raindrops before disruption carry positive and negative charges of electricity in equal amounts so that they are neutral. With the splitting of the drops by the strong convectional currents, the negative and positive drops become concentrated in particular sections of the cloud mass. In this manner great differences in electric potential between cloud and earth, or between different parts of the cloud are generated. One part of a single cloud may be charged positively; another part, negatively.

The electrical discharge caused by these opposite charges usually appears as lightning. Sometimes the electrical discharge takes place between a low cloud and the earth; however, most lightning occurs between clouds and within clouds. When a lightning flash occurs behind a cloud so that the entire cloud is illuminated it is referred to as sheet lightning.

About 1 per cent of the lightning flashes reach the earth. In the United States 700 to 800 persons lose their lives each year as a result of lightning, and twice as many are injured. Fire losses due to lightning amount to over 12 million dollars annually.

Thunder is produced by a violent expansion of the air caused by the tremendous heat of lightning. It is due wholly to an explosive type of expansion resulting from an extremely sudden rise in temperature. Sound from the nearest part of the

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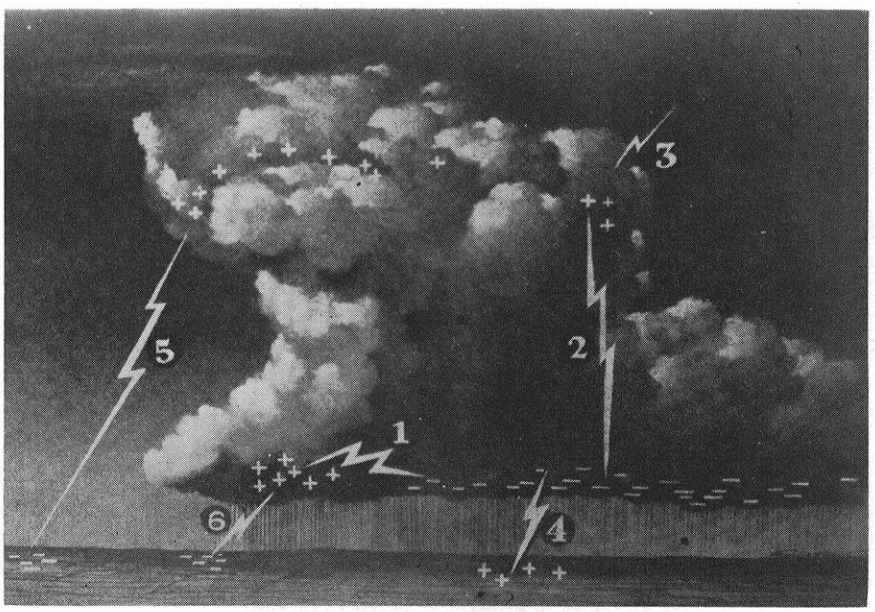

A thunderstorm and the three types of lightning.

—Photo Courtesy of Pete Kuhn

CAREERS WITH BECHTEL

PORTER THOMPSON, *Assistant Chief Engineer, Refinery Division*

MECHANICAL ENGINEERING

One of a series of interviews in which Bechtel Corporation executives discuss career opportunities for college men.

QUESTION: *Mr. Thompson, some engineering graduates seem to believe their first jobs might include little more than filing papers. Would that be true at Bechtel?*

THOMPSON: It would not. When the young man joins the Refinery Division, if he is a structural engineer he starts immediately to do structural design work, under proper supervision. An electrical engineer would join our electrical group, working on electrical systems for refineries, doing some design work, taking off materials and working on instrumentation.

QUESTION: *What about mechanical engineers?*

THOMPSON: Mechanical and chemical engineers may either go right into the process department, where they would do calculations, or into the project group where they would do routine designing and write specifications for pumps, exchangers, vessels, piping, instrumentation, insulation, etc.

QUESTION: *There's certainly no sign of "paper shuffling," is there?*

THOMPSON: No. The training period is interesting right from the start. After a few months, we like to send the young engineer out into the field so he can see the end result of what he has been doing.

QUESTION: *What has been your experience as to the length of time required to train a man?*

THOMPSON: That will vary according to the man, so it's impossible to generalize. The young man will have some responsibility right from the start, but it may well be a matter of several years before he can actually take full responsibility for running a job.

QUESTION: *Assuming he handles his first assignments satisfactorily, what would be his first major step upward?*

THOMPSON: After from 6 to 9 months his first responsible assignment might be on a project in connection with handling pumps. On his next project assignment he might have the responsibility for handling pumps and exchangers. He would likely be assigned some other responsibility on each succeeding project. In that way he would get a good grasp of all types of work and eventually be capable of taking overall charge of a project.

QUESTION: *Suppose he is in the structural phase; would there be any difference in his "basic training"?*

THOMPSON: No. He would still have to serve his apprenticeship, moving gradually into more and more complex design work as he gains, a little at a time, the knowledge and experience which qualify him to handle the overall job.

Bechtel Corporation (and its Bechtel foreign subsidiaries) designs, engineers and constructs petroleum refineries, petrochemical and chemical plants; thermal, hydro and nuclear electric generating plants; pipelines for oil and natural gas transmission. Its large and diversified engineering organization offers opportunities for careers in many branches and specialties of engineering —Mechanical...Electrical...Structural ...Chemical...Hydraulic.

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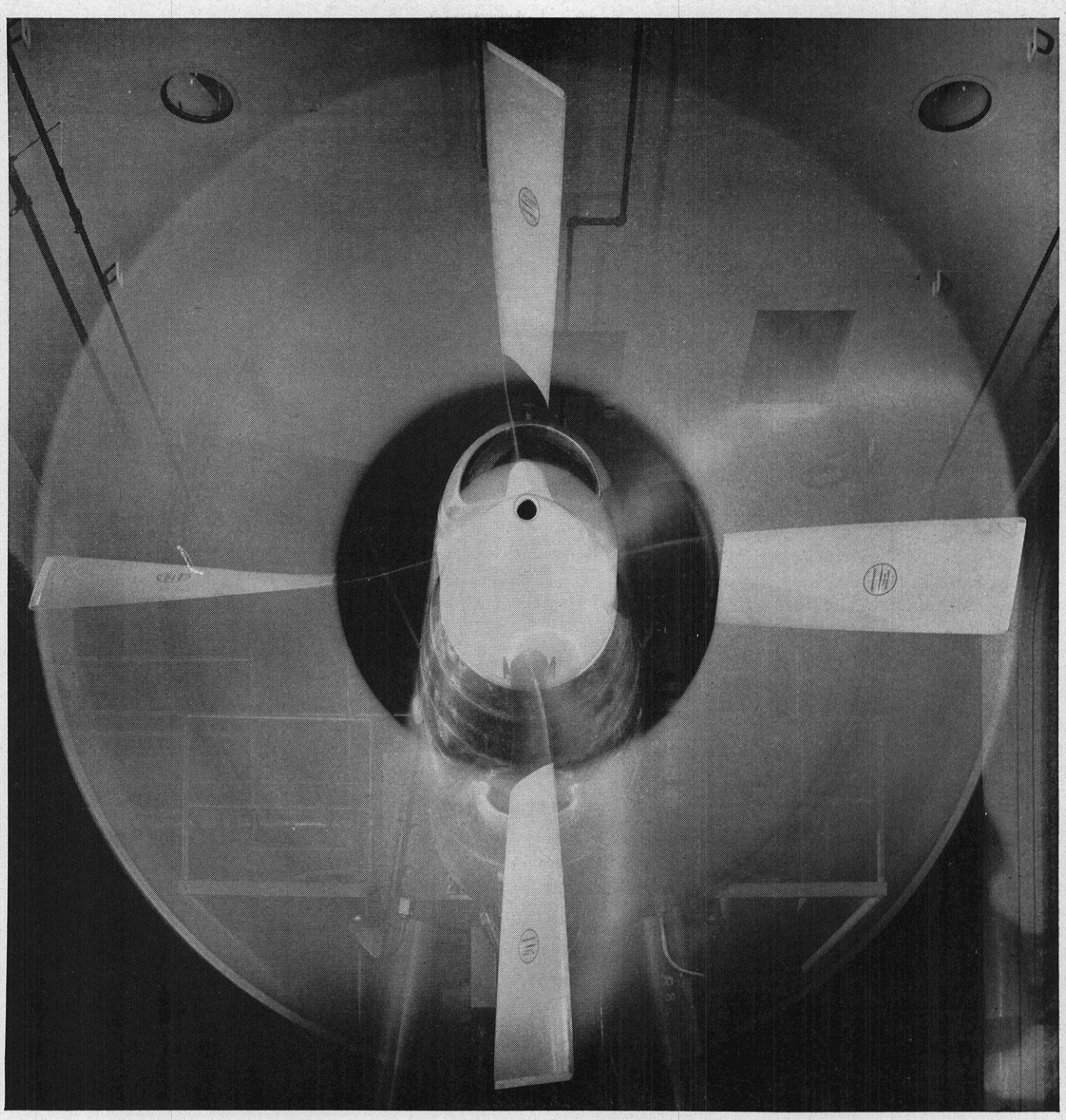


INDIANAPOLIS, IND.: (Special) Hundreds of engineers and technicians, applying their academic training first hand, have designed, developed and produced the Allison Model 501 Prop-jet engine and Aeroproducts Turbo-propeller (above) shown in a test cell at the mammoth Allison plants in Indianapolis. These General Motors experts have produced an engine which develops nearly 2.3-horsepower per pound of engine weight. Already in use with Air Force Troop Carrier Wings in the U. S. and abroad, Allison Prop-jet engines and Aeroproducts Turbo-propellers will power America's first Prop-jet commercial airliner, the ultra-modern Lockheed Electra.

Working shoulder to shoulder with propulsion system experts, newly graduated engineers are assuring their futures by carving a niche for themselves on the General Motors team of today. If you would like to know more about this team, write Personnel Department, College Relations, Allison Division of General Motors Corporation, Indianapolis, Indiana.

AUTOMOBILE SUSPENSIONS— THE HOW AND THE WHY

by John P. Evert

If you have been wondering about the numerous types of automobile suspensions that both Detroit and Europe have been deluging us with, this article will help you to see the differences. The author approaches the subject on the basis of handling characteristics.

SOME of the more important factors to consider in selecting a suspension system are the amount of unsprung weight, the position of the roll center, and cost. Unsprung weight is the weight of everything not supported by the springs. This includes the wheels, and generally the axles and brakes, depending on the particular suspension. It is desirable to keep this weight as low as possible. The roll center is the theoretical axis about which the body and chassis supported by a given suspension will roll, or rotate, during cornering. It will be midway between the wheels and somewhere between ground level and slightly above the wheel centerlines, again depending upon the particular suspension involved. The height of the roll center should be about equal to or higher than half of the distance from the axle centerlines to the ground.

Handling quality is the primary factor to consider in choosing a sports car suspension. Handling characteristics are mainly determined by the roll center height, amount of unsprung weight, and camber and tread variations.

The solid axle front suspension is cheap to manufacture but is bulky, requires stiff springing, and has a very high unsprung weight. Its roll center is at a good height.

The Allard system is cheap and has a good roll center height; but it, too, is bulky and has serious camber and tread variation problems and high unsprung weight.

The parallel control arm system has low unsprung weight, but it has a bad roll center height, serious tread variations.

The unequal length control arm system has a good roll center height, low unsprung weight, moderate cost and the tread and camber changes are not serious.

The solid or live rear axle is cheap but has a bad tendency to skip and bounce during cornering. It has a good roll center height.

The deDion rear axle has good roll center height, but it is very expensive, wears out universal joints fast, and has some bad bouncing characteristics.

The trailing arm rear axle is light, but has a bad roll center height. Cost is moderate.

With independent half axles the roll center is at a good height, unsprung weight is low, but there is a slight tendency for the rear end of the car to raise during cornering and produce oversteer. Cost of this axle is also moderate.

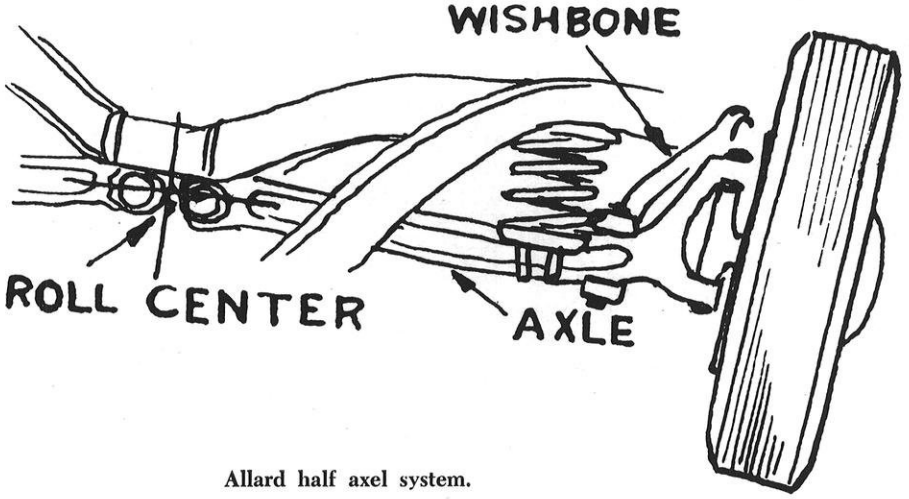
The Mercedes Benz low pivot axle has proven a very good system to use in all types of cars. It has a good roll center location, low unsprung weight, and is not too expensive to produce. Also it has good roll resistance without using very stiff springs.

The facts show that the best systems to use are the unequal length control arm type for the front, and the Mercedes Benz low pivot axle for the rear. These systems possess the best qualities found in suspensions.

There are three major advantages of solid front axles over independent axles. The solid axle provides a high roll center, keeps the wheels always perpendicular to the road surface, and allows a frame of less torsional stiffness than would be needed for an independent axle system. There are also other minor advantages such as ease of fabrication and low cost. Unsprung weight is higher than most other types because of the heavy axle beam.

If semi-elliptic springs are used, they must be placed quite close together to allow the wheels to turn. Therefore, in order to keep a reasonable amount of roll resistance, the springs must be very stiff causing a rough ride with no improvement in the handling ability. This situation can be improved by using a single transverse leaf spring by attaching the ends of the spring close to the wheels. The cost of a solid axle is the lowest of all front suspensions, but because of the large amount of valuable space it takes, the solid axle is no longer generally used.

The Allard half-axle design has often been criticized, but has a lot of merit. It has perhaps the highest roll center of any type of front sus-



Allard half axel system.

pension. As can be seen from the illustration, the roll center is slightly above the two axle pivots.

The axle is generally made by cutting a standard Ford solid axle into two equal pieces. The radius arm or "wishbone" is also split in then welded to the ends of the axle the middle. Bearing adaptors are pieces and wishbone pieces. These, in turn, are fastened to the frame via short shafts and bearings.

The unsprung weight is high, although slightly lower than the normal solid axle and cost is low. The greatest disadvantages of this system are the geometry problems involved. Under deflection, the tread and camber change a lot due to the relatively short swing radius, sometimes causing the entire front end to lift under cornering forces. It can be somewhat improved by increasing the tread, lowering the roll center, adding weight to the front end, or lowering the center of gravity.

This suspension is not used widely because it requires a lot of valuable room in the middle of the chassis for its mounting points.

In a parallel control arm layout with independently spring wheels the wheels are fastened to the frame through two parallel arms of equal length. These arms are usually in the shape of the letter "A", the bottom two ends being the frame mounted ends. As can be seen from the illustration, the roll center is at ground level. This is caused by the infinite effective swing radius of each wheel. The wheels always remain at the same angle to the road, but the tread changes considerably during bounce and rebound, causing a certain amount of tire scrub on the pavement, and rapid tire wear. The unsprung weight of this system is about as low as is available and cost is slightly more than a solid axle layout.

The main advantages of the pillar system of independently sprung wheels lie in the fact that there is no camber, caster, or toe-in change during full bounce and rebound. But there are several bad points to consider also. Because the wheels move straight up and down independently, the roll center is at ground level. The illustration shows that bump travel cannot be very great or else the suspension will be to close to the ground. Therefore, in order to hold the suspension to three or four inches bump travel, the springs must be very stiff, causing rough riding. The greatest disadvantage, though, is the extremely high cost of manufacture. All of the sliding parts must be machined to a very close tolerance in order to maintain reasonable stability. Because the disadvantages seem to far outweigh the advantages is probably why this system is seldom used by any manufacturer.

The use of unequal length control arms is an outgrowth of and improvement on the parallel arm type. The upper arm is shorter than the lower arm, producing a long effective swing radius, which in turn gives a roll center that is raised off the ground. By adjusting the lengths of the arms, the roll center can be raised to five or six inches above ground level. Five or six inches is considered the best overall height to use because it allows a certain amount of roll, which is desirable in order to maintain a good control feel. The tread and camber

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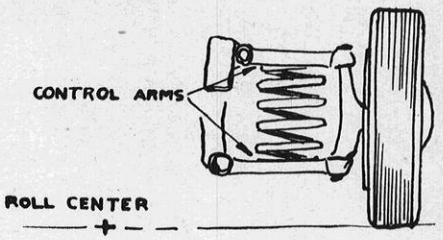
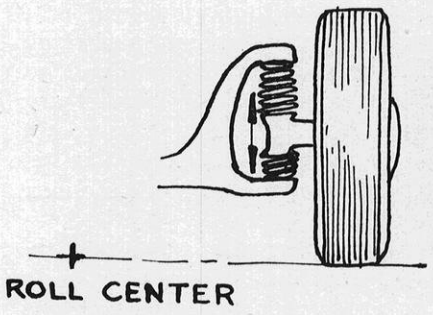
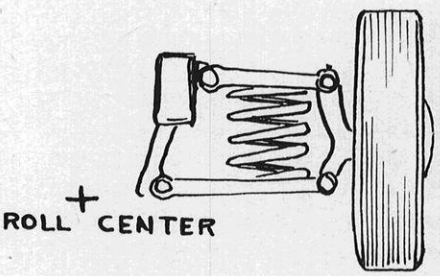


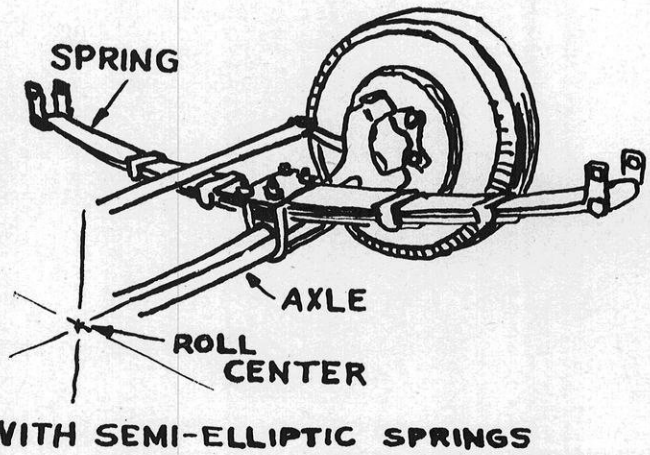
Parallel control arms.

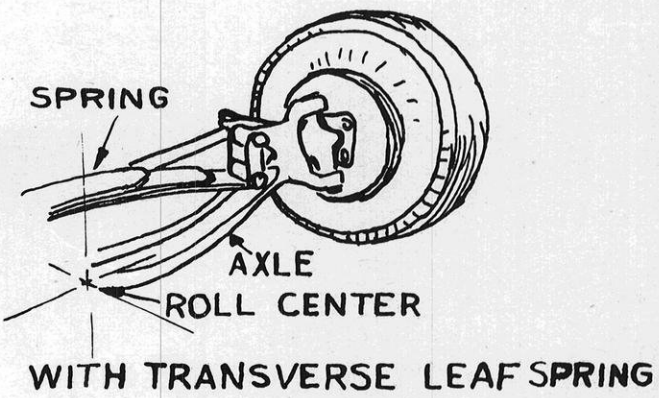


Sliding pillary system.

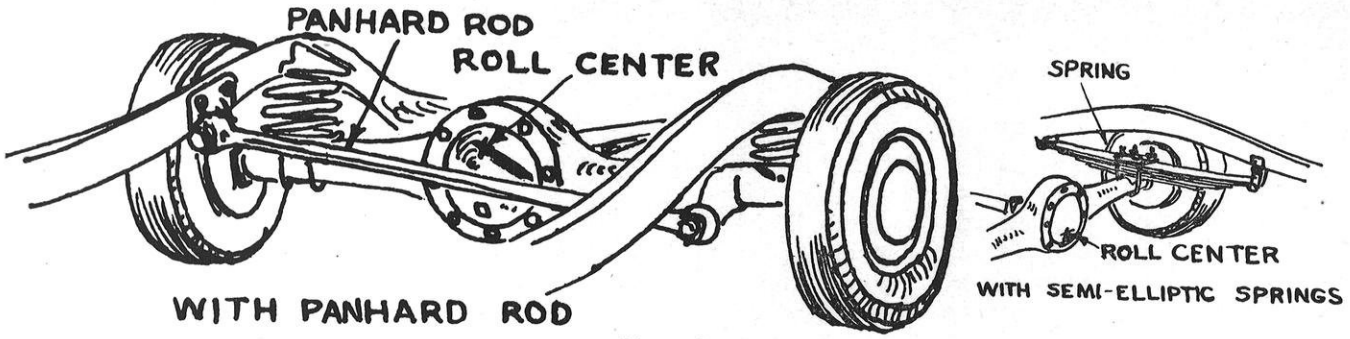


Unequal control arms.





Solid front axels.



Live axles.

vary a slight amount, producing tire scrub. This can be overcome somewhat by using large cross section low pressure tires which will flex a certain amount rather than scrub. The unsprung weight and cost are the same as for the parallel arm type. Being the best compromise of all features concerned, this system of front suspension is the most popular.

Considering rear suspensions, the solid rear axle (live axle) is a highly developed unit and leaves little room for improvement. The ring gear, pinion gear, and differential assembly are all included in the unsprung weight. It is also the cheapest type of rear axle to produce.

If this axle is mounted to the frame by semi-elliptic springs, even more unwanted unsprung weight is added. With semi-elliptic springs there is a tendency for the springs to twist or "wind up" under acceleration and braking torques, causing rapid wear of the universal joints and dipping and rising of the rear of the car upon acceleration and braking. As the illustration shows, the roll center is just below the axle centerline. The forces acting along the axle centerline are taken up in the spring themselves, thus requiring no outside means of positioning.

If a live axle is mounted on other springs, such as coils, for example, some form of longitudinal and lateral support must be provided because the coils will only absorb vertical deflections. This is normally done by the use of arms connected from the frame in front of the axle rearward to the axle and a rod joined to the frame on one side of the car and to the axle on the opposite side of the car, thus positioning the axle in all directions. The lateral rod from the frame to the axle is known as a Panhard rod. This type of suspension is an improvement over the semi-elliptic springs in that it is lighter, has less unsprung weight, more positive positioning of the axle, and a higher roll center, the roll center being just above the axle centerline. It is slightly more costly to produce than the semi-elliptic type, but the handling qualities are better.

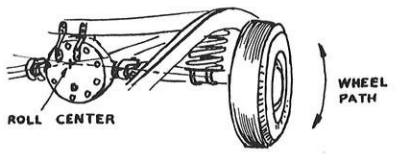
The live axle is subject to various unwanted bouncing and skipping, caused by the concentration of weight at the center of the axle and the direct connection between the wheels. Such a connection does insure that the wheels remain perpendicular to the road during cornering, but there is still the sideways movement of the axle, and therefore the rear of the car, when one wheel strikes a bump. The sideways movement promotes oversteer —a tendency of the rear end to break loose before the front end. Some of the tendencies can be eliminated or at least improved by using some form of independent rear suspension.

The deDion-type independent rear axle offers many advantages over other types; but its cost is higher than the others, thus limiting its use. As compared to an ordinary independent rear suspension, the deDion axle offers no problems so far as wheel and tire attitude are concerned, since camber, caster, and toe-in changes are zero if the axle beam is stiff enough. The rear wheels always remain perpendicular to the road surface and track in true, predictable paths over any kind of road.

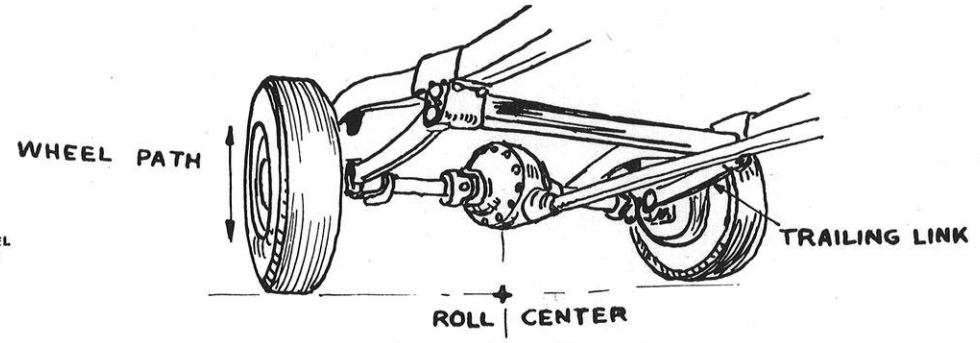
The roll center can be varied by changing the positioning of the axle pivot point. In the illustration the pivot point is shown as the roll center, in that this is a common place for the roll center to be with a deDion axle.

The independent trailing link axle system offers as a main advantage a light unsprung weight. It is the wheels bounce, they cause large angular deflections of the axle shafts, causing rapid wear of the universal joints. Another disadvantage occurs when one wheel strikes a bump during cornering; this causes severe tire scrub on both tires. It can cause loss of rear wheel adhesion, particularly when a cor-

(Continued on page 60)



Independent half axel.



Independent trailing links.

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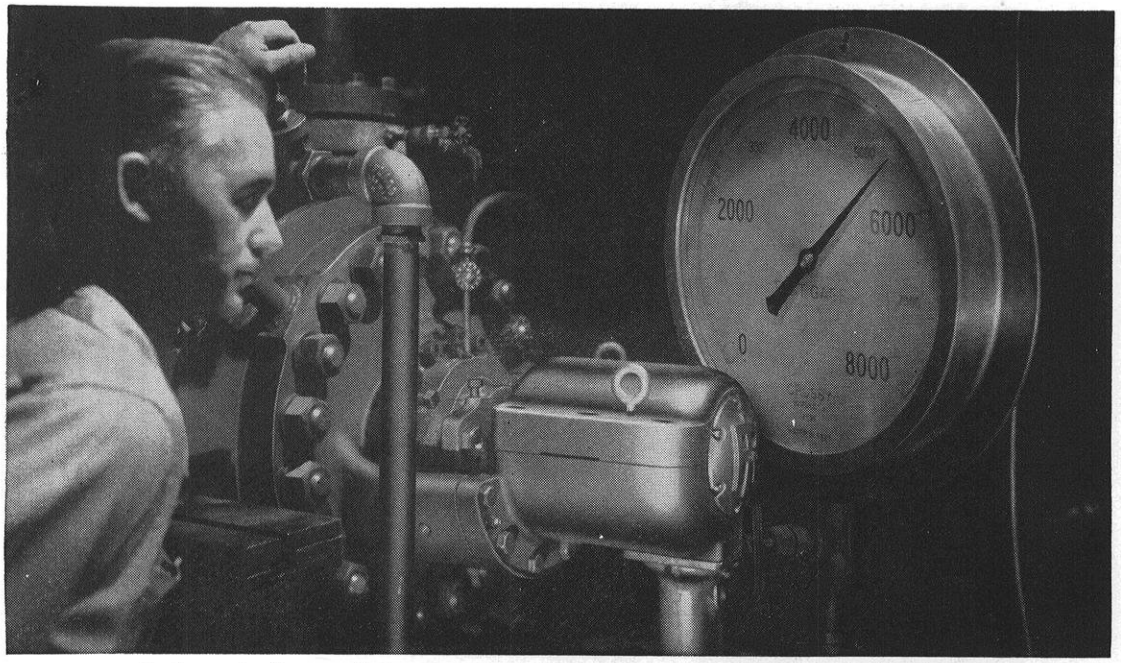

Testing a double-case, high-pressure, boiler-feed pump in Ingersoll-Rand's hydraulic laboratory. Pumps of this type feed hot water into steam boilers at pressures up to 6500 psi.

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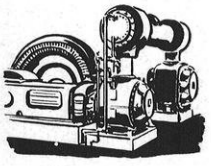

Compressors and Blowers

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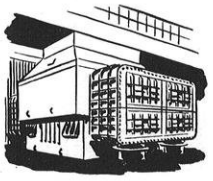
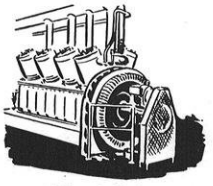


Steam Condensers



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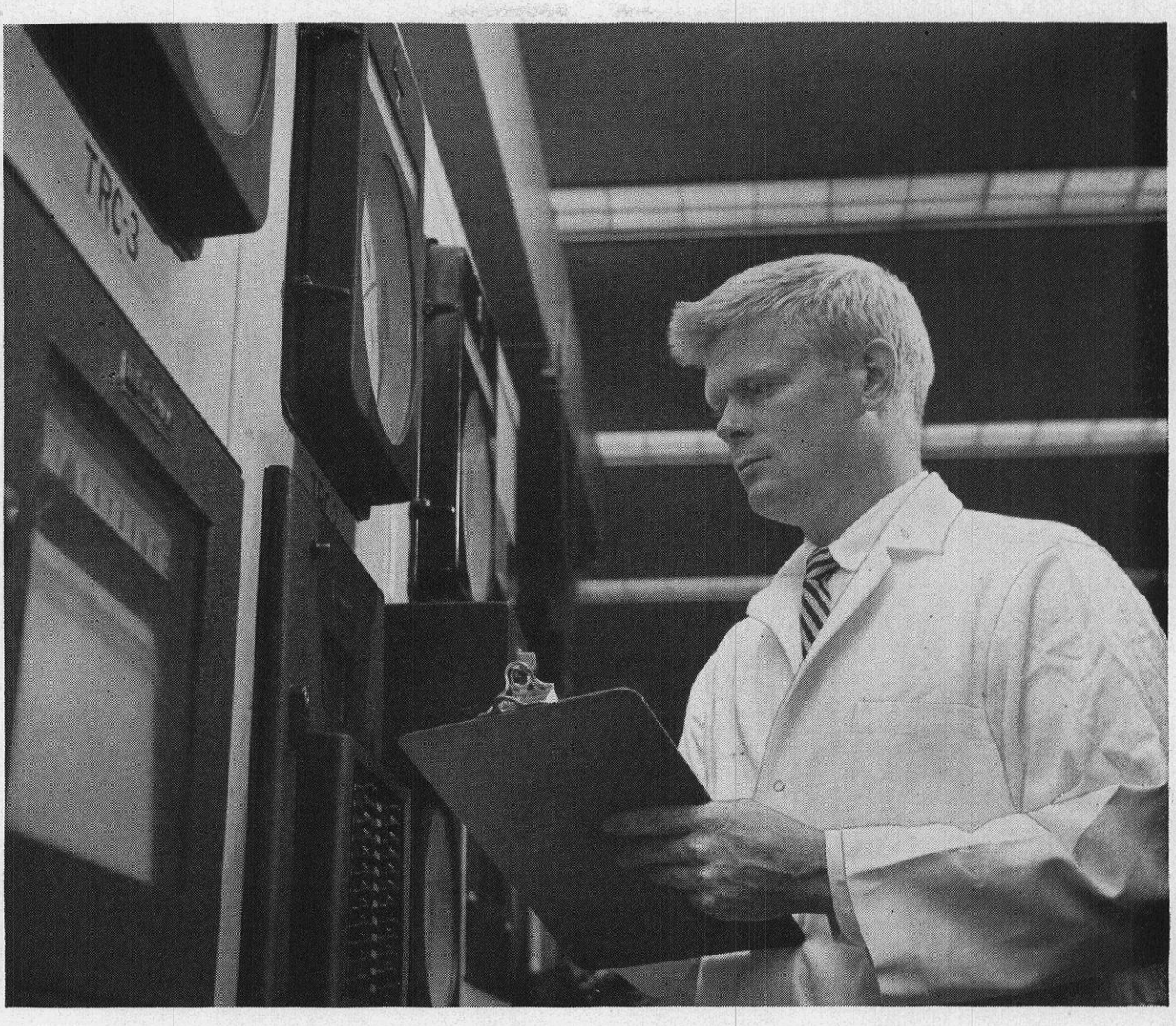

Pushing back the frontiers...in chemistry

Exploring new frontiers is still a pretty exciting business, especially in the great scientific and research centers like the Whiting Laboratories of Standard Oil Company. Here men like Dr. Omar Juveland are engaged in important exploratory work such as the search for new and improved catalysts for use in high polymer chemistry. In the photograph, Dr. Juveland is recording data on a polymerization process taking place in this research area.

Dr. Juveland is one of the group of young scientists in Standard's Hydrocarbon and Chemicals Research Division. Born in Lake Mills, Iowa, he did his graduate work in organic chemistry at the University of Chicago. He received his BS in chemistry from St. Olaf College, Northfield, Minnesota, in 1950. He is a member of Phi Beta Kappa, Sigma Xi, and the American Chemical Society.

Busy young men like Dr. Juveland have found opportunity and work to their liking in the Standard Oil Laboratories at Whiting, Indiana. They share in the progress and accomplishment which contribute so much to the technical advancement and improvement required by America's expanding economy.

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SCIENCE HIGHLIGHTS

by Ed Allen m'60

"BLACK BOXES" SIMPLIFY AIRPLANE OVERHAUL

Restoring malfunctioning aircraft electronic systems to operation aboard airplanes of the near future may become as simplified as stacking bricks upon a shelf and almost as fast.

In fact, the entire operation of returning airplanes to duty after undergoing electronic servicing could resolve into a unique "package deal" involving a matter of minutes to perform, according to an announcement today by Boeing Airplane Company.

Details of the system are described in a patent application by three Boeing electronics engineers who spent a three-year period of research at the company's Wichita Division on the project. In brief, it provides for electronic systems to be packaged in standard sized boxes which fit onto shelving in the aircraft fuselage in much the manner as drawers in a file cabinet.

Developers of the system are George Van Winkle, group engineer in electrical electronics; Walter J. Lohstreter, group engineer in electronics; and Richard Van Wyhe, lead engineer in electronics. The majority of the research was done at the company's Wichita Division, from where patent proceedings were initiated.

The chief benefit of this system would be full utilization of available airframe space, a matter of increasing importance in high-performance aircraft. The plan also makes possible a long desired central cooling system for electronic equipment, and it provides for ease in maintenance, maximum reliability and could mean a reduction in gross weight for airplanes of the future.

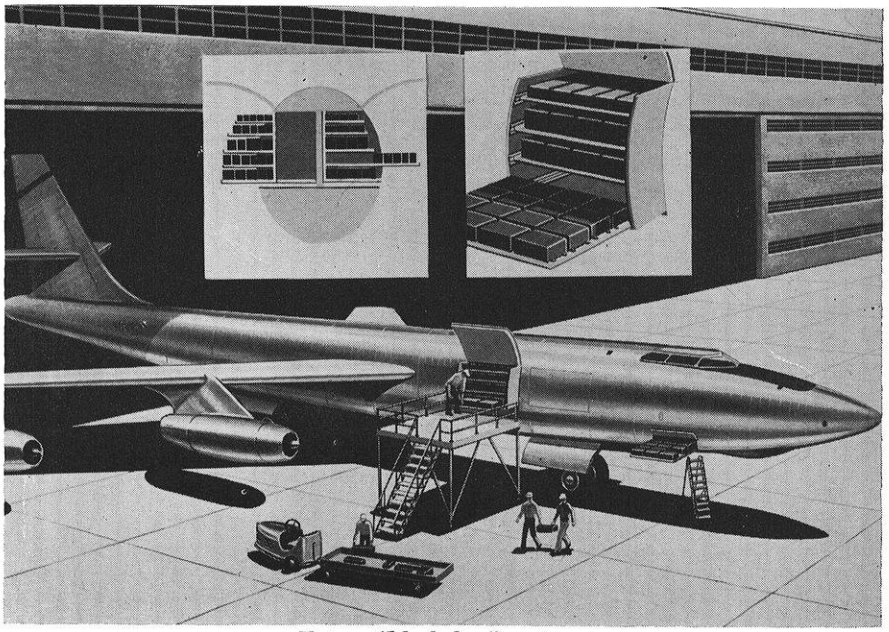
Packages of a given electronic system would be interchangeable not only from one airplane to another, but also between different types of airplanes, resulting in an increase in the usefulness of the equipment itself.

With the standard size "black boxes" in use with the shelf and drawer method of attachment, designers no longer would be forced to tailor electronic equipment to fit specific airframe contours—a practice which has resulted in numerous odd-sized electronic installations in oftimes hard-to-reach locations.

According to the engineering studies, the basic individual package size measures six inches wide, eight inches high and eight inches long, a volume of slightly more than one-fourth cubic foot. These fit onto telescoping tracks in the shelving arrangement and have quick-disconnects to the airplane's electrical system.

Malfunction indicators disclose where any unit is not operating properly, and a moderately skilled ground crewman may obtain a replacement package, pull out the shelf holding the inoperative unit, and quickly make the necessary substitution. Studies at Boeing showed that electronic "turnaround" time, the time required to return an airplane to service after it enters layup, would amount to three minutes for a single unit. Depending on the difficulty and the location of the equipment, this presently can take days.

With technology swiftly advancing in all fields, and electronics being no exception, aeronautical engineers must provide for increasing amounts of new or improved elec-



Future "black box" system.

tronic equipment. Space must be found not only in airplanes on the drawing boards but on many already in service. In the final analysis, this equipment either can be miniaturized or else concentrated in the airframe space at hand. The package plan as detailed by the Boeing engineers places its stress in the area of equipment concentration.

Past techniques in miniaturization have resulted in electronic packages varying greatly in size and shape, with an accompanying inefficient use of available airframe space. This also has proven troublesome during airplane modernization programs, as the equipment installation seldom is adaptable to rapid change. With the electronic package size standardized and with their installation accomplished in the file drawer manner, the problems of space utilization, accessibility and maintenance plus modernization adaptation become more easily solved, the engineers report.

The weight of the shelving does mean that total weight of the equipment would increase, according to the patent application, but future airplane gross weight likely would decrease since the engineers would not need to increase the fuselage to accommodate equipment.

Central cooling of the equipment would be accomplished by circulating air through an integral duct system in the shelving. It also was shown that other types of cooling could be adapted.

Three firms at present have development underway using the package plan principles.

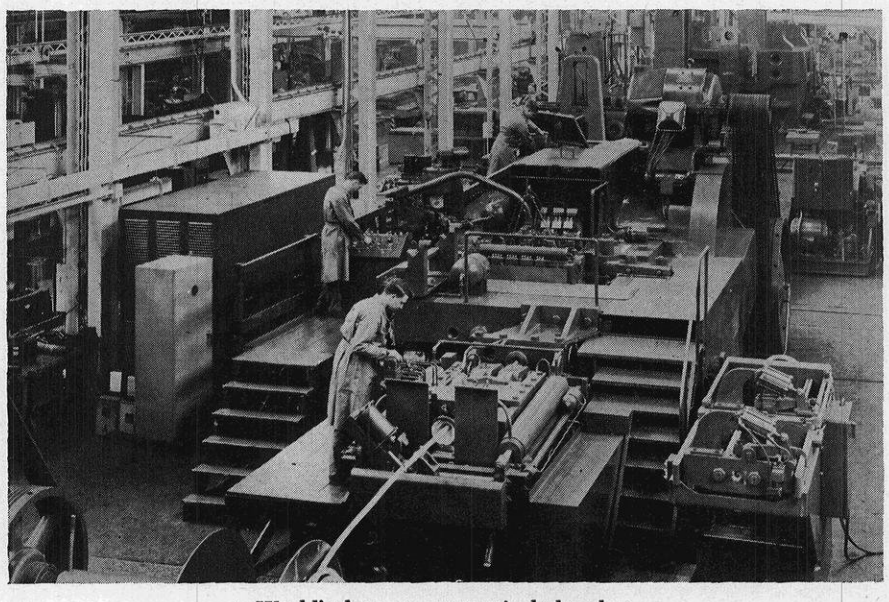
BIGGEST BOLTMAKER IN OPERATION

The largest automatic cold-forging machine ever built—a $500,000 giant Boltmaker—is turning out 1¼ inch diameter hexagon head cap screws at the rate of 40 a minute at The Cleveland Cap Screw Company in Cleveland. This marks the first time it has been possible to produce cold steel forgings larger than ¾ inch diameter by automatic methods.

The big Boltmaker—five years in the making—was designed primarily to make large diameter cap screws and industrial fasteners. The machine will produce hexagon head cap screws, hexagon and square head bolts and high strength structural bolts in sizes from ⅞ inch up to and including 1¼ inch diameter and up to 10 inches long.

The greatest contribution of the giant Boltmaker may be its as-yet untried ability to produce odd-shaped components far larger than any turned out before by automatic cold-forging. In this area the cold-forging behemoth is expected to shoulder aside hitherto unchallenged machining and hot-forging for the production of a variety of non-fastener industrial parts. These parts—principally for the automotive, farm implement, aircraft and electrical industries—might include such special components as pinion drive shafts, pump shafts, transmission shafts, insulator pins, big rivets, coupling bolts, ball-joint suspension parts and various gear blanks. The process employed by this machine is known as the Kaufman Double Extrusion Process. This process consists of taking wire or rods larger than the nominal diameter of the finished fastener and by a series of operations reducing this wire or rod to a pitch diameter ready for rolling. The machine will then automatically head, point and roll-thread the fastener.

The new Boltmaker has variable-speed electronic controls, the first such machine to be so equipped. The electronic controls permit the 200-ton giant to be operated at any speed from four revolutions per minute up to 40 per minute. This precise speed control is particularly important when running large special upsets.



World's largest automatic boltmaker.

RESEARCH TECHNIQUE ELIMINATES TELEVISION PICTURE LINES

The dark horizontal lines clearly visible in any "close-up" look at a television may someday be a thing of the past. Scientists at the Westinghouse Research Laboratories have developed an experimental method for eliminating these "scanning" lines—now considered a natural limitation on the size of television picture people enjoy watching. Elimination of the lines, the scientists say, could be a step toward larger-size television screens in the home.

Elimination of the scanning lines is made possible by a simple but basic change in the construction of the television picture tube found in all standard television receivers. This change consists of splitting in half one of the tube's cylindrical metal "grids" used to focus its electron beam into a tiny round spot. It is the invention of Dr. E. Atti and J. A. Hall of Westinghouse's electronic tube division, Elmira, N.Y.

The standard television picture is broken up into horizontal rows which appear as black and white lines at the television receiver. The white lines contain the picture information, which is 'painted' by a beam of electrons that sweeps back and forth across the fluorescent

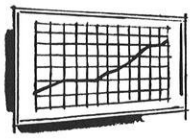
(Continued on page 63)

Highlights of

YOUR FUTURE WITH HONEYWELL

Glenn Seidel, Vice President in Charge of Engineering, B.M.E. Minnesota '36

"Here are some of the facts about Honeywell that have most interested the young engineering graduates we talk to."



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

Honeywell, world leader in automatic controls, is such a company. For the past 30 years, sales have doubled or tripled every five years ($1.1 million in 1926; $287.9 million in 1956.) Employment has increased from 720 to over 30,000 in the same period and net earnings have climbed from $.4 million to $22.5 million.

The future is even more challenging. Planned diversification puts Honeywell in such new fields as office and factory automation, process control, plastics, atomic energy, electronics, missiles and satellites.

Honeywell has the proven skills to design, engineer and build the equipment required by an increasingly automatic world and to sell its products profitably.

Year	Sales ($000,000)	Net Earnings ($000,000)	Plant Space (Square Ft.) (000)
1926	1.1	.4	158
1931	5.4	.6	200
1936	13.5	3.0	432
1941	24.3	2.6	603
1946	45.9	5.7	1,284
1951	135.2	8.9	2,296
1955	244.5	19.3	3,460
1956	287.9	22.5	5,365

Honeywell's growth in sales!

	Employees				
Year	Total	Hourly	%	Salaried	%
1926	720*	540*	75*	180*	25
1931	1,150	839*	73*	311*	27*
1936	3,139	2,200	70	933	30
1941	4,240	2,859	67	1,381	33
1946	9,474	6,490	68	2,984	32
1951	17,182	10,796	63	6,386	37
1955	25,608	14,853	58	10,755	42
1956	30,353	17,301	57	13,052	43

Honeywell's growth in people!

RESEARCH AND ENGINEERING ARE IMPORTANT AT HONEYWELL!

One indication of how important research, design-development and product engineering are to Honeywell's continued growth is the fact that over half of Honeywell's more than 12,000 products were not made by the company 5 years ago.

Some of the problems which Honeywell research and engineering *have solved* recently are: the development of variable inlet-air diffuser systems for jet engines, which adjust to the speed of the aircraft, allow such advanced planes as Convair's B-58 to reach design speed; the production of the space reference system for the Earth Satellite Rocket; and the production of the Supervisory DataCenter* central control panel which enables one man in one location to read and control temperatures for even the largest building.

Major research programs now underway at Honeywell include: the development of new techniques and the discovery of new materials to overcome the problems of extremely high temperatures created by high-speed aircraft and guided missiles; the development of automatic control systems for industrial automation; the development of even more accurate navigation systems for aircraft and rockets which may be called upon for intercontinental and interplanetary travel.

HONEYWELL MEN ADVANCE RAPIDLY!

Naturally, in a company committed to growth, opportunities are numerous for the engineers and scientists who can contribute to that growth. And at Honeywell, other factors accelerate advancement.

Engineers predominate among our vice presidents, divisional executives and department managers. Attitudes and opinions of our scientists and engineers are understood and supported by management.

Honeywell is composed of small units working as a team. These units multiply opportunities for early managerial experience and lay the foundation for more important managerial assignments in future years.

HONEYWELL OFFERS MANY EXTRA BENEFITS!

Honeywell's extra benefit program is one of the most liberal in industry. There's free group life insurance . . . free accident and sickness insurance . . . free hospital insurance. You'll find a generous policy on paid vacations and holidays and a modern retirement program paying lifetime benefits.

Whichever Honeywell division or location you choose, you'll be assured of special training to help you advance in your career. This training includes regular on-the-job instruction, formal classes at the company and tuition-aid courses at nearby institutions.

*Trademark

HONEYWELL'S MAIN FIELDS AND LOCATIONS ARE:

Minneapolis—Aeronautical, Ordnance and Heating and Air Conditioning Controls.

Philadelphia—Industrial Instruments, Computers, Controls and Valves.

Wabash, Indiana—Heating and Air Conditioning Control Dampers and Electronic Air Cleaners.

Denver—Oscillographic and Photographic Equipment and Research.

St. Petersburg, Florida—Inertial Guidance Systems.

Seattle, Washington—Ordnance Controls, Missiles and marine research laboratory.

Monrovia, California—Ordnance Controls and Missiles.

Los Angeles—Aeronautical and Heating and Air Conditioning Controls.

Boston—Industrial Instruments, Servo Components and Controls; Data Processing Systems.

Freeport, Illinois—Precision Switches.

Chicago—Heating and Air Conditioning Controls.

Hopkins, Minnesota—Corporate Research Center.

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HOW TO LEARN MORE ABOUT HONEYWELL!

A Honeywell representative can answer your questions and give you additional information about opportunities at Honeywell. Please consult your college placement office for the date of his next visit to your campus.

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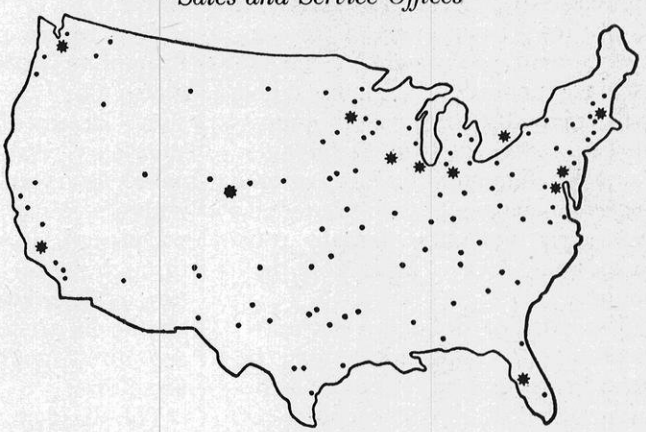

Honeywell

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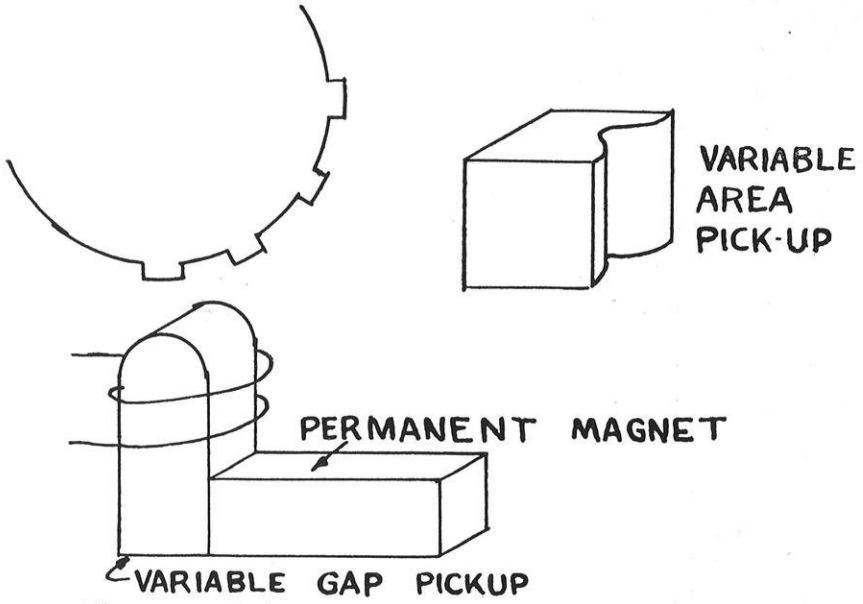

Electromagnetic frequency generator using rectangular teeth on the rotating wheel.

New Sounds

(Continued from page 21)

laps the pickup it produces an asymmetrical variation in capacitance (which) . . . generates a wave rich in harmonics. This capacitance variation is used to vary the frequency of (a 5 Mc) oscillator, producing a frequency modulated signal which is detected by a discriminator and is proportional to the frequency wave-form.

The frequencies of the clamped-end bar are proportional to the radius of gyration and hence to the height of the bar. Thus for a rectangular bar there would be two series of frequencies which will be emitted simultaneously if the bar is struck on a corner. This frequency spectrum is too compressed for simulation of true bell sounds, but if pivoted at one end the frequencies spread too much. A flexible steel rod necked at the damped end will give the proper frequency spread. Two of the frequencies must be eliminated by filtering and pickup placement. One frequency is lacking but coincidentally it is weak and decays rapidly in bell sounds.

For extreme frequency accuracy, maintained tuning forks may be used as generators. It was for this reason that Radio Corporation of America incorporated tuning fork generators in their electronic music synthesizer. A magnetic field set up by a current-carrying coil acts on one of the tines and causes the fork to vibrate. This vibration induces a voltage in a coil surrounding the second tine. This voltage acts as a positive feedback signal from the following two-stage amplified circuit which also has some negative feedback.

Because of the inertia-less operation of a cathode-ray generator, it should provide accurate waveform reproductions with instantaneous response characteristics. It could function much as the television pickup tube by the cathode-ray scanning the waveform. The output signal would then be exactly proportional to the waveform.

Photoelectric frequency generators require that a waveform be recorded very accurately. This waveform may be of the variable density or variable area type as is used in motion picture sound tracks.

This record may then be in the form of an endless tape which modulates the light from a stationary slit. The waveform may be on a stationary disk which is illuminated. By rotating next to it a disk with a series of slits a fundamental wavelength apart the light passing through the slits will be a reproduction of the waveform. One or more photocells pickup the light to give an output signal proportional to the waveform.

The disadvantages in this system are the shrinkage of negatives in developing pictures of the waveform or the difficulty of accurately drawing the waveform.

A similar method of scanning is employed in the Compton Electrone except that the generator is electrostatic. A metallic engraving of the waveform is bonded on an insulator disk. Each disk will contain a series of harmonically related waveforms isolated from each other so that they may be combined as desired. Between each pair of stationary waveform disks is the scanning rotor.

This rotor consists of sets of metallic radial lines which are spaced a half wavelength apart. The scanning webs act as the light slits in the photoelectric generator as they scan only the portion of the waveform under them. The capacitance between the scanning web then varies as the area of the waveform beneath the scanning webs which perform as electrostatic pickups. The output signal is then proportional to the capacitance and consequently the area of the engraved waveform.

Slight inaccuracies in the engraving or variations in the air gap are cancelled by the web or the opposing sides of the scanning rotor. A variation of this method is the rotation of the waveform disks past screws, but the resultant effect is the same.

Electrostatic generators in any form are high voltage, high impedance circuits. For this reason noise is easily introduced and because of the very low signal level special precautions are required to maintain a high signal-to-noise ratio.

The electromagnetic rotary generator is one of the earliest types of frequency generators. Cahill designed and built a system of alternators supplying some frequencies which were mixed to build the required frequency spectrum. At this time there were no amplifiers, so the alternators had to supply all the power required. This necessitated such large sized apparatus that a warehouse was needed to house the complete instrument and on moving 30 railroad cars were required.

The present form of this generator embodied in the Hammond organ could hardly be compared except in operational principles only. This organ is representative of the electromagnetic frequency generator and also the mechanical operation of all rotary generators, so it will be described in some detail.

(Continued on page 42)

The Electronic Classroom—RCA adds a new world of sight and sound to the "3 R's"

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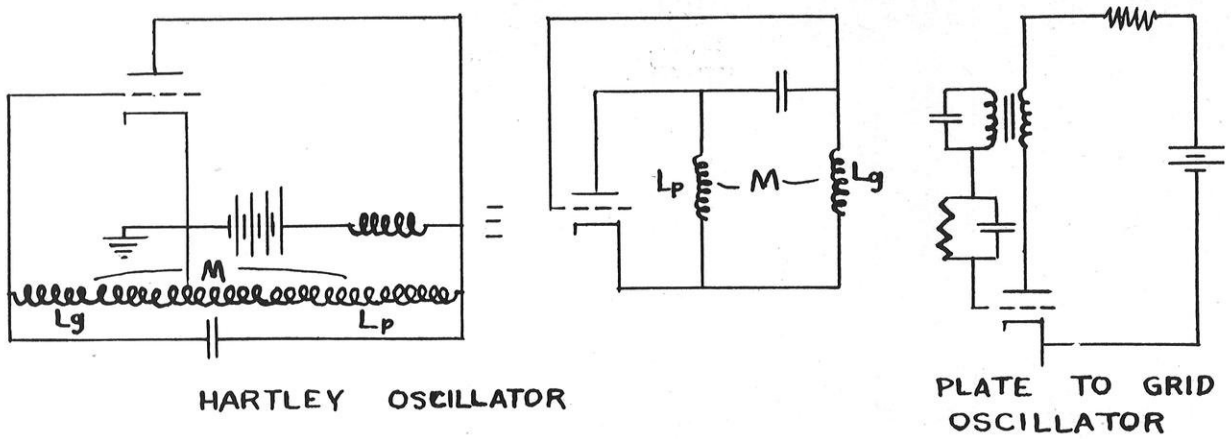


Hartley oscillator is stable and gives a large output signal. Baldwin oscillator incorporates an ordinary plate-to-grid oscillator with high stability.

New Sounds

(Continued from page 40)

The tone wheel is a perfect iron wheel, precisely contoured so that an approximate sine wave will be generated. There is a 0.005 in. gap between the wheel and the sharply pointed end of a permanent magnet. As the tone wheel is rotated past the magnet a current is generated in the coil wound near the pointed end of the magnet.

The tone wheels are mounted in octave groups and each pair is driven through a helical spring coupling by a bakelite gear which is driven by a brass gear on the main shaft. Because each group of tone wheels supplies all the octave frequencies in its group only 12 main brass gears are needed to supply all frequencies. The gearing is designed to approximate the equal tempered scale and the frequency accuracy achieved is about 2½ parts per million. It is difficult to obtain high frequency accuracy because of the large number of teeth required for some of the gear ratios.

Magnetic circuits have several disadvantages which must be compensated for or compromised with. Because of nonlinearity and hystereses the output wave may appear more like a clipped sine wave than a true sine wave. Eddy currents in the wheel produce interfering magnetic fields. Fringing effects redistribute the flux so the generated waveform is distorted.

Because of reluctance effects causing backlash in the gears they must be precisely machined or further waveform distortion will occur. The synchronous motor drive makes the frequency constant except for irregularities caused by changing loads and the resultant "hunting". These variations are damped out by the use of a mechanical filter in which the driving system is coupled through a spring to the main shaft on which is mounted a flywheel on which frictional contact is made.

The several advantages of this well designed generator have made it commercially successful. Because of the high electrical output as compared with electrostatic and photoelectric generators the signal-to-noise ratio is very high. It is compact and its mechanical characteristics are stable.

Another electromagnetic generator has rectangular teeth on the rotating wheel and shaping is done on the pickups rather than the wheel. Fringing tends to smooth out the flux pattern near any sharp corners or clefts, and hence obscures high harmonics. Although the much more pronounced fringe effects make the waveform harder to control with variable gap pickups than with area pickups, they are used because of production economy.

Because of the present high quality of tubes and circuit components, multiple oscillators using tubes constitute the most important type of frequency generator. Even Hammond, noted for its electromagnet generator, has introduced an organ with vacuum tube oscillators. There is no moving mechanism to wear out, so the reliability and long life of tubes makes them well suited to this application.

Their power consumption is small so operation is economical. They are adaptable for almost any type of waveform can be obtained with the proper circuitry. Frequency stability is affected by changes in tube characteristics, constants of the circuit components or changes in the load. However, by proper design these effects can be made negligible and the frequency will be very stable.

Gas tube oscillator circuits have generally had poor frequency stability. If it were not for this handicap their economy would make them well suited for commercial generators. Some generators containing neon diodes in relaxation oscillators have been built with very satisfactory stability. Frequency stability is affected principally by the applied voltage and incident light. The use of a well stabilized voltage and constant light on the tubes gives proper operation.

One model added an electrostatic field to the tube, the frequency of which was controlled by a master oscillator. If the free-running frequency is nearly a submultiple of the master oscillator frequency the diode oscillator will be synchronized to the submultiple and operate as a frequency divider.

Vacuum tube circuits can be designed for high frequency stability and hence are used extensively in frequency generators. Intensive research has been conducted in the design of more economical generators with high frequency stability. It is interesting to note that almost all vacuum tube frequency generators are variations of the Hartley oscillator.

The Minshall organ has replaced its R–C phase shift oscillator because of the instability due to changes in the tube plate resistance

over a period of time. Atmospheric variations also caused frequency instability because of the extremely high grid impedance.

Some types of oscillators must be isolated from the load by a buffer stage to prevent frequency instability due to load changes. Hence, the one tube Hartley oscillator is less expensive in this respect as the signal may be taken directly from the circuit through isolating resistances.

By proper design of the oscillator the effects of variations in plate and heater voltages may be made to cancel each other. This is accomplished by using a design such that voltage ratios which would change the frequency always remain constant. Although the Hartley oscillator is simple it is very stable and gives a large output signal.

The Hartley oscillator consists of a tapped inductor in parallel with a capacitor. The oscillation frequency is given by

$$f = \frac{1}{2\pi}\sqrt{\frac{1}{C(p + Lg + 2M)}}$$

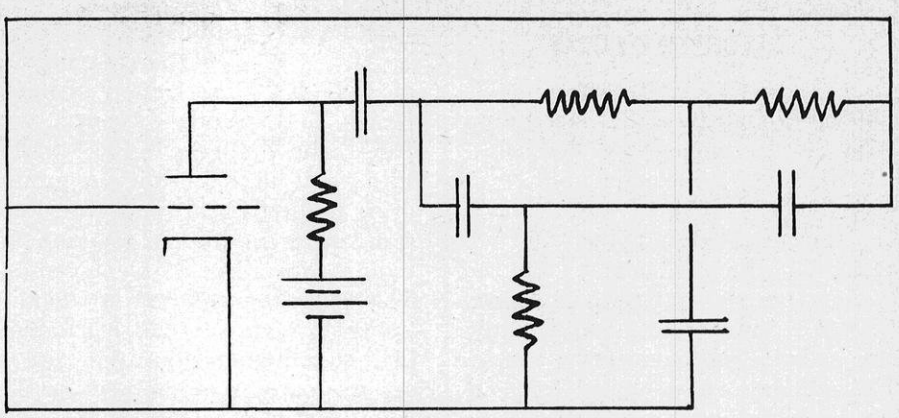
provided plate voltages and tube characteristics are constant or variations are compensated for. The LC tank circuit should have a high Q to increase frequent stability.

The Baldwin incorporated an ordinary plate-to-grid oscillator and achieves high stability with this design.

Another frequency generator is ilustrated by the parallel-T oscillator. Although this circuit is quite difficult to design it has excellent frequency stability and even with low tolerance components is more economical than other types of oscillators. It may be that the Hartley oscillator is so commonly used because a greater variety of waveforms can be generated, thus rerequiring less complicated waveshaping circuitry.

Most electronic organs have keyboards with 61 fixed frequencies covering a range of five octaves. Each octave is divided into 12 fixed frequencies, each frequency higher than the adjacent frequency by $\sqrt[12]{2}$. If each frequency is supplied by an oscillator, octave frequencies will be slightly off frequency because of the impossibility of obtaining the exact frequency.

Thus the harmonics of octave and other frequencies which would theoretically coincide will produce beat frequencies. This effect is very desirable for it makes the musical sound richer and more satisfying. However, it requires that each oscillator frequency be adjusted separately.



PARALLEL - T OSCILLATOR

Frequency generator with excellent frequency stability.

This inconvenience of adjusting each frequency may be eliminated by the use of divider circuits. Each of 12 master oscillators covering the top octave will have a series of dividers providing all the required frequencies. Since these lower frequencies are synchronized through the dividers to the frequencies of the master oscillators only the master oscillators need to be adjusted.

Another consequence of the synchronysm is that the circuit components of the dividers do not need to be as accurate as those of the master oscillators and so this system is more economical than the use of separate oscillators for each frequency. Although the beating effects of separate oscillators is desirable the economy of production and ease of adjustment have made the divider system more popular. To overcome the lack of beating in synchronized octave frequencies various methods of simulation of this effect have been designed and utilized.

Although electronic musical instruments have been greatly improved since their inception and the generated sounds are very satisfying to hear, there is much room for progress, especially in the development of new musical instruments and sounds. However, if such is to occur there must be music composed incorporating these possibilities. Before the music can be composed the composer must know what these possibilities are and so it is up to the instrument designer to initially produce the instrument. This instrument could be similar to present instruments or radically different. In either case it will be electronics that will make such instruments possible.

Much progress in electronics in both design and manufacture is necessary before it will be possible to produce the ideal musical instrument. This instrument is one which can make any sound, known or unknown, or conceivable; to do this we must provide a generator for periodic vibrations embracing the whole audio spectrum of frequencies.

We must be able to select from this generator at will any desired single frequency, or many single frequencies simultaneously, whether harmonically or inharmonically related, or whether in narrow or wide continuous bands. We must further be able to emit these frequencies in any desired sound amplitudes and envelope shapes, even though, in a given sound, all the components require different shapes of envelope.

We must be able to control the emission of these sounds by some suitable playing technique and apparatus. With such an apparatus we shall be able to synthesize any possible sound, continuous, damped, musical, or nonmusical, for we have all the elements of sound and means for putting together any desired combination of these elements in any desired time-amplitude relationship.

THE END

Engineering

(Continued from page 17)

of the Aqabat Jeber Refugee Camp already mentioned, the Jerusalem Y. M. C. A., of which Labib Nasir has become director, has set up a somewhat different school and vocational training center for the young people of that community. What is taught there could hardly be called a full engineering course. Nonetheless, what they learn is truly basic engineering, for it is technical skill that they can apply towards making a living for themselves and for making the life for those about them more comfortable.

On December 8, 1948, a single tent was pitched about half a mile from the camp, which is the largest concentration of Arab refugees in Jordan, and the Y. M. C. A. started its work among the refugees in the Jericho area. There are now eighteen adobe structures with thatched roofs in place of the single, original tent, and the program has expanded to cover many areas.

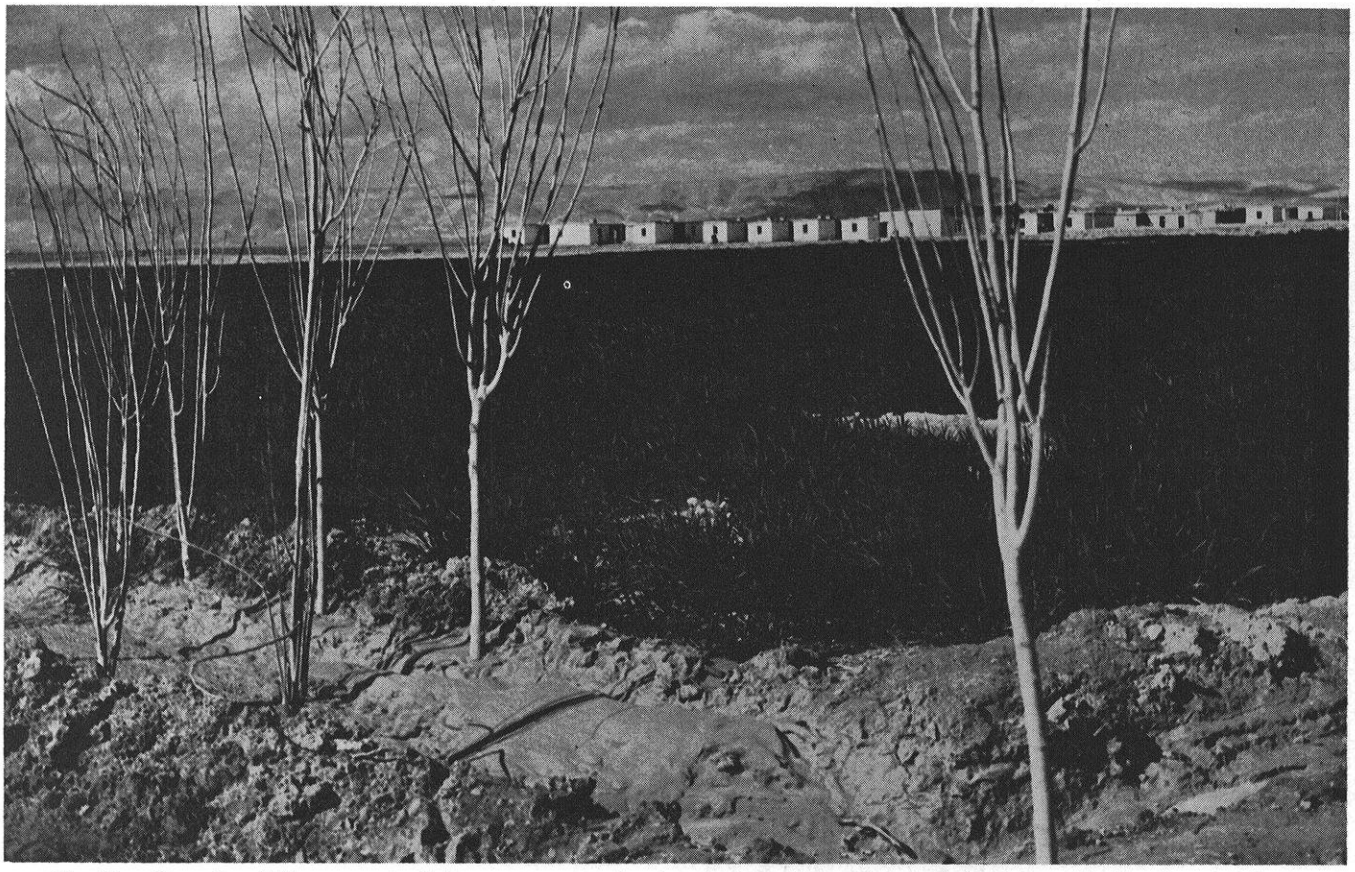
First, and most important in any newly settled area, an elementary school was established by the Y. M. C. A. with the cooperation of UNWRA (the United Nations Relief and Works Agency for Palestinian Refugees in the Middle East) for children in the age group of six to fifteen years with the same standard as the Jordian government requires for all of its own schools. This gave the children an opportunity to complete the equivalent of an eighth grade education, and it set the pattern of literacy for all who wanted it. This school now consists of well constructed adobe buildings for class rooms and study halls to accommodate over six hundred students. In 1955, an electric generator, the gift of American churches, was installed so that studying in the dark winter evenings could be made much easier by providing electric light in the study halls.

In 1951, the areas of study were increased by the donation, through the Near East Christian Council, of tools for carpentry and blacksmith work, so a fuller vocational training program could be initiated. The instruction has now been expanded to include machine work and each shop now has its own building. The carpentry shop has several machines including a band saw and a lathe, as well as the normal hand tools required, and can train twenty-three people at one time in the art of joining, carving, and shaping wood. When a boy graduates from this school, he is given a complete set of tools and is skilled enough to make a living in any of the cities of Jordan.

In the blacksmith or metal-working shop, more than twenty at a time can be taught to operate a lathe, to weld and shape metal (mostly iron), and to finish it with decorative or protective painting. Items such as bedsteads, chairs, flower-pot holders, and wrought-iron tables are made by the boys as practice assignments so that when they graduate they will be able to make items suitable for sale.

A third type of vocational preparation is given in the training of pipe welders. The Near East Christian Council gave the training center at Aqabat Jeber an electric welder, and several graduates now have jobs in the oil fields of Saudi

(Continued on page 68)



The New-Ramadan Village, west of Damascus, was developed along lines pioneered by Musa El Alami and others. UNRWA bored 32 wells and dug nine miles of irrigation canals in this area.

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MISS MANSFIELD APPEARS SOON IN THE JERRY WALD FILM PRODUCTION "KISS THEM FOR ME"

"Thunder Storms"

(Continued from page 26)

path is heard first, waves from the more distant portions arrive later and prolong the thunder. If the lightning takes a crooked path, sound waves from several equally distant points reinforce one another, giving an exceptionally loud crash. Successive lightning discharge over the same path and echo are responsible for the rumbling and roll of distant thunder.

The sound of thunder is heard after the flash of lightning is seen, because light waves travel about 187,000 miles per second and sound waves about 1,000 feet per second. By counting the seconds between the time the flash is seen and the time the thunder is heard, it is possible to estimate the distance between the observer and the lightning.

The local, or heat thunderstorm is the most common type. It has previously been discussed in detail.

Since this type of storm is induced through radiation heating at the ground it is most prevalent in the warm parts of the earth, in the warm seasons of the year, and in the warm part of the day. They are local in character and seldom cover a great area. Usually they occur as isolated storms or groups of storms. They reach their maximum development in the late afternoon and dissipate during the late evening when the cooling ground no longer supplies the necessary sustaining energy.

The orographic thunderstorm is produced by the mechanical lifting of a convectively unstable air mass by a relief obstacle such as a mountain range or a plateau front. The upward deflection furnishes the trigger effect necessary to release large reserves of latent energy in unstable air. It follows, that this type of thunderstorm is more numerous in hilly and mountainous regions.

The advective thunderstorm is due either to warm-air advection at low levels or cold-air advection aloft. They are common on the Great Plains during the night.

Cold-front thunderstorms originate as a direct result of cold-front activity. They are usually more severe and are not confined to any particular time of day, because their origin does not depend entirely upon local surface heating.

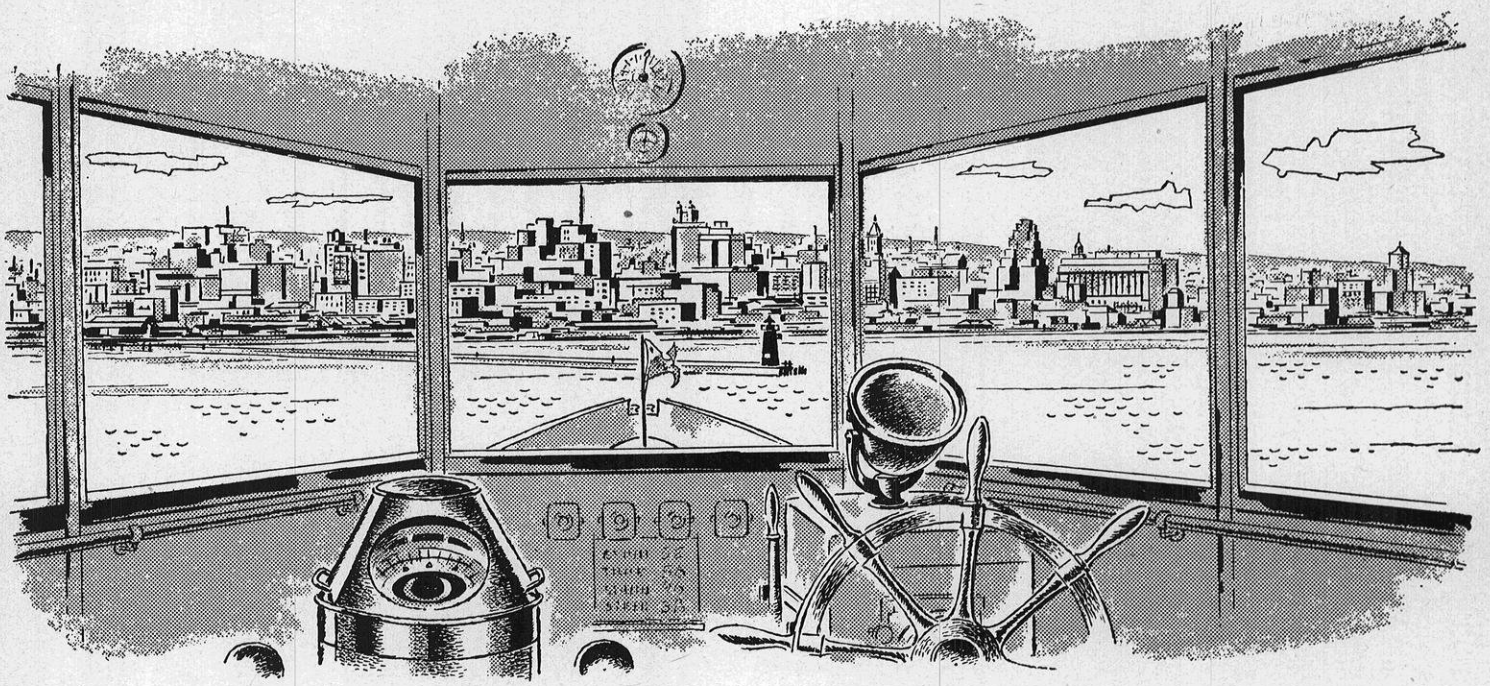
Warm-front thunderstorms almost always occur in hot humid unstable air. The "trigger action" necessary to release the storm energy is the warm wedge of air associated with the warm-front.

Within recent years much has been learned of the working of the greatest of electrical machines, the thunderstorm.

The amount of electricity stored in the cloud at any one time is approximately five billion volts. The supply of electrical power is about one hundred times greater than the biggest electrical set-ups devised by man. The electrical energy generated by a single cloud is sufficient to supply a large city with light and power during the course of the storm.

Perhaps one day this enormous supply of energy will be harnessed by man to do useful work, instead of flashing through the sky uncontrolled and spreading destruction in its path. **THE END**

The world is coming to Milwaukee...



The new St. Lawrence Seaway means more business and more job opportunities at Wisconsin Electric Power Company

With Milwaukee's outstanding harbor as a gateway to an operating territory which extends from the Wisconsin state line on the south into upper Michigan on the north, the business-booming effect of the new St. Lawrence Seaway is bound to result in a great number of fine career opportunities at Wisconsin Electric Power Company.

Job opportunities are available, not only in our Milwaukee metropolitan area, but also in a number of the smaller towns and communities throughout the system. Our companies serve better than half a million electric customers and provide natural gas service for approximately 75,000 gas customers. We employ more than 5,000 men and women.

Here you will be able to begin your career in one of a wide and interesting variety of engineering fields — electrical, mechanical, civil, chemical, statistical, research, administrative, sales, etc. You will find an immediate opportunity for using your engineering skills and for satisfying progress in your chosen field.

Take a step right now into a successful future. Investigate both the immediate and long range advantages of associating with one of the companies of the Wisconsin Electric Power Company System.

When "the world comes to Milwaukee" — via the new St. Lawrence Seaway — be on hand to help us meet the challenges that increased demands for our services will present. Lend a helping hand with our $300,000,000 expansion program which is now in progress. Make a date to see our representative when he visits your campus.

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WHEN HE VISITS THE CAMPUS.

CHECK YOUR PLACEMENT
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WISCONSIN ELECTRIC POWER COMPANY SYSTEM

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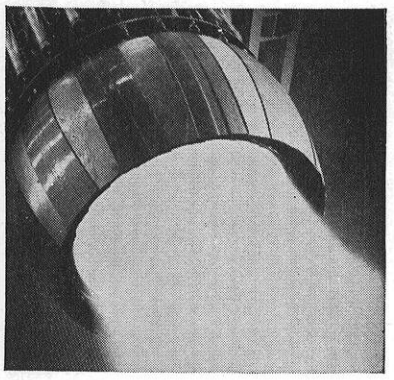
What's doing...



One indication of accomplishment in the combustion field: the J-57 engine, augmented by afterburner, provided the thrust which made supersonic flight practical for the first time.

This special periscope gives Pratt & Whitney Aircraft engineer a close-up view of combustion process actually taking place within the afterburner of an advanced jet engine on test. What the engineer observes is simultaneously recorded by a high-speed motion picture camera.

at Pratt & Whitney Aircraft in the field of Combustion

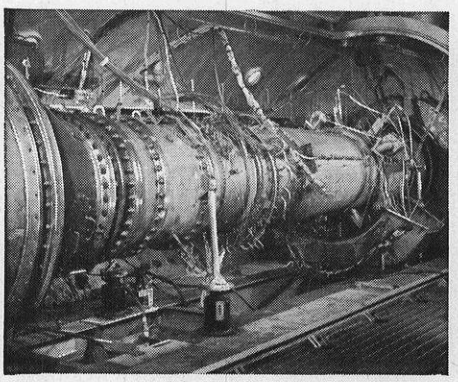
Historically, the process of combustion has excited man's insatiable hunger for knowledge. Since his most primitive attempts to make use of this phenomenon, he has found tremendous fascination in its potentials.

Perhaps at no time in history has that fascination been greater than it is today with respect to the use of combustion principles in the modern aircraft engine.

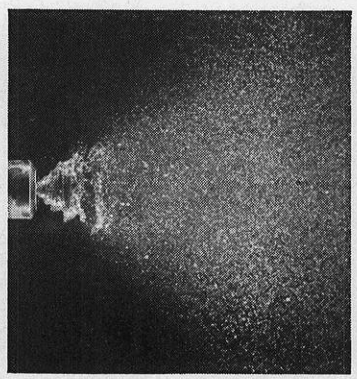
At Pratt & Whitney Aircraft, theorems of many sciences are being applied to the design and development of high heat release rate devices. In spite of the apparent simplicity of a combustion system, the bringing together of fuel and air in proper proportions, the ignition of the mixture, and the rapid mixing of burned and unburned gases involves a most complex series of interrelated events — events ocurring simultaneously in time and space.

Although the combustion engineer draws on many fields of science (including thermodynamics, aerodynamics, fluid mechanics, heat transfer, applied mechanics, metallurgy and chemistry), the design of combustion systems has not yet been reduced to really scientific principles. Therefore, the highly successful performance of engines like the J-57, J-75 and others stands as a tribute to the vision, imagination and pioneering efforts of those at Pratt & Whitney Aircraft engaged in combustion work.

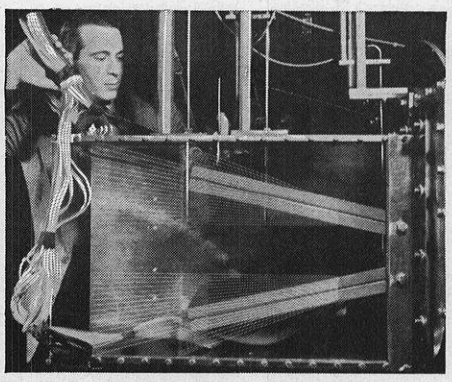
While combustion assignments, themselves, involve a diversity of engineering talent, the field is only one of a broadly diversified engineering program at Pratt & Whitney Aircraft. That program—with other far-reaching activities in the fields of instrumentation, materials problems, mechanical design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



Mounting an afterburner in a special high-altitude test chamber in P&WA's Willgoos Turbine Laboratory permits study of a variety of combustion problems which may be encountered during later development stages.



Microflash photo illustrates one continuing problem: design and development of fuel injection systems which properly atomize and distribute under all flight conditions.



Pratt & Whitney Aircraft engineer manipulates probe in exit of two-dimensional research diffuser. Diffuser design for advanced power plants is one of many air flow problems that exist in combustion work.

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W. S. P. E.

WISCONSIN SOCIETY OF PROFESSIONAL ENGINEERS

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.

SOUTH WEST CHAPTER

Kickoff Meeting Speech, October 1, 1957
Kurt F. Wendt, Dean of University of Wisconsin Engineering College
Subject—The 1957–1959 Construction Program for the University of Wisconsin

A shift of administrative direction to the College of Engineering for the University of Wisconsin planning and construction program makes Dean Kurt F. Wendt responsible for an organization that will solve the planning problems, and coordinate the construction of a currently large and expanding building program of projects authorized by the State Building Commission.

The elementary and high school enrollment clearly indicates large increases in future University enrollment. Results of projected estimates, Dean Wendt said, indicated a minimum enrollment of 27,500 and a maximum of 40,000 students by 1970. To accommodate this rapidly increasing enrollment a heavy building program is underway and will of necessity continue until 1970.

The projects under construction or in the planning stage during the 1957 to 1959 period were summarized by Dean Wendt according to the method of financing as follows:

(1) Projects to be financed by gifts, revolving funds, or loans to be amortized from earnings:

New Chadbourne Hall	$ 3,160,500
Men's Dormitories South of Kronshage	2,100,000
500 Married Student Apartments	4,462,000
Men's Dormitories West of Elm Drive	4,850,000
Women's Dormitories East of Tripp Hall	3,000,000
Addition to Camp Randall Stadium	522,715
New Outdoor Track	44,000
Sterling Hall Addition	1,200,000
Enzyme Building Addition	600,000
Service Memorial Institutes Research Addition (Includes $255,000 State Appropriation)	2,010,000
Sub-total	$21,949,215

Some of these projects are well along in the construction stage.

(2) Projects to be financed by loans to be amortized from rents paid by state appropriations totaled 17 billion dollars.

Financing of these projects has been accomplished under Law 555S passed by the last Legislature, and funds become available to amortize loans on a student fee income basis.

(3) Projects to be financed by direct state appropriations total $1 billion.

(4) Projects to be financed from Hil Farm sales proceeds amount to $348,000.

The grand total of $41,341,015 is the total amount authorized for projects that will be in the planning or construction stage during the 1957 to 1959 period. At the same time there has been authorized construction at State Colleges in the amount of $21,450,000 and other "State" construction in excess of $20,000,000.

The scope of this work will stimulate the fields of engineering and construction for several years in Madison and throughout the State.

Dean Wendt pointed out that we as engineers in Wisconsin will feel the influence of this expanded building program. It may be in increased design personnel or facilities, inspection or construction, related increased housing demands as a resident of the city of Madison, or increased service requirements because of the increase in student population, but the influence of this building program and increased University enrollment will be felt.

In answering questions at the close of his speech Dean Wendt emphasized that this program to prepare for increased enrollment in the near future is primarily made possible because loans can be amortized from earnings, rents, gifts, and student fee income. There are no direct State Appropriations for the residence halls, and only a small part of the funds for the other projects are from State Appropriations.

There were 97 members and guests present at this meeting

(Continued on page 52)

Meet the President

ANTHONY L. GENISOT

"As President of our Society, I wish to say that you may rest assured that I shall do everything within my power to carry out the mandates of the Society and with the men you have elected as members of the Board of Directors I am thoroughly confident that we will fulfill your wishes and prove to you that we have one of the leading Professional Engineering Societies in the United States—right here in our great State of Wisconsin."

With this pledge Anthony L. Genisot assumed the leadership of the Wisconsin Society of Professional Engineers for the year 1957–1958 directing the efforts of the society towards the goal of attaining a higher standard for the "Engineering Profession" in our country.

Anthony L. Genisot was born in France, August 8, 1895. In 1902, he arrived at Montreal, a small town near Hurley in the mining area of northern Wisconsin, where his father found employment.

After the war he availed himself of the Educational Bonus offered by the State enrolling in the Wisconsin Institute of Technology at Platteville, from which college he was graduated as a mining engineer in 1923.

Immediately after graduation he went to work for the American Metal Company of New York which took him to Cuba. After two years he returned to Wisconsin to join the State Highway Commission, District 7, at Rhinelander where he served as a resident engineer on construction for the next ten years.

In 1937 he organized his own construction company at Rhinelander engaging in the construction of buildings, highways, bridges, etc. This work was interrupted by World War II when he entered the service and was commissioned as a Lieutenant in the SeaBees from which he is presently retired with a permanent rank of Commander.

In 1946 he organized what is now known as the "Genisot Engineering Co." at Rhinelander and is serving now as President of this company.

Professionally, Mr. Genisot has been affiliated with W.S.P.E. since its inception and has been vitally interested in the affairs of the Society since 1932. His past activities in W.S.P.E. include: Past President of the Wisconsin Valley Chapter, member of the State Board of Directors, member of the Inter-Professional Committee, Second Vice-President, Vice-President and now as President of W.S.P.E.

In civic affairs he is currently serving as a member of the Rhinelander City Planning Board. He is a member of the Lions Club and of the American Legion. He has always shown considerable interest in conservation and is an ardent enthusiast of sports. The latter interest stems from his college days when he participated in football, baseball and boxing.

W.S.P.E.

(Continued from page 50)

planned as a Kickoff for the organization and planning of the various committees to formulate their plans for the 1957–58 year.

The November meeting, Thursday, Nov. 7 was held at the Barker–Colman Company plant in Rockford, Illinois, jointly with the local section of Illinois Society of Professional Engineers and in connection with the Madison Chapter of American Institute of Electric Engineers.

The December meeting is planned for Friday the 13th at Madison, the Cuba Club. The program will be based on "Unity in the Engineering Profession."

The monthly meeting of the Southwest Chapter was held on November 7th at the Barber–Colman Company. The meeting was held jointly with the I.S.P.E., Rockford Chapter.

Andrew Neureuther, President of the Illinois Society of Professional Engineers, greeted the members. Professional Engineering Registration was discussed by Prof. Paul Grogan of the University of Wisconsin. An inspection trip through several Barber–Colman Departments followed.

WAUKESHA CHAPTER

The first meeting of the new year for the Waukesha Chapter was a dinner meeting held at the Avalon Hotel on October 2nd. A total of twenty-one members and guests were present.

President Joe Kuranz introduced the committee chairmen for the year who in turn gave short reports on the objectives they hope to accomplish this year.

The tentative program list was given by vice-president Perry Wilder. He and his co-chairman, George Flory, are planning a tour of Milwaukee County's Mitchell Field as part of the November meeting.

Another program idea discussed was that of inviting Waukesha County high school freshmen interested in and doing good work in science and math studies to a monthly meeting at which they would see a movie on preparation for an engineering education and be able to discuss the various types of engineering opportunities with chapter members.

After the business meeting, a movie on the splitting of the atom was shown.

MINUTES OF THE MEETING OF BOARD OF DIRECTORS, WISCONSIN SOCIETY OF PROFESSIONAL ENGINEERS

Kings Gateway Inn, Land O' Lakes, Wis., September 22, 1957.

Board members present: A. L. Genisot, President; Cliff Nelson, Vice-President; Harold Trester, Vice-President; A. G. Behling, Past President; Harold Kingsbury, Secy–Treas.; Louis Larson, Director and Theron Brown, Director.

Committee chairmen: Karl Werwath, Carl Geisler, Chas. Nagel, Foster Koehn and Kurt Roth.

Kingsbury moved, Brown seconded that the two vice-presidents be authorized to prepare necessary change in By-Laws in order to change meeting date.

Karl Werwath reported that the trend in Wisconsin was toward a climate that was unfavorable to industry. It was recommended that President Genisot appoint a committee to study the possibility of forming a state committee to make a study of the industrial climate in Wisconsin.

Secretary Kingsbury announced that he was changing positions and could not do a satisfactory job as secretary after the first of the year. He will continue to serve until a new man is elected and appointed.

Mr. Kingsbury, who has served the state for 20 years currently as an engineer with the Board of Health, will be employed by the Sanfax Co. of Atlanta, Ga., manufacturers of industrial chemicals.

W.S.P.E. 10TH SUMMER CONFERENCE, LAND O'LAKES, WISCONSIN

September 20, 21, 22, 1957

Engineers and their ladies started arriving on Friday afternoon, at the Gateway Hotel in Land O'Lakes.

After everyone was "squared away" a buffet supper brought us to the Gateway Inn and was followed by mixer dancing and entertainment.

All functional groups met on Saturday morning and resolved some pending problems. The consulting group completed their Rules of Government and Operation and instructed the Chairman, Bob Straus, to submit same to State Board of Directors.

At a special session of W.S.P.E. State Committee on Education on Saturday afternoon Dr. Clifford Liddle of the University of Wisconsin spoke to a group of 75 members on "Higher Education Faces the

(Continued on page 72)

APPLICATIONS FOR MEMBERS AND AFFILIATE MEMBERS SEPTEMBER 20, 1957

Name and Position	Address	Reg. No.	Sponsor
LAKE SUPERIOR			
Horace Richard Hymer Plan and Design Eng. Wisconsin Highway Comm.	1517 Tower Ave. Superior, Wis.	E- 720	M. B. Olson
NORTHWEST			
Myron James Close Chief Process Eng. U. S. Rubber Co.	Route 3 Eau Claire, Wis.	E-2748	N. W. Gehlhar
WISCONSIN VALLEY			
John F. Pezl Chief Engineer Roddis Plywood Corp.	701 Felker Ave. Marshfield, Wis.	E-5904	L. W. Carlson
SOUTHWEST			
Robert Peter Torkelson Architect and Engineer Mead and Hunt, Inc.	4234 Lumley Road Madison 5, Wis.	E-6335	H. J. Hunt
John Michael Liebmann Design Engineer Research Products Corp.	920 E. Mifflin St. Madison 3, Wis.	E-6275	D. K. Evans
MILWAUKEE			
George Gustav Youngstrum Salesman U. S. Steel Supply Div.	4027 West Scott St. PO Box 2045 Milwaukee 1, Wis.	E-4903	J. R. Meyer
Russell Warren Henke Consulting Eng., Pres. Russ Henke Associates	1000 Grandview Drive Elm Grove, Wis.	E-4669	D. Holt V. Morgan

Total members and affiliates	
Members	1,196
Dues exempt	3
Retired	4
Affiliates	118
	1,321

You want a job

PLUS

. . . plus the chance to get ahead
. . . plus the chance for recognition
. . . plus the chance to keep learning

As a leader in many fields, Union Carbide offers a handsome assortment of plus factors with its jobs. It's a top producer of petrochemicals—and U. S. output of petrochemicals has roughly doubled every five years since World War II. It's a leading producer of oxygen—and new steelmaking methods use such vast quantities of oxygen that consumption in '57 is expected to be double that of '55. And these are only two of the expanding fields in which Union Carbide is a leader.

In terms of jobs with plus, this growth means Advancement with a capital "A." As our markets expand, we need more people to handle the development, production, and sale of our products.

Representatives of Divisions of Union Carbide Corporation, listed below, will be interviewing on many campuses. Check your placement director, or write to the Division representative. For general information, write to V. O. Davis, 30 East 42nd Street, New York 17, New York.

BAKELITE COMPANY Plastics, including polyethylene, epoxy, fluorothene, vinyl, phenolic, and polystyrene. J. C. Older, River Road, Bound Brook, N. J.

ELECTRO METALLURGICAL COMPANY Over 100 ferro-alloys and alloying metals; titanium, calcium carbide, acetylene. C. R. Keeney, 137—47th St., Niagara Falls, N. Y.

HAYNES STELLITE COMPANY Special alloys to resist heat, abrasion, and corrosion; cast and wrought. L. E. Denny, 725 South Lindsay Street, Kokomo, Ind.

LINDE COMPANY Industrial gases, metal-working and treating equipment, synthetic gems, molecular sieve adsorbents. P. I. Emch, 30 East 42nd Street, New York 17, N. Y.

NATIONAL CARBON COMPANY Industrial carbon and graphite products. PRESTONE anti-freeze, EVEREADY flashlights and batteries. S. W. Orne, P. O. Box 6087, Cleveland, Ohio.

SILICONES DIVISION Silicones for electrical insulation, release agents, water repellents, etc.; silicone rubber. P. I. Emch, 30 East 42nd Street, New York 17. N. Y.

UNION CARBIDE CHEMICALS COMPANY Synthetic organic chemicals, resins, and fibers from natural gas, petroleum, and coal. W. C. Heidenreich, 30 East 42nd St., New York 17, N. Y.

UNION CARBIDE INTERNATIONAL COMPANY Markets UNION CARBIDE products and operates plants overseas. C. C. Scharf, 30 East 42nd Street, New York 17, N. Y.

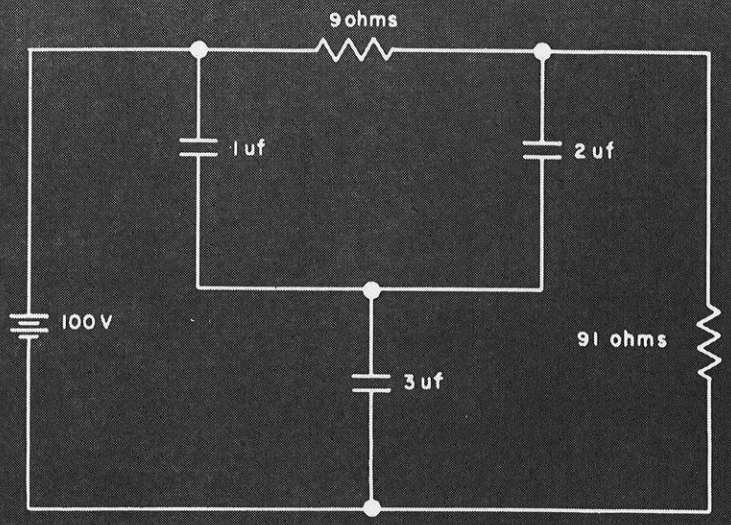
UNION CARBIDE NUCLEAR COMPANY Operates Atomic Energy Commission facilities at Oak Ridge, Tenn., and Paducah, Ky. W. V. Hamilton, P. O. Box "P", Oak Ridge, Tenn.

VISKING COMPANY A pioneer in packaging—producer of synthetic food casings and polyethylene film. Dr. A. L. Strand, 6733 West 65th Street, Chicago, Ill.

GENERAL OFFICES—NEW YORK Accounting, Electronic Data Processing, Operations Research, Industrial Engineering, Purchasing. E. R. Brown, 30 East 42nd Street, New York 17, N. Y.

CAN YOU FIGURE IT OUT?

In the circuit shown, determine the voltage appearing across the 3 microfarad capacitor. Assume that the circuit has been operating long enough to achieve an equilibrium state.



✻Solution at bottom of page

Gerald Maley tells what it's like to be... and why he likes being... a Product Development Engineer with IBM.

***SOLUTION**

The voltage across the 3 uf capacitor is 47 volts. This answer may be verified as follows:

Since the voltage across the 91 ohm resistor is 91 volts in the steady state, then

$E_1 + E_3 = 100$ or $E_1 = 100 - E_3$ (1)

and $E_2 + E_3 = 91$ or $E_2 = 91 - E_3$ (2)

let $Q_1 = I_1T_1 = C_1E_1$

let $Q_2 = I_2T_2 = C_2E_2$

then $Q_3 = I_1T_1 + I_2T_2$ or $C_3E_3 = C_1E_1 + C_2E_2$ (3)

By substituting in equation (3) the expressions for E_1 and E_2 given in equations (1) and (2), we have:

$C_3E_3 = C_1 (100 - E_3) + C (91 - E_3)$

Substituting all known values in this equation gives:

$(3 \times 10\text{-}6)\ E_3 = (1 \times 10\text{-}6)\ (100 - E_3) + (2 \times 10\text{-}6)\ (91 - E_3)$

Dividing by 10^{-6}

$3E_3 = 100 - E_3 + 2\ (91 - E_3)$

$6E_3 = 282$

$E_3 = 47$ volts Answer

FIGURING OUT A CAREER?

Selecting a career can be puzzling, too. Here's how Gerald Maley found the solution to *his* career problem—at IBM:

"What sold me on IBM," says Jerry, "was their approach to engineering. I'd expected rooms full of engineers at desks. Instead, I found all the friendly informality of my college lab." Starting as a Technical Engineer in Product Development, Jerry learned a great deal about electronic computers in a very short time. He was promoted to Associate Engineer after 16 months. Recently, he was made Project Engineer, supervising the development of magnetic cores. "In computer work," he says, "you can actually see electronics at work. This is not the case with all such equipment today. In this new field, you can be an important contributor in a very short time."

* * * *

There are many excellent opportunities for well-qualified engineers, physicists and mathematicians in IBM Research, Development and Manufacturing Engineering. Why not ask your College Placement Director when IBM will next interview on your campus? Or, for information about how your degree will fit you for an IBM career,

JUST WRITE TO:

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IBM Corp., Dept. 851
590 Madison Avenue
New York 22, N. Y.

IBM INTERNATIONAL BUSINESS MACHINES CORPORATION

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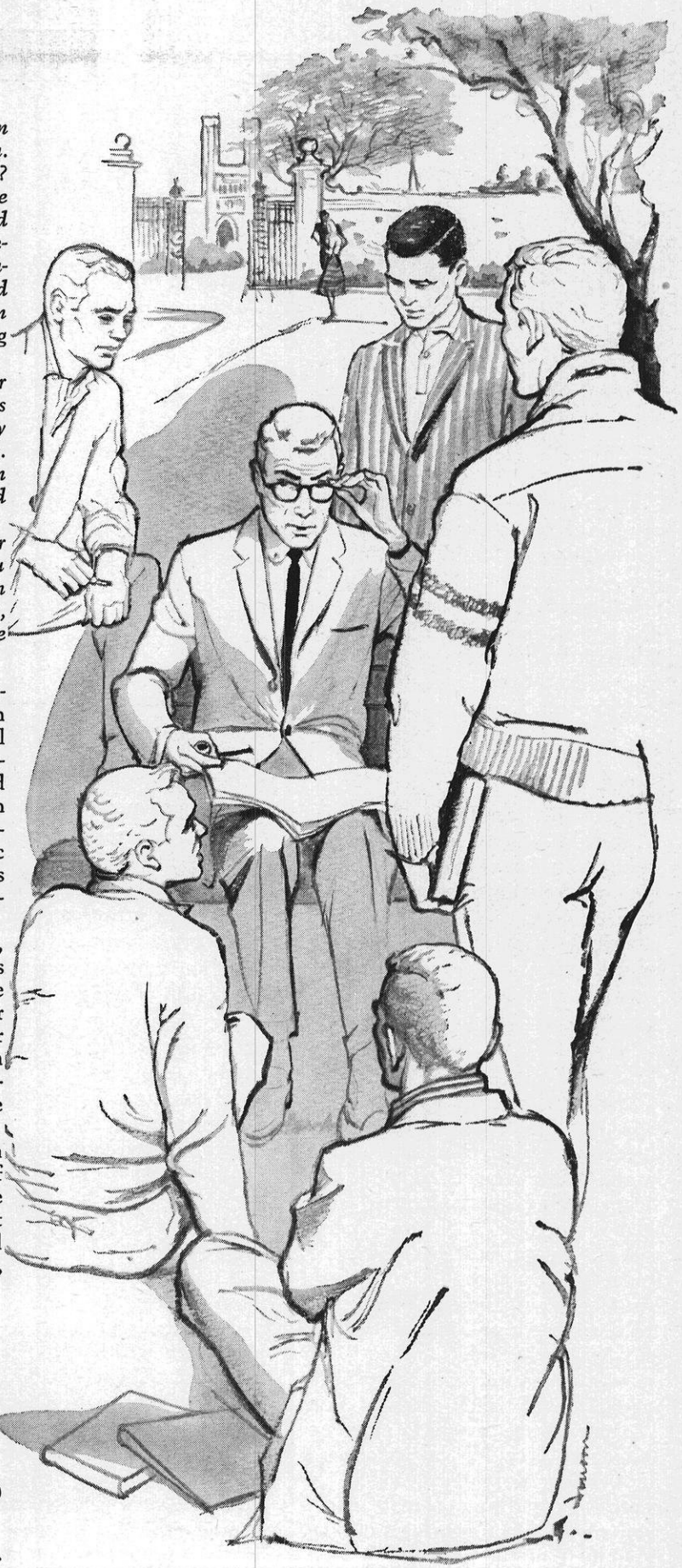
"For today's engineer, yes..."

"You are probably the most sought after young men in America today. Industries of all kinds want you. You've got a wide choice, so which field do you choose?

"The way I look at it, the aircraft industry has the most opportunity for you. It combines more advanced engineering sciences than any other field... electronics, communications, propulsion systems, hydraulics and pneumatics, thermodynamics... all these and many others. With this variety, interesting careers can be had either by specializing in one area or by moving from one to another.

"Obviously, you are going to want recognition for your work. You know that the aircraft industry pays well... but think about this: aviation is relatively young and its life-blood is young men with new ideas. Numerous important advances have been made just in the last few years. Who knows what new fields—and new opportunities—today's research will uncover?

"So, for today's engineer, yes, I would say that your best bet is the aircraft industry. Nowhere else can you find such opportunity, such challenge... and such compensation and added benefits. In my estimation, there is no place where you can put your college training to better use."



In the aircraft industry there is such a variety of engineering fields that a desire for virtually any *one* can be satisfied. As research continues more areas will be embraced and, as aircraft engineers pierce these barriers and solve today's problems, new challenges and opportunities arise. Northrop engineers have been meeting these challenges successfully for years. Airplanes such as the F-89 Scorpion, the new supersonic twin-jet Northrop T-38 trainer, and missiles such as the Snark SM-62 are examples of Northrop's engineering theory and capabilities.

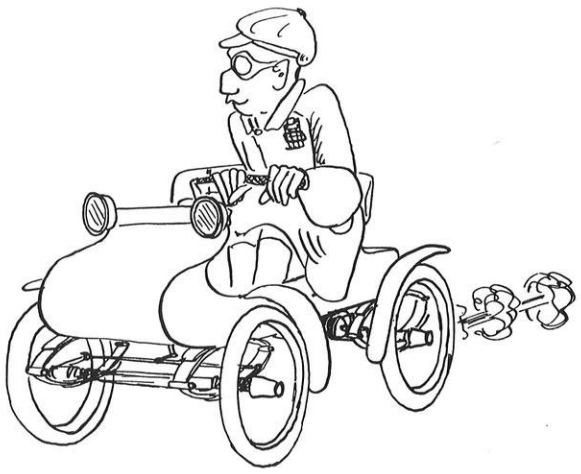
In Northrop's new Engineering and Science Center, your training can be applied to top priority projects and your future will be made more secure by intensive on-the-job training. Regular reviews reward you for your capabilities and accomplishments, adding further financial security. The extra benefits at Northrop, such as company-paid insurance and over three weeks vacation with pay, are among the most generous in the entire industry.

Write *now* and ask us how your qualifications can be applied to a career at Northrop. Regardless of whether you are an upper-classman or not, we believe we can show you that Northrop offers you a great future. Address Manager of Engineering Industrial Relations, Northrop Division, Northrop Aircraft, Inc., 1032 East Broadway, Hawthorne, California.

NORTHROP

Northrop Division of Northrop Aircraft, Inc.

BUILDERS OF THE FIRST INTERCONTINENTAL GUIDED MISSILE



THE ENGINEER OF YESTERYEAR

by Dick Soref ee'58

THE *Wisconsin Engineer* has been published every year since 1896. Gazing through my stereopticon viewer at the first few volumes, I found that the college of engineering has changed considerably, but that the news items used have not. Each month this column will present excerpts from these historic and memorable issues of the *Engineer.*

June 1908

The present senior class is unfortunate in several ways. The great advantage hitherto enjoyed by the graduating classes in engineering in obtaining employment receives its first serious setback this year. The companies which formerly held out opportunities for many men, this year find themselves unable to take any or more than a small number.

February 1909

In the field of Mechanical Engineering probably the most striking development has been that of the larger prime movers, notably the steam turbine and the internal combustion engine. . . . A new type of gasoline engine has been developed for motor car propulsion by the Daimler Company in which, instead of the usual poppet valves and gear, the inlet and exhaust ports are operated by means of sliding sleeves in which ports are cut. The sleeves are caused to move up and down between the piston and the cylinder walls by means of eccentrics carried upon a shaft which is driven by chain gearing from the crankshaft of the engine. . . . Another important advance in automobile engine construction consists in arranging for the circulation of the cooling water on the thermo-syphon principle, with large flow and return pipes, instead of circulating the water by mechanically operated pumps. This change has been made on a number of recently designed engines . . .

In the mind of the general public, the most interesting of the developments of the past year or two are undoubtedly those concerning the art of mechanical flight and that of wireless telegraphy. In our own country and in Europe, notably in France and Germany, the development of the art of mechanical flight is receiving more and more serious attention at the hands of men of high position and great intelligence. A year or two ago the possibility of obtaining practical results with a machine capable of rising in the air and being propelled and steered by a human pilot was contemplated only by a few enthusiasts, and was a subject chiefly of interest to the cartoonist and the editor of the funny paper. Today it is a promising possibility. Both the aeroplane and the motor balloon are limited thus far by the impossibility of navigating with them in anything like rough weather, but interesting progress is being made by both. The principles underlying mechanical flight are not clearly understood, but it is by no means certain that the practical flying-machine of the future, if there is to be one, will resemble either the dirigible balloons or the aeroplane which are now in the experimental stage.

December 1908

The College of Engineering opened this year with an attendance of 874 students. This number compares very favorably with the attendance at the same time last year, although there seems to be considerable falling off in the number of freshman; the junior and sophomore classes have retained their former size, and the senior class has increased in numbers by fifteen per cent.

On Tuesday morning, October 20th, University exercises were dispensed with, and the student body, faculty, and many of the citizens of Madison, attended the memorial services in honor of William Freeman Vilas, held in the University Gymnasium.

April 1908

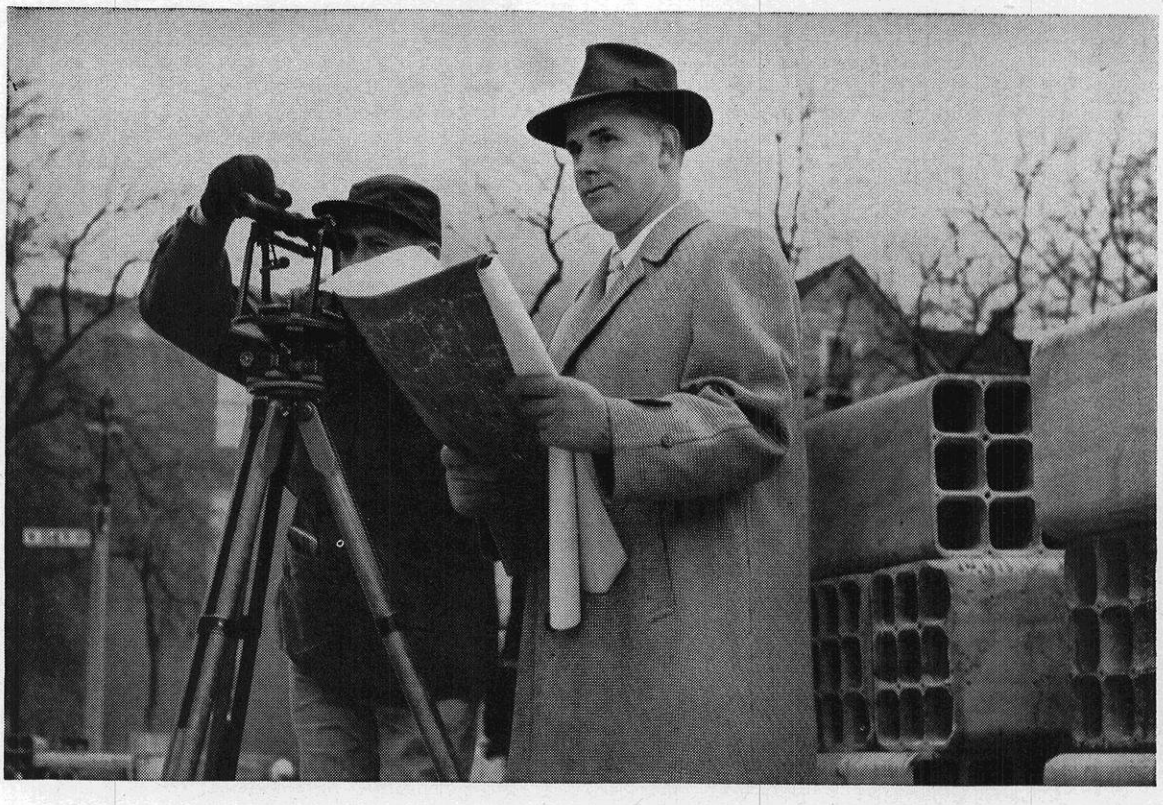
About sixty years ago the first buildings were erected here: University Hall on the crest of the Hill, and the two dormitories, North Hall and South Hall, at the right and left. Too much credit cannot be given to the architect of these first buildings. Their simple, dignified style, correct proportions and honest treatment of materials gave the keynote for future work.

December 1905

One of the most noteworthy improvements which has been made this year is the establishment of the long desired course in chemical engineering. The importance of this work has been urged for many years, but until the present year sufficient funds were not available for

(Continued on page 58)

A Campus-to-Career Case History



"The future looks unlimited"

"I wanted a career that offered variety, opportunity and a chance to work with people," says Lewis William Post, C.E., Michigan State, 1950. "So I chose the telephone company.

"My initial training—two full years of it—probed every phase of company operations and acquainted me with all of the jobs in the Plant Department, where I was starting.

"Today, as Plant Engineer, I'm responsible for preventive maintenance of all field equipment, installation of new facilities for wire and cable, and I work with architects and builders on telephone needs in new buildings.

"Selling's part of my job, too. I sell ideas—like the wisdom of planning for telephone service when you're building. Recently I advised an architect and an owner on telephone wiring and outlets in a new $160,000 medical center. I enjoy getting in on the ground floor of such projects and making contributions both as a civil and a telephone engineer.

"In my area of Chicago there are 80,000 telephones, home and business. More are being added every day. There's expansion everywhere in the telephone business—all across the country. To me, the future looks unlimited."

Lew Post's career is with Illinois Bell Telephone Company. Many interesting career opportunities exist in other Bell Telephone Companies, Bell Telephone Laboratories, Western Electric and Sandia Corporation. Your placement officer can give you more information about them.

Bell Telephone System

Yesteryear

(Continued from page 56)

its inauguration. Fortunately the construction of the new chemical laboratory left available in the old building space which could be utilized partially for this work, otherwise it would have been impossible to begin it at this time . . . This College is especially fortunate in having many alumni already in the gas business, and partly for this reason we are in a favorable position to emphasize this branch of the work. Special provision has accordingly been made in the course for advanced work in gas engineering, and this effort has been very favorably received by prominent gas engineers and associations.

Another considerable improvement under way is the construction of a building on the lake shore for the hydraulics laboratory. Up to the present time laboratory work in hydraulics has been confined to a very few small experiments in cramped quarters in the engineering building. Last year the regents voted an appropriation of $20,000 for the laboratory together with part of the equipment, and the work of construction is now well progressed.

December 1907

An important change has been instituted in the electrical course. The growing importance of alternating currents has led to the placing of the theoretical alternating current course in the second semester of the junior year.

June 1908

In order to facilitate the coming together of students and faculty and to incidentally advertise the club, the Civil Engineering Society gave a smoker on May 13th in the YMCA Union to which all the civil engineering students and the C. E. members of the faculty were invited. The response on the part of both the students and faculty was good, about 150 in all being present. The evening was a pleasant and enjoyable one and led to the free mingling of all those present. A number of the faculty were called upon to speak, a short musical program was rendered, and before the smoker broke up all gathered about the piano and sang college songs.

The "Alumni Magazine" recently contained an article on the apathy of Wisconsin alumni, especially those in Milwaukee. It is certainly lamentable that our alumni show so little interest in the University. Perhaps Milwaukee is too near-by to allow much enthusiasm to be aroused. There may be more spirit in cities further away. The senior class now being graduated should bear this in mind, and as they leave the University keep the spirit alive and try to foster that love and loyalty that characterizes the alumni of older colleges.

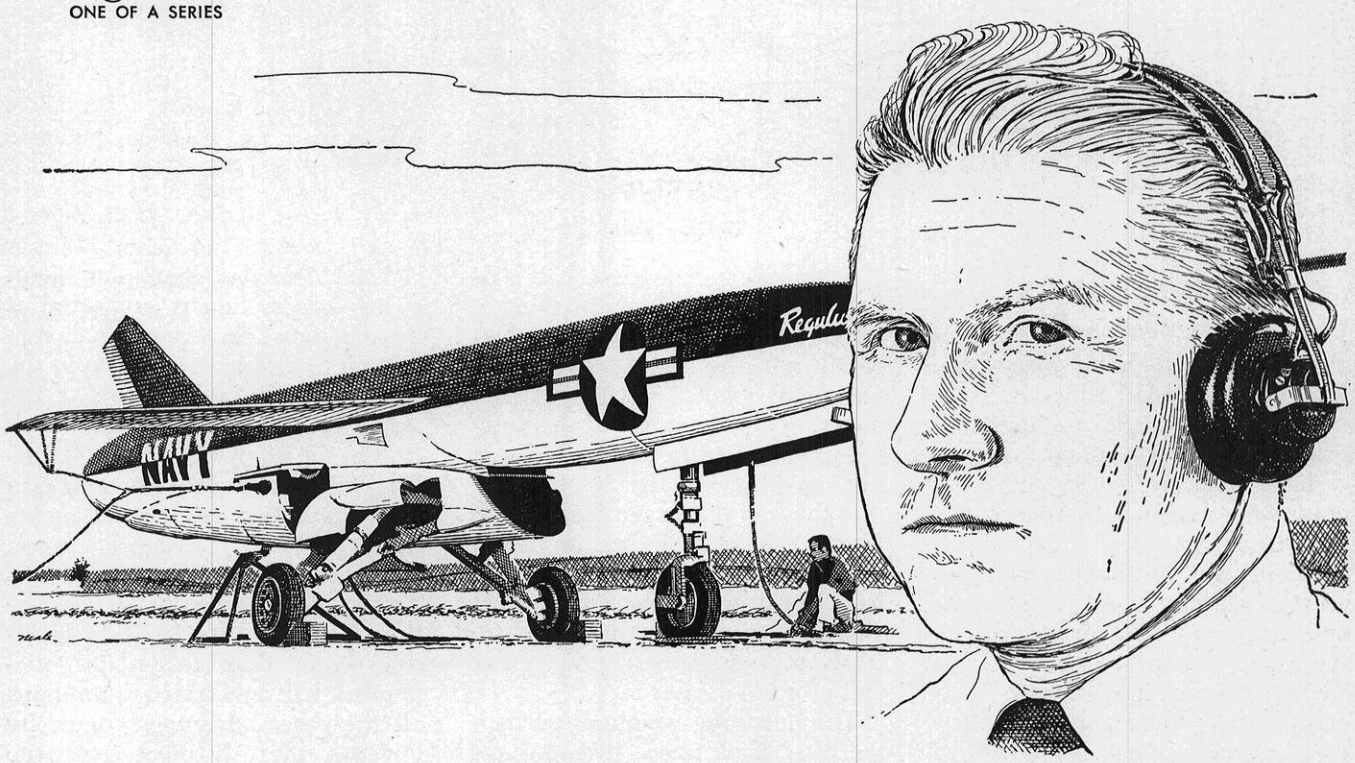
June 1906

PROSPECTS FOR ENGINEERING GRADUATES WITH THE ISTHMIAN CANAL COMMISSION. . . . In the spring and early summer of 1905 there was a general dissatisfaction on the part of the employees as regards conditions for life and work. In those days a man was considered an old timer when he had stayed two months. The quarters there were no where near adequate for the number of employees. For many the quarters which were promised, consisted of nothing but a roof and a canvas cot. The board was far from satisfactory. Malaria and Yellow Fever were prevalent. Therefore it is not strange that the employees did not remain long on the Isthmus. . . . Now that the conditions of life are better, the employees remain longer, and as a result promotions are slower.

. . . Again a large party of engineers is engaged in cross-section work. This kind of work gives the needed practice in instrument work, and the familiarity with actual work that the beginner so much needs. For this reason, a year, or perhaps eighteen months can be put in with the I. C. C. to a very good advantage. One should not underestimate the experience to be gained on a big undertaking like this, through careful observation. The prospects for work will likely be improved if contractors are given the construction of the canal. This would be another good reason for getting a foothold on the Isthmus before the contractors come.

THE END

A Vought Vignette
ONE OF A SERIES



Why the Missile Engineer Never Missed Mail Call

Vought's Regulus II missile took shape just a short walk from the desks of its developers. Engineers handled the new hardware and monitored tests in person — literally flying the big missile on the ground at Dallas. It was a convenient arrangement while it lasted.

Then a big USAF Globemaster landed and taxied to Vought's Experimental Hangar. The missile was winched aboard and airlifted to a desert site for flight tests. By nightfall there was a 1,000-mile rift between Regulus II and home base.

Joe Boston was ready to step into this gap. As Project Assistant for Field Liaison, he'd already equipped Vought's desert crew for extensive flight tests. Now he'd make sure that test data and hardware flowed uninterrupted from the desert to Vought. High-speed feedback of facts on one flight could influence the success of the next.

Mail from the desert poured in to Joe at Vought. From project men at the flight test site came parts for immediate rework and return. From the flight test crew's mobile ground station came rolls of telemetered brush records. From the recoverable Regulus itself, came packets of oscillograph data. And from Field Service — for repair or replacement — an occasional wrench or relay.

Joe served as clearing house and consultant. Flight data was reduced and released to design and support groups. It revealed not only missile performance, but the temperatures and pressures of a strange new environment. When data pointed toward design changes, Joe's time and cost estimates helped specialists reach decisions.

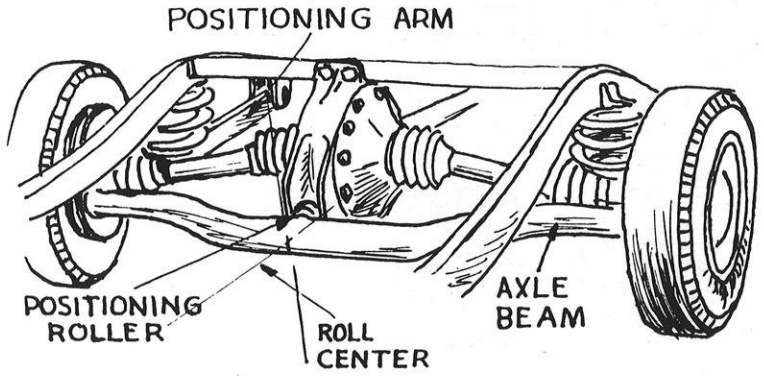
Thanks to Vought's fast overland relay of hardware and data, the records of one flight were decoded and digested in time to improve the next hop. Dividends in performance and reliability were obvious after six flights had been logged by Regulus II.

All six had been flown by one vehicle.

Chance Vought uses comprehensive testing and data analysis to assist the engineer through unexplored problem areas. Test facilities strengthen every phase of the development cycle, and procedures are aimed at feeding data quickly into the engineering process.

BUILDERS OF MILITARY AIRCRAFT
40th ANNIVERSARY
1917 TO 1957

CHANCE VOUGHT AIRCRAFT
INCORPORATED · DALLAS, TEXAS



DeDion axel.

Suspensions

(Continued from page 32)

ner is being taken at nearly the limit of tire-to-road adhesion.

The independent trailing link axle system offers a main advantage of light unsprung weight. It is the only swing axle type that has parallel wheel movement. The wheels move parallel because the trailing arms are firmly pivoted on shafts which are mounted by bearings to the frame, as can be clearly seen in the illustration. These shafts generally serve a dual purpose in that they can be made long enough to serve as torsion bars if one end is anchored to the frame. This gives even a further weight saving because the entire spring system is considered in the sprung weight of the frame. The axles, as in the deDion system, must be splined between the universal joints in order to allow for variations of axle length during bounce and rebound.

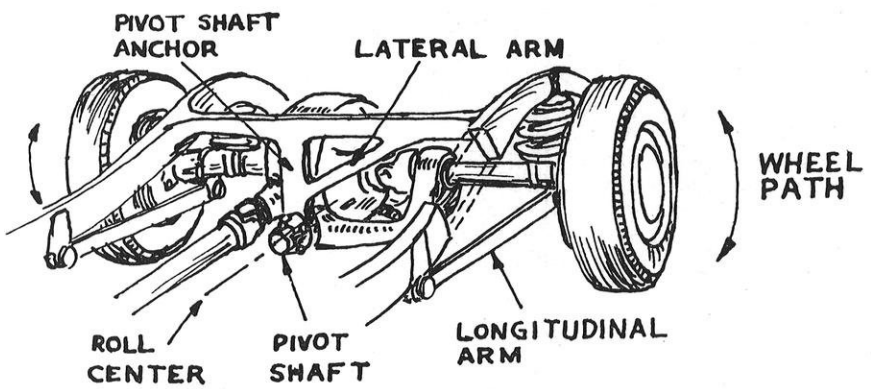
The main disadvantage is the location of the roll center; it being on the ground. This requires very stiff springs in order to control the amount of roll or lean during cornering. The cost is more than for the live axle but much less than for the deDion axle.

A typical independent half axle layout has the half axle pivoting at either side of and close to the differential unit, the pivots being in the universal joints. Cornering produces an outward lean of the outer wheel and a smaller inward lean of the inner wheel, the result being that the rear of the car tends to lift. This is undesirable, as the outer wheel, to which a portion of weight has transferred from the inner wheel, has camber angle which tends to reduce cornering power and produce oversteer.

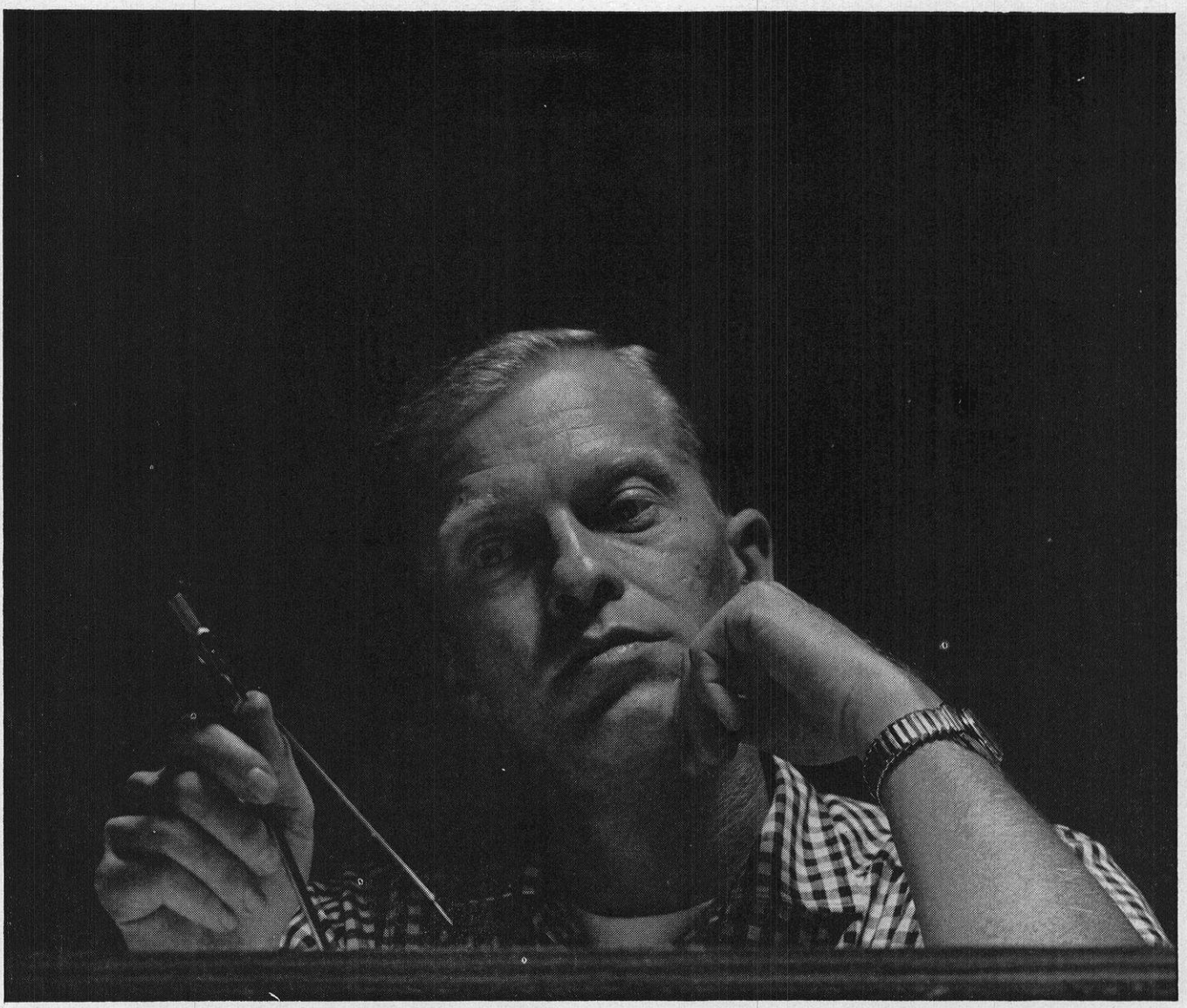
The unsprung weight is perhaps the least of all types. It is also one of the cheapest independent rear axle systems to manufacture. The roll center is slightly above the axle centerlines, as shown by the illustration. There is considerable roll stiffness, which causes a large weight transference to the outer wheels during cornering. As the front suspension almost always has a roll center lower than this, weight transference may be greater at the rear wheels than at the front, causing oversteer. The roll center can be lowered and still retain the lightness and other advantages of the independent half axles, as is done in the next and last type of axle, the Mercedes Benz low pivot axle.

The Mercedes Benz low pivot swing axle system is supported at three points. There are two longitudinal arms from the frame to the axle, one being at each end of the axle. The third is the arm which fastens the pivot shaft to the frame. The third arm also has a lateral arm connecting its bottom to the frame in order to control lateral movement of the whole system. These can be seen in the illustration. The low pivot gives a lower roll center than the plain independent half axle system but retains all the other advantages of it. By lowering the axle pivot shaft, the roll center is lowered and the effective swing axle radius is increased, thereby giving greater roll resistance without extremely stiff springs being used. Unsprung weight is almost as small as with the half axle layout. Camber variations are less than with the half axle system because of the increased swing axle radius. It is no more costly to produce than the half axle system because it is even less complicated. It has proven to be the best overall system to use, both in competition racing cars and in ordinary sports cars and sports sedans.

THE END

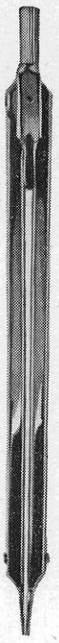


Mercedes Benz low pivot swing axel.



How to engineer a career

"3M Company has traditionally reinvested approximately fifty percent of earnings in research and the capital investment required to produce and market the products of research."—3M Annual Report.



Best career advice we know is to "make no *little* plans". If you're the kind who measures the outer dimensions of the future with the divider's legs standing in a giant stride, we think you'll be interested in the 3M Company.

This unusually fast-growing company encompasses a wide world of products and fields of interest that leave plenty of room for growth—yours and ours.

Take our measure . . . in terms that are vital to your career. 3M sales have more than doubled in the last five years. Fact is, more than 22% of the products now being sold by 3M were developed in the last five years . . . exciting products like "SCOTCH" Brand Magnetic Tapes to guide rockets and "THERMO-FAX" Brand Heat-activated Copying Machines.

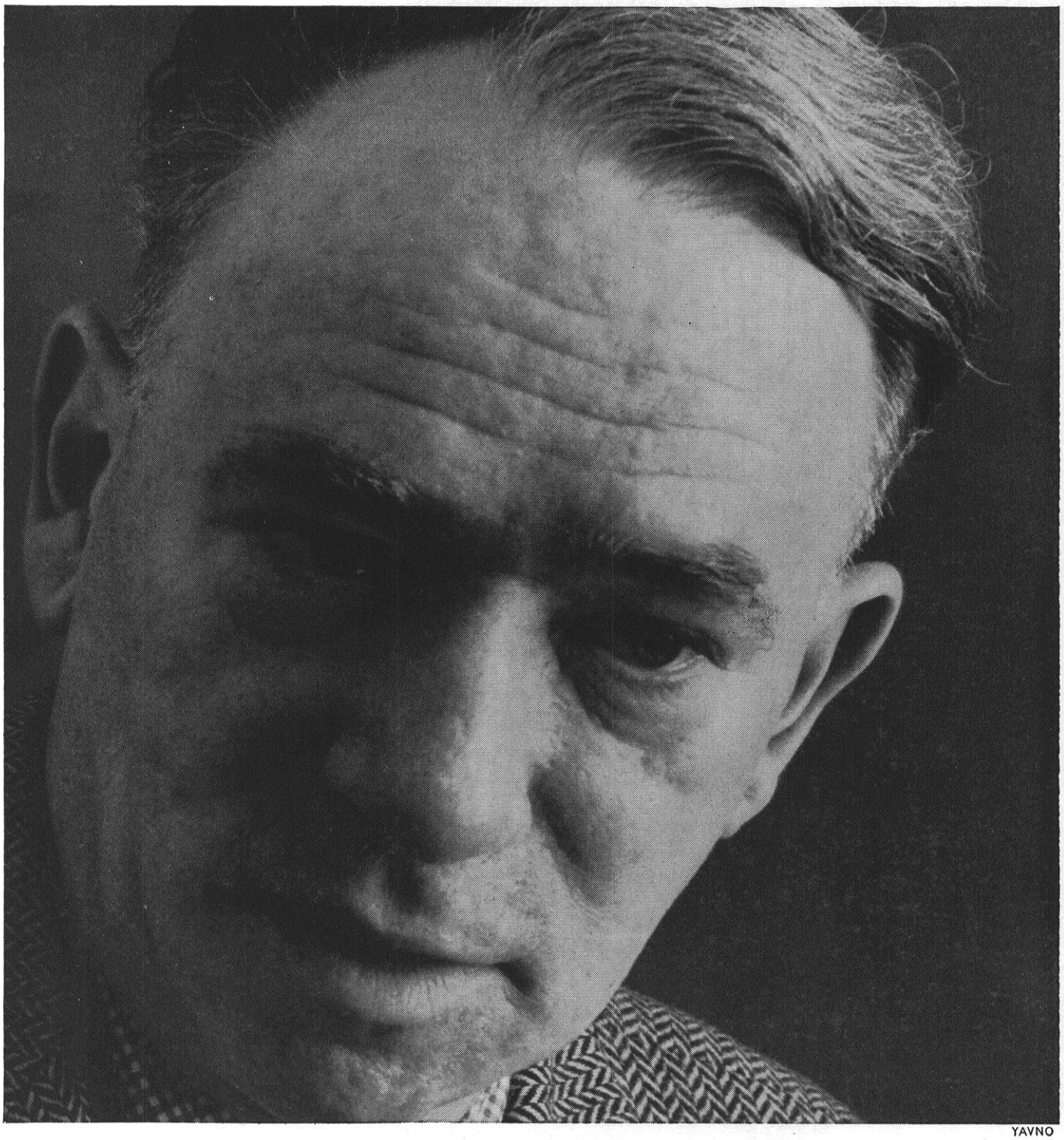
Of course, 3M people are responsible for this growth . . . through new ideas and creative engineering. And it means that they are growing, too . . . in responsibilities, earnings, opportunities.

If we sound like your kind of company, write us now for full information. Minnesota Mining and Manufacturing Company, St. Paul 6, Minnesota.

MINNESOTA MINING AND MANUFACTURING COMPANY

... where Research is the key to tomorrow

3M COMPANY



YAVNO

...on the prevention of total war

"Modern civilization is now faced with a task of fatal urgency. Unless man can find ways of limiting war, modern civilization itself may perish. The difficulties of limiting warfare today contrast with the capacity of major powers to wage total war with ever fewer restrictions and ever fewer survivors. Today, it is no longer a common belief in the dignity and destiny of man, but only prudence and fear, that can prevent total war. And yet, in the light of reason, the efforts to avert total war hold more promise of success than the hope for freedom from all war. It still is easier, as it has always been, for man to restrict war than to establish peace on earth."

—H. Speier, Head of the Social Science Division

THE RAND CORPORATION, SANTA MONICA, CALIFORNIA

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

Science Highlights

(Continued from page 37)

screen on the inner face of the picture tube. The black lines between each pair of white ones are unexcited areas of the screen not used in constructing the picture. Present television standards in the United States set the number of picture lines at 525.

Previous research, which has been verified by experiments, shows that the viewer moves back from a television picture until he just fails to clearly distinguish these individual lines. For a 24-inch picture, this 'normal' viewing distance turns out to be about ten-and one-half feet. Placed closer than this, the viewer begins to distinguish the horizontal line structure of the picture, which structure he finds distracting.

If this line structure is reduced or eliminated, television pictures larger than those furnished by the usual 17 or 21-inch receiver can be viewed with comfort at short distances. With line structure reduction we find that the average viewer tends to select a viewing distance of about six feet from a 24-inch picture rather than a distance of almost 11 feet without it.

The new Westinghouse technique employs a method of wobbling the electron beam vertically as it makes its repeated traces across the television picture tube. The slight up-and-down motion of the beam broadens the white lines which carry the picture information and narrows the distracting black lines which lie between them.

This so-called "spot wobble" actually dates back several years, but heretofore the methods for accomplishing it have involved considerable equipment and have not been entirely satisfactory. The Westinghouse system eliminates these problems by taking advantage of the "split grid" structure inside the television picture tube itself.

The split focusing grid still serves its regular function of sharply concentrating the electron beam on the screen, but at the same time a fluctuating voltage may be applied which wobbles the beam up and down about 15 million times per second. The "wobbling" voltage is supplied by a single electronic tube fitted to a socket into which the television picture tube is plugged.

The Westinghouse scientists emphasize that "spot wobble" is still in its experimental stages and has not yet been adopted on a commercial scale. Such adoption would likely require some change in the habits of television viewers.

NEW PROPULSION SYSTEM FOR LANDING CRAFT

A right angle drive propulsion system for landing craft, combining the advantages of an inboard engine with those of a fully steerable outboard propeller, has been developed by Waste King Corporation. The new system has satisfactorily completed Navy acceptance trials and will now undergo further testing by the Bureau of Ships. It replaces the conventional rudder system in current model landing craft with an inboard engine driving an outboard propeller capable of rotating 360° or more without stops. This increases a coxswain's ability to maneuver in close quarters by providing complete craft control in all directions under the most adverse conditions.

The system also incorporates a new design principle which permits direct mechanical steering by eliminating the torque reaction of the propeller. This enables the craft to make maximum use of available engine power while traveling in any direction. Correct blade rotation in any direction, and under full throttle, assures effective backing and side thrust.

Landing craft using the new system generally are maneuverable enough to avoid broaching on the beach. If they do broach in heavy seas, however, the propeller may be swivelled instantly to the most desirable position. Sufficient side or reverse thrust is then available to pull the craft free..

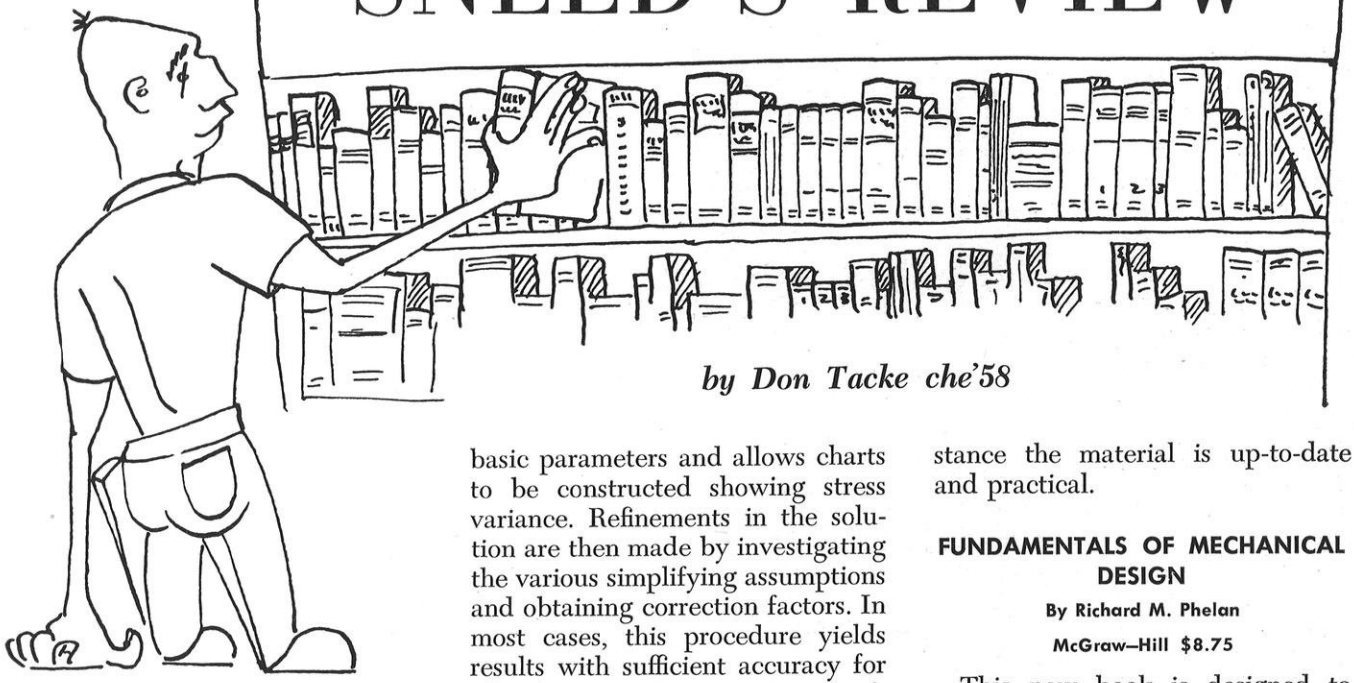
With the new system, a coxswain can maintain complete control at all times by keeping one hand on the steering wheel and the other on a power control lever. This lever combines the functions of a throttle and reverse clutch.

All of the propulsion machinery —including steering wheel, instruments, and engine controls—are mounted on a single frame to simplify installation. There are no alignment problems between machinery and hull. The only connections required are battery cables and fuel lines.

(Continued on page 66)

Right-angle drive for landing craft.

SNEED'S REVIEW



by Don Tacke che'58

THERMAL STRESSES

By B. E. Gatewood

McGraw–Hill $7.50

This is the first book on thermal stresses to cover all phases of the design problem of elevated temperatures. The author's purpose is to give basic information for attacking the problems of thermal stress, and to indicate possible procedures for solving those associated particularly with elevated temperatures in airplane and missile structures, turbines, and nuclear reactors. Not restricted to the classical thermal stress problem of finding the elastic thermal stresses for a given temperature distribution in a structure with no buckling, this book touches on *all phases* of the design problem for structures—temperature distribution; the elastic and inelastic thermal stresses in various structures; the combined elastic and inelastic applied and thermal stresses; the allowable stresses for various materials and loading conditions; the buckling, deflection, stiffness, fatigue, shock, and flutter effects of elevated temperatures.

Method—A complete problem is set up and then simplified by making assumptions based on the physical situation or on experimental data. An analytical solution is obtained for the approximated problem, which demonstrates its basic parameters and allows charts to be constructed showing stress variance. Refinements in the solution are then made by investigating the various simplifying assumptions and obtaining correction factors. In most cases, this procedure yields results with sufficient accuracy for use in the design of aircraft structure.

As emphasis is on fundamental theory, the treatment is applicable to many types of machines other than aircraft—nuclear reactors, rocket motors, steam and gas turbine design, and guided missile air frames. This makes the book of considerable interest to many mechanical, chemical, and metallurgical engineers, and especially to areonautical engineers.

RADIATION SHIELDING

By B. T. Price

McGraw–Hill about $8.00

This book, an invaluable reference for students, teachers, engineers, and research workers in nuclear engineering, covers both the scientific and the practical aspects of shielding. The emphasis throughout is on the basic physics, so that the reader will be equipped with a solid groundwork for developing his own approximate methods of dealing with difficult problems. The book treats health physics, gamma rays, neutron physics, and fast neutron attenuation at length. It also deals with optimization of shield weight, concretes for reactor shielding heating effects, shielding for transport of radioactive materials and shield windows. There is a vast amount of data in graphical form, and in every instance the material is up-to-date and practical.

FUNDAMENTALS OF MECHANICAL DESIGN

By Richard M. Phelan

McGraw–Hill $8.75

This new book is designed to present the fundamentals of mechanical design to engineering students in a minimum time by the integration into one book of the most important concepts normally covered in the design sequence for mechanical engineers: kinematics, mechanism, dynamics of machinery, and design of machine elements. The major emphasis is placed on what can be done, what principles are involved, and where one can find the additional detailed information that may be required in the actual design or selection of mechanical elements or a machine.

Keeping in mind the rapid growth of all fields of engineering and the necessity for constant reevaluation of the curricula, the author has written FUNDAMENTALS OF MECHANICAL DESIGN primarily as a textbook, and not as a complete manual of mechanical design for the practicing machine designer. The book seeks to give background information that will enable the engineer to choose wisely the elements of units to be designed or purchased. There is a wealth of illustrations of actual parts and machines. The philosophy and coverage make it valuable as a starting point for engineers not currently in close contact with the field of mechanical design.

THE END

Tear out this page for **YOUR STEEL NOTEBOOK...**

Small steel tube with a giant memory

IBM engineers needed a small steel tube—a memory unit for a computer—whose whirling surface would pick up thousands of complicated figures as magnetic impulses, retain and, years later, read them back instantly. This called for the cleanest, most uniform quality steel that could be produced. IBM consulted Timken Company metallurgists, who recommended a certain analysis of Timken® fine alloy seamless steel tubing. IBM found the steel so clean that when properly plated it accurately recorded up to 100,000 electro-magnetic impulses. So strong it withstood the centrifugal forces of 12,000 rpm without distortion or damage. It's another example of how Timken Company metallurgists solved tough steel problems.

WANT TO LEARN MORE ABOUT STEEL OR JOB OPPORTUNITIES?

To learn more about electric furnace fine alloy steel, send for "The Story of Timken Steel Quality". And for help in planning your future, write for "Career Opportunities at the Timken Company". We will reply promptly. The Timken Roller Bearing Company, Canton 6, Ohio.

See the next Timken Televent hour, "The Innocent Years" over NBC-TV, Thursday night, November 21st.

TIMKEN *Fine Alloy* STEEL

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

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING

Science Highlights

(Continued from page 63)

The right angle drive unit currently being tested by the Navy is installed in a new LCVP prototype, designed by the Kettenburg Boat Works, San Diego.

"AUTOMATIC ENGINEER" HELPS DESIGN TANKS

An "automatic engineer" that helps to design tanks is now under development by Lehigh Engineering Associates of Newark, New Jersey. This unusual project—a tank fighting compartment simulator— is being developed for the United States Army. Not a training instrument, the simulator is devised to reproduce the various forces which act upon a tank fighting compartment and on the gunner in it. The simulator obtains immediate results, saving valuable design time and months of calculations.

Designed from just the basic idea at Lehigh's Development Laboratory in Orange, New Jersey, the simulator has been the object of intense concentration by the organization's key engineers and technical personnel during the past year. Heading the group is Donald H. Fryklund, Lehigh's Chief Project Engineer.

WHAT IS A GOOD WELD?

A research project recently completed in the Department of Welding Engineering at the Ohio State University in Columbus, Ohio, offers a challenge to industry to eliminate the high cost of weld inspection. The cost of testing and inspecting welds, often required by code to be done with elaborate equipment, frequently equals, or may even exceed, the cost of making the welds. The Ohio State University project, investigating the effects of porosity in welds, has established facts which, if used, could eliminate the necessity for much of the inspection now required to locate and measure porosity in welds.

A series of tensile, bend and impact tests were made on butt welds in ½ inch thick mild steel. The welds were made under controlled conditions with automatic submerged arc and inert gas processes so as to create porosity in welds. These tests showed that the welds could contain porosity amounting in total volume to a void equal to 7% of the cross section of the weld without materially changing the tensile or impact strength and ductility of the welds. The tests were all made on welds machined flat from the ½ inch thickness of the plate. Since most welds are made with a build-up that increases the cross section of the weld, the 7% figure will actually be larger for welds made with normal procedures. The shape and distribution pattern of the porosity had little or no effect on the test results.

A small amount of porosity is generally accepted by current inspection standards. However, since the results of the Ohio State University tests show that up to 7% reduction of the cross section has little or no effect on weld strength, a re-evaluation of inspection standards is indicated.

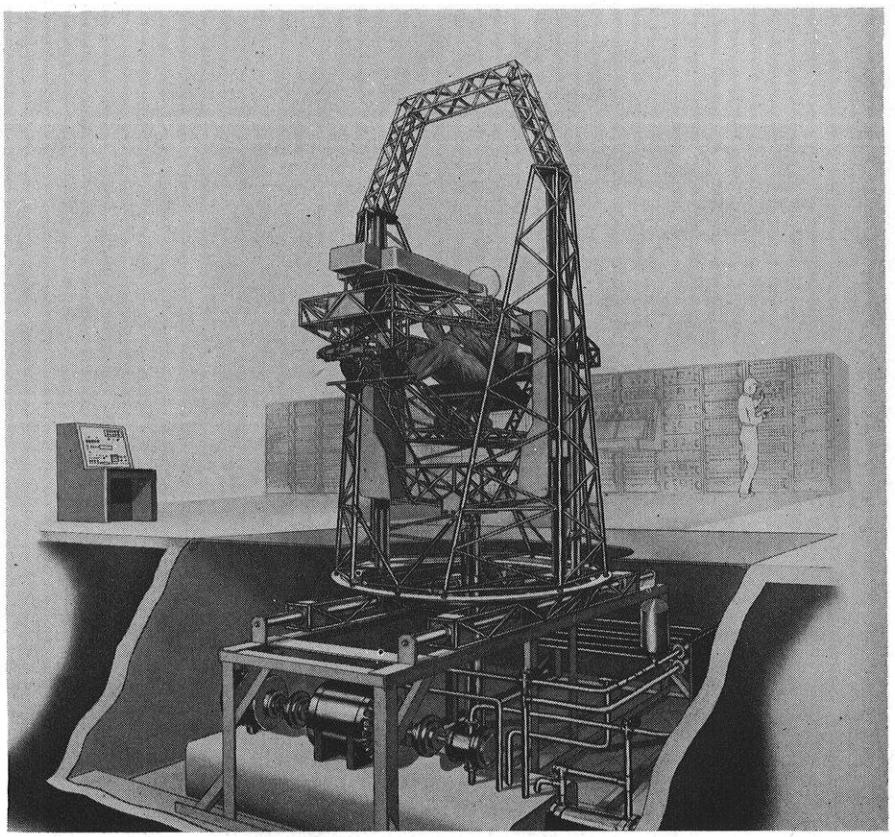
The tests were conducted under the direction of William Green and Roy McCauley of the Welding Engineering Department of Ohio State University and will be reported in a paper to be presented by them before the American Welding Society at its annual spring meeting in April in St. Louis.

NEW MANUFACTURERS' BOOKLETS

A design data booklet to assist in layout of efficient heating systems for factories, auditoriums, gymnasiums and other large area buildings is being made available by Carrier Corporation. Entitled "Design Data Heating" the 71-page manual has been issued by Carrier's Unit Heater Department. It contains engineering information for determining proper application and capacity requirements of unitary or central plant systems. Subjects covered in the guide include survey, design conditions, transmission coefficients, heat loss calculations and piping sizes. The design data booklet can be obtained by writing the Unit Heater Department, Carrier Corporation, Syracuse 1, N. Y.

A 73-page illustrated handbook which details the basic principles of molding and handling Plaskon urea and melamine molding compounds is offered by Barret Division, Allied Chemical & Dye Corp. Because of its general nature, the handbook is believed to be of value not only to molders, but to mold makers, designers and engineers. The manual has been compiled as a general guide to the proper storage, pre-

(Continued on page 68)



Integrated fighting compartment simulator.

FYI

FOR YOUR INFORMATION

Allied Chemical

DIVISIONS
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National Aniline
Nitrogen
Semet-Solvay
Solvay Process
International

- *facts on food colors*
- *new aerosol mold release*
- *chromium chemical data books*

Facts on food colors

What about those headlines on food colors? And the stories that some certified food colors are toxic? Is there anything to the Food and Drug Administration's recent delisting of three previously acceptable colors?

Here are a few facts behind the headlines.

The practice of coloring food is centuries old. Though the early colors were of natural origin, they have been replaced in the coloring of many foods by superior synthetic colors — the certified "coal-tar" colors. The Food and Drug Administration has been certifying a number of these colors for use in food since the early 1900's.

You're probably aware of some of the foods commonly colored today: ice cream, soft drinks, baked goods, candies, processed cheese, gelatin desserts, orange skins, margarine, butter.

Why then have some food colors been "delisted" and why are others being considered for delisting?

The controversy centers on the meaning of a single word in the Federal Food, Drug and Cosmetic Act: "harmless."

The Food and Drug Administration's definition: incapable of producing harm in any quantity or under any circumstances.

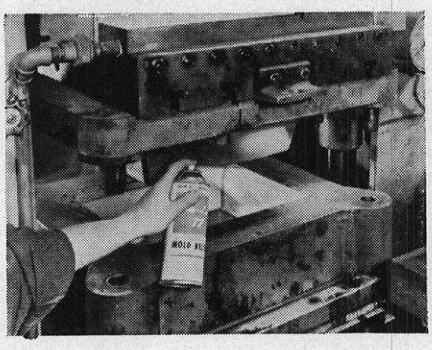
The food color industry's: incapable of producing harm under normal conditions of use.

It is the industry's view that FDA animal tests of certified colors have made use of quantities of color unrelated to — and far in excess of — quantities normally ingested by humans. A newspaper interview quoted the Commissioner of Food and Drugs as saying that he "conceded that three coal-tar dyes recently banned were harmless as used, but explained that their use was [a] technical violation of the law as now worded."

The absolute FDA standard seems to find support in the popular tendency to regard synthetics as inherently inferior to natural products. Yet, many fresh vegetables we eat every day contain small but tolerable quantities of naturally occurring poisons which, if judged as food colors are now being judged, would lead to the elimination of a large part of our vegetable diet.

What the food color industry asks is an amendment to the present law which would clearly grant power to the FDA to set quantitative limits on the use of colors in food. Such limits would safeguard public health, permit maintenance of our food color supply, and encourage research in the field.

Two articles — one supporting the industry's position, the other detailing manufacture and quality control of food colors — have been prepared by Allied's National Aniline Division, the leading food color producer. You can get them by checking the coupon at right.



Aerosol mold release

Remember the line that went, we could have some ham and eggs if we had some ham . . . and some eggs. Stretch your imagination a good deal, and it has some relevance in the business of molding.

Low-molecular weight polyethylene is a superior mold release.

There's hardly a more convenient way to dispense liquids than with an aerosol spray.

Ham and eggs: POLY-LEASE 77, a low-molecular weight polyethylene in a mixed solvent system, supplied in aerosol form. The spray's push, by the way, is from Allied's GENETRON propellants.

Here's how it works. When hot or cold mold cavities or other objects are sprayed, a smooth, relatively hard film forms quickly on the surface. This film provides efficient release with a minimum number of spray applications, resulting in faster cycle time, reduction of rejects and consequent lowering of production costs.

POLY-LEASE 77 will be of interest to molders of rubber, plastics (epoxies, polyesters, phenolics, alkyd, urea, melamine), powdered metal.

Chromium chemicals

The authoritative collection of chromium chemical technical bulletins has been published, appropriately enough, by the leading producer of chromium chemicals.

The books describe Allied's MUTUAL chromium chemicals and their applications in leather tanning, corrosion control, and anodizing of aluminum.

We'd be pleased to send either a brochure describing 49 bulletins available, or the bulletins in your field of interest.

POLY-LEASE 77, GENETRON and MUTUAL are Allied Chemical trademarks

Creative Research

These examples of product development work are illustrative of some of Allied Chemical's research activities and opportunities. Allied divisions offer rewarding careers in many different areas of chemical research and development.

ALLIED CHEMICAL
61 Broadway, New York 6, N. Y.

Engineering

(Continued from page 44)

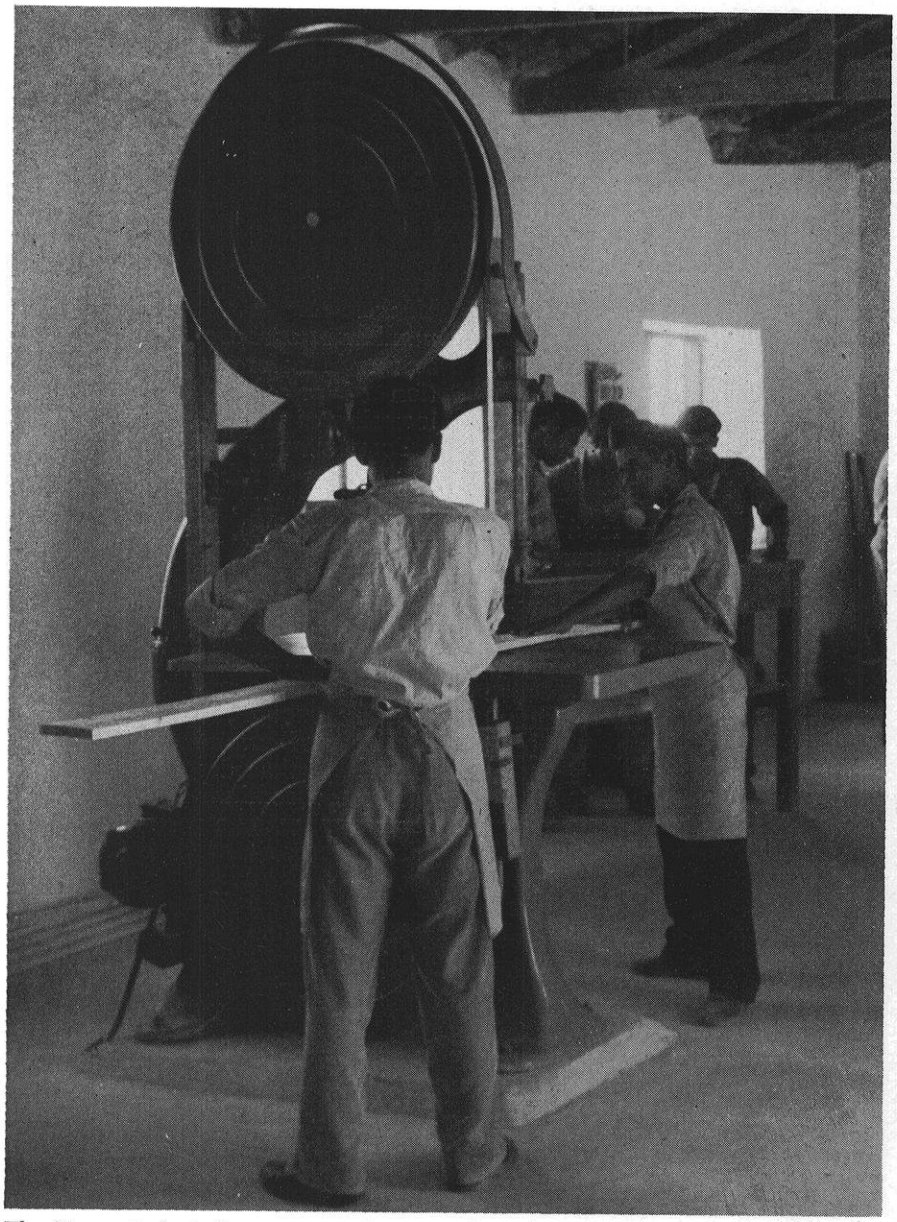
Arabia welding pipes to conduct oil from the wells to the coast where it can be loaded into ships and taken to European and other countries.

Tailoring and pressing are also taught to a number of boys, an art that is always in demand, and that will bring a good artisan a steady income.

recent report on Y. M. C. A. Work with Arab Refugees, the statement is made that "The school is an oasis of hope in the midst of despair and embitterment, and every young man added to the work shop helps in closing down one more devil's work shop."

Here, then, are two examples of how elementary engineering in the form of vocational training in agriculture, carpentry, blacksmith work, weaving, tailoring, etc. is helping people without a home and without a land in the Middle East to find hope in the future and to become productive citizens in the land of temporary exile from their homes which are so near, and yet so far.

THE END



The New—students learn cooperation as well as the use of machinery as they help each other in the operation of a band saw.

The people in the Y. M. C. A. have set up this training center to make the young self-supporting as they grow up and to make these people, who are now refugees and forced to live on charity, useful and productive citizens when they get into a normal environment. In a

Science Highlights

(Continued from page 66)

forming, preheating, molding, finishing and testing of Plaskon urea and melamine molding materials. Its three sections include basic information on molding; properties of the molded products; and general reference material. Illustrations include diagrams and four-color representations of end products. Text is supplemented by charts, graphs and mathematical and physical conversion tables.

Free copies of *Planning For New Sewers* may be obtained by writing to the Clay Products Association, 100 N. LaSalle St., Chicago 2, Illinois.

Architect and engineering professors and students will benefit from a new college outline in timber design and construction prepared by Timber Engineering Company, engineering and research affiliate of the National Lumber Manufacturers Association. The new "Outline for a College Course in Timber Engineering and Construction", mailed recently to engineering and architectural colleges and universities, fills a continuous need for a comprehensive course of study in timber engineering, design and construction. Copies of the college course outline are available, free of charge, from Timber Engineering Company, 1319–18th Street, N. W., Washington 6, D. C.

A unique method of building concrete pouring form panels, that can be re-used many times more than can the conventional type, is helping contractors and builders hold down construction costs, according to Timber Engineering Company, research affiliate of National Lumber Manufacturers Association. Providing added strength and rigidity in each panel, the new method not only extends the service life of the forms, but permits greater precision in poured concrete construction. Construction of the new type panel is detailed in T-L-G Specification Sheet No. 14, and its use shown in a new Teco Project Sheet. Both publications are available, without charge, from Timber Engineering Company, 1319–18th Street, N. W., Washington 6, D. C.

THE END

How to make the most of your engineering career
ONE OF A SERIES

go where engineers don't get lost in the crowd

One of the many hurdles that can slow down your progress as an engineer is getting lost in the crowd. It can happen in smaller companies as well as in big ones.

That's because size itself is not the villain. The thing to watch out for is the kind of company organization that swallows you up and erases your individual identity.

Boeing is one company that takes steps to see that engineers *don't* get lost in the shuffle. Boeing engineers, for instance, work in small integrated teams where initiative and ability get plenty of visibility. Each engineer gets a personal merit review every six months—assuring you a continuing opportunity for individual recognition. In addition, Boeing engineers are eligible for advancement at any time between reviews. There are many other advantages to careers at Boeing—including assignment to exciting missile and jet-age projects, high starting salaries, liberal retirement and company-paid graduate study programs.

There are *family* advantages, too. One is a choice of three sections of the country in which to live. In each Boeing community you'll find good housing and schools, a youthful spirit, and abundant recreational facilities for the whole family.

Boeing has openings for engineers, and for physicists and mathematicians—openings with a world of opportunity for advancement.

Now is the time to start planning ahead. Consult your Placement Office, or write:

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

R. J. B. HOFFMAN,
Chief of Engineering Personnel,
Boeing Airplane Co., Wichita 1, Kansas

BOEING
Aviation leadership since 1916
Seattle, Washington Wichita, Kansas Melbourne, Florida

ENGINE EARS

by Pete DeWitt che'60

STUDENT ENGINEERING AWARDS

Engineering Undergraduates in twenty-six engineering schools and universities received recognition and awards this year in the annual competition sponsored by The James F. Lincoln Arc Welding Foundation of Cleveland for student designs of welded machines and structures. A total of forty-six awards amounting to $5,000 were given to engineering undergraduates. Duplicate awards in scholarship funds were presented to schools honoring the students whose designs received the main awards. Awards were made for papers submitted to the Lincoln Foundation presenting designs of machines and structures improved through the use of welded design.

Two men from the University of Wisconsin Mechanical Engineering School won awards in the contest. David R. Stuff was awarded a $25 award in structural design for his plan for an all-welded aluminum boat, while Philip F. Thaldorf won a $25 award for his design of a power hack-saw base.

AIEE OFFERS PREPRINT

A preprint of the Electrical Engineering Education section of the October, 1957 issue of "Electrical Engineering", the official organ of the American Institute of Electrical Engineers, is being prepared for distribution to colleges and universities.

The preprint will be bulk-mailed to Student Counselors at colleges which have Student Branches or Affiliate Branches of AIEE, who will distribute them gratis to engineering students.

It will contain news of AIEE Student Branches, several technical papers which won AIEE district Student prizes, and other various articles.

ASME MEETS IN NEW YORK

Modern techniques for an ancient industry will be the topic of the Wood Industries Division of The American Society of Mechanical Engineers when it meets in New York on December 5, according to an announcement by meeting chairman L. A. Patronsky of Spokane, Washington. Mr. Patronsky, product development engineer for Pack River Tree Farm Products, said that the one-day session which comprises the division's portion of the ASME Annual Meeting, at the Hotel Statler will feature five talks by authorities in the lumber field.

Chairman for the morning session is Norman C. Bye, director of engineering in the H. K. Porter Company, New York. In the afternoon Frederick F. Wangaard, professor of Lumbering in the Yale School of Forestry will preside. Their vice chairmen will be Harry C. Johnson, vice president of the Babcock Machinery Company and Ronald R. Gale of Ronald R. Gale Associates, respectively. Overall program chairman is Chester Babcock, president of the Babcock Machinery Company.

ASTM SCHEDULES PHOTO EXHIBIT

The American Society for Testing Materials has announced that it will hold its 12th technical Photographic Exhibit in conjunction with its 61st Annual Meeting and 13th Exhibit of Scientific and Testing Apparatus and Laboratory Supplies at the Hotel Statler, Boston, Mass., June 23–27, 1958.

This biennial exhibit has become one of the foremost technical photographic shows in the country. Entries will be accepted from all members of the American Society for Testing Materials and from employees of company members.

Classes of photographs to be displayed are: General, Photomicrographs and Electron micrographs. Black and White, Color Prints, and Color Transparencies will be shown. Special attention will be given to the sections on photomicrography and electron micrography. To be accepted, entries must be informative in their particular technical field.

Students of engineering colleges are especially invited to display their work in metallography and other technical photographic techniques. Membership in ASTM is not a prerequisite to competing as a student.

Further information regarding conditions of entry and applications may be obtained from E. W. Walsh, Chairman, ASTM Photographic Exhibit, The Narragansett Electric Co., 15 Westminster St., Providence, Rhode Island, or the Headquarters of the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

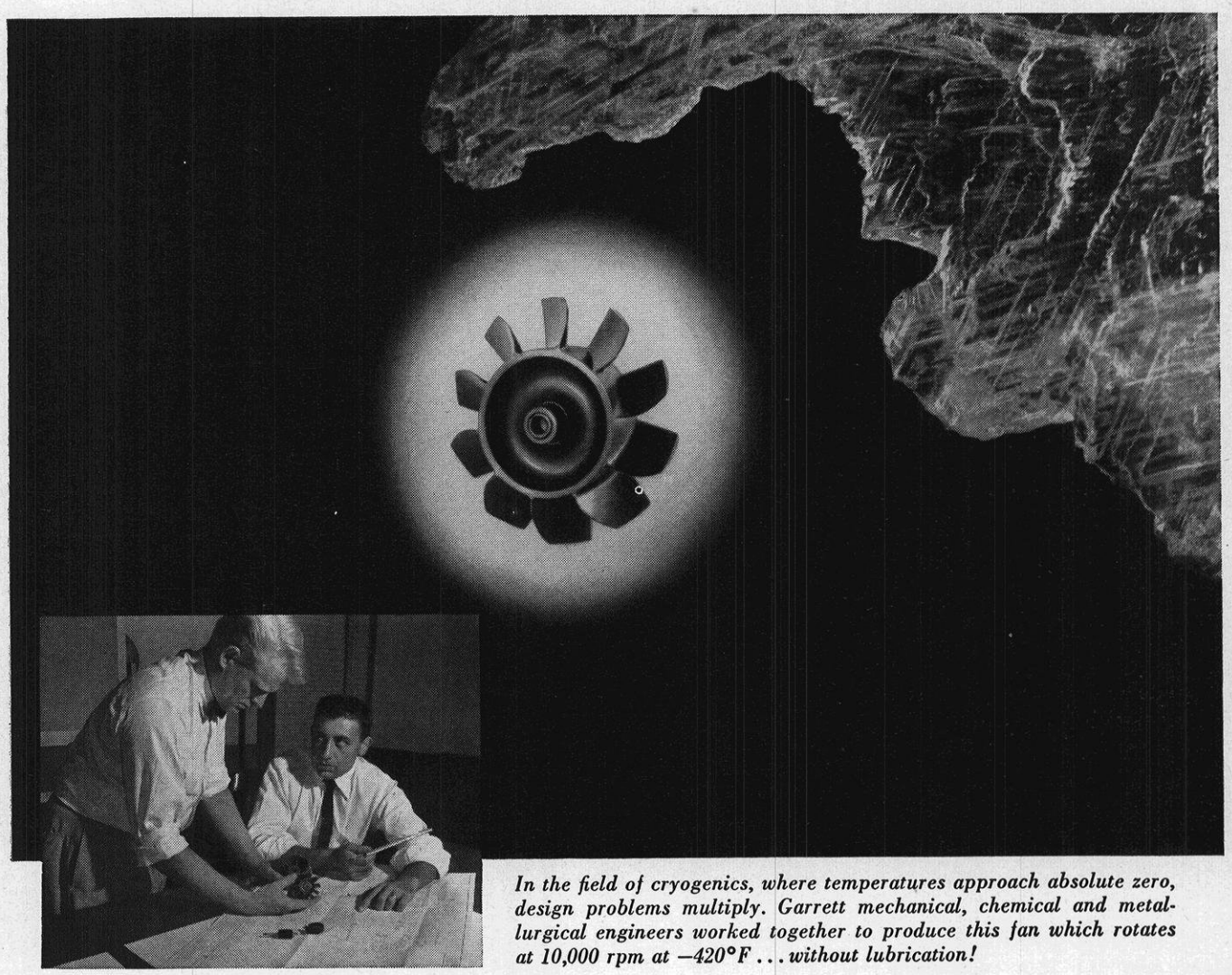
ALUMNI NEWS

HOWSON ASCE PRESIDENT

The American Society of Civil Engineers has elected Louis R. Howson, of Chicago, President for one year. Mr. Howson, succeeding Mason G. Lockwood, of Houston, Tex., will be installed Oct. 16 at

(Continued on page 72)

Maximum results from a college education...



In the field of cryogenics, where temperatures approach absolute zero, design problems multiply. Garrett mechanical, chemical and metallurgical engineers worked together to produce this fan which rotates at 10,000 rpm at −420°F . . . without lubrication!

Education is the springboard for your future. Couple it with the proper engineering experience, such as you receive at Garrett, and you have the ingredients for a successful career in engineering fields which will be expanding for years.

At Garrett, specific opportunities in aircraft, missile and technological fields include: system electronics; computers and flight instruments; gas turbine engines and turbine motors; prime engine development; cryogenic and nuclear systems; pneumatic valves; servo control units and air motors; industrial turbochargers; air conditioning and pressurization and heat transfer.

In addition to direct assignments, a 9-month orientation program is available to aid you in selecting your field of interest. This permits you to survey project, laboratory and administrative aspects of engineering at Garrett. With company financial assistance you can continue your education at outstanding universities located nearby.

Project work is conducted by small groups where the effort of each individual is more quickly recognized and where opportunities for learning and advancement are greatly enhanced. For complete information, write to Mr. G. D. Bradley.

THE GARRETT CORPORATION

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W.S.P.E.

(Continued from page 52)

Future in Wisconsin" Dean A. B. Drought of the Marquette School of Engineering led a discussion on "Relative Roles of State and Private Universities and Colleges in Engineering Education." A discussion on "The Role of Engineering Technician", was led by Karl Werwath, President of Milwaukee School of Engineering. Other discussions on engineering topics were led by Dr. Liddle and Prof. T. J. Higgins of the University of Wisconsin.

The business meeting was held immediately after the education panel and all committee reports were presented.

President Genisot surprised engineers and their ladies with a little party prior to the banquet. It was at this party that the ladies had their first opportunity to tell the men of the wonderful day they had as guests of the Conservation Department. The engineers were envious of tree-planting and fire fighting demonstrations arranged for ladies. A real "Smoky the Bear" made his appearance to emphasize the prevention of forest fires. Seeing wild deer in the woods added real excitement to the ladies' outing on Saturday. We understand also a few nature boy engineers helped open the bow season with two very close shots on "live ones".

The Board of Directors met Sunday morning and conducted business on nominating committee, legislative reports, inter-professional committee, reviewed proposed by-law changes, and proposed study of industrial climate in Wisconsin. The Consulting Function Group presented their Rules of Government and Operation and a budget request to the Board of Directors for their action at the next meeting.

The local arrangements committee of the Wisconsin Valley Chapter certainly deserves a big "Thank You" from the large turnout of engineers and wives attending the 10th summer conference at Kings Gateway.

ENGINEERING EXAMINATIONS

The Wisconsin Registration Board of Architects and Professional Engineers have announced the dates of their next Engineering Examinations as February 3 and 4, 1958. To be eligible for those examinations, application must be on file in the Board's office on or before December 1, 1957. Application forms and information may be obtained at or by writing to the Board's office, 1140 State Office Building, Madison, Wisconsin.

Examinations will be conducted February 3, 1958, at Madison and Milwaukee, Wisconsin, for those desiring Certification as an Engineer-in-Training. To qualify for certification as an Engineer-in-Training the applicant must, in addition to passing the one-day, 8 hour, examination on the fundamentals of engineering, have a record of 4 years of satisfactory engineering experience. All of the required 4 years of experience may have been gained by formal education.

Examinations will be conducted February 3 and 4, 1958, at Madison, Wisconsin for those desiring registration as a Professional Engineer. Holders of certification as an Engineer-in-Training in Wisconsin will be required to appear for examination only on February 4, 1958, while those who are not holders of such certification will be required to appear on both February 3 and 4, 1958. The examination on February 3, 1958, will be on the fundamentals of engineering. The examination on February 4, 1958, covers in the forenoon a field of engineering and in the afternoon a sub-field of the field selected by the applicant for the forenoon's examination. The applicant must choose a field and sub-field which has been established or approved by the Board. Fields and sub-fields for each have been established by the Board as follows:

1. Chemical with the established sub-fields of Chemical Plant, Gas, Sanitary and others to be approved by the Board.
2. Civil with the established sub-fields of Highway, Hydraulics, Municipal, Sanitary, Structural.
3. Electrical with the established sub-fields of Communications, Electrical Machinery, Electric Power—Generation and Distribution, Illumination, Industrial Electronics.
4. Mechanical with the established sub-fields of Air Conditioning–Heating–Refrigeration, Heat Power and Heat Engines, Industrial, Machine and Tool Design.
5. Metallurgical with the established sub-fields of Metallurgical Research and others.
6. Mining with the sub-fields to be approved by the Board.

To qualify for registration as a Professional Engineer the applicant must in addition to passing the 2-day examination have a record of 8 years of satisfactory engineering experience, 4 of which may have been gained by formal education.

THE END

Campus News

(Continued from page 70)

the annual meeting of the Society in New York City.

Mr. Howson was born in Clinton, Iowa. In 1908 he received the degree of Bachelor of Science at the University of Wisconsin. There, too, in 1912, he was awarded the degree of Civil Engineer and, in 1949, a Distinguished Service Citation. He is a registered professional engineer in 30 states and in the Canadian Provinces of Manitoba, Ontario, Quebec and Saskatchewan. He is former President of the American Water Works Association and of the Western Society of Engineers and has held chairmanships in a number of major national professional committees of outstanding public importance. Mr. Howson is Senior Partner in the Chicago firm of Alvord, Burdick and Howson, consulting engineers.

DAVIDSON BECOMES ASSISTANT DEAN

Appointment of Bruce M. Davidson, assistant professor of civil engineering, as assistant dean of the College of Engineering, was approved by University of Wisconsin regents Saturday.

Prof. Davidson will assist Dean Kurt F. Wendt with administrative and student matters on a part-time basis for the remainder of the academic year. The assistant dean's position was created after added responsibilities in connection with the University's building program were placed under the College of Engineering.

THE END

Question:

What makes a company a good place to work?

Answer:

Among other things, we think "the Human Touch" rates high...

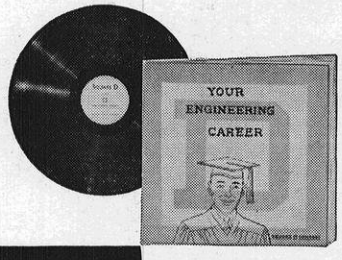
This record tells why—musically

— we'd like to send you a platter

There are a lot of things to consider in selecting the organization with which you will stake your future. For example, how is the company rated in its field? Is it known as a "quality" company? Is it growing? Is it aggressive? Is it big enough to offer you the opportunities you want? Is it too big—to the point where, of necessity, it deals with numbers instead of individuals?

...We think that last factor is mighty important. We call it the "*human touch*" element and it's pretty well explained, *musically*, in a theme song we had recorded for a recent national sales conference. The Ray Porter singers do some rather unusual vocalizing you'll probably enjoy. Clip the coupon and let us send you a record. It's good listening with a little food for thought thrown in.

mail this coupon for your "*Human Touch*" record



Square D Company, Dept. EM
6060 Rivard Street, Detroit 11, Michigan

I'd like a "*Human Touch*" record and a copy of Square D's brochure, "YOUR ENGINEERING CAREER"

I am primarily interested in ☐ Research, Design & Development Engineering ☐ Manufacturing Engineering ☐ Sales Application and Field Engineering

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SQUARE D COMPANY

Collins helped assure the success of SAC's globe-circling non-stop flight. Provided the single sideband ground net that kept Strategic Air Command headquarters in almost continuous contact with this history making flight throughout its 24,325 mile odyssey. Another contribution of Collins creative leadership in electronics.

AROUND THE WORLD IN 45 HOURS, 19 MINUTES...

COLLINS

Collins Radio Company is a dynamic, fast-growing company. Your placement office can tell you when a representative will be on campus, or write to—

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Collins Radio Company
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Fred Aiken
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Harold McDaniel
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Dallas, Texas

Melvin Janes, a friendly, sandy-haired man in his early forties, may well be the world's only trackwalker with a doctor's degree.

Since 1953, Dr. Janes has trudged many a mile along railroad tracks from Maine to Texas. His mission: to check with his own eyes the killing power of a unique railroad-bed weed destroyer.

Weeds are a menace to railroad men. They are a fire hazard; wheels slip on them; they hold moisture which rots the ties and undermines the roadbed; they make maintenance difficult. More than 50 kinds of weeds grow along the tracks. Some die easily and stay dead—but many are too tough for ordinary weed killers.

When Mobil scientists developed a promising new oil-based killer—AGRONYL R—Dr. Janes took to the tracks to check it out. It killed the weeds, all of them. Moreover, it's heavy and doesn't blow on to adjacent farmland. It leaves a film that discourages new growth (and also helps keep the tracks from rusting).

Chemical research is only one of many professions represented on the world-wide roster of Mobil personnel. We also employ nuclear physicists, geologists, mathematicians, engineers of every type, marketing analysts, marketers . . . people prepared to handle more than 100 different positions.

If you qualify, the Mobil companies offer you an opportunity to build a career through training that will utilize your talents to the fullest . . . constantly challenge your ingenuity . . . reward you with a lifetime of richly satisfying work.

For more information about your opportunity with the world's most experienced oil company, see your College Placement Officer.

Mobil

SOCONY MOBIL OIL CO., INC.
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Leader in lubrication for 91 years

AFFILIATES:

General Petroleum Corp., Los Angeles 54, California
Magnolia Petroleum Company, Dallas 21, Texas
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Mobil Overseas Oil Company, New York 17, N. Y.
Mobil Producing Company, Billings, Montana
Socony Mobil Oil Company de Venezuela and other foreign producing companies

So You Think You're SMART!

by Sneedly bs'61

IT'S getting to that season again when the Hill Students are flying South for weekends in the sunshine. Some stay in the South all winter and just fly up for classes. Just the other day Sneedly saw a cluster of Hill Students huddled together like sheep trying to keep warm—not knowing enough to come in out of the cold. A far cry from the men on the west end of the campus.

* * *

Sneedly thought he had troubles until he ran into an EE with a REAL problem. This fellow, "Gritz" Donmacher by name, takes the bus to school and was trying to figure a way to avoid waiting for the bus. Given the following four propositions:

a. If an EE does not have to wait twenty minutes for a bus, then he either likes Mozart or else whiskey, but not both.
b. If a man likes whiskey, then he either likes Mozart and does not have to wait twenty minutes for a bus, or else he does not like Mozart and has to wait twenty minutes for a bus, or he is not an EE.
c. If a man likes Mozart and does not have to wait twenty minutes for a bus, then he likes whiskey.
d. If an EE likes Mozart, then he either likes whiskey or has to wait twenty minutes for a bus. Conversely, if he likes whiskey and has to wait twenty minutes for a bus, then if he likes Mozart he is not an EE.

Under what conditions does "Gritz," an EE, have to wait 20 minutes for a bus?

* * *

Here's another teaser that was given to Sneedly by an L and S student who claims he figured it out in 3 min., 42 sec., and without the aid of a Mechanics course. Sneed tried to beat this time but it took 4 min., just to read it.

Hanging over a pulley there is a rope with a weight at one end; at the other end hangs a monkey of equal weight. The rope weighs 4 oz. per ft. The combined ages of the monkey and its mother are 4 years and the weight of the monkey is as many pounds as its mother is old.

The mother is twice as old as the monkey was when the mother was half as old as the monkey will be when the monkey is 3 times as old as its mother was when she was 3 times as old as the monkey was. The weight of the rope and the weight is half as much again as the difference between the weight of the weight and the weight of the monkey. What is the length of the rope?

* * *

Here is the answer to last month's problem. Sneed was the only one who solved it.

Jones had fifteen Luckies, Perkins smoked Chesterfields and had twenty to start with, six Raleighs came with Reilly, Brown started with three Old Golds, and Turner's supply consisted of eight Camels initially.

* * *

Send in your solutions to Sneedly, % Wisconsin Engineer, Mechanical Engineering Bldg., Madison 5, Wis.

OPPORTUNITIES AT DU PONT CONTINUE TO GROW FOR ALL KINDS OF ENGINEERS AND SCIENTISTS

WHERE DO YOU WANT TO WORK?

by
C. M. Forbes
Du Pont
Representative

I wouldn't be entirely realistic if I said that you can choose your job location from Du Pont's 75 plants and 98 laboratories scattered over 26 states. But Du Pont does have jobs open in many of these locations, so there is a good chance that we may be able to match your preferences and qualifications with available openings.

Right now, most of the Du Pont units are east of the Mississippi, but we have plants in Texas and on the Pacific Coast, too. In the past year plants were completed in Michigan, California, Ohio and Georgia. New plants are also under construction in Kansas, Tennessee, Virginia and North Carolina. Perhaps one of these locations has just what you're looking for in a job.

For a complete list of our plant locations, please write to me at E. I. du Pont de Nemours & Co. (Inc.), 2494-B Nemours Building, Wilmington 98, Del.

Career opportunities at Du Pont are greater today than ever before because of the Company's continued growth. In 1957, Du Pont's sales were at the *$2 billion* level. Four new plants were being built. New research programs were being launched, and new products were moving into the production and marketing stages. All of these developments tend to broaden opportunities at Du Pont for the young scientist and engineer.

ALL KINDS OF ENGINEERS

Students with chemical engineering and chemistry degrees are needed, of course. But the opportunities are equally great for students majoring in many other fields. And the type of work for these men varies greatly. Among other things:

Mechanical engineers work in research and development as well as in plant engineering and production supervision.

Metallurgical engineers conduct studies in metal fatigue and corrosion and engage in fundamental research into the nature and properties of elements.

Civil engineers have many assignments, including design and supervision of the construction of Du Pont plants and laboratories.

Men studying for degrees in *electrical, mining, petroleum, industrial* and many other specialized fields of engineering will find equally challenging outlets for their talents at Du Pont.

If you're interested in finding full scope for your ability, Du Pont offers you plenty of opportunity.

Du Pont Training Tailored to Individual

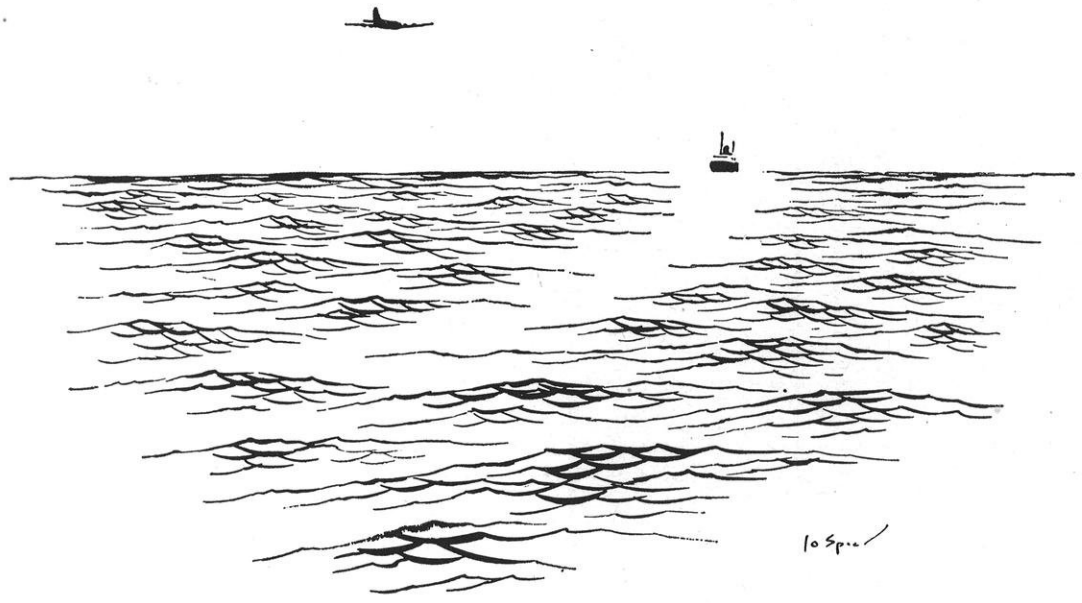
Each of Du Pont's operating departments has its own training program because each has special requirements. But both formal and informal programs are tailored to the interests and needs of the individual.

Generally, you go to work on an assignment at once and start learning right away. This headstart on responsibility is an important factor in your progress. Based on your qualifications, you're given one segment of a project to tackle almost immediately. You learn quickly and informally in consultation with your supervisor and other engineers on the same project. This training is supplemented by frequent meetings, seminars, studies of plant operations and procedures.

And since Du Pont is interested in the progress of the individual, your performance is evaluated at regular intervals by your supervisor. These discussions bring out your strong and weak points and together you work out a program for improvement. This training and evaluation continues year after year as you advance in the Company.

SEND FOR INFORMATION BOOKLET

Booklets on jobs at Du Pont are yours for the asking. Subjects include: mechanical, civil, metallurgical, chemical, electrical, instrumentation and industrial engineers at Du Pont; atomic energy, technical sales, research and development. Name the subject that interests you in a letter to Du Pont, 2494-B Nemours Building, Wilmington 98, Del.



IF YOU WANT TO WORK

OVERSEAS.....

GRADUATES IN EE
ME
WITH GOOD CE
KNOWLEDGE OF PETROLEUM ENGINEERING
ELECTRICITY GEOPHYSICS
PHYSICS

YOUNG MEN, SINGLE AND IN
PERFECT HEALTH.

SCHLUMBERGER OVERSEAS
BOX 2173 - HOUSTON-TEXAS

1958-1959

The Ramo-Wooldridge Fellowships

for Graduate Study at the

California Institute of Technology

or the

Massachusetts Institute of Technology

Leading toward the Ph. D. or Sc. D. degree as offered by each institution

Emphasis in the study program at the California Institute of Technology will be on Systems Engineering, and at the Massachusetts Institute of Technology on Systems Engineering or Operations Research.

The Ramo-Wooldridge Fellowships have been established in recognition of the great scarcity of scientists and engineers who have the very special qualifications required for work in Systems Engineering and Operations Research, and of the rapidly increasing national need for such individuals. Recipients of these Fellowships will have an opportunity to pursue a broad course of graduate study in the fundamental mathematics, physics, and engineering required for careers in these fields, and will also have an opportunity to associate and work with experienced engineers and scientists.

Systems Engineering encompasses difficult advanced design problems of the type which involve interactions, compromises, and a high degree of optimization between portions of complex complete systems. This includes taking into account the characteristics of human beings who must operate and otherwise interact with the systems.

Operations Research involves the application of the scientific method of approach to complex management and operational problems. Important in such application is the ability to develop mathematical models of operational situations and to apply mathematical tools to the solution of the problems that emerge.

The program for each Fellow covers approximately a twelve-month period, part of which is spent at The Ramo-Wooldridge Corporation, and the remainder at the California Institute of Technology or the Massachusetts Institute of Technology working toward the Doctor's degree, or in post-doctoral study. Fellows in good standing may apply for renewal of the Fellowship for a second year.

ELIGIBILITY The general requirements for eligibility are that the candidate be an American citizen who has completed one or more years of graduate study in mathematics, engineering or science before July 1958. The Fellowships will also be open to persons who have already received a Doctor's degree and who wish to undertake an additional year of study focused specifically on Systems Engineering or Operations Research.

AWARDS The awards for each Fellowship granted will consist of three portions. The first will be an educational grant disbursed through the Institute attended of not less than $2,000, with possible upward adjustment for candidates with family responsibilities. The second portion will be the salary paid to the Fellow for summer and part-time work at The Ramo-Wooldridge Corporation. The salary will depend upon his age and experience and amount of time worked, but will normally be approximately $2,000. The third portion will be a grant of $2,100 to the school to cover tuition and research expenses.

APPLICATION PROCEDURE

For a descriptive booklet and application forms, write to The Ramo-Wooldridge Fellowship Committee, The Ramo-Wooldridge Corporation, 5730 Arbor Vitae Street, Los Angeles 45. Completed applications together with reference forms and a transcript of undergraduate and graduate courses and grades must be transmitted to the Committee not later than January 20, 1958.

The Ramo-Wooldridge Corporation

5730 ARBOR VITAE STREET, LOS ANGELES 45, CALIFORNIA • LOS ANGELES TELEPHONE: OREGON 8-0311

STATIC

Is this the Salvation Army?
Do you save bad girls?
Yes.
Well, save me a couple for Saturday night.

* * *

Mother: "Daughter, didn't I tell you not to let strange men come to your apartment. You know how it makes me worry."

Daughter: "It's all right, Mother, I went to his apartment, now let his mother worry."

* * *

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

"Tower to pilot, tower to pilot: repeat after me . . . Our Father Who Art in Heaven . . ."

* * *

Professor: "I won't begin today's lecture until the room settles down."

Voice from the rear: "Why don't you go home and sleep it off?"

* * *

Then there was the M.E. who stepped up to the bar very optimistically, and two hours later went away very misty optically.

* * *

"So you're a painter?"
"Yep."
"Paint houses, I presume?"
"Nope. Paint men and women."
"Oh, I see. An artist."
"Nope. Just paint 'Men' over one door and 'Women' over the other."

* * *

The integral of d-cabin over cabin is log cabin.

* * *

A guest was greeted at the door of the Theta Tau Fraternity House. The frat president welcomed him enthusiastically, not noticing the guest was gazing selfconsciously at his muddy shoes.

"Come in, come in, my boy," beamed the frat man.

"Uh, I'd rather not," whispered the guest, "My feet are dirty."

"So's ours," laughed the frat man, "but we keep our shoes on and nobody notices."

* * *

M.E.: "May I kiss your hand?"
Co-ed: "Whatsmatter? My mouth dirty?"

* * *

Typist: "But, professor, isn't this the same exam you gave last year?"
Professor: "Yes, but I've changed the answers."

* * *

Bess, Harry and Margaret Truman were sitting in the parlor of the White House one afternoon, when Bess said to Harry:

"Harry, dear, I think that you ought to have something done to our front lawn. It's all dried up, and is turning brown."

Harry replied, "I guess that you're right dear. I'll have the men spread some manure on it tomorrow."

Just then Harry was summoned to the telephone, and after he left, Margaret said to Bess, "I wish that you would teach daddy to say 'fertilizer' instead of that awful word 'manure.' After all, he is the President, now."

Bess replied, "Daughter, I believe in letting well enough alone. It took me 27 years to teach him to say 'manure'."

* * *

Mother: "Why did you take so much time last night saying goodby to that fellow?"

Daughter: "But, Mother, if a guy takes you to the movies you ought to at least let him kiss you good night."

Mother: "I thought you went to the Stork Club."

Daughter: "I did."

* * *

Fellow to blind date: "I never really believed in reincarnation—but what were you before you died?"

* * *

A bored cat and an interested cat were watching a game of tennis.

"You seem very interested in tennis," said the bored cat.

"It's not that," said the interested cat, "but my old man's in that racket."

* * *

Student looking through telescope: "God!"

Another: "Aw, g'wan; it isn't that powerful."

* * *

Three football players at different schools had flunked their classes and were dropped from the team. They got together and talked about their misfortune. The man from O.U. said, "That calculus was just too damn much." The man from S.M.U. said, "It was trig that got me." The guy from N.D. said, "Did youse guys ever hear of long division?"

* * *

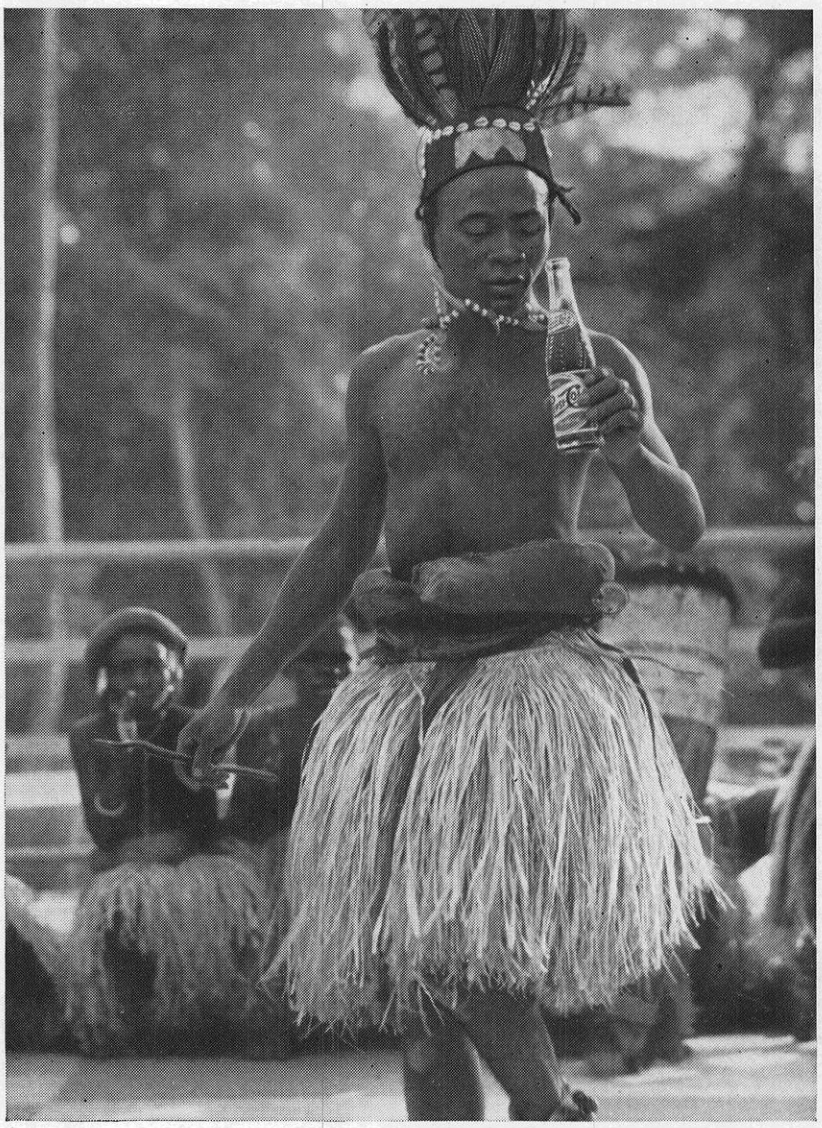
1st Engineer: "Well, did you follow my advice and kiss your girl *when* she least expected it?"

2nd Engineer (with black eye): "My god! I thought you said *where*."

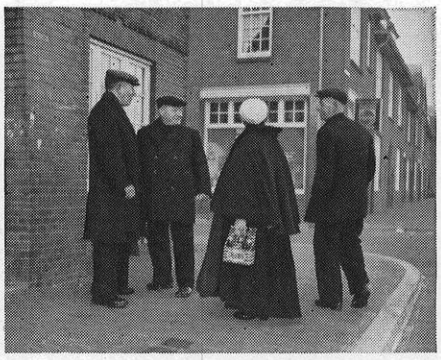
PHOTOGRAPHY AT WORK
No. 30 in a Kodak Series

Pepsi-Cola International Panorama, a magazine of places and people, reaches people around the world, builds recognition for Pepsi-Cola as a product associated with the better, happier side of life.

Photography speaks in every language



What better way to say people take naturally to "Pepsi" whether in Leopoldville or Lichtenstein?



This picture leaves no doubt that Netherlanders are neighborly.

To tell its story in 75 countries, Pepsi-Cola puts pictures to work to add meaning to the product's global billing as "the refreshment of friendship."

To build up an atmosphere of friendliness and understanding in markets around the world, Pepsi-Cola International publishes "Panorama"—and gives the brunt of the job to photography.

Photography knows no language barrier. It is clear to young and old alike—appeals to everyone. With photography, people are real; situations authentic, convincing. This is what makes photography such a powerful salesman.

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Interview with General Electric's Hubert W. Gouldthorpe Manager—Engineering Personnel

Your Salary

Although many surveys show that salary is not the prime factor contributing to job satisfaction, it is of great importance to students weighing career opportunities. Here, Mr. Gouldthorpe answers some questions frequently asked by college engineering students.

Q. Mr. Gouldthorpe, how do you determine the starting salaries you offer graduating engineers?

A. Well, we try to evaluate the man's potential worth to General Electric. This depends on his qualifications and our need for those qualifications.

Q. How do you evaluate this potential?

A. We do it on the basis of demonstrated scholarship and extra-curricular performance, work experience, and personal qualities as appraised by interviewers, faculty, and other references.

Of course, we're not the only company looking for highly qualified men. We're alert to competition and pay competitive salaries to get the promising engineers we need.

Q. When could I expect my first raise at General Electric?

A. Our primary training programs for engineers, the Engineering Program, Manufacturing Program, and Technical Marketing Program, generally grant raises after you've been with the Company about a year.

Q. Is it an automatic raise?

A. It's automatic only in the sense that your salary is reviewed at that time. Its amount, however, is not the same for everyone. This depends first and foremost on how well you have performed your assignments, but pay changes do reflect trends in over-all salary structure brought on by changes in the cost of living or other factors.

Q. How much is your benefit program worth, as an addition to salary?

A. A great deal. Company benefits can be a surprisingly large part of employee compensation. We figure our total benefit program can be worth as much as 1/6 of your salary, depending on the extent to which you participate in the many programs available at G.E.

Q. Participation in the programs, then, is voluntary?

A. Oh, yes. The medical and life insurance plan, pension plan, and savings and stock bonus plan are all operated on a mutual contribution basis, and you're not obligated to join any of them. But they are such good values that most of our people do participate. They're an excellent way to save and provide personal and family protection.

Q. After you've been with a company like G.E. for a few years, who decides when a raise is given and how much it will be? How high up does this decision have to go?

A. We review professional salaries at least once a year. Under our philosophy of delegating such responsibilities, the decision regarding your raise will be made by one man —the man you report to; subject to the approval of only one other man —his manager.

Q. At present, what salaries do engineers with ten years' experience make?

A. According to a 1956 Survey of the Engineers Joint Council*, engineers with 10 years in the electrical machinery manufacturing industry were earning a median salary of $8100, with salaries ranging up to and beyond $15,000. At General Electric more than two thirds of our 10-year, technical college graduates are earning above this industry median. This is because we provide opportunity for the competent man to develop rapidly toward the bigger job that fits his interests and makes full use of his capabilities. As a natural consequence, more men have reached the higher salaried positions faster, and they are there because of the high value of their contribution.

I hope this answers the question you asked, but I want to emphasize again that the salary *you* will be earning depends on the value of *your* contribution. The effect of such considerations as years of service, industry median salaries, etc., will be insignificant by comparison. It is most important for you to pick a job that will *let* you make the most of your capabilities.

Q. Do you have one salary plan for professional people in engineering and a different one for those in managerial work?

A. No, we don't make such a distinction between these two important kinds of work. We have an integrated salary structure which covers both kinds of jobs, all the way up to the President's. It assures pay in accordance with actual individual contribution, whichever avenue a man may choose to follow.

*** We have a limited number of copies of the Engineers Joint Council report entitled "Professional Income of Engineers—1956." If you would like a copy, write to Engineering Personnel, Bldg. 36, 5th Floor, General Electric Company, Schenectady 5, N. Y.** 959-7

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