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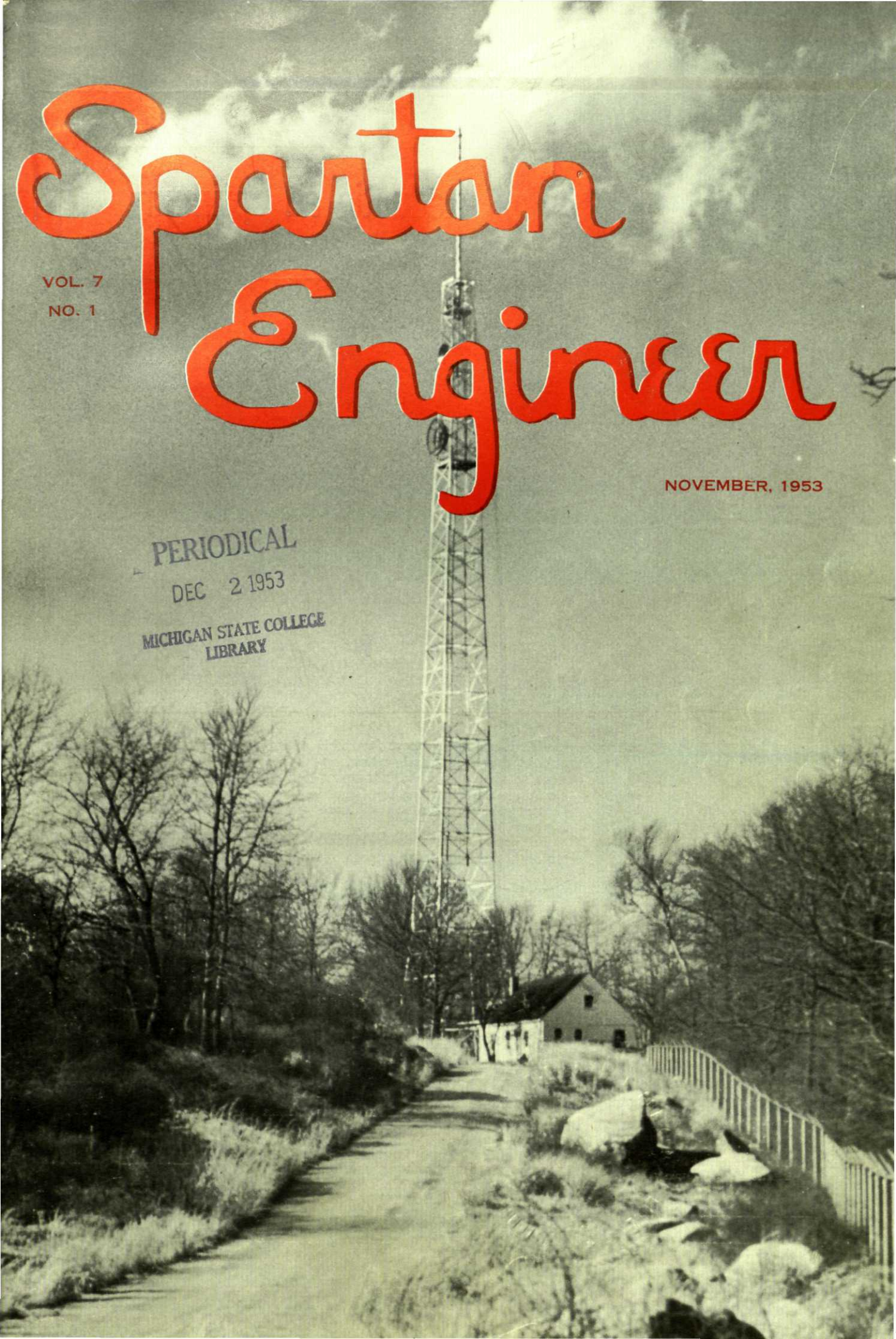

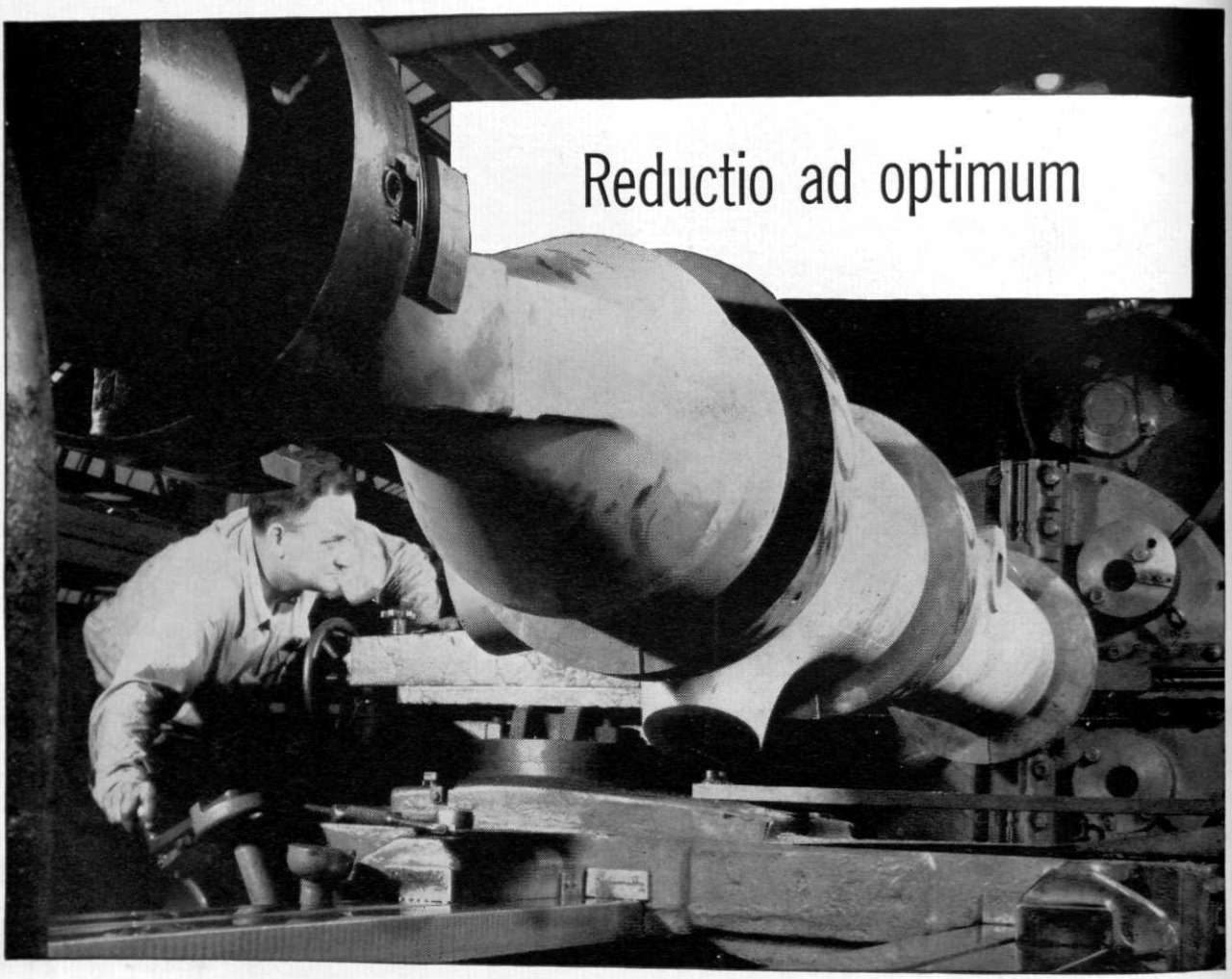

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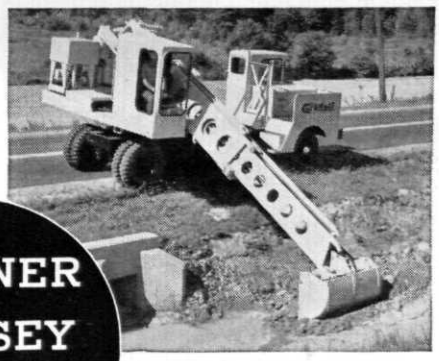

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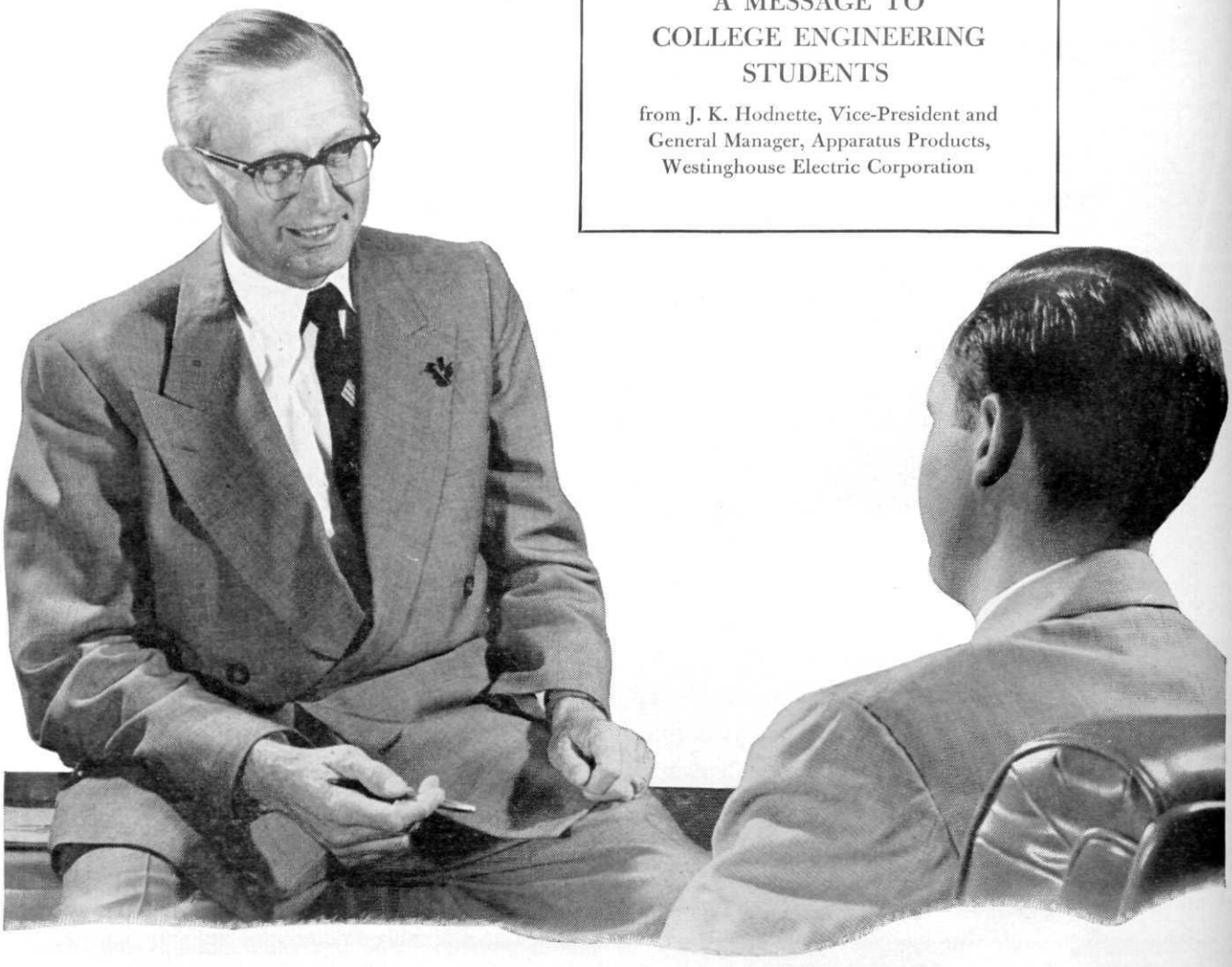
A MESSAGE TO
COLLEGE ENGINEERING
STUDENTS

from J. K. Hodnette, Vice-President and
General Manager, Apparatus Products,
Westinghouse Electric Corporation



To the young man with a vision of success

Success means different things to different men. It can mean professional recognition, or great achievement, or exciting work, or many other things. Whatever its special meaning to you—keep its image in your mind, for you are already well on the way to achieving it!

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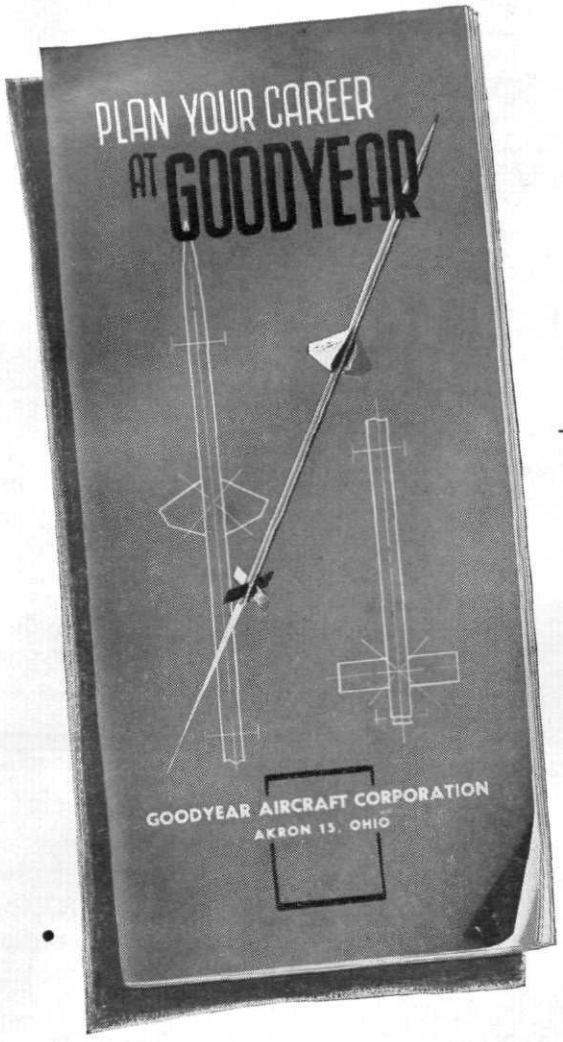

Well worth the reading

(and it's yours for the asking)

The simple step of sending a postal card for the booklet pictured here may well have a tremendous influence upon your future.

Quite frankly, it is written to attract promising young engineers to the opportunities awaiting them at Goodyear Aircraft Corporation.

The facts it presents are as sound as they are inviting—for it gives the story of an engineering-minded organization that is part of a basic industry, one which will always be doing business come peace or war, boom or bust.

It is the story of a pioneering-minded organization which has contributed many important advancements to aviation's progress.

It traces the role of Goodyear Aircraft in the building of complete airships and airplanes, in the research and designing of countless aeronautical components—including helicopter fuselages, droppable fuel tanks, transparent canopies, radomes, bonded sandwich structures as well as radar, guided missiles, wheels, brakes, and electronic computers.

It tells why Goodyear Aircraft offers you unlimited possibilities if you can qualify for membership in an engineering family which has set such an enviable record in the exciting and ever-growing field of aeronautics.

It's well worth your reading. We invite you to send for it — and, if you desire, to accompany your request with a brief resumé of your qualifications or experience.

ADDRESS: Dr. K. Arnstein, Vice President of Engineering, Goodyear Aircraft Corporation, Akron 15, Ohio

GOODYEAR AIRCRAFT

The prof who put off a trip to Europe

He had his tickets. He was all set to sail.

Then this professor of engineering at one of America's leading educational institutions received an invitation to General Motors Engineering Educators Conference.

So, having heard reports on the success of the 1952 conference, he put off his trip and joined in the two-week session of meetings and field trips.

Q.E.D.—he was delighted. Said he wouldn't have missed it.

Why? Because, like his fellow educators, he found GM executives meant what they said when they told their guests:

"One of the principal objectives of this Conference is to make us better acquainted with each other's problems. We hope that you will develop personal contacts during the Conference that will assist you in the future. By developing better mutual understanding and cooperation between education and industry, together, we can do a better job of solving the engineering problems of the future and maintaining our Nation's technical leadership."

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And to you soon-to-graduate engineers, we say, better think seriously about a GM future. It's yours, if you have what it takes.

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Personnel Staff, Detroit 2, Michigan

Spartan Engineer

ARTICLES

FEATURES

COVER

Tower and transmitter building of the RCA - NBC experimental ultra high frequency television station near Bridgeport, Conn.

Published four times yearly by the students of the SCHOOL OF ENGINEERING, MICHIGAN STATE COLLEGE, East Lansing, Michigan. The office is on the third floor of the Union Building, Phone ED 2-1511, Extension 251. Entered as second class matter at the Post Office in Lansing, Michigan, under the act of March 3, 1879.
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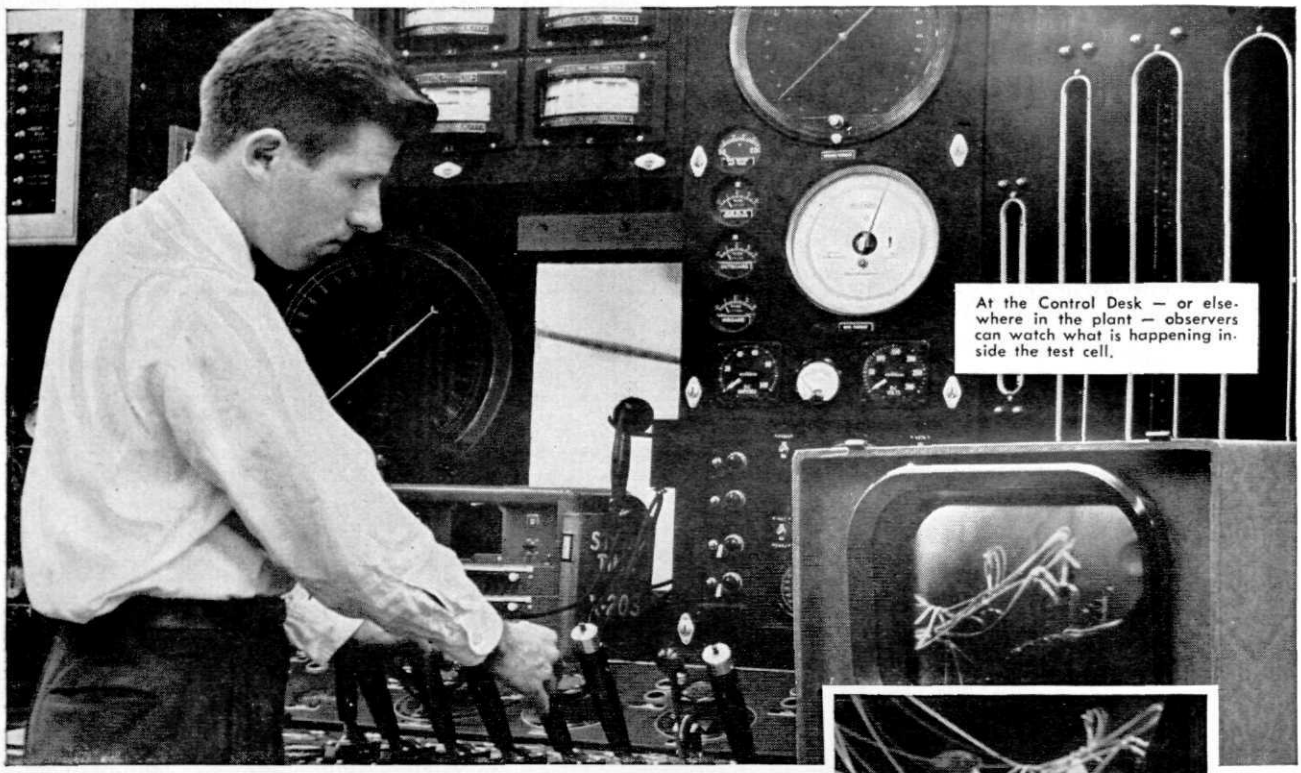
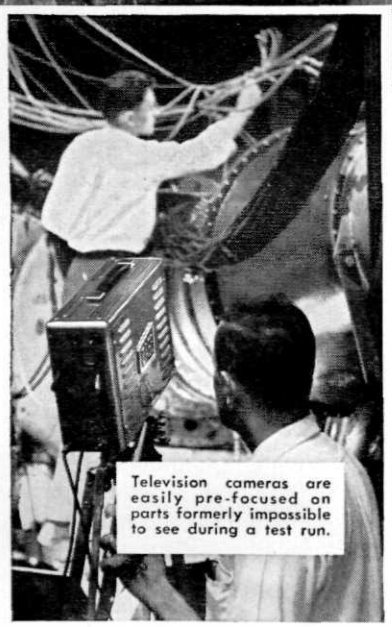
NEW LOOK IN JET ENGINEERING



At the Control Desk — or elsewhere in the plant — observers can watch what is happening inside the test cell.



Television cameras are easily pre-focused on parts formerly impossible to see during a test run.

Through the use of industrial television, Pratt & Whitney Aircraft engineers can now watch what happens as big jet engines are run under abnormal conditions. Without personal hazard, they can see inside the test cell from any location in the plant.

On their television screens they can observe the action of linkages, controls and other parts. Even infra-red characteristics not visible to the human eye can be studied.

But to do this, many technical problems had to be solved. For instance, commercial equipment had to be modified in many ways to operate under abnormal temperatures and in hazardous atmospheres. Soon a further development will permit remote traversing of the camera and adjustment of lenses.

This typifies the way in which new engineering and research facilities are constantly made available to Pratt & Whitney Aircraft engineers. Here engineers are encouraged to experiment with new ideas — given an opportunity to do *real* engineering.

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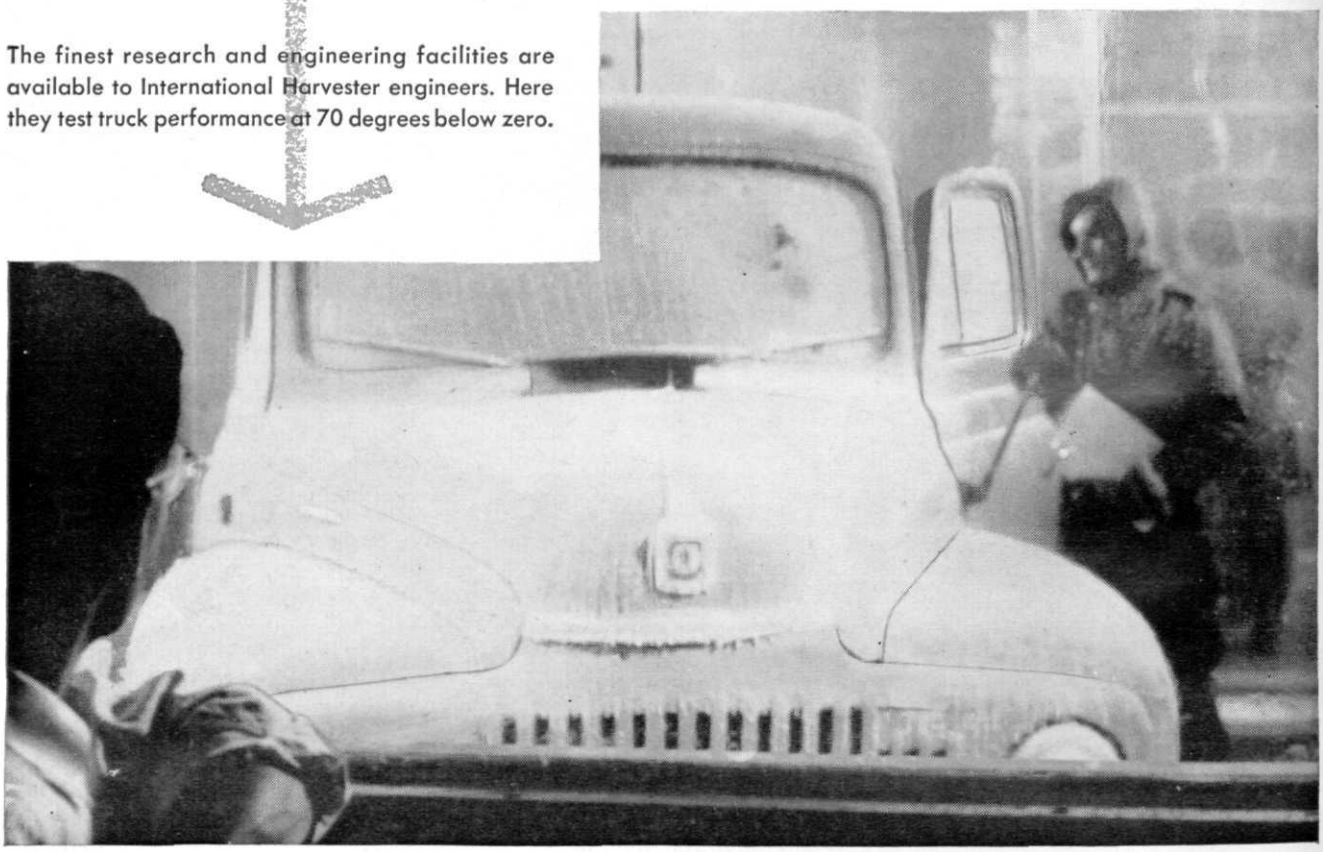

■ The American transportation system is the most highly developed in the world. And International trucks are part of this picture.

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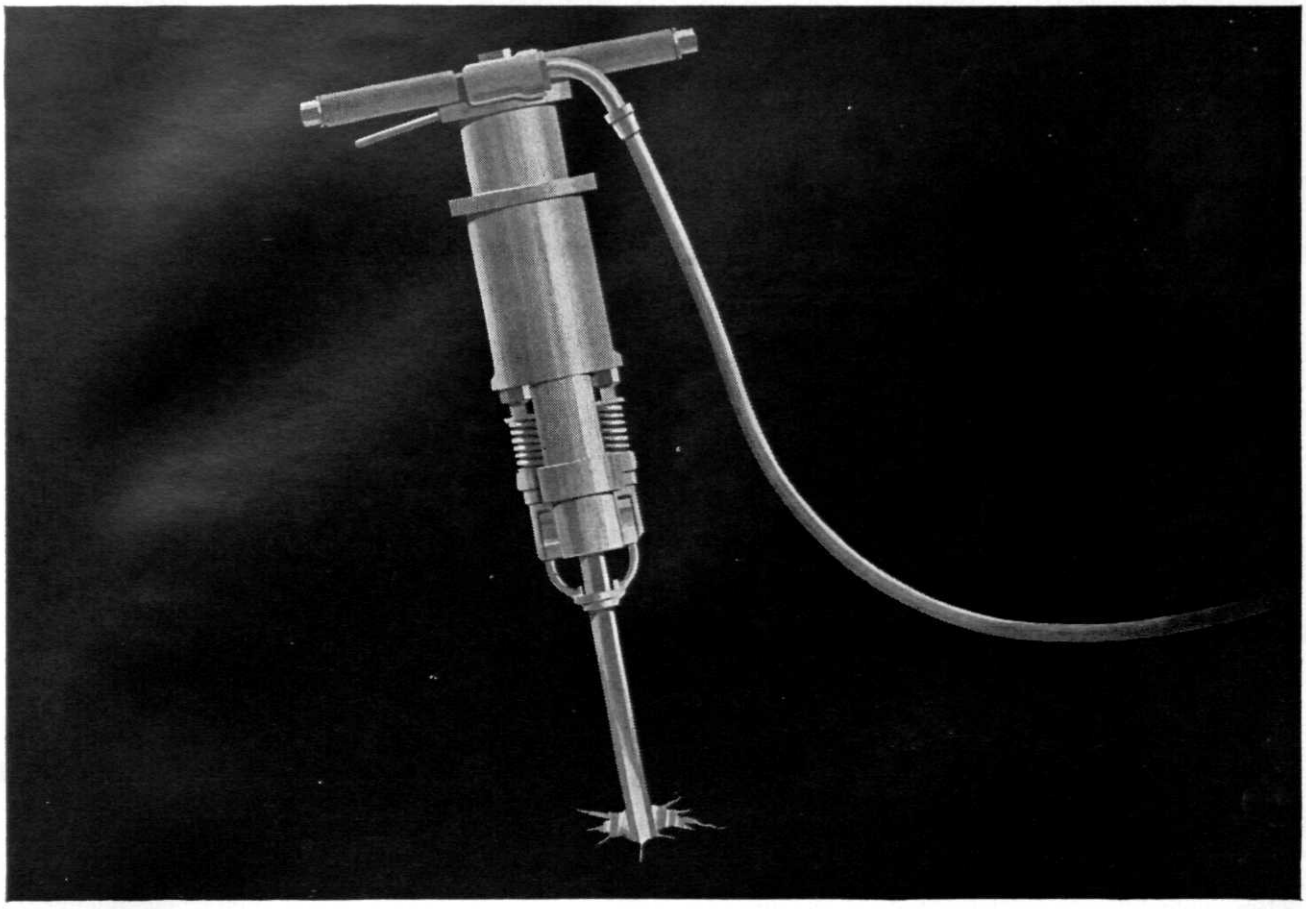

AIR MUSCLE...

Properly compressed and coupled to this drilling tool, air packs a rock-busting wallop. How different from the days when men slung sledges, and even cracking pavement was a slow, tortuous task . . . as were many other manual jobs in industry.

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Editorially Speaking

We need your help.

The Spartan Engineer staff has set for itself the goal of becoming this year the finest engineering college magazine in the country. To do so, however, your assistance is needed.

We can use your help in two ways. The first way you could help us is by your indicating a desire to work as a member of our staff. We now have a small, competent staff; one which would appreciate your help along many lines of magazine work. There are positions open on both the editorial and business sides of our magazine. If you are interested in working on the magazine, let one of our staff members know, or come up to our office in the Union building. We'll then let you know, too, what the Spartan Engineer can do for you.

There is a less obvious, but just as important method by which you might assist us. And that is by offering suggestions on how we can improve the magazine. Therefore, in the next issue, we have started a "Letters to the Editors" column. In addition, we are going to carry out a year-long readership survey. We hope that when one of our staff members asks you for criticisms of our magazine, that you will take that time to help us reach our goal.

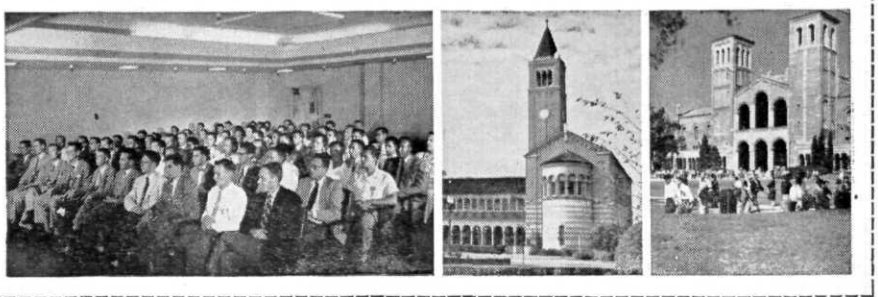
Through these means then: your assistance on the magazine staff and your suggestions on improving the magazine, we hope to go hand-in-hand with you to the achievement of our goal. We believe the Spartan Engineer can be the finest magazine of its kind in the country. Do you?

ENGINEERS
and PHYSICISTS

To those interested in advanced academic study while associated with research and development in industry, the following practical programs are offered:

1
HUGHES COOPERATIVE FELLOWSHIP PROGRAM

for Master of Science Degrees



A group of participants in the Hughes Cooperative Fellowship Program (above left). Fellows study for Master of Science degrees at either University of Southern California (center) or University of California at Los Angeles (right).

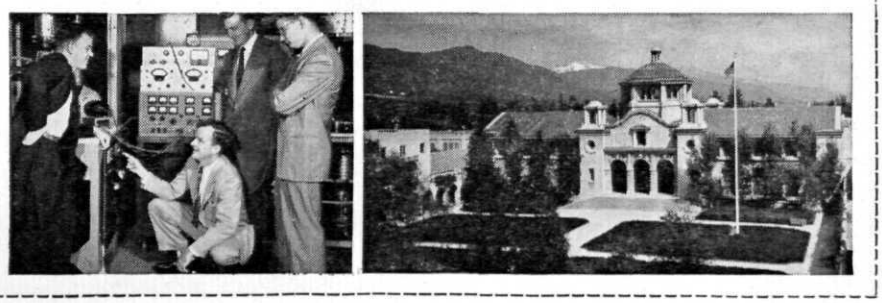
This program is to assist outstanding individuals in studying for the Master of Science Degree while employed in industry and making contributions to important military work. It is open to students who will receive the B.S. degree in Electrical Engineering, Physics or Mechanical Engineering during the coming year and to members of the Armed Services being honorably separated and holding such B.S. degrees.

Candidates must meet entrance requirements for advanced study at the University of California at Los Angeles or the University of Southern California. Participants will work full time at the Laboratories during the summer, and 25 hours per week while pursuing a half-time schedule of graduate study at the university.

The salary will be commensurate with the individual's ability and experience. Tuition, admission fees and books for university attendance will be provided. Provision is made for an allowance to assist in paying traveling and moving expenses from outside the Southern California area.

2
THE HOWARD HUGHES FELLOWSHIPS

in Science and Engineering



(From left to right) Hughes 1952 Fellows Truman O. Woodruff and Allen I. Ormsbee discuss tube processing station in Electron Tube Laboratory with 1953 Fellows Roy Gould and Baxter H. Armstrong. Their advanced study is at California Institute of Technology (above).

Eligible for these fellowships are those who have completed one year of graduate study in physics or engineering. Successful candidates must qualify for graduate standing at the California Institute of Technology for study toward the degree of Doctor of Philosophy in physics or engineering. In summers they will work full time in the Hughes Laboratories in association with scientists and engineers in their fields.

Fellows may pursue graduate research in the fields of physics, electronics engineering, electronic computing, aerodynamics, propulsion engineering, mechanical engineering, or information theory.

Each appointment is for twelve months and provides a cash award, a salary, and tuition and research expenses. A suitable adjustment is made when financial responsibilities of the Fellow might otherwise preclude participation in the program.

HOW TO APPLY: *For complete information concerning either of these Hughes Fellowship programs, consult your Placement Officer or write directly to us. Please indicate the particular program in which you are interested. A detailed explanatory brochure and application forms will be mailed promptly.*

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Alternating current asymmetry in R & L circuits

With the advent of fast operating oil circuit reclosers, it is possible to interrupt alternating currents very shortly after the instant of fault initiation. Physical properties of common power or distribution circuits are such that when a fault or outage occurs, a transient current period nearly always follows. Modern reclosers respond quickly enough to interrupt during the transient conditions. As a result, reclosers experience increased difficulty with the added energy generated during interruption. This energy is a function of current asymmetry conditions. Numerical factors of asymmetry have been obtained for various circuit X/R ratios from a study of transient current phenomena. These factors indicate the additional current that a recloser must interrupt during transient fault conditions.

Introduction to Transients

The purpose of a transient component of current is to provide a gradual transition from an initial current to a steady state current. For example, in one case an initial current may be zero while the final current will have a particular magnitude. The transient involves an increasing current change. In another case the initial current may have magnitude while the steady state current is zero. Here the transient involves a decreasing current change.

Whenever electric energy can be stored in a circuit, transients can occur.

Consider the physical concept of energy stored in an inductance. Inductance is that property of an electric circuit that opposes any change in current and has the ability to store energy in the electromagnetic form. Any change in current in an inductance results in an induced voltage which tends to prevent the change. When current increases, the induced voltage is opposed to the rise. Electromagnetic energy is stored in the field of the inductance. When current decreases, the induced voltage is opposed to the change and returns stored electromagnetic energy from the inductance field to the circuit. It is both theoretically and physically impossible to have an instantaneous current change in an inductance. If it were possible, it would represent an instantaneous energy change, or infinite power:

$$\text{energy change/time} = \text{power} = \tfrac{1}{2}Li^2/\text{time}.$$

In terms of the electric circuit, infinite power would require infinite voltage. The mechanical analogy relating electromagnetic energy $\frac{1}{2}Li^2$ is kinetic energy $\frac{1}{2}Mv^2$. Mass is analogous to inductance while velocity is analogous to current:

$$\text{energy change/time} = \text{power} = \tfrac{1}{2}Mv^2/\text{time}.$$

In both the electrical and mechanical cases, the driving force is limited to a finite power supply. Thus, as circuit inductance increases, the transient period from initial to steady state current increases. Similarly, as the mass of an object increases, the transient period from initial to steady state velocity increases. Or, as mass increases, the period of acceleration increases.

Transients never occur in purely resistive circuits. Such circuits have no capacity for storing energy and, consequently, no properties to prevent instantaneous current or voltage variations. Pure resistance dissipates energy. The effect of resistance in a circuit capable of storing energy (and thus capable of transients) is to decrease the duration of the transient period.

Electrical transients are classified in two groups: Double and single energy transients. Double energy transients occur in circuits where energy is stored in both inductance and capacitance. These circuits include R-L-C parameters. Single energy transients occur in circuits where energy is stored in either inductance or capacitance, but not both. These circuits include R-L or R-C parameters. Only R-L circuits are of concern where energy is stored in the electromagnetic form.

Period of Transient Decay

When an alternating voltage is applied to a circuit, the steady state alternating current usually is preceded by a period of transient current. With an R-L circuit, the transient current contains an exponential form of $e^{-Rt/L}$. This form represents the decay of direct current in an R-L circuit. Figure 1 illustrates such a circuit with a direct current source and an X/R ratio = 1. When switch 1 is closed and switch 2 is opened simultaneously at any time (t), the current in the R-L branch will not cease immediately, but will die out gradually.

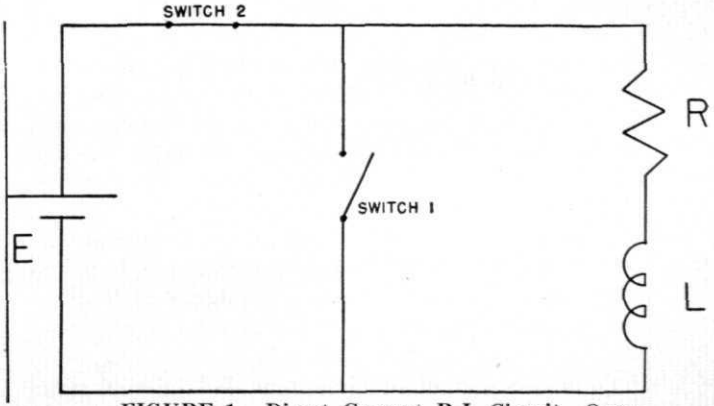


FIGURE 1. Direct Current R-L Circuit. Operating Switches Initiate Exponential Current Decay.

If switch 1 is closed and switch 2 is opened at $t = 0$, $i_0 = E/R$. Then, at any time (t) after the switches are operated, $i_t = i_0 e^{-Rt/L}$. This equation represents a time-current graph of a decaying current in an R-L circuit. See Figure 2 for illustration. Mathematical analysis shows that the current never reaches zero. For all practical purposes it decays to less than one percent of its initial value after four and one-half time constants.

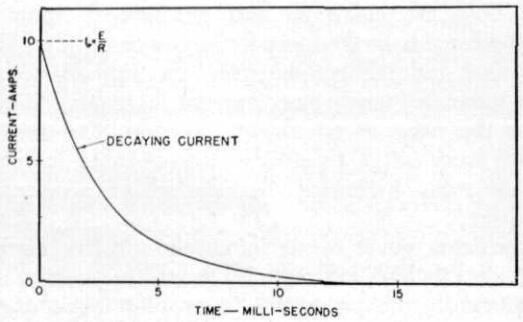


FIGURE 2. Time-Current Graph of Exponential Current Decay.

The time constant of a circuit is defined as the time required for a transient to decay to 36.8% of its value from a given point of observation. The time constant is also defined as the L/R ratio of a circuit: $T = L/R$. After each time constant, a transient decays to a certain percentage of its initial value:

$t = T = L/R \quad i = 36.8\% \; i_0$

after one time constant, the transient decays to 36.8% its initial value;

$t = 2T = 2L/R \quad i = 13.5\% \; i_0$

after two time constants, the transient decays to 13.5% its initial value;

$t = 3T = 3L/R \quad i = 5.0\% \; i_0$

after three time constants, the transient decays to 5.0% its initial value;

$t = 4T = 4L/R \quad i = 1.8\% \; i_0$

after four time constants, the transient decays to 1.8% its initial value;

$t = 5T = 5L/R \quad i = 0.67\% \; i_0$ and

after five time constants, the transient decays to 0.67% its initial value.

Thus, the transient period of current decay in an R-L circuit is a function of the resistance and inductance values alone.

Initial Transient Value

In an alternating current circuit, the form and amplitude of the steady state current will depend on the form and amplitude of the applied voltage. The initial amplitude of the transient current will be governed by the instant at which the circuit is closed. Closing the circuit at any time (t) gives the transient current an initial value equal in magnitude but opposite in sign to the instantaneous steady state alternating current at that time. Table 1 compares initial transient current values with instantaneous steady state alternating current values at various times (t) of circuit initiation as indicated in Figure 3.

Only one instant of closing an R-L circuit exists where a transient cannot occur. That time is at steady state current zero. See time t_4 in Figure 3. The transient is avoided since the energy distribution in the circuit at current zero is exactly the energy distribution that would occur if steady state current were flowing. No instantaneous current change is necessary in order to realize steady state conditions.

TABLE 1
Initial Transient Current vs. Instantaneous Steady-State Alternating Current at Various Instants of Circuit Initiation

Time of Closing (t)	Steady State Amps.	Initial Transient Amps.
t_1	3.4	—3.4
t_2	5.0	—5.0
t_3	1.7	—1.7
t_4	0.0	0.0
t_5	—3.8	3.8
t_6	—2.4	2.4

Maximum transient current occurs when the circuit is closed at time of peak instantaneous steady state alternating current. See time t_2 in Figure 3.

At any time of closing the circuit, current must start from zero. Its rate of rise is proportional to the E/L circuit value. Since it cannot rise to steady state instantaneously, another current must exist, the transient component. The algebraic sum of the transient component and the instantaneous steady state component must be zero at the instant of circuit closing. The end result is that a direct current transient occurs and offsets the alternating current from the zero axis to a new asymmetric axis. This offset alternating current is known as an asymmetric wave. The new asymmetric axis is the direct current transient. Its initial magnitude has a value equal to the instantaneous value of the steady state current at the instant of circuit closing. Its decay duration depends on the R and L circuit values. Four and one-half time constants (4L/R) after circuit closing, the alternating current asymmetry will decrease to proportions that are negligible.

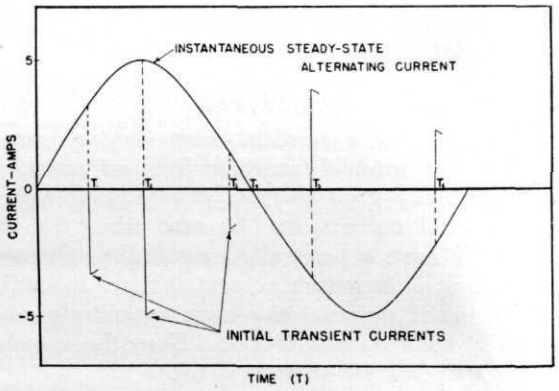


FIGURE 3. Initial Transient Value vs. Instantaneous Steady - State Alternating Current Values of Various time (t) of Circuit Initiation.

Two Instants of Circuit Initiation

In any circuit, current components are classified as steady state and transient. In a sinusoidal alternating current R-L circuit, the steady state current component has the general form $i_t = i_{max} \cos wt$. The direct current component has the general form $i_t = i_0 e^{-Rt/L}$. During the transient period, the total current is the sum of both steady state and transient components, $i_{total} = i_{max} \cos wt + i_0 e^{-Rt/L}$. Since

instantaneous values of any similar quantities can be added algebraically, it is possible to represent graphically the total current during a transient period by adding steady state and transient instantaneous currents.

Figure 4 with circuit X/R = 1 shows total current for two points of circuit initiation.

First, consider circuit initiation at steady state alternating current peak. The direct current transient's initial value is equal in magnitude but opposite in sign to the peak alternating current. The direct current component then decays to zero in about one cycle according to the general form $e^{-Rt/L}$. The total current is represented by the equation:

$$i_{total} = i_{steady\ state} + i_{transient}$$
$$i_{total} = -i_{max} \cos wt + i_{max} e^{-Rt/L}$$
$$i_{total} = i_{max} (e^{-Rt/L} - \cos wt)$$

Figure 4 shows that the total current first has a minor loop below the zero axis. The current then rises in a major loop with a higher peak value than the steady state alternating current peak. The reason a minor loop occurs, or, the total current goes negative first, is that the direct current transient decays at a faster rate than the steady state alternating current increases.

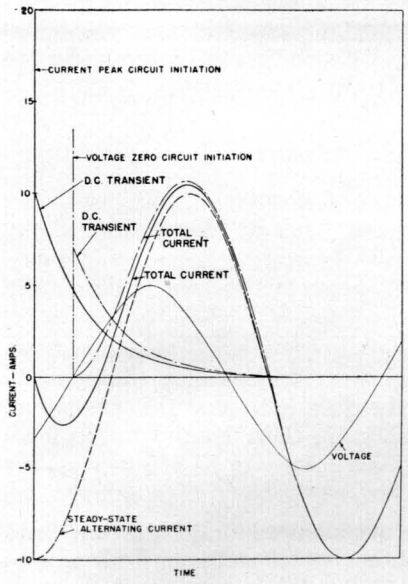


FIGURE 4.
Current Asymmetry as a Function of Instant of Circuit Initiation with X/R = 1.

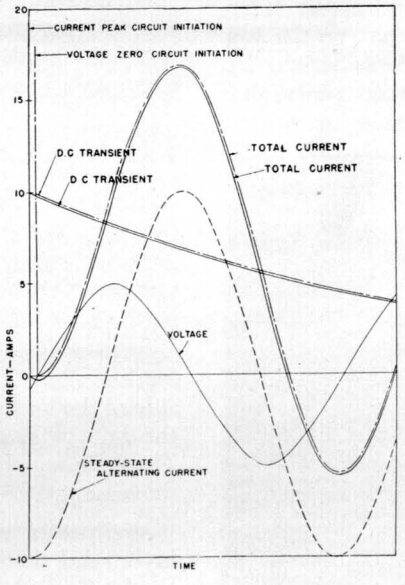


FIGURE 5.
Current Asymmetry as a Function of Instant of Circuit Initiation with X/R = 8.

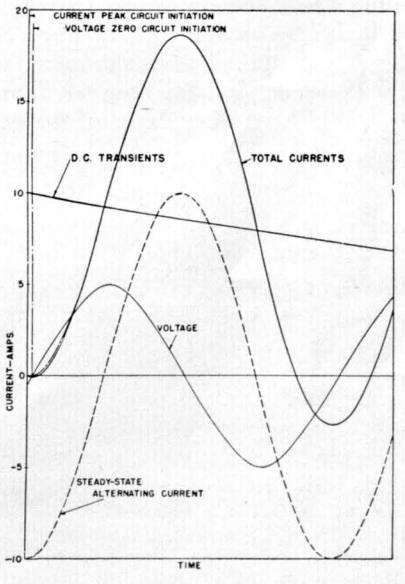


FIGURE 6.
Current Asymmetry as a Function of Instant of Circuit Initiation with X/R = 20.

Second, consider circuit initiation at the instant the voltage wave passes through zero. The direct current transient has an initial value i_0, equal in magnitude but opposite in sign to the instantaneous alternating current at voltage zero. Let that time be known as t = 0. The total current is represented by the equation:

$$i_{total} = i_{steady\ state} + i_{transient}$$
$$i_{total} = -i_{max} \cos (wt + \phi) + i_0 e^{-Rt/L}$$

where ϕ is the angle in degrees between peak steady state current and voltage zero. For X/R = 1, ϕ = 45 degrees. The dot-dash line in Figure 4 shows that the total current no longer has a minor loop below the zero axis. The current now rises gradually, starting from zero slope, and attains a peak value which is the highest possible for any instant of circuit initiation in an X/R = 1 circuit. There is no minor loop when circuit initiation is at voltage zero. The increasing rate (slope) of the steady state alternating current equals the initial slope of the direct current transient and increases thereafter at a greater rate than the direct current component decreases. At circuit initiation, t = 0, the respective slopes are:

$$i_{max}(w) \sin \phi = i_0 R/L$$

Reviewing the X/R = 1 circuit, maximum direct current transient occurs when circuit initiation is at a steady state alternating current peak. However, a minor current loop must occur before the first major current loop. As the point of circuit initiation approaches voltage zero, the increasing slope of the steady state alternating current approaches the initial slope of the direct current transient. The minor loop thus diminishes. At voltage zero a minor loop no longer occurs. The first asymmetric current loop is the maximum major loop. Its peak magnitude is the highest possible. This is true for all circuits from X/R = zero to X/R = infinity.

Asymmetry Effects in Circuit Reclosers

In an alternating current circuit, interruption is fundamentally simple because of the natural current zero passage. No artificial means is necessary to bring the current to zero. The problem is to create dielectric strength in the arc path at the instant of current zero at a faster rate than the voltage across the parting contacts increases.

The Kyle recloser utilizes an oil cross-blast arc-interrupting structure to speed dielectric build-up. See Figure 7. This structure employs two tubes which house the stationary contacts and are connected by a cross-blast chamber. The two contacts are arranged

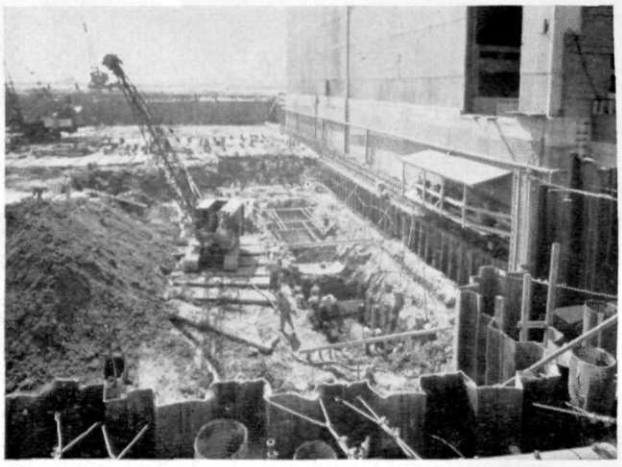
(Continued on page 34)

Electric curtain stabilizes wet ground for deep excavation

IT'S WIERD AND UNCANNY! Almost unbelievable! But electric current from several motor generator sets passed through the soil from pipe anodes to wellpoint cathodes, driven around the perimeter of 210 x 280-ft. plot, has changed a treacherous wet soil into firmly stabilized ground that permits excavation of a trench 21 ft. deep without sheeting or further dewatering.

This is all taking place at the John C. Weadock generating plant of the Consumers Power Co. at Essexville, Mich., near Bay City, where excavation and foundation preparation are now under way for addition of units 7 and 8 to the existing plant.

To obtain an unlimited supply of condensing water, the plant is located parallel to and only 40 ft. away from the Saginaw River. River level is only 3 to 4 ft. below natural ground level. At the site the top 18 ft. of ground is a saturated sand, underlain by 13 ft. of sandy silt, then 19 ft. of soft, peaty silt, followed by a deep layer of water-bearing sand.



FIRST EXCAVATION after electro-osmosis had stabilized wet silt formation was in outlet tunnel alongside old plant. Single wall of sheeting in foreground, protecting switch yard started to move in when silt was being excavated before stabilization.

For the previous six units, built at various times in three stages, a heavy concrete mat was placed just below bottom of top sand, supported on piling, but the deep trench for the condensing water duct had to be excavated well into the silt layers inside of an inner cofferdam.

Each time, this trench was dug out with considerable difficulty.

The foundation situation for new units 7 and 8 threatened to be even worse, as the units are much larger (135,000 kw against 60,000) than their predecessors, calling for a lower general slab and a deeper duct. Consumer engineers and the contractor figured they would somehow bull their way through the bad ground.

First step was to strip the site 3 or 4 ft. from ground level El 586 down to water table (river level) at El 583, exposing the top sand layer. A Griffin wellpoint system was then set up around the entire perimeter, 220 x 300 ft., to unwater the sand down to El 565.

Under protection of the well-point system, second-stage excavation proceeded, removing all sand and a little of the silt down to El 564. Meantime, a double wall of sheet piling was driven as a cofferdam along the West river end of the lot, and a single row of sheeting was driven across the opposite end to protect an existing sub-station.

Upon completion of excavation to El 564, shells for cast-in-place were driven concrete piles.

The Third Stage

Third-stage excavation was to remove the top 9 ft. of the sandy silt formation down to El 556, just below proposed base of foundation slab. Before long, a row of cut-off sheeting was driven along the existing building line, giving sheet-pile protection around three sides of the lot.

Excavation of the third stage was started, but not for long. As the hole was deepened on the opposite side of the lot from the river, in front of the sub-station, the line of single sheeting there started to move in. The hole was backfilled hastily to El 565 to stop this movement.

Wellpoints were installed to drain the top sand layer, and then another set of wellpoints, all around the lot, from the El 565 level, penetrating to the water-bearing sand beneath the silt, El 533, to relieve much of the uplift pressure. Wellpoint Dewatering had figured on using this second set of wellpoints as a vacuum process for dewatering the silt.

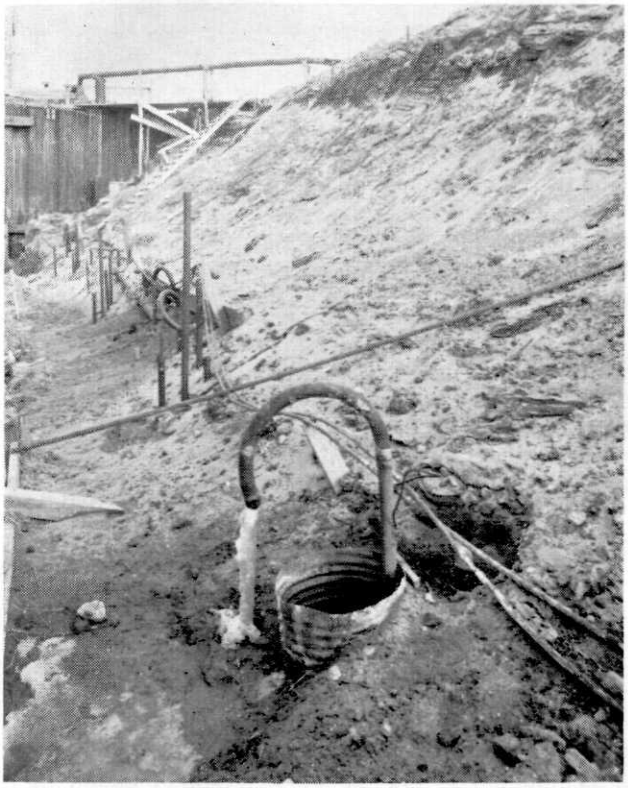
But when the sheeting moved in, it was apparent to all concerned that the saturated silt couldn't be handled by any ordinary means, or even by the vacuum wellpoint system – especially those deep trenches for the condenser ducts.

Some time ago, exclusive arrangements had been made with Dr. Leo Casagrande to handle and promote the little-known electro-osmosis system of fine-grain soil dewatering and stabilization. Dr. Casagrande, soils scientist and brother of another famous soil man, Dr. Arthur Casagrande of Harvard, had developed this system and holds patents in America and abroad on certain features, and has several more patents pending.

He had adopted this long-known, but little-used, principle of electrical physics to soil stabilization on four previous occasions in Europe. Stabilizing excavation for U-boat pens in Norway during the war was his most notable achievement along these lines.

Dr. Casagrande and other officials made a proposition to Consumers Power Co. to stabilize the silt layer by electric-osmosis.

Here's what they did, and here's what happened. Later on we'll try to explain the scientific principles of electro-osmosis soil dewatering and stabilization.



WELLPOINTS serve as cathodes, through which water escapes from the fine-grain silt, pushed out by electric potential. Header system has been removed, and water dribbles out of open-top wellpoint, freezing into an icicle.

They converted the second-stage wellpoint system into an electro-osmosis system by utilizing well-points about 20 ft. apart as cathodes, or negative poles. In between these points they drove pipes as anodes, or positive piles.

A battery of motor-generator sets was hooked into the system to furnish dc current at 80 v and relatively low amperage. Although the electro-osmosis process will force water to the surface through open well-points, header and pumps were used at first to aid in water disposal and to reduce the voltage otherwise required.

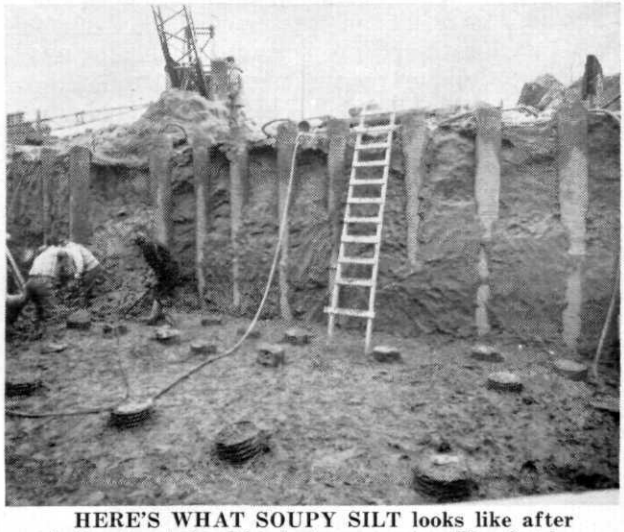
The effect was astounding. Before long water began to dribble out of the wellpoints, and to bubble out at the surface around the points. In 3 or 4 days, the quaking, saturated silt began to solidify into a stiff, sandy-clay formation. Piledrivers resumed work and excavation of the third stage, through 7 ft. of former sloppy silt, was carried down to desired slab grade without further trouble.

But there was still another 11 ft. of excavating to be done for the duct trenches – through the middle of the lot and a long way from the electrode system along the sides. Just to make sure, an inner set of electrodes was installed just outside of proposed trench lines for further stabilization, if needed. But to test the main system to the utmost, excavation of the trench was started without turning any current into the secondary system.

The current never was turned on in this last group of electrodes. The main system had stabilized the entire silt deposit within the cofferdam so completely that excavation could be carried down with straight walls without any sheeting or bracing. In fact, clay spades were necessary to trim the vertical walls, while the trench excavation was taken out with clamshell buckets.

Current was kept on the electrodes 24 hrs. per day, 7 days a week, though later on the voltage was reduced to 60 v. Investigation showed that the stabilization was greatest nearest the electrodes, and lessened somewhat out toward center of lot – but it still was sufficient to hold firm 18 ft. of former treacherous silt.

In original state, the silt contained from 30 to 50% moisture. Although no tests were made to reveal the exact reduction of moisture resulting from electro-osmosis, it was observed that only a slight reduction increased the shearing strength of the soil many fold. The longer the current was kept on, the drier the material became, resulting in increasing shearing strength.



HERE'S WHAT SOUPY SILT looks like after being treated with electro-osmosis. The intake tunnel is being excavated with clamshell and clay spades, walls standing straight up without shoring or bracing.

One big difference of this system, in contrast to orthodox wellpoints, is that under electro-osmosis the system can be shut down for a time for generator repairs without the soil being affected.

Severe electrolysis is set up around the electrodes, especially affecting the anodes. Many of the original pipes were so badly corroded that they had to be supplemented by heavy reinforcing rods driven down inside the pipes. It will be interesting to note the condition of the sheet piling when pulled.

(Continued on page 42)

Atomic blonde

Reprinted from "THE PHOENIX", Imperial College of Science and Technology

The Prof. was frowning narrowly as I entered his room.

"Sit down, Mr. Staggers," he said. "I am afraid that I have some bad news for you. The firm which was financing your research project has been taken over by the Anglo-American Fina and Betta Products Corporation. Their practice is to have all their research done in America, so I am afraid your grant has been ended."

I felt very distressed. I was working on the thermodynamics of liquid isobol and, though I could never imagine what interest it could have for McScroggins Ltd., who made corsets, it would be annoying to leave the job half-done. Particularly as I had a new apparatus designed and ready to order.

"How much farther can you go with your present apparatus?"

"Not at all, sir. We've reached the limit."

"In that case it looks as though I shall have to find you a new problem. Do what you can in the meantime."

I went downstairs and contemplated the thicket of glass that constituted my apparatus. There was an altogether disproportionate amount of sealing wax and insulating tape about it. I had intended to replace it with a very tony job in stainless and jack up the pressures. Eighteen months wasted. I looked at the glass jungle again and loathed it. Moodily I kicked the leg of the table. A Dreschel bottle fell off and smashed. I looked in the cupboard. None left.

"Oh, hell," I said.

I spent some days writing up the work, then I drifted over to the Union and read my way through every magazine there. I had reached the stage where I was playing chess against myself, and cheating, when I was summoned to the Prof's. room.

Seated beside him was a Guards-type in army uniform.

"This is Captain Fluellen," said the Prof. "He is from Atomic Research and has something very important to say to you."

Fluellen twitched a lip, then suddenly barked at me.

"First you must swear to keep secret everything I am about to say."

I swore. The captain still looked hesitant.

"This really Staggers?" he said. Even on being reassured he didn't look any too happy. Finally, he took the plunge.

"Heard about you and the Smithium. Good show you put up. Want new men. Thought of you. This is it, now. Atom johnny found new whatdymecallem – isotope, that's the word – isotope of carbon. Stable by itself, radio-active in combination in large molecules, such as proteins. Sounds queer to me, but there it is."

It sounded queer to me, too, but it was not for me to say so. I was on record as saying the atomic bomb was impossible ten days after the first had gone off at Los Alamos.

"See the idea. Drift this stuff over. Masses of it. Gets incorporated in people's innards. Becomes radio-active. Half life five and a half minutes. End product nitrogen. Result, everyone dissolves into a mess of amines and things. Opposition just a lot of little puddles on the floor."

He suddenly laughed heartily. It didn't seem so funny to me.

"Lot of work to be done on the sidelines, of course. That's where you come in. Care to?"

"Well, sir," I said, "Er, I don't know if you're a technical man . . . "

"No, no. Security. Just picked up some of the jargon."

"In that case," I said, bottling up my pleasure, "I'll keep it simple. Once news of this leaks out, the obvious countermeasures are the provision of specific contra-absorbents of superior hyglophobic inductivity. The best of these is undoubtedly isobol. So that the very first thing needed is a fundamental investigation into the properties of isobol."

The Prof. beamed approval; as I had hoped, the Captain looked somewhat at sea.

"Oh, ah!" he said, "you're probably right. But come up to Bottlewell Monday and tell it to the boffins. All I want to know is that you're on the ration strength. Bye, bye." And he went, suddenly.

Bottlewell is out Hitchin way and when I got there I found I had lost. The types there stood no nonsense about isobol. They were the real atomic types, blue chinned, big jawed, radium burned ears and hands. One of them had two heads, but they claimed he was like that before he took up nuclear physics. I found myself landed with the reaction kinetics of two unpronounceable molecules – I'm sorry I can't give you their names, but I've lost the bit of paper I had them written on. I always thought of them as *Pongo* and *Fluffy*, after a couple I knew whose rate of reaction was of a very high order.

When I told the Prof., he was very upset.

"Reaction kinetics! Good Heavens, that's *chemistry!*"

I tried to soften the blow.

"Yes, sir. But physical chemistry. It might have been worse. It might have been analytical chemistry."

He shuddered.

"I suppose so. We must look on the bright side."

My instructions were to read up on Pongo and Fluffy until I heard further from Bottlewell. I was plodding along when I was called up to the Prof's. room again. As well as Captain Fluellen, he had with him a most luscious blonde. I tried to ignore her, since she seemed to be none of my business, but, even so, I began to wish I'd put on my other shirt – the one with the collar. After the usual preliminaries, we got down to cases.

"I want to introduce Miss Ahrrm. She has been assigned as your Security Officer."

Now that she was some of my business, I took a good look. Short blond hair. Blue eyes. Red lips, very red lips. Good figure. Well dressed. Nice legs. Nylons. Then I worked my way slowly up again. Arriving at her face, I tried a tentative leer. She froze at once. Not so good.

"Miss Wilberforce," the Prof. went on, "will be in charge of the laboratory arrangements. Bottlewell would like you to go there for the whole of next week and, while you are away, Miss Whatsit will see to things here."

On this vague note, I was dismissed. The week at Bottlewell was quite astounding. I would spend the morning with a man arguing about the apparatus and a rough sketch would be produced. Arriving back from lunch I would find the rough sketch gone and in its place a print, still damp, showing several views of the apparatus, all completely dimensioned. Then, we would find fault with it until afternoon tea, after which it would be back, with all the amendments made. If we approved it, was whisked off to some place spoken of as "Progress."

At the end of the week I returned to college. I went in to my old lab. In one corner was my apparatus, covered in dust; but it could scarcely be seen for a strange assembly of people and instruments. It looked for all the world as though a group of scientists were going on safari, taking their assembled apparatus with them. At first there seemed to be dozens of bodies about, but soon I realized there were only eight.

"Hullo," I said. "Going to be crowded, aren't we?"

The response was a collective growl, then an Assistant Prof. of malevolent aspect said, "Oh, no, *you'll* be all right, Staggers, *you're* in 21."

I went out, puzzled. 21 is our biggest lab. and normally houses twelve people. 21 was locked, with a notice saying 'Entrance through Room 22.' This was the Asst. Prof's. room. I went along. It was labelled 'Submersible Colloids Research'. I knocked diffidently and went in. All the Asst. Prof's. apparatus had disappeared, but his bookcases, carpet, electric kettle and desk remained. The desk was now turned to face the door, and behind it sat Miss Wilberforce, knitting profusely. She looked up.

"Ah, Mr. Staggers. Can I see your pass?"

In the end, she saw my Bottlewell's pass, Identity Card, Passport, and Union Card. At last she was satisfied.

"What's going on, for heaven's sake?"

"Routine precautions, you know. Security. You will work next door. I have had a communicating door put in. And, to outsiders, we are Submersible Colloids Research. Officially we shall be *Operation Flowerpot.*"

I drifted in next door. No wonder I was unpopular in the Department. It was overcrowded enough already, without my displacing half the first floor. Inside, standing in splendid isolation, there was the apparatus I had finished designing two days ago, with a glass-blower adding finishing touches. Bottlewell certainly had things organized. In the corner, two plumbers were finishing the installation of a shower bath. I went over.

"What's all this?"

"Your shower, sir. Lovely job. We had a bit of trouble with the hot water line. Had to put in sixty foot of pipe, and all of it had to be lagged. Not very good layout, sir." The senior plumber shook his head reprovingly.

"But I didn't ask for a shower."

"Oh, but you did, sir. See here. You're Honeycomb, aren't you?"

"No, I'm Flowerpot."

"Cor . . . Fred, you was right. Honeycomb must be that one in Glasgow. Well," he said, surveying the tiled walls and porcelain runoff, "we can't take it out now. Just sign here, sir, and we'll get another one for Glasgow. After all, it might come in handy if the summer's hot."

Since the shower had been placed so that one side of it was against a full length window facing the women's hostel, I was not inclined to agree, but to get rid of them I signed.

After they had gone, I had peace until about half past three, when I heard a commotion: the blonde and another woman arguing furiously. I realized the other voice was Apples, and guessing what had happened, I hurried out. Apples' lab. is across the road from me, but every day about three-thirty she becomes filled with a desire to know more about isobol, so, naturally, she comes to see me. For about half an hour we discuss isobol and, just to be sociable, I give her a cup of tea. No doubt she had come over to tea today and encountered the Wilberforce's security patrol. I was right. As I entered, Apples was standing, arms akimbo, white-faced and trembling, using words I had certainly never taught her. Miss Wilberforce turned to me.

"Mr. Staggers, will you please make this – this person – see reason? She cannot be allowed in here, still less in Your Laboratory."

"Jonathan Staggers, I'm not going to stand for it. I've known you now for three years and I'm not going to let any peroxided bitch call me a Security Risk."

"Now, now, Apples. Miss Wilberforce is right; we can't have tea here. Let's go over to the Union."

Miss Wilberforce broke in.

"I'm sorry, Mr. Staggers, but I can't allow it. I have no proof of this person's bona fides and, if you are

(Continued on page 36)

Automatic driver helps prevent accidents

An exploration of how electronics can be put to work to reduce highway disasters and to relieve drivers of tiresome tasks on modern superhighways has been initiated by Dr. V. K. Zworykin, electronics scientist and television pioneer.

Recent electronic advances, such as the tiny, power-thrifty transistor, indicate that electronic aids to many automobile driving problems are approaching the realm of practical application, according to Dr. Zworykin. Although the day of completely automatic control of automobiles is far off, Dr. Zworykin said, certain electronic devices to assist drivers in such matters as bad weather steering and collision prevention are nearer at hand.

Zworykin Inspects Electrically Controlled Auto. Dr. V. K. Zworykin, pioneer electronic scientist, examines electronic apparatus of model car that drives itself. The car has been equipped in a study of problems of avoiding accidents and of automatic driving on super-highways of the future. The experimental car keeps itself centered over the wire, which radiates a signal. It can automatically stop or turn into another lane when another car is in its path.

To study the basic problems of automatic driving, Dr. Zworykin and assistants have equipped a model five-foot car with electronic equipment. This laboratory car, which is powered by a storage battery, can:

1. Steer itself along a prescribed route.
2. Stop itself when approaching a metal obstruction.
3. Turn out of its original lane into a second lane as if to pass another car moving at a slower speed.

In the laboratory set-up, the model car is guided by a wire which represents a cable that would be laid in the roadbed of a superhighway. The wire sets up a magnetic field of a certain frequency which is picked up by the two coils, one on each side of the car. If one coil receives more of the signal than the other, it means the car is no longer centered over the wire and electronic equipment controlling the steering wheel immediately brings the car back "on course."

To prevent a collision with an obstruction, simple transistor circuits associated with the guidance wire send out warning signals (of another frequency) whenever an obstruction passes or is stalled over them. These warning circuits, in effect, produce a "radio tail" at the rear of any sizeable metal obstruction on the route. When equipment in the model car receives the warning signal, the brakes are automatically applied and the car comes to a halt.

To simulate two lanes in the same direction, Dr. Zworykin has parallel guidance wires with a diagonal wire connecting them. When the model car senses the radio tail of an obstruction in the inner lane, its electronic equipment shunts it along the diagonal into the outer lane so as to pass the obstruction.

A system of warning circuits in the roadbed to produce a "radio tail" when an automobile passes over would be quite impractical with electron tubes, Dr. Zworykin pointed out. Such circuits would be needed approximately every 20 feet and the electrical power to operate the tubes would be enormous, he said. But when transistors are available in large quantity at low cost, he said, such circuits become feasible because power consumption would be reduced a million fold over that required by tubes.

Discussing the trend toward modern highways on which driving is becoming both simple and tiresome, Dr. Zworykin said that "the time has arrived for consideration of automatic driving techniques which may relieve the driver of his routine duties whenever his car enters an express highway system.

"Even now," he said, "with power steering, control devices are used to guide the car in preference to direct steering. Similarly, with power braking, the driver supplies a control signal rather than the physical force required to slow or stop the car. The automatic headlight dimmer is another device to take over a routine function of the driver.

"The number of such devices may be expected to increase and it is not too early to examine ultimate objectives of driving simplification. Long-range advance planning appears essential in this field in view of the large number of parties vitally concerned. Successful development depends on the cooperation of governmental authorities, the highway builder, the car manufacturer and the safety engineer for the benefit of the individual driver and the public at large.

"The basic requirements of an automatic driving system harmonize with trends in modern highway construction," Dr. Zworykin continued. "The require-

ments are that the roads have at least two lanes in each direction and that crossings and left turns across traffic be eliminated by cloverleafs and similar systems. With these conditions satisfied, the stage is set for a gradual introduction of measures to reduce traffic risks and simplify driving procedures.

"The changes should necessitate neither sudden abandonment of established driving habits nor wholesale installation of new equipment on roads and vehicles. This means: (1) The driver must retain the freedom of choice of speed, within prescribed limits, and of choice of either manual or automatic control. (2) Automatic control systems must be restricted, initially at least, to high-speed long-distance road systems subject to special regulation, such as turnpikes and thruways. (3) Vehicles equipped with automatic driving devices must be able to benefit in mixed traffic, consisting of equipped and unequipped vehicles.

"It is clear that car owners and purchasers will not bear the added cost of the control equipment unless it proves useful under current conditions, namely with the vast majority of cars under purely manual control. At the same time it would be both politically and economically impractical to restrict traffic on high-speed road systems to equipped cars.

"As a first step, equipment should be provided to enable the driver to keep his vehicle centered on the traffic lane under conditions of fog and poor visibility in general. This may be accomplished by a cable, buried in the concrete, carrying moderate-frequency alternating currents (of the order of 100 kc) and a pair of magnetic pickups mounted on the car. The difference in the signals derived from the two pickups may be used either to indicate the off-course position of the vehicle on the dashboard or applied directly to the steering mechanism so as to maintain the car in the center of the lane. Feedpoints for the cable may be provided at intervals along the highway.

"In this system the driver not only would retain complete control of the car speed, but, in addition, could switch at will from manual to automatic steering. The automatic setting could be linked to an external indication on the car to inform road supervisors and other drivers of the fact that the car is under automatic control.

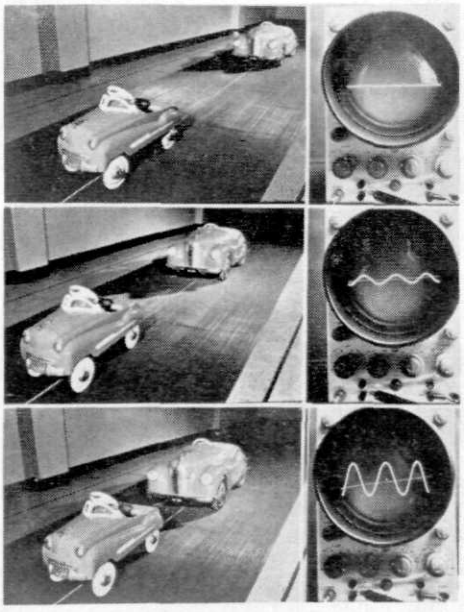
"The second step in the evolution of the automatic driving system, the prevention of collisions, is a natural extension of the guidance equipment.

"The essential feature of one proposed collision prevention system is the transfer of energy from a high-frequency power cable, to a series of tiny oscillators or transmitters along the lane. The transfer of energy is controlled by the passage of a car and a long time constant circuit or 'memory' causes the transmitter to function for a time after the car has passed. The oscillations are transmitted backward along a high-attenuation cable and sensed by pickup coils on the following cars. Thus every car, whether equipped with automatic driving devices or not, would be followed by a 'flying tail' of warning signals. Their amplitude would increase as the car slowed down and become a maximum for a stalled car. Conversely, the sensing system of the following cars would be coupled with the car speed indication in such fashion that the warning signal would increase with their speed.

"In a completely automatic system this warning 'tail' could be used to switch a car from one lane to another at specified cross-over points. In this case, the sequence of events as a car approaches another vehicle which is either stalled or moving at a lower speed is: As the signal picked up from the 'flying tail' of the preceding vehicle reaches a certain level, the guidance setting would be shifted to the left lane. Then, the car would pass over to the left lane at the next cross-over point and pass the slower vehicle unless:

a. The turn-off is blocked by signals from a nearby vehicle which is already in the left lane, or

b. The slower vehicle impedes further progress even before the turn-off point is reached.



Experimental Car Stops Itself Electronically. Model car equipped with experimental electronic equipment is shown stopping itself to prevent a collision. Designed to study electronic control of automobiles on superhighways, the car at the rear picks up a warning signal generated in circuits connected with the wire. The warning signal is set off by the metal of the parked car in front. Oscilloscope pattern at right of each picture shows how the warning signal received in the rear car gets stronger as it nears danger point.

"In the second instance the signal from the 'flying tail' would continue to increase in intensity; its indication to the driver may be either auditory or visual — in the form of a sound of rising amplitude or a flashing light of increasing frequency, warning him to decelerate or apply the brakes. As an alternative, the signal, from a certain level on, may reduce the fuel intake and, at a still higher level, actuate the power brakes. Again, by a three-way switch, the driver could be given the choice of unassisted manual control,

(Continued on page 54)

This is not an Editorial

Let's all get on the gravy train

by Tom Clark, Ch. E. '54

Everybody is getting on the gravy train, especially the student engineer of today. The student engineer can almost name his starting salary in the job that he likes in any part of the country.

Of course, the student's ability to do all of this depends upon how well he prepares himself in college. He must, in order to successfully prepare himself, maintain a balance between his studies and his social and extra-curricular activities as well as gain some actual engineering experience through summer employment with engineering firms. The average Joe College engineer of today pretty well gets himself ready to get on the gravy train by keeping his marks up to par and by entering into social and extra-curricular activities. This particular guy, however, hasn't thought about getting any practical engineering experience during the summer.

Why . . .

If you ever ask this fellow about summer employment in engineering, this is probably what he'll tell you: "I can't work for an engineering firm outside of my hometown. If I did, I wouldn't have enough money to go back to school." But ask the fellow who is planning to get a job outside of his hometown for the summer and who is also working his way through college. He'll tell you, "Maybe I do have to save here and there throughout the year, but brother, I figure it's worth it to gain some practical experience in engineering before I get out on my own." Then there is the guy who is going to ROTC summer camp. He isn't going to apply for a summer job, because he figures that no one will hire him for half a summer. The cagey fellow on the other hand gets a job after summer camp with a company that he knows will hire ROTC students. The company that hired this fellow is willing to hire ROTC students, because the ROTC student, after he serves on active duty, is better trained to supervise those who are assigned under him.

Let's get back to Joe College. He's the guy that thinks that summer employment isn't going to help him. He probably doesn't look at a job in engineering for the summer as an excellent opportunity to get professional contacts and references for future job applications. Summer employment to a lot of students is a chance to find out, before they graduate, what the engineering profession is like and just what type of work they might like to get into. There are some who will get summer jobs in industry because they know that some employers of engineers will add as much as $15 per month to their starting salary, if they have had summer experience with an engineering firm.

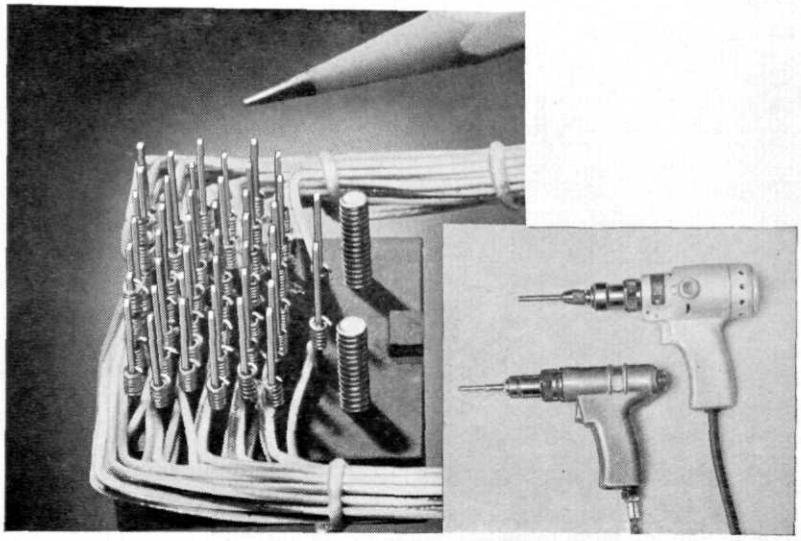
The Student Who Wonders

Then there is the student who has often thought of getting an engineering job for the summer, but who hasn't gotten around to applying for such a job. He probably wonders: "How can a company give me a position where I can gain some practical experience if I am only going to be working for them for three months?" The fact is that when a man is hired for summer employment, these companies will try to give him a job where he can gain some experience. It is to their benefit as well as his that he gets this practical experience. A student can gain a wealth of knowledge about engineering by just asking questions and by keeping his eyes and ears open while working for an engineering firm for the summer.

For the freshman, sophomore and junior engineers, now is the time to start thinking seriously about applying for a job next summer. You may find that if you wait until next spring, the job that you would have liked to have had has already been taken by someone who was on his toes in the fall. The easiest way to get application blanks for a summer job with the companies of your choice is to ask for the forms at the placement bureau on campus. When the companies with whom you have filed applications come on campus to interview the seniors, you, too, can interview these companies with them. Through interviews, you can increase your chances of getting offers for summer employment, and you will also find out just what each company has to offer you in the way of experience during summer employment.

Here is an offer to get an education and to be paid for getting it at the same time. Here is also a chance for you to get ready to jump on the gravy train when it comes your way. Don't pass it up!

Good Connections ...electrically speaking



New solderless method permits the making of very closely spaced connections, as shown on this experimental terminal block.

Electrically powered "wire wrap" tool (above) and compressed air tool (below) for making wrapped solderless connections.

GOOD CONNECTIONS are mighty important to us for, you see, we make more than a billion electrical connections each year. It takes that many to manufacture and install complex telephone equipment in the Bell System.

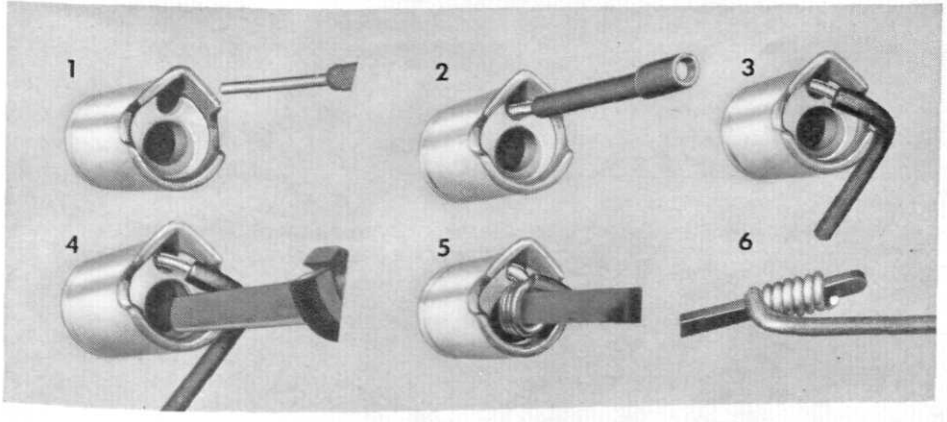
That's why the revolutionary new method of making electrical connections *without solder*—a method created by Western Electric engineers together with their teammates at Bell Telephone Laboratories—is indeed one of the significant engineering achievements of recent years.

Like most really creative engineering jobs, the development of a tool to make solderless connections grew out of a problem. We had to find a way to connect our newly designed wire spring relay to other components in giant bays of switching equipment. This new relay—something of an engineering achievement itself—can have as many as 36 terminals in an area only 1-3/8" by 11/16". Obviously, the conventional method of hand-wrapping and soldering wires onto the terminals is extremely difficult in such a small area.

After more than five years of research and experimentation, the engineers came up with a pistol-like power tool capable of making mechanically sound solderless connections. Shown above are two tools now used at Western Electric manufacturing locations. They literally shoot wire onto terminals . . . and do it surer, faster and less expensively than conventional methods using solder. That's not all. The new "wire wrap" tool keeps equipment free from solder splashes, wire clippings and reduces bent and distorted terminals. Electrically, the "wire wrap" tool gives a far better connection than can be made manually . . . the high pressure contacts are stronger, cleaner, more compact and more uniform.

In keeping with the Bell System policy of sharing technical know-how with all of industry, Western Electric will make this tool commercially available to electrical manufacturing companies, such as radio, television and communications producers, through licensed tool manufacturers.

You're right if you think we're more than a little pleased with our accomplishment. And as we have been many times before, we're proud of the engineers in all fields—electronics, mechanical, electrical, metallurgical, chemical, industrial—who uphold our reputation for leadership in fundamental manufacturing techniques.



How a solderless connection is made: (1) Skinned wire approaches the small flared opening in the tool tip. (2) Wire is inserted in hole. (3) Wire is bent and anchored by means of notch in side of gun tip. (4) Gun tip is slipped over rectangular wire terminal. (5) Spindle of gun tip rotates to wrap wire around terminal. (6) Six wire wraps around terminal complete electrically sound joint without soldering.

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1832

Manufacturing plants in Chicago, Ill. • Kearny, N. J. • Baltimore, Md. • Indianapolis, Ind. • Allentown, Pa. • Winston-Salem, N. C. Buffalo, N. Y. • Haverhill, Mass. • Lawrence, Mass. • Lincoln, Neb. • St. Paul, Minn. • Duluth, Minn. Distributing Centers in 29 cities and Installation headquarters in 15 cities. Company headquarters, 195 Broadway, New York City.

Job 13758

out in front...

by design!

A *dynamic industry*, a *progressive company* and a *good start* with basic, broad training are important to a successful engineering career.

With that in mind, consider these facts:

First, the automobile industry continues to expand. In fact, experts predict that 80,000,000 vehicles will be on the road by 1975.

Second, probably no car has ever earned itself a more enviable position in the automobile industry than Pontiac. Pontiac has pioneered many important advances in automobile engineering, advances that have been adopted by the entire industry. But there are many problems still to be solved. Young men with fresh ideas and new approaches—with the guidance of experienced engineers—will solve many of them.

Third, the majority of all leading positions in automobile engineering are held by men who have had experience in designing—one of the most basic approaches to an engineering career.

Yes, there's a great future in store for young engineers with well-rounded training in automobile designing—and this training is especially promising for young men with ability who want a career at Pontiac based on opportunity, advancement and liberal General Motors compensation and employment benefits.

Plan now to design—for a great future!

Pontiac's huge new engineering building is the industry's most modern, with every conceivable facility for designing better and better Pontiacs.

PONTIAC

MOTOR DIVISION • PONTIAC, MICHIGAN

GENERAL MOTORS CORPORATION

You'll be at the head of the jet parade at Boeing

For long-range opportunities, it's hard to beat the jet aircraft field. If *you* want to get into this exciting branch of engineering after you graduate, get in at the head of the parade—at Boeing.

Through the fighter-fast B-47 six-jet bomber, and the giant new eight-jet B-52, Boeing has acquired more experience designing, flying and building multi-jet aircraft than any other company, either here or abroad. In addition, Boeing is the first American company to announce its entry into the jet transport field.

Engineering graduates will find in the aviation industry an unusually wide range of experience, and great breadth of application — from pure research to production design, all going on at once. Boeing is constantly alert to new techniques and materials, and approaches them without limitations. Extensive subcontracting and major procurement programs, all directed and controlled by engineers, afford varied experience and broad contacts and relationships.

Aircraft development is such an integral part of our national life that young graduates can enter it with full expectation of a rewarding, long-term career. Boeing, now in its 37th year of operation, employs more engineers today than even at the peak of World War II. Its projects include guided missiles, research on supersonic flight and nuclear power for aircraft.

Boeing engineering activity is concentrated at Seattle in the Pacific Northwest, and Wichita in the Midwest. These communities offer a wide variety of recreational opportunities. Both are fresh, modern cities with fine residential sections and shopping districts, and schools of higher learning where engineers can study for advanced degrees.

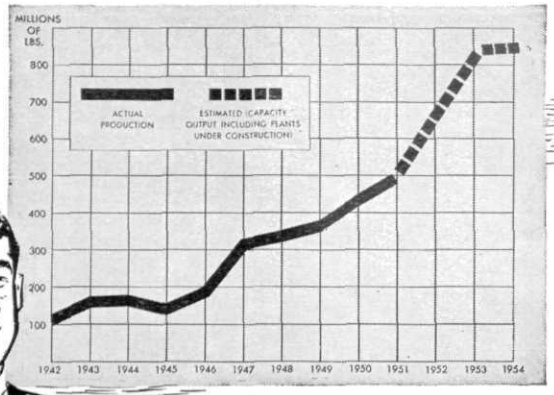
There are openings in ALL branches of engineering (mechanical, civil, electrical, aeronautical, and related fields), for **DESIGN, DEVELOPMENT, PRODUCTION, RESEARCH and TOOLING.** Also for servomechanism and electronics designers and analysts, and physicists and mathematicians with advanced degrees.

• • •

For further information consult your Placement Office, or write:

JOHN C. SANDERS, Staff Engineer — Personnel
Boeing Airplane Company, Seattle 14, Washington

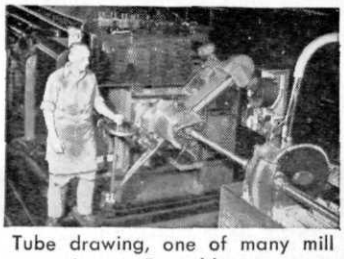
BOEING



Reynolds expanding production —historic chapter in 33 years of continuing growth.

A Fertile Place for Careers to Grow...

Settling tanks, where impurities are separated from sodium aluminate



Tube drawing, one of many mill operations at Reynolds

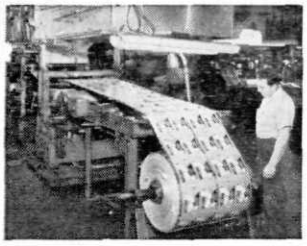
A broad vista of opportunity opens up for college graduates who come to work for Reynolds. The phenomenal rise of the Reynolds Metals Company, known throughout business and industry, is clearly depicted by the above chart. The five-fold expansion in total production of aluminum ingot alone spells broad opportunity. Add to this the vast and productive fabricating facilities of Reynolds —in themselves an enterprise of considerable proportions—and here indeed is a fertile field for any ambitious engineer.

From bauxite mining through metals refining and fabrication to application engineering, sales and marketing, Reynolds offers broad career opportunities. Operating 27 plants in 13 states, and still expanding, there is virtually no limit to what can be accomplished by a capable graduate engineer.

Preliminary orientation in production and sales... direct on-the-job training... liberal insurance, hospitalization and retirement programs... these are all parts of a sound personnel policy maintained at Reynolds.

For important information on "your future in Aluminum," *mail the coupon.* If you are definitely interested now, write direct to General Employment Manager, Reynolds Metals Company, 3rd and Grace Streets, Richmond 19, Va.

REYNOLDS ALUMINUM



Foil — for many uses, including colorful, protective packages and labels; also famous Reynolds Wrap.

Full color movies tell the fascinating story of Reynolds Aluminum. 16mm films available for group showings.

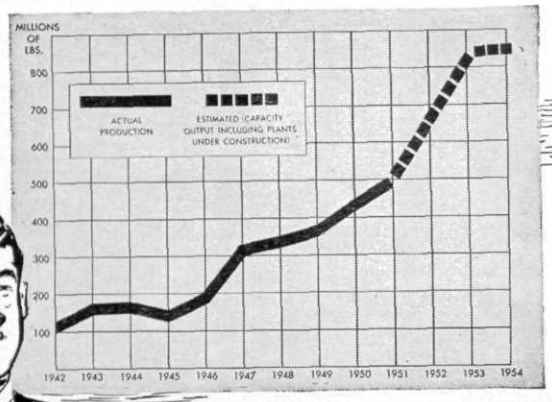
Reynolds Metals Company,
Employment Dept.
Richmond 19, Virginia

Please send me, **FREE,** your 96-page booklet "The ABC's of Aluminum"; also the 44-page book, "Reynolds Aluminum ... and the Company that makes it."

Name _____

Address _____

School _____ **Class** _____ **Course** _____



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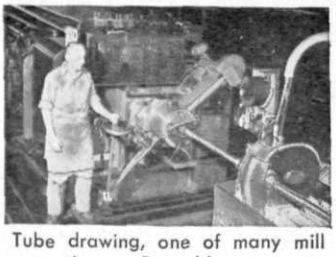

Tube drawing, one of many mill operations at Reynolds

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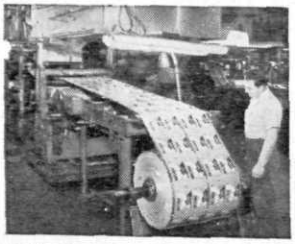

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Name _____

Address _____

School _____ **Class** _____ **Course** _____

There's a gold mine back of olds hall

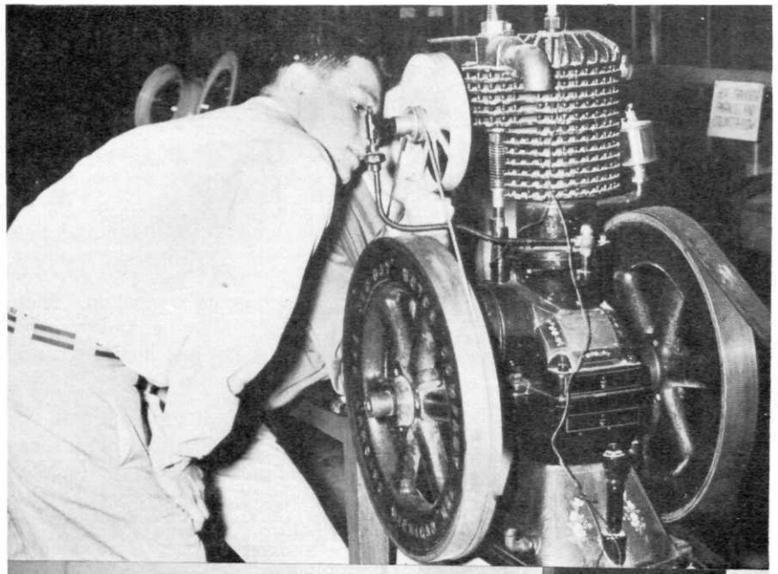
by Bruce Harding, Met. E. '54

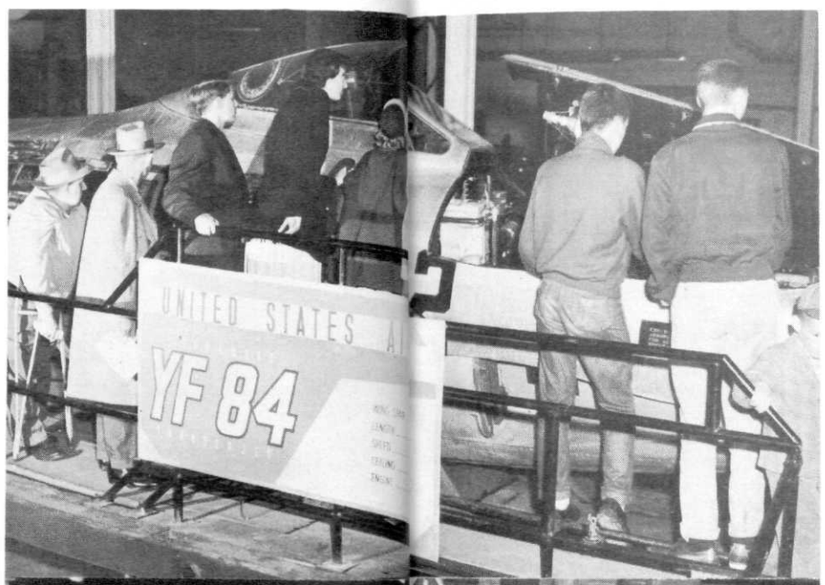
Go out the west door of Olds Hall, turn left and walk south for about a hundred feet, and go through the door of the foundry (if it is shut, open it first). Or, if you are more daring and love adventure, take the scenic route through the Power Lab and go out the west door by the Cummins diesel. You will find yourself in "Death Alley," and if you manage to get across it without being run over, go into the little door slightly to the south (this door is similar to the other and should be opened first).

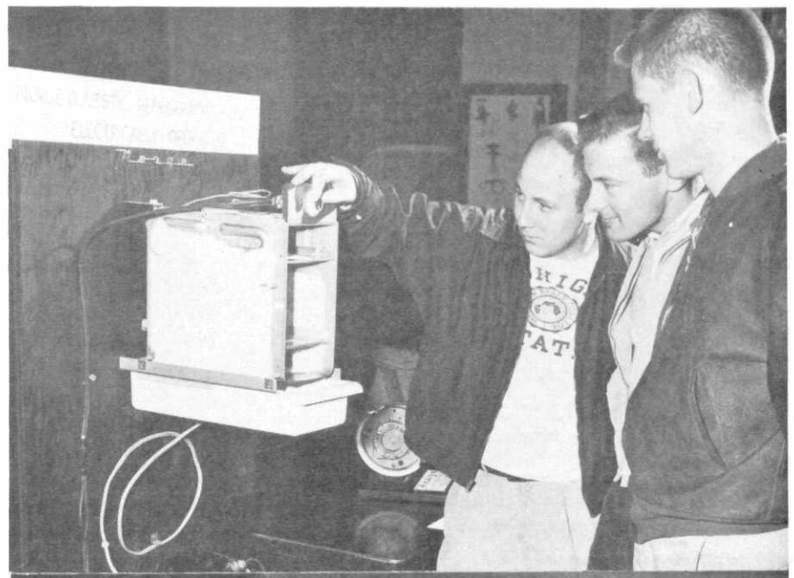
Whichever path you have taken, you will find yourself in a goldmine! There are all sorts of odd characters running about, pounding sand and muttering about "green" sand when it's all black or brown. "This is a goldmine?!" you ask. True, our foundry doesn't look much like a goldmine, for it is the opportunities which the student meets there which are golden. The foundry industry itself offers a promising future to those entering it. Here in our own foundry is an opportunity to get a taste of nearly every phase of the cast metals industry, so we can know what each entails and perhaps choose one as a vocation. These phases are the "veins" of our goldmine, and we must dig into each a bit to determine just how promising is is; and, choosing one, we have to keep on digging to get the gold out!

Looking at the industry itself, we see that a foundry is usually either ferrous or non-ferrous (seldom both), but aside from this distinction there is that of the casting processes involved, and a foundry may specialize in only one or apply many. Most common of these processes are, of course, green sand and dry sand molding, and there is also investment (lost-wax) casting, plaster casting, die casting, and permanent mold casting. Recent additions to the growing list are the "C", "D" and "P" processes, or the Croning (shell), Dietert, and high-pressure processes respectively, while there are also a few rarely used processes to round out the list. Just look at all of the different fields of work the foundry has to offer you! Each of these processes has its own applications, but knowing

(Continued on page 52)

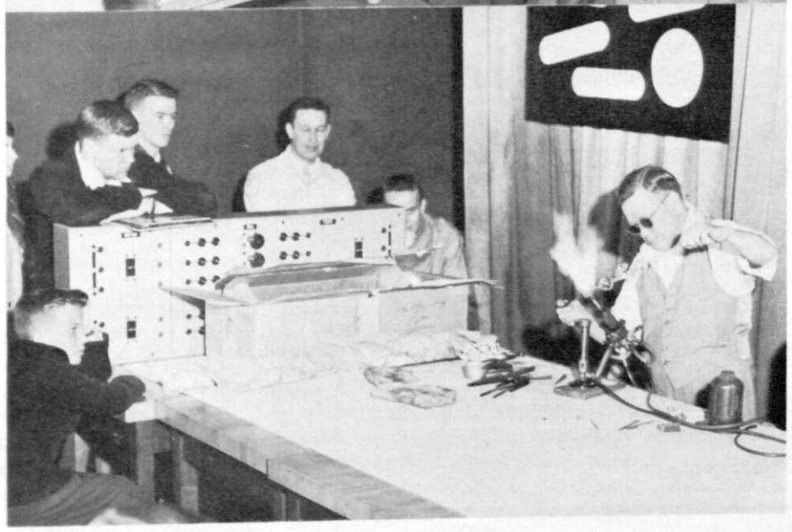






CANDID SHOTS OF THE NGINEERING EXPOSITION

PHOTOS BY BOB BRANDON AND BILL MITCHELL



Clubs and societies

A. S. C. E.

Highlight of the activities of the American Society of Civil Engineers was the annual student chapter-parent chapter joint banquet on November 3. Speakers for this event were Lyle Ferris, of the United States Geological Survey, and Carl L. Shermer, professor of civil engineering at Michigan State College. Mr. Ferris' talk was on "Ground Water: It's Challenges and Opportunities to the Engineer," while Mr. Shermer's talk was entitled, "Talking Turkey."

The first activity of the ASCE this year was a "get-acquainted" meeting October 6, held in the Old College Hall of the Michigan State Union Building. Feature of the meeting were talks by Andrey A. Potter, retired dean of engineering at Purdue University and acting dean at Michigan State College; and by Harry L. Conrad, president of the Christman Company, of Lansing.

Attendance at this first meeting totaled approximately 75. Of those, about half were sophomores, who had been to summer surveying camp, and faculty members. The ASCE invites anyone interested in joining their organization to attend its bi-weekly Tuesday night meetings.

In addition to having its regular meetings this fall, the ASCE has sponsored a touch football team in the independent intramural league. The team started its season successfully with a 6-0 victory October 13.

AIEE-IRE

The first joint AIEE-IRE meeting of the Fall term was attended by nearly 250 electrical engineering students. Prof. Ira B. Baccus, head of the Electrical Engineering Department, and Prof. I. O. Ebert explained the purposes of the American Institute of Electrical Engineers and Institute of Radio Engineers, respectively.

At its second meeting on October 27th, Mr. D. L. Chestnut of the Educational Sales Section of General Electric spoke on "Developments in the Power Field."

The officers this year are: Gene Lazarus, president; Wayne Scutt, vice president; John Clark, treasurer; Dick Pfeil, AIEE secretary; and Bill Bartley, IRE secretary.

TAU BETA PI

Leo Jedynak, president of Michigan Alpha Chapter at Michigan State College, attended Tau Beta Pi's 48th national convention at Clemson College, South Carolina, on October 8, 9, and 10. The convention was attended by student delegates from 90 undergraduate chapters. Four new undergraduate chapters were granted charters at the convention. The new chapters are at Brown University, University of Denver, University of Rhode Island, and the University of Toledo.

Owner goes 'round the world in 40 seconds!

With this new multi-wave portable you can circle the globe in the time it takes to twist a dial.

That's because the RCA Victor Strato-World radio has Electronic Band Spread Tuning.

Instead of being squeezed together on one band segment, short-wave stations are in spread formation across the dial of your 7-band Strato-World. You tune London, Rome, Moscow, Tokyo just like local stations.

There's real *one-handed* portability, too. The Strato-World is a trim 23 pounds, with batteries . . . or it can be plugged into an electrical outlet. Smartly styled, with genuine cowhide case!

Here is the performance, the engineering and design you've come to expect from RCA Victor, a division of the Radio Corporation of America. See this globe-trotting, pace-setting portable at your RCA Victor dealer's.

CONTINUE YOUR EDUCATION WITH PAY—AT RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short-wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and producing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to College Relations Division, RCA Victor, Camden, New Jersey.

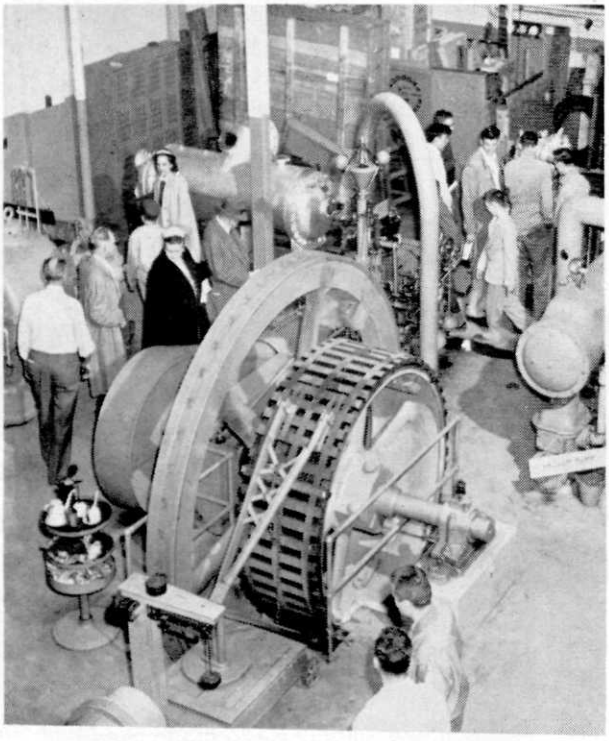
Also many opportunities for Mechanical and Chemical Engineers and Physicists.

RCA ® *RADIO CORPORATION OF AMERICA*

World leader in radio—first in television

The engineering council

This is the first of a series of articles designed to acquaint you with the Engineering Council. As an engineering student at Michigan State College, you should know how the Council can help you and also how you can help the Council.



At the Engineering Exposition visitors see new developments in engineering, engineering equipment, and the school of engineering.

The Engineering Council is comprised of student representatives from all the engineering organizations on campus. Each engineering society, such as the American Society of Mechanical Engineers, sends three representatives, one sophomore, and two upperclassmen; while the honorary fraternities such as Tau Beta Pi, are entitled to one member. In addition, the Spartan Engineer sends three representatives. Several times a month these representatives get together to discuss and plan the projects of the Council. If they find that they need help, they can call upon either Mr. Anderson, their general advisor, or their financial advisor, Mr. Rotty.

The general organization of the Council resembles that of most other groups. The offices of president, secretary, and treasurer entail the usual responsibilities, but in this organization the talents of the vice-president too are employed. He automatically becomes chairman of the Engineering Exposition. Other officers include the sergeant-at-arms and the publicity director.

At present the members of the Council are busily working on their first project of the year, the annual semi-formal dance. It has become traditional to hold the dance before the Thanksgiving holidays, and that's how it gets its name, the Holiday Ball. This year the Engineering Queen, who reigns over the Holiday Ball and the Engineering Exposition, is being chosen in conjunction with the dance.

The Engineering Exposition is the major project of the Engineering Council. It is an annual event, held each spring, and consists of displays designed by industrial firms and also by students. Students, their parents, and everyone else who is interested, are free to walk through the buildings housing the various exhibits. They are given a chance to observe engineering as it is put to work in industry and also a chance to see what is going on in the engineering departments on campus. A feature of the Exposition is a speech by an outstanding industrialist. Also on hand is an interesting show that explains in simple non-technical language the principles of operation of many of our present day machines and the plans for those of tomorrow. The Exposition is a joint project of the Council and the various Engineering societies.

The Council aids the School of Engineering in the operation of JETS. JETS, which stands for Junior Engineering Training for Schools, was instituted to give high school students information about the engineering profession and the college engineering curriculum upon which to base their career decisions. The plan has been very successful and at the present time there are over thirty-five such groups in the state of Michigan.

The Council maintains a list of the programs which are available to the various societies and also posts a calendar in Olds Hall listing the dates of all organization meetings.

The Engineering Council performs an important and necessary function in coordinating the activities of the engineering school.

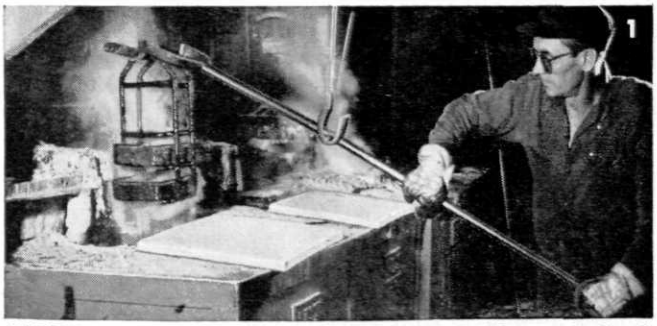
What's Happening at CRUCIBLE

about REX HIGH SPEED tool bits

Many millions of REX High Speed Tool Bits have been produced, in recent years, at Crucible's Sanderson-Halcomb Works, Syracuse, New York.

Our Tool Bit Department is actually a manufacturing plant in itself, where production is counted in pieces—in sharp contrast to the larger production units of most other phases of steelmaking.

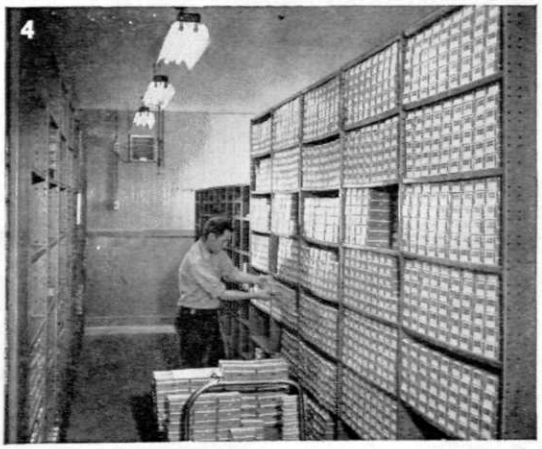
REX High Speed Tool Bits are made from high quality high-speed steel bar stock, produced at Crucible's Sanderson-Halcomb Mill. Bars are cut to tool bit lengths, heat-treated, grit-blasted or ground, and inspected.



HARDENING — Small batches of REX High Speed Tool Bits are hardened in modern salt bath furnaces. The bits are then quenched in either salt or oil.

TEMPERING — Tempering is done in circulating air furnaces. All of the steps illustrated help insure a correct combination of maximum red hardness, toughness and abrasion-resistance necessary for continuous high cutting efficiency.

TUMBLING — Prior to inspection and packaging, REX High Speed Tool Bits are cleaned by tumbling.



STOCKS — REX High Speed Tool Bits are stocked in standard packages in Crucible's warehouses.

Uniformity Each individual REX High Speed Tool Bit possesses the same uniform high quality. Each bit is inspected by the magnetic particle method . . . and representative bits are tested for microstructure and hardness. These tests control quality of the finished product . . . insure that REX bits will give higher production from each grind, and a minimum of "down-time" on your machine.

Crucible Engineering Service Available Crucible engineers are available to work with you in the selection of the proper REX grade for highest cutting efficiency on your particular job.

CRUCIBLE first name in special purpose steels

53 years of Fine steelmaking

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

Midland Works, Midland, Pa. • Spaulding Works, Harrison, N. J. • Park Works, Pittsburgh, Pa. • Spring Works, Pittsburgh, Pa.
National Drawn Works, East Liverpool, Ohio • Sanderson-Halcomb Works, Syracuse, N. Y. • Trent Tube Company, East Troy, Wisconsin

R & L Circuits

(Continued from page 15)

to give two breaks in series. As the movable contacts open downward, an arc is drawn in each tube – one in the generating chamber and the other in the venting or exhaust chamber. The arc in the generating chamber creates gas pressure that forces the cool oil from the cross-blast chamber across the arc in the exhaust chamber and through the exhaust port. The arc in the exhaust chamber is thus extinguished as its products of ionization are expelled through the exhaust port.

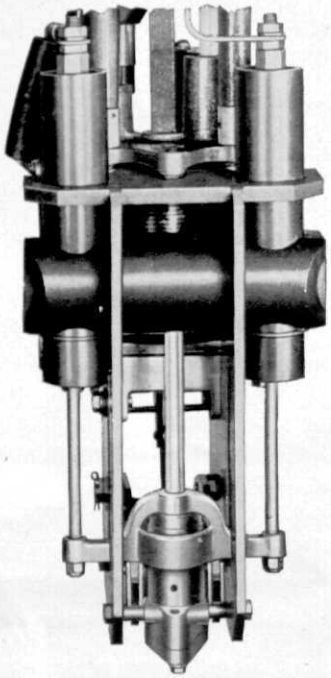


FIGURE 7. Kyle Type "E" Cross-Blast Arc Interrupting Structure.

A successful interruption by a circuit recloser depends upon its ability to extinguish the arc (or, build up dielectric faster than recovery voltage) before energy is generated in sufficient quantity to destroy the device. Arc energy, from parting of contacts to current extinction, is the sum of the product of instantaneous arc voltages and currents. From this viewpoint, the asymmetric current with the highest instantaneous values generates the greatest amount of arc energy. If the energy is generated in excess quantity, several detrimental actions take place:

1. The metallic electrodes give a violent emission of new electrons. This burning effect not only reduces the contact mass but also increases the gas bubble ionization, which reduces dielectric build-up. The possibility of arc reignition after a current zero is thus increased.
2. Excess liberated heat causes intense oil dissociation into carbon and gases. Also, with longer arc duration, the bubble grows to enormous dimensions.
3. Fiber members in contact tube structures burn and deteriorate rapidly with excess heat. Fiber parts are used as exhaust ports in cross-blast reclosers to keep arcs in shorter and more easily extinguishable lengths. The exhaust port is a series of small holes in a fiber section. This arrangement prevents the arc from generating excess energy while its products of ionization are expelled.

Numerical Factors of Asymmetry

Modern circuit reclosers have minimum opening times from one-half to one cycle (time from fault initiation to contact separation). Arc energy in the form of heat will be generated during the next half cycle to cycle and a half. The heating effect of a sinusoidal current is represented by its RMS value. Thus, the measure of a recloser's difficulty of interruption due to transients can be determined by the RMS value of the asymmetric current. For practical purposes, AIEE recommends a particular time for asymmetric current measurements rather than integrating instantaneous power over a time interval. A logical time for measurement is the minimum opening time of one-half cycle. The RMS value of an asymmetric current is defined by AIEE as the square root of the sum of the squares of the direct current component and the RMS alternating current component:

$$I_{asy} = \sqrt{I_{dc}^2 + I_{ac}^2}$$

See Figure 4 with circuit X/R = 1. One-half cycle after voltage zero circuit initiation, the direct current component has decayed to 0.3 amps. The alternating current RMS value is 7.07 amps. Then:

$$I_{asy} = \sqrt{0.3^2 + 7.07^2}$$
$$I_{asy} = 7.09 \text{ amps}$$

The heating value of the asymmetric current is 1.003 times greater than the alternating current RMS heating value one-half cycle after circuit initiation, or, the RMS factor of $I_{asy}/I_{ac} = 1.003$. See Figure 5 with circuit X/R = 8: $I_{dc} = 6.68$ amps, $I_{ac} = 7.07$ amps, then $I_{asy} = 9.74$ amps. The RMS factor of $I_{asy}/I_{ac} = 1.378$. See Figure 6 with X/R = 20: $I_{dc} = 8.55$ amps, $I_{ac} = 7.07$ amps, then $I_{asy} = 11.1$ amps. The RMS factor of $I_{asy}/I_{ac} = 1.57$. As X/R approaches infinity, the I_{asy}/I_{ac} factor approaches 1.732, or $\sqrt{3}$.

Figure 8 shows I_{asy}/I_{ac} factors one-half cycle after circuit initiation (at voltage zero) for various X/R values. Figure 8 provides multiplying factors to convert from symmetrical current values to asymmetrical current values. Hence, if the X/R of a fault circuit and the symmetrical fault current are known, multiplying the symmetrical fault current by the proper numerical factor will give the RMS asymmetrical current that a recloser would be required to interrupt.

For example, consider the application of a Kyle Type "E" recloser capable of interrupting 2500 amperes symmetrical current. If a fault occurs at system voltage zero and the fault circuit has an X/R = 8, the recloser must be able to interrupt $1.38 \times 2500 = 3450$ amperes RMS. Thus, Figure 8 provides multiplying factors to obtain an asymmetrical interrupting rating for a recloser.

Effect of Load Current

In the previous discussion there was no current prior to circuit initiation. However, circuit reclosers

normally carry a load current determined by the circuit impedance. The occurrence of a fault reduces this impedance to a lower value and results in fault current initiation. Maximum fault asymmetric current is possible when there is no load current. Any load current with a lagging power factor reduces the initial transient fault component and thereby reduces the maximum fault asymmetric current. The initial transient fault component will have a value equal to the difference between the fault steady state alternating current and the load alternating current. Consider fault initiation at voltage wave zero in a circuit with X/R = 8. See Figure 9. The initial transient fault component now is less than the fault steady state alternating current value, and the resulting fault asymmetric current has been reduced. Logically, since I_{asy} is less, the factor of asymmetry will be less. This is understandable from a recloser's viewpoint of easier interruption due to decreased arc energy.

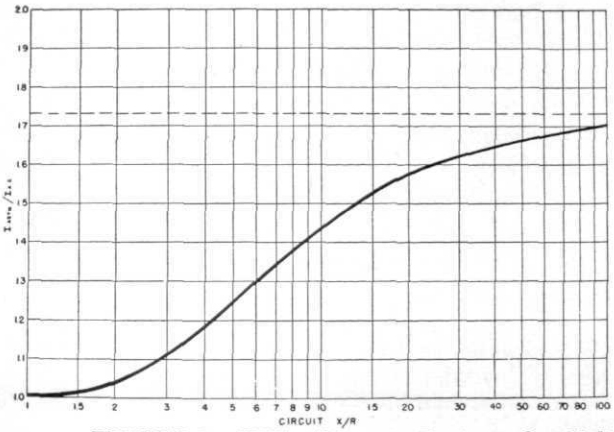


FIGURE 8. RMS Current Factors One-Half Cycle After Instant of Circuit Initiation for Various X/R Values.

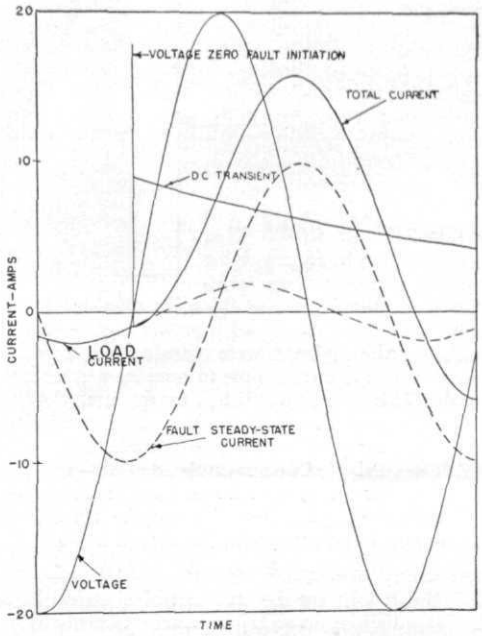


FIGURE 9. Fault Current Asymmetry Reduction by Load Current.

Reprinted from "THE LINE" of the Line Material Co.

Atomic Blonde

(Continued from page 19)

having tea with her, I must insist on being present, to ensure that nothing classifiable as Security is discussed."

Then there was more trouble, which ended in Apples marching off in high dudgeon. That evening Apples talked of nothing else but the blonde. She was over-bearing, petty authority at its worst, without sense or dignity, and probably had designs on me. At this point, Apples abandoned all pretense of impartiality and dissected poor Wilberforce with venom, touching her peroxided hair, irregular features, artificial bosom, lack of dress sense, and ending by wondering how she acquired such expensive nylons.

Next morning the blonde met me with a lecture, obviously prepared, on the dangers of associating with women not personally vouched for by the Prime Minister or, preferably, Miss Wilberforce.

The next week was ghastly. The job was no more than monotonous repetition work — no smoking work at that. The loneliness got on my nerves, but if I emerged from the lab., I was treated like a leper by the unfortunates I had displaced. Of course, there was always Miss Wilberforce. Decorative though she was, I found her trying. For instance, she began to go through my bookcase and found the International Critical Tables. She was horrified.

"Good Heavens!" she said, "Published in Germany! As Unrestricted! What can they be thinking of? These results should have gone to the Allied Control Commission, who would circulate them to such scientists as are interested and reliable. But to publish them like this, so that anyone can read them! I must send my Branch a report at once."

Then she found a paper by an Englishman in which he gave Russian references and she wrote another report. I believe the poor man's home life was ruined by Special Precautions men snooping round him. He thought his wife was trying to get evidence for a divorce, while his neighbours thought they were C.I.D. men, after him as a confidence trickster.

And every day I was lectured by the tall, beautiful, earnest Wilberforce on the dangers of consorting with untrustworthy brunettes, and every evening I was lectured by the small, lovable, spiteful Apples on the dangers of working with unprincipled, man-hungry blondes. Apples still called for me for lunch and tea, and the few minutes she and the blonde were together in the office were the most unpleasant of the day. What with one thing and another, I was relieved to be called to Bottlewell for a conference.

I had hoped to return by lunch-time on the next day, but it was late afternoon when I got back. Miss Wilberforce was sitting behind her desk looking uncommonly smug. She was obviously bursting with news.

"Something happened, Miss Wilberforce?"

"Yes, Mr. Staggers. It has turned out that my suspicions were justified after all. Today at lunchtime I

found Miss Appleton going through the secret files on my desk."

"You did what?"

"Yes, Mr. Staggers. I detained her, and the Special Precautions Branch has now taken her into custody."

"You did what?"

I found myself advancing upon her, with no definite purpose in mind, but a great anger in my heart. Looking very alarmed, she slid around the desk and made for the door, endeavoring to remain mistress of the situation.

"Well, *if you don't need me any more today*, I must go and report to the Branch."

And she ran off down the corridor.

For a moment, I stood helpless. It seemed impossible to do anything in the face of a vast anonymous organism like the Security Precautions Branch. Then I remembered I had a lead – Fluellen. If I could persuade the blonde she was wrong – but that was hopeless. She had her knife into Apples and was obviously delighted with what she had done. The only thing was to remove her – no, that was no use – discredit her, that was the thing. Discredit her so that her evidence was no longer trustworthy. There was only one way to do that in the eyes of her branch. She must be proved to be politically unreliable. Proved? Nonsense. It was a piece of cake. But it had to be done quickly. Fluellen was the man. I spent a very hasty five minutes meddling with Miss Wilberforce's desk, then I dashed around to the War House, to be halted in the hall by a cordon of commissionaires, flourishing forms. From what I had heard, it was impossible to get past them without at least an hour's delay. I took a form. It was about double foolscap size and had fifty-one questions on it. Ignoring the questions, I wrote right across it

Staggers to Fluellen. Information re Red infiltration into Operation Flowerpot. Urgent.

I called for envelopes and sealing wax and, before the eyes of the astonished commissionaires, went through the ritual prescribed for dealing with Most Secret documents. At last I handed over a package of about six envelopes, one inside the other, all smothered in wax seals. It worked. A messenger shot off and arrived back for me in about five minutes, panting hard. He ushered me in to Fluellen's office and closed the door, which locked automatically. The office had the dead air of a carefully sound-proofed room. There were no windows. Fluellen came straight to the point.

"You say urgent. What's wrong? More spies?"

"Worse than that, Fluellen. But first, who O.K.'d the woman Wilberforce for Special Precautions work?"

"I did. Why?"

"Then, I'm sorry, Fluellen, I can't talk in front of you alone. Can we see your superior?"

Thoroughly alarmed. Fluellen grabbed his red scrambler telephone. Two minutes later we were in a colonel's room, swapping identifying documents till we appeared to be playing three-handed nap. At last, honour was satisfied.

"What is it, Staggers?" barked the colonel. "And why me?"

"My information concerns the woman, Wilberforce, and, since Captain Fluellen O.K.'d her, I insisted on seeing you. It is only fair to us both. Colonel Meek, Wilberforce is politically unreliable."

The two men looked at one another in dismay, but, I was interested to see, without surprise.

"My God," said Meek, "Another of 'em."

"The last one," said Fluellen, defensively, "was Kaspar. He was O.K.'d by you."

"What have you got?" said Meek to me.

"She reads the *Times* at work. I noticed she was very careful not to leave it about, so I took care to have a look at it. Gentlemen, the middle pages are missing and, instead she has the *Daily Worker* inside! Also, I have seen her reading something which looks suspiciously like one of Lenin's books. I tested her by misquoting the Communist Manifesto, *and she corrected me.*"

They were looking very doubtful, but, as I had hoped, they could not reject it outright as rubbish.

"But surely," said Fluellen, "it's a bit thin . . . "

"Of course it is!" I cried. "That's why I didn't come to you before. I didn't want to make wild accusations, but I didn't like the idea of her being free of the lab., so I asked Miss Appleton to keep an eye on her while I was away. And what do I find when I return? Miss Appleton – a woman for whose patriotism I have the highest regard, a woman whom I would entrust with my life and whom I have frequently entrusted with my honour – Miss Appleton in jail on some trumped-up charge brought by this crypto-Communist. Obviously she found out something and this – this Wilberforce – is trying to discredit her."

"There may be an innocent explanation . . . ," began Fluellen, when Meek broke in:

"Fluellen, I see you are at great pains to defend Wilberforce."

They eyed one another, and I could feel the mistrust between them growing every second.

"It is true," said Meek, "that Miss Appleton made no reference to this when she was interrogated."

"Did you expect her to? Held prisoner by what she believes to be the accomplices of a Russian spy?" I sprang to my feet. "Good heavens, she's probably expecting to be beaten with rubber truncheons at any time. We must go to her at once!"

This was the crucial moment and, fortunately, Meek was persuaded.

"We must indeed. Fluellen, get a car."

When Fluellen had left Meek turned to me.

"A good man, but susceptible. A pretty face, you know . . . But he's basically sound, I'm sure . . . I think." He heaved a great sigh. "Can't trust *anyone* these days."

During the drive we were silent and I caught Fluellen and Meek exchanging glances, wary, worried, puzzled glances. When the drive ended there followed

(Continued on page 38)

Atomic Blonde

(Continued from page 37)

the wearisome business of identification and the unlocking and locking of doors, till the last door opened on Apples. I was relieved to see that, apart from a steel door, the cell was no worse than a hostel room. Then Apples was in my arms, sobbing bitterly. I carried her over to a chair, sat down with her on my knees and, for some time, paid no attention at all to Meek and Fluellen. When at last she had recovered, I told her we now knew it was all a ghastly mistake and then said,

"Tell us what really happened in Room 21."

"I thought you were coming back for lunch, so I went down to see if you were there. The office was empty, but I could hear someone moving about in the lab. and I assumed it was you. I thought I'd wait and was just picking up the *Times* off that woman's desk when she came in and accused me of going through her papers."

I hastened to make capital of this.

"Notice, gentlemen," I said, "Wilberforce was in the lab.: she came out to find not only that her prying was discovered, but also that Miss Appleton was about to open her *Times*. She had to work fast. And she did."

Meek was completely convinced.

"Miss Appleton, I must make my apologies and amends for this terrible error at some other time. I am in too much haste now to do more than tell you you are free. Mr. Staggers, transport will be laid on to get you and Miss Appleton home. Captain Fluellen, you must consider yourself suspended from duty until there has been a thorough investigation."

"And you, sir?"

"I shall get Wilberforce." And he was gone.

I felt a sudden twinge of conscience.

"What will happen to the blonde, Fluellen?"

"Oh, nothing much. Shan't shoot her or anything, if that's what you mean. Probably give her a job where she can't get into mischief. Counting birds on St. Kilda or something like that."

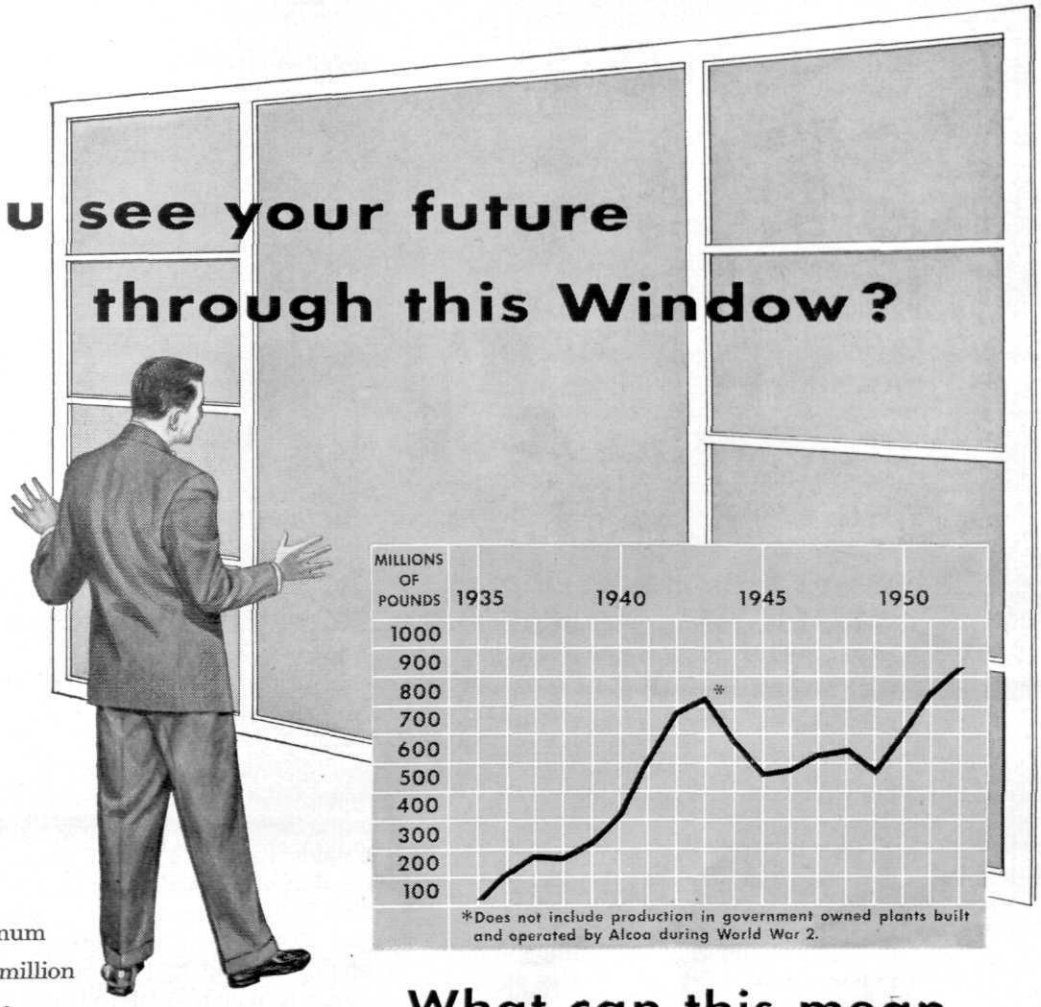
On the way back to College, I told Apples how I had rescued her. She was very grateful to me, but I thought it very bad taste of her to gloat over the blonde's predicament.

"I hope they never let her go. Oh, dear, but what will happen when they find out she doesn't read the *Worker* and so on?"

"You know all the desks in the department open with one key? Well, when they look inside her desk they will find a copy of today's *Times* with the *Worker* inside it. As well as a copy of Volume II of Lenin's Works, with an Agatha Christie dust-jacket round it.

(Continued on page 40)

Can you see your future through this Window?



This is an aluminum window, one of four million that will go into buildings in 1953. Twenty years ago, it was just an idea in the mind of an Alcoa development engineer. Ten years ago, only a few thousand were made annually. Now, production *is increasing* at the rate of over half a million a year. This is just one of a torrent of new uses for aluminum which means that Alcoa must continue to expand. Consider the opportunities for you if you choose to grow with us.

What can this mean as a career for you?

This is a production chart . . . shows the millions of pounds of aluminum produced by Alcoa each year between 1935 and 1952. Good men did good work to create this record. You can work with these same men, learn from them and qualify yourself for continually developing opportunities. And that production curve—is still rising, we're still expanding, and opportunities for young men joining us now are almost limitless.

Ever-expanding Alcoa needs engineers, metallurgists, and technically minded "laymen" for production, research and sales positions. If you graduate soon, if you want to be with a dynamic company that's "going places", get in touch with us. Benefits are many, stability is a matter of proud record, *opportunities are unlimited.*

For more facts, consult your Placement Director. ALUMINUM COMPANY OF AMERICA, Pittsburgh, Penna.

Alcoa Aluminum

ALUMINUM COMPANY OF AMERICA

Atomic Blonde

(Continued from page 38)

I got the *Worker* from the Union and the Lenin is one of my books."

"You are clever; Staggers, darling, you think of everything."

And she went on being grateful to me.

I saw her to her rooms and then I went back to the Department and found the place was buzzing with gossip. Meek had descended on the place with an armed posse and "got Wilberforce" and the contents of her desk. I was standing in the office, picturing her counting seagulls on St. Kilda and thinking that no matter what Apples said, it was, in a way, a waste of good material, when Prof. Yardstick came in.

"Ah, Staggers. Just the man. What's all this about Miss Whatshername?"

"She has been taken into custody as a Communist spy, sir."

"I see. I'm afraid she has been wasting her time. I had a visit this afternoon from Hereward of Bottlewell. It seems they have made an error – a purely clerical error, I gather, but one having serious consequences for us. It would appear that a clerk in typing out some minutes got the formula of one of our compounds wrong – I forget exactly what, an *amino* instead of *amido* and a *two* instead of *two dash,* I think. The result is that we are working on the wrong reaction. Even worse, the correct reaction has been thoroughly studied and its constants tabulated over the range in which Bottlewell are interested."

"Oh, Lor. Does that mean I'm out of a job again, sir?"

"Not exactly, Staggers. I pointed out to Hereward that there has been a large sum of money expended on useless apparatus, and if the grant were cancelled, although they might be able to hush it up, we should have to have some explanation to offer in our annual report to the Duke. Whereas if the present grant were continued and used on some other project, the expenditure already incurred could be written off as for preliminary investigations. Hereward was inclined to demur, especially when I pointed out that you had a good case for continuing your work on isobol – or should I have said a plausible case? – but when I suggested that there might be Questions in the House, and that the newspapers at present are rather keen on Misapplication of Public Funds, he gave in."

And the old blackmailer broke into a hearty chuckle.

"Do you mean I can junk this and go back to isobol?"

"Go back? Certainly not. Go ahead on isobol, you mean. Get out that design in stainless steel, Staggers; we've got enough steel coming to build a battleship. And if you need any Smithium – we've got dollars as well. So, as Mr. Smith used to say, 'Get crackling'."

And he departed, still chuckling.

* * * *

Mother, are there skyscrapers in heaven?

No, dear, engineers build skyscrapers.

MODERN FARMERS like J. A. Parks of Maloy, Iowa, using the gang plow above, can produce much more in much less time than the farmer of just a few years ago. In the horse-powered days of farming it took as many as 35 man-hours to produce and harvest an acre of corn. Now, on many mechanized farms, it is done in fewer than 11 man-hours. In addition, the shift from animal power to machine power released about 72,000,000 acres of cropland from producing feed for horses and mules to producing food for the nation's tables.

WHAT EVER HAPPENED TO THE MAN BEHIND THE PLOW?

THE "man behind the plow" is still very much in the picture, but he's *up front now.* And because he is, you and your family—even the world—are better fed today.

Not many years ago the American farmer walked behind the old horse-drawn plow, worked longer hours and produced much less than he does today. But that was before the development of the "hired hands" that never tire—the tractors, trucks and implements which do the work of many men, and the petroleum fuels and lubricants which keep them running.

In the last 50 years or so, while America's population was growing from 75,000,000 to more than 150,000,000 a remarkable change was taking place in agriculture. Today 8,000,000 *fewer* persons on America's farms are producing food for 75,000,000 *more* Americans.

Yet America has never been better fed. It has never been better equipped to export needed foods to other countries for normal requirements, or to combat famine—an ally of communism—wherever it appears.

Never have so few fed so many so well.

To help make ours a more abundant land, Standard Oil pioneered in delivering petroleum products right to the farmers' doors in the quantities needed and at reasonable prices. This on-the-spot delivery, started way back in 1910, was vital to the rapid growth of mechanized farming in the Midwestern farmers than any other oil company.

So many rural customers have learned to depend on Standard Oil products and services that we now serve far more Midwestern farmers than any other oil company.

Standard Oil Company

910 South Michigan Avenue
Chicago 80, Illinois

STANDARD

Electric Curtain

(Continued from page 17)

Water seems to dribble from the cathodes, in slowly decreasing quantities, as long as the current is on. When we visited the project on March 9, all piles had been driven, the floor and walls of the duct trenches had been poured, and about half the base slab, from trenches to old plant, had been placed. Current to electrodes along the old building wall and part way across adjacent ends had been discontinued.

Some of the remaining electrodes had been disconnected, though those still hooked up were discharging a small amount of water. The rest of the slab was yet to be poured, and excavation – with clamshell and clay spades – was under way for some deep sump pumps – again without sheeting or any ground support.

Dr. Leo Casagrande explained the principles of electro-osmosis stabilization of soils in a paper presented before the Structural Section, Boston Society of Civil Engineers, on January 10, 1951.

Skipping a lot of high-powered mathematics, we'll try to present Dr. Casagrande's explanation of the physical principles involved. Remember, we are talking only about fine-grained silt and clay soils, where the pore size is microscopic and water movement is by capillary action.

In 1807 one Reuss discovered that if an electric potential is applied to a porous diaphragm, the water moves through the capillaries toward the cathode; the water flow stops when the current is turned off.

In 1879 one Helmholtz explained this phenomenon mathematically (which we aren't going to do). In a cylindrical capillary tube filled with water, we must distinguish between the free water and a boundary film of water adjacent to the capillary wall – this last Helmholtz called a "double layer" because he assumed the existence of opposite electric charges on two layers forming the double layer.

One part of the double layer, very thin in comparison with total thickness of the double layer, and which carries the negative charges, is rigidly attached to the wall. The much thicker part of the double layer, carrying the positive charges, is movable.

When an electric potential is applied to the capillary, the positive charges move toward the negative pole, dragging the water molecules of the double layer along with them. In turn, the cylinder of free water, completely surrounded by the double layer, is also dragged along. This phenomenon is known as electric-osmotic flow.

That's the simple explanation of the process. If the cathode is open to admit the flow, such as a well-point, the water will be forced into the pipe and up to the open top with an unbelievably high pressure – up to 6,000 psf.

As the capillaries are freed of water, they shrink, and thus the ground consolidates and becomes stabilized. As an experiment, one cathode was extended

(Continued on page 54)

THE DU PONT DIGEST

Design

AND DEVELOPMENT

Call for Knowledge, Ingenuity, Teamwork

Making new products in large amounts, devising new processes, and improving old ones—such problems are the job of Design and Development. An example was the development of a large-scale process for making "Orlon" acrylic fiber starting from small laboratory samples of polyacrylonitrile.

Quantity production of polymer was only a beginning. A whole set of new and unusual problems arose in spinning the fiber, because polyacrylonitrile decomposes before it melts, and it dissolves only in high-boiling solvents.

A team of Du Pont technical men—chemical and mechanical engineers, instrumentation specialists, metallurgists, and materials handling experts undertook to find a solution. Here are a few of the problems they met:

1. Solve problems in heat transfer and fluid flow arising from the fact that the spinning solution must be blanketed with inert gas to prevent fire hazards.

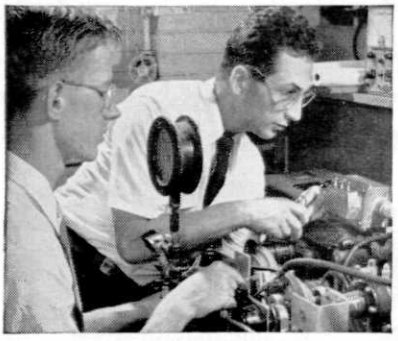
2. Design a system for controlling the temperature of the viscous spinning solution within ±0.5°F. at hundreds of points in the plant.

3. Design new mechanisms for winding yarn at high speed without any deviation in yarn tension.

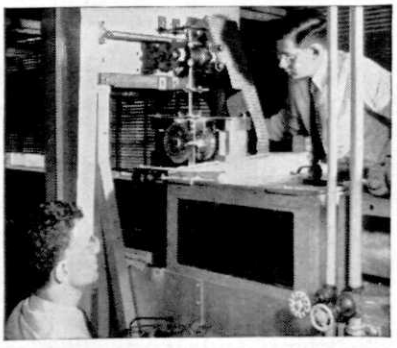
4. Design air conditioning and ventilating systems to remove fumes from specific spots, but still allow easy access to all areas.

Among Du Pont's many research and engineering activities, Design and Development jobs provide great opportunity for the knowledge, ingenuity, and teamwork capacities of men in a great variety of technical fields.

The characteristics *of a super-pressure pump, designed by Du Pont engineers and made in Du Pont shops, are studied by Ralph C. Grubb, B.S.M.E., Tennessee '51, and Paul D. Kohl, B.S.M.E., Purdue '46.*



Albert Rand, *B.S.M.E., M.I.T. '50 (right) develops controls for chemical equipment.*



Carl Hellman, *B.S.Ch.E., Syracuse '50, and J. M. McKelvey, Ph.D.Ch.E., Washington '50, search for new ways to coat plastic on wire.*

ASK FOR "Chemical Engineers at Du Pont." New illustrated booklet describes initial assignments, training and paths of promotion. Just send post card to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Building, Wilmington, Delaware. Also available: "Du Pont Company and the College Graduate" & "Mechanical Engineers at Du Pont."

DU PONT

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BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

Watch "Cavalcade of America," on Television

Question

A large forging company in the East had a contract to make a certain size turbine blade. The small drop forge which they had planned to use had only enough power to give all but the last "whack" required to finish the blade. The cost of their next larger press was prohibitive, and a great waste of power would be involved, so they found a way to use the smaller press. How would you have done it?

Answer

All but the last "whack" were performed as usual, and then the operator brushed a volatile oil onto the die surfaces, and this oil exploded on the last drop of the press, adding the extra force needed to finish the blade!

A hill is half a mile long on the upgrade and half a mile long on the downgrade. If a car travels up the hill at 30 mph, how fast will it have to travel downhill to average 60 mph over the full mile?

A true music lover is a guy who, hearing a blonde soprano sing in the bathtub, puts his ear to the keyhole.

* * * *

Professor: "If you start at a given point on a given figure and go all the way around it what will you get?"

Freshman: "Slapped, sir."

* * * *

Dr. Schaefer reported that high winds on New Hampshire's Mount Washington have shown a high correlation with the presence of the jet stream in preliminary studies made by R. E. Falconer, G-E meteorologist. Dr. Schaefer also has suggested to forestry officials that they investigate effects on forest fires of high winds connected with the jet stream.

* * * *

A citizen had been arrested for selling illegal whiskey. As he stood before the bench, the color of his nose was evident to all spectators. His attorney rose.

"Look at the defendant," he said, "can you honestly say he looks like a man who would sell whiskey if he had it?"

It took the jury less than a minute to bring in a not guilty verdict.

* * * *

A young governor in an Eastern State was asked to address the prisoners at the State Penitentiary. It was his first speech after election and he was somewhat nervous.

He started off, "Fellow Citizens." Then he realized that the prisoners were deprived of their citizenship during their imprisonment. He stopped and started again, "Fellow Prisoners."

He realized too late his second mistake, so he continued, "Well, anyway, I'm glad to see so many of you here."

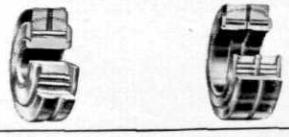
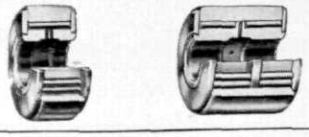
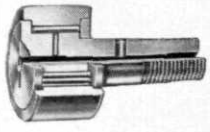
The Torrington Needle Bearing... many types for many needs

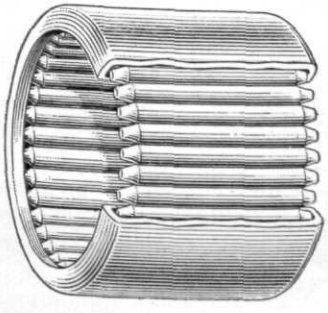
In previous advertisements in this series, the many advantages of the Torrington Needle Bearing and the proper procedure for its installation and maintenance have been discussed. The DC unit type bearing was used in these discussions because it is the Needle Bearing with by far the greatest variety of applications throughout industry.

From the basic Needle Bearing design, however, many modifications have been made. The result is a complete line of Needle Bearings suitable for specific applications. Although these bearings are all different, each offers the advantages which have made the DC unit type so popular. They give the highest possible radial load capacity in a minimum of space; they are light in weight, easy to install and simple to lubricate.

The following chart shows many types of Torrington Needle Bearings, gives their design features and general applications for which they are designed.

The new Torrington Needle Bearing catalog will be sent on request.

TYPE	SERIES	BEARINGS	DESIGN FEATURES	APPLICATIONS
DC	B		Thin, drawn shell, retaining full complement of small diameter rollers. Inner races are furnished when shafts are not hardened.	Wherever high load capacity is needed and space is at a premium.
HEAVY DUTY			The outer race is made in one channel-shaped piece, hardened and ground to precision limits. Heavy inner race.	For heavy-duty applications where split housings occur or where press fit of bearing into housing is not possible.
AIR-CRAFT	NBC		Heavy inner and outer races, with end washers securely fastened to inner race.	Aircraft applications involving oscillating motion only.
	NBE *(left)* NBK *(right)*		Similar to NBC except have self-aligning outer races.	Aircraft applications where alignment is difficult or deflection is severe.
	NBF *(left)* NBL *(right)*		Similar to NBC except have heavy outer races to carry rolling loads.	For use as rollers under heavy loads at low speeds.
CR	CR		Heavy solid-sectioned outer race and rollers made from high-quality bearing steel. Portion of stud which serves as inner race is hardened. Threaded end left soft to avoid brittleness.	Cam follower applications where maximum load capacity and shock resistance are required.



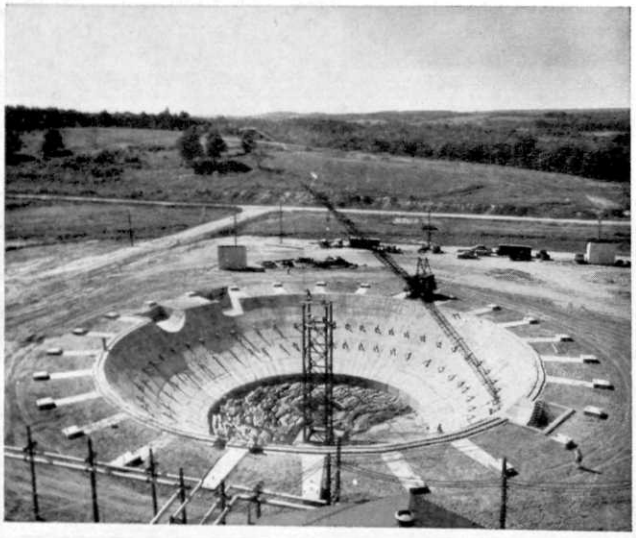
New developments

Saucer Foundation Completed

The saucer-shape foundation for the 225-foot steel sphere that is to house a nuclear submarine power plant being built by the Atomic Energy Commission for the U. S. Navy has been completed, and work on assembling the hull of the land-based prototype submarine is underway, it was recently announced.

The spherical design of the reactor building was adopted to give additional protection to operating personnel and to off-site areas during test operations beyond the many safety controls of the reactor itself.

Similar structures are widely used in the chemical and petroleum industries, but the West Milton sphere will be the largest ever constructed. In the remote event that simultaneously all other controls failed, the resulting release of radioactive material would be contained in the sphere which will have a net "free" space of more than 5,400,000 cubic feet.



This huge concrete saucer, 179 feet in diameter and 42 feet deep, is the foundation for a 225-foot steel sphere, largest ever constructed, that will house an atomic power plant being built by the Atomic Energy Commission for the US. Navy. The central tower and derrick used for assembling the sphere will rise to a total height of 424 feet above ground level.

The outer periphery of the building will be 706 feet. The sphere will rest on the concrete saucer just completed which is 179 feet in diameter and 42 feet deep. A ring of steel columns set on concrete outside the structure and reaching to the middle of the sphere will give further support to the building. Welded steel plates will make up the skin of the ball. The plates will be hoisted into position by a derrick mounted on top of a temporary central steel tower. The derrick, now in place, reaches up 424 feet above ground level.

Every weld in the structure must be X-rayed to assure that there are no leaks. To do this on the bottom, a four-foot space is provided temporarily between the base of the sphere and the concrete saucer. After testing is completed, this space will be filled with concrete and aggregate. Inside, the concrete floor on which the reactor will rest will be slightly above ground level and the well of the saucer beneath the floor will be filled with compacted mixture of aggregate and earth. The reactor building will be air conditioned.

As scon as the columns are in place, the first ring of plates will gird the sphere at its center and assembly will proceed both upwards and downwards.

Meanwhile the hull of the submarine will be assembled just outside the building and when the latter is completed and tested, the hull will be skidded into the huge ball through a special wall section and the sphere again sealed.

Stronger Metals

Tiny but "perfect" crystals may provide a clue to metals many times stronger than those now in use, a metallurgist said here this evening.

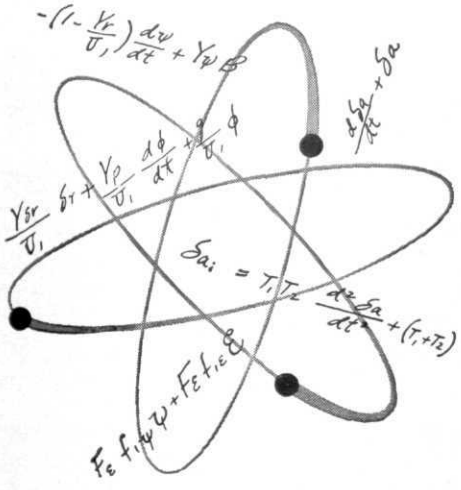
X-ray tests, as well as photographs made at high magnification, show them to be virtually perfect crystals, he said. From the amount which they may be bent and still spring back, it is possible to measure the stresses to which they are subjected. This shows them to be far stronger than ordinary crystals, he added.

Dr. Hollomon said that work on defects in crystals is now assuming great importance both in the laboratory and the world at large. Metals, as used ordinarily, consist of crystals, and there are usually defects in the regular arrangement of the atoms of which they are built. If such defects can be eliminated, he added, theory indicates that metal strength might be increased as much as a thousand times.

He also told of work in crystal growth, which has been found to take place in a helical direction, similar to that of a so-called "spiral" staircase. When a crystal forms, successive layers of atoms are built up. It had been a puzzle, he said, as to how, when one layer had been laid down, the crystal was able to start another. Now it turns out that a layer is ordinarily never entirely completed, but advances in a spiral, continually getting higher.

Materials used both in permanent magnets and electromagnets also involve defects, he stated. Such magnetic material consists of a great number of minute "domains." Each of these is a magnet, but they counteract each other. When the material is magnetized the boundaries between these domains, which are literally defects in the crystal arrangement, shift a little. Some domains get smaller while others get bigger, so that they predominate.

Future of Automatic Controls brings new opportunities for engineers and scientists at Honeywell



As science advances, and as our country continues to develop its industrial might, the business of automatic control gets bigger and increasingly important.

For the prime force behind the 20th century revolution has been and will continue to be *automatic control.*

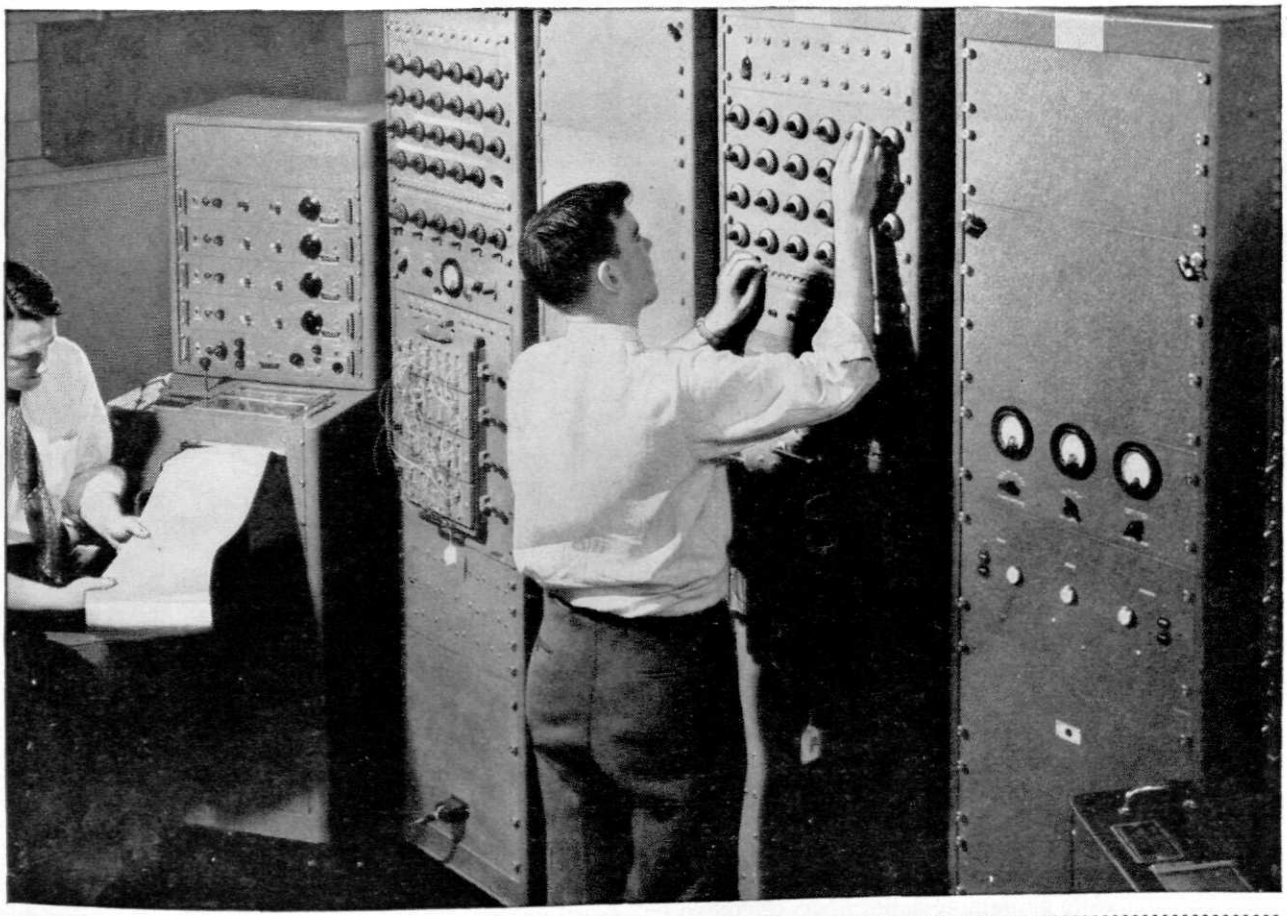
So at Honeywell, leader in this field for over 60 years, it of course means a bigger, more exciting, more challenging job ahead—all of which adds up to greater opportunities for engineers and scientists.

And that's why we're always looking for men with ideas and ambition to grow with us.

Here at Honeywell one out of ten employees is engaged in research and engineering activities.

Shown below is part of our Aeronautical Division's analog computing equipment, which helps our research engineers to develop and simulate flight tests on automatic controls for aircraft. It's typical of work being done by all of the company's eight divisions in plants across the country.

So if you're an engineer or scientist and like to use your imagination freely in such fields as electronics, hydraulics, mechanics, chemistry, physics, and a wide variety of others, be sure to send in the coupon below.



America lives better—works better—with Honeywell controls.

MINNEAPOLIS **Honeywell**

First in Controls

MINNEAPOLIS-HONEYWELL REGULATOR CO.
Personnel Dept., Minneapolis 8, Minnesota

Gentlemen: Please send me your booklet, "Emphasis on Research" which tells more about engineering opportunities at Honeywell.

*Name*_____

*Address*_____

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

Austin Bush, Rensselaer, '50, Helps Develop New Pump

AUSTIN BUSH, inspecting stuffing box assembly on boiler feed pump.

Reports interesting project engineering assignments at Worthington

"Despite its size as the leading manufacturer in its field," says Austin Bush, "I have found Worthington pays considerable attention to the interests of the individual. The company's excellent training program consists of several months of working with the various types of equipment manufactured, augmented by technical lectures, and talks on the organization of the corporation.

"Following this training, I was given an opportunity to choose the department in which I wanted to work—engineering, sales, or manufacturing. My choice was the engineering department where I have already been assigned to several interesting projects.

"In addition to the training program, the members of our engineering department hold monthly seminars at which engineering topics of general interest are discussed.

"Opportunities for advancement are good, and pleasant associates make Worthington a fine place to work."

When you're thinking of a good job, think *high*—think *Worthington.*

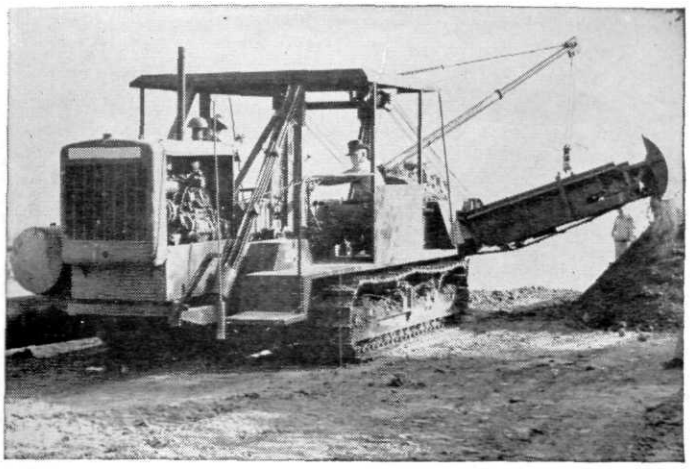
FOR ADDITIONAL INFORMATION, see your College Placement Bureau or write to the Personnel and Training Department, Worthington Corporation, Harrison, New Jersey.

WORTHINGTON

The Sign of Value Around the World

2.54X

Another page for **YOUR BEARING NOTEBOOK**

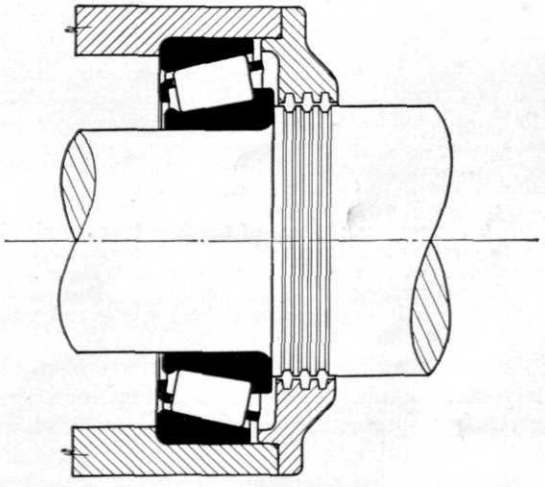


Big trencher gouges out 13 cu. yards per minute!

This big digger crawls along at 10 to 12 feet per minute digging a ditch 7½ feet wide and four feet deep. To keep it operating with minimum maintenance in this tough service, the engineers specified a total of 69 Timken® tapered roller bearings in the differential, transmissions, and track rollers. Line contact between rollers and races gives Timken bearings extra load-carrying capacity. Tapered construction enables Timken bearings to take radial and thrust loads in any combination.

Maintenance reduced with TIMKEN® bearings

Timken bearings make closures more effective, holding housings and shafts concentric. Lubricant stays in, dirt stays out. Maintenance is minimized; long, trouble-free operation is assured.



TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

Want to learn more about bearings or job opportunities?

Some of the engineering problems you'll face after graduation will involve bearing applications. For help in learning more about bearings, write for the 270-page General Information Manual on Timken bearings. And for information about the excellent job opportunities at the Timken Company, write for a copy of "This Is Timken". The Timken Roller Bearing Company, Canton 6, Ohio.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⓞ AND THRUST —ⓞ— LOADS OR ANY COMBINATION

Jet streams

By carefully-co-ordinated observation of cloud formations, weather stations across the country could establish the location and direction of the jet stream, a mysterious wind tunnel in the sky, according to a famed General Electric Company weather scientist.

The presence of three of the four types of cloud formations is strong evidence that the major axis of the jet stream is high overhead. These are cirrus streamers, white feathery wisps with tufted trails, seen moving at high speeds and high altitudes.

At a meeting of the American Meteorological Society, Dr. Vincent J. Schaefer said that four "specific and rather spectacular cloud types" are visual keys to the whereabouts of this high-speed stream that often doubles the speed of high-flying aircraft.

Field research he directed last summer as scientific adviser for the Munitalp Foundation, now sponsoring basic research in meteorology, showed Dr. Schaefer that any three of the four tell-tale cloud formations, plus high cloud speeds and "coherent" patterns, may be used to determine the presence of these powerful winds.

At present it takes fairly complicated upper air soundings to locate this skein of winds that blows at speeds of from 80 to more than 200 miles an hour at altitudes of 20,000 to 50,000 feet. The stream moves at slower speeds at lower altitudes.

Dr. Schaefer listed the four basic cloud formations as:

Cirrus streamers, white feathery wisps with tufted trails, seen moving at high speeds and high altitudes.

High cirrocumulus—small, white, rounded clouds in patches often scattered at random, but sometimes shifting rapidly to cirrus streamers with delicate wave patterns. They often take on tints of green and red near the sun.

Altocumulus, fleecy, nearly stationary formations with lens-shaped clouds, piled layer upon layer at middle altitudes (about 20,000 feet). These clouds change rapidly, especially when sending snow in long streamers down wind. Such streamers are evidence of the high-speed movement of the air. Some of these formations also are tinted near the sun.

Billowing altocumulus clouds which often extend from horizon to horizon, with parallel waves running at right angles to the direction of air flow.

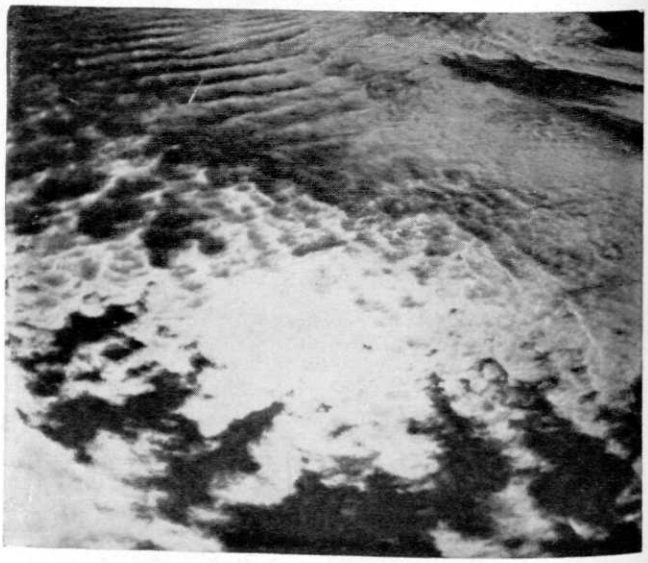
Other tell-tale signs of the proximity of the major axis of the stream include:

Gustiness at ground level in about half the cases observed; persistent cool, crisp air; generally blue skies, with visibility unlimited; precipitation often limited to "sporadic sprinkles of rain or snow," and rapid changes in cloud cover, from one-tenth of the sky to nine-tenths and back again, "in less than an hour."

Quick identification of this phenomenon is becoming increasingly vital to aviation and also to weather forecasting, he reported.

Studies made by Dr. Schaefer and other scientists show that the jet stream shifts about over the northern hemisphere as the seasons change.

"Sometimes two or more streams may be identified," Dr. Schaefer said.



Altocumulus clouds, as those above, often extend from horizon to horizon and have parallel waves running at right angles to the direction of air flow.

In summer the stream throttles down to about half of its tremendous wintertime speeds.

The rocket-like air corridor is blamed for many freak weather conditions believed caused when its undulating path carries polar air to Florida and tropical air masses to the north. Many floods, droughts and persistent cold and hot spells are attributed to its influence.

THE HYDROSTATIC TEST

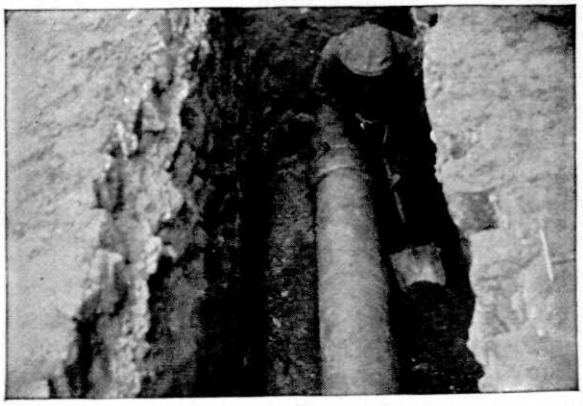
Nobody can buy a length of cast iron pipe unless it has passed the Hydrostatic Test at the foundry. Every full length of cast iron pipe is subjected to this test under water pressures considerably higher than rated working pressures. It must pass the test or go to the scrap pile.

The Hydrostatic Test is the final one of a series of routine tests made by pipe manufacturers to assure that the quality of the pipe meets or exceeds the requirements of standard specifications for cast iron pressure pipe.

Few engineers realize the extent of the inspections, analyses and tests involved in the quality-control of cast iron pipe. Production controls start almost literally from the ground up with the inspection, analysis and checking of raw materials—continue with constant control of cupola operation and analysis of the melt—and end with inspections and a series of acceptance and routine tests of the finished product.

Members of the Cast Iron Pipe Research Association have established and attained scientific standards resulting in a superior product. These standards, as well as the physical and metallurgical controls by which they are maintained, provide assurance that cast iron pipe installed today will live up to or exceed service records such as that of the 130-year-old pipe shown.

Cast iron pipe is the standard material for water and gas mains and is widely used in sewage works construction. Send for booklet, "Facts About Cast Iron Pipe." Address Dept. C., Cast Iron Pipe Research Association, T. F. Wolfe, Engineer, 122 So. Michigan Ave., Chicago 3, Illinois.



Section of 130-year-old cast iron water main still in service in Philadelphia, Pa.

CAST IRON PIPE SERVES FOR CENTURIES

Gold Mine

(Continued from page 27)

what process to use in any given case is, of course, a product of experience.

Although it is about 99 per cent experience, the foundry is in need of more and more technical men. The METALLURGIST is indispensable in the modern foundry, with all of the new metals and alloys, and tougher material specifications rolling in every day; in fact, he will probably find his greatest opportunity in the cast metals industry.

The foundry is an INDUSTRIAL engineer's paradise, for there more pounds of material are handled per pound of finished product than in any other industry, and each of these materials – sand, scrap, air, and castings (to mention a few) – presents an entirely different type of handling problem.

The "general" MECHANICAL engineer will most likely find himself experimenting with the various casting processes, applying them where they best fit, and improving casting design and methods wherever possible.

ELECTRICAL and MECHANICAL DESIGN engineers have a great challenge before them in the foundry, that of developing and perfecting better and automatic foundry equipment to keep up with modern production and quality demands. (One foundry in Texas has replaced 110 men with 5 men and an automatic foundry which produces 4800 molds a day, pours them, shakes them out, etc.!)

The HEATING and VENTILATING engineers have their hands full maintaining safe and comfortable working conditions, while CHEMICAL engineers are becoming increasingly important in the foundry as research goes farther into sand problems.

Yes, there are places for all kinds of engineers in the foundry, and there are many problems and fields of research that as yet have hardly been touched. So here it is – a virgin field, and an opportunity to get a head start in it – how's about dropping in at the foundry sometime soon and digging a little in our goldmine, huh?

° ° ° °

"Papa, what is the difference between prosperity and depression?"

"Well, my boy," papa replied, "in prosperity we have wine, women and song; but in depression, all we have is beer, Mama and the radio."

° ° ° °

I've decided to get a divorce. My wife hasn't spoken to me in six months.

Better think again. Wives like that are hard to find.

° ° ° °

Drunk: "Believe it or not, ofisher, I'm looking for a parking plasch."

Cop: "But you haven't got a car."

Drunk: "Yeah, I have. Itsh in the parking placesh I'm looking for."

"Allis-Chalmers Graduate Training Course Was Just What I Needed,"

says LOWELL E. ACKMANN

University of Illinois—B.S., E.E.—1944
and now manager, Peoria, Ill., Branch Office

"MY EXPERIENCE with machinery in the Navy during the war convinced me I needed a training course. There was so much equipment on board that was a complete mystery to me that I became very 'training-course minded'.

"After investigating many training courses, the one at Allis-Chalmers looked best to me then—and still does.

"In my opinion, the variety of equipment is what makes Allis-Chalmers such a good training spot.

"No matter what industry you may be interested in, Allis-Chalmers makes important, specialized equipment for that industry. Electric power, steel, cement, paper, rock products, and flour milling industries—to name a few, are big users of A-C equipment.

"Before starting on the Allis-Chalmers Graduate Training Course, I thought I would like selling, preferably technical selling but, as is often the case, I didn't know for sure. This course, together with some personal guidance, helped me make up my mind. That, too, is an important advantage of the GTC program.

"But whether you want to be a salesman or designer, production engineer, or research engineer, Allis-Chalmers, with its wide variety of equipment and jobs, is an ideal place to get off to a good start—without wasting time."

Facts You Should Know About the Allis-Chalmers Graduate Training Course

1. It's well established, having been started in 1904. A large percentage of the management group are graduates of the course.

2. The course offers a maximum of 24 months' training. Length and type of training is individually planned.

3. The graduate engineer may choose the kind of work he wants to do: design, engineering, research, production, sales, erection, service, etc.

4. He may choose the kind of power, processing, specialized equipment or industrial apparatus with which he will work, such as: steam or hydraulic, turbo-generators, circuit breakers, unit substations, transformers, motors, control, pumps, kilns, coolers, rod and ball mills, crushers, vibrating screens, rectifiers, induction and dielectric heaters, grain mills, sifters, etc.

5. He will have individual attention and guidance in working out his training program.

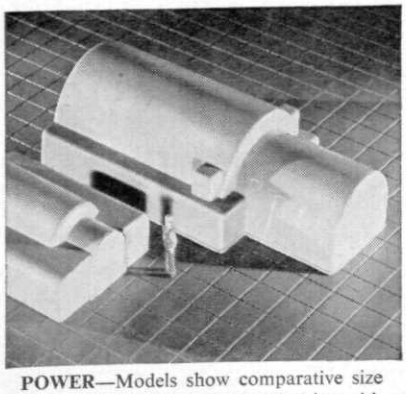
6. The program has as its objective the right job for the right man. As he gets experience in different training locations he can alter his course of training to match changing interests.

7. For information watch for the Allis-Chalmers representative visiting your campus, or call an Allis-Chalmers district office, or write Graduate Training Section, Allis-Chalmers, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

C-5676

PROCESSING—Allis-Chalmers built solvent extraction plant processes one hundred tons of rice bran per day at oil processing plant in Texas.



POWER—Models show comparative size of generators having the same rating with and without super-charged hydrogen cooling. Allis-Chalmers is first to supply super-charged hydrogen cooling.

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*Inside front cover
**Inside back cover
***Back cover

Electric Curtain

(Continued from page 42)

20 ft. above ground, and water still dribbled out of the top in undiminished flow.

It seems to us what happens is that the current forces the water out of the capillaries and drags the hole in behind it. Or maybe it isn't that simple!

Much To Be Learned

Even the experts hesitate to predict the full possibilities of electro-osmosis in soil stabilization, but obviously it has applications in tunnels and mines where wet, fine-grained soils are encountered, as well as in open-cut work.

Voltage and amperage requirements and spacing of electrodes can be determined to some extent by laboratory analysis of the soil to be treated, but experimenting under actual field conditions probably will dictate the various combinations for best results. Costs compare with wellpoint dewatering.

The record shows that at the John Weadock plant an electric curtain made bad ground lie down and be good, and kept the Saginaw River from moving into the deep hole.

Automatic Driver

(Continued from page 21)

manual control assisted by instruments indicating his position and the proximity of other vehicles, and of completely automatic guidance and collision prevention.

"Full automatization of the driving process can be envisaged as the final stage of the development. In addition to the installation of guidance and collision prevention equipment on the roads and in the vehicles, this would involve automatic inspection of the vehicle equipment and a continuous recording of traffic conditions at the gate stations. Indications of the position and velocities of the vehicles along the road section between successive stations would aid supervising personnel in the problem of traffic distribution. In addition, it would give immediate notification of breakdowns requiring emergency action.

"Freight transport along the highways presents one of the most challenging applications of full automatization. The establishment of a network of truck routes, separate from a highway system designed for passenger vehicles only, has been discussed repeatedly.

"With full automatization, it offers the possibility of driverless freight transport over long distances, with route terminals taking the form of marshalling yards. Here, small dispatching crews would send out the loaded trucks to their distant destinations and assign incoming vehicles to drivers for local delivery of the consignment. Assuming a cruising speed of 30 miles per hour, a separation between vehicles of 100 feet, and an average truck load of 5 tons, a one-lane route could handle nearly 200,000 tons a day. This large shipping capacity provided with minimum manpower requirements would do much to alleviate present bottlenecks in the delivery of consumers' goods and industrial raw materials."

How your pipe dreams may become realities!

Lengths of Republic Electric Weld Casing are rapidly joined together and lowered hundreds or thousands of feet into an oil or gas well to line it with tough steel—to protect its walls against the tremendous pressures that otherwise might cause collapse of the hole.

YOU MAY NEVER DRILL for oil as a career. Nevertheless, this pipe has a message for you.

Pioneered some 23 years ago by Republic, this pipe is made by a process of electric resistance welding. Flat-rolled steel, uniformly thick, with both sides visible for inspection, is cold formed and electric welded into tubular form. The resulting pipe is uniformly round, uniform in wall thickness and uniformly strong throughout every inch of its structure. These qualities have speeded installation and improved pipe performance. Millions of feet of casing and tubing, and thousands of miles of line pipe in service have proved the dependability of the process.

You may be out of school for several years before all the economic importance of these qualities have become a part of your experience. At this point, just consider this one fact about electric welded steel pipe: it was developed by a producer of steel. Republic is now the leading manufacturer of this type of product. Republic also fabricates many other products from steel—such as tubing, conduit, culverts, radio towers, windows, office furniture, steel cabinets for kitchens. It is a leading manufacturer of these products, too.

Your pipe dreams of success in industry are more likely to flow with realities if you associate with a dynamic company. Some companies merely produce a material. Wouldn't you be better off with a company that not only produces a basic material, but also knows how to design and fabricate its own product? *That* company really knows what it is making—and selling. Such a company is Republic Steel.

REPUBLIC STEEL

GENERAL OFFICES • CLEVELAND 1, OHIO

REPUBLIC STEEL

WORLD'S WIDEST RANGE OF STEELS AND STEEL PRODUCTS

Side tracked

A British officer was inspecting troops coming in from the front lines in Burma during the Second World War when some of the commands contained troops from several nations. He stopped a mud-caked American GI and said, "Are you Indo-Chinese?

"No suh," replied the GI, "Ah is out-doah Kentucky."

* * * *

Professor: "Why don't you answer when I call your name?"

E.E.: "I nodded my head."

Professor: "You don't expect me to hear the rattle all the way up here, do you?"

* * * *

The Sunday-School teacher had asked her class where God lives. One small boy replied, "He lives in our bathroom."

"Why, Jimmy, what makes you say that?"

"Well, every morning my pop stands in front of the bathroom door and says, "God, are you still in there?"

* * * *

The freshman's father paid his son a visit regarding some of the reports he had been getting back home. Arriving at 4:00 a.m., he banged on the door of the fraternity house. A voice from the second floor yelled, "What do you want?"

The father answered: "Does Joe Johns live here?"

The voice answered: "Yeah, bring him in."

* * * *

A young C.E. was proudly showing the Governor his first big project, a three million dollar dam. The Governor stared in amazement and exclaimed, "My gawd, the water – it's supposed to be on the other side."

* * * *

After storming a Communist post in North Korea, a party of Marines had dug in to consolidate their position. One of the boys was badly upset by the groans of a wounded Red who lay just beyond his trench. When he could stand it no longer he went back to investigate. "My leg. My leg," moaned the Commie – apparently able to speak some English. The leatherneck was a sympathetic soul, so he hoisted the enemy soldier on his back and started out for the surgeon's tent. Somewhere along the way, a burst of shrapnel took the Red's head off, unknown to his benefactor, who continued on his way, eventually arriving at the hospital tent. There he lay all that was left of the Red on the receiving table.

"You crazy idiot," shouted the surgeon, "What are you bringing that man in here for – why, his head's off."

"Oh," wailed the Marine, "the dirty liar – he told me it was his leg."

The big day was here. The wonderful gigantic bridge connecting two of the country's largest cities was being formally opened. At the height of the festivities, when thousands of people had thronged onto the bridge, the center span – with a crash heard for miles – fell into the bay, a mass of twisted girders and human bodies. The frenzied mayor, seeing the engineer, dashed up to him, "Look what you have done."

The engineer, scratching his ear, replied, "I told Joe that decimal point was in the wrong place."

* * * *

British Sentry: "Halt! Who goes there?"
Soldiers: "British soldiers."
British Sentry: "Pass, British soldiers."
British Sentry: "Halt! Who goes there?"
Soldiers: "French soldiers."
British Sentry: "Pass, French soldiers."
British Sentry: "Halt! Who goes there?"
Soldiers: "Whoinell wants ta know?"
British Sentry: "Pass, Yanks."

* * * *

During maneuvers an army commander ordered a notice to be displayed on a bridge stating: "This bridge has been destroyed by air attack." But to his chagrin, he noticed through his field glasses that a foot regiment was crossing the bridge despite his orders. He sent his adjutant to the officer in charge post-haste to find out how he dared to defy his orders. An hour later the adjutant was back. "It is all right, sir," he reported. "The troops are wearing signs saying 'We are swimming'."

* * * *

Then there was the bum who, after years of sleeping under bridges and viaducts, switched to culverts and became a Man of Distinction.

* * * *

Feudal Lord: "I hear you misbehaved while I was away, Son."

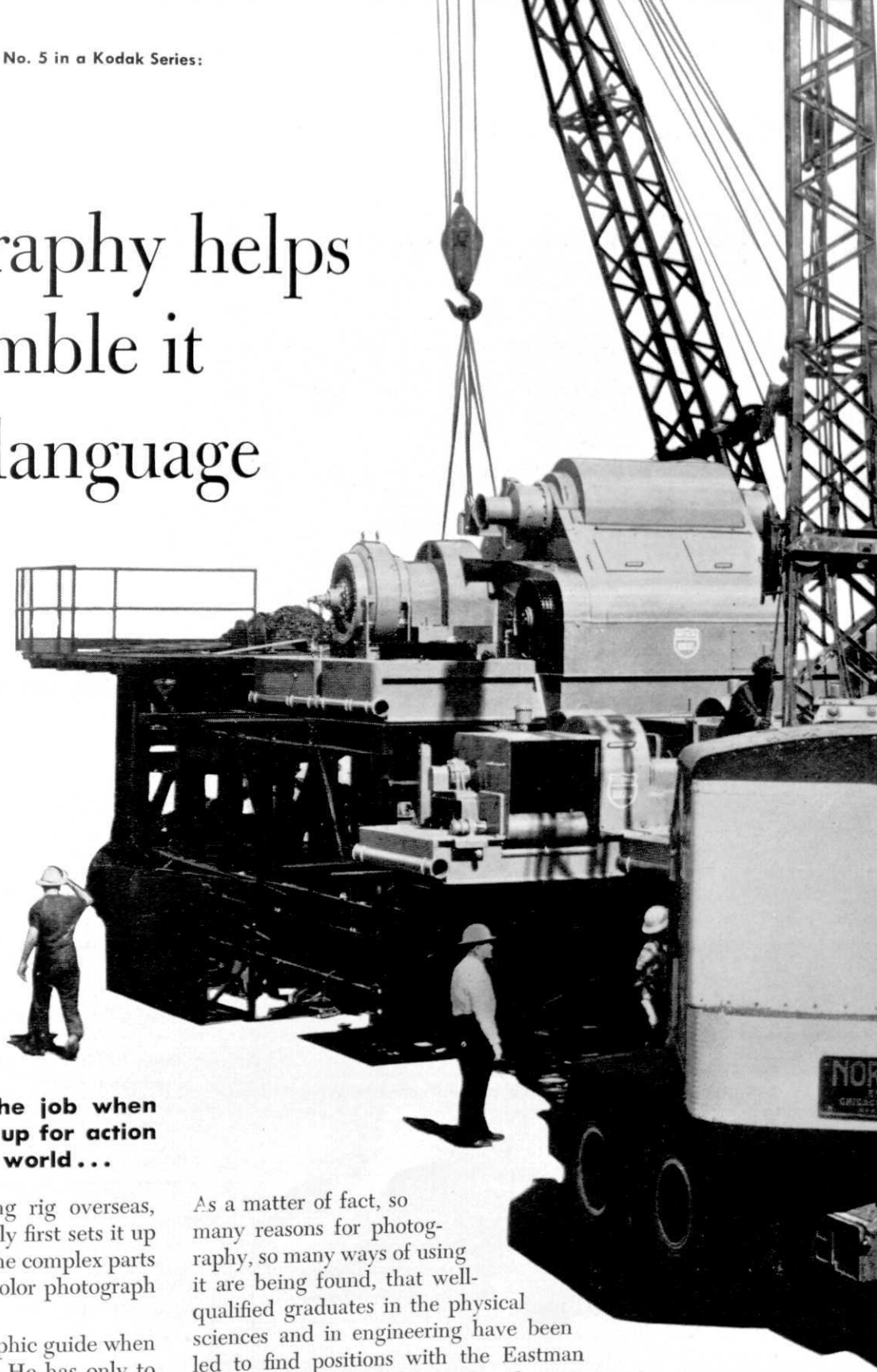
Son: "In what manor, Father?"

* * * *

A couple of officials were walking by Oak Ridge, when they discovered a strange unidentified object lying on the ground. They decided to take is up in an airplane and drop it to see what would happen. They flew over some woodland in the South and dropped it. When it hit the ground it blew up. Just then a long-bearded old man wearing a Confederate uniform and shouldering a musket came running out of the woods. As he looked up and saw the atomic mushroom he said, "I don't know what Lee's going to do, but I'm going to surrender."

PHOTOGRAPHY AT WORK No. 5 in a Kodak Series:

Photography helps assemble it in any language



Pictures help boss the job when this drilling rig is set up for action half way around the world . . .

Before shipping a drilling rig overseas, National Supply frequently first sets it up here for tests and paints the complex parts in *coded colors*. Then a color photograph is made.

Why? To serve as a graphic guide when the rig reaches its buyer. He has only to follow the photograph—matching color to color—and the rig virtually assembles itself. As a technique, this use of photography makes unskilled labor more efficient, slices through the problem of language barriers.

National Supply's experience is an example of how photography saves time, cuts cost, reduces error, improves output.

As a matter of fact, so many reasons for photography, so many ways of using it are being found, that well-qualified graduates in the physical sciences and in engineering have been led to find positions with the Eastman Kodak Company. This number has included many returning servicemen.

* * *

If you are interested, write to Business and Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.

Eastman Kodak Company
Rochester 4, N. Y.

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TRADE-MARK

JOHN B. NOLTE, Purdue University, asks:

"What is G.E.'s Manufacturing Training Program?"

The Manufacturing Training Program at General Electric is a program of basic training for manufacturing leadership, including planned rotational work assignments and related classroom study for outstanding young men who are interested in a career in manufacturing. It was organized to meet the increased demand for effective manufacturing leadership and technical "know how," in line with the expansion and development of the Company's operations by developing trained men to fill future key positions in the organization.

Who is eligible for this program?

In general, the Program is open to college graduates with degrees in engineering and science, and a limited number of business administration and liberal arts graduates. We are looking for outstanding young men with sound educational backgrounds, well-balanced personalities, demonstrated thinking abilities, and having the potential to develop toward top level responsibility in key assignments.

How long is the program?

The normal length of the Program is three years. However, some individuals may be able to complete their training in a shorter period because of previous knowledge or experience in manufacturing work.

What type of work assignments are made?

Work assignments are provided in all phases of manufacturing and related functions so that each man will acquire knowledge of manufacturing engineering, including manufacturing methods and techniques, shop operation, production control, personnel administration, labor relations, engineering activities, sales and manufacturing co-ordination, and general business administration.

In addition to job assignments, classroom courses cover such subjects as Company organization, manufacturing operations, labor and personnel relations, business administration, law and relationships between manufacturing and other functions of the business. Progress on the job and in classroom work is carefully observed and reviewed periodically with each man to assist him in his career.

What happens after training is completed?

After completing the training program, graduates are placed in operating departments and divisions throughout the Company in positions where leadership and initiative are needed. All placements are made in relation to the aptitudes, abilities, and interests of the graduates.

At General Electric, manufacturing operations involve the administration and supervision of activities of more than 100,000 men and women in more than 100 plants, who are involved in the making of some 200,000 different products.

The wide scope of these activities, the great variety of products, and the diversity of manufacturing activities offer limitless opportunities and exciting challenges to college graduates today.

Manufacturing training is a foundation for leadership—and an opportunity to build a satisfying, rewarding career in one of America's most important industries.

If you are a graduate engineer, or a graduate with definite technical inclinations that include an interest in the career possibilities in manufacturing, see your college placement director for the date of the next visit of the General Electric representative on your campus. Meanwhile, for further information on opportunities with General Electric write to College Editor, Dept. 2-123, General Electric Company, Schenectady 5, New York.

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