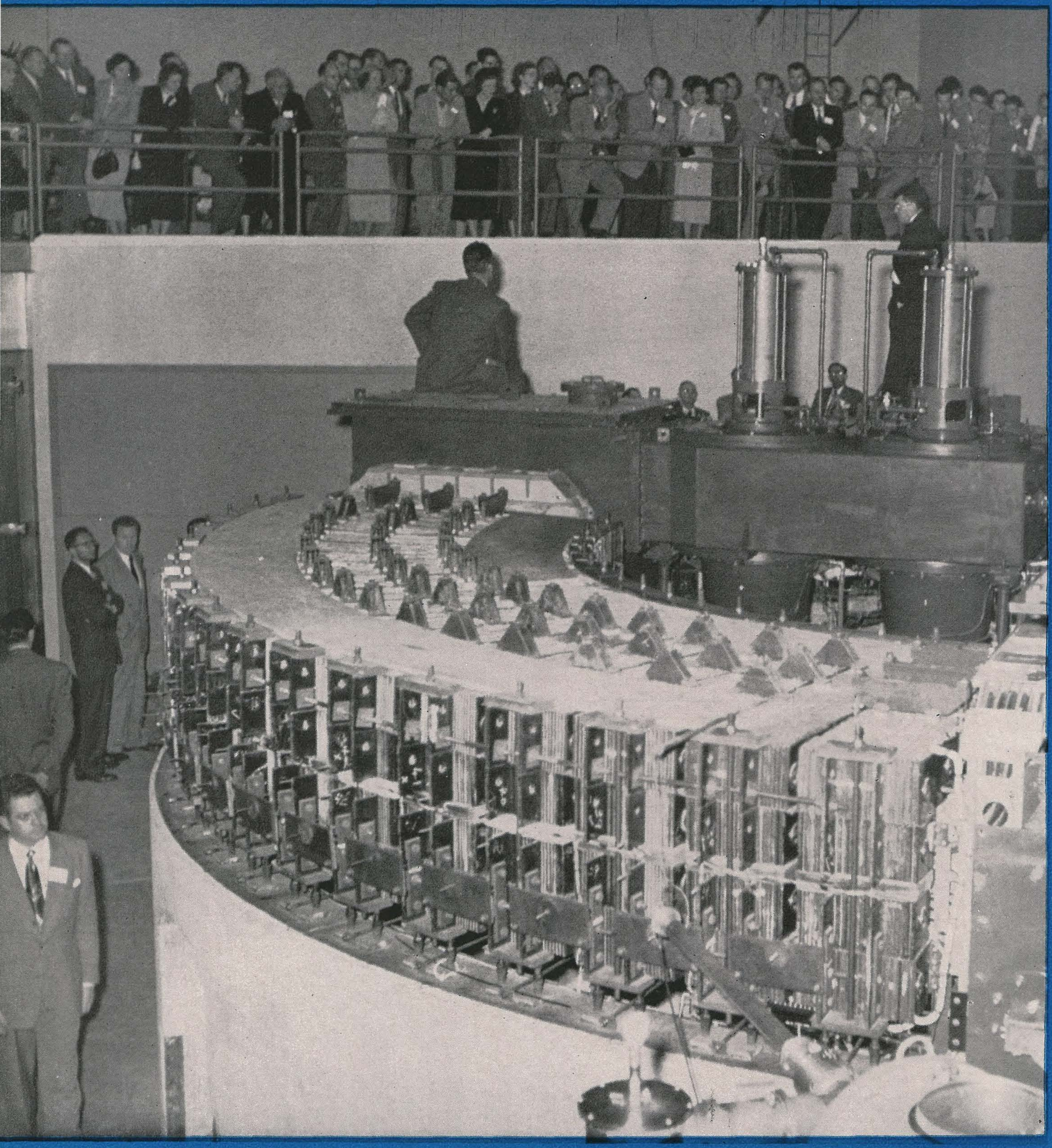
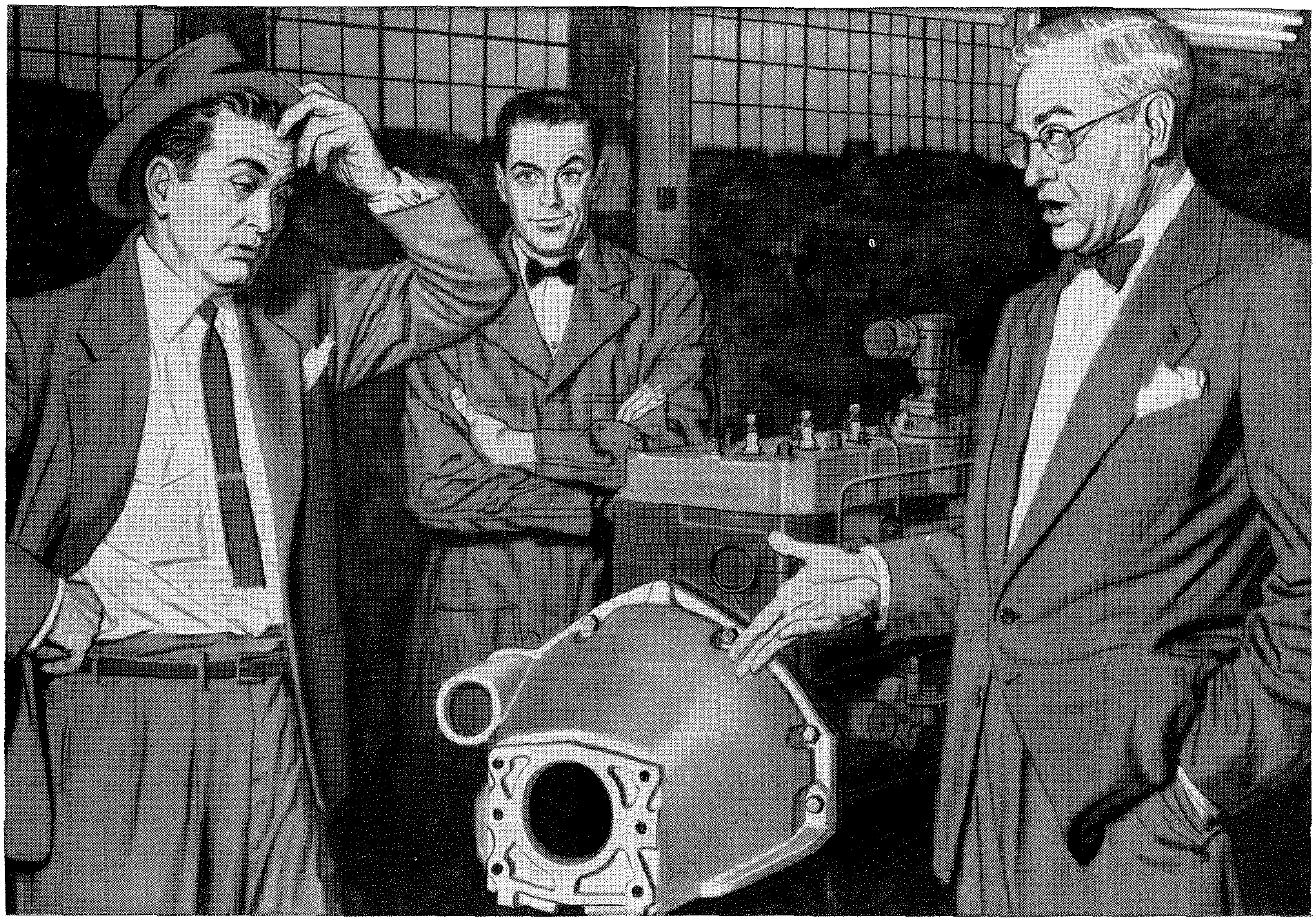
ENGINEERING | AND | SCIENCE

MAY/1951



Seminar Day . . . page 35

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY



Why can't this be an ALUMINUM DIE CASTING?

This challenge was thrown at us by a leading automobile maker.

"It's possible," we agreed. But . . . the clutch housing also supports half the engine's weight, it is highly stressed, must absorb vibration. Could a die casting economically be made that strong?

An Alcoa Development Program was started. With the auto maker we drew up designs. We selected our strongest die casting alloy; poured *sand castings* from it; machined it to the dimensions of the die casting design.

Shear static loads and bending stresses were measured. Brittle lacquer and strain gauges show us stress concentrations. Castings, engine and transmission were assembled, then run with an unbalanced shaft to measure dynamic stresses.

With the auto maker we modified designs. Die castings were made. We repeated the laboratory tests while the auto maker made road tests. The first stressed automotive die casting was a success. 25% stronger in shear, 10% stronger in bending, 100% better in fatigue life than the original clutch housing. Only ¼ as much weight as the original cast-iron housing. *And 15% lower in cost.*

This case is typical of the engineering problems Alcoa men undertake and solve. Throughout the Alcoa organization similar challenging jobs are in progress now and others are waiting for the men with the imagineering ability to tackle them.

Aluminum Company of America, 1825 Gulf Building, Pittsburgh 19, Pennsylvania.

A business built on co-operation

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HENRY GROSS AND HIS DOWSING ROD

by Kenneth Roberts
Doubleday & Co., Inc., N.Y. $3.00

Reviewed by Robert P. Sharp
Professor of Geomorphology

KENNETH ROBERTS, famed writer of historical novels, here recounts the truly amazing water dowsing performances of Henry Gross, a game warden of Biddeford, Maine.

When Gross and Roberts first got together in 1947, Henry was a good water dowser of considerable experience and many successes, but he was not particularly adept in obtaining detailed information from his dowsing rod as to depth, volume of flow and related matters. Encouraged and stimulated by Roberts, Gross gradually developed almost unbelievable abilities along these lines. He soon learned to establish the depth, volume, direction of flow and potability of water in "veins." He could even predict the type of material to be drilled through. Then Gross discovered he could locate water in veins and obtain information concerning them merely by being on the property and not necessarily directly over the vein. About this time he also found that his rod could locate people hidden from view, giving direction and distance to the desired person, and, further, that his rod could locate lost objects such as an outboard motor dropped by accident to the bottom of a lake.

Next Gross learned that he could dowse a piece of property from a picture of the house on that property, and later this remote dowsing ability developed to the stage where he could determine the number, nature, depth, volume of flow, and location of water veins on a piece of land merely from a description of its location or by knowing the owner's name, even though the property were tens or even hundreds of miles away. Wherever possible these instances of remote dowsing were checked by subsequent dowsing directly on the premises, and the agreement in results was all that could be desired.

Map dowsing

Most impressive of Henry Gross' performances is map dowsing. Using a map of Bermuda in the bar at Roberts' house near Kennebunkport, Maine, Gross located four water domes with numerous associated veins on the island of Bermuda, an area notoriously short on supplies of potable ground water. A dome is a pipe or spout of water rising from great depth. The exact location of these domes was later pinpointed on the ground by Gross. According to his dowsing rod one was polluted, but the other three were subsequently drilled and two produced potable supplies of fresh water. The third dome drilled yielded slightly saline water owing to an error of location on the part of the drilling crew.

Anyone who thinks that geologists are a bunch of numbskulls will greatly enjoy this book, for Roberts loses no opportunity to deride their almost universal disbelief in water dowsing. Oscar E. Meinzer, a lifelong student of ground water and a leading figure in the field, is described as representing "entrenched ignorance grown to full flower." Geologists will have to revise drastically their concepts of groundwater behavior, and geophysicists struggling with the internal constitution of the earth will find that the water

CONTINUED ON PAGE 40

Oh say can you see-

"That's Jonesey—putting out his flag again.

"He hasn't missed one Sunday in the eight years we've been neighbors. I used to kid him about it a lot. Asked him why didn't he buy a cannon to shoot off with it. He took it good-natured-like. But we got to talking last week about war in general. That was the first time I even knew he had a son.

"His boy, Joe, enlisted right after Pearl Harbor and got overseas fast. When young Joe came back, Jonesey met him at the railroad station, stayed up with him all night and rode out with him to the cemetery on the hill. After it was all over, the sergeant gave Jonesey the flag that had covered Joe. *That's it over there.* I don't kid Jonesey any more.

"Instead, I've been listening respectfully when he talks about the flag . . . only when *he* says it, it's Flag. With a capital F. Same capital F he puts on Freedom, which is what he really means. Jonesey sure made me think about Freedom a lot. For instance . . .

"When I vote, nobody knows where I put my X's. Nobody puts me in jail for picking out my own church. And no teachers tell my kids to spy on me and turn me in because I squawk about taxes or high prices. And when I told my boss I was quitting to open a little grocery with the dough I'd saved in war bonds, he wished me luck and said he'd have his missus buy their groceries from me.

"*That's* what Jonesey meant when he said our Freedom is right under our noses. Can't feel it or see it. But it's there just the same, wrapped up in every star and stripe in that Flag across the street.

"And, if you'll excuse me, I'm going outside and hoist *my own* Flag, too . . . just bought it last night. 'Oh say can you see?' *I sure can . . . now!*"

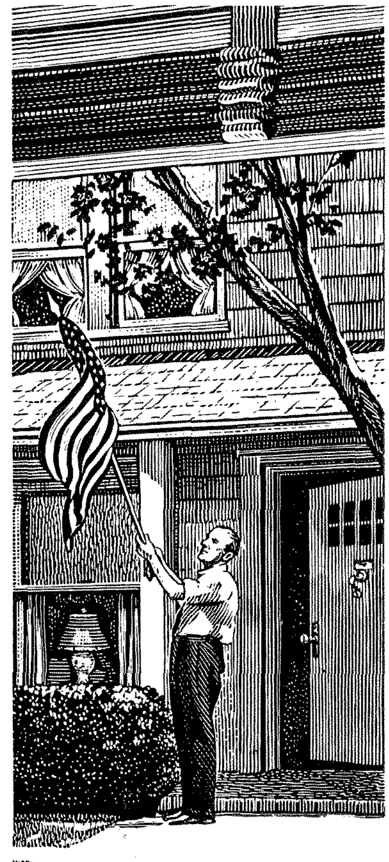
REPUBLIC STEEL

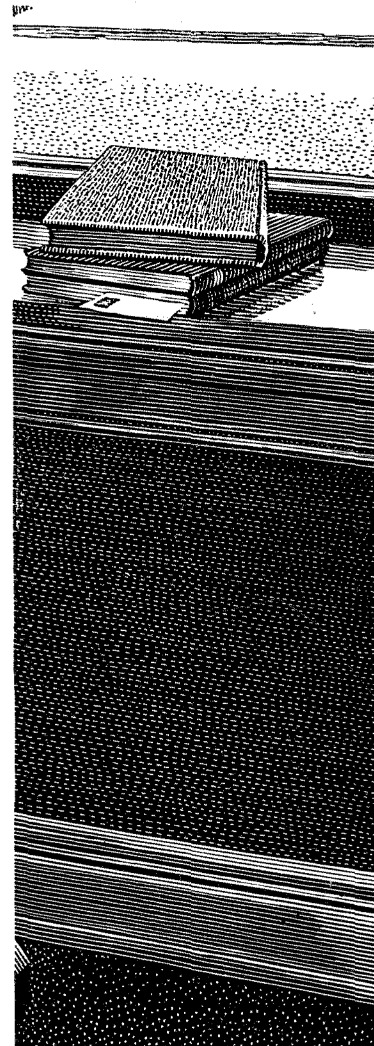
Republic Building, Cleveland 1, Ohio

Republic BECAME strong in a strong and free America. Republic can REMAIN strong only in an America that remains strong and free . . . an America who owes much of her prosperity to her many huge industries that provide her people with the world's finest living. *Through these many industries, Republic serves all America.* A typical example can be found in the Petroleum Industry whose products furnish much of the nation's power, heat and light. In this production, too, steel plays a vital role . . . carbon, alloy and stainless . . . much of which comes from the many mills of Republic.

* * *

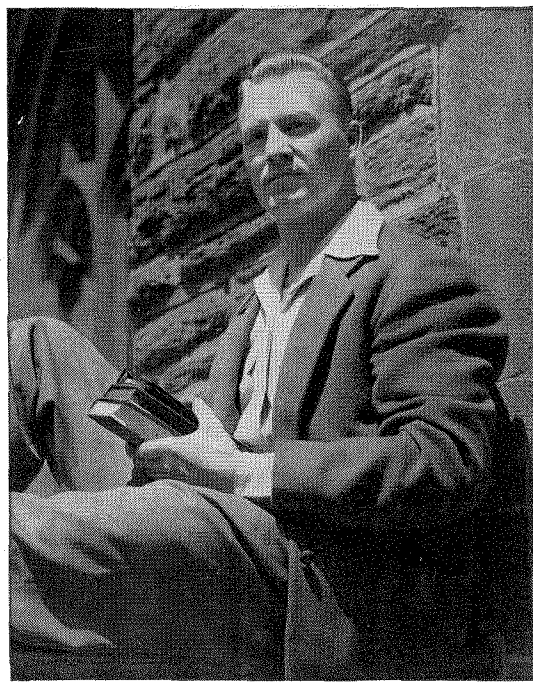
For a full color reprint of this advertisement, write Republic Steel, Cleveland 1, Ohio





YOU REMEMBER LOU . . .

He'd Give His Eye Teeth For This Opportunity



Lou came out of W. W. II with the bug for electronics. He'd been an electronics maintenance specialist in the Navy . . . attended service schools in radar, sonar and gunfire control to earn his petty officer's rating. He came to school under the GI Bill . . . majored in electronics . . . now has his degree in electrical engineering. Lou is doing all right now but wishes he could be closer to his chosen career — *electronics.*

Maybe you know Lou—or somebody like him. Perhaps you yourself have a similar background and can qualify for this unusual opportunity to secure broad foundational experience in the rapidly growing field of electronics engineering.

RAYTHEON GOVERNMENT FIELD ENGINEERING

GOVERNMENT FIELD ENGINEERING is our name for the Raytheon organization which supplies world-wide technical service to the Government relative to the intricate electronic equipment which we manufacture. This highly qualified group has won an acknowledged eminence among similar organizations. During World War II, Raytheon produced more search radar for the Navy than all other manufacturers combined. Its Submarine Signal Division has been the leader in sonar and underwater sound since 1901.

Since V-J Day, Raytheon has continued in all phases of electronics development and production for the Army, Navy and Air Force, and is now being called upon to gear its facilities to the growing needs of the Armed Forces. We now have a limited number of openings for candidates who have the special service and educational background required and who can meet the rigorous qualifications which we must impose in order to maintain our high operating standards.

JUNIOR FIELD ENGINEER

Successful applicants for the position of Junior Field Engineer in the Raytheon Government Field Engineering Organization will have the same general biography as our friend, "Lou". Military experience with electronic equipment in the Army, Navy or Air Force is desirable. A degree from a school of Physics or Electrical Engineering in a recognized college or university is essential. Experience after graduation is of little consequence.

The position of *Junior Field Engineer* presents a rare and unusual opportunity to become acquainted with the most modern techniques in the science of electronics. For the graduate engineer, it is a once-in-a-lifetime chance to familiarize himself with the many phases of electronics prior to specialization.

Junior Field Engineers are called upon to (1) supervise equipment installation, (2) supervise or personally attend to its repair and maintenance, (3) train military or other qualified personnel to operate, repair or maintain it, and (4) contribute toward the solution of engineering problems which may arise in the field. The Junior Field Engineer may be called upon to undertake important missions of a classified nature in the interests of the Government. He will at all times, by the nature of his position, be a representative of the Raytheon Manufacturing Company responsible for sustaining and improving our relationship with and service to the Government.

SALARY AND BENEFITS are liberal, commensurate with the technical knowledge and skill and the responsibility involved. They include travel and subsistence payments, free accident insurance, low cost life insurance, retirement and hospitalization plans. All in all, this adds up to a job for which only a relatively small group of engineers can qualify, but in which successful applicants can profit more professionally and financially, can advance more rapidly, and can acquire a wider range of valuable and interesting experience than in any other branch of the industry.

WHO CAN QUALIFY?

Practicing engineers, recent graduates and those about to graduate are eligible to apply; preferably those between the ages of 22 and 30. If you know of a qualified applicant, you will be doing him a tremendous favor by calling this opportunity to his attention. All applications will be carefully considered and held strickly confidential. Send a brief resume to

Government Field Engineering

RAYTHEON MANUFACTURING COMPANY

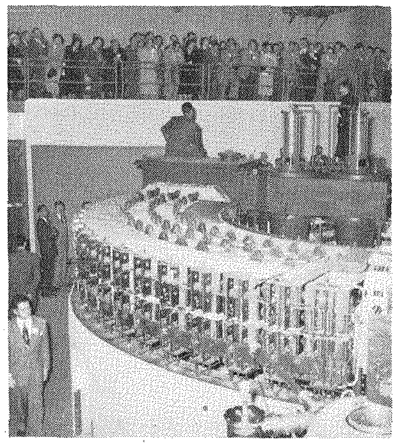
138 RIVER STREET · WALTHAM 54, MASSACHUSETTS

RAYTHEON

Excellence in Electronics

ENGINEERING AND SCIENCE

IN THIS ISSUE



This month's cover shows some of the 560 alumni and their wives and guests who descended on the Institute on Alumni Seminar Day, April 14, looking over the synchrotron which is now under construction on the campus. For some other angles on Seminar Day, see page 35.

Horace Gilbert, Professor of Economics at the Institute, returned to work here last month after a year's leave, during which he served on the staff of the U.S. High Commissioner in Germany. His article on page 7 includes the highlights of his observations on Germany during the past year. He concentrates on economic matters, and even more particularly on German industry, which was the field of his special assignment. But, because of the critical trend of world events, he has related these economic matters to their political contexts. The principal question he tries to answer, however, is: "What is the status of German industrial recovery, and what has the contribution of the United States been to that recovery?"

Peter Kyropoulos, technical advisor for the AAA on the recent Economy Run, has some tips on economical driving for everyone on page 11.

James Boyd '27, one of the Institute's most prominent alumni, reports on the current status of our strategic minerals resources on page 18.

PICTURE CREDITS

Cover	Robert Spencer
pps. 7, 11, 14, 16, 17	Robert Spencer
pps. 28, 30	Robert Smith
p. 32	Ed Matzner
p. 35	Robert Spencer

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REPORT ON GERMANY

by HORACE N. GILBERT

IMMEDIATELY AFTER the war German industry and trade were prostrate. I was in Germany during the summer of 1945 as a member of the United States Strategic Bombing Survey, and I witnessed the tremendous physical damage and economic disorganization that had paralyzed every economic sector except agriculture.

The directives under which the Allied Control Council operated proved unsatisfactory, largely because of Russian non-cooperation, and valuable time was lost putting Germany's energies to work for her own support. Economic conditions were bad. The Occupation Forces were obliged to make large outlays for the reestablishment of minimum economic activity, such as coal production, electric power, and transport, and for subsistence food supply. Even so there was widespread privation. The principal part of the cost of this Government and Relief in Occupied Areas (GARIOA) program fell upon the United States. The influx into Western Germany of some 8,000,000 ethnic German expellees and refugees during the first postwar years contributed to the difficulty of the situation.

The first important economic milestone was the combination of the initiation of the Marshall Plan in the spring of 1948, and currency reform in June, 1948. Currency reform put the gears of the German economy in mesh, and the Marshall Plan provided a blood transfusion to the entire economy in the form of food and industrial materials.

The result was a remarkable demonstration of economic mechanics. People went to work to supply the tremendous deficit in consumer demands for almost all manufactured products. The rate of industrial production, which had approached zero after the war, has now caught up roughly with the average of Marshall Plan countries. German factories today are humming with activity, and on a current basis the output of goods is contributing creditably to consumer needs, to restoration of industrial plants, and to exports.

It must be remembered, however, that only a dent has been made in the restoration of total war damage, both that suffered by industrial concerns and private individuals through bombing and related war action, and through economic dislocations such as currency reform.

Uses of Marshall Plan Aid

U. S. dollars go to work twice for the recipient nations. First, as dollars, they pay for imports. These imports are not gifts, however, to those who receive the specific commodity—wheat, cotton, or machinery. Some importer must pay for them in his own currency. This process gives rise to what are called "counterpart funds", the local currency counterpart of the dollar-financed imports. Two opportunities exist, therefore, to direct the best use of monies deriving from U. S. aid: what should be bought with the dollars, and what should be bought with the counterpart funds.

By the time I arrived in Germany, in October, 1949, the general thinking regarding the dollar program had been quite well established. It had been decided to concentrate on food and industrial raw materials. Less than 5% of the dollar funds had been allocated to the purchase of industrial equipment with which to enhance Germany's long-run ability to earn her own living. This program by itself is what might have been expected, since Germany has been for several generations the leading manufacturer of industrial equipment on the European continent. While Marshall Plan aid was supplying great quantities of grist for its industrial mills, German industrial ability was rebuilding the mills.

The German dollar program, however, when compared with the dollar programs of other Marshall Plan countries, more particularly France, raises an important issue: With U. S. aid, industrial plants are being built in these other countries to supply markets formerly supplied chiefly by Germany.

If it was the intent of the Marshall Plan program to change the balance of industrial power in Europe, the program followed has tended in that direction. I am afraid, however, that this was not the overt intent, but that Marshall Plan funds have been used to further the nationalistic ambitions (however modest) of those other countries. For the longer run the issue raised is an important one. Two of the possibilities are that the Germany economy will have a hard time making a comeback, or the newly established concerns will be unable to compete with Germany. Either possibility will reflect discredit on the Marshall Plan.

The German counterpart fund program has been quite a different matter from the dollar program. Counterpart funds have been used almost entirely to provide investment capital for the most needy sectors of the German economy. In collaboration with the German Ministry of Economics, the Marshall Plan Mission to Germany worked out investment programs for these funds as sums became available through dollar aid.

The criteria used in the initial years were these: Will the investment contribute a maximum to the expansion of production of essential goods and services? Will it aid expellees and refugees and reduce unemployment? Will it increase dollar-earning ability or reduce the need for dollar imports? More recently another criterion has been added: Will it increase Germany's contribution to western defense?

The application of these criteria has resulted in the distribution of counterpart funds for investment in the following principal fields: improvement of agricultural productivity, expansion of electric power production, general aid to export industries, housing, and, more recently, coal and steel. The amounts of money involved have been large, but the needs have been even larger. Germany has a long way to go to restore and modernize its industrial installations, and an even longer way to go to rebuild its cities and houses.

Obstacles to reconstruction

The restoration of German industry would have been most difficult if only because of war destruction and disorganization. The task has been made even more difficult because of certain disabilities imposed by the Allies. Those having to do with strictly military matters, such as the prohibition of production of weapons, have presented no problem, but others intended to restrict civilian industries, have penalized recovery. Disarmament of civilian industries—the purpose of which was to reduce the level of German production—has been completed. This was called by Germans the "Morgenthau Plan," and has been greatly resented.

Restrictions on industries remaining after dismantlement are embodied in the Prohibited and Limited Agreement. This covers ceilings on production of steel, aluminum, and styrene, limitations on productive capacity of several leading industries—especially steel (including restrictions on the adoption of improved technology)—and controls over several other sectors of German industry such as ball bearings, machine tools, and electronic tubes.

It is not my purpose to dispute Allied policy in Germany with respect to military security. It became clear shortly after my arrival, however, that many of the restrictions on German industry were directly opposed to Marshall Plan objectives, namely, economic recovery and reduction of the burden on the U. S. taxpayers. We, as a party to the restrictions, were going in opposite directions at the same time. Furthermore, I became convinced that many of the restrictions on German industry had been imposed with military security as the excuse, but actually to penalize Germany's competitive position in world markets.

The United States had succeeded in getting a review of the dismantlement program in 1948, in the light of the newly declared Marshall Plan, and late in 1949 a few industrial plants were removed from the dismantlement list. Extensive dismantlement continued, however, principally in the Ruhr (British Zone), during the first two years of the Marshall Plan. Dismantlement was not completed until March, 1951.

The United States took a lead in securing the relaxation of industrial restrictions imposed by the Prohibited and Limited Industries Agreement. In the summer of 1950, tripartite meetings began in London, aimed at the removal of unnecessary controls on civilian industries. These meetings resulted in small but significant relaxations in September, 1950, with respect to shipbuilding and steel production.

During the succeeding months our hopes ran high for a time that all industrial controls which had no connection with weapon production, would be removed. Tripartite agreement could not be secured, however, and in March, 1951, only a limited list of relaxations was announced. Several important controls remain. Among other things, Germany's steel industry is still subject to controls which prevent modernization and the balancing up of productive capacity for certain products to meet market demand. Occupation-imposed industrial disabilities still impair Germany's industrial productivity and help to keep her from contributing to western defense.

The existence of these disabilities on German industry has made it very difficult to convince industrialists, and also workers and the general public, that U. S. policies in Germany make sense. Opinion is uniformly enthusiastic regarding the generosity and high purpose of the Marshall Plan, but regarding the continuing punitive actions it is said that the United States talks nobly, but lets France and Britain have their ways. Repeatedly I heard the comment that if the restrictions on German industry which have no direct bearing on the production of weapons and related war material were removed, economic conditions would improve and there would be a closer approach to economic self-support.

The morale of industrialists under the conditions that I have described, has not been high. The situation is especially bad in the Ruhr, where five years of wholesale dismantlement have worn out the spirits of most responsible industrial directors, and created an attitude of resignation.

It is hard for us to understand the relationships between the victor and the vanquished under such circumstances. The removal of the best of Germany's steel industry, for example, was obviously an imposed action. Neither the German Government nor property holders appeared to possess any rights. Some interesting points about the propriety of certain of these Occupation acts may be raised later in international courts of law. Many grievances were presented to me by German industrialists; those that bore a relationship to the success of the Marshall Plan I tried to do something about, but my record of accomplishment was poor.

The German Government at both federal and state levels tried hard to secure relief for German industry from these disabilities. Chancellor Admaner petitioned the High Commission on many occasions to stop specific dismantling actions or to relax industrial restrictions. Almost without exception these requests were refused.

In spite of the various disabilities suffered by German industry, a remarkable degree of recovery has taken place. Marshall Plan food and industrial materials, factories and equipment reconstructed by German technical resources, labor that is both skilled and hard working, and enterprise that exhibited a commendable spirit, have combined to bring a greatly improved status to Western Germany. The record is a good one. Allied Occupation policy might be described as tolerable if it were not for the clear purpose of the Marshall Plan to create even better conditions, and if it were not for the Russian threat.

Political attitudes today

Just as Germany has made an economic recovery assisted by the Marshall Plan, so has she made substantial progress with the adoption of democratic ideas. It is difficult to be sure about such matters, especially since there are so many conceptions of democracy. But the improved standard of living has successfully combatted political unrest, and Communism is a small factor except in a few spots such as the Works Councils of some industrial concerns.

The political atmosphere still contains reminders of the traditional German leaning toward authoritarianism, but it also appears to be well purged of the worst features of Nazi totalitarianism. The position of a government under Occupation conditions is difficult at best. In this light Germany is fortunate to have succeeded as well as she has with the reconstruction and reform of governmental machinery on the federal and state levels, and with the adoption of a basic law, or constitution. The problem was not so difficult on the local government levels.

Except for the Russian threat, the progress being made in Germany along political lines under the Occupation could have been considered satisfactory. But the speed of world events, following the outbreak of war in Korea, has been too fast for the tripartite High Commission machinery. The United States, generally speaking, was ready to keep pace with these events, but not so France and Britain.

These countries have persevered with steadfastness of purpose in their policy to prevent Germany from being able to support another aggression. They have swerved from this objective scarcely at all because of the Marshall Plan or the Russian threat They have succeeded very well with the reduction of German strength. Many times it occurred to me, however, that their present success was perpetuating hate and distrust. The preamble to the UNESCO charter makes reference, I believe, to the fact that since wars begin in the minds of men, the way to peace lies there also. If this is true, only the U. S. policy toward Germany has been creating in German minds attitudes favorable to future peace.

This criticism I have made of the attitudes of our Allies in Western Europe should be qualified in one important respect: the Schuman Plan. This is truly a new and bold conception of a means to secure the peace of Europe. Its success is still problematical, but it has reached the initial stage of finalization, and there is promise that the governments of the six member countries will give it their approval. If France has been keeping restrictions on Germany only until the Schuman Plan became a reality, much of the criticism I have leveled at her should be retracted.

Western defense

The most important political problem in Western Europe today is probably the matter of German participation in western defense. Russia's attitude is clearly one of recognizing Germany's key position in this respect, both with reference to industrial production and manpower, and she is using every device to neutralize Germany. France and Britain appear to have continued too long with their purpose to reduce Germany. A fully disarmed and passive Germany has been good politics in both countries. Perhaps they have been genuinely scared by Russia's declaration that she would regard the rearming of Germany as an unfriendly act.

The United States has persisted with its high-minded and bold policies; it has taken a lead in relaxing Occupation controls, in the gradual reestablishment of German sovereignty, and in the challenging of aggression. Britain and France, however, do not want to see Germany rearmed before they are, and they are eager to have first call on defense funds which the United States makes available for the defense of Western Europe. The economic and military weakness of these two countries is probably a factor in their attitudes.

The German attitude has not been encouraging with respect to active participation in western defense. There is no heart for rearmament. There is widespread knowledge of what Russian Communism means, however, (every fifth person in Western Germany is an expellee, refugee or former prisoner of war in Russia) so those who think, understand that they must fight. The less thoughtful are choosing neutralism, in the hope that the Russian tide—if it comes—will sweep over them but not destroy them, and that existence under the Russians will not be as bad as feared.

Officially Western Germany has declared itself for the West, and I have no reason to doubt the sincerity of the declaration. But scarcely any tangible steps have been taken to implement that position. Germany is still under strict prohibitions with respect to both industrial and manpower mobilization. Public opinion has been estranged by certain Occupation actions, such as dismantling and shipment on reparations account of needed industrial equipment, restrictions on civilian industries, and the forced export last winter of extra amounts of Ruhr coal at a time when German homes were cold and German factories were closing for lack of coal.

The German attitude toward participation in western defense is torn between the clear conviction that she prefers the West, and resentment at restrictions imposed on her which are in contradiction to the normal relationships of partners in a joint defense effort. General Eisenhower pointed to this situation when he said that German military units would be welcome in his army when they would be on an equal basis. The problem he passed to statesmen has not been solved.

The plain fact of the situation today is that little progress has been made in bringing Germany into the western defense picture. It is exceedingly doubtful, furthermore, whether German public opinion will support active participation. The explanation, in my mind, is Allied bungling. U. S. policy months ago was to bring forward German public opinion actively in support of the West, to create a positive attitude toward us similar to that held by Berliners because of the air lift. We have gotten almost nowhere with that policy. There may yet be time to bring Germany into the job of western defense; some small beginnings are being made. There is considerable opinion among informed people in Western Europe that without German manpower and industrial resources, General Eisenhower's efforts will not be much of a worry to Russia.

The immediate crisis

Western Germany has made a remarkable economic recovery, aided in an important way by Marshall Plan funds. She has also made good progress with the establishment of democratic government. With peace and access to world markets there is a strong basis for believing that Germany will be able to support herself well as a friendly member of the community of nations.

The immediate crisis in Western Europe today has to do with defense against Russia. Allied policies toward Germany in this matter have failed to create a constructive basis for her participation. There is much evidence that Germany is still today, as it has been in centuries past, the bulwark against aggression from the East. It is of vital importance, in my opinion, that France, Britain, and the United States find a way to bring Germany cautiously but effectively into the western defense effort.

United States foreign policy in Germany, according to my personal observation, has been high-minded and bold. At times it has perhaps deserved the British criticism of being changeable and unwisely bold. Much of the criticism I have heard of our State Department for its German policy, however, impresses me as unjustified, or, at least, misdirected. I firmly believe that in the large our policies have been right. The trouble has been in failing to get British and French agreement to our policies. The critics of our State Department and of Mr. Acheson, and even of the Marshall Plan program, might well shift their attention to Paris and London and find the reason for the repeated vetoes of our policies.

Dr. Peter Kyropoulos uses a sound-level meter microphone to measure the heart beat of an automobile engine

TAKE THAT LEAD OUT OF YOUR SHOES

Do you drive with a "heavy foot"? Take it easy, and you'll get more out of your car. Here are some basic rules for economical driving, inspired by the recent Economy Run

by PETER KYROPOULOS

IF YOU CAN AFFORD to drive a car, you cannot afford to pass up the lessons that can be learned from the 1951 Mobilgas Economy Run. The results are tabulated on page 15.

These results, of course, amount to the gospel according to the advertising department. After looking them over, your reaction is sure to be: How come and how can *I* get that?

The answer is intuitively obvious: The Economy Run demonstrates "potential performance." This sounds impressive. What does it mean? What is performance anyway?

Let us look at the 4000 pounds of shiny gadgetry in which you take your life in the remaining left hand (the right arm was lost in the purchase).

What price speed?

The chart on page 12 (#1) shows the power-required of a typical car plotted against speed in mph. The curve is the average for a Ford, Chevy Styline (bustle back), and Fleetline (torpedo back). This is the power you really need for level road cruising. It is called the *road load*.

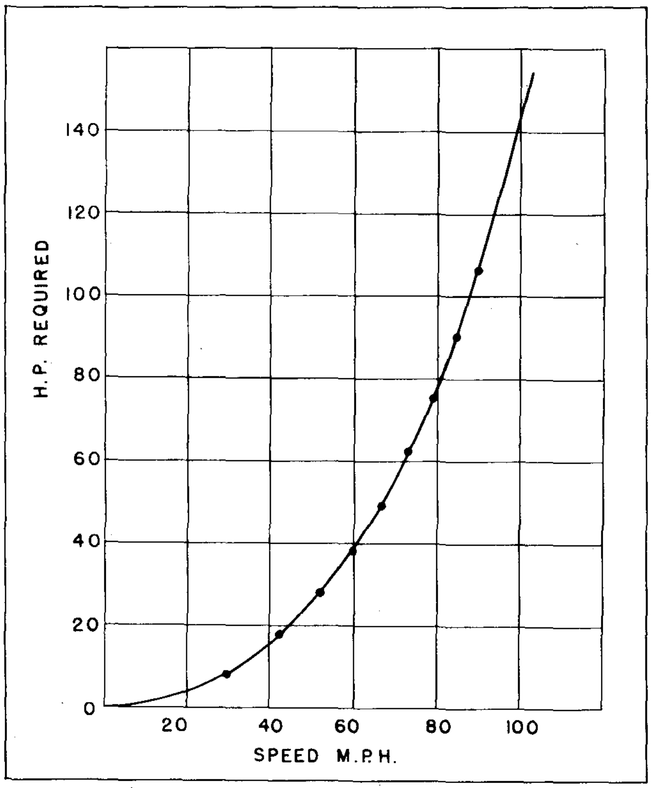


Chart 1

Power-required of a typical car as a function of forward speed (mph). The curve is an average for Ford, Chevrolet Styline and Fleetline. (Reference: Full-Scale Wind Tunnel Tests of 1949 Automobiles by Kenneth Razak, University of Wichita, Bulletin #21, 1950).

Chart 2 shows the power which the engine can furnish (power-available). There are three curves: the highest corresponds to full throttle operation; the two other curves are for part throttle operation. (Part throttle means reduced manifold pressure. A manifold vacuum gauge is a useful tool in determining engine performance, since a change in manifold vacuum indicates a change in power.)

Chart 3 shows the fuel consumption as a function of horsepower at different engine speeds. The road-load is shown as a dashed line. It corresponds to the power required from Chart 1. Transmission is in direct drive (transmission output rpm = engine rpm), whence for a given rear axle ratio there is *one* engine rpm which gives the road power-required. The fuel consumption is given in "pounds of fuel per brake-horsepower per hour" (brake specific fuel consumption). The use of all this is best shown by an example. Let us calculate the level road fuel consumption of our car at 40 mph.

From Chart 1 we find that the power required is 15 hp.

From Chart 3, with 15 hp and on the road load curve, we find the fuel consumption to be 0.65 lbs/bhp-hr.

We are drawing 15 hp, hence we are using 0.65 x 15 = 9.75 lbs of gasoline per hour, or, since there are 6 lbs of gasoline in a gallon, 9.75/6 = 1.625 gallons per hour.

During this hour we are traveling 40 miles (speed was 40 mph). Therefore, the fuel consumption is 40/1.625 = 24.6 mpg. A somewhat hasty road test on my Chevrolet Powerglide, adjusted for the torque converter losses, showed 23.2 mpg, averaged over five runs. These test runs included two stops each. The method used to obtain fuel consumption data is described at the end of this article.

Now we know how this mysterious "potential performance" comes about.

But your brother has a friend who has a neighbor who has a Powerglide which he calls a "gas burner." It gets 12 miles to the gallon. How can this be? Most likely this is exactly what he gets, but I submit that *he* is the gas burner, not the car. Another road test example will illustrate this.

Test conditions: Colorado Street in Pasadena, 11:00 a.m. on a week day.

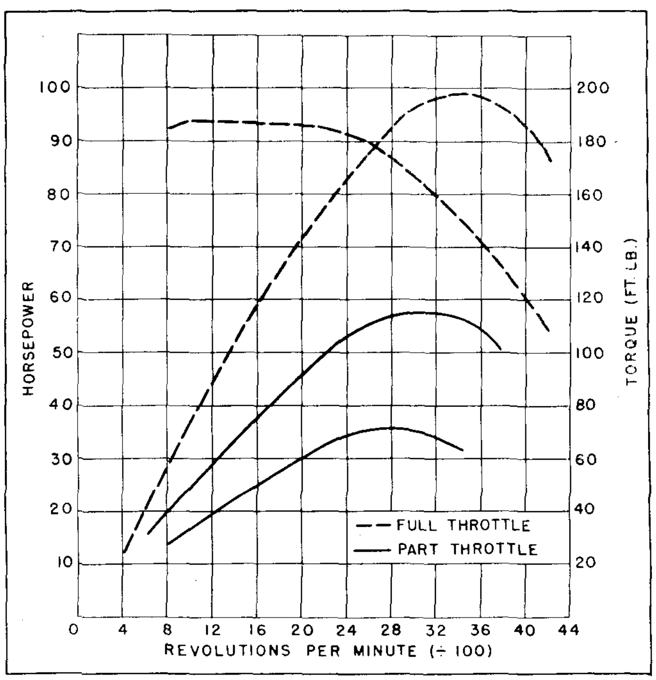


Chart 2

Power-available from a 235-cu.-in. Chevrolet engine. (Reference: Chevrolet 1951 Specifications).

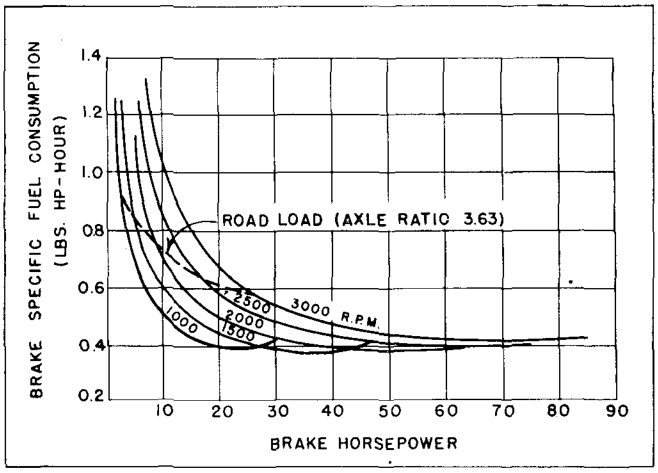


Chart 3

Typical part throttle fuel consumption data. (Reference: High Compression Ratios in Automotive Engines by D. F. Caris and A. D. McDuffie, SAE Reprint, Dec. 8, 1947).

Traffic lights: theoretically synchronized to 25 mph; actually s. n. a. f. u.

Number of stops: too many.

Speed: a patient 25 mph, staying in the same lane, starts in low.

Average mileage: 18.5 mpg.

The same course, driving as fast as space will permit, with quick starts: Average—15 mpg.

This brings out the point that driving habits and traffic conditions determine mileage. Driver training, therefore, is also the reason for the performance during the Economy Run.

The comparison quoted is typical and can be obtained with any car. The Southern California Automobile Club some time ago published tests on a Dodge. The results were as follows:

Downtown L.A. traffic: 8.7 mpg.

Residential street, 5 stops, 25 mph: 14.7 mpg.

Highway, no stops, 25 mph: 22.3 mpg.

Economy with hydraulic transmission

Why do the automatic transmissions, particularly the Dynaflow type, have a reputation for poor mileage? Well, for one thing, they do not have to be nearly as bad as most drivers manage to make them.

Chart 4 shows typical efficiency curves for a transmission like the Dynaflow or Powerglide (called a polyphase torque converter—and what a mouthful. No wonder it costs $169.85 extra). Again we have a marked difference between full throttle and road load performance. Let us say that you are moving along at 10 mph and you really want to show that blonde in the convertible in the next lane that you are not nearly as old and feeble as your looks might indicate—in short, you floor the throttle and take off. The transmission efficiency is 50%. If you draw only road load, the efficiency is 85%. It is easy to see why this sort of thing takes a lot of gasoline.

Killjoy was here

It seems, then, that by implication I am acting like the doctor who puts an embargo on drinking, smoking, etc. A man simply can't have fun. Before getting discouraged, let us examine what "having fun driving" really costs.

Suppose that you drive an average family car 10,000 miles per year with a mileage of 20 mpg. You are then buying 500 gallons of gas, at about say 25 cents per gallon, for 125 dollars. If the mileage were improved to 25 mpg, you would save exactly 25 dollars. If you were driving like the proverbial bat out of hell, at 15 mpg, it would cost you 42 dollars more a year (this does not include fenders and other breakage). It might

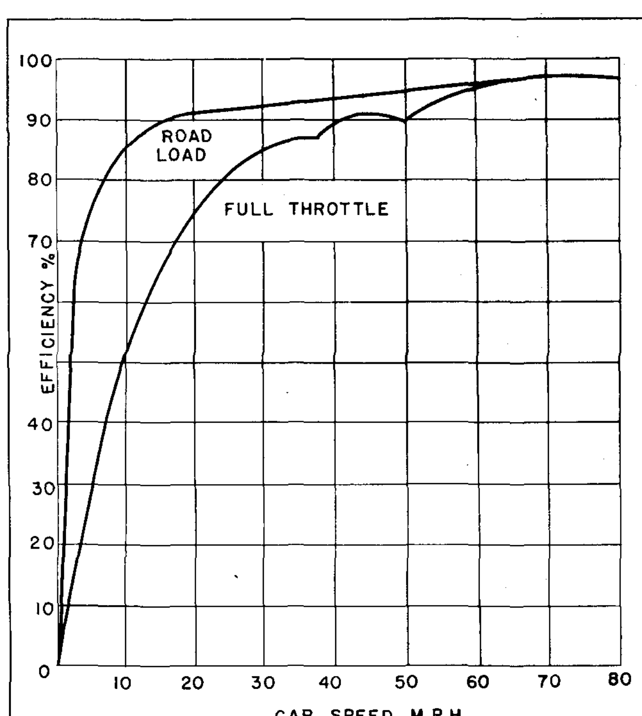


Chart 4

Typical efficiency curves for a polyphase torque converter—Dynaflow or Powerglide. (Reference: Automatic Transmissions, Part 8, by P. M. Heldt, Automotive Industries, July 1950).

well be suggested that it you cannot afford 42 dollars a year on having some fun, you have no business driving a car anyway. So, speed on big boy; hell ain't half full yet.

This is, of course, a matter of taste and opinion. One may also make a sport of getting good economy and, in that case, here are a few suggestions.

Basic rules for economic driving

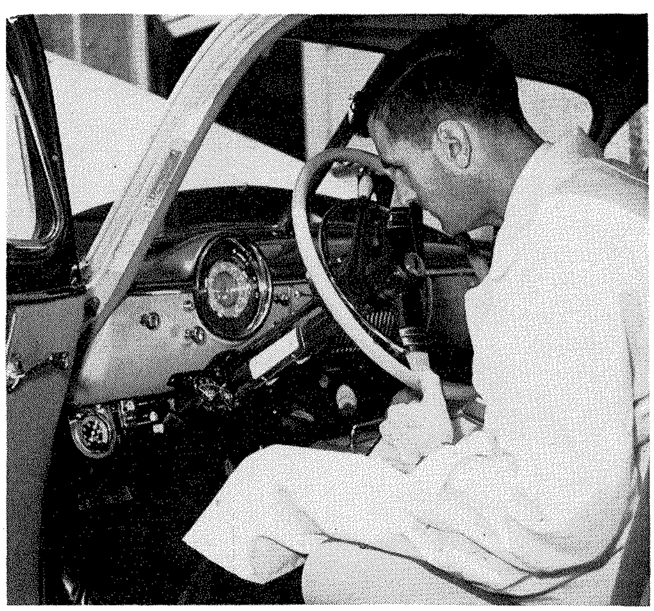
Let's begin in the morning.

(1) Don't jiggle the throttle (accelerator) before starting. Kick it down once for priming. (Each time the throttle is opened, the accelerator pump goes into action. 8 strokes are about equivalent to 1 mile of driving at a consumption of 15 mpg.

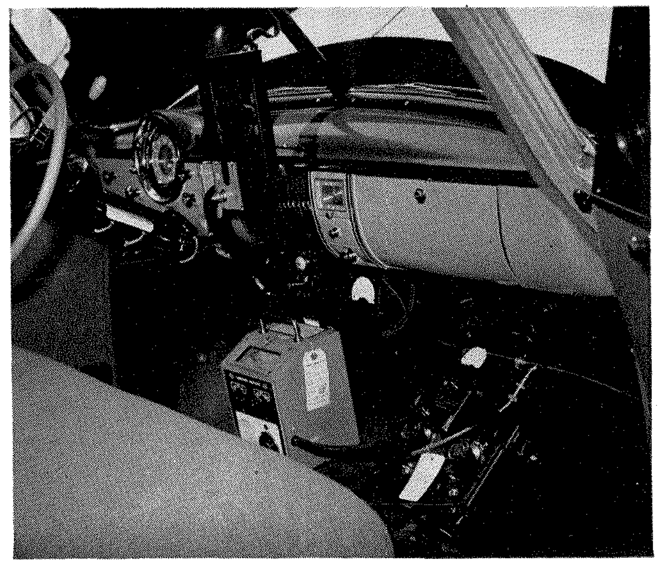
(2) Choking: If you have a manual choke, you are a lucky man. Choke as little as you can. It wastes gasoline, increases cylinder wear and results in dilution of the crankcase oil. If you have an automatic choke, it most likely overchokes. The least that should be done is to keep the choking mechanism in tip-top shape (some more about upkeep later).

3) Warm-up is good, especially with automatic choke, but it costs gasoline, too. So don't overdo it. Warm-up should be rather fast (1000 rpm). Most carburetors have a fast idling provision. After about $2\frac{1}{2}$ minutes of fast idle the cylinder walls are warm enough to prevent excessive condensation (which causes cylinder corrosion). You can now safely take off.

(4) Take it easy until the engine is at normal temperature as indicated by the thermometer on the dash.



Instrumentation for road testing — tachometer (reading engine rpm) is next to steering pole; manifold pressure gauge is below left hand corner of dash.



Instrumentation for road testing — fuel consumption burette is above center of dash; altimeter and thermocouple (reading engine temperatures) are under radio grille; sound level meter for knock indication is at lower right; grey box is exhaust gas analyzer.

(5) Don't pump the accelerator while waiting at stops.

(6) Don't take off from stops like a race driver. It costs plenty and does not materially speed up your progress. In other words, don't bear down on the accelerator and accelerate with full throttle. (This is called driving with a "heavy foot", whence this article gets its title.)

(7) Use brakes as little as possible. This means that you should plan your stops wherever you can.

(8) If you have a conventional transmission, do not drive in low gears at high engine speed. It sounds sporty, that's all. Shift into high as soon as possible, and use overdrive where you can.

(9) If you have an automatic transmission, rapid acceleration results in excessive consumption more drastically than with conventional transmission. Allow the engine to pick up the load at part throttle (remember the efficiency curves of a torque converter in Chart 4).

What about the condition of the car?

A reasonable schedule of engine tune-up is as important as regular lubrication. Periods between tune-ups vary. 10,000 miles is a reasonable figure. Such a tune-up consists of a check of carburetor and ignition. Here are a few points to look for:

Intake air filter as well as crankcase breathers should be kept clean.

Choke and carburetor preheater need special attention.

Bad ignition timing, poor breaker points as well as over-aged and dirty plugs spoil performance.

Valve adjustment also affects timing, hence performance.

Remember that you judge performance mainly by *acceleration*. You automatically compensate for any loss of power by increasing the throttle. Hence, as you lose power, *you operate with progressively wider throttle*. This brings you not only into the high consumption range in steady driving, but also results in more frequent and extensive use of the accelerator pump.

Some secondary effects worth noting

Low tire pressure increases road resistance and costs gasoline.

Keep your starting system in good shape. This means that the battery should be kept up, starter commutator and switch kept clean. Otherwise fuel is wasted in lengthy starting.

Low viscosity oil does not improve economy (a change from SAE 30 to 10 results in an improvement of approximately 0.3 mpg).

Appendix

Fuel consumption reported in the preceding passages was measured by means of a flow meter, pictured on page 14, which shows the instrumentation of a Chevrolet for road testing. The meter consists of a burette of 1/10 gallon which can be filled while under way and then switched to the carburetor. Other instruments are 12 thermocouples installed in various places on the engine. Engine rpm and manifold pressure are also measured and are used to get the power available from the power chart (such as Chart 2). Altimeter and psychrometer are needed to correct power for atmospheric conditions. A sound level meter is used for checking knock in the engine while driving. The microphone is mounted under the hood.

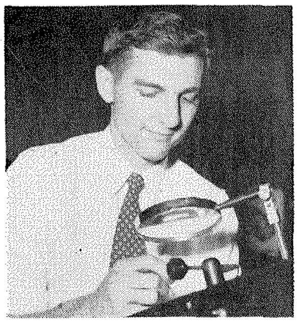
Acceleration is measured by successive timing.

1951 MOBILGAS ECONOMY RUN

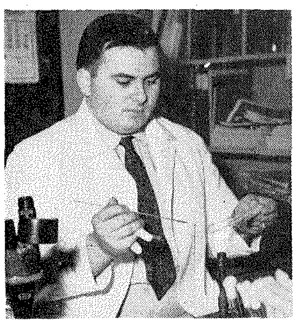
Class & Price	Place	Car Make	Type	Ton-Miles per gallon	Miles per gallon	Miles per hour
A $1400-1750	1	Ford	V-8	54.587	25.994	40.570
	2	Studebaker	Champion	54.381	28.621	40.474
	3	Ford	6	53.838	25.915	40.288
	4	Plymouth	Cranbrook	47.934	22.990	40.627
	5	Chevrolet	Styleline	45.956	22.041	40.475
B $1751-1950	1	Studebaker	Commander	58.173	28.001	40.465
	2	Nash	Statesman	52.637	26.122	40.338
C $1951-2175	1	Mercury		59.860	25.945	40.316
	2	Studebaker	Landcruiser	58.744	27.644	40.240
	3	Nash	Ambassador	58.268	25.926	40.487
	4	Kaiser		52.828	24.773	40.800
	5	DeSoto	DeLuxe	51.135	21.622	40.319
D $2176-2450	1	Packard	"200"	53.020	22.023	40.595
	2	Chrysler	Windsor	52.268	20.886	40.568
	3	DeSoto	Custom	47.760	19.921	40.601
	4	Hudson	Commodore 6	46.723	19.590	40.583
E $2451-2700	1	LINCOLN		66.484	25.448	40.487
	2	Hudson	Hornet 6	53.785	22.623	40.565
F $2701-3000	1	Cadillac	61	55.492	21.719	40.488
	2	Packard	"300"	52.196	20.941	41.414
G $3001-3300	1	Chrysler	Imperial V8	59.457	21.178	40.395
	2	Cadillac	62	56.412	21.531	40.329
	3	Lincoln	Cosmopolitan	47.601	17.123	40.899
H $3301-4000	1	Cadillac	60 Special	58.795	21.979	40.395
I $4001-6000	1	Chrysler	Crown Imperial	63.289	19.208	40.265
	2	Cadillac	75	58.513	19.869	40.474
Special 4 Cylinder	1	Henry J	4	49.153	30.109	41.701
	2	Willys	Jeepster	46.110	26.769	40.741
Special 6 Cylinder	1	Nash	Rambler	53.489	31.053	41.132
	2	Plymouth	Concord	48.954	24.143	40.697
	3	Henry J	6	48.340	28.860	40.680
	4	Willys	Jeepster	43.266	24.973	40.542
Average		All Cars		66.484	25.448	40.487

SUMMER FELLOWS

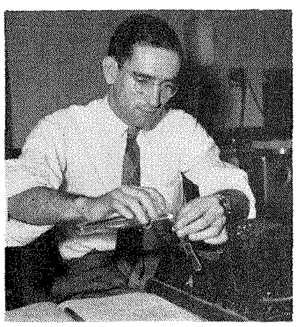
A NEW APPROACH TO SCHOLARSHIPS



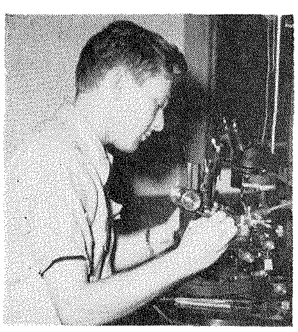
Kaiser



Gershowitz



Eggman



Ripley

SEVENTEEN GRADUATE STUDENTS working in biology and closely related fields at the Institute have just been announced as recipients of McCallum Foundation Summer Scholarships for 1951.

The McCallum Foundation was established by Arthur McCallum and his wife, Helen. Mr. McCallum is president of Flako Products Corp. of New Brunswick, N. J., which manufactures Flako Pie Crust Mix as well as mixes for biscuits, shortcake, popovers, cup cakes and corn muffins.

The Foundation has already set up a McCallum Fellowship at the Institute—an annual grant of $2500 made to a student working in a field basic to nutrition. The first McCallum Fellowship, for 1950-51, was granted to George Ellman for work with Neurospora mutants.

The new McCallum Summer Scholarships are unique—to the California Institute at least. One of the most urgent needs in the way of fellowship assistance at the Institute has been for a fund that could be used to help graduate students who want to continue their thesis research work during the summer months.

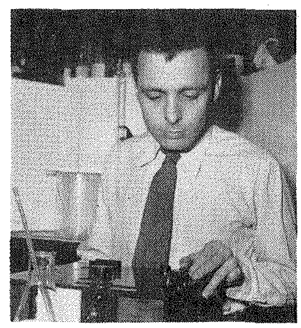
Most of these students have Tuition Scholarships and Graduate Assistantships, on which they do part-time assisting in teaching during the school year. For this service they are given $100 a month over and above their tuition. But during the three summer months they have no source of support unless some sort of make-shift employment is arranged, or grants-in-aid are made to them from funds not primarily intended for this purpose.

The McCallum Foundation Summer Scholarships are intended to help tide such students over the summer, and permit them to continue their thesis research work. The total fund of $5,100 provides $300 to each of the seventeen Fellows for this purpose.

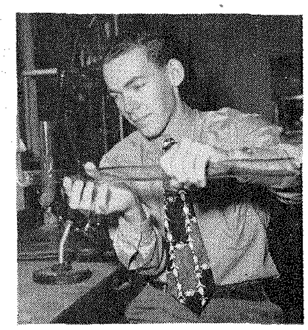
The seventeen recipients of summer scholarships:

ARMIN DALE KAISER, 23, Piqua, Ohio, for virus research.

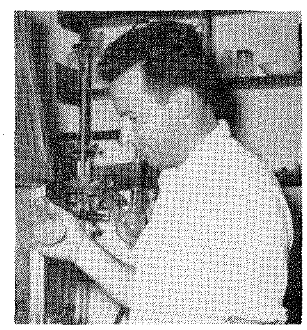
HENRY GERSHOWITZ, 26, New York City, for studies of the mode of action of a Neurospora gene which seems to have a triple function.



Fischer



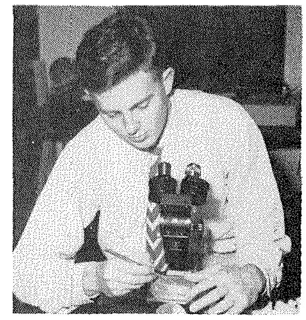
Crosby



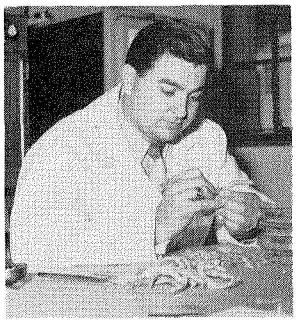
Good

Jansen

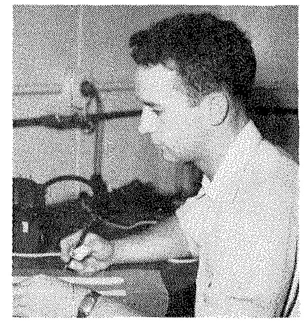
Seventeen graduate students win McCallum Scholarships



Holloway



Viglierchio

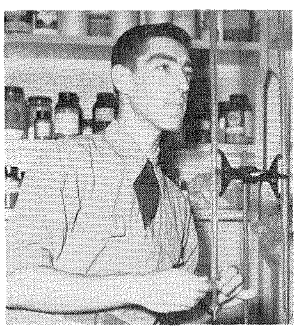


Dubes

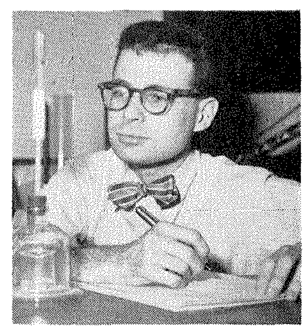
WILLIAM LUTHER EGGMAN, 27, Walton, Indiana, for work on the characterization of the major protein fraction of green leaves.

SHERMAN HARVEY RIPLEY, 24, Pietermaritsburg, South Africa, for work on neuromuscular physiology.

GLENN ALBERT FISCHER, 29, Pritchett, Colorado, for studies of the enzymatic differences between mutants and wild-type trains of Neurospora.



Ames



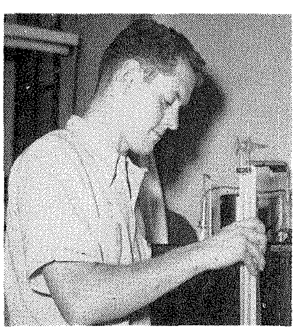
Ellman

DONALD GIBSON CROSBY, 22, Portland, Oregon, for research into the problem of how plants make their chemicals.

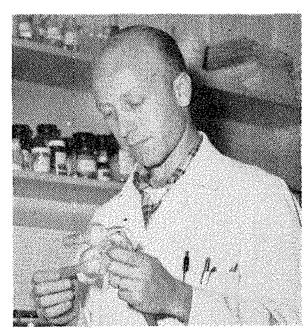
NORMAN EVERETT GOOD, 34, Ontario, Canada, for work on the metabolism of the amino acid lysine.

LEONARD LEROY JANSEN, 29, Lubbock, Texas, for studies of the growth factor requirements of fruit development.

DAVID RICHARD VIGLIERCHIO, 25, Madera, California, for a study of a wound hormone of the navel orange.



Kurtz



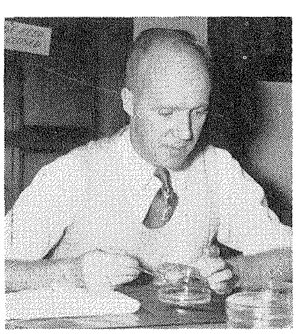
Rappaport

BRUCE NATHAN AMES, 22, New York City, for studies in the biochemistry of the amino acid histidine.

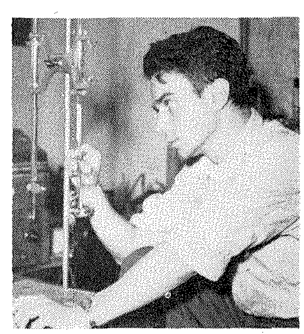
EDWIN BERNARD KURTZ, 34, Iowa City, Iowa, for studies of the waxes and fats of plants.

DOUGAL HAROLD MCRAE, 34, Vancouver, B. C., for a study of the effect of vitamin inhibition on the growth of plants.

BRUCE HOLLOWAY, 22, Adelaide, Australia, for studies on the genetics of fungi with the aid of the red bread mold called Neurospora.



McRae



Reissig

GEORGE RICHARD DUBES, 24, Sioux City, Iowa, for work on the elucidation of the growth requirements of certain unknown mutants in Neurospora.

GEORGE LEON ELLMAN, 27, Chicago, for work on the isolation and identification of phosphate-containing compounds in Neurospora.

IRVING RAPPAPORT, 26, Brooklyn, New York, for a study of the organ specificity of chickens and rats.

JOSE LUIS REISSIG, 24, Buenos Aires, Argentina, for a study of the metabolism of threonine.

OUR STRATEGIC MINERALS RESOURCES

by JAMES BOYD

Director, United States Bureau of Mines and Administrator of the Defense Minerals Administration

As graduates of the California Institute of Technology where we received our principal training in physical sciences and engineering, all of us are vitally concerned with sources of supply and the application of materials with which me must work or which we plan to use in future scientific developments. In normal times, the problems of raw material supply, especially in the field with which I am associated, are sufficiently complex to tax all of our ingenuity. Today, these problems are even more complicated. The advent of an emergency program, requiring substantial shifts in the nation's industrial economy, invariably is characterized initially by serious shortages of materials. These shortages can only be handled, at least in the early stages, by stringent controls.

For the first two years of World War II, we also encountered such conditions of scarcity. Special control mechanisms had to be established under the War Production Board. As time passed and more satisfactory methods of control were established, productive capacity began to satisfy expanding military programs. Raw materials ceased to be the main guiding influence and our productive capacity was limited more by manpower than by the materials themselves. In fact, by the end of the war we had sufficient stocks of mineral raw materials to carry us over the difficult reconversion period and still leave substantial quantities for transfer to the national stockpile. This experience shows that by use of foresight it should be possible to provide sufficient quantities of raw materials to supply our ever-changing and shifting economy.

The impact of a military program

It may seem strange to you that an industrial economy which has been operating at full capacity, as ours has been for the past two years, should have its raw material resources strained by conversion to a military program. Upon analysis, however, the reasons for current difficulties become fairly obvious.

The vast machinery of production, which is the foundation of our industrial economy, is always in delicate balance with the supply of raw materials. The economic laws of supply and demand tend to gear productive capacity from the raw materials stage to the final product in equally close balance. However, increased production of war materials markedly shifts that balance, and accelerated military programs require larger amounts of critical materials in proportion to the manpower required to process them. Furthermore, military equipment is used under much more exacting conditions and requires larger quantities of critical materials.

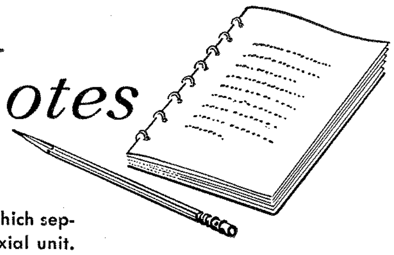
The most dramatic examples are steel, aluminum, copper, and especially the ferro-alloys. Increased aircraft production, ammunition manufacturing, and other military programs draw heavily upon aluminum, far in excess of normal peace-time requirements. The ammunition and communications programs of the military make equally tremendous demands upon our available copper supplies. Furthermore, the expansion and creation of additional productive facilities for all metals and chemicals draws heavily upon these and other scarce raw materials.

Steel is a case in point: the military program seriously disrupts the gigantic industry by making heavier demands on alloy steels and certain semi-fabricated shapes, such as plate. Special requirements for steels to resist high temperatures for increased jet engine programs and for high speed cutting tools make unbelievable demands upon production of such critical materials as cobalt, columbium, tungsten, and chrome. Normally, there would be a relatively small demand for these materials in the peacetime economy. Productive capacity under a peacetime competitive enterprise system without artificial stimulants is obviously not sufficient to meet this rapidly increasing emergency requirement.

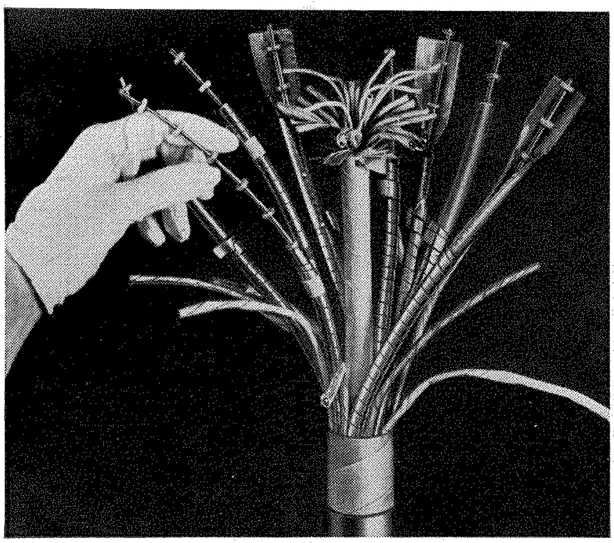
Since new mines cannot be created or developed at a speed comparable to that of a manufacturing plant, new domestic raw material supplies cannot be made available

An address given before the Fourteenth Annual Seminar of the California Institute of Technology Alumni Association, April 14, 1951

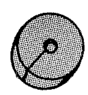
Newsworthy Notes for Engineers



Between the gloved fingers, you see the plastic discs which separate and insulate inner wire from outer tube of coaxial unit.



Plastic "life-savers" For Coaxial Cable

(ACTUAL SIZE) 

In every mile of new eight-unit Bell Telephone coaxial cable there are over half a million little plastic insulating discs. They look simple enough—like small plastic "life-savers"—but there's a lot of engineering behind them.

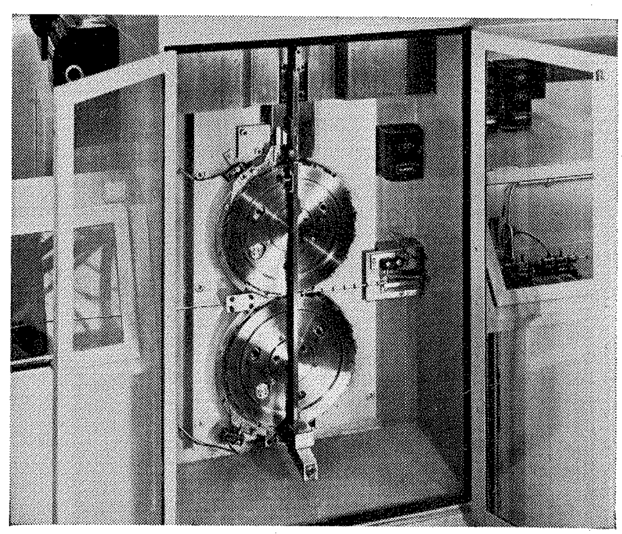
In early coaxials, the insulators were made of hard rubber. But scientists at Bell Telephone Laboratories found that polyethylene—because of its extremely low power factor and lower dielectric constant—reduced shunt losses to about one-twelfth of those with rubber discs.

Use of polyethylene plastic, however, required the development by Western Electric—manufacturing unit of the Bell System—of unusual handling techniques and special machinery.

Punching the discs, with a neat hole in the center, from sheets of the tough plastic is routine. To position them on the coaxial conductor accurately and speedily is not so simple. Equipment was designed and built which receives the discs from a hopper, forces each against a knife edge to slit it, and slips them on to the wire at regular intervals of one inch. At the same time another part of the machine forms copper tape into a tube around the wire and discs, gives a high voltage test, and wraps the tube with two spiral layers of steel tape to produce a completed coaxial unit.

Before the discs go into the machine, they are subjected to an "ozone atmosphere" and to the radiation from radium salts to remove static electricity which would cause them to stick together and refuse to enter the feeding tracks.

All of this — the development of new production methods and machines, the infinite care in manufacture — requires engineers of many kinds—electrical, mechanical, chemical, metallurgical, industrial. Working closely together, they help to convert scientific developments in communications into economically manufactured products for the Bell System.



Plastic insulators, fed into this mechanism, are slit — and pressed on to the coaxial conductor exactly one inch apart.

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

in less than two to five years. Nor is it possible to obtain a sudden expansion of domestic stocks of metals and other minerals from foreign sources, especially when foreign users are likewise in the midst of an expanding economy.

All that can be done is to curtail consumption by less essential users in order to divert materials to the military program. This can result in serious disruption of fabricating industries which depend upon these materials for their existence. Thus, the diversion of cobalt, for example, from normal channels to the military can compel radical engineering design changes in the radio and television industries.

Adaptability of engineering

Scientists and designing engineers exert a profound influence upon the application of raw materials. Consider again metal requirements for high temperature resistant parts of the jet engine or specialized atomic energy equipment. In most cases, the designing engineers and scientists predicated their plans upon materials available at the time, with little thought directed toward the possibility of meeting requirements of a vastly expanded program. The lack of such knowledge must eventually result in design changes.

Columbium is an outstanding example. If the original jet engine designs were left unchanged, the requirements for columbium would exceed in a single year all the world's known ore reserves of this metal. When designing engineers were apprised of this condition, they were able to reduce the quantities of columbium for jet engines to bring requirements into balance with available supply.

Unfortunately, many substitute materials, such as nickel, chromium, cobalt, etc., are also in this critical class. However, resources of these materials can be defined within limits and in many cases the problem of supply can be solved eventually by increased raw material production or through expanded metallurgical research into methods of obtaining greater recovery from known ores.

As soon as producers, or those responsible for production, are sufficiently informed to plan for future expansion, it is possible to anticipate that requirements will be met. Unfortunately, these most critical and scarce materials are subject to rising prices, and the problems of supply raise serious questions of economic stability and international relations.

To state the matter simply—and this will perhaps over-simplify it—we know that we can artificially stimulate increased production and supplies of some metals and minerals by price incentives of various sorts such as premiums or bonuses, higher ceiling prices, special tax relief or increased import traffic. Thus, domestic ores which are not now commercial because of excessive distances from market, or because of poor grade or lack of amenability to standard methods of benefication would be brought to market. However, such sources are not too dependable and would give added impetus to the inflationary spiral. Further, the use of tariffs as a measure of domestic protection—take the case of copper, for example—would be offensive to certain friendly foreign nations on whom we are now dependent for substantial quantities of metals and minerals.

In extreme cases, however, drastic action is called for. Tungsten is a case in point. Since the beginning of World War II, and earlier, we have geared our domestic manufacturing industry to the use of high speed cutting tools which are dependent upon tungsten alloys for their cutting edges. The sudden increased demands for tungsten for military uses—armor piercing shells, electronic equipment, armorplate, and a thousand other special uses—coupled with suddenly increased demands for this metal for machine tools has created a currently critical shortage of the metal. Limitations on the uses of this metal have been ordered by the Government in order to restrict its availability to the most essential uses.

Think for a moment what it would mean if the machine tool industry were to be deprived of tungsten, and the industry were required to go to other and inferior material for the manufacture of high speed cutting tools. I have been told that such a step would reduce the efficiency of industrial production in some lines by as much as 90 per cent. This would mean the necessity of doubling the working forces or time of manufacture, or reducing the output of some materials by half, thereby multiplying the costs of the manufactured items.

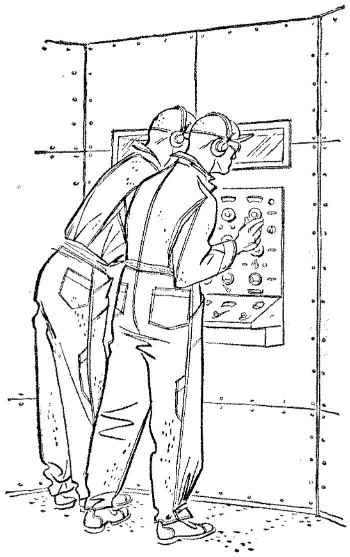
Thus, the lack of a metal like tungsten, the total annual value of which has amounted to less than $500,000, would have an inflationary effect tremendously in excess of its intrinsic value. In this extreme case, therefore, a price increase for the raw material or other incentive would in effect be deflationary, rather than inflationary. This illustration with tungsten indicates, I believe, the serious economic as well as engineering problems that shortages of critical and strategic minerals create.

Supply and demand

We are dependent upon economic laws of supply and demand. Serious increases in the demand for scarce materials are reflected by proportionate increases in price, and the necessity of tapping lower-grade sources can further force increases out of all proportion to normal peacetime values. Except for molybdenum, this country has never been self-sufficient in critical ferroalloy metals and minerals.

These problems cannot be solved in a short time, but this does not necessarily mean that we must lose our military potential by being forced to reduce production. The dilemma leaves us with a difficult alternative: In order to have an ample supply of scarce commodities,

How Honeywell Controls help discover what it's like 90 miles straight up



The U. S. Government uses V-2 rockets to explore the upper atmosphere. Sensitive instruments in these rockets record vital data about atomic fission, cosmic rays, weather and many other phenomena of practical value.

Obviously, every part of these instruments must be especially accurate, dependable and *rugged.* That's why a Honeywell Micro Switch was chosen to control the motor in the V-2's special camera. Directed by this one-ounce switch, the motor causes the film to shift eight times, then closes the unit for protection against the enormous impact of landing.

This small but necessary function is only one of the many jobs Honeywell Controls now perform in the all-important fields of atomic energy, guided missiles and aviation.

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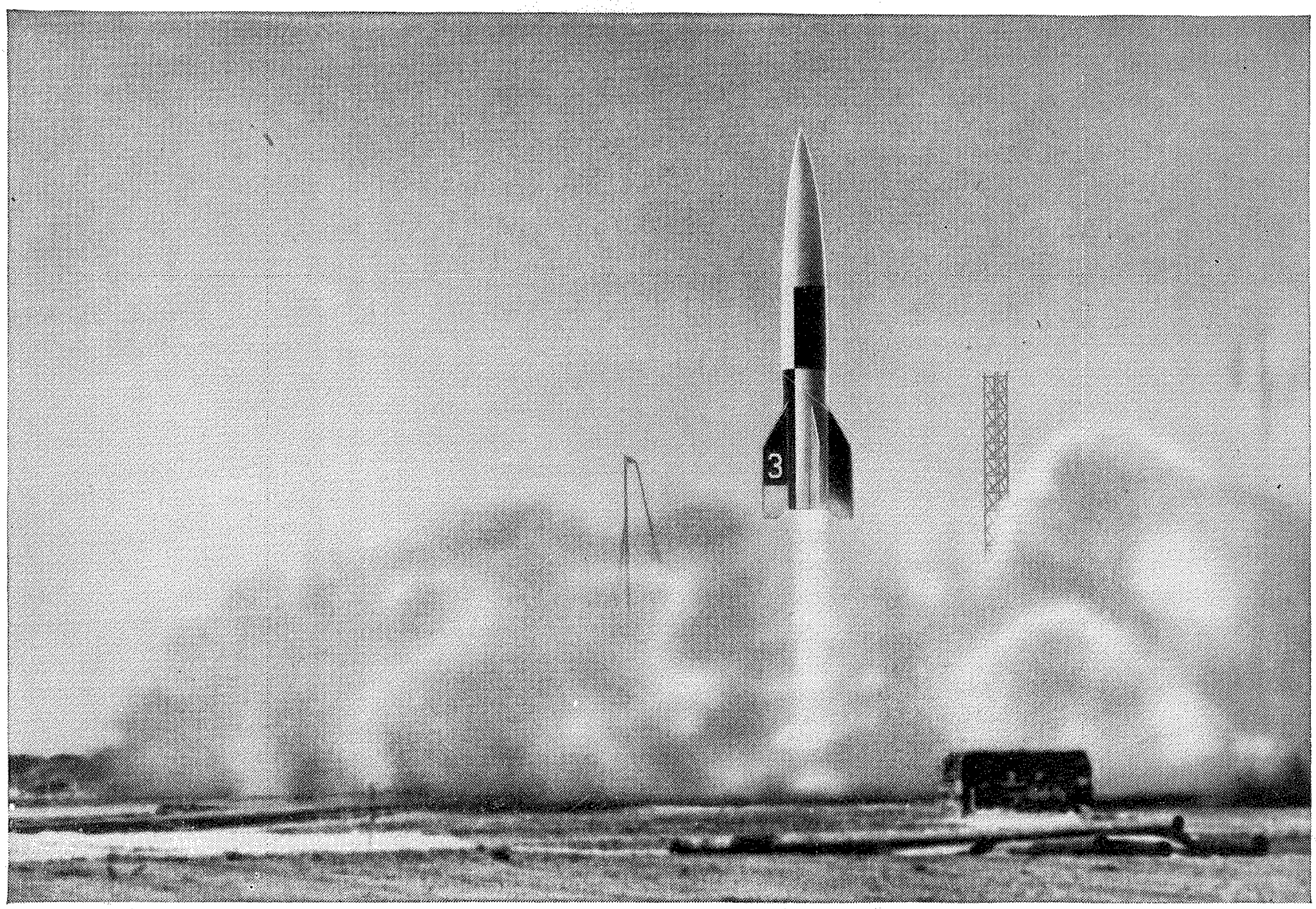

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For information about opportunities in our engineering and research departments write us, stating your qualifications. Depending on the location you prefer, send your letter to Personnel Dept., Minneapolis-Honeywell, Minneapolis 8, Minnesota; Personnel Dept., Minneapolis-Honeywell, Brown Instruments Division, Philadelphia 44, Pennsylvania; or Personnel Dept., Micro Switch, Freeport, Illinois.

we must curtail unnecessary or nonessential use and redraft our plans to permit use of more abundant materials. Thus, careful planning is called for on the part of scientists and designing engineers. All of our native American inguenity will be required to keep the vast industrial mechanism we now possess in good working order.

Because we have always thought that our natural resources of raw materials were limitless, as a nation we have never seriously considered the possibility of scarcity, nor have we ever before in peacetime been obliged to ration our resources to counteract continually increasing rates of consumption. As our technology advances, and as scientific discoveries provide a more livable world, our population is bound to increase. With this increase, the demands for raw materials can reach astronomical proportions. Consequently, we must devote ever greater attention to the discovery, production, development and use of all our basic raw materials.

Within the United States we have skimmed off the cream of our higher-grade mineral deposits—those orebodies that were easily found. The price of these raw materials must be high enough to absorb the costs of search and discovery as well as extraction and refining. Increased efforts must be made to improve the techniques of extractive metallurgy in proportion to efforts directed toward improved methods in physical metallurgy.

A technologic challenge

To me, one of the most significant advances is that exemplified by the new metal, titanium, which I reported on in *Engineering and Science* several years ago (May, 1948). Recognizing the inherent possibilities of this metal, the United States Bureau of Mines obtained funds for the production of experimental quantities and for physical research on titanium products. Aside from the funds we ourselves have obtained for this purpose, the Armed Forces have transferred additional money to the Bureau primarily for physical metallurgy and for research in the application of titanium metal.

Although the raw materials from which titanium is extracted are almost limitless on the North American continent, present methods for obtaining titanium from its ore are costly and power-consuming. Our efforts with respect to this metal have been largely concentrated upon its use and applications. We have virtually neglected research in improved methods for extracting the metal from its ores. Demands for titanium which have developed over the past two or three years are now far in excess of our existing production capacity.

In an effort to solve this problem, the Defense Minerals Administration, under the Defense Production Act, is assisting at least two large companies to expand production of titanium sponge by utilizing the present known extractive processes. However, those now engaged in the production of titanium are concerned about investments in these plants; more efficient processing methods can render these installations obsolete almost overnight.

What the current mobilization program has done in effect is to plunge us into avenues which have not yet been fully opened, explored and developed technologically. Given time and opportunity for concentrated effort, there is no doubt but that the engineers and scientists of industry and Government and those in our colleges could work out more economical and speedier extractive methods, develop the proper methods of processing the metal, learn the characteristics and properties of innumerable alloys and adapt them to the great variety of manufacturing methods and needs. Here is a whole new field of great promise which challenges the technologists of the nation. I have no doubt that we will successfully meet that challenge, but the times call for intensified effort and greater speed.

Stockpiling program

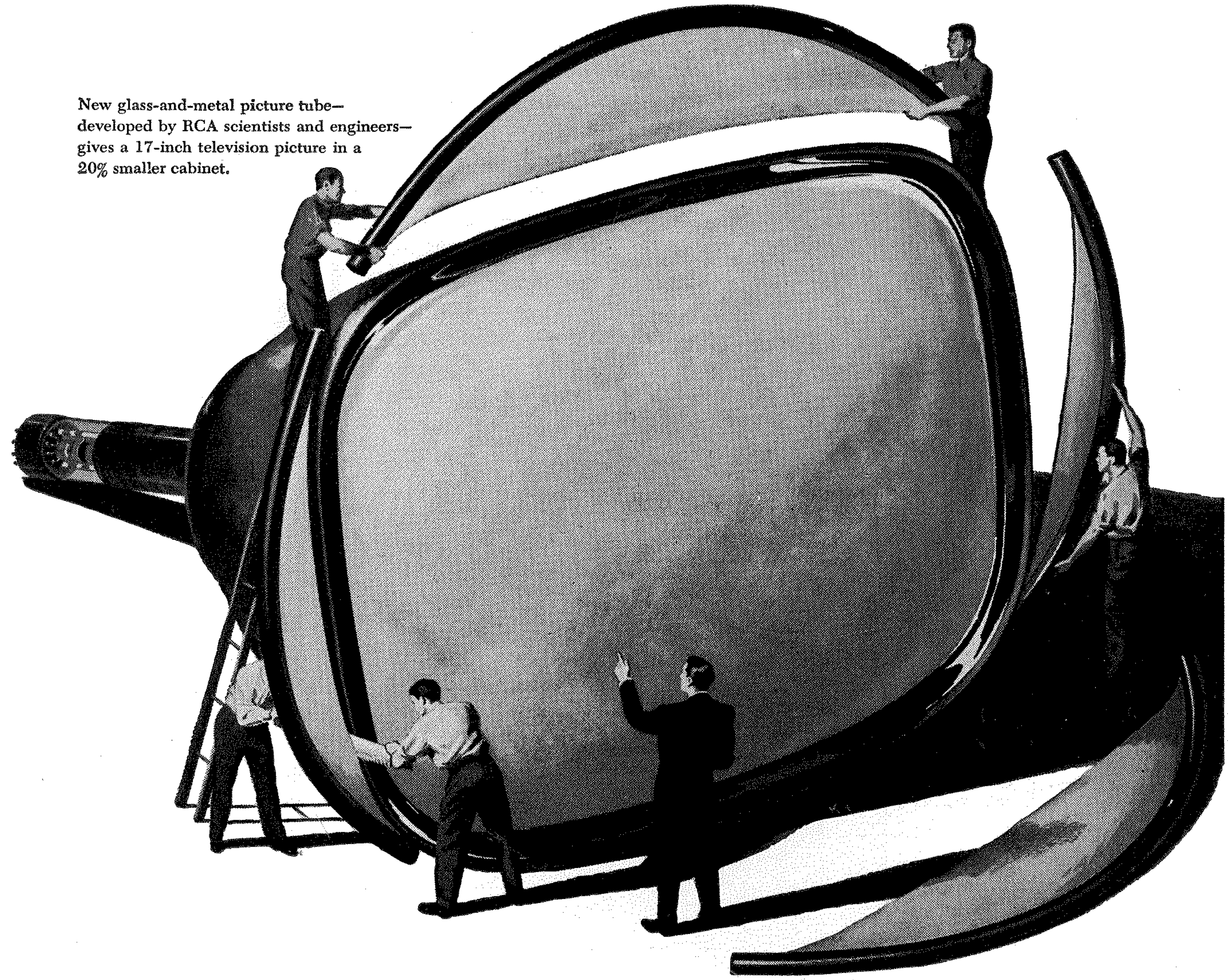
It is not possible to discuss strategic mineral resources without some reference to the stockpiling program.

For many years there had been a few voices crying in the wilderness in the attempt to establish a stockpiling doctrine. Material shortages during World War I were not sufficiently acute to launch the nation into a substantial stockpiling program. It was not until a few months before World War II that the necessity for stockpiling was fully recognized and money was set aside for the accumulation of raw material stocks in this country to protect us in the event of a cut in foreign sources.

The shortages that developed, however, in World War II did lend substantial impetus to the program. Toward the end of the war, Public Law 520 was passed by the 79th Congress and this action launched the nation on a real program of stockpiling. Unfortunately, the effectiveness of the program was soon to be diminished.

The military authorities who were in charge of the program, although subconsciously realizing the necessity of it, lowered their sights in the fear that money directed to stockpiling would be diverted from the design and production of military end products. It was not until the sinister impact of Communist imperialism made itself felt across the breadth of the United States that we as a nation became properly alive to the need for having in our hands sufficient quantities of strategic raw materials to carry us over danger periods. By that time, however, the need for military production was acute and the consequent disruption of the national economy, which I have mentioned before, became evident.

Under these conditions, the task of stockpiling became much more difficult. Fortunately, the stockpile accumulation has progressed to a point where we are in a much safer position than was the case in 1941, although by no means far enough along for us to relax the procurement pressure for a minute.



New glass-and-metal picture tube—developed by RCA scientists and engineers—gives a 17-inch television picture in a 20% smaller cabinet.

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In a situation like this, there is a tendency for one group to blame another for defects or deficiencies in such a program. There may be, however, some comfort in realizing that public pressure under our democratic system has been responsible for the degree of success of the program thus far. We are not all activated by logic or foresight, for it was the desire to cut down on Government spending, balance the budget, and economize generally that resulted in the decline in stockpile accumulation at the very time when we should have been pushing a policy of aggressive procurement.

Defense Production Act

The question is, what do we do now? Until the passage of the Defense Production Act last September, the only means for expanding production of critical raw materials above current industrial levels was through the use of stockpile procurement to encourage the opening and development of new raw material sources.

With insufficient funds available, the program did not get very far and stockpiling accumulations were derived largely from existing world surpluses, due largely to the low state of the industrial recovery in Western Europe and other industrial areas.

The operations of the European Recovery Program, with consequent increased industrial production, have made demands upon world supplies of raw materials approaching those of the pre-war period and far above the demands of the United States when it was contracting in the world markets for stockpile accumulations. There remains then only the solution to the problem of increasing existing capacity.

The Defense Production Act gives the President wide latitude in bringing into production new sources of critical raw material supply, and the President in turn has placed this responsibility upon the Secretary of the Interior and his agency, the Defense Minerals Administration. That agency in turn is requested to help create new industries. Naturally, everybody expects the agency to do the job overnight.

The evident solution to many of the problems involved in this program requires the use of economic tools that are entirely new in peacetime, or even during a period of partial mobilization in this country. In order to entice private capital (the Defense Production Act requires the work to be done through private enterprise and with private capital), incentives must be created to encourage individuals or corporations into a field which is notoriously speculative. Since this must be done during a time of high taxes and a shortage of manpower and materials, real incentives are required.

Because this policy necessitates committing the Government for substantial sums of money over long periods of time, programs must be developed with care and executed with finesse in order that the strength of the Government may be available to producers without subjecting them to the evils of bureaucratic control. I for one believe that the entrepreneur approach is necessary to the discovery and development of new mineral resources and this approach cannot be achieved under the shadow of exacting bureaucratic control.

The principal financial instrument for stimulating mining ventures is the assurance of a market for the ore over a sufficient period to permit amortization of investment. There must be reasonable assurance to the investor that some opportunity exists for the recovery of invested capital. To provide this assurance for the innumerable small operations in the mining industry as well as the large ones imposes a tremendous administrative burden on any Federal agency. The Defense Minerals Administration is handling the larger projects on an individual basis through direct negotiation, while developing general programs to assist the smaller units of the minerals industry without the necessity for detailed negotiations with Federal authorities.

It may be difficult for the average engineer to appreciate the enormousness of the task in establishing such a program and having it approved in our vast Government mechanism. First of all, we must have sufficient ingenuity to think up a plan that is nearly foolproof.

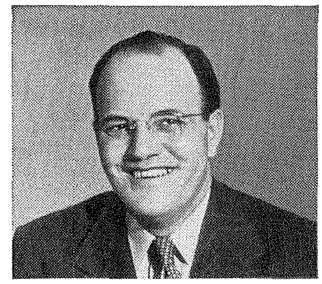
Last month we may have achieved something toward this objective in the tungsten program that was adopted, by establishing a ceiling price for the metal sufficiently high over a five-year period ($65) to permit production from high-cost domestic operations. At the same time a floor was set under that price by having the Government guarantee to purchase any tungsten concentrates which could not be sold on the market at $63 during the same period.

Since there will probably be no bonanza discoveries of tungsten in this country, and the demand is so greatly in excess of the present supply, this form of program for this particular material presents no serious economic hazard of an inflationary nature. However, with the bulk commodities, such as copper, lead, and zinc, iron ore, etc., the economic problems become much more difficult and the means used to stimulate tungsten production would obviously be undesirable with this group of commodities.

A national problem

I sincerely hope that I have made clear to my fellow alumni that those of us who are working in this field must be more alert than we have been in the past to the problems of supply. A handful of Government employees cannot solve the supply problem for metals and minerals. This can only be achieved through intelligent action by a well-informed public cognizant of the situation and ingenious enough to provide the solution through their own initiative. I am certain that there are very few in active research, either in the colleges, industry or in the consuming field, who cannot help.

The Most Important Job in the World



O. V. TALLY

by O. V. TALLY, *Manager, Midwest Region,*
General Machinery Division, ALLIS-CHALMERS MANUFACTURING COMPANY
(Graduate Training Course, 1927)

YOUR FIRST JOB is the most important job in the world. Picking that first job carefully can mean the difference between a running start in a really satisfying life work and merely working for a living. You must have been giving this problem a lot of thought as you look toward the end of your scholastic career. I had exactly the same problem while I was working for my E. E. at North Carolina State in 1925.

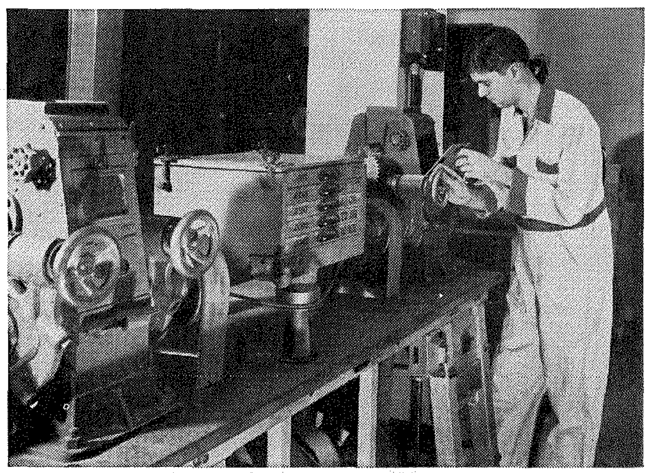
I happen to think that the man who applies his company's product in the field is the most important man in the American business system. Not only does he help create the demand that keeps our factories working, he is also the force behind many of the great improvements in products and processes which have been made. He must know and understand the customer's problems and the factory's facilities, then bring the two together to produce better goods at lower cost.

I knew I wanted this kind of work. Most of all, I wanted to be free to try several fields of work; to find out where my talents lay; to see where my individual effort would bring the greatest satisfaction.

Allis-Chalmers Serves All Industry

I chose the Allis-Chalmers Graduate Training Course because Allis-Chalmers has a hand in solving the problems of every basic industry . . . food, steel, mining, aluminum, electric utilities, public works, chemicals, and many others. Here I saw my chance to find out which I wanted to work in.

Taking the course in many different departments, I learned as much as I could about as many products and industries as I could. Then I began application engineering in the New York District Office. Since then, I have been in Washington, Philadelphia, St. Louis and Chicago. As it turned out, I didn't specialize in any industry, but worked on applications for all kinds of goods to many industries. And I found the work that has made me happy.

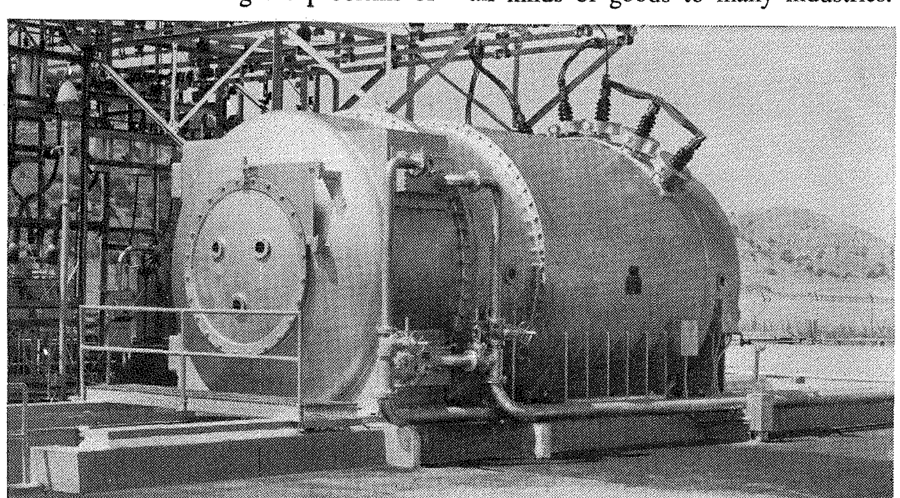


In Basic Industries laboratory scaled-down equipment is used to investigate processes and make pilot runs. Lab includes complete food, ore, wood, rock products pilot plants.

Find Your Spot

Of course, not everyone wants to be a field application engineer. The Allis-Chalmers Graduate Training Course offers you an opportunity to find out which branch of industry you will be happiest in and which job in that industry you can do best. You choose your own courses and may alter them whenever you like. You choose among electric power generation, distribution and utilization equipment; motors, pumps, blowers; basic industry equipment for processing cement and rock products, ores, wood, chemicals, food; and many other types of equipment. You can get actual practice in design, manufacturing, sales, research, administration, service and erection before choosing which one to follow. And many Allis-Chalmers customers have openings for training course graduates.

As I've said, I believe the most important job in the world to you is your job after graduation. Choose the job that gives you the greatest opportunity for advancement through your own effort. If you want to talk to someone about the opportunities at Allis-Chalmers, visit your nearest Allis-Chalmers Sales Office. Or write Allis-Chalmers, Milwaukee 1, Wisconsin, for details.



Large Allis-Chalmers synchronous condenser corrects power factor on giant Southern California Edison Company distribution system.

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THE MONTH AT CALTECH

Project Vista

THE INSTITUTE has been granted a short-term lease on the guest-house portion of McCornack General Hospital in Pasadena for a special national defense project.

The project is being undertaken at the joint request of the Army, Navy and Air Force under a contract with Army Ordnance. The buildings will house and provide office space for personnel engaged solely in studies and analytical work. Development of equipment is *not* involved and no laboratory work of any sort will be conducted—but the exact purpose of the project is classified and cannot be revealed.

Caltech faculty members and personnel borrowed temporarily from other institutions will comprise the group working on the project, which will be known as Project Vista. It is expected to be completed by next January, when the Caltech lease on its portion of the hospital, formerly the Vista del Arroyo Hotel, will be terminated.

Science Advisor

PRESIDENT L. A. DUBRIDGE, already a member of the Scientific Manpower Advisory Committee of the National Security Resources Board, was chosen last month to serve on two new national defense projects.

He has now been appointed to a special committee of 11 scientists to advise President Truman and Mobilization Director Charles E. Wilson in matters relating to scientific research and defense. The Science Advisory Committee, set up by President Truman within the Office of Defense Mobilization, will advise on progress in defense scientific research problems, and transmit the views of scientists on defense matters.

Also last month Dr. DuBridge accepted the invitation of General Dwight D. Eisenhower to serve as a member of the new National Manpower Council established at Columbia University. This 15-man council, financed by a $100,000 grant from the Ford Foundation, has been set up to identify and evaluate the major areas where significant manpower wastes now occur; to determine methods for improving present use of the nation's manpower resources.

Air Force R.O.T.C.

THE INSTITUTE has been selected as a site for one of 62 new Air Force R.O.T.C. Units, which will be launched with the freshman class entering college next fall.

"The Institute has always stood ready to serve national defense in time of need," said Dr. DuBridge. "At this time, therefore, it is glad to make its facilities available to the United States Air Force for use in providing technically trained officers.

"The need for officers with adequate scientific and engineering background is critical and the shortage is severe. We are confident that a large number of Caltech students will welcome this opportunity to prepare themselves to serve their country."

This will be Caltech's second R.O.T.C. unit. The first was established in 1916 and disbanded in 1929. The Institute had a Navy V-12 program during World War II.

The Air Force program will be staffed by three officers and three airmen. The Senior officer, who will be appointed Professor of Air Science and Tactics, and the other officers, who will have appropriate academic ranks, will teach material prescribed nationally.

The first two years of the program will consist of basic courses in air science and military drill, with more specialization in the last two years. The freshman-sophomore group will have two class hours and one drill period weekly, while junior-senior men will be in class four hours and have one drill period a week.

Upon completion of the four-year course, the graduates will be commissioned second lieutenants in the U.S. Air Force Reserve, and will be subject to call to active duty at any time.

Students will not live in barracks and will wear the blue air force uniforms—which will be provided them—only for air force classes and drill. After completing two years they will be deferred from induction into the army under the prospective selective service law as long as they maintain good standing in the air unit as well as Caltech.

Reserve officer candidates normally will be required to spend part of the summer between their junior and senior years training at an air force base.

Students enrolling in the R.O.T.C. program must meet the standard Caltech requirements for admission. Present students will not be eligible except in special cases, but any C.I.T. freshman, except those with major physical disabilities, may join the unit on a voluntary basis. Resignation from the program is possible at any time.

National Academy

DR. H. P. ROBERTSON, Professor of Mathematical Physics now on leave from the Institute, has been elected to the National Academy of Sciences. He is the twenty-fifth member of the present Institute staff to be elected to membership in the National Academy—one of the highest scientific honors in the country.

Dr. Robertson's work in mathematical physics has

CONTINUED ON PAGE 28

been largely devoted to the Einstein theory of relativity, and he has made important contributions to cosmology and the theory of the expanding universe. During World War II Dr. Robertson worked on problems of elasticity, hydrodynamics and shock wave propagation. In 1946 he received a Medal for Merit for his solutions of complex technical problems in the fields of bomb ballistics, penetrations and patterns and enemy secret weapons.

Dr. Robertson received his Ph.D. degree from Caltech in 1925 and studied in Gottingen and Munich as a National Research Fellow for two years. After he returned to this country he served on the faculties at Caltech and at Princeton, and has been Professor of Mathematical Physics at the Institute since 1947. He is currently in Washington, serving as Research Director of the Weapons Evaluation Group of the Department of Defense.

Two other Caltech alumni, William Shockley '32, and Wililam G. Young, Ph.D. '29, were elected to membership in the National Academy at the same time as Dr. Robertson. (See page 34).

Dudley Medal

PROFESSORS DONALD S. CLARK and Pol E. Duwez are to be awarded the Charles B. Dudley Medal of the American Society of Testing Materials at the society's June meeting in Atlantic City next month. This, the highest award of the society, is made for a paper of outstanding merit constituting an original contribution on research and engineering materials. The award goes to Professors Clark and Duwez for their paper, "The Influence of Strain Rate on Some Tensile Properties of Steel", which was presented before the society in June, 1950.

Professor Donald S. Clark, Associate Professor of Mechanical Enginering at the Institute, received his B.S., M.S., and Ph.D. degres at Caltech and has been on the faculty here since 1934.

Professor Pol E. Duwez is Associate Professor of Mechanical Engineering at the Institute, and Chief of the Materials Section of the Jet Propulsion Laboratory. He has been on the Institute staff since 1942.

Wilson Retires

DR. RALPH E. WILSON, Staff Member of the Mount Wilson and Palomar Observatories, retired last month after a long and distinguished scientific career.

He has spent most of his career in research on the motions of the stars and has achieved world-wide recognition as an authority on the subject. He took a leading part in preparing the monumental "Boss General Catalogue," which records the angular motions of more than 33,000 stars and he recently completed a compilation of all known velocities of the stars measured with the spectroscope.

He has been associated with the Mount Wilson Observatory since 1938, when he moved to Pasadena from Albany, N. Y., where he had served since 1918 in the Department of Meridian Astronomy of the Carnegie Institution. During World War II he was a consultant to the Office of Scientific Research and Development on the development of altimeters and oxygen apparatus. During World War I he was the American representative on the Committee of Allies at Santiago, Chile, and also performed technical work for the Bureau of Aircraft Production in Dayton, Ohio. Dr. Wilson received the gold medal of the Danish Academy of Sciences in 1926.

The CE Field Trip

by Alfred C. Ingersoll
Instructor in Civil Engineering

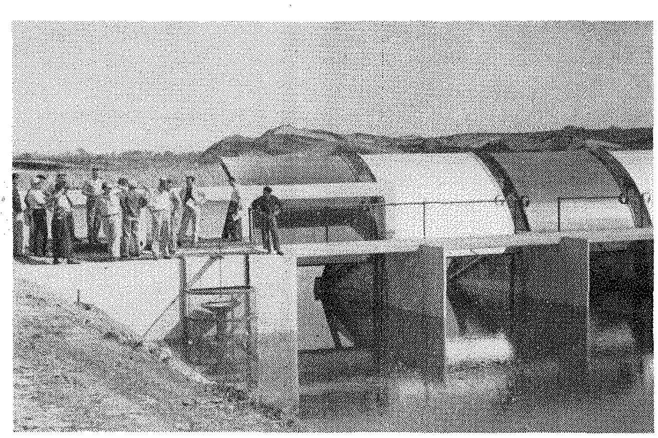
EVERY YEAR, close to the period between second and third terms, the graduate students in civil engineering set off on a four-day jaunt called "The Grand Tour of the Lower Colorado River Basin."

This trip, inaugurated some three decades ago by Dean Franklin Thomas, is one of the most extensive inspection tours offered at any school of civil engineering in the country.

Students spend a day and a half inspecting the workings of the Imperial Valley Irrigation District; another day inspecting Parker Dam and the Colorado River Aqueduct; and the last day visiting recently-completed Davis Dam and—as a grand finale—Hoover Dam and Power Plant.

This year's roster included twelve regular civilian C. E. grads, four of the special Army advanced students, one senior and two instructors, C. W. McCormick and the writer. Transportation was provided in the form of the Caltech carryall (a sort of beefed-up station wagon), and three private automobiles.

All vehicles left the campus Wednesday morning, March 28. Toward mid-afternoon the caravan entered the Coachella Valley, the richest date-producing area—Scripps and Oxy to the contrary notwithstanding—in the U.S., and the first tangible evidence of benefits from the Colorado River.



Civil engineers at one of the check gates in the All-American Canal.

An Invitation to Every American Who Has an Idea for a Better Petroleum Product

To encourage progress, The Sinclair Plan will open the doors of the company's great petroleum laboratories to the best ideas of inventors everywhere.

INVENTIVE Americans are often hamstrung today. Not because of any lack of ideas, but because of a need for large and expensive facilities to find out if and how their ideas work.

This was no obstacle in our earlier days. With nothing but his own hands and a few dollars, Henry Ford proved that he could build an automobile that ran. Eli Whitney built his cotton gin in a barnyard with homemade tools—and it worked.

In contrast, the first pair of nylon stockings took ten years of research time and $70,000,000.

Today, science and invention have become so complex that a man with an idea for a better product often needs the assistance of an army of specialists and millions worth of equipment to prove his idea has commercial value.

Within the petroleum field, The Sinclair Plan now offers to provide that assistance.

The Sinclair Plan

Under this Plan, Sinclair is opening up its great research laboratories at Harvey, Illinois, to independent inventors who have sufficiently good ideas for better petroleum products.

Sinclair Research Laboratories have nine modern buildings equipped to handle every phase of petroleum research. These laboratories were built with an eye to the future, and their potential capacity is larger than is required for current work. This capacity will be made available for developing the best ideas of outside inventors.

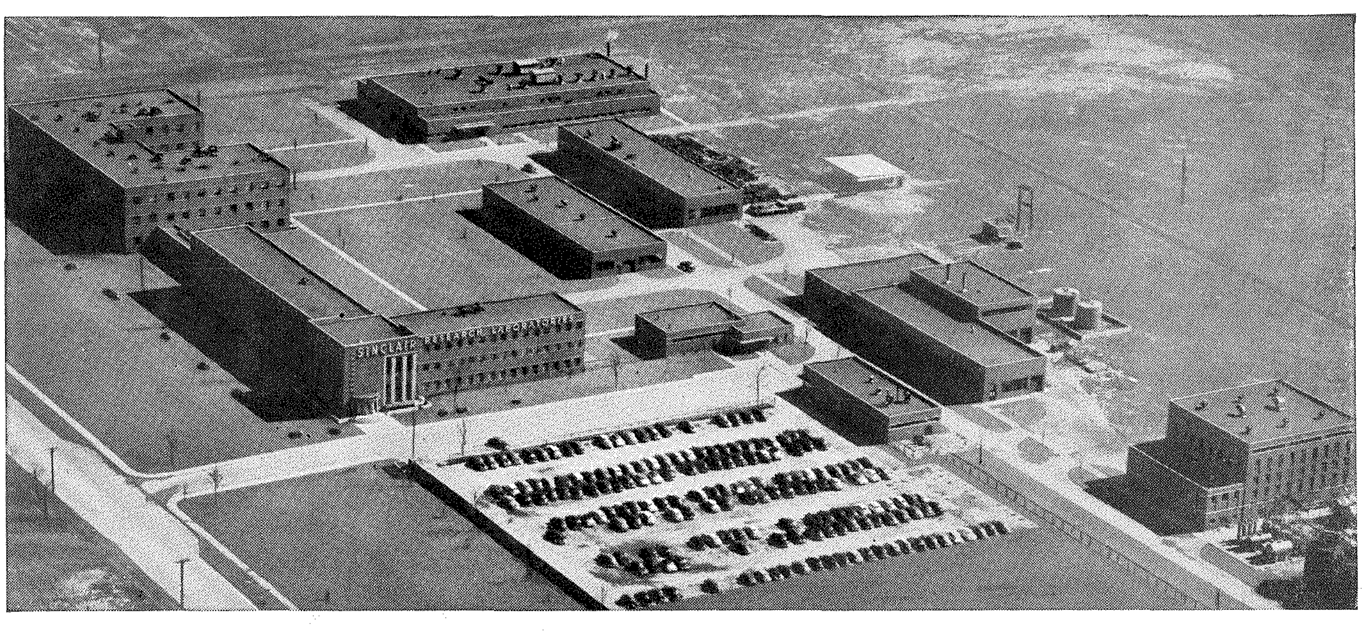
If you have an idea for a better petroleum product or for a new application of a petroleum product, you are invited to submit it to the Sinclair Research Laboratories, with the provision that each idea must first be protected, in your own interest, by a patent application, or a patent.

If the directors of the laboratories select your idea for development, they will make, in most cases, a very simple deal with you: In return for the laboratories' investment of time, facilities, money and personnel, Sinclair will receive the privilege of using the idea free from royalties. This in no way hinders the inventor from selling his idea to other companies or from making any kind of arrangements he wishes without further reference to Sinclair.

How to Participate

Instructions on how and where to submit ideas under The Sinclair Plan are contained in an Inventor's Booklet that is available on request. Write to: Executive Vice-President, Sinclair Research Laboratories, Inc., 630 Fifth Avenue, New York 20, N. Y. for your copy of this booklet. *Important:* Please do not send in any ideas until you have sent for and received the instructions.

SINCLAIR—A Great Name in Oil



SINCLAIR RESEARCH LABORATORIES at Harvey, Illinois, have contributed many of today's most important developments in the field of petroleum. Under The Sinclair Plan, the available capacity of these laboratories is being turned over to developing the promising ideas of inventors everywhere.

Thursday morning saw the start of the inspection tour proper. Expertly guided by one of the chief engineers of the Imperial Irrigation District, the student group inspected various features of the All-American Canal, which provides irrigation water for some 612,000 acres in the Imperial Valley, the largest irrigation district in the United States.

The next stop was at Hydroelectric Plant No. 4 where there is a drop of some 54 feet in the level of the canal. One of the two turbines was removed for repairs and the students were allowed to climb inside the scroll case, in which the water is normally conducted to the turbine, and even inside the upper end of the draft tube, through which the water leaves. Many of the group counted this the high point of the whole trip.

The final point of the irrigation tour was Imperial Dam and the large desilting basins at the head of the All-American Canal. Although the greater part of the silt burden of the Colorado River is removed in Lake Mead above Hoover Dam, there are about 8 million cubic yards of silt per year entering the canal works.

That afternoon the group headed across the desolate desert for Gene Camp, the community of operating and maintenance personnel at the east end of the Metropolitan Water District's Colorado River Aqueduct.

The food at Gene Camp deserves some kind of special mention. Such was the quantity and quality thereof that the single men were requesting application blanks for employment by the Metropolitan District at Gene Camp and the married men were arranging a special educational tour for their wives to go to Gene Camp and take cooking lessons from the chef!

Inspecting pumps in the Gene Pumping Plant of the Metropolitan Water District.

The menu for breakfast on Friday morning will serve as a fair example. Each table seating eight men was loaded with a huge pot of steaming coffee, four or five quarts of milk, two serving bowls of grapefruit and five or six different boxes of breakfast food. Presently a platter of bacon was brought on, with eight bundles of bacon, each comprising five or six of the ordinary strips. Next came a platter of fried eggs and finally, platter after platter of piping hot flapjacks were brought on and consumed with a half-gallon of Vermont maple syrup. Each man was then given an apple to eat as he waddled out the door!

Friday's operations consisted of short excursions from Gene Camp, scheduled carefully so as to be back at the mess hall in ample time for each meal. In the morning the group inspected the Gene Pumping Plant, where the aqueduct water receives its second boost of three hundred feet. It was particularly interesting to the students from Caltech since the giant pumps, each handling 200 cubic feet per second, were designed and tested in the Hydrodynamics Laboratory on the Tech campus.

The next item was an inspection of Parker Dam, which forms Lake Havasu, the intake reservoir of the Colorado River Aqueduct. This dam was built by the Bureau of Reclamation with funds provided by the Metropolitan Water District. The Bureau operates the dam and, in fact, the dam and reservoir remain the property of the government. As the power plant was closed for security reasons, the principal features of interest were the spillways and the great steel gates controlling the water flowing over them. Each of the five gates is 50 feet square and built like a railway bridge lying on its side. Each weighs some 225 tons and withstands water forces about ten times as great.

Friday afternoon's guided wanderings took the group to Gene Lake, the intake reservoir for Gene Pumping Plant. The eye-catcher here was a small constant-angle arch dam. The striking property of this type of dam is that the downstream face is vertical at the center of the dam, rather than sloping away as in the customary gravity or constant-radius arch section. In this case it is not an optical illusion. Standing on the crest at the center of the dam, one sees the downstream face apparently dropping straight down for 150 feet or so, and it actually *does* just that!

Finally, on Saturday afternoon, a trip through Hoover Dam provided a fitting climax to the entire trip, after the multitude of evidence of the purposes and uses of the dam which had been seen in the preceding days. Following an exhaustive tour through the entire plant, the inspection tour drew officially to a close. As a forceful element in their civil engineering education, the Grand Tour had enabled them to see the products of their chosen profession, integrated in man's complex 20th century society.

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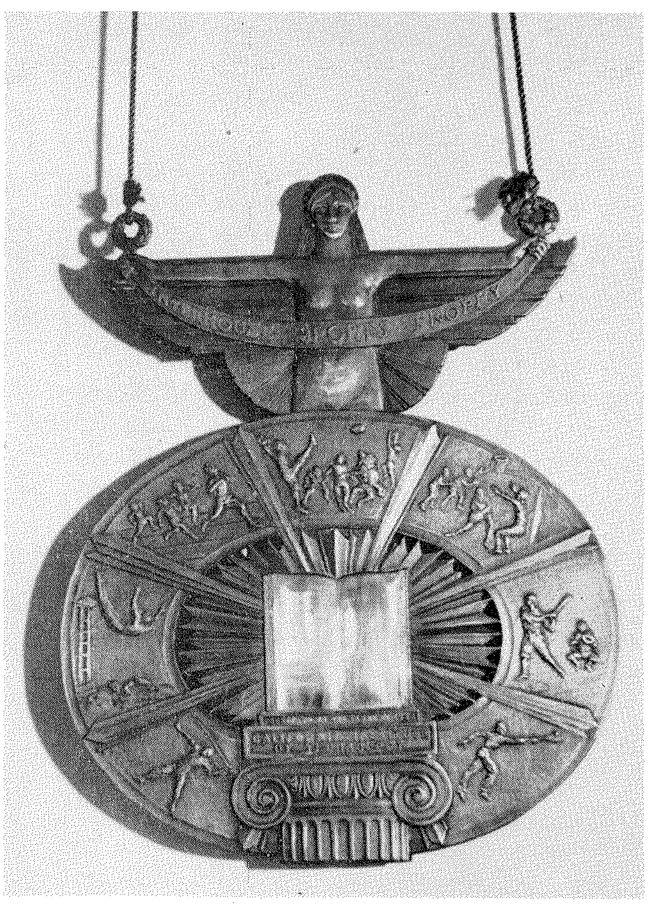
Some Notes on Student Life

EACH OF THE STUDENT HOUSES can boast of its own distinguishing customs and traditions, but no other has so consistently maintained a tradition to compare with the firm hold Fleming House has had upon the two important interhouse athletic trophies: the Interhouse Trophy, and the Varsity Rating Trophy.

The Interhouse Trophy is awarded at the end of each school year to the house that has totaled the greatest number of points during that year in intramural athletic competition, consisting of nine sports: baseball, cross country, basketball, softball, track, tennis, swimming, touch football, and volleyball. The points are awarded on the basis of the final standing of each house's teams in all of the nine sports. For example, track, which is considered a major sport, earns the winning house 25 trophy points, while the other houses receive 20, 15, 10, and 5 points, respectively, depending upon their performance in the interhouse track meet. Volleyball, on the other hand, is considered a minor sport, and earns 15, 12, 9, 6, and 3 points, respectively.



The Interhouse Trophy: at long last—after seventeen years—it leaves Fleming House for Throop Club.

Always before, Fleming has succeeded in amassing the greatest number of points, either by outscoring its nearest competitor by a margin of almost 25%, as last year, or by the hairbreadth of a few points, as three years ago. But this spring it is mathematically impossible for Fleming to add its name beneath the unbroken column of seventeen monotonously uniform "FLEMING'S" opposite the numerals ranging from "1933-1934" down to "1949-1950" on the Interhouse Trophy.

The prospect of retaining the Varsity Rating Trophy, which has been won by Fleming every year since 1940, when it was donated by the Alumni Association, offers little consolation, because the Fleming House tradition has always included winning both trophies. This latter trophy is awarded to the house which during the school year has furnished the greatest share of participants in Tech's intercollegiate teams. Points are awarded on the basis of the importance of each sport, and the status of the athletes (freshmen get reduced credit).

Throop Club, the off-campus organization with a status equal to that of a student house in athletic and many other matters, is the winner of the Interhouse Trophy this year. The disruption of the Fleming tradition is happily regarded by all concerned, except Fleming, of course. To the other houses, Fleming's loss of the Interhouse Trophy is the prelude to a new era in interhouse relations. The significance of the change will not be fully realized, however, until next fall when the houses turn their individual propaganda campaigns upon the freshmen during the rushing period. Fleming's reputation has rested upon its spirit as exemplified by its achievements in athletics. But all may well be for the best, for while fighting to regain possession of both trophies, Fleming will undoubtedly increase its prestige by emphasizing other achievements indicative of its spirit.

The Competitive Spirit

The history of the trophies is misleading if it suggests that competitive spirit in interhouse athletics has been dampened by Fleming's consistent record of winning. Actually, the race for the Interhouse Trophy is one of the focal points for interhouse spirit. For example, the noontime serenade of the Dabney House "Orchestra" in Fleming Court on the day of an important athletic contest between the houses serves to intensify the rivalry which exists between them.

Recently dinner guests in one of the houses were faced with the embarrassing treat of chocolate sundae-desserts while their drooling hosts watched with the envy peculiar to members of a house who had lost desserts they had bet on a swimming meet. Betting desserts on athletic contests is a custom which cannot fail to draw the interest of even the most apathetic residents of the houses to the outcome of their games.

Despite a lack of such seemingly important facilities as a gymnasium (not to mention a swimming pool), the opportunities available to undergraduates are abundant. Beside the nine interhouse sports and eleven varsity and freshmen intercollegiate sports, there are two tennis tournaments, an interclass track meet, and various interhouse contests for possession of the Discobolus, a challenge trophy.

Annual Athletic Report

The entire athletic program furnishes an unending supply of names, numbers, and statistical work for the Athletic Office and the elected athletic managers of the houses. The summary of all these efforts is released by the Athletic Office in the form of an annual report on the athletic program. The ten-page report covering the academic year 1949-50 could well draw the envy of other schools where our scores in intercollegiate games and meets might not. Following are some excerpts for 1949-50, based on an undergraduate enrollment of 681:

1. Number of men entering into competion 57.71%
2. Number of men not competing..................42.29%
3. Number of men entering into both Intramural & Intercollegiate competition........26.87%
4. Number of men having Intramural, but no Intercollegiate competition..................18.74%
5. Number of men having Intercollegiate, but no Intramural competion....................12.04%
6. Total number of men having Intramural competition 45.67%
7. Total number of men having Intercollegiate competition 38.91%
8. Men excused from Physical Education....33.89%

Figures for the freshmen were even more heartening:

1. Number of men entering into competition 68.90%
2. Total number of men having Intramural competition 50.61%
3. Total number of men having Intercollegiate competition 61.59%
4. Men excused from Physical Education.... 5.49%

From the undergraduate's point of view, this well-rounded athletic program more than compensates for our lack of marked achievement in some intercollegiate sports.

—*Al Haber '53*

ALUMNI NEWS

National Academy Members

THREE CALTECH ALUMNI were among the 29 American scientists elected to membership in the National Academy of Sciences at its annual meeting last month—William Shockley, '32, William G. Young, Ph.D. '29, and H. P. Robertson, Ph.D., '25. (See page 26).

William Shockley has been a member of the technical staff at the Bell Telephone Laboratories since 1936, where he has been a research physicist since 1945. His work has been in the field of physical research, specializing in thermionic emission, application of quantum mechanics to the theory of solids and the applied physics of vacuum tubes.

During World War II he developed training facilities and methods for the improvement of radar bombardment and conducted specialized operational research and analysis of military problems. He received the Medal for Merit in 1946.

Since the war he has led a group doing research on the fundamental physics of solids. Out of this work has come the invention of the transistor, which promises to rival the vacuum tube in its many and varied uses in electrical circuits.

William Gould Young held a National Research Fellowship at Stanford University in 1929-30, then joined the faculty at UCLA, where he has been Dean of the Division of Physical Science since 1946. In the field of research he is best known for his work on allylic rearrangements. He has also carried out research on polyenes, stereoisomerism, plant pigments, carbohydrates, organometallic compounds and oxidation.

McMillan's Award

EDWIN M. MCMILLAN, B.S. '28, M.S. '29, University of California Professor of Physics has been selected to receive the 1950 Research Corp. Scientific Award for his researches in nuclear physics.

Dr. McMillan is a co-discoverer of neptunium, first of the transuranium elements, and of plutonium, which is so important in the atomic bomb and in the potential development of atomic energy.

In 1945 he developed independently the "theory of phase stability," which has led to the development of multi-billion-volt atom smashers like the synchrotron, synchrocyclotron and bevatron.

Alumnus of the Year

WE NOTE WITH PRIDE that Kenneth S. Pitzer, research director of the U. S. Atomic Energy Commission, was honored by the alumni of the University of California

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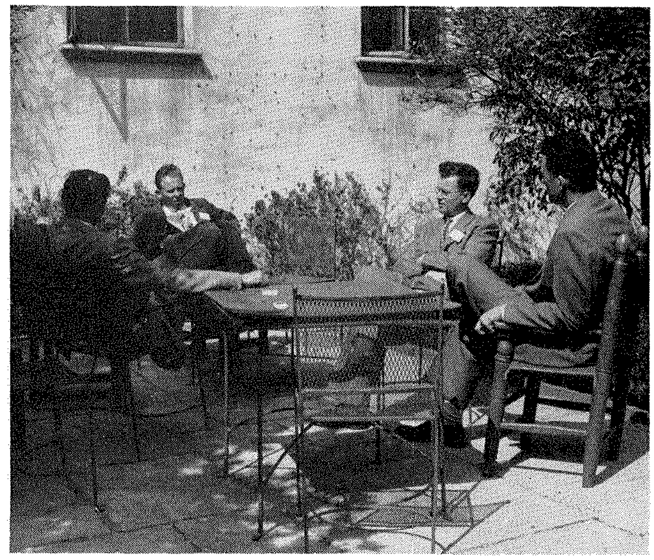


SEMINAR DAY

THE FOURTEENTH ANNUAL Alumni Seminar, held at the Institute on Saturday, April 14th, was certainly the biggest, and maybe even the best, ever. There were 560 people on campus during the day (60% of them being wives and guests, incidentally) and 300 attended the evening banquet.

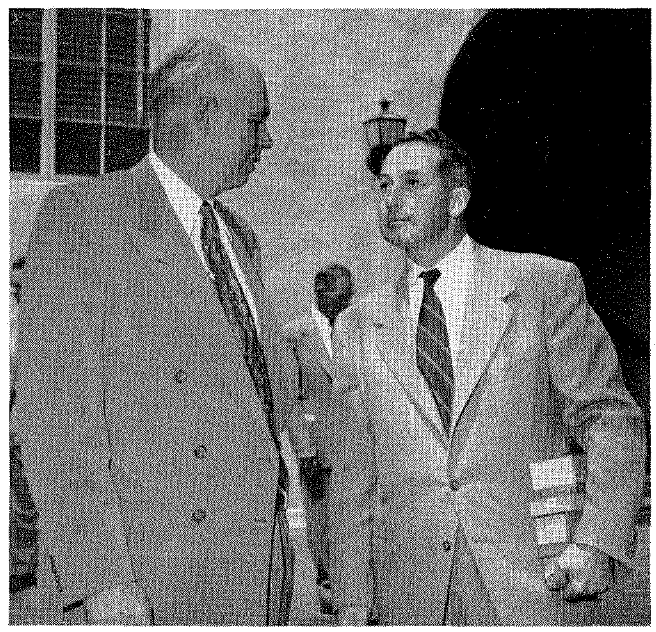
Random shots on this page show (above): R. P. Sharp, v.p. of the Alumni Association, Prof. R. L. Daugherty, and one of the main speakers of the day, James Boyd '27.

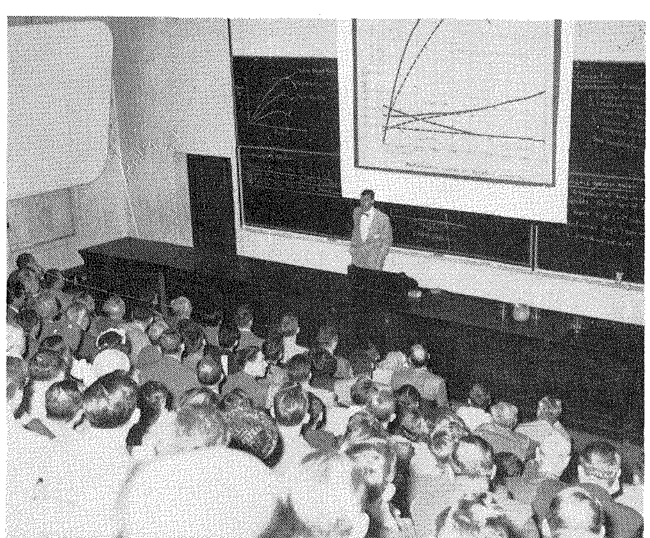
Top, right: A group of alums settled in for a bull-session in one of the student house courts.

Right: Howard B. Lewis, former president of the Alumni Association, and R. F. Bacher, who addressed the alumni on High Energy Physics.

Right, below: Nick D'Arcy, Ira Bechtold, Alumni President G. K. Whitworth, and E & S Publisher Dick Armstrong.

Below: Peter Kyropoulos draws a full house, and then some, for his talk on automobile design trends.





with "The Alumnus of the Year" award at Cal's 83rd annual charter day banquet recently.

Ken received his Ph.D. from Cal in 1937 but we think it might be pointed out that Tech deserves a little credit too. Ken Pitzer got his B.S. here in 1935.

Annual Meeting

THE ANNUAL MEETING of the Alumni Association will be held at the Los Angeles Athletic Club on June 6. Dinner at 6:30. Speaker of the evening will be Dr. Gordon P. Larson, Director of the Los Angeles County Air Pollution Control District.

Eight classes will hold their reunions this year—1946, 1941, 1936, 1931, 1926, 1921, 1916 and 1911.

Family Picnic

THE ALUMNI ASSOCIATION'S Family Picnic is coming up on Sunday May 20. It's being held at Munz Lakes Resort in the Angeles National Forest near Palmdale—and by this time everyone should have received a map in the mail, showing how to get there. The tariff is only $1.75 per family, which not only includes all the recreational facilities of the resort, but beer and soda pop too.

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The San Francisco Chapter meets for lunch at the Fraternity Club, 345 Bush Street, every Thursday.

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PERSONALS

1916

Max H. Carson writes from Honolulu, Hawaii, that he is still District Engineer, Surface Water Branch, Water Resources Division, U. S. Geological Survey. Max is also Chief Hydrographer for the Territory of Hawaii.

1918

H. Darwin Kirschuman, M.S. '19, Ph.D. '29, says he hasn't been around for any professional activity for quite a while. He's just returned to Honolulu, Hawaii, after a 12-month trip around the world.

1922

Harold S. Ogden writes from Erie, Pa., that he's now Section Engineer in the Locomotive and Car Equipment Division of the General Electric Co. Hal recently completed running the Erie Engineering Societies Council Vocational Guidance Program, aimed at getting high school math students started on an engineering education.

1926

Joachim F. Voelker has moved to Nazareth, Pa., where he is Combustion Engineer for the Penn-Dixie Cement Corp.

1930

Loren P. Scoville, M.S., was recently promoted to the position of vice president of the Jefferson Chemical Co., Inc., in New York City.

1931

Walter L. Dickey is supervising structural engineer for the power division of the Bechtel Corporation. In this capacity he was recently associated with the construction of the large Contra Costa Steam Plant at Antioch by the Bechtel Corporation for the Pacific Gas and Electric Co. Walter's home is in Palo Alto.

Cdr. Perry M. Boothe writes that he's been transferred to the Schenectady Operations Office of the A.E.C. at the Knolls Laboratory operated by the General Electric Co., where he's a Civil Engineer officer and Senior Bureau of Ships representative. The newest addition to the family is Thomas Mattison, 20 months old.

1932

Eric J. Miles, M.S., writes from Mount Pleasant, Pa., that he's retired from the investment business as of April 16 (his birthday) and plans to devote full time to developing his 177-acre farm and finishing his new country home. At the time of writing he was busy planting 5,000 evergreen trees and 4,000 fence roses.

Fred Hamlin, who had been with the Bridge Dept. of the California Division of Highways for the past 15 years, has entered upon a new and unique business enterprise. He's renting portable bridges—with headquarters at San Luis Obispo.

1936

David Harker, Ph.D., is now Director of Protein Structure Project at the Polytechnic Institute of Brooklyn, New York.

Peter Serrell, M.S. '39, is Consulting Engineer with his own company, the Sandberg-Serrell Corporation, in Pasadena.

1937

Martin H. Webster writes from Los Angeles that his first male heir, Lawrence Frederick, arrived last month—weighing six pounds, 12 ounces, and showing no indication of a desire to attend law school, even though both his parents are attorneys.

1939

Tyler R. Matthew writes from Cherry Point, N. C., that he's in his third year there as Assistant Navy Supply and Fiscal Officer. He's just been elected president of Toastmasters Club No. 296, which is affiliated with Toastmasters, International (headquarters in Santa Ana, Calif.). Ty says he'll be at home in Hollywood this summer, and hopes some of the old gang will give him a ring there.

Miller W. Quarles, Jr., M.S. '41, of Houston, Texas, received the annual award of the Society of Exploration Geophysicists for the best paper on geophysics in 1950. The presentation was made at the national convention of the society, meeting in joint session with the American Association of Petroleum Geologists and the Society of Economic Paleontologists and Mineralogists last month.

1940

Victor Wouk, M.S., Ph.D. '42, writes from New York City that he's been re-elected Secretary-Treasurer of the Professional Group on Quality Control of the I.R.E., and that the company of which he's president and chief engineer, the Beta Electric Corp., has recently secured the Rocke International Corp. as foreign field engineers—thus enabling the Beta Co. to provide field engineering services throughout the world.

Ellery C. Stowell, Jr. writes that he left his position as research associate at the University of Washington (Dept. of Pathology) to become an instructor in the Dept. of Biochemistry at U.S.C. in Los Angeles.

Robert L. Wells, M.S., writes from

PERSONALS . . . CONTINUED

Chester, Pa., that the activities in the Aviation Gas Turbine Division at Westinghouse are continuing at a rapid pace, in line with the needs of the Air Force and Navy—the jet engine development work being the focal point of the effort. Bob was recently appointed Manager of Engine Design Engineering, and this assignment includes the project sections on all engines and related stress metallurgical sections.

1941

Eldred Hough, Ph.D., '43, and his wife, Jane, announced the arrival of a daughter, Christine Elizabeth, last fall. Eldred is working on surface physics at the research laboratory of the Stanolind Oil & Gas Co. in Tulsa, and is teaching fluid flow mechanics on a part-time basis at the University of Tulsa.

Stan Stohler writes from Los Angeles, his letterhead sporting a horse's head and the legend *Thoroughbred Business Service:*

"It seems likely that other Tech grads derive the same morbid pleasure that I do from reading about the travel, business and reproductive experiences of other grads. In the middle of sending out announcements about our new office location, it seemed as good a time as any to apply my seek-em and soak-em system to the typewriter and add in a little history on myself.

"After the five war years at North American Aviation we'll skip quickly over the short stays at Menasco in Burbank and the AAF at Wright Field. The urge to be independent led me to the life insurance business in 1947. Result satisfactory but not spectacular.

"Ran across the bookkeeping service field by accident, and found that the only people in it were either accountants or promoters, both of which are notoriously bad organizers of internal efficiency. Luck produced the opportunity and the capital at the same time. So, I've been in the bookkeeping field for two years and have never posted a single item and never expect to. I have a C.P.A. for a partner, and three girls in the office to do all the work. I design the forms, sell a few accounts, service the active ones, and generally mess around. It is not difficult to describe the pure bliss of *not* setting the alarm clock, getting up when I want, and sitting down with a cigar and the morning paper until I get good and ready to go to work. This is particularly hard to describe at this time because I haven't had a chance to try it yet. However, I have a rather touching faith that such will eventually be my fate.

"Actually, we are over the first hump, (making enough to eat on from week to week) and own nearly all our equipment. We've just moved our office to larger quarters (3140 W. Manchester, Inglewood 4) and added a man to assist on sales and service.

"One of the things we stumbled into was the bookkeeping for trainers at the Race Tracks, hence the horsey letterhead. This Thoroughbred stuff has a few interesting angles that help break the monotony, such as flying up to Bay Meadows, Tanforan, and Golden Gate Fields, whenever the horses are up there.

"Personal stuff—still married to the girl I met while at North American Aviation. Three sons, aged 6, 3, and 1. Now living at Redondo Beach, Calif.

"By way of parting comment—I would still take those four years at Tech even if I knew this was going to be my racket. A man with the 'scientific mode of approach' as stated by Dr. Millikan (bless his heart) has got a terrific edge over anyone else, especially in a field which does not have very many such men in it. Engineering can be applied to more things than are listed in the text books."

Joe Lewis, former president of the Alumni Association (1949-50), has taken on a new job as General Manager of the Arnold O. Beckman Company in South Pasadena. Joe's previous job was with the U. S. Steel Products Company—where he was assistant to the Vice President and

General Manager of the West Coast Division.

1944

Leon Green, Jr. M.S. '47, was married to Eleanor Broome Samuels in Pasadena last month.

Don Greenwood and Esther Harju were married in Ann Arbor, Michigan, in March. Don expects to receive his Ph.D. in Electrical Engineering at Tech this June.

Frederick T. Sadler (formerly Kirk), has been reactivated into the Navy. At present he's at Chincoteague, Va.

1946

Elmore Brolin, after two years in the Engineering Department of the Standard Oil Co. of California left to enter the Graduate School of Business at Stanford. He graduated from there with an MBA last June, and returned to his home state of Washington (Tacoma) where he went to work as a mechanical engineer at Fort Lewis. Last February, however, Elmore accepted an offer to return to work for Standard Oil in San Francisco as an Organizational Planning Engineer.

Charles W. Dick writes that he's still a bachelor and working in the Pittsfield Works of General Electric Company in Mass. doing commercial engineering with the Lightning Arrester Sales Division. Chuck has, however, been recalled from inactive reserve by the Navy and doesn't know yet to what duty he'll be assigned.

1947

Charles B. Shaw, Jr., has a new son, David Elliot, born March 29th. The Shaws are living in Chicago.

David A. Cooke writes from Sharon, Pa., to tell us that his second child, Larry, arrived on January 10. David is still working for Westinghouse in the Ordnance Engineering Dept. in Sharon.

Carter Sinclair writes from Schenectady, N. Y., that he's still with General Electric, handling all frequency-changer resistance-welder controls.

1948

Edward A. Bohjanen, employed as Chemical Engineer at S. C. Johnson & Sons, Inc., in Wisconsin, worked out the processing for a new product called Pride, for Johnson's Wax. Ed who is married and has a daughter, 2, recently purchased a house in Racine, Wis.

Harry Lass, Ph.D., recently turned out a new book—*Vector and Tensor Analysis*, published by McGraw-Hill Book Co. The book seeks to acquaint the student with the methods and tools of vector and tensor analysis as applied to geometry, mechanics, electricity, hydrodynamics, and the theory of relativity, and to prepare him for more advanced work in theoretical physics.

Bill Shippee, Lt., was called back into the Army to serve with the 337th Chemical Department when it was reactivated last fall. He has since been transferred to the 330th Chemical Maintenance Co. at Camp Rucker, Albama, where he and his wife, Cathy, became parents of their first child, Mary Ruth.

Robert J. Heppe is currently with the Arma engineering division in Brooklyn, N. Y. Any graduates from Tech who may be interested in joining Arma are encouraged to write him.

Frank F. Sheck writes from New York that he'll be getting his law degree from Columbia early next month. He'll take a short vacation and then report for work with the patent law firm of Pennie, Edmonds, Morton, Barrows, & Taylor in New York City. His wife, Jane, has been writing radio scripts for the Far East Section of the Voice of America.

C. Gordon Murphy, writing from Ohio, says he's spent two years obtaining an MBA at the Harvard Business School and is now training for the Proctor & Gamble Overseas Mfg. Division at Cincinatti. His wife had a baby boy last fall, his name—Greg.

1949

Carl A. Price writes from Cambridge, Mass., about some recent Tech alumni: *Walt Mudgett* '50, now works for Raytheon in Waltham, Mass.; *Bruce Stowe* '50, was recently approved for an AEC Fellowship at Harvard in Plant Physiology; *Willy Boutelle* '48, has a "plush" job with the Bulova Watch Company in New York, and *Tom Stix*, also '48, is a sober and respectable married citizen and stands a good chance of being a Ph.D. in physics at Princeton this June. Carl married ex-Tech mail-office clerk Liz Turner last month.

Frank T. Edwards, Jr., is currently employed by the U. S. Weather Bureau in Alaska—has been for the past two years. He says forecasting at Annette isn't so hard since rain is a safe bet almost anytime. There are no additions to the family yet, but one is due shortly.

John F. Kostelac says that he was absorbed by Westinghouse after graduation from Tech, and was sent to Pittsburgh on their training program. After about 1½ years with them John accepted a position as Assistant Electric Superintendent with the Crucible Steel Co. of America in Midland, Pa. There's also a new baby at the Kostelac house—a son.

1950

Peter T. Knoepfler is getting his M.A. in chemistry at Columbia University this June. He'll go to Cornell Medical School to work toward his M.D. next year.

William A. Freed was married to Margaret Jean Barney of Pasadena, last February in San Gabriel.

Harold C. Martin, Ph.D., is currently an Associate Professor of Aeronautical Engineering at the University of Washington. He'll present a paper based on his Ph.D. thesis before the First U. S. National Congress of Applied Mechanics in Chicago next month.

Robert C. Howard, M.S., is touring Europe during vacations and attending London University when it's in session. He'll be back at Tech next fall.

Worthie Doyle reports from Culver City, California, that there's nothing new, although he's now working for the Hughes R. & D Labs.

Donald W. Stillman has become the father of a 9-lb. 11oz. son—Robert Scott.

BOOKS CONTINUED FROM PAGE 2

dome under Mt. Washington in New Hampshire which rises from a depth of 57,500 feet, having at that depth a temperature of only 141° F., requires a considerable reorganization of their concepts of various crustal and subcrustal layers and geothermal gradients. The origin or ultimate source of water at this depth is not treated.

Ground water

In matters pertaining to ground water Henry Gross' rod is infallible. If water is not found where Henry says it should be, then the driller failed to follow directions carefully in locating the well or by clumsy work crushed the veins, thus sealing them off. Unfortunately, scientific tests of Gross' performances have been poorly designed and improperly carried out. They indicate only the stupidity of the scientist and his closed mind in refusing to believe the incontrovertible facts.

The ultimate potentialities of Gross's rod seem almost unlimited. "Henry's rod, for example, will answer any question he chooses to ask it—Is there underground water on the planet Mars? Will the Red Sox win the American League pennant?" (p. 79). The rod will answer these questions, but no one is yet certain that the answers are right. However, in view of the amazing progress and development reported by Roberts in this book, is it too much to hope that someday the rod will answer such questions with the infallibility with which it now solves problems pertaining to water veins and domes for Henry Gross?

NO TRIP LIKE THIS AND OTHER STORIES
by C .C. Cawley
The House of Edinboro, Boston $2.75

CLIFFORD CAWLEY received his B.S. in Engineering from Caltech in 1932 and his M.S. in Civil Engineering in 1933. In recent years, with a successful career in engineering behind him, Mr. Cawley has switched to writing for a living.

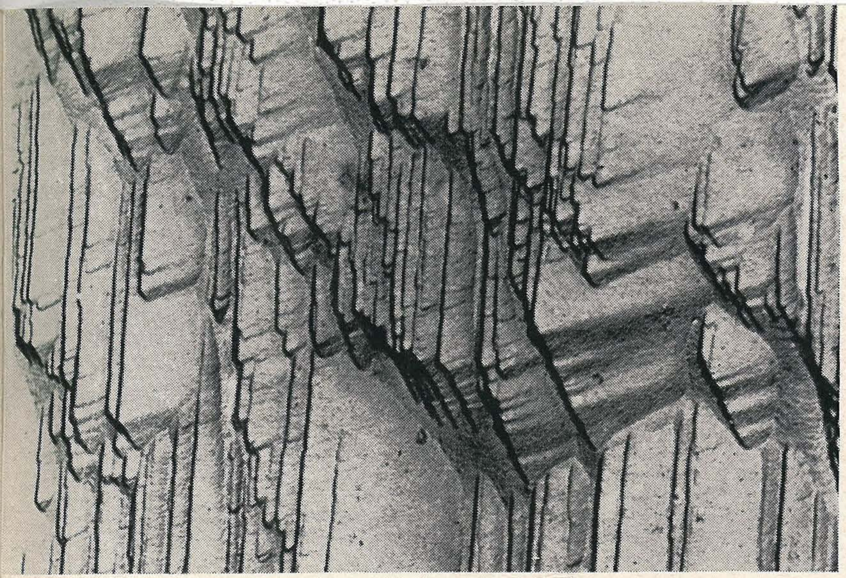
No Trip Like This is a collection of five of Mr. Cawley's short stories. Aside from the fact that he has dedicated this, his first book, to Prof. Harvey Eagleson of the Institute's English Department, Mr. Cawley gives little indication of his Caltech or engineering background.

These stories are, for the most part, concerned with the agonies of adolescence, or the equally intense agonies of lonely young men. The stories are all set in or around Los Angeles.

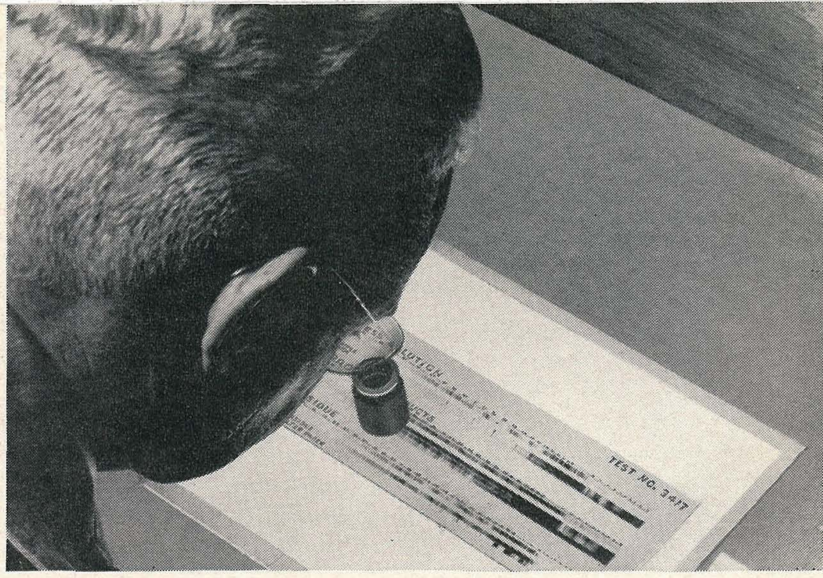
In the title story a frustrated young office clerk feverishly tries to make a dime-store salesgirl on a Catalina weekend—against a complicated counterpoint of interrelated episodes involving the reactions of several other males, young and old, to sex and love.

"Belle Monahan" is a warm and affectionate account of the odd courtship of a lively young Irish schoolgirl by a dedicated young Protestant pastor. "When Day Is Done" and "The Lost" describe the disillusionment of some tender adolescents. And "The Grunion Run" tells how a repressed young man finally gives in to love.

The two long stories — the title story and "Belle Monahan"—make probably the best reading in the book, and give the best indication that Mr. Cawley should be coming up soon with an interesting first novel.

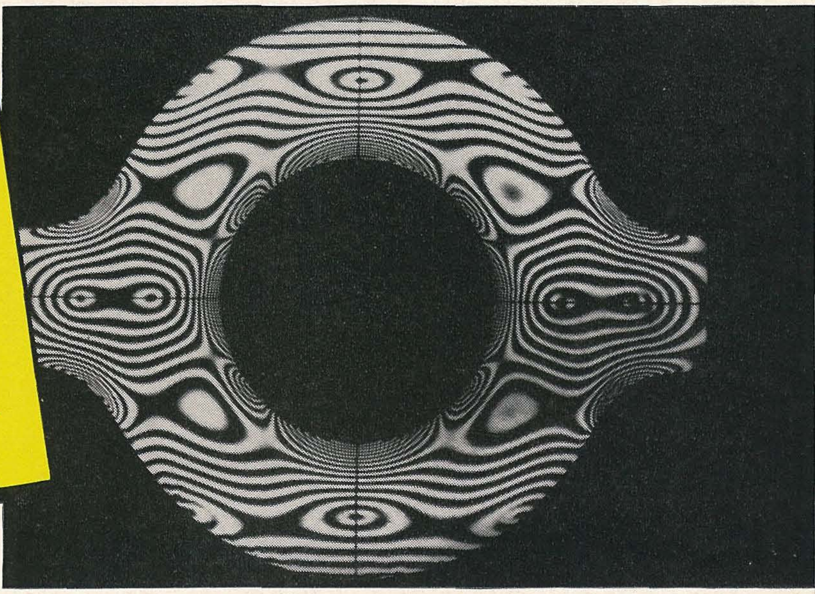


REVEALS NEW FACTS ABOUT METAL STRUCTURE. Electron micrography—up to X50,000 with the electron microscope—reveals new facts about metal structure, surface protection, and effect of processing procedures.



DETERMINES COMPOSITION OF MATERIALS. The composition of almost any material is shown in a flash through spectrography. It is a means of making frequent production line analyses that keep a check on specifications.

Engineering has an ally in photographic analysis



SHOWS STRESSES AND STRAINS VISUALLY. By photographing the patterns developed by polarized light as it passes through a plastic model of a part, the engineer can have visible evidence of the points of stress within the part.

In the engineering laboratory—on the production line—photography is today an important tool. It searches metal structure through electron micrography, x-ray diffraction, and micro-radiography. It makes swift mechanical motions seeable by showing them at a snail's pace with high speed movies. Or it can halt an instant of an instrument's fleeting trace and record it for study.

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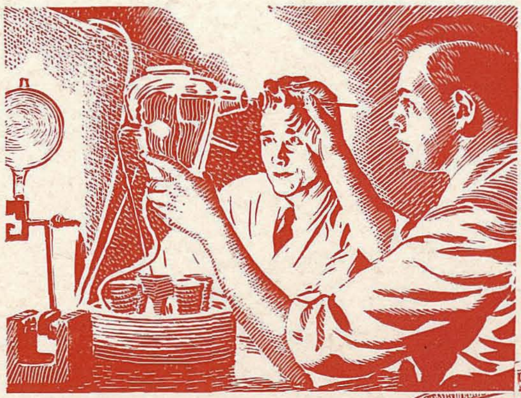
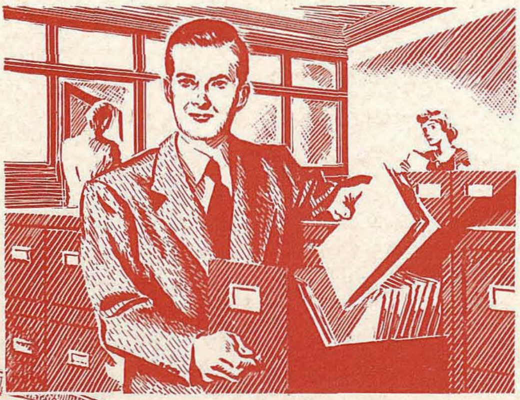
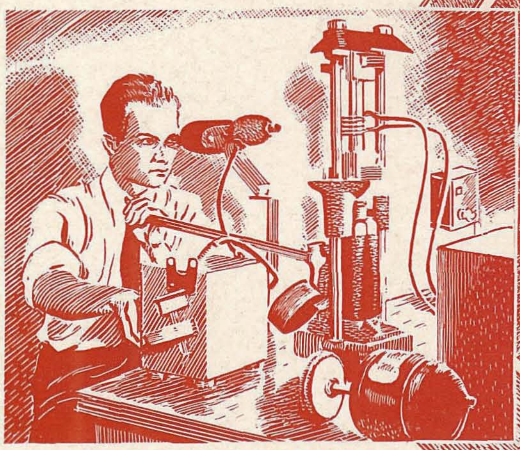


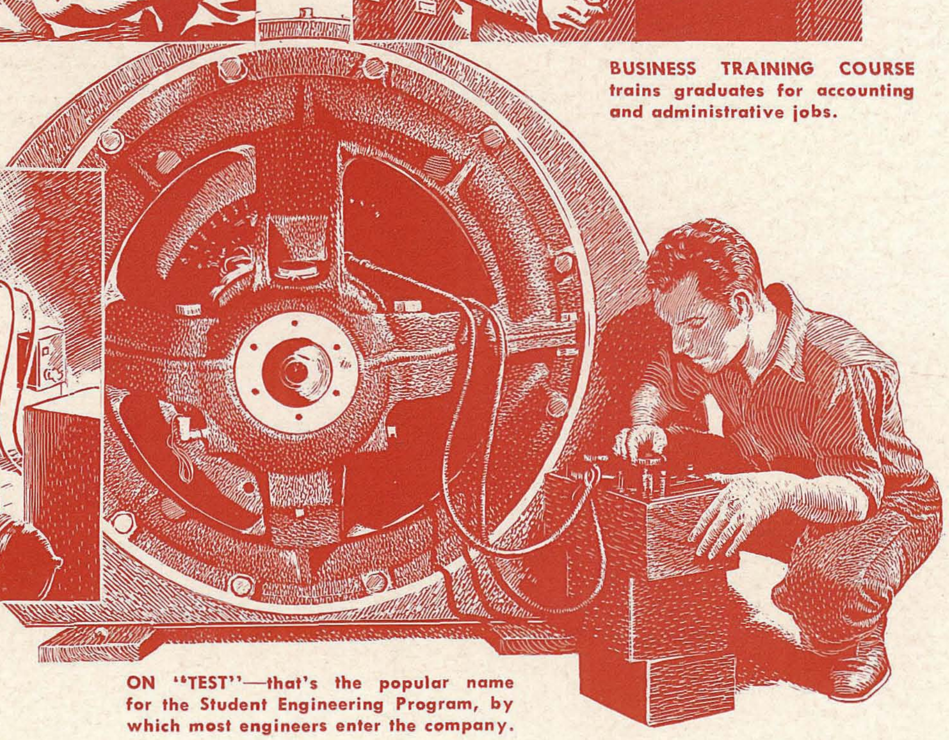
PHYSICS PROGRAM offers studies and rotating assignments for physics majors.



BUSINESS TRAINING COURSE trains graduates for accounting and administrative jobs.



CHEMICAL AND METALLURGICAL PROGRAM is for chemists, chemical and metallurgical engineers.



ON "TEST"—that's the popular name for the Student Engineering Program, by which most engineers enter the company.

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