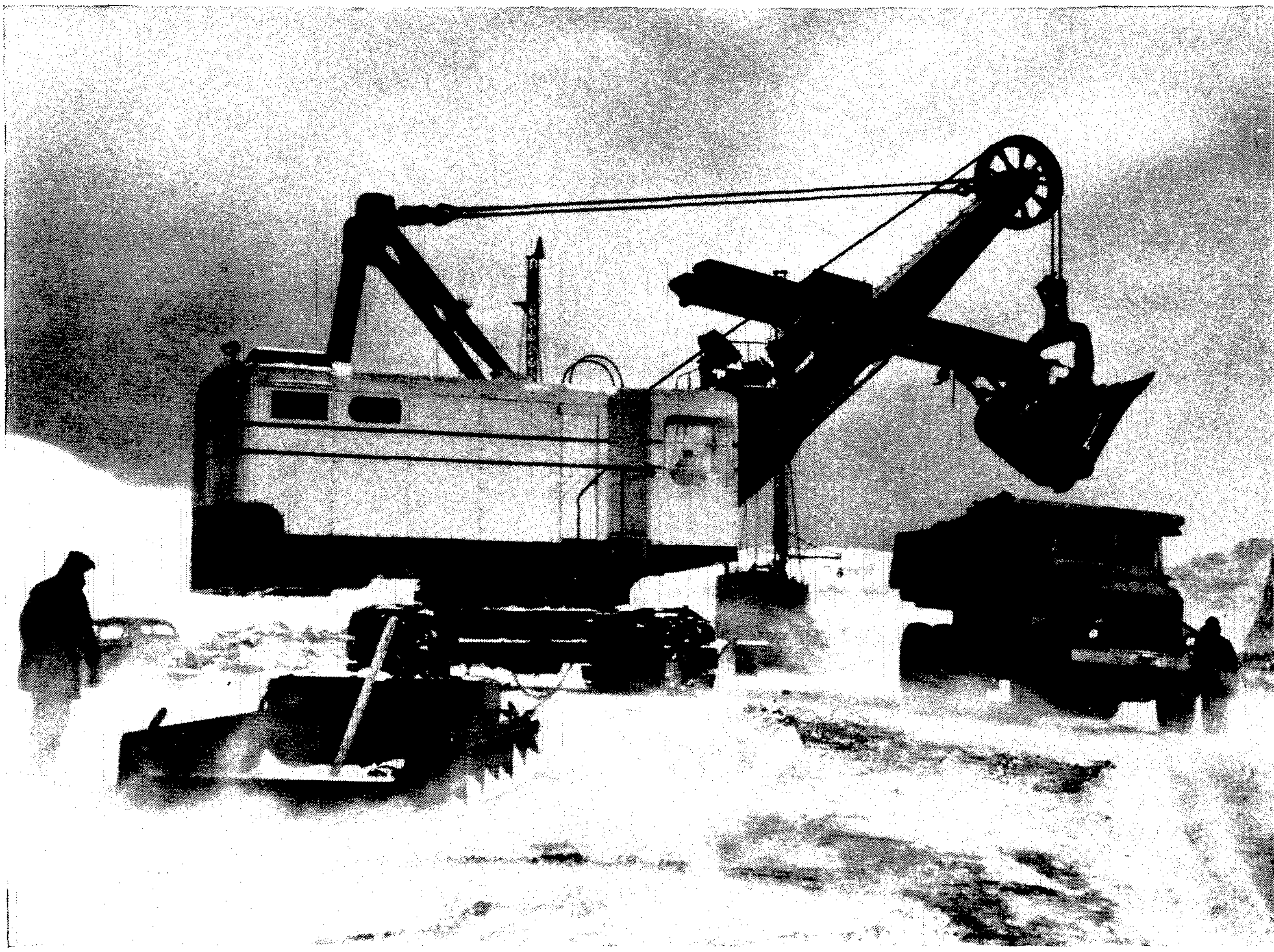
ENGINEERING | AND | SCIENCE

DECEMBER/1952

Automotive Powerplants . . . page 18

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY



There's been a cold war on in Minnesota lately

. . . And our metallurgists have won it.

Up in the iron ore range, where 40 below zero can be expected frequently, shovel operators usually plan their operations to remove a year's supply of ore during warm weather months when the ore is workable. But recently, with steel requirements ever increasing, shovel operators began working around-the-calendar.

And they ran into trouble.

During one cold spell when the temperature dropped to 40° below throughout the iron ore range, the ore froze solid. The extreme cold caused steel in the equipment to lose some of its toughness, and power shovel booms and dipper sticks broke all over the range as the huge steel dippers were rammed into the frozen ore with tremendous force.

But there was one significant exception. Operators using shovels with booms and dipper sticks made of one particular steel went right on gouging up frozen ore without any equipment trouble.

Those shovels stood up because the heavily stressed parts were made from U·S·S TRI-TEN—a remarkably strong steel that has a high degree of toughness, even at low temperatures.

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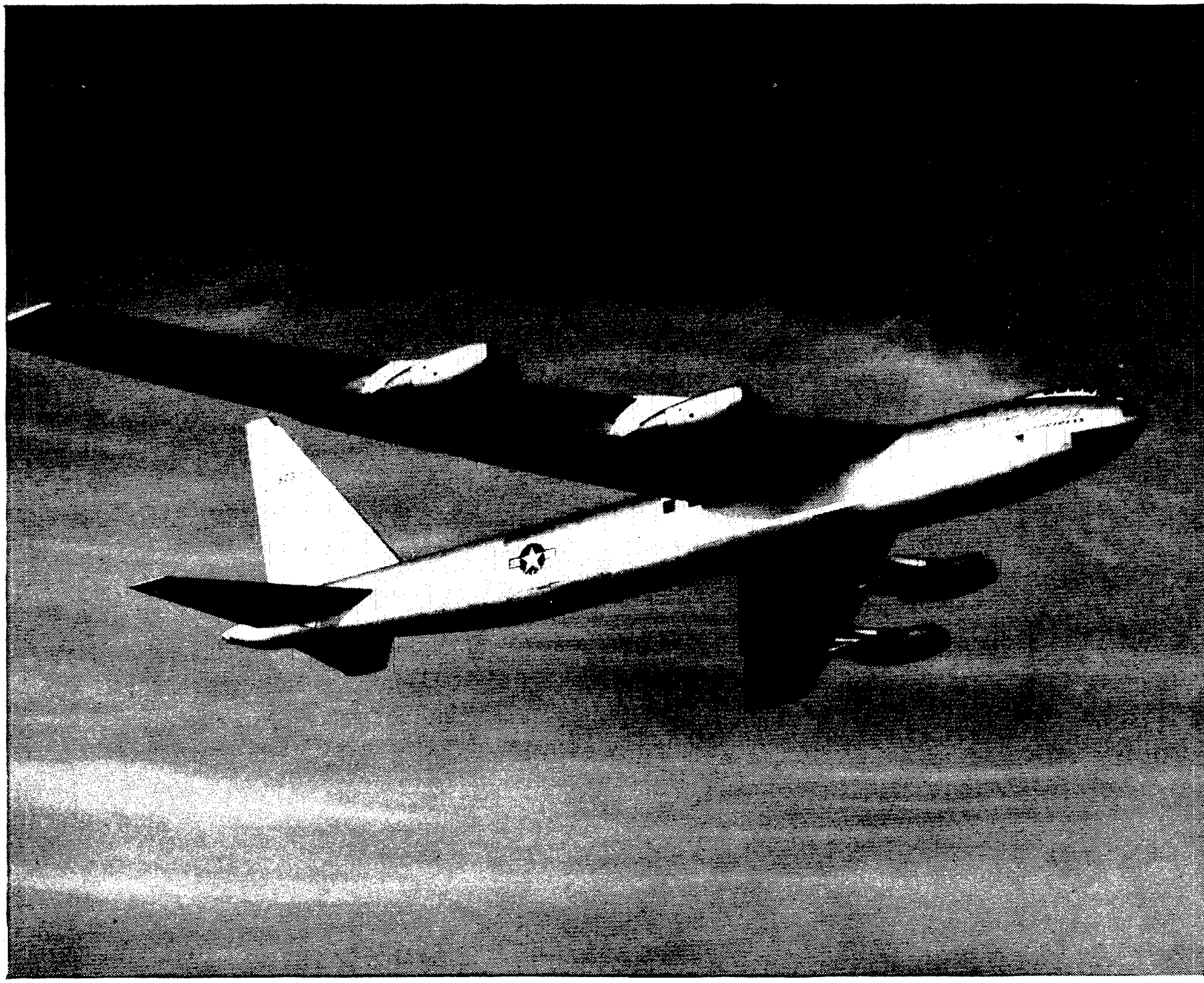

This is the Boeing team's jet heavyweight

Here is a flight shot of the giant Boeing B-52 Stratofortress. An eight-jet heavy bomber, the Stratofort is a fast, husky teammate to the B-47 Stratojet medium bomber. It's 153 feet long, measures 185 feet from wing-tip to wing-tip, and is powered by eight Pratt & Whitney J-57 engines. Speed and other performance details are carefully guarded secrets.

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BOOKS

GENERAL GENETICS
by Adrian M. Srb & Roy D. Owen
W. H. Freeman & Co., San Francisco
$5.50

THIS IS UNDOUBTEDLY one of the most up-to-date textbooks in genetics now available. Written by Adrian Srb, Professor of Plant Breeding at Cornell University (who was a Research Associate at the California Institute in 1949), and Ray Owen, Associate Professor of Biology at Caltech, the book is intended for beginning students in genetics. The first 16 chapters provide elementary coverage of the field, while the remaining 8 chapters deal with more advanced topics. The authors have carefully selected new examples from many organisms, such as chickens, foxes, etc., while retaining the standard examples from corn and Drosophila. And they have made an effort to include, wherever possible, results from recent investigations.

The book is copiously illustrated and contains a number of spectacular three-dimensional drawings of the chromosomes, which are the work of Evan L. Gillespie.

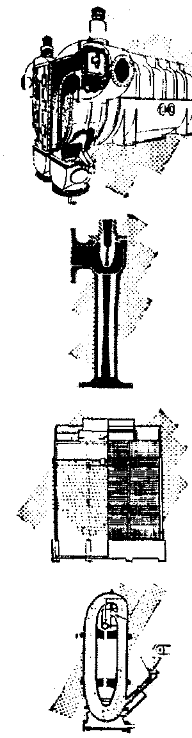
The text is nicely adapted for use by elementary students in genetics. It contains a good many problems for students to solve. Each chapter ends with a summary of its contents. And the authors have made a great effort to write with the utmost simplicity. In spite of the rather informal style, the approach is rigorous and thoroughgoing.

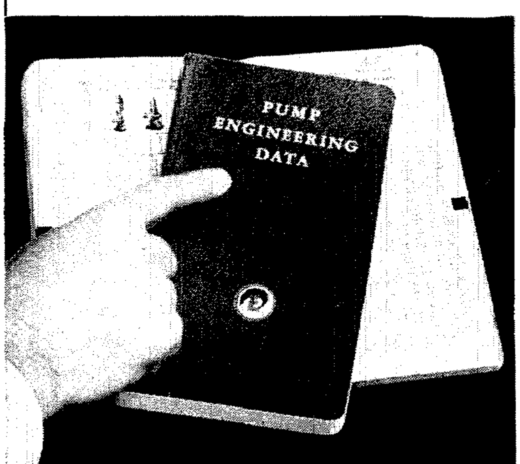
ELASTICITY IN ENGINEERING
by Ernest E. Sechler
John Wiley & Sons, Inc., New York,
$8.50

THIS IS THE sixth published volume in the GALCIT Aeronautical Series, and the second in the series to deal with problems of structural analysis and elasticity. The earlier book, of which Dr. Sechler was the co-author (with Louis G. Dunn), dealt specifically with problems of airplane design. As a result of his work in this field, Dr. Sechler became convinced that the treatment of problems in elasticity which result from the aeronautical approach might have interest and value in other engineering fields.

Elasticity in Engineering bridges the heretofore unfilled gap between strength of materials and theoretical elasticity. As such, it should be useful to engineers working in all fields of structural analysis, as well as in undergraduate and graduate courses in applied elasticity and advanced strength of materials.

Ernest E. Sechler was graduated from Caltech in 1928, received his M.S. here in 1929, and his Ph.D. in 1934. Now Professor of Aeronautics at the Institute, he is in charge of all aernouatical structural course work and research.

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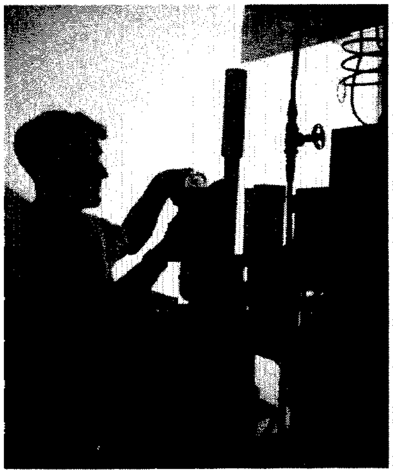
DATA

ENGINEERING AND SCIENCE

IN THIS ISSUE



This month's cover shows Peter Kyropoulos feeding chemical hay to a mechanical horse. He is, in plain language, operating a knock-test engine in Caltech's Mechanical Engineering Lab — pouring 100-octane fuel into the variable-compression fuel test engine.

Dr. Kyropoulos, Associate Professor of Mechanical Engineering at the Institute, is co-author with Craig Marks, Research Assistant in Mechanical Engineering here, of the article on page 18: "Recent Developments and Trends in Automotive Powerplants."

"Psychoanalysis as Science," the title of the article on page 11, is also the title of a book published this month—from which our article has been adapted. The book includes five lectures, delivered at Caltech in 1950, under the sponsorship of the Hixon Fund, by Dr. Ernest R. Hilgard, then Chairman of the Department of Psychology at Stanford—now Dean of the Stanford Graduate School; Dr. Lawrence S. Kubie of New York, Clinical Professor of Psychiatry and Mental Hygiene at the Yale University School of Medicine, and a member of the Faculty of the New York Psychoanalytic Institute; and Dr. E. Pumpian-Mindlin, then Clinical Director, now Chief of the Mental Hygiene Clinic of the Veterans Administration in Los Angeles.

The article on page 11 has been extracted from the second of the two lectures given by Dr. Hilgard. If space allows, in subsequent issues, *E&S* will run additional material from the book. "Psychoanalysis as Science."

PICTURE CREDITS

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Published monthly, October through June, at the California Institute of Technology, 1201 East California St., Pasadena 4, Calif., for the undergraduates, graduate students and alumni of the Institute. Annual subscription $3.50, single copies 50 cents. Entered as second class matter at the Post Office at Pasadena, California, on September 6, 1939, under the act of March 3, 1879.

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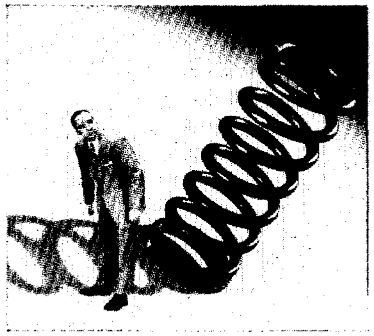

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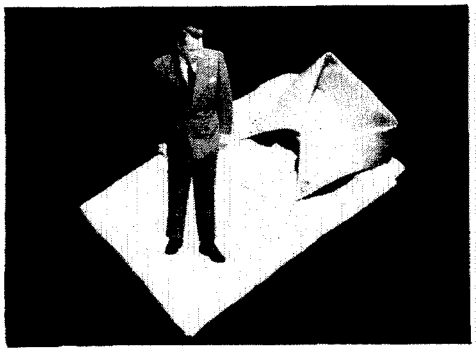

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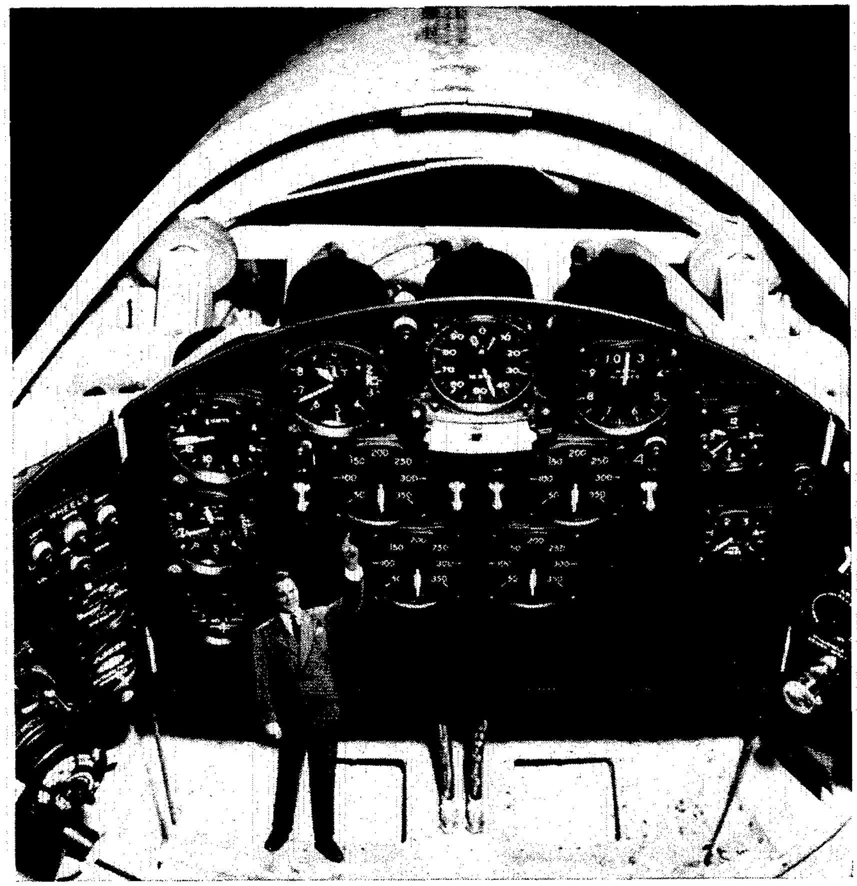

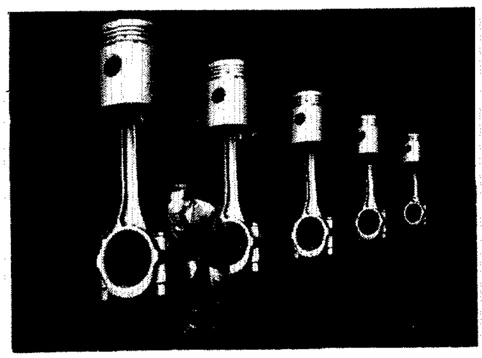

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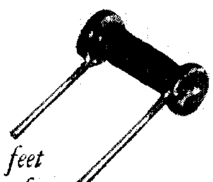

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Takes a lot to lay a carpet in the jungle

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Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Harrison, New Jersey.

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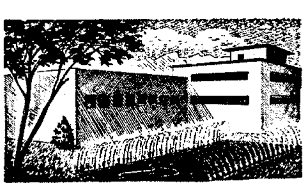
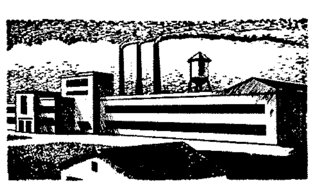
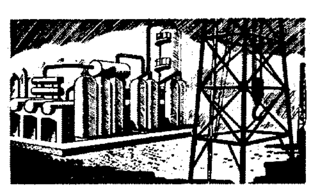


Good Water and Sanitation—engines pumps • water treatment • comminutors air compressors • air tools

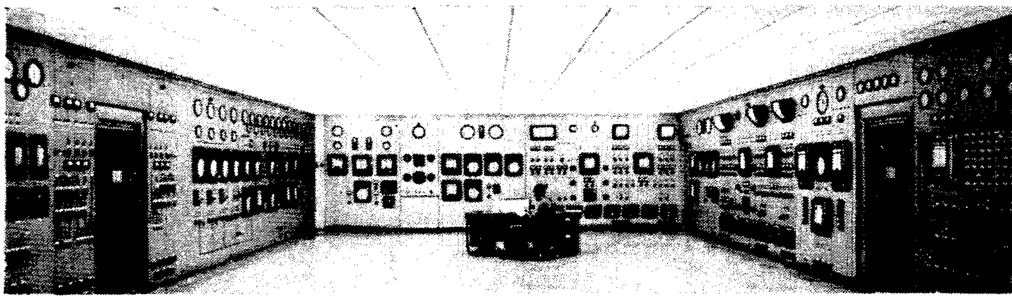


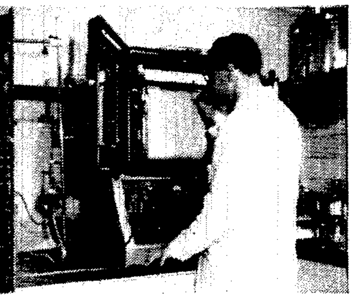
Lower-Cost Manufacturing—pumps compressors • steam turbines • motors power transmission • air conditioning



Petroleum Products—compressors engines • pumps • chilling equipment refrigeration • decoking systems

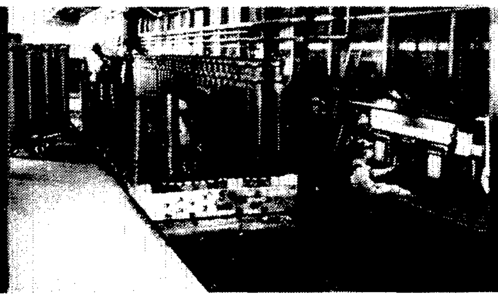
More Abundant Food—compressors fertilizer mixers • air conditioning refrigeration • pumps

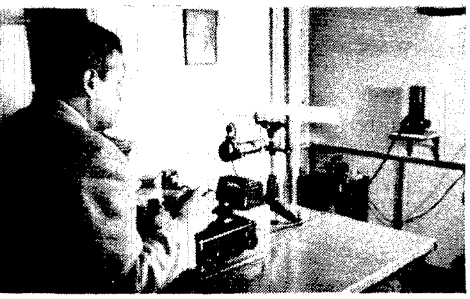




L&N instruments "From Coal Pile to Bus Bar" in central station's control room

Electro-Chemograph

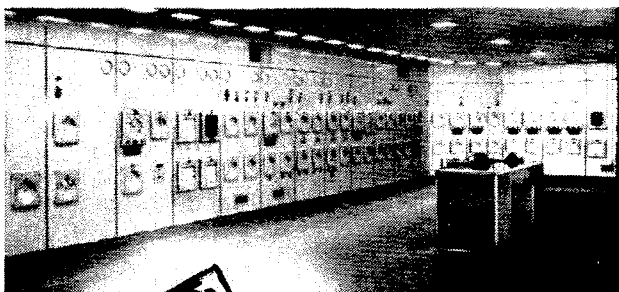


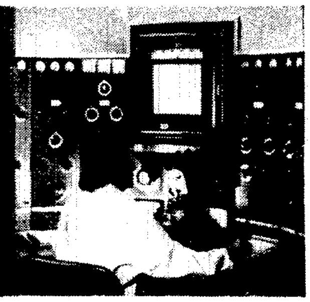


Speedomax control on annealing furnace

Speedomax control of ceramic kiln temperature

Research with K Potentiometer & accessories

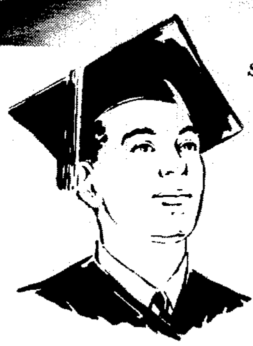




Speedomax instruments in a refinery

Homocarb furnaces in auto plant

Aircraft testing



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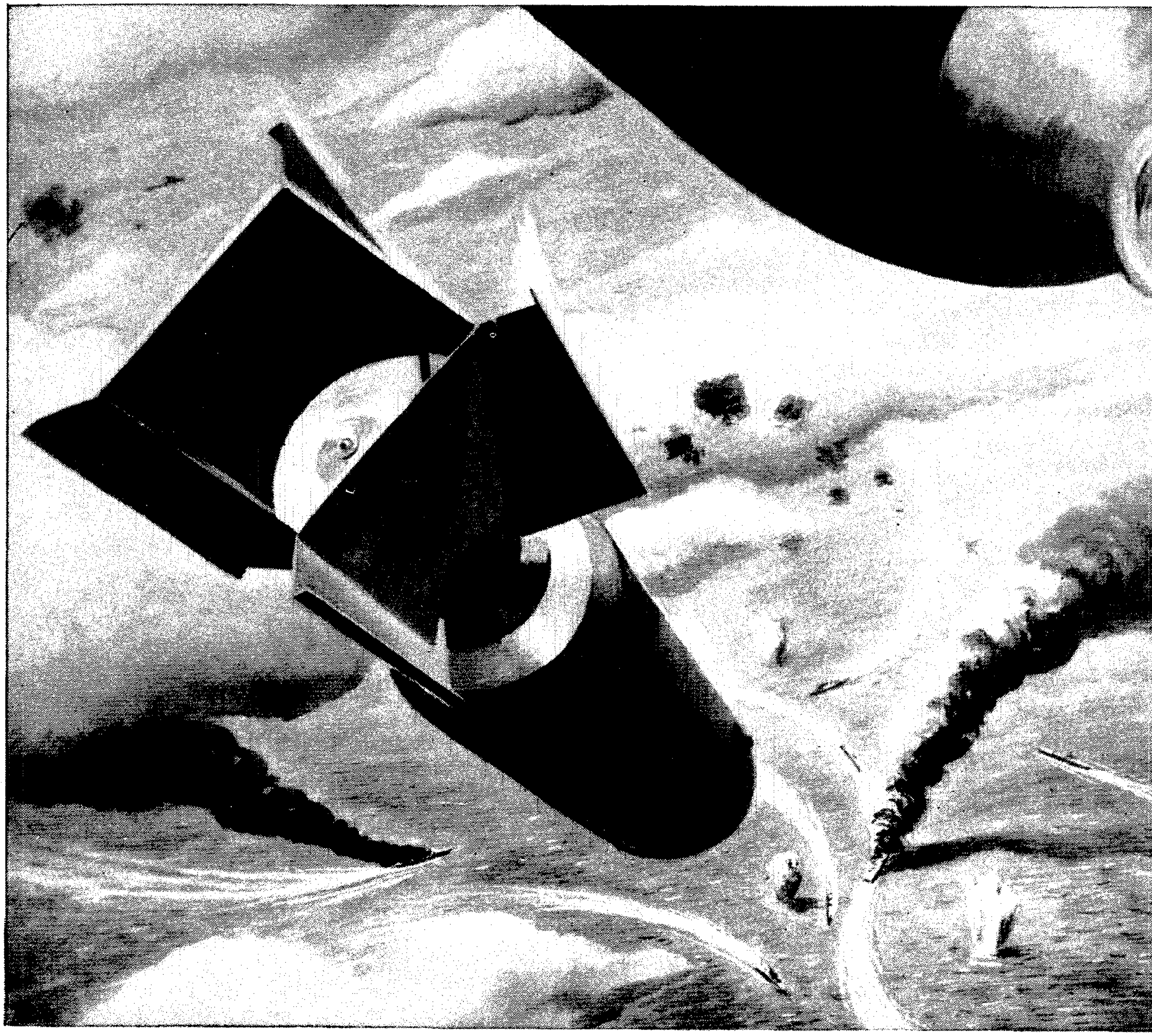

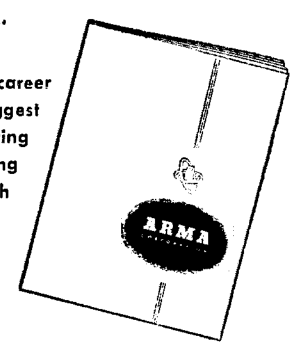

ARMA

PSYCHOANALYSIS AS SCIENCE

Is there any science in it at all? Here is what some researchers found out in trying to test some of the basic principles of psycotherapy.

By ERNEST R. HILGARD

PSYCHOANALYSIS is primarily a way of treating people who are emotionally disturbed. It is a medical psychology.

When we mention psychotherapy we are talking about cure by psychological means, as contrasted with cure by surgery, or by drugs, or by other forms of physical or medicinal treatment. Psychotherapy usually means a cure by way of conversations between the patient and therapist. It may be caricatured as a talking cure, if you will—so long as we know that this is a caricature.

Psychoanalysts sometimes distinguish between psychoanalysis and psychotherapy—meaning, by the former, the full-scale long-time analysis; by the latter, shorter methods of therapy. The shorter methods make use of psychodynamic principles, but do not employ complete psychoanalytic technique. Thus, if we follow this distinction, most child guidance clinics use psychotherapy, but the children and parents who go there for treatment do not get psychoanalyzed.

I do not intend to enter here into the professional problems of conducting a psychoanalysis, or into controversy as to just where psychotherapy ends and psychoanalysis begins. I am using the word psychotherapy as a classificatory word for the process of achieving changes in emotional adjustment by psychological means. I am interested in what we have found out, and what we can find out, about how the changes in the patient take place, so that these changes, and the control of them, may become part of established psychological science.

The general conduct of a psychoanalysis has become familiar to the public through the motion picture, through cartoons in the weekly magazines, and even in the comic strip of the daily newspaper, with the usual distortions that these media produce.

Let me describe what psychoanalysis is actually like. The analyst usually begins by getting something of the personal biography of the patient, after the manner of a social worker's case history. The patient sits up and talks as he would to any physician. The analyst may have better interviewing methods, but there is little that is distinctive about the early sessions.

There may be several sessions before the patient takes to the couch, before the typical free association method is used. Then the patient is taught to follow, as well as he is able, *the basic rule:* to say everything that enters his mind, without selection. This is much harder than it sounds, even for patients who are eager to co-operate

"Psychoanalysis as Science," published in book form this month by the Stanford University Press, consists of a series of lectures delivered at the California Institute of Technology in the spring of 1950, under the sponsorship of the Hixon Fund. The lecturers—and authors: Ernest R. Hilgard, Lawrence S. Kubie, and E. Pumpian-Mindlin. The article above has been extracted from Dr. Hilgard's talks.

with the analyst. In fact, the whole lifetime has been spent learning to be tactful, to achieve self-control, to avoid outbursts of emotion, to do what is proper rather than what is impulsive. This all has to be unlearned for successful free association.

What free association aims at is the bringing to awareness of impulses and thoughts of which the person is not aware. Because these impulses are active, but out of awareness, they are called unconscious. It is necessary to break through resistances in order to bring them to awareness. The role of the psychoanalyst is, essentially, to help the patient break down these resistances, so that he may face his disguised motives and hidden thoughts frankly, and then come to grips in realistic manner with whatever problems or conflicts are then brought into view.

The activity of the analyst is directed skillfully at this task of helping the patient eliminate resistances. He does this in part by pointing out to the patient the consequences of his resistances: the times of silence when his mind seems to go blank; forgetting what he intended to say; perhaps forgetting to show up at an appointment; drifting into superficial associations; or giving glib interpretations of his own. The analyst not only calls attention to signs of resistance, but he also interprets the patient's associations in such a way as to facilitate further associations.

Interpretations—shallow and deep

Otto Fenichel[1] defines interpretation as "helping something unconscious to become conscious by naming it at the moment it is striving to break through." If this is accepted, then the first interpretations are necessarily fairly "shallow" ones, the "deeper" interpretations waiting until the patient is ready for them.

The deeper interpretations are the ones we often think of in characterizing psychoanalysis, but very much of the time in an actual psychoanalysis is spent in rather matter-of-fact discussion of attitudes toward other people and toward oneself as they show themselves in daily life—without recourse to universal symbols, references to libidinal stages, and so on.

Not all psychoanalysts agree on just how interpretations should be made, or when they should be made, and it is my guess that those who think they do agree may actually behave quite differently when conducting analyses of their patients. This is one reason why it is difficult to study psychoanalytic therapy—and a reason, also, why there are so many schisms within psychoanalytic societies.

Another aspect of the psychoanalytic therapy goes by the name of "transference." Transference refers to the tendency for the patient to make of the analyst an object of his motivational or emotional attachments. It is too simple to say that the patient falls in love with the analyst. Sometimes he makes of the analyst a loved parent, sometimes a hated parent; sometimes the analyst substitutes for a brother or sister, or for the boss at the office. The patient unconsciously assigns roles to the analyst of the important people in the patient's own life. Part of the task of the analyst is to handle the transference. The word "handle" is easily spoken, but this handling of the transference is said to be the most difficult part of the analyst's art.

The psychoanalytic interview is a social one, an interpersonal one, with two people involved. The analyst is a person, too, and he reacts to the adoration and abuse of the patient he is analyzing. He is a good analyst to the extent that he understands himself well enough so that he preserves his role in the analytic situation, and does not himself become involved, as his patient is, in what is called countertransference—that is, using the patient as an outlet for his own emotions.

I have gone this much into detail here because the public does not always understand why psychoanalysts insist that they must themselves be analyzed. The reason is that they could not otherwise handle the problems of transference with the kind of detachment that is necessary if the patient is to be helped. The reason is *not* that they must have a laying on of hands or special indoctrination in order to transmit the faith held by their therapist. If it works that way, as it occasionally does, then the training analysis has been unsuccessful in achieving its aim (as it undoubtedly is in some instances).

To make the blanket charge that psychoanalysis is unscientific because the method requires that the analyst himself be analyzed is unwarranted, although this charge is commonly made. There is a danger that analysts become too doctrinaire. If you ask an analyst about his theoretical position, he may reply by telling you under whom he had his analysis. There are parallels in other sciences as well. A biologist's or a physicist's work often reflects the master under whom the scientist studied. There is need for caution in both instances.

Because there is danger of indoctrination does not mean that there are not ways of avoiding that danger. For example, psychoanalysts profit greatly from doing control analyses under more than one training analyst, representing somewhat divergent viewpoints. Postdoctoral fellows in the natural sciences often prefer to work in laboratories at a different place from the one in which they received their training, in order to break their provincialism. It may be that a personal analysis is as essential to conducting a psychoanalysis as learning calculus is to becoming an engineer. The problem then becomes how to achieve the gains and avoid the pitfalls.

Disturbance in analysis

Very often there is within the midst of psychoanalysis a state in which the patient is more disturbed than he was before entering treatment. Those unfriendly to psychoanalysis occasionally use this as an indication of its therapeutic ineffectiveness.

Two comments can be made here. First, what appears to others to be disturbance may not be "neurotic" at all. Some individuals are excessively kind to other people, at great cost to themselves. If they suddenly express their feelings more openly, they may become less pleasant to live with or to work with, because they can no longer be exploited. The troublesome child may be a healthier child than the child who is too "good." If a person changes, new social adjustments are required, and some that were in equilibrium now get out of focus. This is the first observation regarding apparent disturbance in the midst of analysis.

The second comment is that the disturbance in the midst of analysis may be a genuinely neurotic one, an aggravation of the typical transference. That is, the substitution of the analyst for other figures emotionally important to the patient may produce an emotional crisis, in which the patient actually acts more irrationally than before treatment. If this crisis is well handled. the patient emerges the better for it. Although some analysts believe that such crises are inevitable in an analysis, others attempt to ward them off by such devices as less frequent therapeutic sessions when transference problems become too hard to handle. In any case, the fact that an aggravated transference neurosis may occur does not invalidate the therapeutic usefulness of psychoanalytic technique.

Three words often crop up in discussion of what is taking place as the patient improves. These are "abreaction," "insight," and "working through."

"Abreaction" refers to a living again of an earlier emotion, in a kind of emotional catharsis—literally getting some of the dammed-up emotion out of the system.

"Insight" refers to seeing clearly what motives are at work, what the nature of the problem is, so that instinctual conflicts, as psychoanalysts call them, are recognized for what they are. Insight is not limited to the recovery of dramatic incidents in early childhood that were later repressed. Sometimes such insights do occur and sometimes they are associated with relief of symptoms.

The process of working through

But neither a single flood of emotion in abreaction nor a single occasion of surprised insight relieves the patient of his symptoms. He requires, instead, the process of "working through," that is, facing again and again the same old conflicts and finding himself reacting in the same old ways to them, until eventually the slow processes of re-education manifest themselves and he reacts more nearly in accordance with the objective demands of the situation and less in accordance with distortions that his private needs create.

It is chiefly because the process of working through takes so long that psychoanalysis takes so long. The psychoanalyst often has the basic insights into the patient's problems quite early in treatment, but the patient is unready for them and could not understand the analyst if he were to insist upon confronting him with these interpretations.

I have sometimes likened an analysis to the process of learning to play the piano. It is not enough to know what a good performance is and to wish to give one. The process has to be learned. The learner may know all about musical notation and may have manual skill and musical appreciation. But there is no short cut. Even with a good teacher the lessons must continue week after week before the player can achieve the kind of spontaneous performance he wishes to achieve. We do not begrudge this time, because we believe that the end is worth it.

What the analyst is attempting to do is far more complex than what the piano teacher is attempting to do. The skilled management of a life is more difficult than the skilled management of a keyboard.

It must be clear by this time that laboratory experimentation that preserves anything like the richness of a psychoanalysis will be very difficult indeed, if not, perhaps, impossible.

Animal and human experiments

With this background, we may well wonder whether there is any profit in attempting to study psychotherapy using animal subjects. Surely they will not free-associate, develop resistance, and improve through the careful handling of the transference. What meaning can abreaction, insight, and working through have for them?

As a matter of fact, the outlook is not so bleak as might be supposed, and a number of studies have been concerned with the induction of neuroses in animals and with the therapy of these artificially induced neuroses.

But our primary interest in therapy is in the treatment of human illness, so that experiments that study therapeutic principles directly with human subjects have a cogency that experiments with animals can never have.

One kind of venture is that which seeks to evaluate the relative success of different kinds of therapy without any experimental control of the therapy itself. Such investigations are important, but the scientific generalizations from them are bound to be meager. They may tell what kind of patient ought to go to what kind of physician, but then we would still have to ask why one is more successful than the other. We might find, for example, that Alcoholics Anonymous did more than psychoanalysts for alcoholics. But this would be only a start in further inquiry. Today we are concerned with what goes on within psychotherapy, not with what kind of therapeutic arrangements are to be recommended in the community.

I wish to give one illustration of the kind of data that can be obtained from therapeutic sessions that deal with the course of treatments of real people who come to a psychotherapist for help. Sometimes scientists use data that they create for experimental purposes; sometimes they turn available data to scientific use. This first illustration is the kind of situation in which available data are turned to scientific account. I refer to some studies of short psychotherapy made by Carl Rogers[2] and his students in the counseling center at the University of Chicago.

To those of us oriented in the field of contemporary clinical psychology, it may seem somewhat surprising that I bring Rogers into a discussion of psychoanalysis, for he is, in some sense, an enemy, or at least a competitor. But a person in trouble, who is being counseled, is not concerned about the theory that is being used on him. He is burdened by his troubles, and if he finds relief and we discover how, the principles are important ones, no matter who his therapist is.

In some sense, Rogers' antagonism to psychoanalysis produces interviews that reveal better than psychoanalysis itself some of the principles about which analysts speak.

Nondirective therapy

Rogers' method, known as nondirective therapy, consists in a supportive therapy based primarily upon the permissiveness of the therapist. An effort is made to avoid getting embroiled in transference, and interpretations are at a minimum. The therapist listens attentively and reflects the feeling in the assertions of the patient, avoiding evaluations or judgments of his own. What then happens during successive sessions?

Rogers and his students have systematically recorded what is said in their interviews, using the modern electromagnetic records. Secretaries are taught to transcribe the "mm's" and "ah's" and to note the length of rest pauses. Hence it is possible to make detailed content analyses of the interviews to give quantitative answers to some questions about what goes on.

It is said, for example, that in the early interviews the patient commonly restates his problem, returning over and over again to the same point of difficulty, but after he has been in the situation awhile he gradually achieves insight, and these occasions of insight are signs of therapeutic progress.

By carefully coding what is happening in the interviews we may ascertain whether or not this march of events does in fact go forward. On the chart below are plotted the average results of ten cases for whom there were from three to nine interviews each. When the records are divided into fifths, we see that the statement and restatement of the problem decreases relative to the increase in statements revealing insight and understanding.

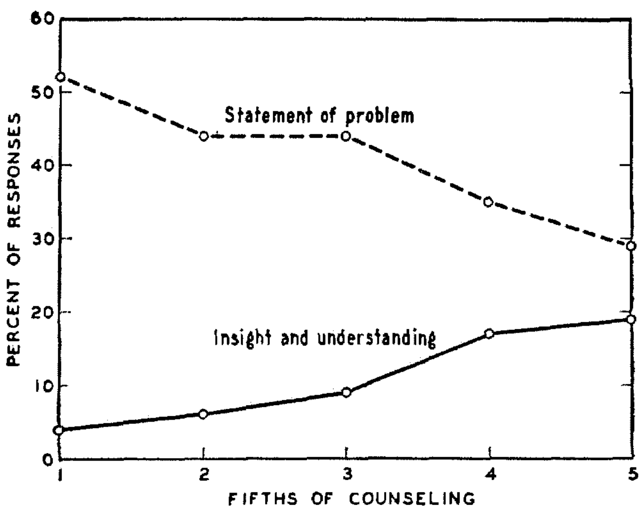

Chart shows changes taking place in patients during brief psychotherapy. Restatements of the problem decrease relative to increase of insight and understanding.

One can imagine a real experimental design superimposed upon a process of this sort. For example, at some stage the therapist might deliberately introduce interpretations of the kind carefully avoided in the nondirective method. If the height of the line showing statements of insight and understanding increased, by this criterion, the interpretation would be shown to be helpful: if the line were to taper off, it would show that the interpretations slowed up the progress.

One of the chief advantages of Rogers' method for purposes of research on psychotherapy is that it provides a highly disciplined interview technique, with minimum active participation by the therapist. Hence other methods might well use it as a control method, noting how the other methods accelerate or slow up progress. Fortunately, the consequences of Rogers' nondirective method are generally benign, so that no harm would be done in using it as a reference method.

A start has been made in the direction of comparing two methods in a very ingenious experiment by C. D. Keet[3]. I wish to describe his experiment in some detail because it serves as a useful model of experimental design in this difficult field. If its results are substantiated by others, I believe that the experiment will prove to be something of a landmark.

Comparing counseling techniques

Thirty normal subjects participated in this experiment, designed to compare the effectiveness of two counseling techniques in overcoming a conflict symptomatized by the inability to recall a word just memorized. Through a cleverly devised method, the subject learned a list of six words, including a critical word to which he had shown emotional responses in a word association test.

The word association test was the one made familiar by Jung. A list of one hundred words is read off to the subject, one word at a time. The subject is instructed to reply as promptly as possible with the first word that he thinks of. The experimenter notes the word, and records the time of response with a stop watch. The list is gone through a second time. Emotional conflict is shown in a number of ways, according to what have come to be known as "complex indicators." These include far-fetched responses, failure to respond, repeating back the stimulus word, repeating an earlier response, and so on.

In this experiment two complex-indicators were chosen. First, those words were selected for which responses were changed from the first to the second reading. Second, among these words, that one was chosen for the purpose of the experiment that had the longest reaction time.

By this strictly objective method, a critical family of three words was selected, one stimulus word and the two words given as responses to it on the two trials. In the example to which we are about to turn, the set of key words was "nasty—messy—mean." That is, to the word "nasty" the subject had replied "messy" after a delay on the first trial, and then on the second trial had replied "mean," but also after a delay.

The critical stimulus word was then imbedded in a list including five neutral words. Subjects experienced no difficulty in learning and remembering this list of six words. But now a new list of six words was memorized, producing some interference with recall of the first list.

We experimental psychologists have a fancy expression for this interference. We call it retroactive inhibition. When the effort was made to recall the first list, twenty-five of the thirty subjects forgot the critical word but remembered the remaining five neutral words. We here see the activity of a moderate repression. The emotionally loaded word is forgotten when conditions for recall are made slightly more difficult, even though the word was freely recalled in the process of memorizing the list of six words. Subjects felt very annoyed that they could not recall this word that was "right on the tip of the tongue."

This "microneurosis" provided an opportunity for short therapy, the success of the therapy to be judged, first of all, by the recovery of the forgotten word. Two therapeutic techniques were compared. One of these, called the "expressive technique," was permissive, and allowed expression of feeling. It was very close to Rogers' nondirective technique. As used in this experiment it was unsuccessful. It failed in all thirteen of the cases with whom it was used. That is, none of the thirteen recovered the forgotten word during the therapeutic session.

The second technique, called the "interpretive technique," had all the features of the first, but added the more active interpretive comments of the therapist at appropriate times. Thus to the insights of the client were added those of the therapist, at, of course, a "shallow" level from the point of view of psychoanalysis. But the method deviates from the Rogers method in the direction of the psychoanalytic method. The method was highly successful. Eleven of twelve subjects met the first criterion of therapeutic success; that is, they recalled the forgotten word within the therapeutic session.

Interpretation and recall

The question we wish to ask is this: Just how did interpretation help to bring about the recall of the forgotten word? The author, Keet, suggests that through interpretation his subjects were freer to use normal associative processes. Then the affective experience that determined the failure to recall came into awareness. Once the affective experience was in awareness, the conflict over recall could be resolved, because the subject was able to recall the circumstances under which the critical word was forgotten.

I wish to present a verbatim account of one of Keet's interpretive therapeutic sessions, to illustrate the nature of his interpretations and provide evidence that will permit us to judge whether or not the consequences are as he describes them.

Therapeutic interview

The subject, a young married woman, replied to the word "nasty" first with the word "messy," then with the word "mean." Because both of the replies were long delayed, the word "nasty" was chosen as the critical word in the memory experiment. She first memorized the following list of six words: green, make, ask, nasty, paper, sad. This she did without difficulty. Then she learned another list of six words. The memory method used was somewhat unusual, but I am not going to take the time to give the details. After the memorization of the second list she was asked to recall the first. It is at this point that the therapeutic interview took place.

EXPERIMENTER: Now please repeat the first set of key words.

SUBJECT *(confidently)*: Green, make, ask, paper, sad. *(A pause followed with the experimenter looking inquiringly at the subject.)* Wait a minute, there were six and I have only five. That's silly. Of course there were six. I should be able to remember the sixth one. Let me see. Green, make, ask, sad, paper. No, that's wrong. Paper comes before sad. That's right, isn't it?

E: You want me to help you. [This is a characteristic Rogers nondirective response.]

S: If you would only tell me that, then I would perhaps remember the missing word. *(Pause.)* It's annoying. . . . It's funny. . . . I know it was in the fourth place, wasn't it?

E: Try to work it out by yourself, by . . .

S: I see you want me to recall the word by myself.

E: That would be more satisfying, wouldn't it?

S: Sure. I mean it is always nice to solve a little problem. It's quite an easy job remembering six words after you've said them several times. *(She moves in the chair and gives vent to little sounds of annoyance . . . a considerable pause.)*

E: You are quite annoyed with yourself.

S: Yes, I am, why should I be so stupid. . . . Green, make, ask, blank, paper, sad . . . sad, paper, blank ask. Oh, that will be no use. *(she tries again, counting on fingers and apparently saying the words silently. Makes exclamations of annoyance.)* Is it bread? No, it isn't. That's in the second lot. . . . *Is* it bread?

E: We agreed that it would perhaps be better if you tried to remember it yourself.

S: I am too annoyed to think clearly. All sorts of words pop into my mind. Is it all right if I say them?

E: You are free to go about it any way you please.

S: Well, the last set was water, long, try, bread . . . er . . . er . . . bird, wasn't it?

E: You do want help, don't you?

S *(laughs heartily)*: Yes, I'm all mixed up. If I could get certainty on the last list it might help me to remember.

E: You feel confused.

S *(laughs)*: Yes, all mixed up and disturbed. It's funny that I can remember the last list and not the first one. One word in the first one: blank, blank, blank. That's no good. I shall have to give up.

E: You are quite free to do that, you know.

Up to this point the interview has followed the general pattern of the expressive technique. The experimenter has been permissive, has recognized the subject's feeling, but has not interpreted. The permissiveness of the experimenter's last response ("You are quite free . . .") releases a good deal of expressed emotion in the next response. This is the kind of therapeutic consequence claimed for the nondirective method. The first response classified as an interpretation follows this release of feeling by the subject.

S: That's a relief. You think me very stupid, don't you? *(Laughs.)* I suppose I am, really. I should be able to recall the word. It is most exasperating. I feel quite angry with you, sitting there smug and self-satisfied. Could you do it? I mean have you tried it on yourself? *(She laughs when she sees the experimenter smiling.)* Oh, is the word "green"? That doesn't seem to ring quite true. I am sure it is not "green." I went overseas once and got quite seasick . . . turned green . . . *(pause)*.

[Now note that the experimenter departs from the non-directive method to offer a simple interpretation.]

E: Perhaps there is something about the word itself. . . . You may have had some experience, or something like that.

S: I often used to feel sick when I got angry. I did a moment ago. Just the faintest feeling in my stomach when I felt a bit angry with you. I was very seasick when I went to Europe. Turned pasty and green. . . . I was all alone . . . the youngest in a swimming team. Pasty. *(Pause.)*

[You will notice the similarity between the word "pasty" and the word she is trying to recall, which is "nasty." The experimenter stays with the problem of her feelings, however.]

E: You say you feel a little nauseated when you are angry.

S: Yes, whenever my sister and I quarreled and I got very angry I was nauseated. Once I even got sick and vomited. I didn't like the mess. This is not so bad nowadays. Only when I try to hold my irritation back, then I get it. I always thought my sister was stronger than I am. We used to have real fights sometimes. *(Laughs.)* I don't feel so confused any more. Do you think the blank, blank word . . . *(laughs)* I can't remember it yet. Can it have something to do with my quarreling with my sister? My father liked her very much more than he did me. *(Pause.)*

E: Maybe. And perhaps it is connected with some more recent experience.

[These interpretations by the experimenter may seem to be very trivial, but their importance lies in their timing. He had noted in the subject's hesitation at this point something that might be interpreted as a thought near to expression. Her response proves the correctness of his hunch.]

S: You mean with my husband. . . . Oh, that just slipped out. *(Laughs.)* Now I have said it. I might as well tell you we had a quarrel the other day—a rather bitter one. *(Pause.)* I still think he was very mean. *(With some vindictiveness.)* When people get nasty like that I get very angry. I mean nasty. Of course, that is the word. "Nasty." Well, I never. How do you like that! Do you really think this has something to do with my quarrel with my husband? It is very funny.

The success of the cases in which there were these rather simple interpretative intrusions as contrasted with those in which interpretations were avoided gives clarity to the manner in which such interpretations help penetrate a thin veil of resistance. The element of surprise at what she discovers is, by the way, characteristic of the insights that come in psychotherapy.

But I am not yet through talking about this experiment. So far we have seen one therapeutic result: the recall of a word that had undergone repression within the experiment.

The second cycle

The experimenter was not satisfied with this, for that would be mere symptom alleviation. Therapy must go deeper than that. Now, he asked, did the therapy here go any deeper, or, to put it another way, can any generalization or spread of its results be detected?

The second cycle of the experiment was almost a repeat of the first, by again introducing the learning of a list, the learning of a second list, and then the attempted recall of the first. But this time one of the response words in the critical set was used. The subject who said to "nasty" first "messy" and then "mean" is now asked to learn a list in which the first response word ("messy") is included.

The conjecture is as follows. If the therapy really released some of the emotion or produced some insight connected with the disturbing set of key words, then the repressive tendencies should have been weakened. Hence, those whose therapy was unsuccessful should repress the new word, while those whose therapy was successful should be able to recall the word without trouble.

The conjecture was completely substantiated. Those who forgot and never recovered the original stimulus word in the first part of the experiment *also* forgot the response word in the second part of the experiment: those who forgot, but later recovered the stimulus word, had no trouble in recalling the response word in the second cycle of the experiment.

A useful pattern for future work

If we take the experiment at its face value it is a beautiful epitome of much that is said to go on within psychoanalysis. I have no reason to doubt the experimental findings, except that psychologists are brought up to be skeptics, and I shall not rest happy until someone repeats and confirms the experiment. Whether or not the results in a repetition turn out as decisive as Keet's results, I believe he has set a very useful pattern for further work.

There are several very good features to Keet's experimental design.

(1) In the first place, the subjects are selected from the general population for the purposes of the experiment. They are not people who come to a physician because they believe themselves to be sick.

(2) In the second place, a symptom is produced under laboratory conditions, so that an element of control is introduced.

(3) In the third place, the methods of therapy used are clearly delineated, and criteria of therapeutic success operationally defined.

(4) Fourth, all of this is superimposed upon a recognition that a laboratory neurosis is necessarily connected with the biography of the individual. The word association test in this experiment provides a bridge to the real person, so that the experiment does not take place in a psychological vacuum. The importance of this is readily recognized when you recall the highly personal and individual material that comes out even in this very brief psychotherapeutic session.

The main points that I have been emphasizing in these lectures are that it is possible to experiment in this field and that we already have a considerable body of experimental results.

1. For one thing, it has been possible to parallel many psychoanalytic phenomena in the laboratory. When this is done, the correspondence between predictions according to psychoanalytic theory and what is found is on the whole very satisfactory.

2. A second point needs to be made. If experiments supporting psychoanalytic interpretations are any good, they ought to *advance* our understanding, not merely *confirm* or *deny* the theories that someone has stated.

Many experiments give merely trivial illustrations of what psychoanalysts have demonstrated to their own satisfaction in clinical work. Such illustrations may be useful as propaganda, or in giving psychoanalysis a fair hearing, but they do not really do much for science unless there is some fertility in them.

Only a few of the experiments that I have reported serve this constructive role, but these few set useful patterns for the future. The content analysis of Rogers and his students might be used to produce new knowledge about the course of improvement under psychotherapy. Keet's experiment suggests that we may be able to produce and cure mild neuroses in the laboratory, thus making possible precise comparisons of different methods.

3. A third point is that experimental work thus far bears most directly only on the most superficial aspects of psychoanalytic theory, while many of its deeper problems are scarcely touched. I do not worry much about this, however, for if we are able to design experiments appropriate to the more superficial aspects, we can move on to deeper stages.

We must be careful not to be trapped by the word "deeper," when we think of psychoanalysis as a "depth" psychology. Two meanings are possible. An impulse or emotionally loaded experience may be deeply repressed, possibly because it is connected with something from very early childhood. This is the usual meaning of deeper. But there is another meaning. Something is deeply important for the individual if it is in some sense central or nuclear, heavily freighted with emotion.

Depth: the metaphor and the reality

Classical theory says that these two senses correspond—the nuclear conflicts are those from early childhood, and deeply repressed. But we may find that what is deeply important for therapeutic purposes is that which arouses depth of feeling in the present, regardless of its relative importance at some remote time. Depth is a metaphor, and we need to know the realities to which it refers.

There is no doubt but that psychological science will be advanced further, as it has already been advanced, by taking cognizance of the teachings of psychoalaysis. This would be true even though psychoanalysis were to disappear in the process.

But how about psychoanalysis itself? What are its prospects as a science?

In a trenchantly critical, albeit friendly, review of the possibilities for a scientific psychoanalysis, A. Ellis[4] notes a number of "dangers," that is, features tending to delay the development of a truly scientific psychoanalysis. His main points are that psychoanalysts seem to prefer defending an accepted theory to an impartial examination of evidence, and they move too quickly to a complete and final explanation of events, when, in the present state of psychological knowledge, more modest claims would be both more fitting and more becoming.

Anyone who tries to give an honest appraisal of psychoanalysis as a science must be ready to admit that as it is stated it is mostly very bad science, that the bulk of the articles in its journals cannot be defended as research publications at all. Having said this, I am prepared to reassert that there is much to be learned from these writings. The task of making a science of the observations and relationships may, however, fall to others than the psychoanalysts themselves.

Following the rules

If psychoanalysts are themselves to make a science of their knowledge, they must be prepared to follow some of the standard rules of science. Ellis lists thirty-eight suggestions, although many of them overlap. Half of his statements warn against accepting speculative theories uncritically: making a god of some one psychoanalytic authority; letting one's own prejudices stand in the way of accepting contradictory evidence; falling into mysticism and obscurantism; seeking "complete" explanations.

The other half restate the ordinary principles of science: hypotheses tentatively proposed and subject to empirical test; control experiments; objectively recorded data; experiments on subjects other than patients under treatment; a search for contradictory as well as for confirmatory evidence; repetition of observations by independent investigators, and so on. It must not be implied that psychoanalysts themselves have not been concerned about these matters. Some suggested research problems and procedures will be discussed in the lectures by Dr. Kubie that follow.

Whatever the psychoanalysts do about research, the obligation is clearly upon experimental, physiological, and clinical psychologists to take seriously the field of psychodynamics, and to conduct investigations either independently or in collaboration with psychoanalysts. It is a tribute to Freud and his psychoanalytic followers that the problems faced by psychologists in their laboratories have been enormously enriched by the questions the analysts have taught us to ask.

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RECENT DEVELOPMENTS AND TRENDS

By PETER KYROPOULOS

and CRAIG MARKS

WHAT IS THE status of automotive engines today? How do the various powerplants compare as to output, bulk, efficiency? What is the trend for future development?

This discussion will be limited to two basic classes of applications of automotive powerplants—passenger cars, with a power range from 100 to 200 hp; and highway trucks with a power range of 150 to 1100 hp.

For these vehicles, four types of powerplants are worth current consideration—the gasoline engine, the diesel engine, the gas turbine and the compounded powerplant (combinations of reciprocating engines and gas turbines).

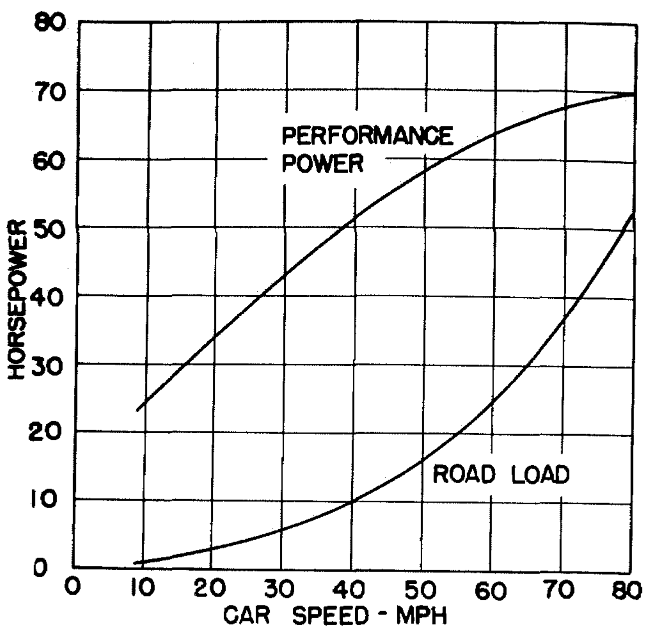
Passenger cars

A passenger car is expected to accelerate rapidly, to have good hill-climbing ability, to reach maximum speed quickly and to have reasonable fuel economy. In order to reconcile these conflicting requirements with each other it is necessary to consider the combination of engine and transmission, i. e., the whole power package, rather than each component separately.

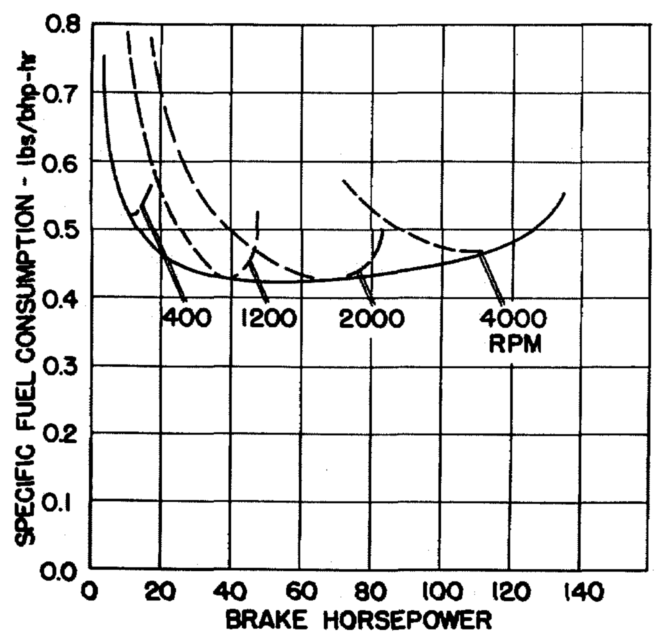
It is the aim of the transmission designer to produce a transmission which will take full advantage of the inherent economy of the engine while providing the necessary performance in acceleration and hill-climbing ability[1].

A design for given vehicle performance is based on power-required and power-available curves. Typical curves of road load horsepower for a passenger car[1] are shown in Chart A. The lower curve represents level road power required, the upper one shows power required for satisfactory acceleration and hill-climing ability.

The power delivered by the engine at any engine speed is shown in Chart B, plotted against values of specific fuel consumption. Operating the engine at constant speed and varying throttle settings results in one of the dashed curves of this chart. These curves are the so-called fish-hooks or consumption loops. For each speed there is *one* power of minimum fuel consumption. Especially at the lower engine speeds, fuel consumption increases rapidly if the power is changed ever so slightly in either direction away from the point of minimum consumption. The solid curve envelops all consumption loops. It represents, then, for all possible powers, the absolute minimum fuel consumption of this engine. Operation of a vehicle powerplant on this minimum curve would only be possible with an ideal transmission which would automatically adjust the engine



A. *Passenger car power requirements—for level roads (lower curve) and hill-climbing (upper curve).*



B. *Fuel consumption as a function of power and engine speed. Typical passenger car engine.*

This article has been adapted from a paper presented before the California Natural Gasoline Association, October 10, 1952.

speed to that required for any desired power output.

The efforts of engine designers are directed towards lowering this curve. Two steps are taken to accomplish this: (1) Increase in compression ratio; (2) Improvement in breathing.

The effect of *increased compression ratio,* both on power and fuel consumption, has been studied[2], as well as advertised extensively. Chart C shows the percent gain in power and decrease in fuel consumption for a typical modern V-8 engine, referred to 8:1 compression ratio as a base. The improvement is appreciable. No insurmountable design problems have arisen from increased compression ratios. Although octane requirements increase with compression ratio, this is an economic problem rather than one of engineering. If demand warrants production of such high octane motor fuels, they will be available.

Improved breathing can be brought about by supercharging as well as by proper manifolding[3]. This is illustrated in Chart D. Data represent production engines rather than experimental types and hence reflect realistically what can be expected.

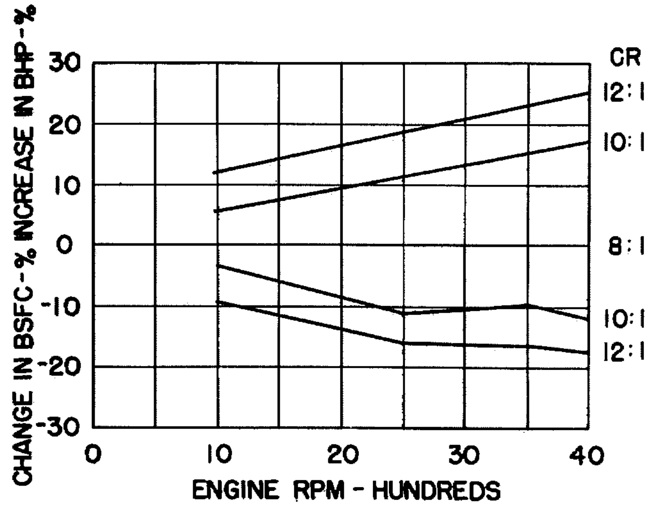
General problems arising in connection with the application of superchargers to reciprocating engines will be discussed later.

Engine-transmission relationships

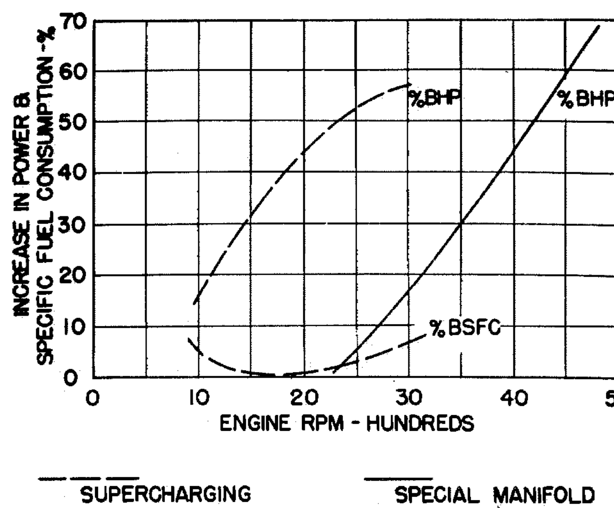
Returning to Charts A and B, it becomes apparent that the level road power-required is considerably smaller than the power-available. For example, at 25 mph approximately 5 hp are needed. In Chart B this corresponds to an engine speed of 400 rpm with a consumption of 0.6 lbs./bhp-hr; however, with present-day transmissions, the engine is rarely ever at its minimum fuel consumption. The ideal transmission would keep the engine operating on the solid (minimum) curve of Chart B at all times.

What this means in economy potential is shown in Chart E[1], in which the brake specific fuel consumption has been translated into the more tangible miles per gallon at road load. The ideal transmission curve represents the best obtainable mileage from the given engine. Comparison with the curve representing a typical stock car shows a possible improvement by a factor of two at around 30 miles per hour.

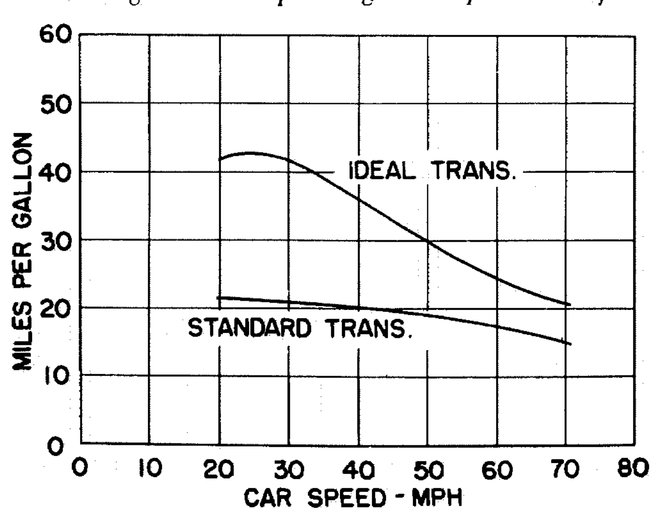
It should be emphasized that this gain is possible merely by developing a transmission which fully utilizes the potential of the engine. Any improvement in engine performance can be added to this gain. It is concluded that the proper matching of engine and transmission represents the most fundamental problem in vehicle development today. It is obviously not limited to the passenger car field.



C. *Change in fuel consumption and power with compression ration. (GM research engine,)*



D. *Change in power and fuel consumption for production engines with supercharger and special manifold.*



E. *Economy of passenger car with standard and ideal transmission. (GM research engine.)*

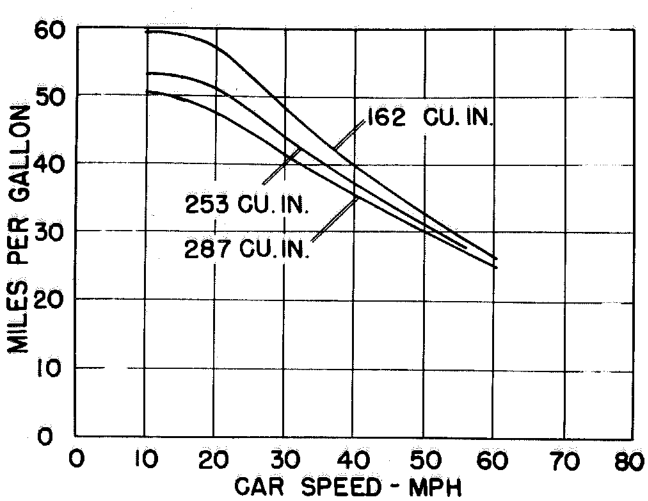
CADILLAC TEST CAR DATA

(1951 and 19XX cars are equipped with hydramatic transmissions).

	1915	1935	1951	19XX
Bore (inches)	$3\frac{1}{8}$	$3\frac{3}{8}$	$3\frac{13}{16}$	$3\frac{3}{4}$
Stroke (inches)	$5\frac{1}{8}$	$4\frac{15}{16}$	$3\frac{5}{8}$	$3\frac{1}{4}$
Displacement (cu. in.)	314	353	331	287
Compression Ratio	4.25	6.25	7.50	12.0
Brake specific fuel cons. lb/bph-hr		0.63	0.55	0.46
Miles per gallon at 50 mph	6.8	11.5	18.6	25.5
Max. Brake Torque (ft lb)	152	234	268	266
Max. bmep (psi)	73	100	122	140
Max. bhp	77 at 2600	108 at 3000	133 at 3600	148 at 4000
Hp/cu. in.	0.245	0.306	0.402	0.522
Wheelbase (inches)	122	128	126	126
Curb Weight (lbs)	4140	5050	4440	4440
Eng. rpm/mph	46.5	51.4	40.2	32.9
Axle Ratio	5.07	4.6	3.36	2.75

It is interesting to note, at this point, the effect of engine size (displacement) on economy, assuming the ideal transmission to be available. Chart F[1] shows a comparison of economy for three engine sizes. The advantage of the smaller engine is derived from the reduced throttling necessary for low power output; however, this advantage is not as great as might be expected, even at low speeds. At higher car speed it practically disappears. There is, on the other hand, no incentive to build engines with greater displacement volumes. The trend is towards smaller displacements with a possible optimum around 250 cu. in.

In order to put those minds at ease which might be alarmed by this discussion of a non-existent, hypothetical ideal transmission, Table 1[4] is shown above. It represents a comparison of Cadillac cars tested simultaneously, and illustrates the economy trend realized through engine development only. Even without the ideal transmission, the 19XX car manages to show an appreciable gain in economy over the 1951 model.



F. *Economy of passenger car with ideal transmission and engines of different displacement.*

The table further indicates the trend in displacement volumes. The brake horsepowers listed for the 19XX car seem to contradict the 1952 practice, which has become known as the "horsepower race." It is admitted among engine designers that much of this race has more advertising value than engineering merit.

For several reasons, there have been no attempts in the U. S. to utilize diesel engines in passenger cars. The small diesel has particularly poor part-load economy when compared with gasoline automotive engines. This, combined with such problems as smoking, the high cost of maintenance of injection systems, and poor starting in cold weather, makes this engine undesirable for passenger car service.

The gas turbine, likewise, is not particularly suited for passenger car service—a fact we will consider later on.

It must be borne in mind that the present gasoline engine has been developed until it is an extremely reliable powerplant, and production as well as servicing facilities are well established. To overcome this head start, any potential substitute must exhibit a real and present advantage, as well as promising future improvements to match those which are expected from the gasoline engine.

Trucks

Truck powerplants can be expected to undergo the most extensive development in the next ten years. Much of the incentive for this will come from the problems arising in highway trucking in the Rocky Mountains and on the West Coast. Let us formulate the requirements: a truck-trailer combination of 75,000 lbs. gross weight should be able to travel on grades from 3 to 7 percent at altitudes up to 8000 feet at speeds of not less than 45 miles per hour. These requirements demand powerplants of the order of 1100 hp; however, no such engine of reasonable size and price is now available for use in commercial vehicles.

Two primary requirements for this powerplant stand out: (1) High output per cubic foot of powerplant space; (2) Reasonable economy in cents per mile.

For the reciprocating engine this means high output per cubic inch of displacement and a strong advantage for the large diesel engine—which has a low fuel consumption, as well as being able to use a fuel that is inexpensive compared to high octane gasoline. This is the reason for the present predominance of diesel engines in large trucks.

It should be noted that attempts to utilize Bunker C fuel oil in conventional diesel engines have not so far been successful, because of excessive variation in its properties. Certainly it is worth bearing in mind that a powerplant which can be designed to utilize these low grade fuels is in a strong competitive position cost-wise.

High output per cubic inch displacement points to supercharging in both gasoline and diesel engine.

Supercharging

The four-stroke diesel is best suited for supercharging, and considerable development is under way in this direction. Since superchargers have been used extensively and successfully on reciprocating aircraft engines, we are often tempted to assume that application to vehicle engines should be a matter of course. This is by no means the case. The aircraft engine is basically a constant speed engine and transients are a minor part of its operation. The vehicle engine, on the other hand, seldom operates at one speed for extended periods. It is constantly accelerated and decelerated. Around this fact are centered the problems of supercharging vehicle engines.

Supercharging may be done either by means of a positive displacement pump (a Roots-type blower), or a centrifugal blower—driven mechanically, or by an exhaust gas turbine.

The mechanically driven Roots blower is well suited for variable speed operation but has relatively low efficiencies. The centrifugal blower is capable of high efficiencies but only over a limited range of flows. It is therefore not very adaptable to variable speed engine operation.

Axial flow compressors are not attractive for use on vehicle engines because of their excessive space requirements and cost, even though they promise high efficiencies.

The use of exhaust energy to drive the supercharger is thermodynamically highly desirable, since the power required to drive the blower is obtained from residual energy in the exhaust, whereas the mechanically driven supercharger uses engine power output directly. The turbocharger is not satisfactory, however, for applications which have stringent requirements for flexibility over a wide range of speeds and loads — such as are encountered constantly in vehicle powerplants.

It might be well to indicate at this point the order of magnitude of supercharge pressures and blower speeds. Typical pressures range from 37″ Hg absolute at 1200 engine rpm and 22,000 blower rpm to 49″ Hg absolute at 2100 engine rpm and 38,000 blower rpm. Roots blower speeds are lower and pressures higher at low engine speeds. The high speeds of the centrifugal blower indicate that the blower drive design problem is serious, especially if engine speeds vary rapidly. The high inertia of the rotating impeller imposes very high loads on the blower drive during changes in speed.

Considerable development work is needed before satisfactory powerplants will be produced which match in reliability the unsupercharged engines. High performance centrifugal superchargers for variable speed service must be produced.

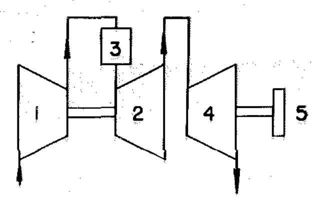
Octane requirements of supercharged gasoline engines are high, and present the same problems which the high compression engine presents. Anti-detonant injection for truck powerplants has been developed and is satisfactory. These facts notwithstanding, the advantage is with the diesel engine.

Weight and size of the reciprocating vehicle engine get rapidly out of hand as the power increases. The gas turbine then becomes at once an interesting possibility for vehicle (truck) applications in this high power range.

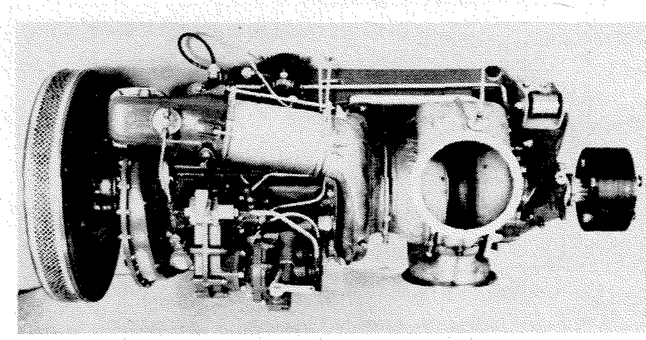
The gas turbine

The rapid development of gas turbines during the last 10 years has attracted considerable attention. Nevertheless, the basic theory was worked out and understood 45 years ago. Recent work has been directed towards making this powerplant reliable and competitive with other types. Applications have been made principally in the field of aircraft propulsion and power generation, both stationary and for rail service.

The Boeing truck gas turbine (below), with a schematic diagram of its components (right).



1 = COMPRESSOR
2 = COMPRESSOR TURBINE
3 = COMBUSTION CHAMBER
4 = POWER TURBINE
5 = POWER TAKE-OFF



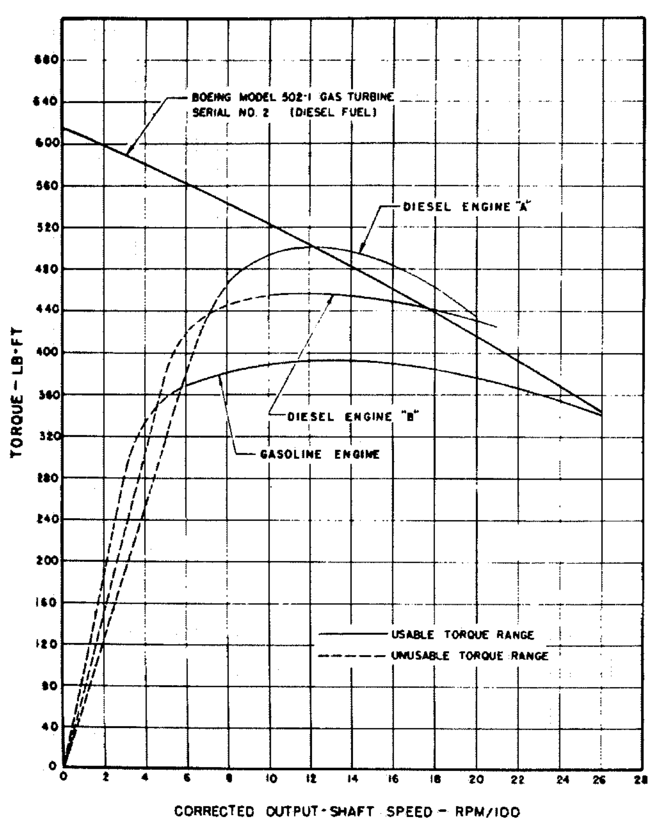
COMPARISON OF BOEING TRUCK TURBINE WITH OTHER POWERPLANTS

	Model 502	Aviation Gasoline	High Speed Diesel	Gasoline Industrial Automotive
*Part numbers in Engine	175	310	480	396
*Number of Parts in Engine	220	825	1400	881
Number of Close-Tolerance Running Fits	16	100	135	100
Max. Bhp	180	180	180	180
at rpm	36000	2700	1100	3600
Engine Weight—Pounds	200	395	2000	1500
Length—Inches	38	38	70	55
Width—Inches	22	32	30	26
Height—Inches	22	30	45	46
Installation Envelope—cu. ft.	12.7	25.2	66	46

*) Standard parts such as nuts, bolts, etc., not included.
"Part Numbers" counts only *once* any identical parts, i.e. 6 pistons = 1 part number but 6 parts.

It should be noted that these applications call for essentially constant speed service, for which turbo-machinery is most suited. Experimental vehicle powerplants have been designed and constructed and have demonstrated the potential of the gas turbine in this field.

The Boeing 502 truck gas turbine is shown on p. 21, along with a schematic diagram of its components. The unit consists of a centrifugal compressor driven by a gas turbine. The exhaust from the first turbine then enters the second or power turbine which, through a suitable reduction gear, drives the vehicle. This separation of compressor and power turbine is essential for vehicle applications since it allows speeding up of the compressor and gas flow, while the power turbine is at rest.



G. Comparison of gas turbine and other engines. Torque as a function of speed.

Table 2[5], above, is a comparison of the Boeing turbine with other powerplants of comparable output. The favorable weight-power ratio of the turbine is at once apparent: it is 1.1 lbs./bhp for the turbine, 11 lbs./bhp for the diesel engine and 8.3 lbs./bhp for the gasoline engine. The differences in space requirements and number of parts are similarly striking. Since present experimental vehicle turbines have been developed from aircraft applications (auxiliary powerplants) they have been designed with emphasis on weight reduction. Most likely this results in high cost. For vehicles, these extreme efforts to save weight may be a luxury so that a compromise may well be in order.

In Chart G[5] the torque characteristics of these powerplants are compared. The high stall torque characteristic of the turbomachine is highly desirable for vehicle application.

The fuel consumption curves, Chart H[5], reveal the most serious drawback of the turbine: high fuel consumption, or low thermal efficiency, especially at low speed. This difficulty arises in all gas turbine applications and is one of the most pressing assignments of research and development in this field.

It is well at this point to recall some of the fundamental facts concerning gas turbines in relation to the requirements of a vehicle powerplant.

(1) The turbine is basically a high speed machine. This is responsible for the small size per unit power.

(2) Maximum efficiency is obtained at *one* definite speed. The efficiency-speed relation is such that

CONTINUED ON PAGE 24

Dakar, capital of French West Africa, is one of the latest cities to be connected to the United States through Bell System Overseas Telephone Service. Initial period rate is only $15. You can talk to some 90 countries and territories from your telephone.

Dakar is on the line

No more than 25 years ago, American voices were landlocked. They could travel around the North American continent, but, except for Cuba, they were stopped at the coastlines.

Then in 1927 telephone people inaugurated two-way commercial radiotelephone service between New York and London. In that instant the world grew smaller.

It has kept on shrinking over the years till now such overseas calls are commonplace. In 1951, nearly 900,000 were made over Bell System facilities. Today you can speak to some 90 countries and territories, 96% of the world's telephones. Dakar, French West Africa, is one of the latest additions to the list.

On this 25th Anniversary of Bell System Overseas Telephone Service, we are busy working to make the record of the next 25 years even better. This never-ending effort to find better ways calls for the best engineering and scientific minds available. Such continued research provides constant opportunities for enterprising, talented college graduates.

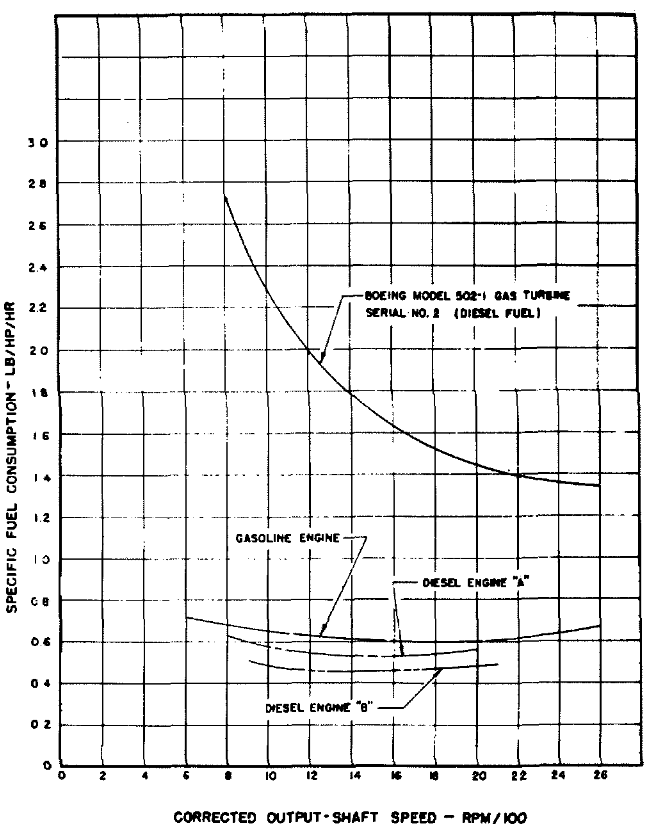
BELL TELEPHONE SYSTEM

good efficiency can be had only over a limited speed range. Below and above this range, very poor efficiencies are encountered. This is another way of saying that the turbine is basically a constant speed machine. The efficiencies we are talking about are thermal efficiencies. Their order of magnitude is 20 percent for the gas turbine, 30 percent for the gasoline engine and 35 percent for the diesel engine.

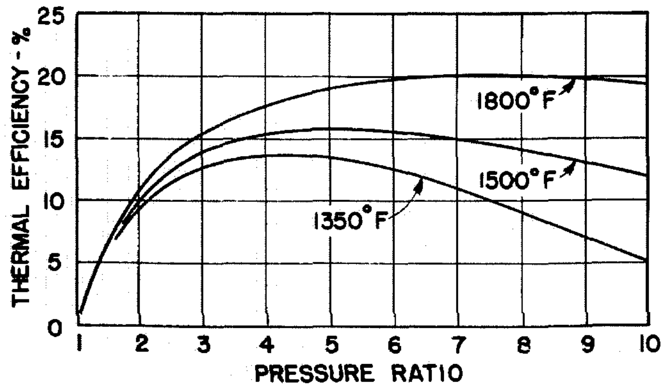
(3) The flow rates of the working medium are high compared to those of reciprocating engines. This presents problems of silencing, ducting, filtration and exhaust disposal. Not insurmountable in themselves, these items must be kept in mind where stringent requirements of shape and space must be satisfied, as well as human comfort.

(4) A definite lower limit of size exists below which a turbine with satisfactory efficiency cannot be built. To be sure, the small turbine will run, but it will have an excessive fuel consumption. On the other hand, the larger the turbine, the more rewarding will be attempts to improve efficiencies. Two hundred horsepower may well be considered the lower useful limit of gas turbines for vehicles. This is quite satisfactory, since in the class from 50 to 200 hp reciprocating engines are quite acceptable. The gas turbine thus takes over where the reciprocating engine becomes unwieldy.

In order to understand the problem of increasing thermal efficiencies and to visualize the approach to its solution, a closer look at the thermodynamics of the gas



H. *Comparison of gas turbine and other engines. Specific fuel consumption as a function of speed.*



I. *Simple gas turbine cycle. Effect of turbine inlet temperature on thermal efficiency.*

turbine is necessary. For the sake of simplicity we shall consider the simple gas turbine cycle. Here one turbine furnishes both the power necessary to drive the compressor and the useful work.

Several parameters vitally affect efficiency. These are pressure ratio (compressor inlet pressure over outlet pressure), turbine inlet temperature and component efficiencies (compressor and turbine efficiencies).

The temperature effect is shown in Chart I. At any one temperature, there is *one* pressure ratio for maximum efficiency. The need for high turbine inlet temperatures is obvious. This diagram points out two important prerequisites to gas turbine development: after thermodynamic theory, early in this century, indicated the potential capabilities, successful design had to wait for development of temperature-resistant materials and compressors with high efficiencies at high-pressure ratios. These two requirements, today, are still primary objectives of research and development.

Since the overall efficiency of the powerplant is a function of the product of the *component efficiencies*, it can be seen readily how important high compressor and turbine efficiencies are. Even though 80 percent for each component looks very good and, by present-day standards, *is* good (typical values are 77 and 71 per cent for compressor and turbine respectively), the product, 64 percent, is less attractive. The quest for high compressor efficiencies is the incentive for the vigorous development of axial flow compressors.

The exhaust from a gas turbine carries away considerable amounts of energy. Appreciable gains in efficiency can be had from *regeneration*. Regeneration takes place in a heat exchanger (called a regenerator) in which exhaust heat is used to preheat the air between compressor outlet and combustion chamber. Heat exchanger studies show that both space and weight requirements are such that the use of regenerators in vehicles is feasible.

The effect of regeneration on thermal efficiencies (Chart J), shows at once why regeneration must be considered. Fifty percent regeneration means that one half of the available thermal energy in the exhaust is put back into the cycle. For actual cycles the useful range

CONTINUED ON PAGE 26

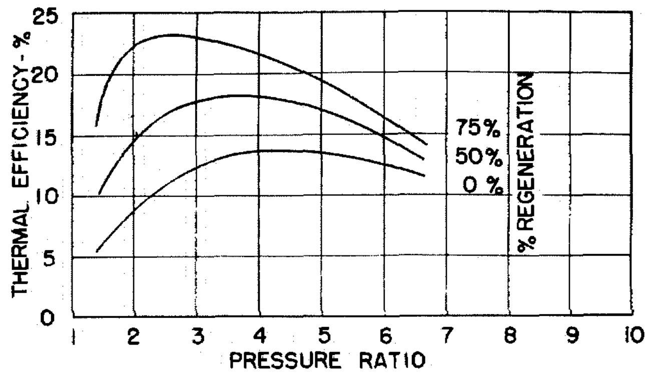
of regeneration lies between 50 and 75 percent. It is possible, then, to raise the efficiency from around 13 percent to 22 percent by this means alone. Gains of this magnitude determine whether or not a gas turbine may be considered at all.

The question as to the importance of regenerator pressure drop must be answered. As with all heat exchangers, we have to pay a price for having them around. Pressure drops must be held to a minimum if the gains from regeneration are to be realized. For efficiency calculations the pressure drops are additive. This means that a drop of 1 percent of the inlet pressure on the air side and 2 percent on the gas side has the *composite effect of a 3 percent pressure drop on the cycle* efficiency. The detrimental effect of pressure drop is the more pronounced, the lower the turbine efficiency. This again emphasizes the need for high component efficiency.

The compounded powerplant

In the preceding discussion it has been tacitly assumed that the gas turbine is to be used by itself. This is by no means necessary. Since the power requirements of vehicles vary between great extremes—low speed cruising with an empty cargo space as compared with high speed climbing at full gross weight—it is entirely reasonable to think of a powerplant which uses a 200 hp gasoline or diesel engine for low power operation, and carries a turbine with about 800 hp capacity for high power operation. Such powerplants have not yet been built but are common practice in other fields. The cruising and high speed turbine combination in naval vessels is a typical example. The comparatively small weight and space requirement of a turbine makes it ideally suited for this type of standby service. The two powerplants may be entirely separate and operate independently, or they may be combined thermodynamically to a so-called compound powerplant. Such powerplant combinations have been investigated. A variety of combinations is possible.

The turbo supercharger is an example in which the exhaust turbine is an auxiliary power producer. If the size of the turbine is increased, reciprocating engine and turbine become of similar size. The order of size may also be reversed. The engine then becomes, so to speak, the combustion chamber of the turbine. This arrangement has definite advantages over the conventional turbine arrangement at part load.

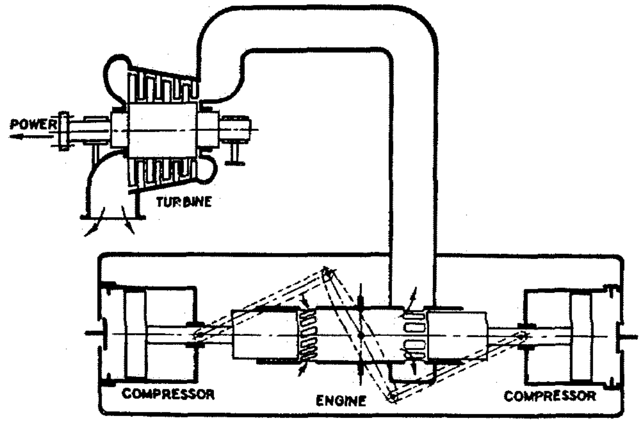


J. *Effect of regeneration on thermal efficiency.*

In another variation the reciprocating engine may be used to drive a compressor. The engine exhaust is mixed with the compressed air, fuel is injected, and the resulting gas does work in the turbine. These are only a few of the possibilities. Actually about 100 variations are said to have been proposed.

For use in vehicles, one special compounded powerplant seems to offer particular promise. This is the so-called free piston gas generator. A schematic drawing of this powerplant is shown below. Such powerplants have been tested and are being built in Europe, and several companies in this country are engaged in development work in this direction.

As far as suitability for vehicle applications is concerned, the compound powerplant is basically a gas turbine plant, distinctly different from a dual powerplant using a gas turbine for high output operation only. There is, however, no reason why the latter could not be modified to operate as a compounded system.



Compounded powerplant: The free piston gas generator.

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S.A.E. = Society of Automotive Engineers
A.S.M.E. = American Society of Mechanical Engineers

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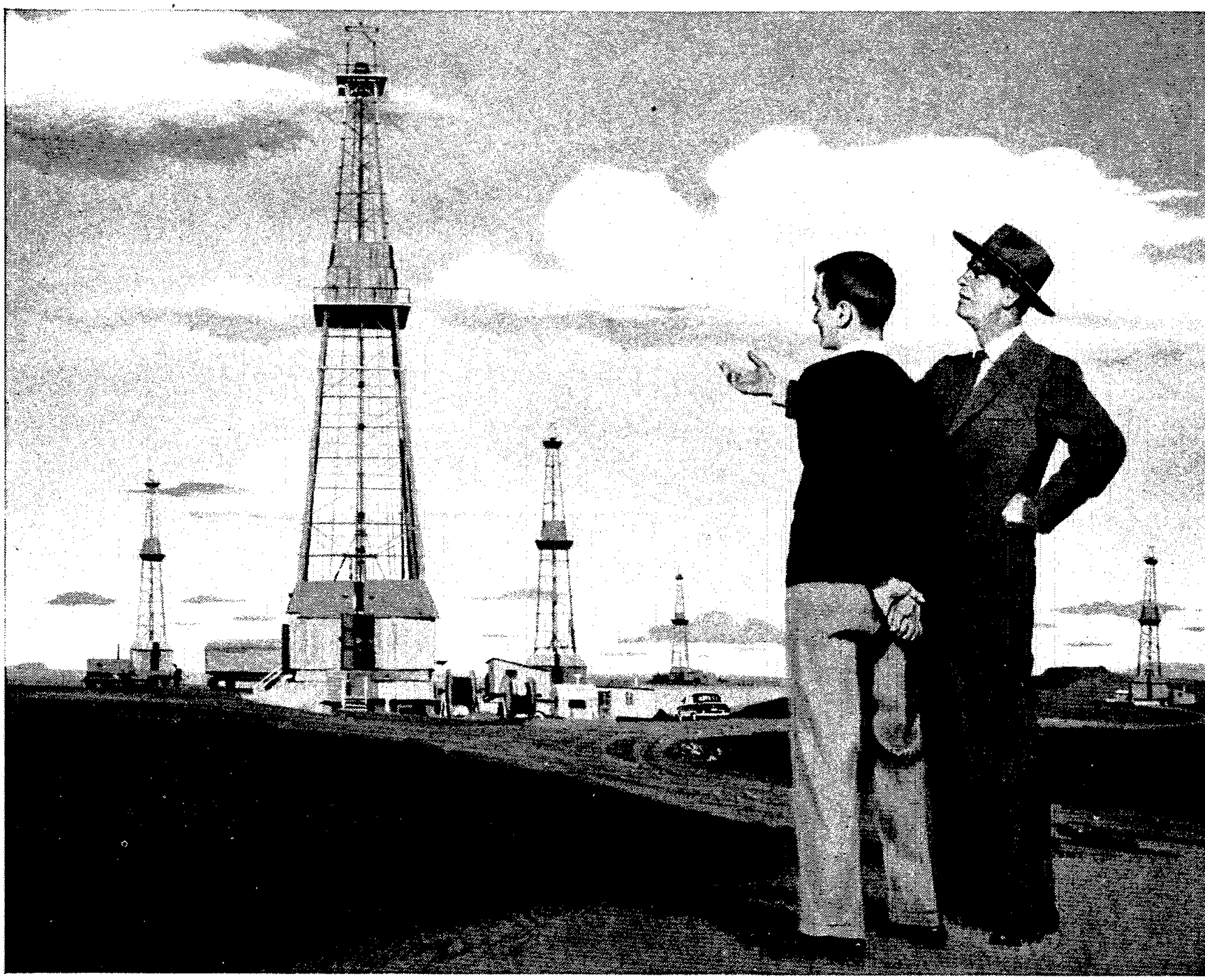

To a Young Man who wants "Room to Grow"

That's one of the attractions of the oil business as a career: big and substantial though it is today, prospects are that it has a long way yet to grow.

The discovery of new sources of petroleum and new *uses* for petroleum has gone ahead faster during the past five years than in any other comparable period. Phillips Petroleum Company gross income increased from $222 million in 1946 to $611 million in 1951. And 8,300 new job opportunities were created.

The *primary* business of Phillips Petroleum Company is producing, refining and marketing fuels and lubricants. Yet Phillips is one of the most widely diversified oil companies, and we offer opportunities for the technical graduate in many other fields: development of chemical derivatives from petroleum, ammonia and sulfur compounds, rubber synthesis, atomic research, geophysics and analytical techniques.

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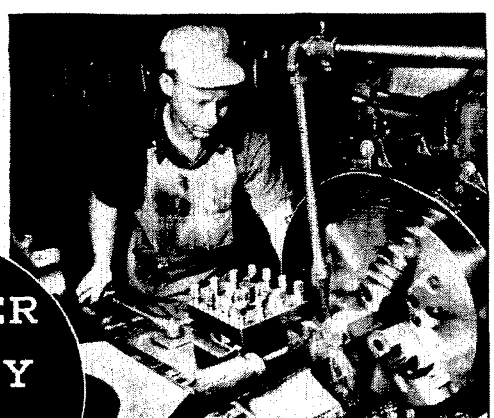
How high taxes destroy jobs

JOHN SMITH is a good mechanic who saves his money and starts a little alley shop making widgets. He works hard, hires two good fellow-workers, his wife keeps the books, and he prospers. He keeps costs low, sells widgets at $2 each, and has a good year—he makes $1000 profit.

He's delighted. Now he'll buy modern machinery that will cut costs so he can sell widgets for $1.50. He knows he'll sell so many he can hire 3 more men and raise everybody's wage. Progress!

But no! The government steps in and takes a big part of his $1000 for taxes. So John Smith cannot buy the new machinery, 3 new jobs are not created, wages cannot be raised.

In other words, the expansion which would have increased widget supply and cut their cost from $2 to $1.50 does not take place—exorbitant taxes have throttled progress, kept supply restricted, and have kept prices high; taxes have held down the standard of living. In other words, taxes have reduced jobs and wages, and injured progress. *Just as high taxes always do.*



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THE MONTH AT CALTECH

Chemical Education Award

HOWARD J. LUCAS, Professor of Organic Chemistry at the Institute, was recently named winner of the 1953 Award in Chemical Education given by the Scientific Apparatus Makers Association.

The award of $1,000 and an inscribed certificate will be presented at the annual spring meeting of the American Chemical Society in Los Angeles next March. The award was established in 1950 "to recognize outstanding contributions to chemical education."

For nearly forty years Professor Lucas has been in charge of the undergraduate course in organic chemistry at Caltech. Among his many students who have been outstandingly successful are Drs. Saul Winstein, Professor of Organic Chemistry at the University of California at Los Angeles, and William C. Young, Dean of Graduate Students at UCLA.

For the past quarter-century Professor Lucas has been identified with what is known as modern organic chemistry. He was one of the first chemists to recognize the value of electronic interpretations and was an early worker in the field of electronic structure of organic molecules. He has published more than 85 research papers.

His pioneering work, however, has not been limited to research. In 1935 he published the first textbook in his field which clearly related organic chemistry to modern chemical theory. This book is credited with establishing the pattern of all of today's elementary texts in organic chemistry. His more recent book, *Principles and Practice in Organic Chemistry*, has been highly praised by American chemists.

A native of Marietta, Ohio, he received the A.B. and M.A. degrees at Ohio State University, where he was an assistant in chemistry from 1907 to 1909. He later did research at the University of Chicago and was an assistant chemist with the U. S. Department of Agriculture from 1910 to 1913. He came to Caltech in 1913 as an instructor in chemistry.

Electronics Award

DR. ROBERT A. MILLIKAN, Professor of Physics, Emeritus, and Vice President of the Institute's Board of Trustees, received a plaque for his contributions to science, at the 10th anniversary banquet of the West Coast Electronic Manufacturers Association, held in Los Angeles on November 13.

Dr. Lee DeForest, inventor of the vacuum tube, was also honored at the banquet. The awards were presented by Dr. A. M. Zarem (M.S. '40, Ph.D '44), Director of the Stanford Research Institute, who served as master of ceremonies.

An added feature of the banquet was the presentation of four freshman scholarships—one each to Caltech, Stanford, UCLA and SC.

Harry C. Van Buskirk, 1872-1952

HARRY C. VAN BUSKIRK, Professor Emeritus of Mathematics, died on November 21 of a heart ailment. He was 80 years old.

Dr. Van Buskirk was born in Wiscoy, New York, in 1872. He received his Ph.D. from Cornell University in 1898, and came to Throop Polytechnic Institute, the predecessor of Caltech, in 1904. In 1915 he was made Professor of Mathematics and Registrar of the Institute, serving in this double capacity until 1935. He retired as a mathematics professor in 1942.

Dr. Van Buskirk leaves his widow, the former Grace Gillette, whom he married in June, 1951. He was previously married to the former Nora South, who died in 1947.

Campus Architects

PRESIDENT DUBRIDGE announced last month that the Institute had employed the Los Angeles architectural firm of Pereira & Luckman to serve as consultants "in developing a program for future development of the campus."

According to Dr. DuBridge, no plans for extending the campus beyond its present boundaries are foreseen, but "it is desirable for the Institute to have a modern campus development program worked out. Then, when and as funds become available for the construction of new athletic facilities, new dormitories, or new laboratories, the location and general design will have been planned in advance with a view to a coherent development of the entire campus."

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But I haven't majored in aeronautical engineering

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It's your aptitude, your knowledge of engineering principles, your degree in engineering that count.

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But Lockheed offers you more than a career. It offers you a new life, in an area where living conditions are beyond compare. Outdoor living prevails the year-'round. Mountains, beaches are an hour from Lockheed.

See your Placement Officer today for the details on Lockheed's Aircraft Training Program for engineers, as well as the better living conditions in Southern California.

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Lockheed Aircraft Corporation
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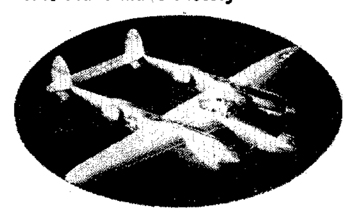
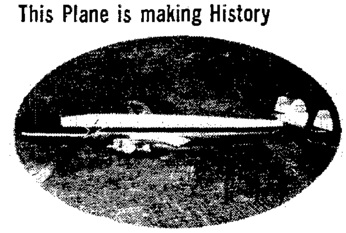
This Plane made History



The P-38 Lightning—first 400 mile per hour fighter-interceptor, the "fork-tailed Devil" that helped win World War II.

This Plane is making History

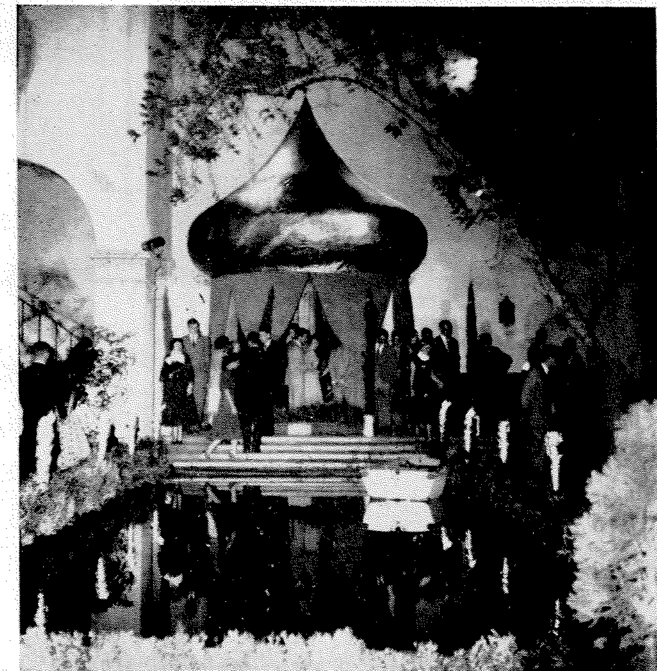


The Super Constellation—larger, faster, more powerful; the plane that bridges the gap between modern air transport and commercial jet transport.

This Plane will make History

The jet of the future—the plane you will help create—belongs here.

This plane—which exists only in the brain of an engineer like yourself—is one reason there's a better future for you at Lockheed. For Lockheed will always need engineers with ideas, engineers with imagination, engineers who build the planes that make history.



At Blacker it's an Arabian Night

Fleming is a Pleasure Dome of aluminum foil

STUDENT LIFE

FROM THE DAWN OF HISTORY TO KUBLA KHAN

DESPITE THE FACT that it capped a busy week of mid-terms, the recent Interhouse Dance was undoubtedly the most successful in many years.

Dabney's "Dawn of History" decorations included a talking dinosaur and numerous other prehistoric monsters, with luminescent paint for skin. The master stroke of their decorations was a huge volcano which filled Dabney Court, and belched forth flames with a deafening roar. (A spark coil and butane gas supplied the flames; the roar was achieved by amplifying the sound of tennis balls bouncing against a screen.)

Blacker Court boasted a manikin flying on a carpet

CONTINUED ON PAGE 34

In Blacker Court—a flying carpet

In Dabney House—a talking dinosaur

Fleming's decorators appropriated 60 medicine-cabinet mirrors to make a solid mirrored wall—forcing at least one rugged individual to shave in the lounge.

overhead, and an artificial pond, to help portray an "Arabian Night." Inside, an Aladdin's lamp, by means of clever lighting, produced a genie upon rubbing.

Ricketts was turned into a "Haunted House," with spiders, skeletons, and a creaking staircase. They were either clever here in putting up artificial cobwebs, or lax in removing the real ones.

Throop Club featured an underground cavern theme with an underground spring, and guests were obliged to crawl through a tunnel to enter and leave the dance.

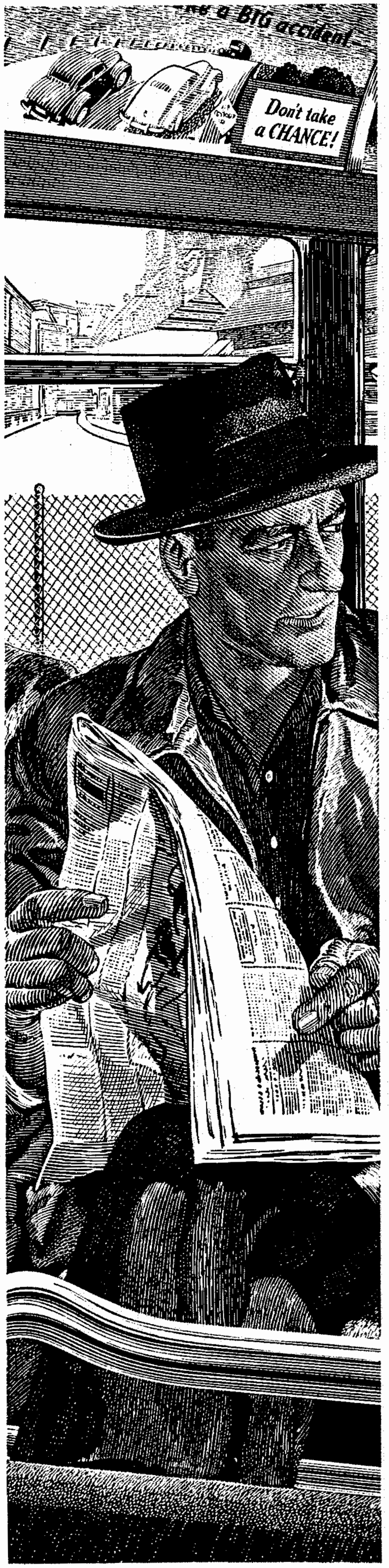
Fleming came through with the coolest decorations of the evening. Modeled after the Pleasure Dome of Kubla Khan in Coleridge's poem, all walls and exits were covered with aluminum foil, and stalactites hung from the ceiling. Two entrances were lined with walls of solid ice (3,500 pounds). Although a student house rule forbids undue water in the rooms, there was considerable debate over whether or not 500 pounds of ice could legally be placed on someone's bed. A huge mirror covered one whole wall—made up of some sixty individual mirrors from as many medicine cabinets.

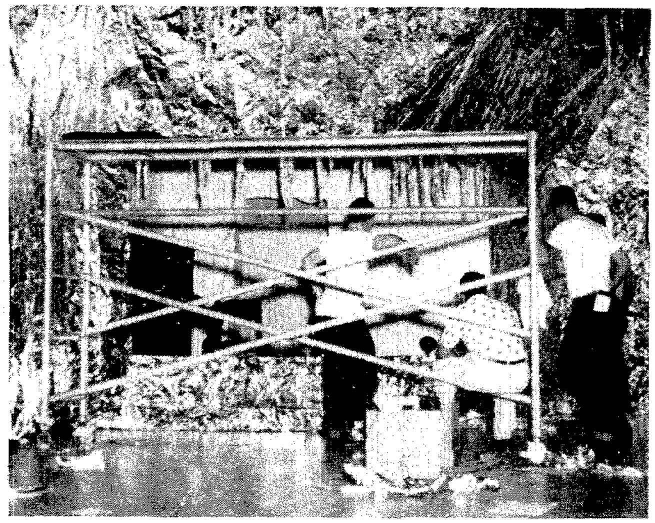
Political Note

SHORTLY BEFORE the election, the Caltech YMCA sponsored a straw vote among Tech undergrads, grad students, faculty and employees. The results:

	Undergrads	Grad Students	Faculty
Eisenhower	255	86	39
Stevenson	141	95	68
Others	30	3	5

CONTINUED ON PAGE 36


Don't take
a CHANCE!



The night before: Stalactites still going up at 4:30 a.m.

The Stevenson vote among the undergraduates seems far more than could be expected, judging from their geographical and economic backgrounds. There was a significant tendency of science majors to favor Stevenson. As for the faculty's overwhelming vote for Stevenson—it only proves what education does for people.

Shepard Scholarship

PERHAPS ONE OF the most unusual scholarships offered to students anywhere is the Don Shepard Memorial Scholarship. Shepard, who graduated from Tech in June of 1950, was killed in an airplane accident in October of the same year. He not only took part in school activities, he was also interested in the many cultural opportunities in southern California.

As a memorial to him, his parents and friends set up a $150 award to the student who could most profitably benefit from attending the many operas, plays, and concerts in this area. The award is given to men who have paid their tuition, but who could not participate in these other activities without aid. This year's recipient is Neil Stefanides, a senior who is also one of the most effective line-backers in our football conference.

On Water Fighting

THERE ONCE WAS a time when the water fight was a noble tradition in the student houses. Last year, however, a rule was passed stating that anyone throwing water around inside the student houses was eligible to be fined at least $5, the money to go to the Interhouse Committee. Recently, however, the students changed the rule so that the money now goes into the treasury of the house wherein the infraction occurs. Nobody seems to be getting rich fast, so we must assume that water fighting, like goldfish eating, has gone the way of all great ideas in this changing world.

—*Al Haber '53*

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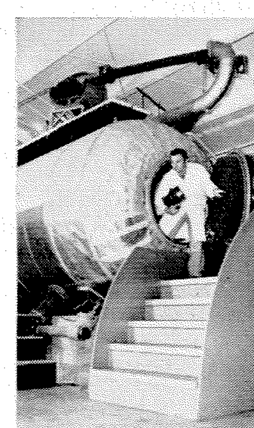
Apply to: James Crawford, Admin. Engineer, Los Angeles.



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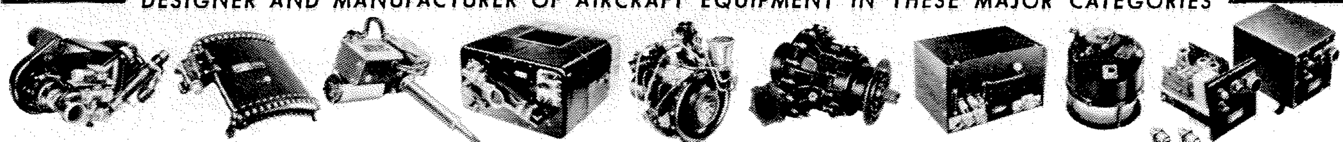

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says A. J. MESTIER
Massachusetts Institute of Technology Sc. B.—1943
and now Manager, Syracuse District Office

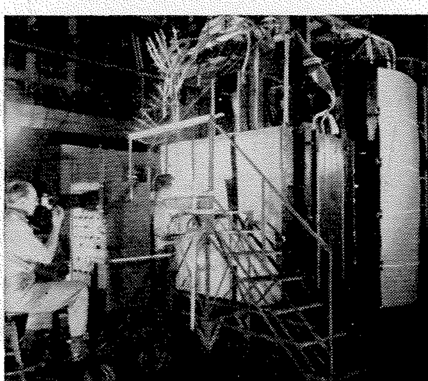
"I WAS LOOKING for an engineering job, but I wasn't very sure just what phase of this broad field would interest me most. I didn't know whether I wanted straight engineering, sales engineering, production or some other branch of industrial engineering.

"Allis-Chalmers Graduate Training Course gave me a means of working at various jobs—seeing what I liked best—and at the same time obtaining a tremendous amount of information about many industries in a very short time."

Experience Typical

"My experience is typical in many ways. I started the Graduate Training Course in 1946, after three years in the Army. My first request was to go to the *Texrope* V-belt drive department. From there I went to the Blower and Compressor department; then the Steam Turbine department. By the time the course was completed in 1948, my mind was made up and I knew I wanted sales work. I was then assigned to the New York District Office and in 1950 was made manager of the Syracuse District. The important thing to note is that all Allis-Chalmers GTC's follow this same program of picking the departments in which they want to work.

"Best of all, students have a wide choice, for A-C builds machines for every basic industry, such as: steam and hydraulic turbine generators, transformers, pumps, motors and other equipment for electric power; rotary kilns, crushers, grinders, coolers, screens and other machinery for mining, ore processing, cement and rock processing. Then there is flour milling machinery, electronic equipment and many others."

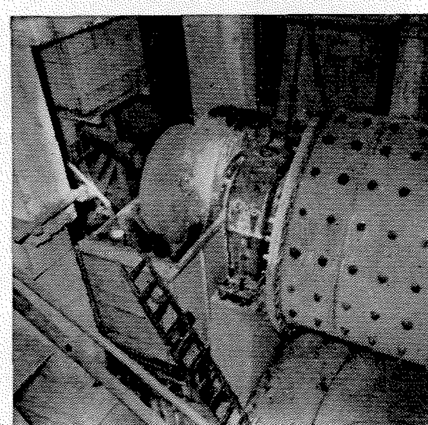


Taking surge voltage distribution tests on power transformer in A-C shops with miniature surge generator and cathode-ray oscilloscope.

A Growing Company

"In addition, new developments and the continuing growth of the company offer almost endless opportunities for young engineers.

"From my experience on the Graduate Training Course, I believe it is one of the best conducted in the industry and permits a young engineer to become familiar with a tremendous variety of equipment—both electrical and mechanical—which will serve him in good stead in his future profession."



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Texrope is an Allis-Chalmers trademark.

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ALUMNI NEWS

January Dinner Meeting

THE JANUARY dinner meeting of the Caltech Alumni Association will be held at the Lakewood Country Club near Long Beach (3101 E. Carson Blvd., Lakewood) on Wednesday, January 14. Speaker of the evening will be Dr. A. M. Zarem (M.S. '40, Ph.D. '44), Director of the Stanford Research Institute, who will discuss the smog situation and show a colored motion picture on the subject. Dr. John R. Weir, Associate in Psychology at the Institute, will also give a preliminary report on the Caltech alumni survey.

Honored Graduate

DR. THOMAS CLEMENTS, M.S. '29, Ph.D. '32, head of the Geology Department at the University of Southern California, has been selected as the year's most honored graduate of Texas Western College of the University of Texas.

Dr. and Mrs. Clements and their daughter, Anne, a student at S.C., went to El Paso for the college's homecoming activities on November 15.

Dr. Clements was graduated from Texas Western in 1922 when it was known as the Texas School of Mines. He joined the S.C. faculty in 1929.

Sorensen Fellow

JEROME K. DELSON, M.S. '50, who was chosen as the first recipient of the Royal W. Sorensen Fellowship in Electrical Engineering last year, has received the award for 1952-53 as well. Delson is expected to finish his doctorate studies at the Institute this year.

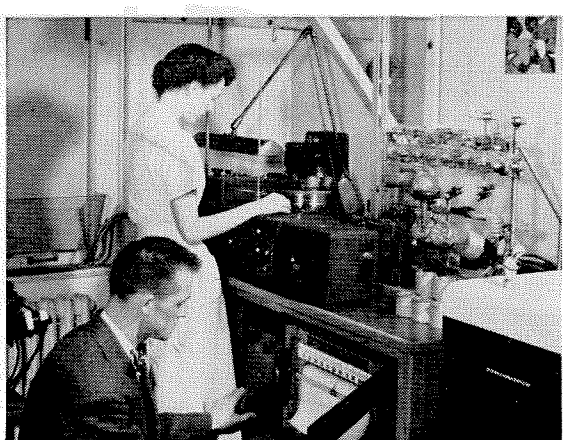
The Sorensen Fellowship, set up in 1950 by a group of Caltech alumni, is a $900 graduate award.

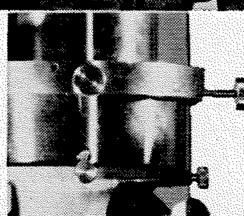
San Francisco Chapter

THE SAN FRANCISCO CHAPTER had a most enjoyable evening at the H. P. ("High Pressure") Henderson home in San Mateo on Saturday evening, November 1. The party started with a pot luck supper to which everyone brought his favorite recipe. The attendance was one of the largest we have had, totaling about eighty-five.

The highlight of the evening was the Howard Vespers' presentation of colored pictures of their trip to Europe last summer. Howard regaled his audience with a running commentary and Ruth gave us the ladies' slant on the European situation.

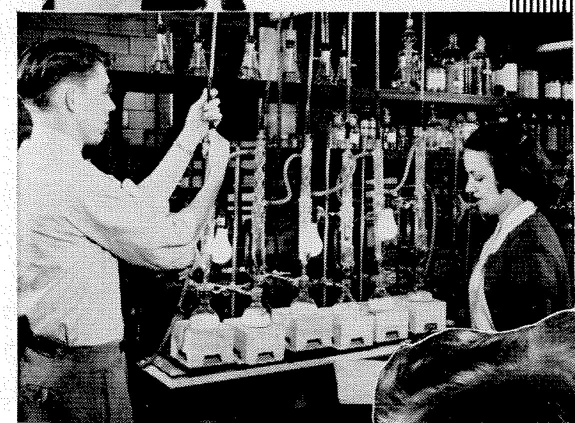
—*Robert Heitz '36, Secretary-Treasurer*





Making an analysis with the infra-red Spectrophotometer.

Testing action of Perchlorethylene on various metals.



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COLUMBIA-SOUTHERN

Focusing the Electron Microscope on a chemical sample to be photographed.

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1921

George N. Hawley, Ex., was recently elected to the vice-presidency of the Southern California Edison Company. He is in charge of the Commercial Department.

1922

Howard G. Vesper, President of the California Research Corporation in San Francisco, is chairman of the advisory committee which directs the American Petroleum Institute's research on the composition and properties of petroleum. This was one of the main topics under discussion at the API's 32nd annual meeting, held at the Conrad Hilton Hotel in Chicago in November.

1926

Royal E. Fowle, Ex., has been appointed for a year to the central coast region water pollution control board, according to a recent announcement by Governor Warren. The control board reviews and sets up minimum standards for sewer and similar projects affecting stream and ocean pollution in the area from Santa Cruz to San Luis Obispo counties.

1927

Kenneth Belknap is still in the insurance business, operating as Belknap and Belknap, although a few years ago he did move to a new location. Ken has been in insurance now for almost 20 years. His two boys—Bruce, 15, and Raymond, 11—are in La Canada High School.

Allen C. H. Mitchell, Ph.D., represented Caltech at the inauguration of Dr. Russell J. Humbert as 15th president of DePauw University on October 18. Allen and representatives of 215 other colleges (ranging from the University of Rome, founded in 1303, to the Universidad de los Andes, founded in 1949 in Bogota, Colombia) marched in the inaugural procession. Allen is now in the Physics Department at Indiana University in Bloomington.

1929

James W. Dunham has been elected president of Local 777 of the National Federation of Federal Employees for the coming year. He's living in Los Angeles.

Homer Reed, M.S. '30, former chief engineer of Union Oil Co., will head Brea Chemicals, Inc., a new company formed as a subsidiary of Union Oil to develop, manufacture, and market chemicals from petroleum.

1930

L. Sprague de Camp is co-author with Willy Ley of a new book, *Lands Beyond*, published by Rinehart & Co.

1932

Henry B. Pownall was elected president of Plantation Foods, Inc. in May, 1952. Plantation Foods has headquarters in Miami, Florida, and distribution centers in 16 cities in Florida. It's the state's largest manufacturer of ice cream products. Besides this, Henry is still president of Freezing Equipment Sales, Inc. in York, Pa. They sell rotary booster compressors and manufacture a continuous package freezer for the frozen food and ice cream trade. The Pownalls are now living in Miami.

David W. Anderson has three daughters, now lives in Altadena, and is employed by the Navy.

Albert W. Atwood, Jr., M.S. '33, ha been an electrical engineer with Southern California Edison—working on substation hydro and steam plant design—since th end of the war. He is married, and ha been an L. A. resident since graduation

1933

Arthur N. Prater, M.S., Ph.D. '35, was elected chairman of the Division of Agriculture and Food Chemistry of the American Chemical Society. Art is also technical director at the Gentry Division of the Consolidated Grocers Corporation.

Robert G. MacDonald has been released from active duty with the Army. He is still with the Department of the Army, however, as civilian engineer advisor to the Quartermaster General in Washington, D. C.

1935

Arthur E. Engelder, who is director of the Engelder Labs in Douglas and Morenci, Arizona, has been dividing his time between the practice of medicine and surgery and research work on a number of new medical instruments. Next year he hopes to have his organization set up so he can devote all his time to the instrument business.

Ensign Robert Tookey has been on active duty in the Naval Reserve for over a year, serving on a destroyer in the Pacific area.

1936

Meral W. Hinshaw, vice-president of the Felker Manufacturing Company, arrived safely in Johannesburg, South Africa, late in October, following a crash landing in Rome earlier, aboard one of Britain's eight-mile-a-minute Comet jet airliners. None of the passengers or crew members on board was hurt when the plane raced into the air off Rome's Ciampino Airport and then smashed back to earth in a belly landing. Meral was on his way to the Diamond Syndicates Lab in South Africa to do research work for his company. The Felker Co. makes diamond abrasive tools.

Clarence L. Dunn, Ph.D., is head of the physical chemistry department of Shell Development Company, Emeryville, Calif.

Bruce Beckley, a patent attorney in San Francisco, married Eleanor Cary last October.

1937

Daniel G. Schuman was elected controller of the Stromberg-Carlson Company in Rochester, N. Y., in August. He has been associated with Stromberg-Carlson since 1949 when he came to Rochester as a representative of Price Waterhouse and Co., to develop improved methods and procedures for the company. He later joined Stromberg-Carlson as assistant treasurer.

Dan was a manager in the systems department of Price Waterhouse for six years. During the war he served in the U. S. Navy, Bureau of Ships, leaving as a Lieutenant Commander in 1945. He and his wife, Jacquelyne, have three children.

1938

Herbert B. Ellis, M.S. '41, left JPL last March to work for Lockheed at Marietta, Georgia. Since September 1, he has been manager of the assembly methods department. The Ellis family, including John, 9, and Joan, 7, is now living in Atlanta.

Henry K. Evans is a transportation specialist for the U. S. Chamber of Commerce in Washington, D.C.

Carroll F. Chatham, a consulting chemist in San Francisco, is one of the few Americans who admits having entered the diamond-making race. Carroll has already succeeded in making emeralds, which are structurally and chemically like the kind nature yields, except that his can't be destroyed by fire. However, he doesn't think a practical method for making diamonds commercially will be hit on overnight.

Newman Hall, Ph.D., has been appointed director of the engineering sciences division of the Office of Ordnance Research at Duke University. He was the former head of the analysis section of the research division of United Aircraft Corporation. Newman is at OOR on leave of absence from the University of Minnesota, where he is Professor of Mechanical Engineering and head of the heat and power division of the Department of Mechanical Engineering. While at Minnesota, he did consulting work in the field of combustion and gas dynamics for United Aircraft, the Naval Ordnance Laboratory, Bureau of Standards, and the Aircraft Nuclear Propulsion Division of General Electric. Newman and his wife, Eileen, have two children and are living in Durham, North Carolina.

Gardner P. Wilson has joined the Consolidated Engineering Corporation of Pasadena as a senior development engineer. He will be in charge of the mass spectrometer group of the engineering department. From 1945 to 1952, Gardner was head of the test division of the Naval Ordnance Test Station in Pasadena. He and his wife and two children now live in Altadena.

Saul Winstein, Ph.D., of the University of California, has been added to the consulting staff of the Hercules Powder Co.

1939

Major William M. Green moved last September from Kirtland Air Force Base in Albuquerque, New Mexico, to Ann Arbor, Michigan. The Air Force is sending him to the University of Michigan for graduate work in the field of guided missiles this being part of the program of the USAF Institute of Technology, Wright Patterson Air Force Base, Ohio. Bill finds it a little rough getting down to methodical study, particularly in mathematics, after all this time. The program lasts for two years. His wife, children—Billy, 10, and Barby, 6—and household possessions are now in Ann Arbor *and* in a house—an item noted for its scarcity around those parts.

Harold L. Levinton, M. S., has been working in property management in the Los Angeles area since 1947. He was with the Metropolitan Water District of Southern California in Los Angeles from 1931 to 1938, then, from 1938 to 1947, worked for the Bonneville Power Administration in

Portland, Oregon. Harold and his wife, Irene, his daughter Sharon, and his stepdaughter, Claire, live in Hollywood.

1940

George C. Barber left Douglas Aircraft in Santa Monica last March, where he had worked since graduation. He's now employed by Hughes Aircraft as an aeronautical engineer working on helicopter structures design. He and his wife have three young daughters, and live in Mar Vista.

1941

Eldred W. Hough, M.S., Ph.D., '43, has joined the faculty of the petroleum engineering department of the University of Texas. He was formerly with the Stanolind Oil and Gas Company.

1942

Wendell Harter, M.S. '47, has been a dynamics engineer at Northrop Aircraft in Hawthorne, for the past year and one-half. He is now lead engineer in charge of dynamic loads. Wendell's family has reached its full complement of the following: Madelyn (wife), Lowell (6), Gordon (4), and Janet Lynn (12½ months).

1943

Bertram A. Nelson, M.S., is an agriculturist in the Fort Collins, Colorado, district of the Great Western Sugar Company.

1945

Halcyon Ball is busy studying for his CPA exam, while teaching accounting and having his own accounting practice in Long Beach. The Balls have two kids—Teresa (4), and Kenneth (1).

Dick Neerken, who has been with the Worthington Corporation since his graduation, moved October 1 from Phoenix, Arizona to Los Angeles to become Assistant Office Engineer. The Neerkens have a baby girl, born in May, 1952. They've just bought a new home in Westchester and hope to move in before the first of the year.

1946

Theodore S. Gilman, M.S., is an Assistant Professor of Chemistry at the University of Colorado. His son, Gardner McClung, was born March 13, 1952.

Willard A. Ross is a Lt. (jg) in the Civil Engineer Corps of the U. S. Navy. He's an assistant public works officer for transportation at the Naval Station in Key West, Florida. He and his wife, Evelyn, have two children, Roger and Timothy, 3½ and 2 years old, respectively.

1948

Bill Jarmie was married last June to Joyce Dawson of Oakland. He hopes to receive his Ph.D. in physics shortly from U. C. Berkeley, but says he's enjoying life thoroughly in the meantime.

Curtis C. Whittlesey, ID, went to work for General Motors immediately upon receiving his Professional degree. He's now in Detroit, as a junior executive in G. M.'s styling department. His picture has been appearing in newspapers and magazines lately, in connection with the new Le Sabre car.

George L. Humphrey, M.S., has recently been appointed Assistant Professor of Chemistry at West Virginia University, Morgantown, W. Va. George did research in rocket propellants at Caltech and in thermochemistry for the U. S. Bureau of Mines.

George P. Rigsby, M.S. '50, with several other graduate students in geology, put in time this summer on the Saskatchewan Glacier in Banff Park, Canada. This was the beginning of a coordinated program to make this the most thoroughly understood glacier in the Western Hemisphere—to serve as a "field laboratory" for future glaciological research.

1949

Byron C. Karzas married Diane Stathas on November 8 in Highland Park, Illinois. The couple will live in Evanston.

Hardy C. Martel has been awarded an RCA Fellowship for the second successive year to continue work toward a doctorate in electrical engineering at Caltech.

1950

Robert D. Clark, M.S., a development engineer with the Union Oil Company of California, was recently transferred to the outfit's research center at Brea. There, Bob is engaged in the design of chemical-processing and petroleum-refining equipment which operate at high temperatures and pressures.

Ralph J. Stone joined United Geophysical in September of 1950, and spent a year with them in Kuwait, Persian Gulf. He's now in Alaska where he's spent the last six months working for United Geophysical in Fairbanks and on the Naval Petroleum Reserve south of Point Barrow.

1951

Royal S. Foote, M.S., reported on his travels around the world for the AEC in a recent issue of *The Fumarole* (the Geology Division's house organ at Tech). After three weeks in Australia he wrote that he'd ". . . just whipped the Australian uranium effort into shape, as advisory man from the States—and now will make Lisbon with some leisurely stops at Singapore, Calcutta, Beirut, Rome, and Madrid. . . . I've been setting up airborne geophysical programs—aeromagnetic and aeroradiometric with a DC-3 and Shoran control—covered the Australian continent from North to South. . . ."

Rod Phippsto, M.S., and his wife, Dorothy, sent word that the Canadian stork delivered Graeme Grant Phippsto on October 18 in Calgary, Alberta.

1952

Edwin B. Kurtz, Ph.D., was married last June to Lois L. Leecing. He is Assistant Professor of Botany at the University of Arizona.

Etalo G. Gnutti, M.S., has strayed from engineering and science and is now practicing law. He's the Borough Court Judge in Stafford Springs, Connecticut. He is married and has a son.

Douglas C. Alverson is with the U. S. Geological Survey in Plant City, Florida.

Daniel B. Appleman, Ex., is a graduate assistant at Johns Hopkins.

William F. Edmondson is with the Superior Oil Company in Bakersfield.

Donald Lamar is a graduate assistant at the University of Kansas.

F. Beach Leighton, Ph.D., is Assistant Professor of Geology at Whittier College. He is also football coach to the "Poetbabes."

Dallas Peck is a graduate assistant at Harvard University.

Jack I. Simmons is doing graduate work at Northwestern University.

Deake K. Smith is a graduate assistant at the University of Minnesota.

Herbert H. Winters is with the Florida Geological Survey in Tallahassee.

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ALUMNI CALENDAR

January 14	Dinner Meeting, Lakewood Country Club	April 11	Annual Seminar
February 7	Dinner Dance	June 10	Annual Dinner Meeting
March	Dinner Meeting, Santa Monica area	June	Annual Family Picnic

CALTECH ATHLETIC SCHEDULE

VARSITY BASKETBALL

Dec. 4, 5, 6
Redlands Tournament
Dec. 9, 4:30 p.m.
LaVerne at Caltech
Dec. 13, 8:00 p.m.
Caltech at Chapman

FROSH BASKETBALL

Dec. 9, 4:45 p.m.
LaVerne JV at M Kinley
Dec. 13, 6:45 p.m.
Chapman JV at Chapman

FRIDAY EVENING DEMONSTRATION LECTURES

7:30 p.m.—201 Bridge

Dec. 5 "Old and New Problems in the Theory of Numbers," by Professor T. M. Apostol

Dec. 12 "Inherited Effects of Atomic Bomb Radiations" by Professor E. G. Anderson

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