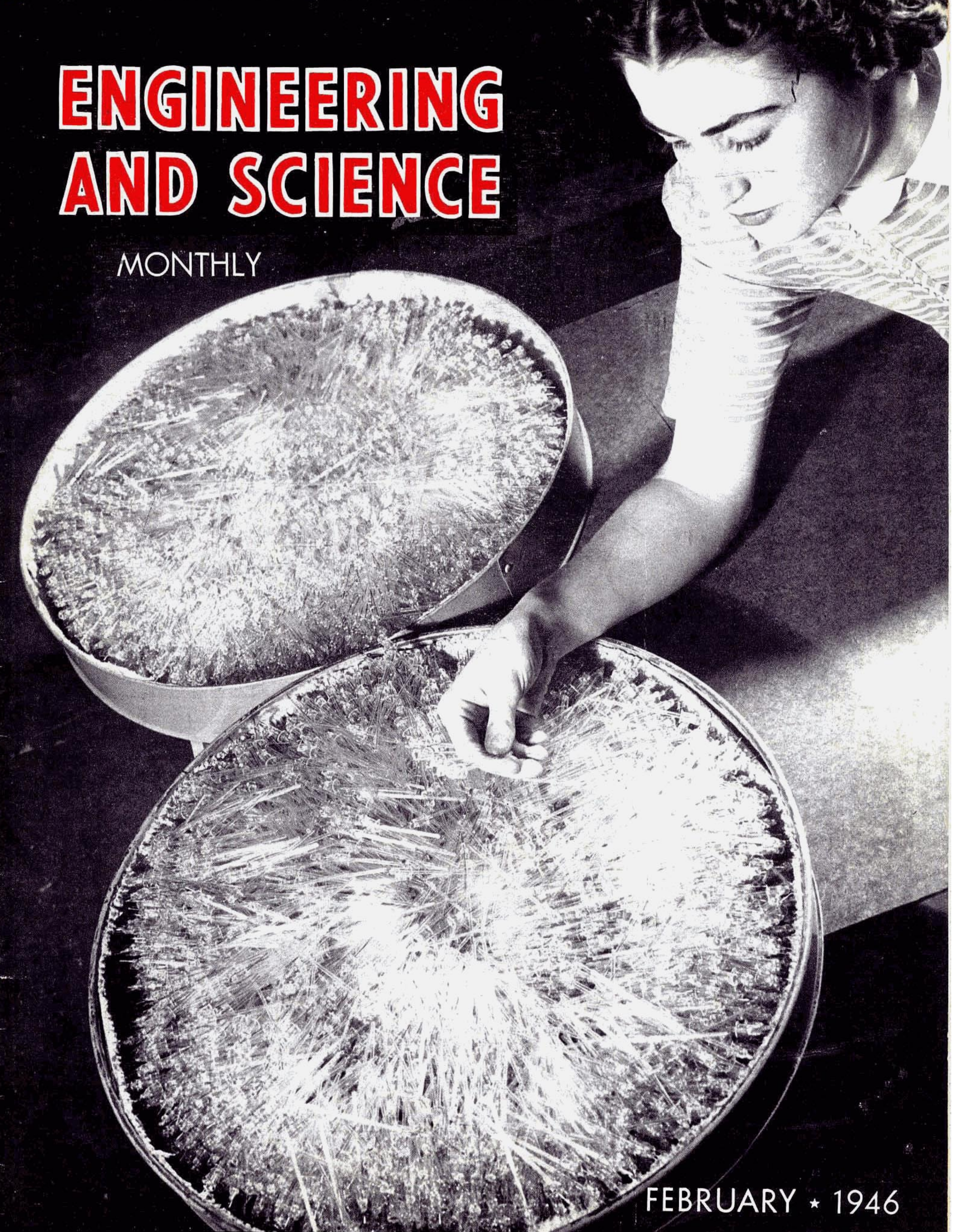
ENGINEERING AND SCIENCE

MONTHLY



FEBRUARY ★ 1946

PUBLISHED BY CALIFORNIA INSTITUTE OF TECHNOLOGY ALUMNI ASSOCIATION

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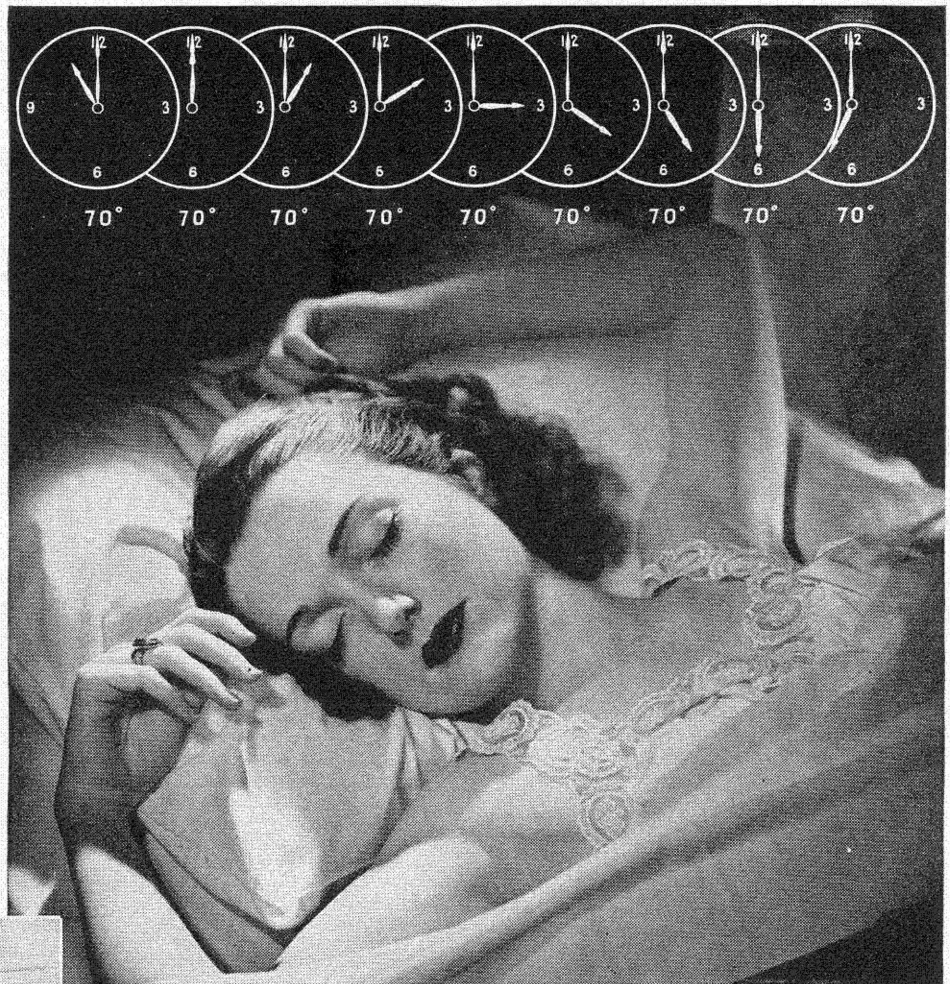

She likes to sleep "snug as a bug in a rug" on zero nights. Her husband is a ruggeder, warmer-blooded sort. But a feather-weight G-E automatic blanket for each is perfect—for these blankets can be adjusted to keep beds at any degree of warmth evenly all night long, despite temperature changes. G-E automatic blankets are made according to the same principle that keeps high-altitude flying suits "electrically warm" even at 60° F. below zero.

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BY-LINES

CLINTON K. JUDY

Clinton K. Judy has been Professor of English and chairman of the Division of the Humanities at the Institute since the Division was organized. He holds degrees from the Universities of California, Harvard, and Oxford. Few graduates of the Institute have failed to feel the stimulating effect of his fine critical mind.

• • •

DONALD S. CLARK

Donald S. Clark was graduated from the California Institute of Technology in 1929 and received his Ph.D. degree from that Institute in in 1934. Doctor Clark is Associate Professor of Mechanical Engineering and in charge of physical metallurgy at the Institute. During the war he actively directed research activities for the Institute under contract with O.S.R.D. and W.P.B.

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BENEDICT CASSEN

Benedict Cassen received his Ph.D. degree from the California Institute of Technology in 1930. Dr. Cassen has since been engaged on various research projects, most of which have been associated with X-ray and radiation physics, largely for industrial companies. He is now with the Research and Development Department of the U. S. Naval Ordnance Test Station.

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WILLIAM DOUGLAS SELLERS

William Douglas Sellers was graduated from the California Institute of Technology in 1925. After two years with General Electric in Schenectady, he entered the United States Patent Office as an examiner. Upon completion of law studies at George Washington and De Paul Universities, he received the degree of Juris Doctor and, subsequently, a Master of Patent Law Degree from John Marshall Law School. Mr. Sellers has recently engaged in general patent practice in Los Angeles.

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E. H. HEINEMANN

E. H. Heinemann, author of "The Air We Fly In," has been chief engineer of the Northrop Corp., a subsidary of Douglas Aircraft Co., Inc., for the past nine years. Under his supervision many famous models such as the SBD Dauntless, A-20 Havoc, DC-5, A-26 Invader, and BT2D Skyraider were developed. Assisting Mr. Heinemann in the preparation of the article were engineers P. A. Dennis and Howard Roberts. The chart was executed by R. G. Smith.

ENGINEERING AND SCIENCE

Monthly

The Truth Shall Make You Free

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For biography of E. C. Watson, refer to *Engineering and Science*, December issue.

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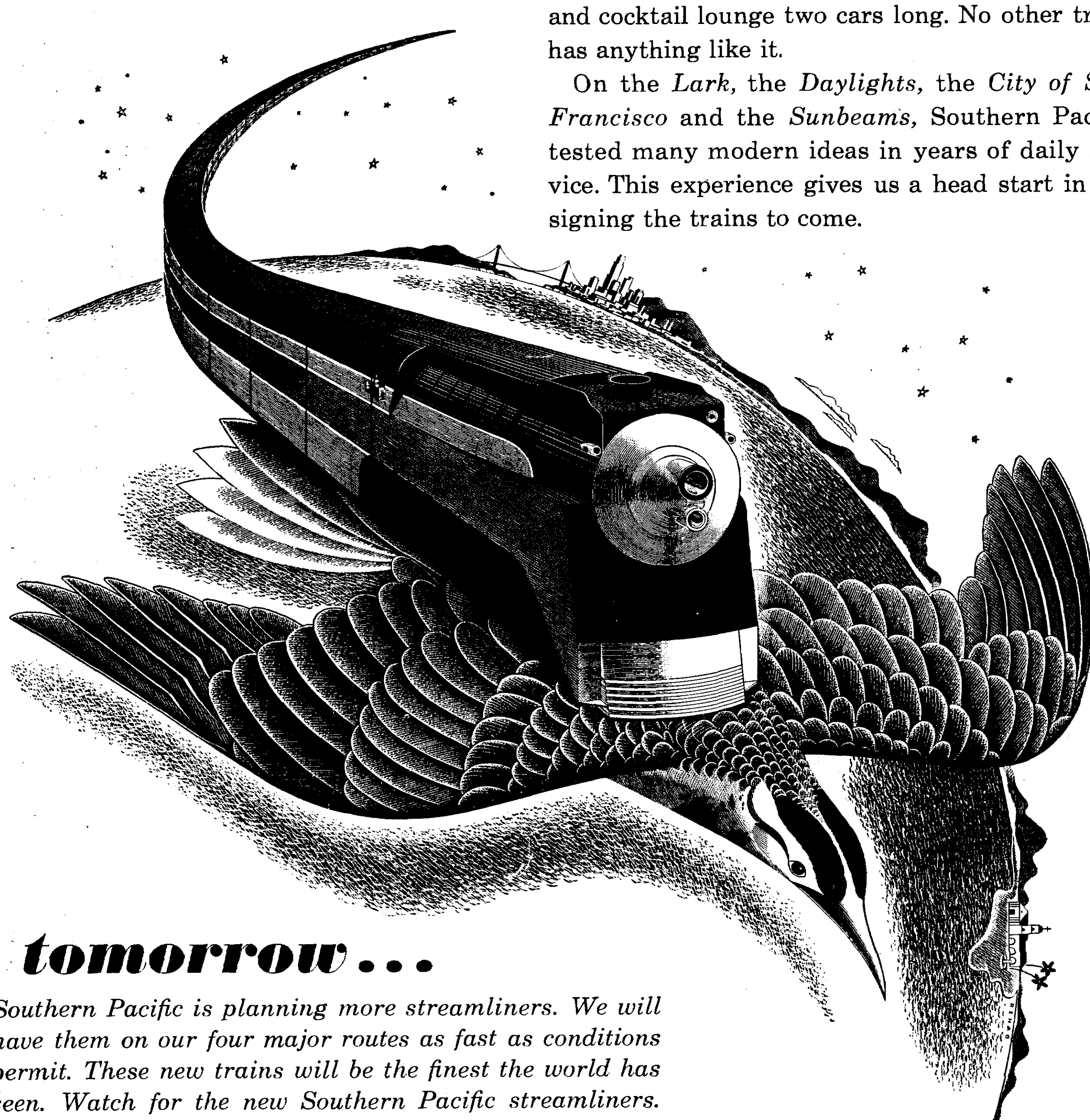

ENGINEERING AND SCIENCE
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THE HARVARD REPORT

By C. K. JUDY

EVERY college man amuses himself at times with casting a backward glance at his years in school. What did those years give me? Does their contribution fit harmoniously into the pattern of my life? Would I, could I begin again, revise my course of study?

A critical examination of many replies to such questions yields generalizations, each of which may become a focal partisan issue: basic science or technology; vocational courses or liberal; natural or social science? For several years, the advocates of liberal education have issued manifestoes and appeals in an effort to check the over-emphasis on science and on vocation in educational practice. The war stimulated them to greater effort, for it seemed that in war the paramount value of science and technology would cheapen still further the liberal courses. Parenthetically, it might be noted that the climax of destruction and the war's end have, ironically enough, generated a reaction among scientists themselves; some, at least, are favoring the inclusion of the social sciences as beneficiaries under the Bush Plan—the most grandiose proposal ever made for subsidizing scientific investigation.

Closely similar to the revisionist campaign waged by the exponents of liberal education is the reform proposed by the Harvard report (*General Education in a Free Society:* Harvard University Press); the authors indeed admit that they might have used the term "liberal" instead of "general" had they been talking only of college curricula.

COMMITTEE APPOINTED

Three years ago the president of Harvard University appointed a committee of twelve to study American education and to make a report on "The Objectives of a General Education in a Free Society." The report, published recently, is a model of analysis and conservative appraisal. It cannot fail to interest an alumnus of the Institute, and for two reasons: it presents a rationale of general or liberal education, against which as a background he may set his own experience in college (for better, for worse); and it sharpens for his attention as a parent the outlines of an education for his children in high school or college.

REPORT COVERS WIDE FIELD

The report is not about Harvard University: only one of its six chapters is given over to suggested improvements in the Harvard curriculum; four chapters are devoted to high school and college in general, and one to adult and extra-academic education. In the four chapters presenting the general argument, the high school is oftener under discussion than the college, and rightly so, for high school graduates outnumber college graduates six to one; and all have equal rights in a free society.

Education is our labor-saving device to enable a man to live a good life in the environment in which he finds himself. Now for some time—roughly for a hundred years—the multiplication of the fields of knowledge, mainly scientific and technological, and the need for developing expertness through a kind of division of labor, have led to a multiplication of courses in schools to keep pace with the changing world we see. Spectacular changes have diverted our attention from the constants, or the more slowly changing elements, in human life: the common ground, the traditional wisdom, the inheritance, we enjoy without earning. We are not born in a vacuum. There is a tension in life between the divisive influence of separate interests and the unifying influence of common beliefs and ideals. The Harvard committee contends that at the present moment it is the common ground that needs emphasis.

> "A supreme need of American education is for a unifying purpose and idea. As recently as a century ago, no doubt existed about such a purpose: it was to train the Christian citizen. Nor was there doubt how this training was to be accomplished. The student's logical powers were to be formed by mathematics, his taste by the Greek and Latin classics, his speech by rhetoric, and his ideals by Christian ethics . . . this enviable certainty both of goal and means has largely disappeared. . . . For some decades the mere excitement of enlarging the curriculum and making place for new subjects, new methods, and masses of new students seems quite pardonable to have absorbed the energies of schools and colleges. . . . In recent times, however, the question of unity has become insistent. We are faced with a diversity of education which, if it has many virtues, nevertheless works against the good of society by helping to destroy the common ground of training and outlook on which any society depends."

(Continued on Page 9)

Fluoroscopic Examination of Metallic Objects

By B. CASSEN and D. S. CLARK

ALTHOUGH since their discovery some half century ago, X-rays have been used in a big way for medical applications, their industrial applications to metallic materials has been restricted primarily to the detection of flaws in castings and other metal parts by radiography. In radiography, the image of any defect is recorded on a photographic film. The industrial application of fluoroscopy, that is, the observation of metallic objects by means of fluorescent screens, has been very slow. This condition may be attributed, in part, to insufficient knowledge of the signficance of the observed image on the fluorescent screen. Even in radiography, the absence of a thorough understanding of the significance of certain defects has led to the tendency to play well on the safe side and to reject structural items for any detectable defective condition.

During the war a large tonnage of X-ray film, besides much critical equipment and manpower, was used to inspect radiographically very large quantities of aluminum alloy and magnesium alloy castings used in aircraft. The acceptance standards in many cases were set so high that castings could not have any radiographically detectable defects if they were to pass inspection. This drastic selection procedure may be justified on the basis that if only one bomber could be saved, it would be worth the loss of questionable parts by rejection. However, the real basis for this procedure has been lack of confidence brought about by absence of precise knowledge. The use of the much more rapid and cheaper method of inspection, by fluoroscopy, was not considered to be adequate because the very small defects observed on X-ray film could not be detected with the fluoroscopic equipment then available.

THE PROBLEM

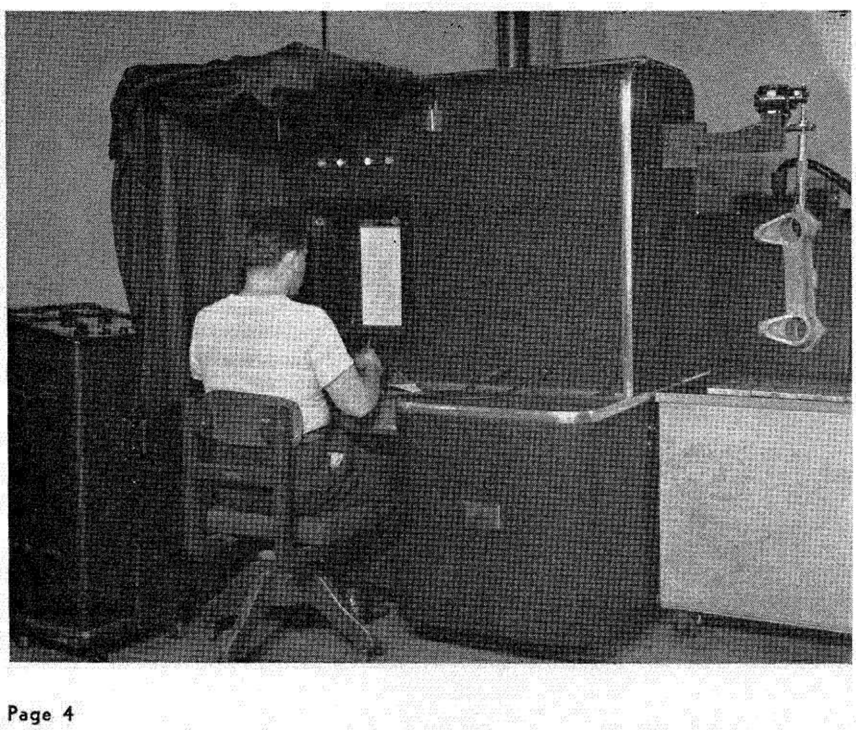
It is recognized that if the limitations of fluoroscopy, as applied to metallic parts, could be established, time and photographic materials could be saved. Several individuals associated with aircraft production problems, sensing the unsatisfactory foundations of X-ray inspection and the benefits to be derived from fluoroscopic inspection, recommended that the Office of Production Research and Development of the War Production Board support an investigation of the possibilities and limitations of fluoroscopic methods of inspecting metallic materials. This investigation was assigned to the California Institute of Technology under a contract with the Office of Production Research and Development of the War Production Board.

The purpose of this investigation was to determine the limitations and the reliability of fluoroscopic methods of examination of metallic materials, in comparison with radiographic methods, as a supplement to, or replacement for, radiography of metallic materials, and to extend the field of usefulness of fluoroscopy by improvement in equipment and technique.

PRELIMINARY SURVEY

As this work was started, commercial fluoroscopic equipment was only beginning to make its appearance for the examination of industrial products. This equipment was largely limited to specially designed industrial units for detecting frozen fruit, or detecting foreign matter in foodstuffs, or for the examination of plastic parts. As one of these industrial units was not immediately available, a somewhat similar unit was constructed at California Institute of Technology. This consisted of an oval, wooden structure on which were mounted sliding trays attached to an endless chain driven by a motor. These trays, traveling within a tunnel structure, were loaded with the object to be examined. The object then passed over an X-ray tube mounted below the trays, suitably protected with lead sheet. Above the trays, on the observer's side of the equipment, were a fluorescent screen and a lead glass protective window. The observer was then able to look through the lead glass screen with safety and observe the image of the object on the fluorescent screen. The X-ray tube, having a focal spot of 2.4 mm., was mounted at a point 20½ inches below the trays carrying the object. The X-ray equipment was operated at a voltage of 140 kvp.

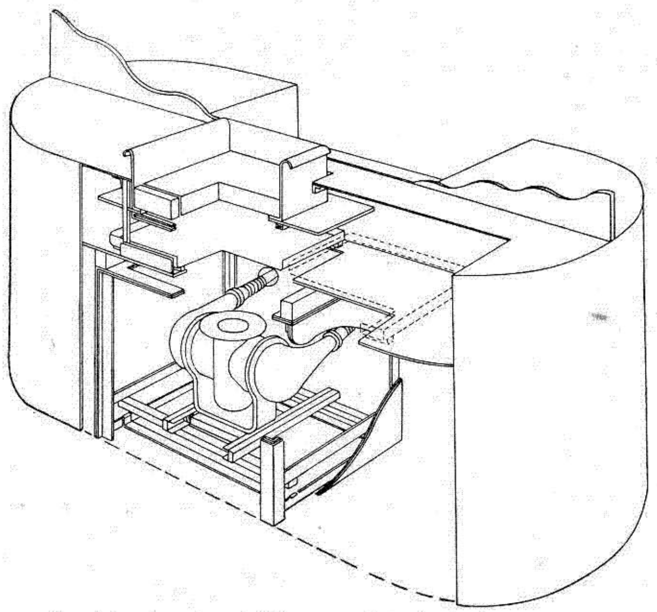
As a preliminary measure, this equipment was taken to several commercial foundries where large numbers of identical castings could be examined. More than 6,000 castings, including sand castings, permanent mold castings, and die castings, of 356T6, 195T6, and 43 aluminum alloy, and sand and permanent mold castings of Dow metal 17 and other magnesium alloys, were examined by members of the project



AT LEFT:
Front view of commercial fluoroscope unit constructed at C.I.T. showing fluoroscent screen and lead glass protective window.

staff. The whole purpose of this program was to become acquainted with the nature of the problem of fluoroscopy.

With fluoroscopic examination it is customary to adapt the observer's eyes to the dark before beginning observation. This is normally done because of the low intensity of brightness on the fluoroscopic screen. Such a procedure was followed in this exploratory study. However, it was found that adaptation to the levels of illumination present on the fluoroscopic screen rather than to the dark was desirable. In general, the results of this preliminary study were enlightening only in the sense that fluoroscopy under the conditions experienced could serve as a screening test prior to radiography for the detection of large defects. Furthermore, conditions were not always reproducible at the places where the investigations were made. It was apparent that certain variables required investigation.



Outline drawing of first model of the fluoroscope

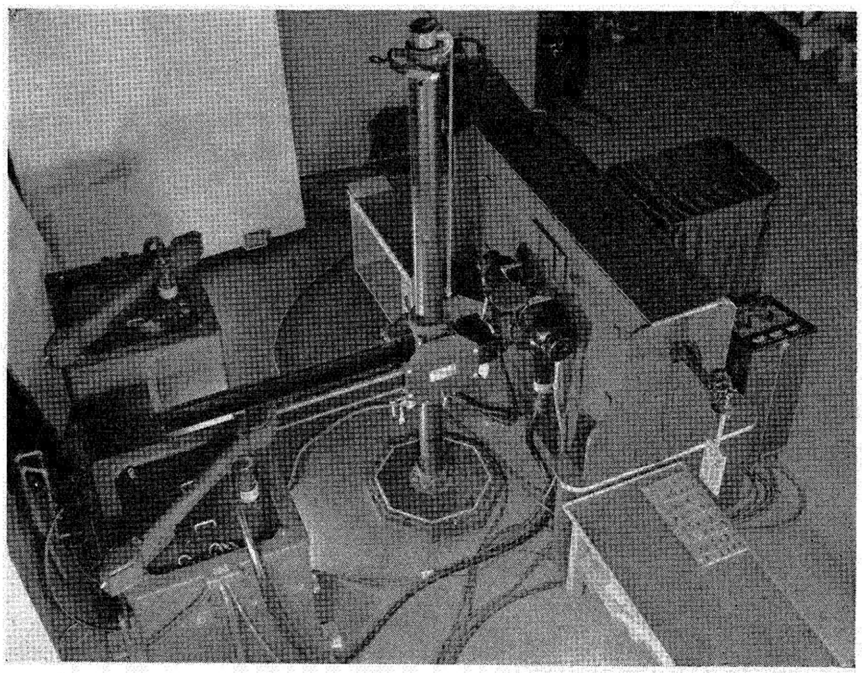
VARIABLES

The fluoroscope was modified so that the effect of some of the variables could be studied. The X-ray tube was mounted so that it could be adjusted to any distance from the object that might be desired. A set of artificial specimens was made. These consisted of sandwiches of two flat blocks of 3SO aluminum alloy, each block being 2½ inches long, 1½ inches wide, and ¼ inch thick, making the total thickness of each specimen ½ inch. The effective thickness of these specimens was increased by adding additional sheets of aluminum. Artificial defects in the forms of spherical cavities, long cylindrical cavities, and flat, washer-shaped cavities were introduced at the surface between the two blocks of each sandwich. These defects were of known dimension. A group of these specimens was then placed in the field of observation together with some specimens which did not have any defects. A large number of observers examined these specimens and reported what they saw. The thickness of the defects varied from 0.005 inch to 0.063 inch. Each of the observers was scored for each observational condition, namely, the position of the tube and the position of the screen with respect to the casting. The first, and probably most significant, result was found when the X-ray tube was only a short distance from the object under examination. This condition had the effect of increasing the intensity on the fluorescent screen by a factor of almost 10. The visual brightness of the screen became sufficiently high to make seeing an easier task and to make dark adaptation of the observer unnecessary. Under this condition it was found that anyone, old or young, having ordinary good vision for reading, made a satisfactory observer, although some persons were more imaginative than others.

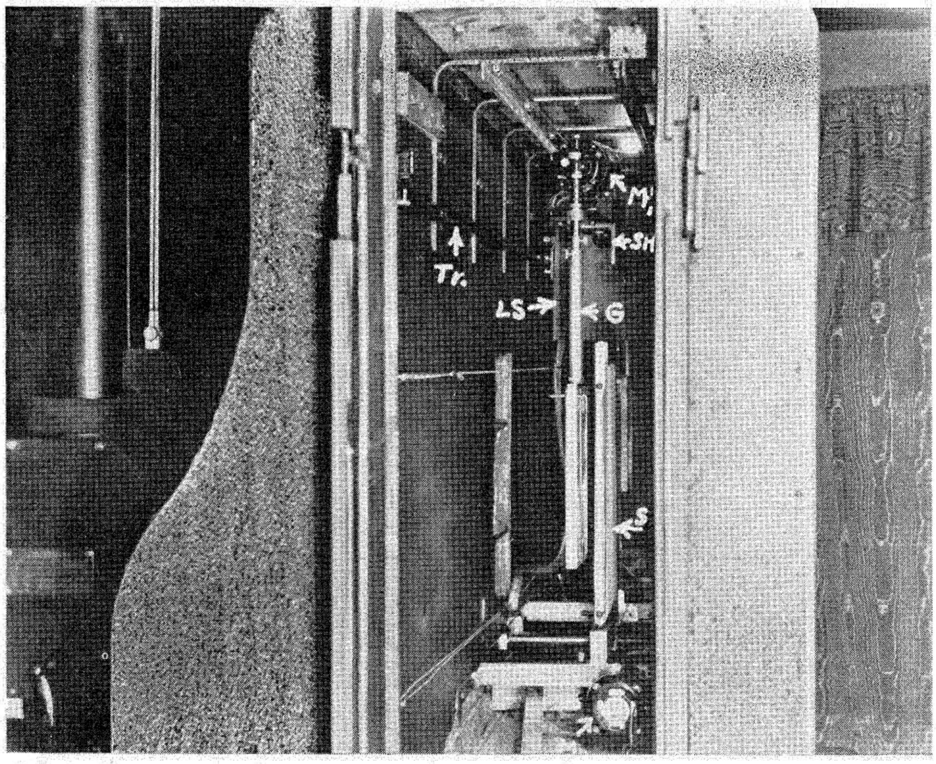
With the higher X-ray intensity obtained with a short tube screen distance, it was found that the lead glass discolored very rapidly, making observation difficult. This difficulty was eliminated by utilizing a new type of protective window. This consisted of a lucite box or cell filled with a saturated acqueous solution of lead perchlorate. Lead perchlorate is sufficiently soluble in water so that the actual lead content of a 3 inch thickness of the saturated solution is equivalent to about ¼ inch of metallic lead. If properly prepared, the solution is as clear as pure water. The refractive index of the solution is about the same as that of lucite, so that no reflections occur at the lucite-solution interface. X-rays appear to have no effect upon this window.

ROTATIONAL EFFECT

When the target of the X-ray tube is not far from the object being examined, a small relative motion of the tube and object produces an appreciable rotational distortion of the X-ray shadow on the fluorescent screen. Advantage was taken of this effect by making the tube movable across the normal field of view. By moving the tube back and forth it was then possible to examine first one side of a rib or lug and then the other. This is an important feature of fluoroscopy, and, coupled with the high X-ray intensity obtainable with short tube object



AT RIGHT:
Rear view of fluoroscope with 220 kv. constant potential X-ray unit (rock of artificial specimens are ready to enter fluoroscope).



AT LEFT:
View of inside of fluoroscope. SH-Shuttle, Tr-Shuttle track, G-Spindle for specimen support, M-Motor to rotate spindle. LS-Lead shield, S-Screen, M_2-Motor to position screen.

distance, brings fluoroscopy into the realm of commercial usefulness.

FIELD TESTS

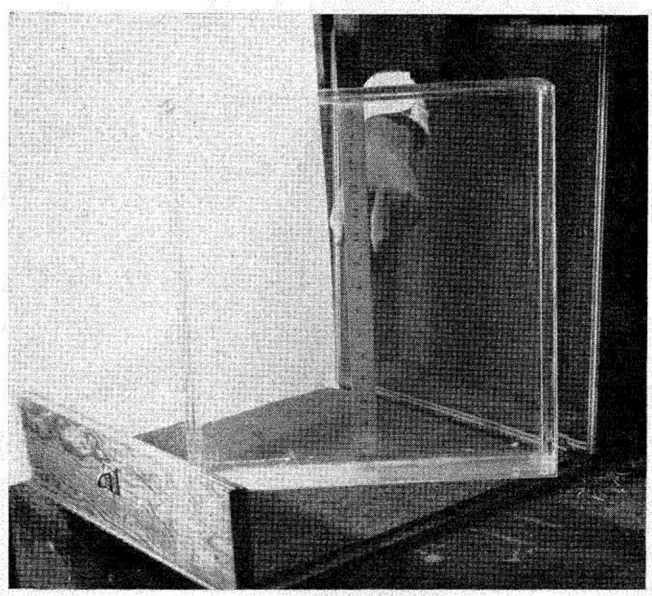
After the most suitable conditions for fluoroscopic observation had been established, the equipment was moved to three commercial X-ray laboratories, where some 10,000 aircraft aluminum alloy castings were examined with the fluoroscope. Installation of the equipment at these places permitted the inspection of large numbers of castings that were being radiographed. The radiographs produced on these particular castings were read by members of the project staff, who then compared the results with those obtained by fluoroscopic inspection. In all of the castings observed there was a total of approximately 14,000 defects. Of this total there were approximately 5,000 very small defects that were detected by radiography, but were not observed fluoroscopically. On the other hand, approximately 1,700 larger defects were observed fluoroscopically, although not detected on the commercial radiographs.

Undoubtedly this latter condition was the result of benefits derived from the rotational scanning effect obtained with the equipment utilized. It is probable that most of these larger defects could have been found radiographically, had more views been taken of the castings.

THE SIGNIFICANCE OF DEFECTS

One of the most important factors in the inspection of castings by radiography or fluoroscopy is a knowledge of the significance of the observed defects in regard to the strength characteristics of the part being examined. The basis for acceptance or rejection must be a rational one. To establish the size and character of a defect that will or will not reduce the strength of a given casting is not simple. The number, distribution, and character of defects are so widely diversified in even one type of casting that the problem becomes very complex.

In most respects the present basis for the rejection of castings by radiography is not strictly rational. It is founded upon the judgment and experience of those concerned with the use of the individual castings and upon the results of a few tests. With the demonstration that the fluoroscopic method of inspection is adaptable to the detection of certain types and sizes of defects within certain limitations of thickness, the question arises: Are the defects which can be seen in the radiograph, but are too small to be seen fluoroscopically, contributory to decreased strength of the casting? It is granted that some attempts have been made to obtain a correlation between the presence or absence of defects, as determined radiographically, and the strength of a given

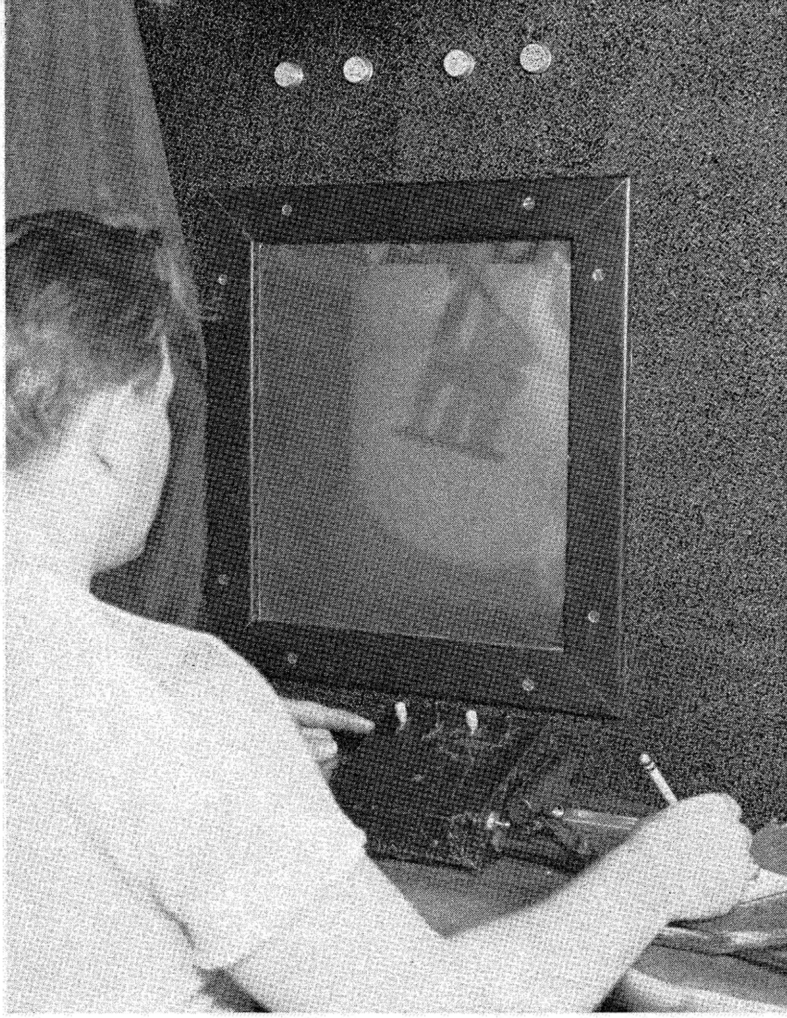


The lucite-lead perchlorate cell for protection of the operator during fluoroscopic observation.

casting. It appears that the study must be carried further on more of a statistical basis.

As an exploratory measure, approximately 500 pieces of a given casting were secured for investigation. Of these 500 castings, approximately 400 had been radiographically rejected by the consumer's inspector. The other 100 castings had been radiographically accepted. These castings were again radiographed by a commercial X-ray laboratory, fluoroscopically examined, and statically tested in a universal testing machine. From these tests it was found that the average strength of the castings which were accepted on the basis of commercial radiography was not greater than the average strength of the rejected castings. It was apparent that very large defects had some effect in reducing the strength of the part. It was particularly noticed that the variation in the strength of the accepted casting was in general as great as that observed in the rejected casting. This variation may well be associated with the variation in the strength of the material itself. It was further observed that defects which communicate with the surface near the region of maximum stress contributed more to failure than any other type of defect.

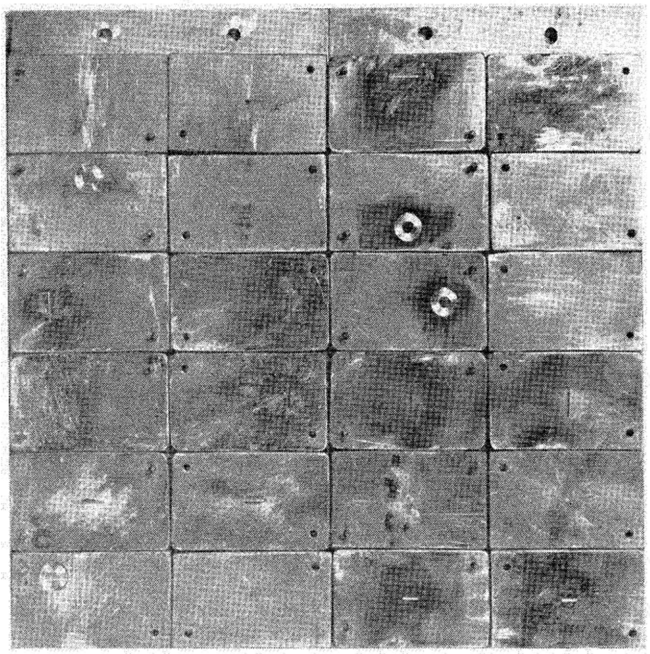
This preliminary work was carried out on some additional castings, although in not quite such large numbers. In general the results were about the same, and in general it was concluded, as a first approximation, that defects which could not be detected fluoroscopically had a negligible effect upon the strength of the casting. While these results do not give any quantitative evaluation of the significance of various types of defects, they have definitely pointed to a problem which should be investigated further.



A casting being viewed in the fluroscope.

RADIOGRAPHIC CONSISTENCY

One may pose the question: If a particular casting is radiographed independently by three different X-ray laboratories, all of which are well qualified to conduct such work, will the three radiographs all reveal the same defects? To assist in securing an answer to this question, approximately 2,000 castings were submitted in turn to three different commercial X-ray laboratories. Each laboratory used its own technique in making the radiographs. All of the radiographic films produced by all of the laboratories were then read by a member of the project staff. These same castings were then inspected fluoroscopically and a record made of the examination of each casting. These results were then analyzed, defect for defect. This analysis showed that less than half of the defects detectable on the films of one of the three laboratories were detectable on the films of the other two laboratories. In other words, approximately 5,000 of the total of 10,000 defects were detectable on the films of all three laboratories. Approximately this same number of defects was observed fluoroscopically.



Showing artificial defect specimen—inner surface. The number, distribution and character of defects are widely diversified.

It appears from this study that the number of defects that can be detected in an aluminum alloy with a fair degree of certainty by commercial radiography is comparable with the number that can be detected with high brightness rotational fluoroscopy.

HIGH VOLTAGE FLUOROSCOPY

With the experiences cited so far, in which equipment operating at a voltage of approximately 150 kvp was employed, one may ask: "If higher brightness of the screen resulted in considerable improvement in the results, why would not higher X-ray voltage give considerable improvement?" Certainly with thicker castings higher brightness can only be secured by using higher voltages, thus securing greater penetration of X-rays. However, it is known that at higher voltages the X-ray contrast is decreased. In spite of this decrease in contrast, the increase in brightness of the screen may have a compensating effect.

(Continued on Page 12)

An Engineer Before the United States Supreme Court

By W. D. SELLERS

IN Washington, D. C., in a massive monumental temple dedicated to Justice, sits the United States Supreme Court. The cornerstone of one of the three branches of our Federal Government, its part in our daily lives is little appreciated or understood. The executive and legislative divisions receive the popular acclamation and denunciation, and slight attention is given to the fact that the words and acts of these two go for naught if they fail to stand the tests to which they may be subjected by the court.

There are times when the importance of this tribunal is firmly brought to the attention of the public. An instance was the *Schechter Chicken Case, 295 U. S. 495*, which resulted in the disintegration of the N.R.A. Generally, however, the effect of the court's decisions is not so immediately visible and accordingly not so generally appreciated.

That our government and nation are what they are today is to be credited in large part to the early decisions of the Supreme Court during the formative years. The struggle in the court between those favoring a strong central Federal Government and those opposing it was crucial in our history. No name stands out more clearly in this connection than that of John Marshall.

The constituency of the court changes as death comes to its members, or as they retire, and with the coming of even one new member the direction of the evolution of the law can veer sharply. The court frequently, and in recent years very frequently, is divided upon its decision, five in the majority and four in the minority. Obviously, if the philosophy of a new member is in agreement with that view which was previously in the minority, the scales will be tipped and the minority philosophy will become the majority philosophy.

Today the Supreme Court protects itself against the necessity of considering countless unimportant cases by requiring the filing of a petition for "Writ of Certiorari." The would-be appellant is required to petition the court to be heard, the petition being supported by a brief and by the record for the consideration of the court. Unless the court views the case as entitled to its review, the petition is denied and the decision of the tribunal below becomes final.

THE ENGINEER FACES THE COURT

There is about the court and its inspiring setting an impressiveness which cannot be ignored. The members become in some way more than mere men when they solemnly enter the courtroom through an opening in the velvet drapes, the Chief Justice entering first, and stand by their places, the clerk pronouncing in a polished, resonant voice the opening of court.

With the court seated, the members of the bar and the audience resume their seats and the Chief Justice in a low, conversational tone gives the number of the case to be heard. The parties and their counsel are ready, have probably been ready for days, and counsel for the appellant moves to a stand directly in front of the Chief Justice. He places his material upon the stand, which is inclined; he straightens his coat; he swallows hard; and he hopes.

Let us assume that you, an engineer, stand before the court. Those first few seconds are difficult. The eyes of the court are upon you. Chief Justice Stone, Justices Roberts, Black, Jackson, Douglas, Rutledge, Frankfurter, Reed, and Murphy await your first words. You know your subject. This is the moment you have foreseen, in your mind's eye, a hundred times. You are charged with a duty to turn back an encroaching philosophy which threatens to overturn a statutory remedy sanctioned by a hundred years of sound decisions. You begin.

Yours is the hour. The audience and fellow members of the bar await your words. The court listens attentively. The facts. They must be presented with the history of the case. Your notes, carefully prepared, are there to refresh your memory and to give you confidence. The argument progresses and your assurance gains. You have already forgotten the audience and only the court receives your attention.

You hear a voice and you stop. It is Justice Roberts asking about the application of a particular statute. That question you have considered twenty times and you answer. Justice Roberts nods: his fine, mobile and flexible face, relaxes its usual severe lines, and he smiles. You are certain he agrees with you. But what are Justices Black and Douglas doing with their heads together, talking, while you are answering Justice Roberts?

The argument is taken up where you left off to answer Justice Roberts and you are back on the track again. This point is good and you prepare mentally to give it everything. You start to say—but Justice Black's voice is heard and you look at him and courteously listen to the question which you now judge was bothering him and Justice Douglas. Justice Black asks whether a patent should be granted under certain hypothetical conditions. How in the world did that question get in here? What is in the back of the Justice's mind? You answer, pointing out the irrelevancy of the question with all possible tact, laying emphasis upon those facts or factors in your own case which serve to distinguish.

That question answered, you center yourself at the stand, grasp it firmly with both hands, and glance at your notes to see where you were and where you are going. Unfortunate is he in the Supreme Court who cannot lose his place entirely and later pick up his argument at the first opportunity. The court is no respecter of counsel's plans, and the wise barrister answers the interrupting questions fully and completely as they are asked, depending upon sound preparation and knowledge of the case to help him to return to his own presentation at the first opportunity.

A LAMENTABLE FAILURE

An advocate presenting a case to the Supreme Court is under a terrific burden. The background and prestige of the court are more real to him than to the layman. Good lawyers have failed miserably. Such a tragedy took place while the writer was waiting for his own case to be called and it did anything but increase his confidence.

Two patent cases were on the call of the court, and the questions involved were of interest to business and to the patent profession. The courtroom contained many patent lawyers from Chicago, New York and Washington. The first case was called and counsel, after arranging his papers and books, began his presentation. As always, he was interrupted after progressing fairly well into his subject and stopped his arranged argument to answer the question propounded. His answer, while not too well formulated, was accepted and he turned again to his notes. Unfortunately, he had not prepared an outline of his argument, but was instead working from a typed brief covering many pages. The interruption had driven from his mind the prepared argument. The notes were better suited to reading than to oral presentation, and under the crushing force of the occasion he could not find his place. Pages were fumbled. A drink of water. Papers on one side of the stand were turned. Back to the notes, but without effect. Another drink. More fumbling. For six long minutes that unfortunate man stood mute before the Supreme Court of the United States. Every lawyer in that room could have shrunk through a very small knothole, so real was the feeling of common embarrassment with a fellow lawyer. Finally, and years too late, a junior stood up and asked if he might say a few words. Consent was given by a nod, and the junior took over and did very well. Our friend, after standing a few moments, sat down and did not rise again during the entire case.

This lawyer was experienced in many courts. The weight of the prestige of the Supreme Court, coupled with his failure to prepare adequately to meet such a foreseeable contingency, proved to be his undoing.

THE CLOCK DOES NOT STOP

But back to your case. The notes to which you refer, if you are wise, are such that a hurried glance will tell you what points have been covered and what remain. You do not read your notes, for there is little to read. Each point, however, suggests an entire line of thought; though you are interrupted frequently, you are never lost.

The argument progresses and, noting Justice Roberts' nods, you feel certain that at least this strong man is with you. Justice Frankfurter has been giving some trouble and there are several of the court of whom you have some doubts. All sense of time has long since vanished. Suddenly you become aware of the fact that Chief Justice Stone is leaning forward in his seat. Can your forty-five minutes be up? You lift the long black book which contains your notes and peer over the top of it at the little red and yellow lights which it has hidden on the stand. You suspect that your time is more than gone without your having noticed the warning light. You ask Chief Justice Stone if your time is up and he nods. The clock overhead indicates that you took five minutes not yours. You suggest the advantages of a long book to the Chief Justice, who smiles. You thank the court and return to your place at the lawyers' table, wondering if, under the circumstances, you have not acquired some rights in the quill pen provided there for the lawyers' benefit.

The majesty of the law, the sovereignty of the people and the rights of man are impressed upon the conscience by the Supreme Court in a unique way. Man, the individual, takes on increased stature and the problems of life a new dignity through the knowledge that this court is concerned therewith.

THE ENGINEER'S STAKE

The engineer's interest and stake in the Supreme Court are great. Within the framework of our Federal Constitution this court stands as the arbiter to determine that thus far and no farther may the way of our economic life be changed. Legislators who would nationalize research or abolish the patent system must act with the knowledge that their actions are subject to review by this tribunal. A supreme court composed of so-called liberals will uphold the constitutionality of enactments which would be thrown out by a court composed of so-called conservatives. There is always much to be said in support of a dissent, and a personal bias or philosophy is all that is needed to shift a justice from a majority viewpoint to that of the minority.

The future of engineering and technological research in this country is likely to be the subject matter of much Congressional consideration during the next few years. The patent system which provides the rewards for new developments to those willing to undertake them has been under attack for some time. Bills are now pending before Congress relating to these fields and, if enacted, will in all likelihood be tested before the Supreme Court. Our Congressmen will vary and change with the political winds, but so long as our Supreme Court remains constituted of men outside the normal forces of politics and economics, we can hope that the balance-wheel effect which it provides will serve to protect us.

The Harvard Report

(Continued From Page 3)

"... there are truths which none can be free to ignore, if one is to have that wisdom through which life can become useful. These are the truths concerning the structure of the good life and concerning the factual conditions by which it may be achieved, truths comprising the goals of the free society."

These truths are conceived to lie in three traditional areas of human thinking: the humanities (literature, the fine arts and philosophy), the social sciences (social, political and economic interests and history), and the natural sciences (mathematics, physical and biological science). For the purpose of this review it is not necessary to quarrel with the nomenclature, nor to disturb the schematism by remarking the absence of religion, formerly the strongest of unifying forces.

APPLICATION TO HARVARD

In particular application to Harvard, the proposal is therefore that of the sixteen full courses required for the degree, six shall be general—one from each of the areas of knowledge—and three more which shall not be in the student's "field of concentration."

It is interesting to note that there should be required one course in "Great Texts of Literature," one in "Western Thought and Institutions" and one in either physical or biological science. After "Western Thought and Institutions" a second course in the field of the social sciences should be, "American Democracy." The recommendation of this course furnishes the ground for an objection that has been raised against the philosophy underlying the concept of general education: does the desired unity, the common ground, call for inculcation of a set of social and political principles? If so, it violates the liberal theory long prevalent that, at any rate, higher education should be the exercise of free enquiry, not indoctrination of any view, however excellent. This liberal theory has been maintained with great difficulty against many attempts to invade it. Is the Harvard report such an attempt? Your reviewer does not think so, but the question should be looked at.

The book is highly recommended. It ranks among the best of the many, too many, volumes about education that are dropping weekly from the press. Harvard is not alone in urging a revaluation of the ends of education, and of the means for attaining those ends, but the Harvard report has a breadth of scope, a rationality in analysis, and a conservatism of conclusion, that comport well with Harvard's position as a leader in education.

THE AIR WE FLY IN

By E. H. HEINEMANN

THE earth's atmosphere is, at present and probably will be for many years to come, the most important element in the science of flight. Yet this atmosphere, which supports all present day aircraft and is absolutely necessary to the sustenance of human life, is only meagerly understood by most people.

Until only a few years ago, the atmosphere's composition and characteristics were unimportant to all but a few scientists. Today, the rapid strides of air transportation have caused the earth's atmosphere to affect the lives of millions of people either directly or indirectly. The tide of the war was largely influenced by the air battles fought in the earth's atmosphere.

In peace, a knowledge of the earth's atmosphere and its characteristics is essential to air transportation as well as to accurate weather prediction, radio communications, and the understanding of the many phenomena that occur in everyday life on the earth.

To aid in the understanding of the earth's atmosphere, the earth may be visualized as a ball which is surrounded by three gaseous blankets. The weight of these three blankets is not negligible. In fact a one-foot square column of air which extends from sea level to the top of the earth's atmosphere weighs approximately one ton. These blankets of air are pulled to the earth's surface by the forces of the earth's gravity in the same manner the water is held to the ocean's bottom. Since air is easily compressed, it is natural that the weight of the outer blankets compresses the air so that it has the greatest pressure and weight at sea level. At greater distances from the earth's surface there is less and less weight of the air blankets acting and the pressure and weight of air becomes smaller.

Under normal conditions the heat absorbed by the earth and its lower atmosphere from the sun's radiation causes the temperature at sea level to be greater than the temperature at higher altitudes. Under normal conditions, the temperature decreases steadily with increasing height until an altitude is reached, beyond which the temperature remains essentially constant. This altitude determines the upper limit of the first blanket, which is called the troposphere, and the lower limit of the second blanket, which is called the stratosphere.

HEIGHT VARIES

The height of the troposphere varies, due to the earth's rotation, from about five miles at the poles to about ten miles at the equator. Within this first blanket is concentrated about eight-tenths of the weight of the earth's atmosphere. The air in the troposphere is composed almost entirely of a mixture of oxygen and nitrogen with only small quantities of other gases such as argon, carbon dioxide, helium, hydrogen, and water vapor.

Man's direct measurements of temperature and pressure extend upwards through the troposphere and to less than halfway through the stratosphere. The upper limit of the stratosphere blanket is about 50 miles high.

Even less is known about the third blanket, the ionosphere, except that it is within this layer that many electrical phenomena exist. The invisible Kennelly-Heaviside, or "E" layer, which reflects all but ultrashort radio waves back to the earth's surface, and the visible electrical displays such as the Aurora Borealis, are known to exist but are not yet clearly understood. In short, man, who lives at the bottom of the oceanic sea of air, knows very little about what takes place near its surface.

As aviators have ventured farther and farther from the earth's surface they have required a greater knowledge about the air in which they fly. They quickly discovered that the weather disturbances such as thunderstorms, fog, snow, and rain do not exist in the stratosphere. It was also found that, in order for humans to fly at these extreme altitudes, oxygen must be carried along and certain pressures must be maintained in the airplane cabin. Too rapid changes of altitude were found to produce "bends" due to the pressure changes, just the same as it does with deep sea divers. A few of the other interesting factors which restrict flight of extreme altitudes are noted along the right-hand border of the atmosphere chart accompanying this article.

TRADE WINDS

The winds aloft are as important to the pilot as the trade winds were to the old clippership skippers. The wind pattern of the earth is shown in the upper right-hand corner of the atmosphere chart. This wind pattern is caused by the fact that there is an unequal distribution on the earth's surface of the heat which is absorbed from the sun. Since "warm air rises," the air over the warmer areas of the earth rises and is replaced by an inrush of air from the colder regions. This continuous circulation of air is altered by the earth's rotation towards the east about its polar axis. The resulting wind pattern consists of the trade winds, which blow from the east on the earth's surface, the prevailing westerlies which blow from the west, and the polar winds which blow from the east.

INDIRECT MEASUREMENTS

Since direct measurements have been made of the earth's atmospheric characteristics to an altitude of only 25 miles scientists have used indirect means to determine or predict these characteristics above that point. The composition of the gaseous mixture in the stratosphere and ionosphere has been determined by analyzing the spectrum of the light from the aurora displays. Each gas has particular color banks on the spectrum and by observing the spectra from the auroras, the gas can be identified.

By measuring the "reflection" of sound waves from the sky it has been inferred that the temperature must increase rapidly at altitudes greater than 20 miles. The rare appearance of noctilucent clouds at altitudes of about 50 miles plus the deduction, by some scientists, that these clouds must be formed of ice particles, indicates low temperature. There is disagreement on this point, moreover, among the authorities. There seems little doubt, however, that extremely high temperatures, many times as great as the temperatures at sea level, exist at very great altitudes. Since the air is so rare at these altitudes, however, temperature does not have the same meaning as it does on the earth's surface.

CHARACTERISTICS OF THE EARTH'S ATMOSPHERE

SUMMARIZED FROM INFORMATION AVAILABLE IN 1944

PREPARED BY
DOUGLAS AIRCRAFT COMPANY INC.
EL SEGUNDO ENGINEERING DEPT.

PERCENTAGE COMPOSITION OF EARTH'S ATMOSPHERE (BY VOLUME)

NITROGEN	77.77
OXYGEN	20.86
WATER VAPOR	.41
ARGON	.93
CARBON DIOXIDE	.03
HYDROGEN	.00005
	100.—

COMPOSITION PRACTICALLY CONSTANT WITH ALTITUDE UP TO 30 MILES. (EXCEPT FOR WATER VAPOR).

CHARACTERISTICS OF UPPER ATMOSPHERE UNDER MOST PROBABLE CONDITIONS

ALTITUDE IN FEET	ALTITUDE IN MILES	WEIGHT OF AIR IN LBS. PER CUBIC FOOT	MEAN FREE PATH IN INCHES	MOLECULES PER CUBIC INCH
500,000	94.6		370.	$43.\times10^{11}$
450,000	85.2		65.	$25.\times10^{12}$
400,000	75.8		12.	$15.\times10^{13}$
350,000	66.3	0.2×10^{-8}	1.9	$84.\times10^{13}$
300,000	56.8	2.6×10^{-7}	0.3	$48.\times10^{14}$
250,000	47.4	Ⓐ 2.9×10^{-6}	5.8×10^{-2}	$27.\times10^{15}$
200,000	37.9	1.6×10^{-5}	1.0×10^{-2}	$16.\times10^{16}$
150,000	28.4	9.5×10^{-5}	1.7×10^{-3}	$96.\times10^{16}$
100,000	18.9	.00107	2.7×10^{-4}	$62.\times10^{17}$
50,000	9.5	.0116	3.6×10^{-5}	$47.\times10^{18}$
0	0.0	.0765	Ⓑ 3.5×10^{-6}	Ⓒ $44.\times10^{19}$

Ⓐ 2.9×10^{-6} = 2.9 POUNDS PER MILLION CUBIC FEET

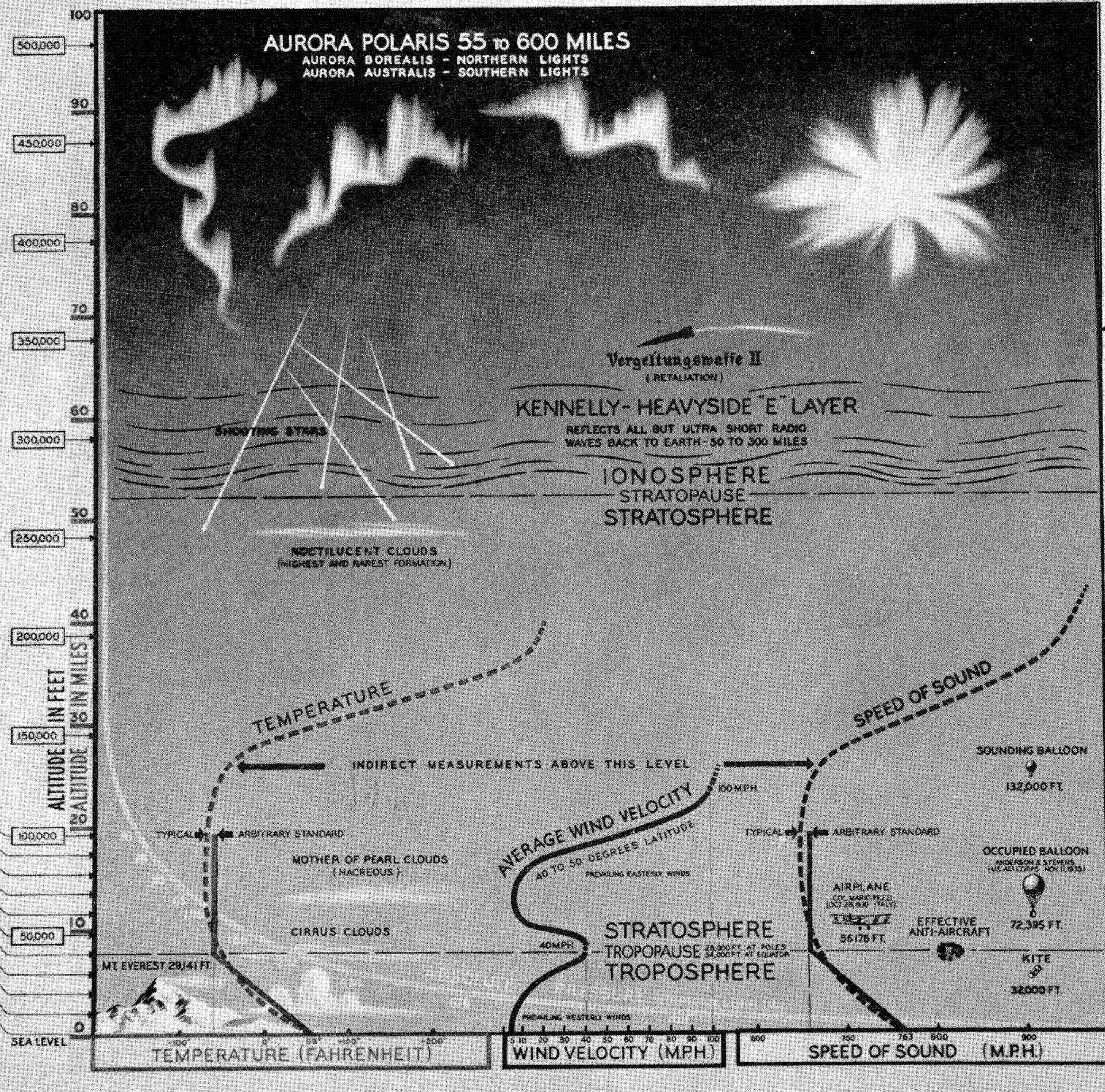
Ⓑ 3.54×10^{-6} = 3 1/2 MILLIONTHS OF AN INCH BETWEEN MOLECULAR COLLISIONS

Ⓒ 44×10^{19} = 440,000,000,000,000,000,000 MOLECULES PER CUBIC INCH

ARBITRARY STANDARD ATMOSPHERE FOR 45° LATITUDE

ALTITUDE IN FEET	SPEED OF SOUND (MPH)	RATIO OF ALTITUDE TO SEA LEVEL DENSITIES	PRESSURE (LBS. PER SQUARE INCH)	F°	C°	WEIGHT OF AIR (LBS. PER CUBIC FOOT)
100,000	664	.014	.16	-67°	-55°	.0011
90,000	664	.023	.28	-67°	-55°	.0017
80,000	664	.036	.40	-67°	-55°	.0028
70,000	664	.058	.65	-67°	-55°	.0044
60,000	664	.094	1.05	-67°	-55°	.0072
50,000	664	.152	1.69	-67°	-55°	.0116
40,000	664	.245	2.72	-67°	-55°	.0187
30,000	680	.374	4.36	-48°	-44°	.0286
20,000	708	.533	6.76	-12°	-25°	.0408
10,000	736	.738	10.11	+23°	-5°	.0565
0	763	1.000	14.70	+59°	+15°	.0765

(F° and C°: TEMPERATURE)



GERMAN V2 ROCKET BOMBS ATTAIN THIS ALTITUDE DURING FLIGHT. APPROX. 340,000 FT. (REPORTED TO HAVE ATTAINED AN ALTITUDE OF 150 MILES IN EXPERIMENTAL VERTICAL FLIGHT.)

SOUND WAVES NOT PROPAGATED ABOVE THIS ALTITUDE DUE TO INCREASED DISTANCE BETWEEN MOLECULES.

TWILIGHT LIMIT. FIRST MAGNITUDE STARS ARE VISIBLE DIRECTLY OVERHEAD WHEN SUN SETS. 210,000 FT.

MAXIMUM OZONE CONCENTRATION (ONE PART OZONE TO 400,000 PARTS ATMOSPHERE.) 106,000 FT.

BLOOD BOILS AT BODY TEMPERATURE, 98.6° FAHRENHEIT 63,000 FT.

100% OXYGEN NEEDED FOR SUSTENANCE OF LIFE. EXACT ALTITUDE DEPENDS ON INDIVIDUAL AND EXPOSURE. 40,000 TO 45,000 FT.

BREATHING PURE OXYGEN EQUIVALENT TO BREATHING SEA LEVEL AIR. 33,000 FT.

GASOLINE BOILS AT NORMAL TEMPERATURE, -65° FAHRENHEIT 32,000 FT.

SKY APPEARS PURPLE ABOVE THIS POINT. 30,000 FT.

CANDLE NO LONGER BURNS. 21,000 FT.

HIGHEST COMMUNITY OF HUMAN BEINGS ANDES MTS., SOUTH AMERICA. 18,000 FT.

OXYGEN REQUIRED FOR SUSTENANCE OF LIFE BY SEA LEVEL DWELLERS. ALTITUDE DEPENDS ON PHYSICAL CONDITION AND DURATION OF STAY. 15,000 FT. TO 20,000 FT.

WIND PATTERN OF THE EARTH

The data which are presented on the atmospheric chart represent the best information available at the present time and have been gathered from many authorities on the subject. As more and more information is obtained these data may have to be modified and extended.

One potential source of direct measurement of atmospheric characteristics at extremely high altitudes is the sounding rocket. Notice that the German V-2 rocket is reported to have achieved altitudes of more than six times as high as any other man-made device yet flown. Balloons are definitely restricted as to their maximum altitude. since they rely on the weight of the surrounding air to support them.

NEW RESEARCH FIELDS

For our present knowledge of the air we fly in. we are greatly indebted to the painstaking and sometimes unrecognized research of many scientific institutions. As man's inquisitive nature forces him to venture outside of the air realm in which we fly at present, he must rely entirely on the knowledge of these scientists if he hopes to return to the earth in safety. It is clearly seen, therefore, that air transportation's desire to learn more about the composition and characteristics of the earth's upper atmosphere opens a vast new field of scientific research. The development of the rocket has supplied the scientist with a new tool with which he can investigate the upper atmosphere. It is hoped that now the scientist will be able to supply the aeronautical engineers with a reliable and complete knowledge of the atmosphere beyond which man-carrying vehicles have flown so that he, in turn, may design aircraft to extend the realm of "The Air We Fly In" to "The Atmosphere We Fly In" and, one day, "The Universe We Fly In."

Fluoroscope Examination

(Continued From Page 7)

To investigate the possibilities of higher voltage fluoroscopy, a fluroscope was constructed incorporating features which were found to be desirable in the use of the earlier model. The fluoroscopic viewing unit consists of a wooden frame structure mounted on heavy rubber-tired casters. The viewing window, a lucite cell filled with lead perchlorate solution, is 4½ inches thick and gives a viewing area of 16 inches by 14 inches. The fluorescent screen is mounted in an aluminum frame which can be moved toward or away from the viewing window by means of a motor. The object under examination is hung from a support mounted on a shuttle. This shuttle, mounted on small ball-bearing wheels, runs on tracks within the cabinet. The shuttle can then be driven into or out of the cabinet, bringing the object to be examined in front of the viewing window. When one end of the shuttle is outside the cabinet the other end is in the viewing position. The cabinet is lined with lead sheet ¼ inch thick, providing ample protection for personnel. During observation the operator may move the part being examined back and forth across the field of view. Provision is also made so that the casting can be rotated as it hangs in front of the viewing window.

The X-ray tube is mounted on its tube stand and is provided with a counter-balance so that it can be moved up or down with ease. The tube port extends through a hole in the cabinet, and protection is provided by means of suitable lead flanges. The tube can be moved up or down a distance of 4 inches from the center position by means of a motor mounted on the cabinet itself.

For the higher voltage work a 220 kv constant potential unit was secured as a loan through the courtesy of the Westinghouse Electric Corporation. This tube had a focal spot of approximately 5 mm. It is common practice to employ X-ray equipment producing half-wave rectified voltage. However, one might expect for fluoroscopic examination that the higher output of constant potential type equipment would prove to be superior, in view of the higher screen brightness attainable. The aluminum artificial specimens referred to before were again utilized in the evaluation of this equipment. Complete tests were made with aluminum varying in thickness from ½ inch to 2½ inches, at voltages varying from 140 to 220 kv. In all of these tests the tube current was maintained at approximately 15 ma.

The results of these tests indicated that no particular advantage was to be gained in the detection of defects 0.050 inch or less in maximum dimension in aluminum in the range of thickness from ½ inch to 2½ inches by using X-ray tube voltages greater than approximately 150 kv. Furthermore, it was evident that there is no particular advantage in constant potential X-ray equipment over the commonly used half-wave rectified type.

In view of the greater X-ray density of steel, it was believed desirable to study the performance of this equipment with samples of steel containing artificial defects. A series of samples was made in the same manner as described for aluminum; thicknesses of from ¼ inch to ½ inch, and voltages of from 140 to 200 kv were employed. The results of these tests indicated definitely that the results secured by operating at a voltage of 200 kv were better than those obtained at 140 kv. It is therefore apparent that with higher voltages fluoroscopy of steel is possible within a certain range of thickness.

FURTHER STUDY REQUIRED

While these studies have been exploratory, they have shown that fluoroscopy can be employed for the detection of certain classes of defects which may appear to be structurally significant. There is no reason why fluoroscopy should not be used as an inspection tool, provided its limitations are recognized. The influence of defects which either can or cannot be observed fluoroscopically, or for that matter radiographically, must be determined in any event, and this leads to a very fundamental research program which it is hoped may be considered sometime in the future.

RED CROSS FUND

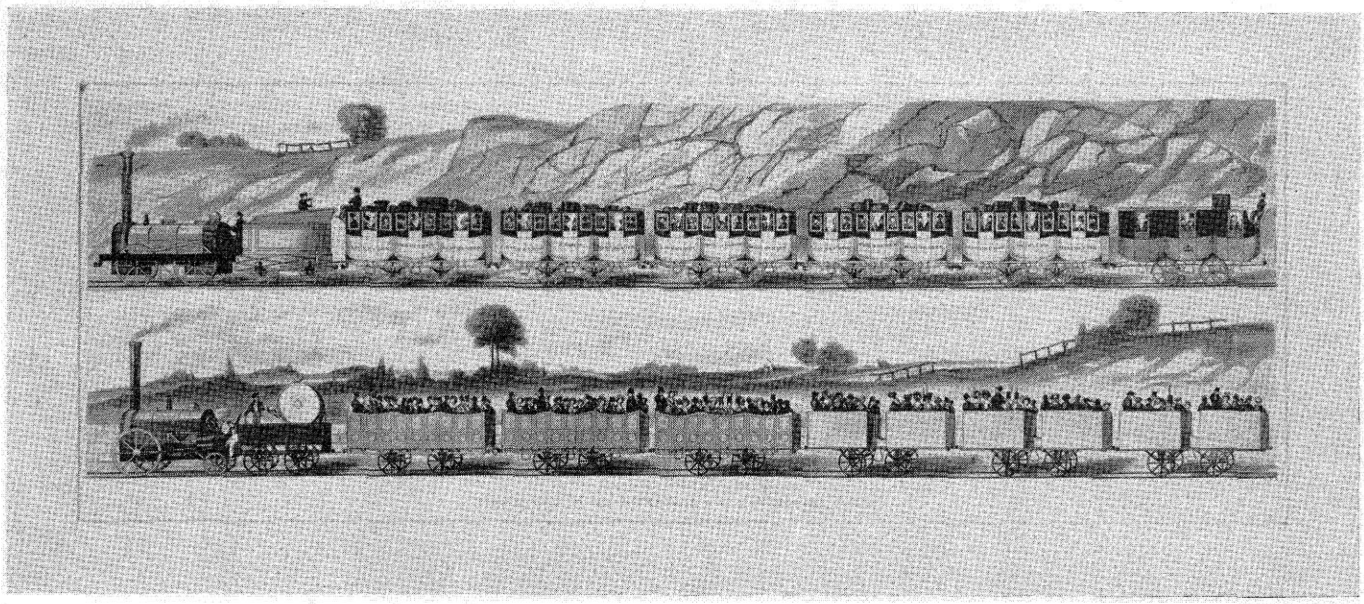
THE American Red Cross enters its 1946 campaign for funds in February. The generous contributions made during the war must continue even though the budget has been reduced 45 per cent. More than any other agency, the Red Cross administers to the comfort and welfare of:

a) Our occupational forces, which still number 1,500,000.
b) The 170,000 servicemen still in the hospitals.
c) The several hundred thousand disaster victims (floods, tornadoes, etc.) in our own country each year.
d) Those unfortunates in the war-devastated areas overseas.

While this is but a partial list of major Red Cross activities, everyone should be able to pick out a particular reason for the urgency of his gift.

At C.I.T., the campaign is being started February 25 by Bob Lehman '31. The support of your local solicitation is strongly encouraged.

R. A. Millikan.



REPRODUCTIONS OF PRINTS, DRAWINGS AND PAINTINGS OF INTEREST IN THE HISTORY OF SCIENCE AND ENGINEERING

7. "Travelling on the Liverpool and Manchester Railway"

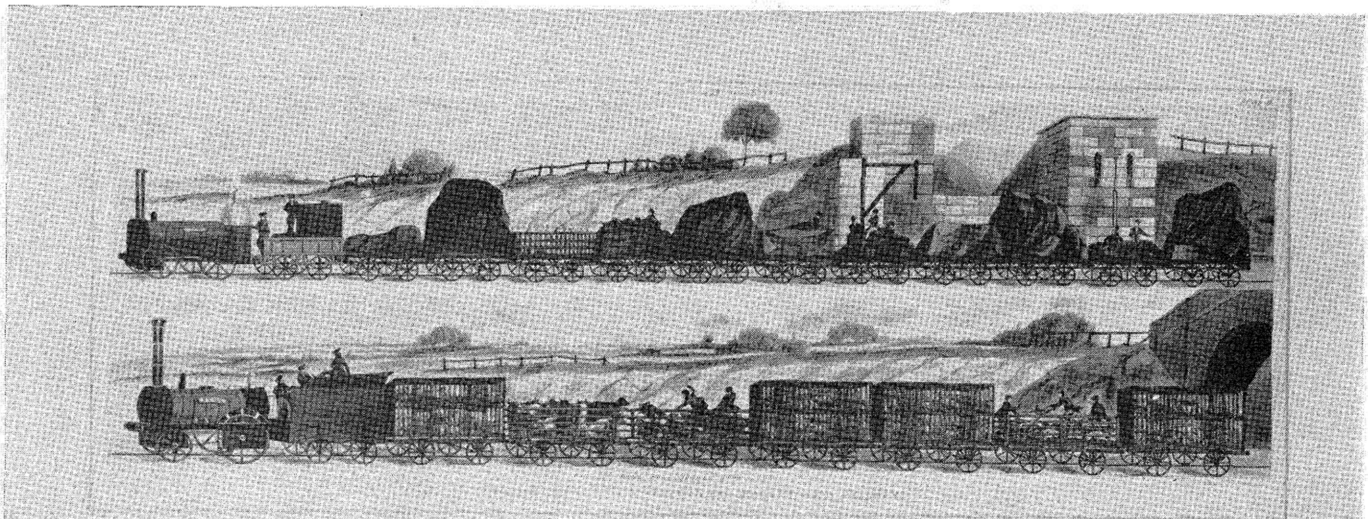
By E. C. WATSON

THE Liverpool and Manchester Railway, opened in 1830, demonstrated that a revolution had taken place in the methods of transportation of both goods and people. Its success was also a great stimulus to mechanical invention, since the first high-speed locomotive of the modern type was invented and constructed for use by the L & M. The interesting story of this pioneer railway has often been told[1] and need not be repeated here. Instead, its early days will be recalled to memory by the reproduction of the famous pair of aquatints, entitled, "Travelling on the Liverpool and Manchester Railway," published in 1831 by Rudolph Ackermann.

The interest aroused by this first great railway line led to the publication of a considerable number of prints and other illustrations. The most beautiful series was that drawn by T. T. Bury, engraved by H. Pyall, and published during 1831 by Ackermann.[2] It consisted of thirteen hand-colored aquatints, 10 inches by 8 inches in size, dealing with typical views along the railroad, such as "Entrance of the Railway at Edge Hill, Liverpool," "Excavation of Olive Mount, four miles from Liverpool," "Viaduct across the Sankey Valley," "View of the Railway across Chat Moss," "Entrance into Manchester across Water Street," "Near Liverpool, looking towards Manchester," "Rainhill Bridge," "Taking in Water at Parkside," etc.

1. Hardly a book has been written about railways which does not refer to the L & M. An annotated bibliography of the most important references will be found in C. F. Dendy Marshall's article, *"The Liverpool and Manchester Railway," Transactions of the Newcomen Society, 2,* 35 (1921).

2. *Coloured Views on the Liverpool and Manchester Railway* (London, 1831).



Late in 1831 two oblong plates, drawn by I. Shaw and aquatinted by S. G. Hughes, were published by Ackermann, each measuring 26 inches by 8 inches. Both are entitled "Travelling on the Liverpool and Manchester Railway" and depict two trains, one above the other (see plate). The "Train of the First Class of Carriages, with the Mail" is hauled by the "Jupiter," a locomotive of the "Planet" class, incorrectly shown with four equal wheels, and has a comparatively modern-looking four-wheeled tender. The "Train of the Second Class, for outside Passengers" is drawn by the "North Star," an improved "Rocket" with the primitive water barrel tender. The engine of the "Train of Wagons with Goods, etc., etc.," named "Liverpool," is of the "Bury" type with coupled wheels. This engine ran on the line for some little time in the early days, but never became the property of the company. The locomotive of the "Train of Carriages with Cattle" is an excellent representation of the "Fury," which had a splasher on the driving wheels and a respectable tender with a cast-iron frame.

The original plates from which these prints were struck, were later reworked, and at least three states of the impressions exist, each with minor variants.

MODIFICATIONS IN THROOP HALL

During the past few years there have been several modifications to Throop Hall. Most alumni will remember that the entrance lobby to Throop Hall was graced by Apollo. The space which he had dominated for so long became desirable for an expansion of the accounting office, so he was moved to the fresh air on the covered area between Throop Hall and the Kellogg Laboratory.

During the war it became necessary to expand the business office. This expansion made use of the north and south hallways on the first floor as a temporary accommodation for office workers. With the construction of the Mechanical Engineering Laboratory in the winter of 1944-45, the space at the north end of the second floor of Throop Hall, occupied by the mechanical engineering offices, was transformed into business offices.

The offices on the west side of the south hallway on the first floor have been modified to accommodate the assistant comptroller, the chairman of the Board of Trustees, and a conference room.

The Engineering Division office is now located on the large stair landing area between the first and second floors. This office was also used prior to July, 1945, as headquarters for E. S. M. W. T. courses.

One very significant change is the removal of the book store from its former location to the northeast corner of the basement floor of Throop Hall. The new quarters are indeed elegant. In fact, it appears to have been transplanted from a modern department store. Beautiful oak panelled display cases and cabinets, illuminated by fluorescent lighting, present a definite sales appeal. Adequate space is also provided for the maintenance of stocks of books and supplies. This book store is provided with an entrance from the walk on the east side of Throop Hall. To provide space for the book store, the Soil Mechanics Laboratory was moved into the space formerly occupied by the athletic office and the athletic office was moved to the area formerly occupied by the Department of Construction and Maintenance engineering group.

The area formerly occupied by the book store on the first floor has now been taken over by the Registrars Office.

C. I. T. NEWS

INSTITUTE LOSES HARRY BATEMAN

PROFESSOR Harry Bateman, world-famed Caltech mathematician who collaborated on the theory of relativity with Dr. Albert Einstein, died suddenly January 21, 1946, en route to New York.

Professor Bateman, according to California Institute of Technology colleagues, "was probably the most widely quoted faculty member, his researches in pure mathematics being internationally acclaimed."

He was stricken on the train as he and his wife were en route to New York to be guests of honor at a dinner, following which the scientist was to be made a Fellow of the Institute of Aeronautical Sciences, and receive a medal for his contributions to aeronautics. Renowned as a chess player, he had participated in many international matches.

A member of the Caltech staff since 1911, Dr. Bateman was unique in holding full professorship in three fields—mathematics, physics, and aeronautics. In 1904-1905, he was so close to the discovery of the special theory of relativity that he, instead of Dr. Einstein, might have been given credit for the then revolutionary concept.

The author of many standard higher mathematics texts, his *"Partial Differential Equations of Mathematical Physics"* is the best known. His contribution to aeronautics, according to Profesor A. D. Michal, an intimate colleague, was vital, in that his work in fluid mechanics was a basic factor in airplane design.

Born in England sixty-three years ago, Professor Bateman was graduated from Cambridge, studied in France and Germany, and served at one time on the staffs of Bryn Mawr and Johns Hopkins. He was honored by being elected a Fellow of the Royal Society, England, and a member of the National Academy of Sciences in this country. His name is among the select group whose names are starred as pre-eminent in *"American Men of Science,"* the American scientific "who's who."

Besides his widow, Mrs. Ethel Bateman, he leaves a daughter, Joan Bateman, a sister, Miss Annie Bateman, and relatives in the east.

DU PONT COMPANY FELLOWSHIPS ANNOUNCED FOR 1946

The Du Pont Company has announced plans to award the following university fellowships in 1946: forty-two post-graduate fellowships in chemistry: five in physics: fifteen in chemical engineering; and seven in mechanical engineering. Six post-doctoral fellowships in chemistry are also included. As in the past, the selection of the fellows, as well as the problems on which they shall work, is left to the universities.

Each post-graduate fellowship provides $1.200 for a single person, or $1.800 for a married person, together with an award of $1.000 to the university. Among the universities listed to receive the post-gradute fellowship awards in chemistry are: Brown University, California Institute of Technology, Columbia University, etc.

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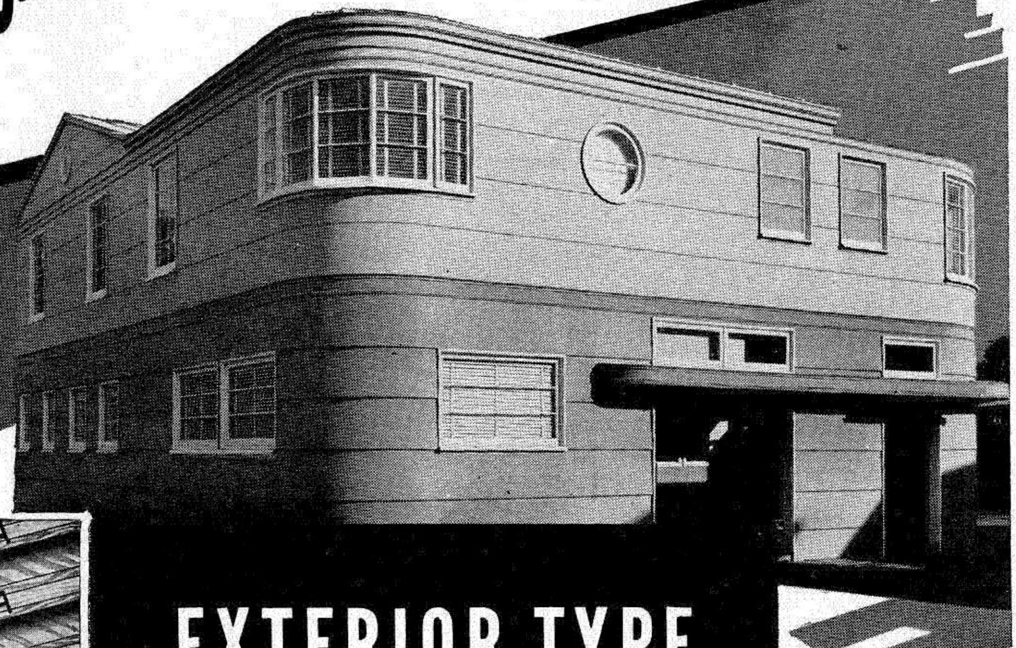

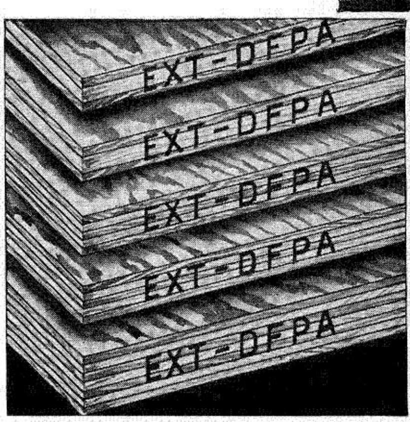

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● Exterior type plywood has been used for years in boat-building, for homes and commercial buildings, for outdoor signs, for boxcars and refrigerator cars. It is a thoroughly proven product and should be specified, furnished and used for **all exterior jobs or for interior uses under conditions of extreme humidity or moisture such as might occur in bathrooms or kitchens.**

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● For prices or delivery information, see any lumber dealer in the United States. All dealers will soon have plywood in stock.

Minkler Tells Alumni of Oil at War

AT the January meeting of the Alumni Association held at the University Club in Los Angeles. Mr. R. L. Minkler. vice-president and director of the General Petroleum Corporation of California. spoke on the subject "Oil at War."

Immediately following "Pearl Harbor." Mr. Minkler spent approximately fifteen months in Washington. D. C.. as director of Petroleum Supply of the Petroleum Administration for War. on leave of absence from the corporation. From this point of vantage he participated in the mammoth job of supplying the armed forces with the "sea of oil" upon which the United Nations "floated to victory."

The astronomical size of the job done by the petroleum industry is illustrated by the facts that two-thirds of all tonnage shipped overseas consisted of petroleum products. meaning that petroleum shipments were over two times as great as the total tonnage of all arms. munitions and supplies. and sixteen times as great as the tonnage of all foods shipped abroad. For a single Pacific amphibious campaign. the Navy's Service Squadron 10 supplied enough oil to fill a train of tank cars 238 miles long with enough oil left over to heat 10.000 homes. To keep our planes in the air—a staggering job considering that a single B-29 uses enough gas in one hour to supply the needs of an average civilian for five and one-half years—the industry stepped up aviation gas from a prewar capacity of 30.000 barrels per day, to 616,000 at the peak of operations. So successful was the job of supply that at no time did the armed services lack for oil.

In addition to supplying the armed forces. the industry was faced with the task of delivering 1,500,000 barrels per day to the East Coast from the Gulf Coast, the same physical feat as transporting the total daily steel production of the United States which is approximately 250,000 tons over the same distance. Although the East Coast reached a point where supplies were reduced to a two-day level, the oil was delivered. According to government authorities. if the supply to war industry had failed we would have lost the war.

Most astonishing fact about the successful accomplishment of the battle of oil was that the work was done without new equipment, through pooling. organization and the joint use of industry facilities. An example of one expedient used to solve the transport problem involved a government ruling that loaded tank cars might move north or east. but that no loaded cars might move south or west. This device prevented duplication of oil flow. In effect. the petroleum industry. by encouraging the abundant—even extravagant—peacetime use of oil in the United States. built a plant structure capable of taking in slack to care for expanded war needs. Thus. what is sometimes called the "competitive inefficiency of the private enterprise system" actually proved the saving factor which allowed us to pull in our belts and outproduce the planned economies of the Fascist states.

This same competitive system within the petroleum industry carried on development and exploration at a rate providing the United States with her greatest oil reserve of all time at war's end. However. the existence of these reserves does not mean that our supply is inexhaustible. for consumption has grown faster than production. During the years from 1942 to 1945 we used 20 per cent of all oil produced in our history. In spite of this ever-expanding consumption. Mr. Minkler predicts that the oil industry. operating as it has in the past. and expanding at a rate which produced 975.000 barrels per day in 1918 in all of the United States as compared to 1.002.000 barrels per day in 1945 in California alone. will discover new fields. invent new processes. or extract oil from natural gas. and that oil will serve us as well in peace as it has in war.

Caltech Conference Standing Good

By H. Z. MUSSELMAN

Director of Physical Education

PASSING the halfway mark in the basketball schedule. Caltech has won two out of five Conference games. to place the Engineers third in the league's standing. just behind Redlands and Occidental. The Conference teams are well bunched this year. and no league game has been won by more than a six-point margin. While the Tech team may not top the Conference in the final standings. they have an excellent chance to improve their position in the three remaining league contests.

In the opening games. the Engineers annexed two close victories in winning from Whittier 30-29. and from Occidental 37-25. Redlands grabbed two torrid contests. both by four-point margins. 51-47 and 43-29. while Whittier in the return encounter annexed a 43-38 victory.

The Beavers have not fared as well in non-Conference engagements. having dropped all their games with U.S.C., U.C.L.A.. Pepperdine. March Field and Camp Ross.

The team has been playing a good floor game, but the lack of consistent scorers has been a distinct handicap. The men have been getting the shots. but have not been able to connect.

A full card of contests with southern California Conference schools has been scheduled in spring sports. With only forty Navy trainees on the campus, the Intercollegiate teams at the Institute now will be composed mainly of civilians. All squads will be inexperienced, as there are practically no lettermen in school who were members of our 1945 teams. However. several track and baseball men who made their letter before the war, are planning to return, and should form the backbone for good squads.

John J. Lund is New Institute Librarian

DR. JOHN J. LUND. formerly university librarian at Duke University. has joined the staff of California Institute of Technology as Institute Librarian.

Born in Denmark in 1906. Dr. Lund. now a U. S. citizen. came to the United States in 1910. and to California in 1912. He received his A.B. from the University of California in 1928. and his Ph.D. in Comparative Philology from the University of Chicago in 1932.

From 1936 to 1938 Dr. Lund was library assistant and instructor in Scandinavian languages at U. C. L. A.. and from 1938 to 1943 he was associated with Duke University as Head of Order Department and University Librarian. During the late war years. Dr. Lund proved his versatility. and participated directly in the war effort by his work as a machine designer in Oakland. California. Victims of the housing shortage. Dr. Lund's wife and two children are still in Oakland.

Among Dr. Lund's publications are: *"The University*

Library: Some Thoughts About Its Past and Some Questions About Its Future," done in collaboration with Gustave O. Arlt; "*The Cataloging Process in the University Library: A Proposal for Reorganization*"; and "*The Undergraduate in the University Library.*"

Former C. I. T. Meteorologists Forecast Japanese Weather

A RECENT letter to Paul E. Ruch, Associate Professor of Meteorology at the Institute, from Captain C. E. Erickson, former instructor in Meteorology at California Institute of Technology, describes the part played by the weather forecasters in helping to defeat Japan. The reference in the following excerpt from the letter is to the contribution of Captain Loren W. Crow, formerly of C. I. T.:

> "I would like to say a word about Crow's work at Guam. I took over for Crow for about three weeks before the war ended while he went back to Hickam for a rest leave, and I know fully well what he contributed to the efforts of the 20th Air Force in defeating Japan. The staff officer relayed Crow's outlooks for coming operations verbatim to the general staff, and the general staff relied almost wholly upon the weather forecast to do their planning. I don't mind going on record to say that no individual forecaster contributed more to the success of the operations of the 20th than did Doc. I can get plenty of men to back that statement, too. Colonel Seaver, the staff officer, relied very heavily on Crow for the dope and had great confidence in him.
>
> "When you next see Crow, don't let him off with his modesty. If Crow had come back a week earlier he would have made the forecast for the Atomic Bomb. As it was, I made the forecast for it five days in advance, and at the time Colonel Seaver said it was the longest operational forecast that had been carried through without a hitch. However, by that time the semi-permanent high was sitting over the empire, and it was little trouble to forecast, in comparison with the obstacles that Crow bucked through the winter and spring."

C.I.T. Student in Siamese Army

The Royal Thai Legation in Washington, D. C., reports that Charoen Vadhanapanich, for two years a member of the class of 1944, now holds the rank of captain in the Royal Siamese Army.

Leaving C.I.T. in the fall of 1943, Vadhanapanich received training from the United States Army, where he became a qualified paratrooper. He was then commissioned as an officer of the Free Thai Military Unit which was formed in this country during the war. Overseas, he entered Siam, which was still under Japanese occupation, and there Vadhanapanich helped in organizing underground resistance and in securing information about the enemy which was transmitted to the Allies.

Letters to the Editor:

Caltech Alumni Association:

I would like to suggest that Tech graduates do a little more "horn blowing" as a matter of common pride. One simple idea would be to make "Caltech" car windshield stickers easily available to alumni. Perhaps these could be given out annually with dues renewals by some means.

I would like to obtain such a sticker, but have not made the special effort to get one. Perhaps others have found the same. Why not?

(Signed) *R. J. Hallanger '35*

For any interested alumni, Caltech windshield stickers may be obtained from the Institute book store. Order by mail, enclosing 10c to cover handling costs.—Editor.

Fill in and send to:

News Editor, Engineering and Science Monthly
1201 East California Street, Pasadena 4, Calif.

Name__________ Class_____

Home address__________

Information about myself (marriage, position, type of work, change of position or location, etc.)

Information about another alumnus

Name__________ Class_____

Dr. Harlow Shapley Visits Campus

DR. HARLOW SHAPLEY, president of the American Academy of Arts and Science, director of the Harvard Observatory, and from 1914 until 1921 a member of the staff of Mt. Wilson Observatory, recently made an informal report before the weekly faculty seminar at the California Institute of Technology. The report covered Dr. Shapley's trip to London and the background leading to the formation of *"Unesco,"* the United Nations Educational, Scientific and Cultural Organization.

An outgrowth of sentiment for an International Office of Education, *"Unesco"* has received support from such diverse groups in this country as the Chamber of Commerce, the C. I. O., the Brotherhood of Pullman Porters and a total of over 50 organizations. Of these organizations, Sigma Xi Fraternity was the first to endorse the idea of an International Office of Education. At Dumbarton Oaks, the Chinese went on record that such an organization was necessary, and at San Francisco a resolution incorporating the basic points of the Taft-Fullbright Bill, providing for an International Office of Education, became a part of the record.

At the London Conference in November of 1945, attended by representatives of 44 nations, a constitution was drafted which provides for "promoting collaboration among the nations through education, science and culture in order to further universal respect for justice, for the human rights and fundamental freedoms—by instituting collaboration among the nations to advance the ideal of equality of educational opportunity without regard to race, sex or any distinctions, economic or social; by suggesting educational methods best suited to prepare the children of the world for the responsibilities of freedom—by assuring the conservation and protection of the world's inheritance of books, works of art and monuments of history and science—by encouraging co-operation among the nations in all branches of intellectual activity, including the international exchange of persons active in the fields of education, science and culture—by initiating methods of international cooperation calculated to give the people of all countries access to the printed and published materials produced by any of them." The *"Unesco"* constitution provides for the necessary machinery of financing and administrating activities and shall come into force when it has been accepted by the governments of 20 of the United Nations.

It is Dr. Shapley's hope that because of the long record of international cooperation in science—there have been over 1,000 scientific international meetings or congresses held to date—*"Unesco"* may be successful in establishing a workable pattern for other types of international cooperation. He believes that the present *"Unesco"* constitution is an excellent start toward the fulfillment of this objective.

Harry Cunningham '26

Harry Cunningham, who has been connected with the U. S. Bureau of Public Roads for 15 years, and successively held ratings as senior engineer and senior economist, has now added another title to his collection. Following completion of a law course at George Washington University, Washington, D. C., and admission to practice before the District Court of the United States and the United States Court of Appeals, he has been given a rating as senior attorney and appointed assistant chief, division of contracts and claims of the Public Roads Administration where his engineering experience should prove very valuable.

As a student, Mr. Cunningham was wrestling manager and boxing coach.

PERSONALS

IT WILL be helpful if readers will send personal items concerning themselves and others to the Alumni Office. Great interest has been shown in these columns, but more information is required. Do not hesitate to send in facts about yourself, such as change of position or location, present job, technical accomplishments, etc. Please help.

—Editor.

1922

HOWARD G. VESPER has been appointed president of California Research Corp., Standard of California's research subsidiary. In war work, Mr. Vesper played an important role in handling allocations of all bulk products, except aviation gasoline, for essential civilian use and military requirements.

COLONEL BEN BENIOFF has just returned from China where he was in the executive office to the Chief of Transportation. U. S. Forces China Theater, and as such worked with Director of Highways for the Chinese government. The Director of Highways was C. Y. Hsaio, '26, in Chungking new headquarters, and of additional interest was his contact with Y. H. Huang, '26, who is chief of hydro-electric power development in China.

MAJAR JAY DEVOE sent to the Alumni office greetings from Okinawa.

1926

ERNST MAAG was recently elected president of the Structural Engineers' Association of California.

MAJOR ORRIN H. BARNES is separated from Service and intends to remain in Honolulu until next summer where he has a temporary position as associate engineer with the firm of Austin and Towill, civil engineers of that city. Major Barnes announces the birth of a son, born October 11, in Honolulu.

LIEUTENANT-COLONEL STUART SEYMOUR is to return to reserve status about the middle of March. Stuart visited the Institute early in January on his return from Leyte where he was recruiting officer for the regular army.

1927

LIEUTENANT-COMMANDER WILLIAM W. AULTMAN is now on inactive status and expects to return to his former position as a water purification engineer for the Metropolitan Water District of Los Angeles.

CAPTAIN ROBERT CREVELING has been discharged from military service and expects to work with the Shell Oil Company. Captain Creveling spent four years primarily on communications—radio and radar equipment—where he has been with the Air Technical Service Command.

1928

LIEUTENANT - COMMANDER R. H. DUVAL visited the Institute in December on terminal leave. Lt. Comdr. Duval's assignment was with the Bureau of Ships, Shipborne and Radar Design Section, in Washington, D. C., where he served twenty-seven months. In civilian life, he intends to go back to his former position as an engineer with the M.G.M. Studios in Hollywood.

EDWARD E. TUTTLE has returned to the firm of Tuttle & Tuttle (Los Angeles) after resignation from an appointment at Caltech on the rocket and atomic bomb projects of the O.S.R.D.

1929

LIEUTENANT MILTON H. SPERLING, U.S.N.R., has returned to civilian life, having been stationed in New York about two years with the Petroleum Section, Inspector of Naval Materials. Milton intends to locate in southern California.

1930

ERNEST HILLMAN was elected to the board of directors of the Structural Engineer's Association of California.

LIEUTENANT JOHN E. ANDERSON visited the Institute when on terminal leave in December. Lt. Anderson was attached to the Norfolk Navy Yard with duties in connection with degaussing.

1931

LIEUTENANT - COMMANDER LAWRENCE L. FERGUSON visited the campus in December. Larry has been in research and development with the Amphibious Forces, Pacific Fleet, for the past one and one-half years. At the end of his terminal leave in January, ne expects to return to his former position on the president's staff of General Electric in New York City.

1932

DOCTOR JAMES D. COBINE, associated with the Research Laboratory of General Electric Co. at Schenectady, worked under O.S.R.D. during the war and was responsible for the development of noise tubes which were to be a source of interference to the enemies radar scope screen.

1933

ANDREW ASHTON has opened a new office in Los Angeles at 3950 W. 6th Street. The firm will be known as Andrew Ashton and Associates, Consulting Engineers. Andy's engineering background includes work with Aireon as Chief Production Engineer, and with Douglas, Disney, and Vega, in engineering design.

1935

HALLEY WOLFE is with Electrical Research Products Division of the Western Electric Co. in Hollywood.

LEWIS BROWDER has recently taken a position with Electrical Research Products, Division of the Western Electric Co. in Hollywood, having formerly been employed by Lockheed Aircraft. Lewis lives in La Canada, California, and is the father of three daughters; Janice aged 8, Eileen 4, and Barbara 3.

LIEUTENANT WARREN T. POTTER was released from active duty in the Naval Reserve after serving in this country and at the Pearl Harbor Navy Yard. Warren intends to make his home in southern California.

WILLIAM F. KEYES has accepted a position as chemical engineer with the Johns-Manville Products Corp., Lompoc, Calif.

ADRIAN GORDON served seventeen months in Iceland and for the past year has been stationed in London at the Air Ministry where his work is nearly all administrative. On return to England, Adrian was reverted to civilian status.

1936

ROBERT JERAULD was injured in an automobile accident and has been convalescing at his home in Torrance, California, for three months.

1937

LIEUTENANT (j.g.) JASPER R. LEGGETT is on inactive status and is now associated with the Byron-Jackson Co. of Los Angeles, Calif.

THEODORE SANDBERG has accepted a position in the production department of Cutter Laboratories at Berkeley, Calif.

ALAN GROBECKER has accepted a position with Gilfillan Bros., of Los Angeles, Calif.

DOCTOR CHARLES F. HADLEY, working under O.S.R.D. during the war, did research on test equipment and special instruments. Dr. Hadley is now with the exploration division at the Stanolind Oil and Gas Co., Tulsa, Okla.

1938

NORMAN WIMPRESS began work on his new position with Industrial Engineers, Los Angeles, in February.

CHARLES WRIGHT of Airesearch Corp. is chairman, Phoenix chapter, of the American Society of Tool Engineers.

JOHN PARKER is now on a civilian status, having been a First Lieutenant in the Air Corps, serving in the States, the Philippines, and on Ji Shima as an aerial navigator.

CHARLES CLARKE, formerly chief product engineer, Air Research Manufacturing Co., division of the Garrett Corp., Phoenix, Arizona plant, has been promoted and transferred to the main plant in Los Angeles in the same capacity. During his tenure in Arizona, Mr. Clarke was 1945-46 chairman of the American Society of Tool Engineers, Phoenix chapter.

1939

FIRST LIEUTENANT RODERICK McCLUNG is on terminal leave, having returned from Chanute Field, Illinois, as Weather Officer, where he instructed army personnel in the operation of balloon-borne, radio-weather observing instruments.

GEORGE O. CROZIER is the father of a son, Thomas Edwin, born on July 19.

BARRY DIBBLE is working on the Southern California Cooperative Wind Tunnel at Caltech.

1940

LIEUTENANT-COLONEL P. M. HONNELL, director of electronics course at the U. S. Military Academy, West Point, is the author of three articles which appeared in print last November, namely: "The Prony Brake", (Journal of Engineering Education), "Measurement of Transformer Turns-Ratio" (Proceedings of the Institute of Radio Engineers), "The Marconi, a New Unit of Frequency" (Letter to the Editor of Electrical Enginering).

DAVID J. VARNES spent his vacation with his wife in southern California over the holidays. Dave is working with U.S.G.S. on mineral deposits in Colorado and lives in Denver.

VICTOR WOUK is at present with the North American Philips Co. Inc. in Dobbs Ferry, N. Y., where he is a circuit engineer doing developmental and theoretical work in the fields of television and FM. For the past two years Vic was employed at Westinghouse in Pittsburgh, working on the Manhattan District Project. Vic has a son, Johnny, now one and one-half years old.

1941

WILTON A. STEWART was discharged from the military service on Thanksgiving day. Wilton served in a tank outfit in France, Germany and Austria. A son, David, arrived at the Stewart home on September 5.

LIEUTENANT M. V. EUSEY is now on inactive duty from the Armed Forces where he has served twenty months overseas on the aircraft carrier U. S. S. Tripoli in both Atlantic and Pacific areas.

JEROME GREEN has accepted a position with the National Aluminate Corp., Chicago, Ill.

GENE LAKOS, who for thirteen months has been an instructor in the Civil Engineering Corps at Camp Endicott, plans to transfer to the regular Navy C.E.C.

LIEUTENANT SIDNEY K. GALLY, U.S.N.R., is the Staff Electronics Officer for a Destroyer Squadron now in the Pacific.

1942

JOHN A. CHASTAIN, a Lieutenant in the Navy, was relieved from active duty in January. John served twenty-eight months in the Pacific area on the attack transport Harris.

LIEUTENANT FRANK A. FLECK, U. S. A., formerly operations officer at Dakar, has returned to the States and is now on terminal leave.

LIEUTENANT THOMAS ELLIOTT who was stationed at Honolulu for two years with duties of aircraft engineering maintenance, was discharged February 1. Tom hopes to locate in southern California.

HENRY ROESE has accepted a position in the engineering department of the Southwest Welding & Mfg. Co., Alhambra, Calif.

1944

PHILIP H. SMITH was home for a few days in December between trips to and from the Pacific area. Philip is on an escort carrier, the Hoggatt Bay, which is bringing troops home.

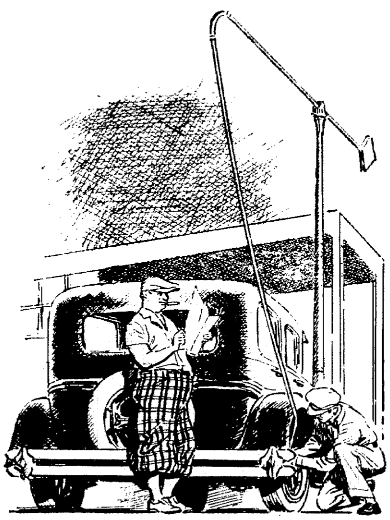
RICHARD LOCKETT and his wife spent Christmas in southern California. Dick works for General Electric Company in Schenectady, N. Y.

ERIC WEISS is employed by the Parker Appliance Co., Los Angeles, Calif.

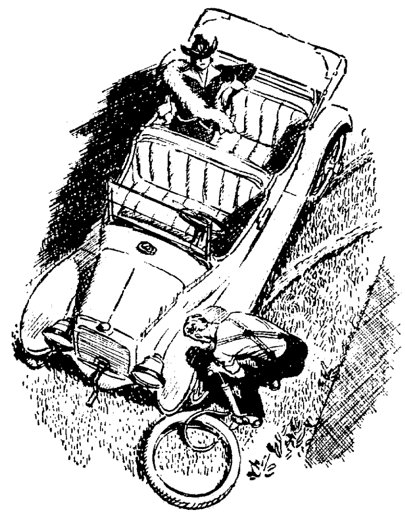
1945

ENSIGN IVAN KEITH, now on inactive status, is employed by the Westinghouse Electric Corp. at their East Pittsburgh plant.

The inside story of Union Oil's air wells

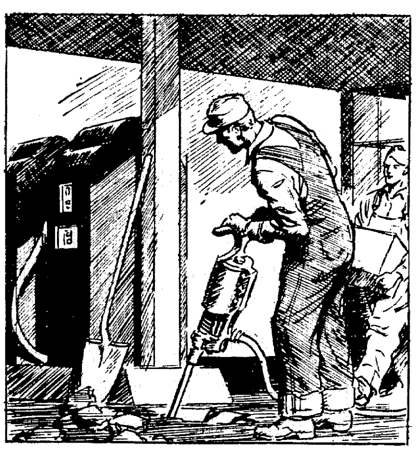


1. If you're over 21 you'll remember that back in 1932 nearly everyone made two stops at a service station. First you drove up to the pump island for gas, oil and water. Then you pulled over to the edge of the lot and got air. No one thought this was particularly unhandy.



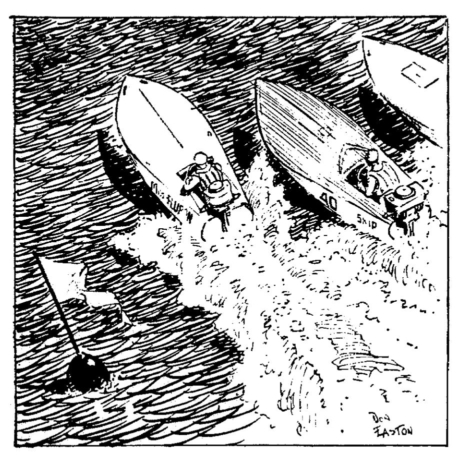
2. It certainly beat pumping up tires by hand. But in 1933 Union Oil's service station department got an idea – why not sink the air and water hoses on drums in wells under the pump island? Then the customer could get everything in one spot.

3. To test the idea, experimental rigs were installed in several stations. The customers loved them. Air and water wells were not only convenient, they saved a good deal of time. Consequently, during 1934 all Union Oil stations were changed over to this type of equipment.



4. Now this change-over cost us a lot of money. In fact, "minor improvements" such as this have raised the cost of service stations from about $1000 each in 1920 to $21,000 today. But we had one compelling reason for spending it – *competition.* We knew that if we could put out even a *little* bit better service than our competitors *we could get more customers.*

5. If the oil industry had been a monopoly – private or governmental – we probably would have saved the money and let well enough alone. There's no need to go after more customers when you already have them all. But, thanks to *competition,* we didn't. And today practically every Pacific Coast service station has followed suit.



6. The moral? Simply this: So long as there's room for improvement in an industry, the only way you can guarantee *maximum progress* is to have an economic system that guarantees *maximum incentives.* Our American system, with its *free competition,* provides these to a degree no other system has ever approached.

UNION OIL COMPANY

OF CALIFORNIA

This series, sponsored by the people of Union Oil Company, is dedicated to a discussion of how and why American business functions. We hope you'll feel free to send in any suggestions or criticisms you have to offer. Write: The President, Union Oil Company, Union Oil Bldg., Los Angeles 14, Calif.

AMERICA'S FIFTH FREEDOM IS FREE ENTERPRISE