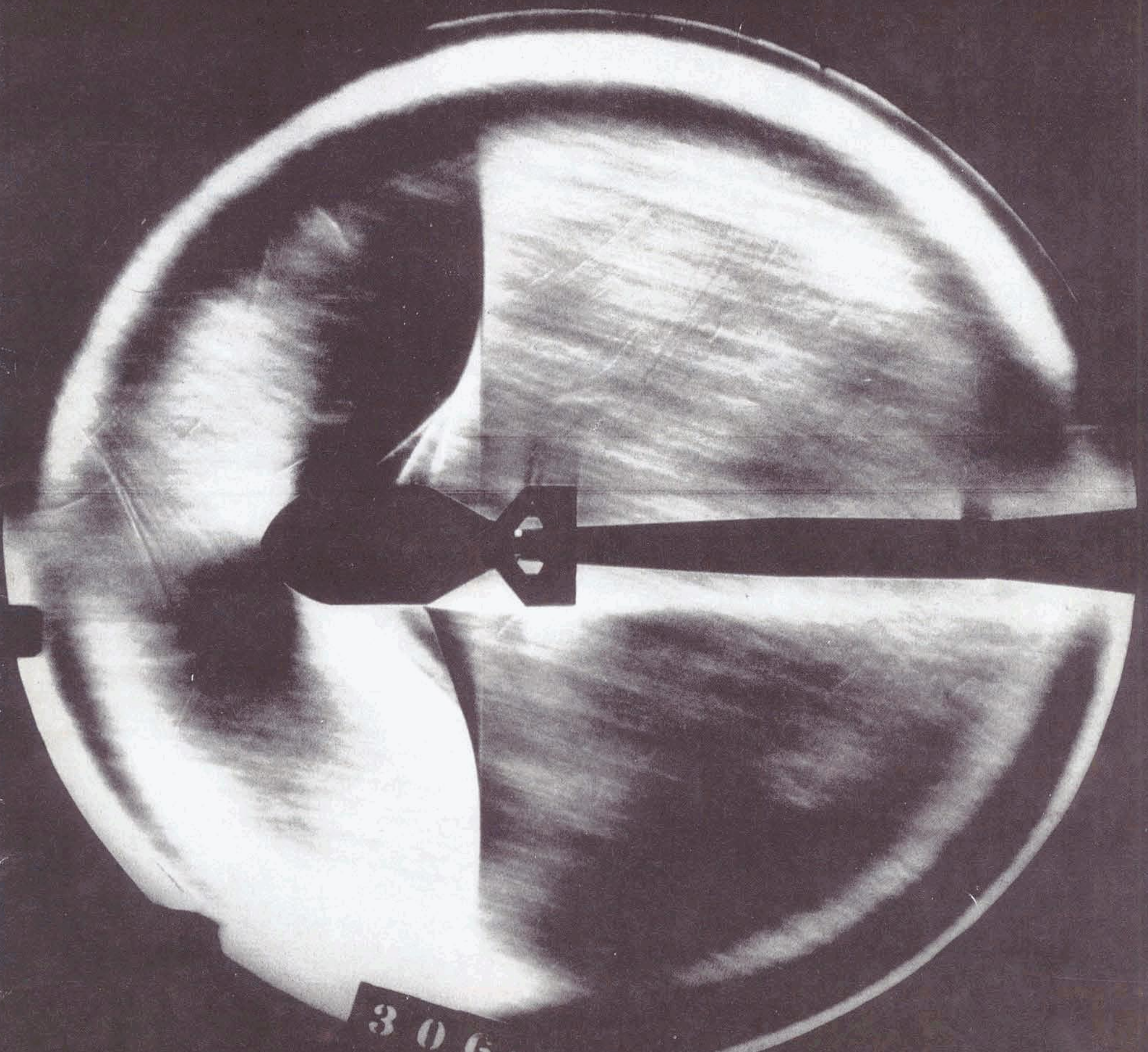
ENGINEERING AND SCIENCE

MONTHLY



DECEMBER, 1946

PUBLISHED BY CALIFORNIA INSTITUTE OF TECHNOLOGY ALUMNI ASSOCIATION

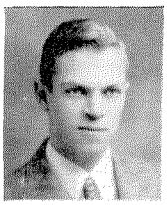
BY-LINES

JOHN MILLS

An article about John Mills, who is on the Institute staff as an advisor to Tech students, will be found on page 11.

• • •

ALLEN E. PUCKETT



Allen E. Puckett, instructor in aeronautics, received his B.S. from Harvard in 1939 and his M.S. from the Harvard Graduate School of Engineering in 1941. He worked as a research assistant under Dr. Theodore van Kármán at the Institute from 1941 to 1943, assisting in the development and operation of the Galcit 2.5 inch supersonic wind tunnel. From 1943 to 1945 he was in charge of aerodynamic design at the Army's Aberdeen Wind Tunnel in Maryland. Since 1945 he has been chief of the wind tunnel section of the Jet Propulsion Laboratories here. Mr. Puckett is now in charge of the supersonic wind tunnel now under construction at the Institute.

• • •

COVER CAPTION

A model of a bomb mounted in the bomb tunnel at Aberdeen Proving Ground, Maryland, being tested at a subsonic Mach number of approximately 0.9. There is no wave ahead of the model, but the shock waves on either side extend far out.

• • •

ENGINEERING AND SCIENCE MONTHLY is published monthly on the 25th of each month by the Alumni Association, California Institute of Technology, Inc., 1201 East California Street, Pasadena, California. Annual subscription $3.50, single copies 35 cents. Entered as second class matter at the Post Office at Pasadena, California, on September 6, 1939, under the Act of March 3, 1879.

ENGINEERING AND SCIENCE

Monthly

The Truth Shall Make You Free

CONTENTS FOR DECEMBER, 1946

The Industrial Scientist as Citizen 3
By John Mills

High-Speed Aerodynamics 5
By Allen E. Puckett

Inauguration of President DuBridge 8

C. I. T. News 11

Alumni News 16

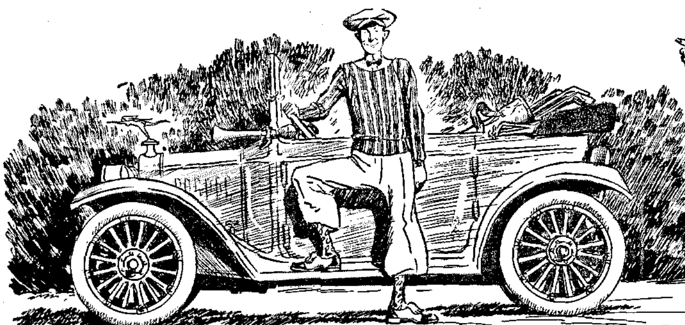
•

ENGINEERING AND SCIENCE MONTHLY

Published at the California Institute of Technology

Picture Quiz

ANSWERS AT BOTTOM OF PAGE



1. In 1925 the average monthly wage of Union Oil employees was $158.62. Last year it averaged $273.56–an increase in 20 years of 72%. What was the principal cause of this increase? . . . .

CHECK ONE:
- ☐ *The Wagner Act.*
- ☐ *The employees got a bigger hare of the profits.*
- ☐ *The employees earned more because they were able to produce more.*

2. You can't dig an oil well with your bare hands. Someone has to provide the employees of an oil company with "tools" –drilling rigs, trucks, service stations, etc. In America this is done by stockholders. How much would you estimate the stockholders of Union Oil have invested in "tools" for each Union Oil employee? . . . .

CHECK ONE:
☐ *$40,886* ☐ *$15,206* ☐ *$1,232*

3. Union Oil Company made a total net profit last year of $8,747,992–6% on gross sales, 5.9% on the capital invested in the company. What would you estimate this net profit averaged per stockholder-owner? . . . .

CHECK ONE:
☐ *$10,432* ☐ *$25,000* ☐ *$258*

4. During the last peacetime year in Europe (1938) the retail price of gasoline was 59¢ a gallon in Berlin, 45¢ in Istanbul, 31¢ in London, and 81¢ in Rome. In America it averaged 18¢–one-half as much (excluding taxes) as it sold for in 1920. What accounts for this difference? . . . .

CHECK ONE:
- ☐ *U. S. Government regulation.*
- ☐ *Competition between oil companies.*
- ☐ *U. S. had larger oil resources.*

ANSWERS

1. *The employees earned more because they were able to produce more.* Last year Union Oil employees worked 35% fewer hours than they did in 1925 and had more vacation, health and pension benefits. But they had *twice* as many "tools" to work with. Consequently they could produce more with less work. Production per employee went up 76% and wages went up 72%.

2. The average Union Oil employee has $40,886 worth of "tools" with which to do his job.

3. 8¾ million dollars is a lot of money, but it was divided among a lot of people. For Union Oil is owned, not by 1 man or 2, but by 33,938 individual Americans, the largest of whom owns less than 1¼% of the total shares outstanding. So the net profits averaged just $257.76 per stockholder-owner.

4. *Competition*–Less than ⅛ of the "favorable oil producing areas" in the world are located within the boundaries of the U. S. *Other countries had more* governmental regulation of gasoline prices than we. But no other country in the world has as much competition in the oil industry and no other country in the world has as low gasoline prices.

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

ENGINEERING AND SCIENCE

Monthly

Vol. IX, No. 12 December, 1946

The Industrial Scientist as Citizen

By JOHN MILLS

The part shat should be played by engineers and scientists in the postwar world has been heavily stressed of late. This article by John Mills should be of interest to all readers of ENGINEERING AND SCIENCE MONTHLY. Statements and opinions advanced are to be understood as individual expressions of the author, and not those of the staff of ENGINEERING AND SCIENCE, the Association, or of the Institute.

—EDITOR

SCIENCE and engineering are the recognized source of the implements and mechanisms of our material civilization. But scientists and engineers are justly accused of exerting little influence upon the uses which society makes of their contributions. They produce while others dispose. The mental characteristics which are the basis of their production—their objectivity and reliance upon quantitative results, their scientific attitude and their ability to originate workable theories of relationships—are increasingly needed to preserve their products from the control of ignorance and from exploitation by passion and prejudice. Any of their developments which they do not safeguard by thought and action, comparable to that of its accomplishment, is an incomplete and half-baked offering which may cause strange disorder in the body politic.

Why is it that the men who devise the physical mechanisms of our civilization are, as a rule—and the exceptions which might be cited only prove the rule—so unconcerned and speechless as to their social utilization? They are driven by two creative urges, intellectual curiosity and the instinct of workmanship, which have produced the art, literature, science and engineering that raised man so far above the other animals of common origin. Curiosity points the way and craftsmanship follows. But for most engineers and scientists the compelling drive of curiosity soon becomes narrow and canalized.

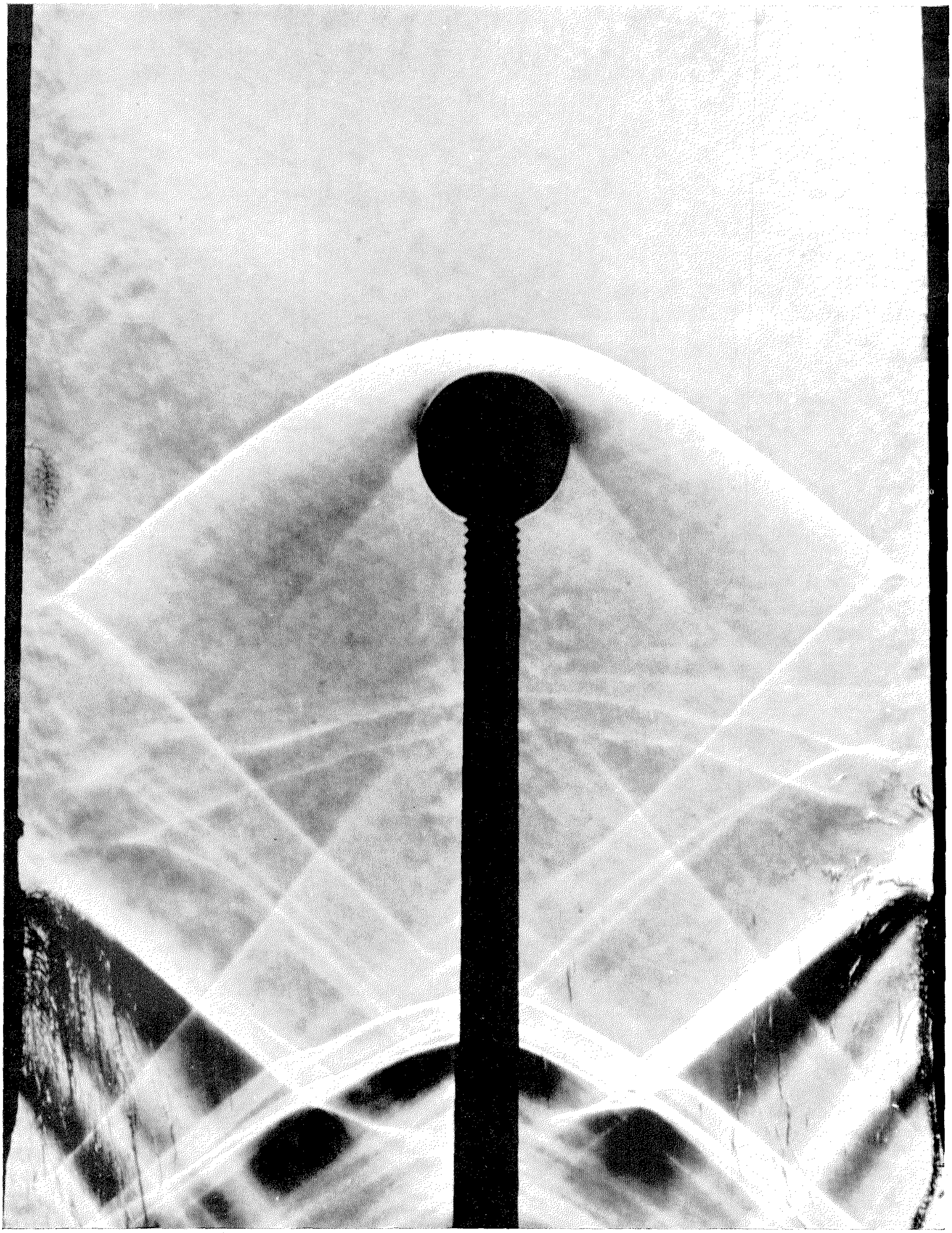
The long and rigorous course of training which they undergo, despite the feeble diversion of so-called courses in the humanities, soon limits their questions to their own chosen fields. They lose—and society to a still greater extent—their mental explorations into matters of human relationships, social, economic and political. Blocked from those fields of inquiry by their own inhibitions they tend to accept unquestioningly the current platitudes of other men or the prejudices and doctrines they earlier absorbed as children.

Their interests and activity are further narrowed into particular subdivisions of science and the engineering arts. They tend to become specialists. And this tendency is pronounced in industry where organization is functional and responsibility usually specific. Much of the power of industrialized science is to be ascribed to its coordination of highly specialized experts. Although there may be breadth at the upper level of executive control, the lower, but creative, levels are departmentalized. For any problem outside an expert's immediate specialty there is, at least nominally, another thoroughly qualified expert. The sphere of influence of each is usually well recognized; and its boundaries are rarely violated, for that would be inefficient and anarchical. Each has vested his interest in his specialty; and when technical advice is needed beyond his range he learns, on a live-and-let-live basis, to rely on co-ranking experts.

In an industrial organization, engineering conferences are assemblies of the experts in the several phases of an entire job; and these men defer to each other on the basis of specialty. The executive head of a group, of course, can speak as an expert on all the phases handled by members of his department. However, his opinions, except when they are based on his individual work, are usually restatements of what his assistants have furnished him.

In industry, in other words, one quickly acquires the habit of relying upon others for all that is outside his immediate field, accepting opinions the more completely the further their fields are from his own. And this phenomenon of specialization results all-too-frequently in a laissez faire attitude in matters where the integument of one's self or department is not endangered . One may even learn how to pass the buck, or at least to feel no responsibility for matters

(Continued on page 10)



Schlieren photograph of air flowing past a sphere at 1.5 times the speed of sound. This photograph was taken in the Galcit 2.5 inch supersonic tunnel.

Notice the strong headwave produced by the blunt body, similar to a boat's bow wave. A considerable portion of the large drag experienced at supersonic speeds is associated with this phenomena.

High-Speed Aerodynamics*

By ALLEN E. PUCKETT

IN recent years considerable popular attention has been focused on the problem of achieving very high speeds in aircraft. This interest has ben accentuated by the war, which made speed one of the prime requirements for military pursuit aircraft. The advertised top speeds reached by aircraft increased from roughly 400 miles per hour before the war to roughly 600 miles per hour, this last being announced in the press not long ago as the speed attained by a British jet fighter. It has been pointed out in the press that difficulties appear as airplanes approach 750 miles per hour, which is the speed of sound, and many fantastic descriptions have been given of the effects in that region. There are, as a matter of fact, some interesting and even remarkable aerodynamic effects in that vicinity, which we will investigate here in some detail. At the same time, the speed of sound is hardly a magic, unsurpassable speed, as every bullet fired from a gun, not to mention the V-2 and various other rocket missiles, goes several times that fast.

CONCEPT OF SUPERSONICS

The peculiar effects occurring at speeds approaching the speed of sound are associated with the fact that air is compressible, and the study of high speed aerodynamics is almost synonymous with the study of "compressibility effects." We shall examine in detail what this means.

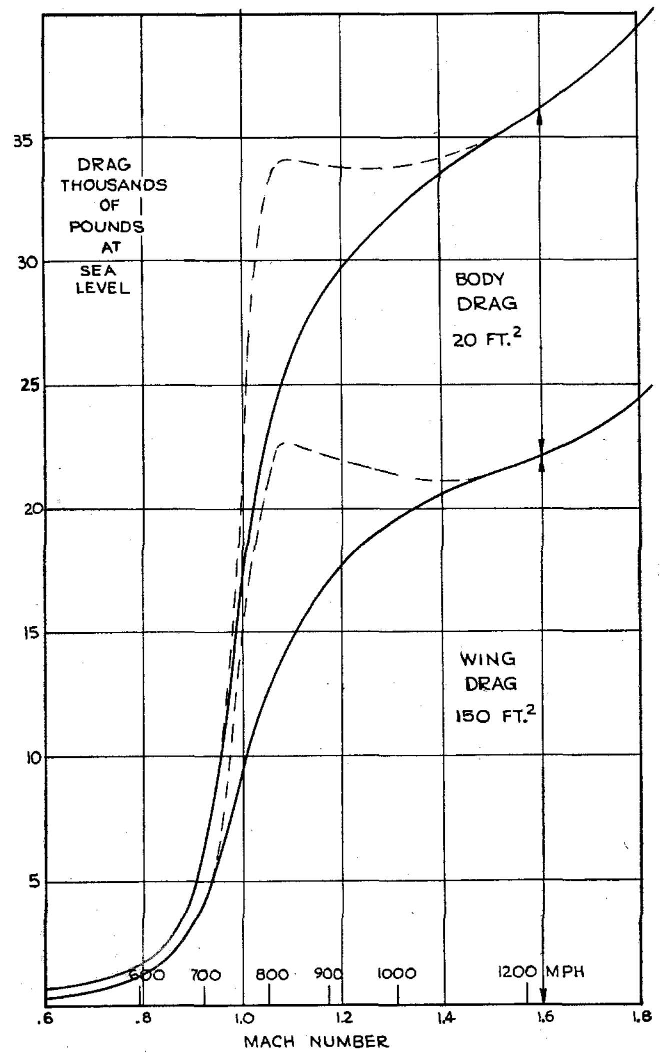
Suppose a small disturbance is made in a room full of air; if the air were truly incompressible, each molecule must press instantaneously on its neighbor, and the effect of the disturbance woud be transmitted instantly to all parts of the room. However, the air is in reality compressible, so that the air molecules cannot transmit a message instantly, but only at some finite speed. A sound wave is an example of such a small disturbance, and the speed of transmission of these small disturbances is called the speed of sound. The speed of sound is a function only of temperature; at sea level it is about 760 miles per hour, and decreases to about 660 miles per hour at an altitude of 35,000 feet. A very strong or large disturbance may travel at speeds above this, but no disturbance will travel at any lower speed.

If a body moves through the air at a very low speed, the disturbance it makes will be propagated to all parts of the air so rapidly, as far as the body is concerned, that the air is effectively incompressible. All classical airplane aerodynamics to date have made this assumption. However, as the speed of the body becomes higher, relative to the speed of sound, it is clear that the rate at which the disturbance is sent through the air may affect the appearance of the flow pattern around the body. Thus the important criterion of speed is apparently the ratio of the speed of the body to the speed of sound. This ratio is given a special name, the "Mach number," after the German scientist who made some fundamental investigations in gas dynamics in the last century. When the Mach number is less than 1, the flow is said to be subsonic; when the Mach number is greater than 1, the flow is said to be supersonic. However, there is a region in the vicinity of Mach number 1 in which the flow is of a mixed type, and this flow is said to be transonic. The aerodynamicist now says little about actual speed in miles per hour, but talks only of Mach number.

If a body moves through the air at a speed greater than the speed of sound, the disturbance it creates will, in general, move at the same speed as the body. This means that some sort of a wave will move in the air just ahead of the body; this wave is very analogous to the wave formed by the nose of a boat on the surface of the water. The wave in air is called a "shock wave." It is interesting to see that a large fraction of the entire mass of air is unaware of the presence of the body—in fact, all the air ahead of the shock wave. Thus the flow patterns and forces produced at a supersonic speed must differ radically from the familiar ones at a low subsonic air speed. On the left is seen a sphere mounted in a supersonic wind tunnel. The strong curved headwave produced by the sphere is clearly visible. Other waves produced by the support apparatus appear behind it.

At low supersonic speeds, we see that the disturbances made by the body will never have an opportunity to pile up into waves stationary with respect to the body. However, the motion of any body through the air will always cause some local acceleration of the air around it, so that there will be local regions over the surface of the body where the relative speed between the body and the air is greater than the "free stream speed," i.e., the speed of the body relative to the air far ahead. Therefore, as the "free stream Mach number" approaches 1, there may be local regions on the body where the air is speeded up to such an extent that it is moving supersonically with relation to the body. A wave could exist in these small local supersonic regions, stationary with respect to the body. An example of this possibility occurs in the flow over an airfoil. It is convenient to think of the airfoil at rest, with air moving in towards it at some free stream Mach number, M, rather than of the airfoil moving into the air at rest; the flow patterns and forces in the two cases are the same of course. If now the free stream Mach number M is of the order of 0.7 to 0.8 or higher, there will be small regions on the surface of the airfoil in which the Mach number (measured in relation to the stationary airfoil) is greater than 1. In these regions, when the Mach number is sufficiently greater than 1, a shock wave may form, stationary with relation to the airfoil. The exact reasons for the formation of a shock wave in a small locally supersonic region are still not clear, and it is not

*Presented at the Alumni Seminar, April, 1946.



Curves of the estimated body drag and wind drag in the transonic region at sea level.

absolutely certain that it must always occur. However, thus far it has not been possible to avoid it. The effects of this shock wave on performance of the airfoil are, for the most part, very deleterious; they will be discussed in more detail below. On the cover is shown a model of a bomb mounted in the Bomb Tunnel at the Aberdeen Proving Ground, at a subsonic Mach number of approximately 0.9. There is no wave ahead of the model, but the shock waves on either side extend far out.

PERFORMANCE CHANGES WITH SPEED

The effects of the changes in flow pattern mentioned above may be related to the performance of an airplane by examining the forces acting upon it. A forward force, the thrust, is produced by the propeller or jet of the plane. A rearward force, called the drag, is produced by the flow of air over and around the plane. The drag increases, of course, with airspeed, and the plane must accelerate until the drag is equal to the thrust. The top speed of an airplane is thus determined by the available thrust of the plane, and by the speed at which the produced drag is equal to that thrust.

At very low Mach numbers, all forces acting on the plane are roughly proportional to the square of the velocity. As soon as the Mach number has increased sufficiently that the effect of compressibility has become evident, the drag begins to increase somewhat more rapidly than the second power of velocity. However, nothing serious happens until the flow around an airfoil or fuselage becomes locally supersonic, which, as mentioned previously, occurs at free *stream Mach numbers 0.7 and 0.8. Shortly after* this, shock waves form in the locally supersonic regions, and rather violent changes begin to occur in the forces acting on the plane. The shock wave on a wing produces a change in pressure distribution which generally results in diving moments. More seriously, the change in pressure distribution results in a very large drag increase. In the wake of the shock wave a trail of highly turbulent air may follow, since the wave itself is probably very unsteady. This turbulent wake buffets the rear control surfaces of the plane, and may cause complete loss of control.

As the plane speed increases further, the assumption being that thrust is available and control is sufficient, the shock wave moves to the rear. When the free stream speed is exactly equal to the speed of sound, it is at present impossible to say exactly what happens to the flow patterns, and to the forces on the airfoil or the airplane. In fact, there is some indication that no steady state flow pattern is possible at exactly $M=1$, but that the flow must fluctuate rapidly. In this case the particular phenomena and forces at exactly $M=1$ may well depend on the acceleration of the plane as it passes through this speed. There is definitely a range of uncertainty between $M=.95$ and $M=1.05$ in which no one pretends to have made steady-state measurements.

When the Mach number becomes greater than 1, the forces rapidly become steady again, and it is possible to compute and predict the flow patterns. A shock wave now appears, of course, ahead of the body, and with this there is associated, in ordinary cases, a very large drag. But the big jump is over.

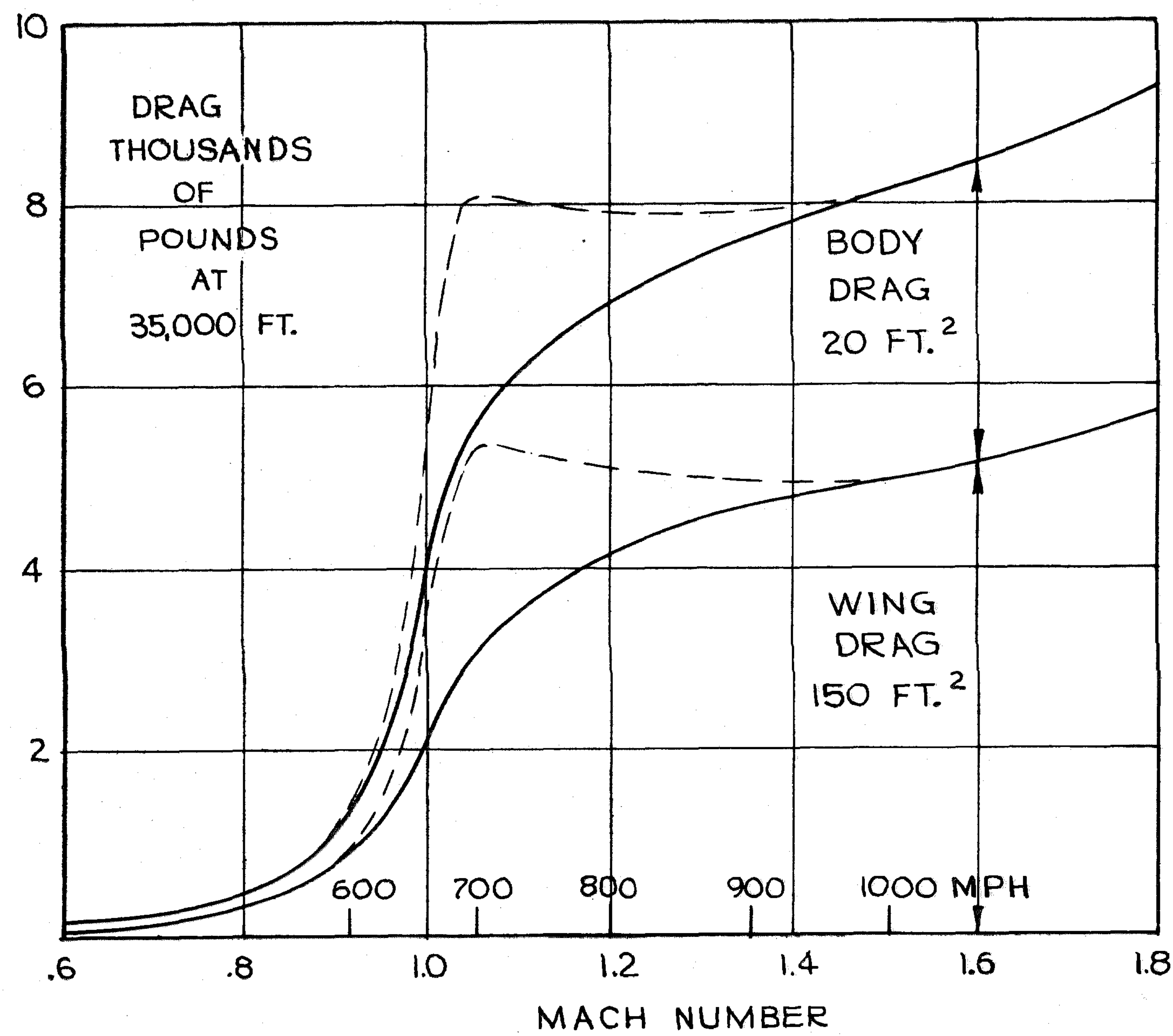
The problem of increasing airplane speeds above Mach number 1 can best be appreciated by an actual computation of the drag in a particular case. To provide a very simple example, let us consider an airfoil of conventional design with an area of 150 square feet—which at 66 pounds per square foot would support a gross wegiht of about 10,000 pounds. This is a reasonable wing loading and weight for a pursuit airplane. The average wing thickness has been assumed to be 9 per cent of the chord. Let us consider also a streamlined fuselage or body of roughly 20 square feet cross section area.

Estimates can be made of the drag of these bodies as a function of Mach number. Above are shown curves of the estimated drag of the wing above, and of the combination. It will be seen that the drag increases slowly up to a Mach number of roughly 0.8, corresponding to 600 miles per hour. Shortly after this a very rapid rise occurs. In the range $M=0.9$ to $M=1.3$ the uncertainty of the wing drag has been indicated by drawing a solid curve at a lower, optimistic estimate, and a dotted curve at a higher value which we have reason to believe may be reached or even exceeded under the proper conditions. The effect of this higher estimate of the wing drag has been indicated by a dashed line in the total drag curve.

It will be seen quickly that the rapid rise in these curves of drag at sea level does represent almost a "drag wall" at roughly $M=0.8$, or 600 miles per hour. A power plant suitable for this hypothetical airplane might at present be expected to produce a thrust of the order of 3000 to 4000 pounds, which is ample for the lower speeds, but is stopped short at 650 miles per hour. At high altitudes, however, the situation is not so bad, because of the much lower density of the air. Below, the same curves are plotted for an altitude of 35,000 feet. It will be noted that the same Mach number now represents an air speed considerably lower. But the ordinates of the curve have been reduced to almost one-fourth of the previous values. It is reasonable to speculate about the possibility of pushing an airplane through M=1. The first striking fact is that if the first large drag hump is overcome, there is a region from M=1 to M=1.3 or 1.4 in which the drag rises very little, or may even decrease. Thus, if we build a power plant sufficiently powerful to overcome the first large drag peak, it will take very little more to push the airplane to a Mach number of 1.5. In fact, if the higher drag curve does exist, the pilot would find it difficult if not impossible to fly at a Mach number of 1.1; at this Mach number, a slight decrease in speed produces an excess of drag over thrust, and a further deceleration. Or a slight increase in speed produces a decrease in drag, causing the pilot to accelerate more.

The region in the immediate vicinity of M=1 will almost certainly cause flow oscillations and instabilities, making it advisable to get through it in a hurry. In addition, the possibility that the peak forces themselves may depend on the acceleration through the speed of sound makes it probable that we will want to go as fast as possible through that region. It appears, then, that the next step in increasing the speed of aircraft will be to provide a power plant with thrust sufficient to overcome the drag peak, and to produce a reasonable acceleration through the speed of sound, with the object of reaching steady-state flight somewhere near a Mach number of 1.4 or 1.5, i.e., 900 or 1000 miles per hour. In other words, the top speed of airplanes may be inched up by a few more miles per hour, but will then probably take a large jump from, say, 650 or 700 miles per hour to 1000 miles per hour. This jump will probably be made at fairly high altitudes. And it is

(Continued on page 15)



Curves of the estimated body drag and wind drag in the transonic region at 35,000 feet.

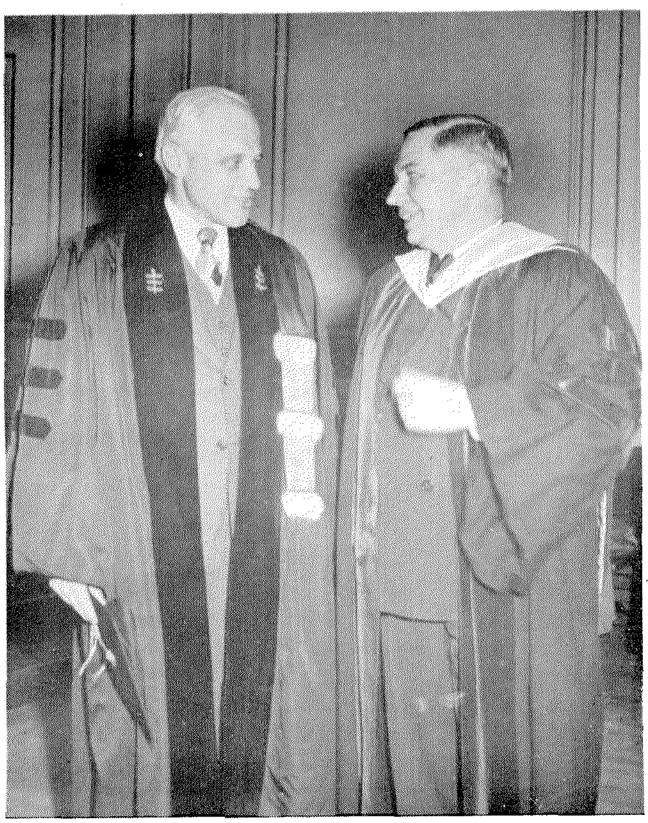
INAUGURATION OF PRESIDENT DUBRIDGE

AT a ceremony November 12 in the Pasadena Civic Auditorium, Lee Alvin DuBridge was formally inaugurated President of the California Institute of Technology. This convocation was attended by 44 institutional delegates, Institute students and faculty, alumni, and other interested Southern Californians. Despite the very rainy weather, over 1500 people were present at the event.

The colorful academic procession commencing the ceremony included trustees and administrative officers of the Institute, special guests including representatives of the United States Armed Forces, Los Angeles City and County officials, representatives of the Associated Student Body, and Allan L. Laws and W. M. Jacobs of the Alumni Association.

Besides delegates from the 44 educational institutions, learned societies, and foundations, four especially honored guests: Vannevar Bush, president of the Carnegie Institution of Washington; Frank B. Jewett, president of the National Academy of Sciences; Alan Valentine, president of the University of Rochester; and Russell David Cole, president of Cornell College, Iowa, were present at the inauguration and other meetings during the week.

Dr. DuBridge was inducted formally into office by James R. Page, chairman of the board of trustees, who introduced the new president to the disinguished gathering.



Presidents Karl T. Compton and Lee A. DuBridge of M.I.T. and Caltech.

KARL T. COMPTON

Dr. Karl T. Compton gave the principal address of the afternoon. He acknowledged "on behalf of American science" a debt which the "rest of us" owe to the California Institute. The debt, Dr. Compton said, was developed here of an institute focusing attention on the future rather than on the past, and on creative science rather than on pure teaching.

M.I.T.'s President characterized Dr. DuBridge's wartime M.I.T. Radiation Laboratory as the greatest such project ever evolved. He used this huge work as an example of the growing partnership of institutional science, industry, and government. He pointed out that the laboratory "steered into production some two and a half billion dollars' worth of radar equipment for air, sea, and ground use."

Four basic trends were mentioned which mark today's technical schools: the extension of research and science; cooperation between technologists; increased financial support of research; and the integration of science and our industrial economy.

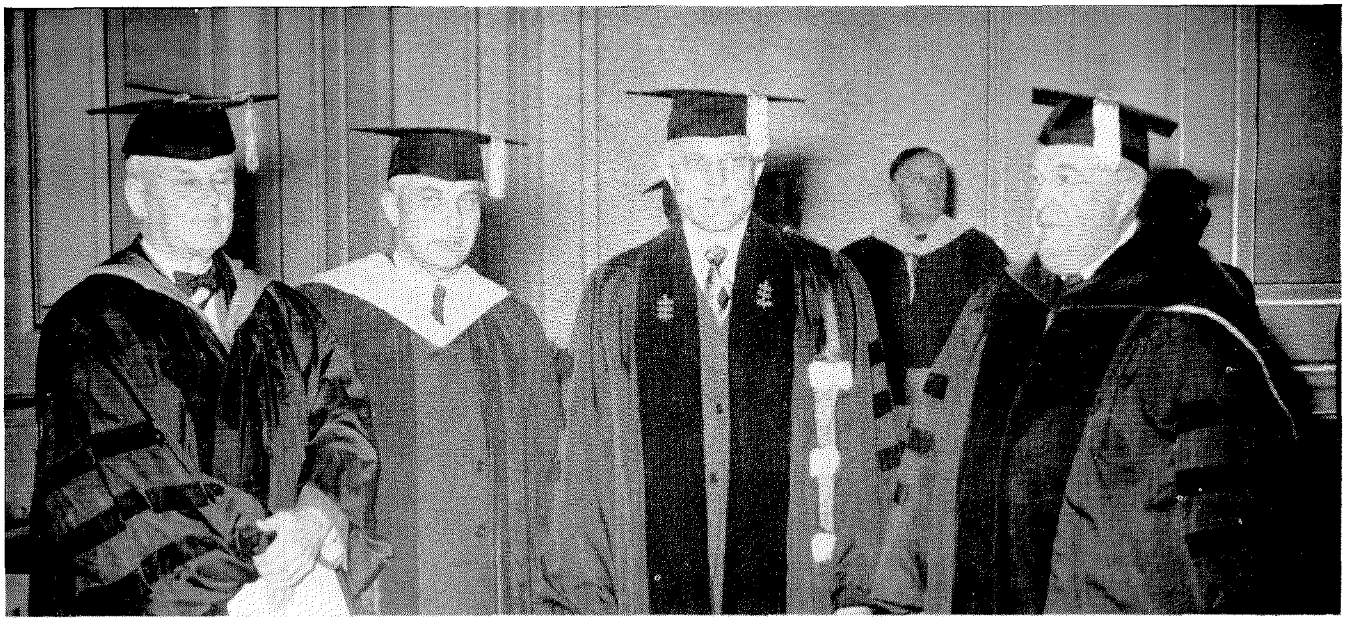
"Science and research should play an even more important role in the programs of technology than they have in the past—new products, new industrial arts, new ideas, are being developed at increasingly rapid tempo. Students of technology in our institutions must be educated more than ever for the opportunities of the future rather than for the techniques of the past."

Dr. Compton added that "operators and draftsmen might better learn their vital but less creative skills in trade schools."

"Teamwork in technological fields is rapidly becoming more important. The recent experiences of the war in atomic energy, radar, rockets, have given a new order of magnitude demonstration of the effectiveness of teams of scientists and engineers, teams of academic and industrial technologists, teams of producers and users. Such teamwork saved time, avoided mistakes and produced results which would have been otherwise impossible."

"It is becoming increasingly expensive to push forward the frontiers of knowledge and to harness nature's forces. Nuclear science, supersonic aerodynamics, gas turbines and jet propulsion, electronics and electronic controls, enzyme chemistry and biology, 200 inch telescope astronomy are all illustrations of this point. With increased taxes and decreased income on endowments this poses a problem that can only be solved by skillful and courageous leadership backed by generous support of constituency and farseeing, public-spirited citizens and organizations."

"Gradually through the years our technological schools have risen in public esteem from being servants of our industrial economy to being partners in it. This partnership became firmly established and



Robert A. Millikan, former chairman of the Executive Council, vice-president of the Board of Trustees and professor of physics, emeritus; Lee A. DuBridge, president of the California Institute; Karl T. Compton, president of the Massachusetts Institute of Technology; and James R. Page, chairman of the Executive Committee.

widely appreciated during the war. The move to establish a National Science Foundation, the substantial programs of the Army and Navy to arrange research contracts in educational institutions, and above all the Atomic Energy Commission are all illustrations of this partnership."

ROBERT A. MILLIKAN

Dr. Robert A. Millikan, outgoing head of this Institute, passed on a summary of administrative policy to President DuBridge.

"The official seal of the California Institute of Technology, especially designed for it by the illustrious Belgian artist DeVrees, represents an ethereal relay race: two beautiful athletic male figures, speeding through the clouds, the older man—member of the older team—passing on the torch to the eager youthful runner—member of the new team."

"In this symbolism is found the key to the main job which the retiring administration has been trying to do during the past 26 years. During that period it has made every possible effort to discover brilliant young men to whom it might pass on the torch."

"The shape of things to come will continue to be molded in very large measure by that wisdom which reflects the light of the past. I, therefore, take this opportunity to list a number of principles and procedures which represent the collective judgments of the older team, in the conviction that it will be of value for the new team to know them and consider them well.

"**Collective wisdom.** It is only where decisiveness and rapidity of action are of first importance, as in war and in some types of business organizations, that the concentration of authority and power in a single individual is a sound procedure.

"In educational matters **wisdom** is infinitely more important than is rapidity of action, and wisdom is only obtained from the collective judgments of able, fully informed and independent minds.

"**The cultivation of the humanities.** The place of the humanities in scientific and technical education—a field in which the Institute has done so good a pioneering job that its example is now being followed by many other somewhat similarly placed institutions, is probably worth considering and strengthening by the new administration.

"**Correctives for modern over-specialization.** The humanities represent but one phase of the old administration's continuous effort to introduce counter-irritants for the modern necessary evil of intense specialization, both inside and outside of university walls

"**The selective principle.** The greatest weakness in American education is its lack of an effective vocational guidance technique or mechanism operating at the end of the twelfth grade (the completion of the high-school course) between the secondary and the so-called higher educational systems. Confronted with this lack, and because deeds speak louder than words, the old administration developed its own selectivity system for entrance to the freshman class, and there is unambiguous evidence that it is working extraordinarily well, both in the interests of those who enter here, and equally so in the interests of those who are deterred, altogether without hardship, from entering a field in which they have little or no chance of succeeding and therefore of leading useful, happy, and successful lives. This has been one of the most satisfactory accomplishments of the retiring administration.

"**Institute support.** The support of the Institute must come from Southern California. It is true that the Institute, like all other American institutions, serves also a national and a world community, as well as a local one, and in so far as it shows marked superiority in that regard it can also draw support, as it has in the past, from more remote sources.

"But every one of the far-seeing men who started it upon its present career with practically no endowment—a unique piece of monumental daring—did so because they believed that this community had potentialities that justified the gamble. The record seems to have justified their confidence, and the way they ran their race may have some lessons for the new team."

Dr. Millikan then presented Lee DuBridge as "the leader of the new relay team." As one of the active sponsors for Dr. DuBridge's two most important academic appointments, the retiring head of the California Institute assured his audience that "I have every confidence that the new relay team will run faster than the old one was ever able to do."

LEE A. DUBRIDGE

Acknowledging the honor conferred upon him by his appointment to Caltech's presidency, Dr. DuBridge continued: "As I take on these new duties I have often wondered if any man can help but be appalled at the task of running any educational institution in these days. In fact many thoughtful men today are just appalled—period. Are we in a world which is systematically and scientifically plotting its own destruction? Is there any hope that in either national or international affairs we can ever reach the point where we seem at least to be heading in the right direction? Is there any chance that our educational system can adapt itself intellectually, spiritually, or financially, to meet the challenge of the modern world? We may not be too late to win out—but it may take an heroic effort.

"Can we in this country in the coming few years find or produce enough men with sufficient vision, sufficient knowledge, sufficient wisdom and sufficient leadership to paddle hard enough in the right direction and save us from the wrong channel? This clearly is the great challenge which America—and the world—faces.

The new President sketched the part that can be filled by the California Institute in bettering, or perhaps even saving the modern world. "Leading mankind in the task of learning the proper use of this power of science can not be done by men who understand nothing of the nature of this power. Nor can it be done by men who understand nothing else. Clearly our leading men in all fields must understand something of science—and we must have leaders in science who understand something of the world of human beings in which we live."

Quoting from the Institute's charter, Dr. DuBridge went on to say "Every effort shall be made to develop the ideals, breadth of view, general culture and physical well-being of the students. Research shall be made a large part of the work, not only because of the importance of contributing to the advancement of science and thus to the intellectual and material welfare of mankind, but also because without research the educational work of a higher institution of learning lacks vitality and fails to develop originality and creativeness in its students."

"The second world war brought the first great chapter of the history of the Institute to an abrupt close. For a period of five years its campus and its staff were devoted almost exclusively to war service. During this war period the Institute proved—if proof was any longer needed—that it had become one of the nation's scientific assets. And the nation's scientific assets, we have now learned, are among its most important and critical possessions in war or in peace

"Chapter two of the Institute's history began as the war ended. If it was unfortunate that a change in leadership should have to come just now, it is most fortunate that chapter one's leader is still with us to supply help and guidance."

After describing the need for acquiring and retaining the finest faculty possible, and citing methods for doing so, Dr. DuBridge turned his attention to the student body at the Institute. "Acquiring a great faculty—and all that it involves—almost but not quite, insures the second necessary asset of an educational institution—a great student body. Caltech now has a great student body—undergraduate and graduate. But keeping a student body fine is also a continuous task. We want first and foremost men of the highest intellectual calibre—but we want them also to be well rounded human beings—men with spirit, with imagination, with character, with health. Of course, we want, and the world needs, the occasional genius who forgets to get his hair cut. But we also need the man whose intellectual power is combined with the spark of leadership and human understanding. Our present student body is great because it contains so many young men with just these qualities.

"A great institution (please note I say 'great' and not 'big') with a great faculty and a great student body—aimed at the great ideals which were laid down 25 years ago—that is our goal. And achieving it is (if I may use the word once more) a great task.

"I believe it can be accomplished. I pledge my every effort in that direction. I know that the Trustees, the Faculty, the Students, and the Alumni, join also in pledging theirs. We shall need but one more thing—the support of the citizens of this community and of this state. The Institute can rise no higher than the people of the community want it to rise. I believe the people of this community do want it to rise. Unless the Institute is one of the community's most important assets it deserves no longer even to exist. If it has been, and continues to be, one of its most important assets, then you will not only wish—you will **demand** that it continue to move forward. I am here today—and glad to be here—because I believe you will demand just that. When you cease to demand it we will know that somehow we have failed. But with your help we shall not fail."

The Industrial Scientist as Citizen

(Continued from page 3)

beyond strict engineering, where engineers pool their expertness. He accepts without question — beyond some confidential mumbling to most intimate friends —the judgment of legal, personnel and patent departments of those concerned with public relations, advertising and sales and of all those engaged in fabricating, utilizing and exploiting his products of science and engineering.

As an expert he bows to the authority of others, whether actual experts or merely in the position thereof. He keeps strictly out of preserves that are not his own; in fact, if he didn't, he would have his ears boxed and hear his more restrained colleagues say that he was shooting off his mouth without knownig all the facts. Nor will he ask searching or embarrassing questions about those other matters "which aren't his business," for that might endanger his career if not the security of his employment.

And thus by a natural transition he becomes sterile in thought and criticism on matters social, economic and political. Would he, for example, take a public position as to tariff changes which now threaten? Wouldn't he instead trust to his company's experts? He will damn a communist, and unjustly, for following his "party line" and taking opinions from Marx or Moscow; but he can remain blissfully unconscious that he is following a "policy line" without subjecting it to an objective criticism.

He has the brains and the analytical ability to handle these larger questions of social import—his I.Q. is usually higher than that of many who do handle them. He has reason to concern himself, for these matters vitally affect all men including himself. But whether or not he considers them, he rarely speaks out and almost never acts. Despite his unique value to society, due to his application of the scientific method, he pulls his punch and fails to follow through. Even as to such a selfish matter as his own remuneration, and its relationship to that of others who produce or acquire, he is usually uninformed, accepting it as a handout like a fellowship grant instead of a reward which should be justly proportioned.

Today in his development he has reached a point where, in the words of a Biblical paradox, to save his life he must lose it. He must, at any rate, make some sacrifice, diverting time and energy from the scientific work that interests him most to the social and economic problems that vitally concern his future and that of all his fellow men. No longer can he safely pass the buck to rely on expertness not his own or that of other men of similar scientific objectivity.

This world of ours already has at its disposal enough products of science to wreck it good and plenty. What it needs is some hair of the dog that bit it. It needs an application to its present problems of the same methods of science as unwittingly provided the mechanisms by which it got where it is. And engineers and scientists must organize to insure that the prescription is filled.

C. I. T. NEWS

JOHN MILLS TO SERVE AS STUDENTS' ADVISOR

"WITH obligations to any student but without portfolio' describes," says John Mills, "the position in the Institute to which I have recently been appointed."

Mr. Mills does not engage in research or teaching, and has no responsibilities in Institute management or business affairs. Instead, to use his own words, "I will be at the beck and call of all students, undergraduate or graduate, who wish to consult me unofficially and confidentially about their educational and vocational problems."

To this work Mr. Mills brings a wide background of experience in industry and in education. He is a graduate in arts from the University of Chicago and in electrical engineering from M. I. T. After 10 years of university teaching he joined the research staff of Bell Telephone Laboratories. Then after 10 years of research and engineering—marked by about 30 patents and by pioneer work in transcontinental wire-telephony and early radio-telephony—he became personnel director with the responsibility of the selection and placement of scores of engineers and scientists each year. This work was followed, until his retirement last year under the Laboratories Pension Plan, by activities in publication and publicity.

He is a fellow in the professional societies of physics, electrical engineering and radio engineering. Mr. Mills has also written 11 books. In the first of these, **Electricity, Sound and Light,** he was junior author to Dr. Millikan, who first excited his interest in physics. His text, **Radio Communication,** was used by the Signal Corps in World War I and is a pioneering treatment of the triode and an exposition of vector methods as applied to radio circuit problems. His latest books have been popularizations. **Electronics, Today and Tomorrow,** is now in its sixth printing, and over 150,000 copies were issued by USAFI during the war. This book is also recorded on phonograph records as a feature of Talking Books for the Blind. His latest book, **The Engineering Society,** published last March, is a provocative study of the scientist as a citizen; and as Harrison Brown said in a recent Saturday Review of Literature, "It contains a bold and comprehensive discussion of salaries and organizational hierarchies in industry."

To the problems of engineers and scientists, Mr. Mills brings years of sympathetic observation and a cold-blooded knowledge of what manner of men scientists are and what industry should and should not expect of them. Students are taking advantage of Mr. Mills' experience by visiting with him during his regular office hours.

MEMBERS OF '26 AND '36 TEAMS GUESTS AT ANNUAL GRID BANQUET

ATTENDING the annual Varsity Football Banquet held Dec. 9 at Brookside Municipal Clubhouse were over a hundred students, faculty and alumni, with Dr. J. E. Wallace Sterling, professor of history and government, acting as toastmaster.

Present at the dinner were representatives of the varsity football teams of 10 and 20 years ago. Speakers were President Lee A. DuBridge, Coaches J. Mason Anderson and Pete Mehringer, and Frederick Runyon, editor of the **Pasadena Independent.** The Wheaton Trophy presented on the basis of scholarship, sportsmanship and moral influence was awarded to this year's stellar halfback, Doug MacLean of the junior class. MacLean and Norman Lee, guard, were announced as co-captains for 1946, elected by the team. Twenty-four grid men, 10 water polo men and 6 cross country men received awards.

Members of the 1926 varsity football squad invited to the dinner were: Elmer Muff, Guy Chilberg, George Watson, Phil Cravitz, Clyde Shields, Layton Stanton, Ed Hines, Dick Folsom, Austin Hoyt (Mgr.), Bob Heilborn, Charles Lewis, George Moore, Al Lombard, Bill Mohr, Gary Collings, Frank Nickell, Ray Copeland and Len Ross (Mgr.).

Grid men of 1936 also invited were: Claude Brown, Clay Smith, John McLean, Jack Baker, Carl Larsen, Bill Wetmore, Jim Balsley, Al Zimmerman, Jack Osborne, George Mann, Wendell Miller, Jim Van Horn, John Griffith and Frank Hewett.

ISSUES OF "TECH" MADE AVAILABLE BY MAIL

THE CALIFORNIA TECH, the official student body publication, is available to Alumni and others interested in student activties at the Institute. For convenience the Tech staff is sending out letters which, when returned with a dollar enclosed, will assure prompt delivery of the paper for the remaining two terms of the year.

The Tech, containing detailed news of student activities at the Institute, besides numerous feature articles and general information, is published every Friday through the school year. Anyone despairing of receiving a letter from the paper may write to The Editor, California Tech, 1201 East California Street, Pasadena 4, California, enclosing one dollar.

Starting with the next issue, January 10, 1947, the paper will be mailed out regularly.

SECOND WATER TUNNEL OF UNIQUE CONSTRUCTION NEARS COMPLETION

WITH a 72-foot hole, 12 feet in diameter, already excavated below the sub-basement level of the Hydrodynamics Laboratory, the Institute's new high speed water tunnel is taking shape. Water velocities ranging up to 100 feet per second may be achieved in the working section of the tunnel, which will be used for research on cavitation.

Steel casings are now being cemented in the sump pit, which was excavated with the aid of a steel monorail installed above ground floor level between the pit head, just north of the entrance to the hydrodynamics laboratory, and the south door. A winch brought dirt from the pit up to a position where it could be rolled down to the door and deposited in waiting dump trucks.

This tunnel is the second to be built at the Institute or anywhere else in the United States. Similar tunnels are planned, but none have been built so far. Construction of the first was started in 1941, but the completed structure, which has a maximum water speed through the working section of 70 feet per second, was used almost entirely for war research. The first tunnel had a 14 inch working section, as wlil the new structure.

Pressure-velocity relations will be varied in different sections of this tunnel in order to keep air in solution in the flow entering the working section. In this region pressures will be comparatively low. The 72-foot sump pit will be divided into four separate sections by means of a vertical partition through the middle, and five-foot pipes in each of the semi-circular halves. Pressures of about 100 pounds per square inch in this section of the tunnel will force air to dissolve again after being released from solution in the low pressure working section.

The impellers used in the tunnel will be standard commercial pump forms, adapted to be driven from the suction side instead of from the discharge side as is customary with standard installations. Five hundred and fifty horsepower will be available on the impeller shaft. A direct current electric motor is to be used for easily regulated power. The highest speed, 100 feet per second of flow, with full power, will not be used too frequently in the basic studies of cavitation planned.

Balances to measure the reaction of shapes tested will be similar to wind tunnel forms, but somewhat simplified. The working section will be six feet long, with a circular cross-section of 14 inches. Four steel members spaced around the section will hold thick transparent walls of plexiglass in place to facilitate observation of the object tested.

Design and installation of the tunnel is being carried out by the staff of the Hydrodynamics Laboratory under the supervision of Robert T. Knapp, Ph.D. '29, associate professor of hydraulic engineering, and Dr. Vito A. Vanoni '26, assistant professor of hydraulics.

TWO WINS, FOUR LOSSES FOR BEAVER FOOTBALL SQUAD

WINDING up with two wins and four losses, the 1946 Caltech football season is over. Missing the services of fullback Douglas MacLean, who received a shoulder injury in the 19-7 defeat by Whittier—third game of the season—the team lost to Redlands, 21-6, and to Pomona, 32-13.

Faring badly in their encounter with the Pomona College Sagehens, the Beavers had an epidemic of fumbling, saw touchdown drives end with scores for Pomona. To open the game Tech received, and rolled 71 yards in four plays. A pass by Chaffee was intercepted on the Pomona 14. On the first play the Hens' fullback, Shoji, cut off right tackle, reversed his field, and raced 86 yards for a touchdown. Before the first two minutes of play were up, Pomona had seven points.

A Tech fumble shortly after the following kickoff opened the way for a Pomona pass which brought the ball to the Beavers' five yard line. Pomona scored on the next play.

Fumbled by Pomona shortly after the next kickoff, the ball was advanced by Caltech deep into the Sagehens' territory. Trouble again hit the Beavers, and Chaffee's pass was intercepted by Malan, Pomona halfback, who carried the ball to the 35, then lateralled to a teammate who ran down the sidelines for a touchdown.

Tech rallied late in the second quarter, advancing the ball 65 yards in eight plays with a pass to Parode for the score.

Pomona scored again in the third quarter with a 90 yard power drive for six points. The last Sagehen touchdown came in the fourth quarter, six plays after Pomona intercepted another Tech pass.

The second Beaver score of the day came after a nine play, 85 yard drive.

On the books the Institute team looked quite good, with 13 first downs to eight for Pomona. The Hens gained 298 yards compared to the Beavers' 281. Further breakdown shows that Tech gained 160 yards by rushing and 153 through passes, while Pomona gained 244 yards on the ground and only 50 yards in the air.

The best playing of the season was seen in the first half of the Pepperdine game with MacLean back in uniform. For 29 minutes and 58 seconds of this period, the Beavers held the Pepperdine Waves, the strongest small college team in Southern California, to a standstill. Late in the second quarter Tech caught a punt on the five yard line and was forced to kick. Pepperdine ran the ball back to the Tech 36, and passed to the eight. Snapping the ball two seconds before the gun went off, the Waves swept wide on a reverse to score. Up to this point each team had registered six first downs, but Tech rolled up 152 yards to the Waves' 105.

Pepperdine's reserve strength proved too much in the second half. Two Beaver drives reached the opponents' 30, but lacked the power to advance further.

BASKETBALL TEAM OPENS CONFERENCE PLAY IN JANUARY

TECH basketball prospects look fair this year in spite of the fact that only one man from last year's team and only two former lettermen are on the squad. However, besides center Paul Saltman of last year's team, and centers Bob Stokely and Kirk Lewis both of the 1943 team, guard Harry Moore who won letters in 1942 and 1943 will be back in school in January in time to start the Conference schedule.

After losing two practice games to Muir Junior College, the Beavers beat LaVerne College 32-27 and Chapman College 43-35. The only available comparison with any conference teams is Pomona's 46-43 win over Chapman.

BASKETBALL SCHEDULE 1947

Saturday	January 11	Loyola	at Caltech
*Friday	January 17	Caltech	at Pomona
Saturday	January 18	Caltech	at Chapman
*Tuesday	January 21	Occidental	at Caltech
*Friday	January 24	Caltech	at Redlands
*Saturday	February 1	Pomona	at Caltech
*Friday	February 7	Whittier	at Caltech
Saturday	February 8	La Verne	at Caltech
*Saturday	February 15	Caltech	at Occidental
*Friday	February 21	Redlands	at Caltech
*Friday	February 28	Caltech	at Whittier
Saturday	March 1	Caltech	at San Diego NTC

*Conference games

All home games will be played at the National Guard Armory at 145 North Raymond, Pasadena. The "B" game preliminary will start at 7:00 P. M.

FINAL WORD FROM REGISTRAR'S OFFICE

WITH Institute students now pre-registered for the Winter term and finishing Fall term final examinations, the Office of the Registrar has finally completed tabulation of the men now taking courses here.

The largest previous peacetime enrollment was 960, in 1941. This year's sees 1372 undergraduates and graduate students in Institute courses.

Larger not only in numbers, but also in percentage, than any previous group, are the 1946-1947 graduate students, with 314 engineers and 267 scientists. The undergraduate enrollment of 791 shows 179 freshmen, 372 in engineering courses, and 240 in science.

The Division of Mechanical Engineering has the largest number of undergraduate students enrolled, but in graduate work aeronautics rates first with 137.

Questionnaires answered by 1350 of the students indicated that 887 are veterans; 448 are married, and 859 single. Failing to indicate their marital status were 53.

Seventy-four foreign students are enrolled, 16 of them undergraduates and 58 graduates. Canada has the largest number, with 16. From China came 13, India 10, and Great Britain 7. Others represented were: Argentina, 4; Mexico, 3; Egypt, Iran, Ireland, and Turkey, two each; Austria, Bolivia, Chile, France, Germany, Hungary, Italy, Norway, Peru, Poland, Siam and South Africa, one each. One student listed no country.

Only 82 students are at present in the armed services, contrasted with war-time enrollments when at the peak 75 per cent of the students were in uniform. Servicemen enrolled now total: Army, 43 (officers on special training assignments); Navy, 38; British Royal Air Force, one.

NEXT YEAR'S REGISTRATION

Applications to take the 1947 entrance examinations are coming in undiminished. January 15 is the last day on which these applications will be received at C.I.T. All four entrance examinations in English and chemistry, mathematics and physics, will be given next March.

Transfer to the upper classes will be permitted a number of students who desire to be Institute sophomores next year. No transfers to junior standing in mechanical or electrical engineering will be accepted in 1947.

REGISTRATION TOTALS

	Sophomores	Juniors	Seniors	U. G. Total	Graduates	Total Students
Mechanical Engineers	66	67	54	187	56	243
Electrical Engineers	60	41	31	132	64	196
Civil Engineers	17	19	17	53	37	90
Aeronautical Engineers					137	137
Industrial Design					20	20
	143	127	102	372	314	686
Chemists	19	13	12	44	74	118
Applied Chemists	24	17	9	50		50
Chemical Engineers					21	21
Applied Physicists	4	5	7	16		
Physicists	43	31	17	91	85	192
Biologists	4	4	0	8	16	24
Geologists	9	8	2	19	29	48
Mathematicians	6	2	4	12	20	32
	109	80	51	240	267	507
Total Engineers and Scientists	252	207	153	612	581	1193
Freshmen						179
Total Students						1372

"FOX" STANTON

W. L. (Fox) Stanton, who coached C.I.T. teams from 1921 to 1942, died at the home of his son, Layton, in Olympia, Washington, on Thursday, November 28, 1946. Coach Stanton died shortly after returning from a Thanksgiving Day football game.

Not unknown at Tech when he arrived in 1921, Coach Stanton had grabbed the Southern California Conference football title in 1909, 1910, 1911 and 1914 while coaching at Pomona College, and led Conference champions again in 1916 while at Occidental, when, incidentally, his team beat the University of California, 14-13. At Tech he produced championship teams in 1923, 1930 and 1931. At the time of his retirement in 1942, Stanton had coached more consecutive years at one institution than any other man on the Pacific Coast.

It was at the Institute that he earned the title of "Fox." Never having much seasoned and experienced material at his command, Stanton produced teams which turned in upset after upset over rivals, which admittedly were much stronger potentially. His teams could always be depended upon to pull the unexpected.

Coach Stanton had an almost unprecedented background for coaching football: captain and halfback on the Drexel Institute team of Philadelphia in 1892; halfback, fullback, captain and coach for three years at Pennington Seminary, N. J., from '94-'96; while serving in the Spanish American War in 1898 he served as coach and captain of his brigade's football team, which defeated the University of Georgia in two games; halfback, fullback at Dickinson College, Carlisle, Pa., from 1899-1902; and captain and coach in his senior year.

Acting on the stage for a year after graduation from Dickinson, Stanton returned to coach at Morristown, N. J., at Hamilton Institute, N. Y., and finally at Pomona College in 1908. Serving with the United States Army in World War I, he was mentor of the Camp Lewis Army team which played the Marines at the Tournament of Roses game at Tournament Park, January 1, 1918. He returned from overseas with the Army to coach Occidental again until he came to Tech in 1921. Besides football, his track teams won the Conference championships in 1926 and 1941.

When he came to Tech there was strong faculty sentiment against football, but it was finally agreed to tolerate a team provided that study time and averages were not sacrificed. Stanton knew that it was a great game if brilliant men played it, but he also knew that it was just a game. He had supreme respect for the mentality of his team and no play was considered too difficult for the minds of his players.

"Fox" Stanton coached eight championship teams in the conference, but will be most remembered for his fine character, sober point of view, and his great sense of humor.

FALL MINOR SPORTS SEASON ENDS QUIETLY

THE reconversion year 1946 proved a bad one for fall minor sports. Coach Bob Merrick's water polo squad, formed with no returning lettermen and few reserves, played nine games, finishing all on the low end of the score. In spite of practice in an outdoor pool from 4:30 to 6:00 P. M. and the difficulties of reaching the P.J.C. campus for practice, a squad of 14 men remained out all season.

"Doc" Hanes' cross-country men took only one victory in the 1946 season, defeating Santa Barbara 40-20. With four men in the first four places, Redlands had little difficulty in winning the Perpetual Trophy awarded for victory in the Conference meet. This Trophy, which will be kept permanently by the team that wins it three times, was the property of Caltech in 1941 and 1942, the first two years that it was awarded.

STUDENTS RAISE RECORD $950 FOR WSSF

OVER $950 was raised last month in a "Y" sponsored drive for the World Student Service Fund. More than $600 of this amount was contributed by students. The money is to be used for food and clothing, books and medical facilities, for students and faculty in the war-torn Orient and Europe. The administration of the W.S.S.F. funds is handled by a central agency. The practice is to distribute aid equally between Europe and the Orient.

This amount is the largest ever accumulated on campus by a student-sponsored drive.

High-Speed Aerodynamics

(Continued from page 7)

certain that the power plant will be some jet propulsion device.

AN AERODYNAMICIST'S PROBLEM

The estimates made thus far have referred primarily to a more or less conventional airplane design, in that the performance estimates have been based on tests of such designs. However, the aerodynamicist can resort to a few additional tricks in the battle against drag. One of these is the use of a wing platform with leading edges swept back from the normal to the free stream flow. In an infinite wing, it can be shown that the Mach number which determines the performance characteristics of this swept-back wing is not the free stream Mach number, but the component of it normal to the leading edge. Thus, for a 45 degree sweepback, at a free stream Mach number of 1, the effective normal Mach number will be only 0.7, and we may expect that the appearance of the sudden rise in drag will be at least postponed somewhat. Experimentally this seems to be the case, and the height of the drag peak itself will probably be considerably decreased. This immediately brings the prospect of flight through the speed of of sound much closer. However, there are many practical problems connected with the use of swept-back wings, such as poor stalling characteristics, and increased structural difficulties, which cause the designer to hesitate somewhat before building all airplanes with swept-back wings.

There are many possible variations on the basic idea of a swept-back wing. One of these is a triangular, or "Delta wing." These wings appear to have some considerable advantages for use at supersonic speeds. Their drag for a given lift may be roughly one-fourth of the drag of a conventional airfoil at supersonic speeds. At present almost no idea is too fanciful, no design too radical to be unworthy of attention.

SUPERSONIC TUNNELS

A word about the difficulties involved in making aerodynamic tests at these high speeds is in order. Wind tunnels have been developed for many years to make tests at low speeds on models of airplanes supported in them. These have reached such heights of perfection as the NACA 80 foot x 40 foot tunnel at Moffet Field, in which full-scale airplanes can be tested, or the 8 foot x 12 foot high-speed Southern California Cooperative Wind Tunnel being operated by Caltech. This latter tunnel, powered with 12,000 horsepower, is able to produce Mach numbers approaching very near to 1. But as this range is approached, the wind tunnel meets difficulties not unlike those encountered by the airplane; a very large intererference between model and wind tunnel walls begins to appear. As the Mach number approaches closer to 1, the model must be made smaller and smaller to avoid these interference effects. At exactly $M=1$, the maximum model size is theoretically zero, which is hardly practical. No really reliable wind tunnel tests have been made between Mach numbers of roughly 0.95 and 1.05.

At supersonic speeds, testing in a wind tunnel becomes straightforward again, with the exception that the power required to drive the tunnel has increased in a manner similar to the drag of the airplane. For instance, the Cooperative wind tunnel may use 12,000 horsepower to blow air at $M=0.9$ through an area of roughly 100 square feet, with an air density of one-fourth atmosphere. A supersonic tunnel of the same size, operating at a Mach number of 2.0, at the same density, will require 130,000 horsepower. At the present time much essential test data can be obtained in supersonic tunnels of a much smaller size, but we must be prepared to build large supersonic tunnels in the near future.

It is clear that the problems facing the aerodynamicist at high speeds are now such that the next advances will not be made by building everything a little more powerful, or a little bigger or stronger, as has been the case in the past, but only with the aid of extensive and careful fundamental research. Moreover, the necessary information and design data cannot be provided overnight when the need arises, but must come from a long-range systematic program of research.

The practical impetus for work in this field of high-speed aerodynamics has come from its military applications, but it is certainly to be hoped that the emphasis will shift. Because of the peculiar whims of man, we may be interested in whisking a businessman from breakfast in Los Angeles to lunch in New York two hours later. This is certainly within the range of serious possibility. Fortunately, the aerodynamicist does not ask why, he simply tries to do it.

ALUMNI NEWS

ALUMNI ASSOCIATION OFFICERS

PRESIDENT A. L. Laws '26	SECRETARY D. S. Clark '29
VICE-PRESIDENT W. M. Jacobs '28	TREASURER W. R. Freeman '25

BOARD OF DIRECTORS

F. T. Schell '27	J. R. Bradburn '32
C. F. Friend '38	R. D. Andrews '15
H. B. Lewis '23	H. M. Huston '29

C. W. Varney Jr. '22

ALUMNI CHAPTER OFFICERS

New York Chapter:

PRESIDENT — Evan Johnson '38
969 Madison Ave., New York 21, N. Y., Tel. BUtterfield 8-4116
VICE-PRESIDENT — H. E. Mendenhall '23
3 Oakridge Avenue, Summit, N. J. — Tel. SU 6-2822
SECRETARY-TREASURER — Richard Pond '39
174 North 19th Street, East Orange, N. J. — Tel. OR 4-2164

San Francisco Chapter:

PRESIDENT — Maurice Jones '26
908 Curtis Street, Berkeley 6, California, Tel. THornewall 2893
Bechtel McCone Brothers — Tel. DOuglas 4032
VICE-PRESIDENT — Ted Vermeulen '36
2226 McGee Avenue, Berkeley 3, California
Shell Development Company — Tel. EXbrook 5400
SECRETARY-TREASURER — Robert P. Jones '35
1431 Park Blvd., San Mateo, California, Tel. San Mateo 3-7634
Standard of California — Tel. SUtter 7700

The San Francisco Chapter meets weekly for lunch at the Fraternity Club, 345 Bush Street, on Mondays.

ROBERT BRUMFIELD WINS TEMPLIN AWARD

ROBERT C. Brumfield '40, Ph.D. '43 was recently designated recipient of the Templin Award by the American Society for Testing Materials. Established last year, the Templin award is given for the purpose of "stimulating research in the development of testing methods and apparatus, encouraging the presentation to the Society of papers describing new and useful testing procedures and apparatus, and recognizing meritorious efforts of this kind." The award consists of a cash prize of $25 and a suitably engraved certificate.

Bob received his B.S. degree in 1940, his M.S. in mechanical engineering in 1941, and his Ph.D. in 1943. His thesis covered "A Method for Recording and Studying Crack Growth in the Corrosion Fatigue of Metals." Concentrating on corrosion fatigue research for several years, he was an instructor at the Institute, and later research and development engineer for the Aerojet Engineering Corporation, and also was affiliated with the Naval Ordnance Test Station in Pasadena.

BAY CITY ALUMNI MEET AT AUTUMN FUNCTIONS

Dick Folsom Talks at Dinner Meeting

TWENTY-SEVEN Tech alumni met at the "Holland House" in San Francisco for a dinner meeting on October 25. Dr. Dick Folsom '28 was the speaker of the evening. His connection with the American war effort started in the summer of 1940 and is still continuing.

Dr. Folsom's talk was most informal and concerned many of his personal experiences with submarines, landing vehicles and several other war developments. He presented some excellent colored movies of the "atom bomb" tests along with several reels on "alligators," fire control, wave action, and preliminary studies of the "Bikini" tests.

Alumni present were M. A. Baldwin, Sid Bamberger, P. H. Brown, P. H. Cate, Ronald Connelly, S. C. Dorman, Lou Erb, H. P. Henderson, L. P. Henderson, Maury Jones, R. P. Jones, Hilmer Larson, Robert Leo, Jules Mayer, Bill Moore, A. E. Myers, Homer Wellman, L. P. Stoker, Ted Vermeulen, and Walton Wickett.

Fall Dance Entertains 33 Couples

The Brazilian Room in the beautiful Berkeley Hills was the scene of the Autumn Dance on November 23. Thirty-three couples of the San Francisco Chapter danced to the excellent music furnished by Bert Scarborough '40 and his collection of fine records.

Ted Vermeulen '36 made all arrangements for refreshments of beer, coke, apple cider and crackers. About eleven o'clock plenty of hot coffee, ice cream and cake completed the refreshments of the evening.

Among those present were H. E. Baker '30, W. E. Brown '40, S. F. Bamberger '33, W. B. Dandliker '45, H. Deardorff '30, W. L. Dickey '31, G. L. Edwards, M. Edwards '26, R. G. Folsom '28, J. J. Halloran '35, J. C. Harper, A. J. Hazzard '30, E. S. Hill '34, M. T. Jones '26, J. Kohl '40, W. J. Johnson '35, J. F. Mayer '40, W. W. Moore '33, D. S. Nichols '28, H. M. O'Neil '34, K. J. Palmer '38, N. T. Partch, J. Perterson, D. J. Pompeo '26, W. D. Scarborough '40, E. W. Smith '24, L. P. Stoker, H. Wellman '30.

MUSSELMAN RELEASES QUARTERLY SPORTS BULLETIN

ATHLETIC News Bulletin No. 55 has just been mailed out. The quarterly Bulletin has been sent to all men who have made varsity letters and to any others interested, since July 1933. Coming out in September, December, March and June, Coach Musselman's publication lists seasonal prospects and summaries, offers notes on other conference teams, and contains complete tabulations of Caltech and Conference athletic activities.

Coach Musselman advises that any interested persons may receive the Athletic News Bulletin by sending their name and address to the Athletic Office, C.I.T.

DUBRIDGE SPEAKS TO ALUMNI ASSOCIATION

WITH President DuBridge speaking on "Some Special Problems and Prospects" as the attraction of the evening, the December 10 meeting of the Southern California Chapter saw 207 Alumni present. Except for Alumni Seminars, this congregation at the Pasadena Athletic Club is believed to be the largest group of Caltech Alumni ever assembled.

President Allan L. Laws opened the meeting, discussed some projected activities of the Association for the coming year, and presented members of the Board of Directors. Dr. Rene Engel '33, former Tech geology instructor, was introduced. Dr. Engel has returned recently from the Philippines where he was interned in a Japanese prison camp during the war.

Allan Laws turned the meeting over to Fred Schell, program chairman, who introduced President DuBridge.

Dr. DuBridge considered first the Institute's financial picture. There is now an endowment of 17 million dollars and an estimated deficit for 1946-1947 of 200,000 dollars. However the anticipated settlement of estates totalling 5 million dollars in value will provide the needed revenue to overcome this deficit. Future necessities and plans include an increase in salaries totalling 250,000 dollars per year, which will require a 6.25 million dollar endowment. Expansion dictates the allotment of 500,000 dollars more per year, requiring an investment of 1.5 millions. Therefore the problem confronting the Institute is that of building up the endowment to about 40 million dollars. One way to secure part of the necessary income, Dr. DuBridge pointed out, is through the Institute Associates.

Associates of the California Institute, community leaders with a sincere interest in C.I.T., contribute 1,000 dollars per year toward the annual budget of the Institute. Simple arithmetic shows that each Associate represents an endowment of about 25,000 dollars to Caltech. In these days when large endowment gifts are possibly rare, the Institute may be increasingly dependent upon the Associates, the President said.

Projected new buildings and equipment for the engineering departments and in the field of nuclear physics are expected to entail 3.25 million dollars. One and one-half millions will be needed for the furthering of biochemical research.

For the students, a gymnasium and swimming pool are planned in Tournament Park, if this land is purchased from the City of Pasadena. In addition, further dormitories are needed, and a student union building of some sort is hoped for. As a part of this plan, the present student houses north of California street might be converted to graduate dormitories.

Dr. DuBridge stressed the importance of furthering Institute public relations in order to make Pasadenans aware of the part C.I.T. plays in the community life. The hoped-for expansion into Tournament Park is only one of the needed projects that requires the full cooperation of the people of the City of Pasadena.

Much impressed by student interest in fall athletics, the President said he believed Caltech should continue in its intercollegiate, intramural and interclass sports program. "Sports" said Dr. DuBridge, "are an excellent way of consolidating the student body, as they create a common interest and spirit." He also praised the admirable attitude of the student body in supporting the Institute football team under the adverse conditions encountered in this year's schedule.

Leadership, in athletics, and in other fields is a much-desired trait in prospective students, said Dr. DuBridge. Besides entrance examination results, the personal qualities of applicants for admission should also be taken into account.

The Alumni can be a great help in this respect. Graduates living outside the Southern California area can become better acquainted with schools in their vicinity and provide a liaison between students and faculty of these schools and the Institute. Prospective students would profit by interviews with these men. Besides, Alumni in remote places could be of considerable assistance by administering entrance examinations.

President DuBridge concluded his talk with further consideration of membership in the Institute Associates. Representing a nucleus of capital investment, this group could very well include Alumni. Also, members of the Association could render great assistance to the Institute's program by talking to the President about men who, through their position in the community and interest in Caltech, might be considered prospective Associates.

The meeting closed with an open discussion in which the Alumni promised to aid Dr. DuBridge and the Institute to their fullest capacity.

MISSING ADDRESSES

The residence, business or military addresses of the following graduates are unknown. If anyone reading this column could supply this information, it would be appreciated if they contact the Alumni Office. —Editor.

1900
Davidson, Leonard E.

1906
Norton, Frank E.

1911
Lewis, Stanley M.

1914
Newton, Walter L.

1915
Black, Harold A.
Call, Raymond

1916
Allen, Robert N.

1919
Ransom, John H.

1920
Goodhue, Elbridge A.

1922
Cox, Edwin P.
Gillies, Robert
Seivert, Guilio E.

1923
Merrill, Robert A.

1924
Freeman, Hugh B.
Gridley, Horace V.
Hastings, Robert C.
Honn, Harry T.
Miller, Palmer
Stoker, Lyman P.
Stone, George B.
Warren, Harry L.
Wolochow, David

1925
Aggeler, William F.
Byrne, Hugh J.
Greenlees, A. Lloyd
Hansen, Raymond J.
Hirano, Fred M.
Scott, Percival T.
Smith, Dwight O.
White, Ernest C.
Wilson, Keith M.

1926
Anissimoff, Constantin I.
Chang, Hung Yuan
Chase, Carl T.
Farman, Ivan L.
Foster, Alfred
Granger, Wayne E.
Huang, Jen Chieh
Kingsbury, William S.
Parker, Percy E.
Schabarum, Bruno R.
Sokoloff, Vadim M.
Wisegarver, Burnett B.
Yang, Kai Jin

1927
Gilliland, Ted R.
Marsland, John E.
Mesenkop, Louis H.
Peterson, Frank F.
St. Clair, Raymond E.
Sarno, Dante H.
Turner, Francis E.
Vaile, Robert B., Jr.
Warner, Arthur H.

1928
Chou, P'ei Yuan
Clark, Alexander
DeBroekert, Frederick W.
Graham, Thomas C.
Martin, Francis C.
Morgan, Stanley C.
Podolski, Boris
Ure, William
Wells, John C.
Wingfield, Baker

1929
Briggs, Thomas H.
Haeff, Andrew V.
Nelson, Julius
Olman, Samuel
Sandberg, Edward C.
Uyterhoeven, Willy
Van Beroldingen, Linton
Welton, Francis G.

1930
Chao, Chung Yao
Clark, John D.
Ellis, Eugene
Gates, Clinton E.
Hiyama, Thomas T.
Imus, Harry
Kinney, Edward E.
Mason, Harry S.
Michels, Walter C.
Richardson, Omar B.
Stapp, Frederick P.
Suzuki, Katsunoshin
White, Dudley
Wilkinson, Walter D., Jr.

1931
Anderson, Maynard M.
Biddle, Russell L.
Ho, Tseng Loh
Hoch, Winston C.
Murdock, DeWolf O.
Oaks, Robert M.
Ravitz, Sol F.
Webb, Glenn M.
Weise, Carl A.
Wenner, Ralph R.
Woo, Sho Chow
Yoshoka, Carl K.

1932
Breitwieser, C. J.
Gregory, Jackson, Jr.
Martin, R. S.
Rumbaugh, L. H.
Schroeder, L. D.
Webb, Robert W.
Welge, Henry
Wong, David Y.

1933
Applegate, Lindsay M.
Ayers, John K.
Bernstein, Theodore I.
Craig, Philip H.
Davis, Edwin N.
Hassler, Gerald L.
Herlin, Robert G.
Lewis, Charlton M.
Mendenhall, John D.
Michal, Edwin B.
Murdock, Keith
Rice, Winston H.
Schlechter, Arthur H.
Skaredoff, Nikolai
Skinner, Selby M.
Smith, Warren H.
Wilking, Arnold P.
Wolf, Alexander

1934
Campbell, James R.
Chawner, William D.
Cook, David E.
Gulick, Howard E.
Harshberger, John D.
Magden, John L.
McNaughton, Duncan A.
Sunderland, Robert C.
Vosseler, A. B.

1935
Antz, Hans M.
Beakley, Wallace M.
Ewing, Gordon R.
Genachte, Paul F.
Grimm, George, Jr.
Gross, Siegfried T.
Huang, Fun Chang
Huang, Hsia Chien
Joseph, Paul A.
Kitusda, Kaname
Koons, Harry M.
Maloney, Fred V.
Matthews, Elmo S.
McCoy, Howard M.
Miller, Eugene C.
Obatake, Tanemi
Pehoushek, Frederick
Portman, Herman G., Jr.
Scherb, Ivan V.
Sheppard, Dickson M.
Simmons, Norwood L., Jr.

1936
Fleming, Morton K., Jr.
Hartlein, Robert L.
Kurihara, Hisayuki
Nichols, Robert M.
Ohashi, George Y.
Onaka, Takeji
Schafer, Sidney
Stern, Benjamin
Strange, Hubert E.
Tan, Chia Chen
Uhrig, Leonard F.
Wood, Reuben E.
Wright, Frederick H.
Zimmerman, Don Z.

1937
Bennett, Foster C.
Berry, Frederick A., Jr.
Cheng, Ju Yung
Dykes, Christopher
Easton, Anthony
Feuer, Stanley I.
George, Jack W.
Gilmore, Hugh M.
Graul, Donald P.
Harris, Dale R.
Hemmendinger, Arthur
Miller, Nash

PERSONALS

1921

TRUMAN F. McCREA has returned to this country from China and plans to stay. He and an associate have formed the American Trading and Export Company in San Francisco.

1925

LEROY NEWCOMB is now chief mechanical engineer of Emsco Derrick and Equipment Company in Los Angeles.

1926

HAROLD F. HUGGINS is planning a vacation in the East during December. Harold is merchandise manager of the United Rexall Drug Company.

JOHN E. MICHELMORE was recently active on the California State Elks Association Scholarship Committee.

1927

ROLAND W. REYNOLDS has been released from the Army and is now working for the Los Angeles Air Polution Control.

1928

RICHARD C. ARMSTRONG (AUSIEKER) M.D. has started a practice in the First Trust Building in Pasadena. Dick was a flight surgeon during the war, having the rank of captain in the Army Air Forces.

F. GUNNER GRAMATKY is the father of a baby girl born in October and named Mimi Elizabeth.

GEORGE HARNESS, formerly of the electrical engineering department of Columbia University, is now professor of electrical engineering at U. S. C. His family is here with him and they are living in Los Angeles.

EDWARD E. TUTTLE of the company Tuttle and Tuttle announces the removal of their law offices to larger quarters in the Title Guarantee Building in Los Angeles.

1929

MICKY O'HAVER has been appointed to the position of general supervisor for the Southern California Gas Company in dealer sales in Los Angeles.

LES SCOTT is the father of a new baby boy, Jan Christopher, born October 8.

1930

DEANE E. CARBERRY, commander in the U. S. Navy, is now stationed at Point Mugu, California, at the Naval Air Missile Test Center. Deane was head of the Aviation Facilities Construction Department at Washington, D. C. Prior to that he was officer in charge of construction of N.A.S. (Lighter than Air) in Richmond, Florida.

REA E. HOPPER is employed at Hughes Aircraft in Culver City, as chief engineer.

DR. GEORGE F. WISLICENUS is living in Toledo and employed by the Packard Motor Company.

1931

WALTER DICKEY is now a civil and structural engineer with Myron C. Gould Associates, San Francisco.

1933

SID BAMBERGER has opened an office for practice of architecture and structural engineering under the name of "Bamberger and Reid," San Francisco.

1934

FRANCIS W. WYATT reports on his activities: "The first of May, this year, I was appointed to the position of senior engineer in charge of engineering work for the light oil division at Standard's El Segundo Refinery. In this position I have twelve engineers under my supervision and the responsibility for all maintenance and construction engineering work for the light oil division. This position also includes duties I formerly held as technical assistant in the same division as that position was eliminated."

1935

DR. CLIFFORD GARNER is assistant professor of chemistry at U.C.L.A. where he will use the 38 inch cyclotron sent there from Berkeley for a series of experiments in nuclear chemistry.

HARRY M. KOONS, lost to the Alumni Association and associates for sometime is now in Los Angeles. He had been interned in the Philippine Islands during the war but is now back and working for his previous employer, Bechtel Bros. McCone, in the industrial building division.

C. W. LINDSAY resigned as assistant plant manager of the Maui Cannery at Kahului, T. H., to become superintendent of the Exchange Orange Products Company plant in Ontario, California. A part of the Sunkist Organization, this company processes oranges into juice, concentrate and other products.

1937

J. S. EDWARDS, JR., has left military service where he served as a first lieutenant in the Marine Corps. He is now living in Santa Barbara.

CARL E. LARSON who has been with the P. J. Walker Company since graduation has been superintendent throughout the construction of the new $2,000,000 Bullock's store on South Lake Avenue in Pasadena.

1938

J. L. VELAZQUEZ was released to inactive duty from the Navy after two years service during which he was assigned as head of the airplane structural loads group in the Bureau of Aeronautics in Washington, D. C., and served aboard the aircraft carrier U. S. S. Lake Champlain on a special mission. He is now a structural engineer with North American Aviation.

1939

LLOYD R. ZUMWALT has gone back to work in Oak Ridge, Tennessee.

1940

ROBERT S. NEISWANDER has moved from Pasadena to Niagara Falls, New York, after receiving an M.S. here in September. Bob has started work at Bell Aircraft as project engineer and pilot.

JEAN B. STEVENS will make the Navy a career. He is now taking graduate work in aeronautics on campus and living in Long Beach.

1941

ROY M. ACKER has returned to this area and is living in Burbank. Roy is back with his old employer, Lockheed, at the same rating of "A" draftsman.

1942

JACK D. STONE is working at Standard Oil at El Segundo as construction engineer. Jack took one year in aerology at U.C.L.A. under the Navy program after leaving Tech and was stationed in Hawaii about one year out of his total of two and one-half years of service. He is married to a Chicago girl and they are living in Manhattan Beach.

HARRISON A. PRICE has been in Peru since June 1. At home he has a 10 pound baby boy, born October 9.

1943

ROBERT L. BENNETT has taken a position in the plant department of the Southern California Telephone Company where his duties involve maintenance of their motor vehicles.

1944

CHARLES G. ALMQUIST is working as an oilite bearing engineer with Almquist Bros. and Viets Company. Chuck says he has chosen powdered metal work because it is a relatively new field and is growing rapidly, replacing solid metal bearings and castings.

ENSIGN LOUIS G. DAMESON is stationed at the Bureau of Ships in connection with Operation Crossroads and will remain there until the first of the year. He is living in Washington, D. C.

ELMER S. HALL has moved from Riverdale, Maryland, to San Gabriel, California.

LT. (J.G.) FRANKLIN H. KNEMEYER is living in Washington, D. C., and his station is located at Silver Springs, Maryland. He is technical assistant and liaison to the officer in charge.

1945

PAUL R. CRAWFORD is employed by the W. F. Kilpatrick Company in Los Angeles.

STANLEY E. FARMER is in Portland, Oregon, working for the Willamette Iron and Steel Company.

JEROME HARRINGTON was discharged from active duty from the Navy in July. Jerry has recently purchased a home in Pasadena and he and his wife, Roberta, have been working vigorously with hammer and paint brush.

DONALD W. SINCLAIR has moved to Los Angeles where he is working for the Gilfillan Company.

CHESTER R. STONE is working as an analyst in the research laboratory of Northrop Aircraft. Chester's younger brother, GLENN, who attended Tech last semester has had to drop out of school this term because of an injured ankle but plans to return as soon as possible. He will be the third Stone brother to work for a degree here.

1946

STUART BATES is employed by the Southern California Gas Company.

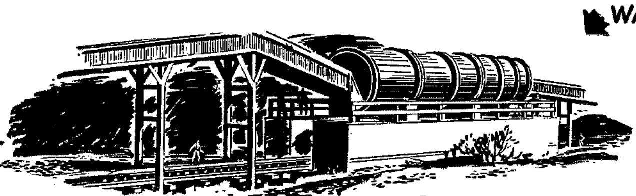
RICHARD G. KUCH is working as an electronic engineer for Menasco, Inc., at Burbank.

BARK A LOG BETTER AND YOU GET MORE PAPER..FINER PAPER!

90% OF ALL PAPER IS MADE FROM WOOD!

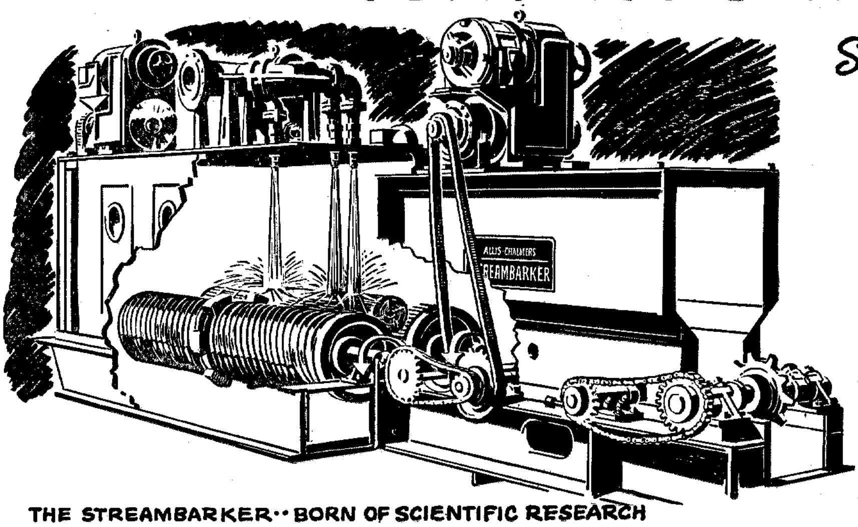
BEST WOOD PULP FOR PAPER CONTAINS NO BARK, NO DIRT. HAND BARKING AND CLEANING IS SLOW, COSTLY, OUT OF THE QUESTION FROM A PRODUCTION STANDPOINT.......

CONVENTIONAL DRUM BARKER SOLVES THE PRODUCTION PROBLEM BUT INVOLVES HUGE MACHINERY... WASTES VALUABLE WOOD FIBRE.......



AMAZING NEW STREAMBARKER

DEVELOPED BY A-C SCIENTISTS!



SCARCITY OF MANPOWER AND RAW MATERIALS MADE BETTER BARKING IMPERATIVE. A-C HAD BEEN USING WATER UNDER HIGH PRESSURE FOR CLEANING CASTINGS. SIMILARLY, COULDNT LOGS BE BARKED AND CLEANED HYDRAULICALLY? THE STREAMBARKER WAS BORN. SCIENTIFICALLY CONTROLLED JETS OF WATER REMOVE BARK AND DIRT BY EROSIVE ACTION AS LOGS ARE REVOLVED AND PROPELLED THROUGH THE BARKER. RESULTS—IMPORTANT WOOD CONSERVATION..MORE AND FINER PAPER FOR MR.& MRS. AMERICA!

THE STREAMBARKER··BORN OF SCIENTIFIC RESEARCH AND SKILLED ENGINEERING IS TYPICAL OF DAILY PROGRESS BEING MADE ON MANY OF THE 1600 DIFFERENT PRODUCTS ALLIS-CHALMERS BUILDS FOR INDUSTRY TO SERVE THE WORLD··**ALLIS-CHALMERS, MILWAUKEE, WISCONSIN**

ALLIS CHALMERS

ONE OF THE BIG 3 IN ELECTRIC POWER EQUIPMENT
BIGGEST OF ALL IN RANGE OF INDUSTRIAL PRODUCTS

The Main Line

DECEMBER, 1946

This month travel on Southern Pacific trains peaks up again as families get together for Christmas reunions.

Last year at this time, you may recall, railroad facilities were strained to the utmost as thousands of returning veterans jammed Pacific Coast ports. This year, of course, no such situation will exist. However, travel will be heavy and we advise you to do your Christmas shopping for train reservations, as well as presents, *early*.

No matter where you plan to go, Southern Pacific offers a wide variety of trains and accommodations for you to choose from. Here is a brief roundup:

Pacific Northwest-San Francisco

1. The all-Pullman *Cascade*, now running on the fastest schedule in its history. Lounge car.
2. The money-saving *Beaver*, with chair cars, coaches and tourist Pullmans. Lounge car for tourist Pullman passengers. Chair car and coach seats should be reserved in advance.
3. The *Klamath*, with standard and tourist Pullmans, coaches and chair cars, dining car.
4. The *West Coast*, through train to Los Angeles. Standard and tourist Pullmans, coaches and chair cars, dining car.

San Francisco-Los Angeles

1. The streamlined *Lark*, generally considered the finest overnight train in America. All-Pullman.
2. The streamlined *Morning Coast Daylight*. Reserved seat chair cars, parlor observation car, tavern car, diner and coffee shop.
3. The streamlined *Noon Coast Daylight*. Same equipment as the morning train.
4. The streamlined *San Joaquin Daylight*, between San Francisco-Oakland and Los Angeles via San Joaquin Valley.
5. The streamlined *Sacramento Daylight* between Sacramento and Los Angeles via San Joaquin Valley.
6. The overnight *Coaster*. Standard and tourist Pullmans, coaches, dining car.
7. The overnight *Owl*. Standard and tourist Pullmans, chair cars and coaches, diner.

San Francisco-Chicago

1. Streamliner *City of San Francisco*, now leaving every Tuesday, Thursday and Saturday. Streamlined Pullmans and reserved seat chair cars. Dining and coffee shop cars, lounge car. Extra fare.
2. The *Overland Limited*, now running on the fastest schedule in its history. Over the High Sierra by daylight. Most Pullmans are streamlined. Streamlined chair cars (all seats reserved in advance). Dining car, lounge car, coffee shop. Through Pullmans to New York. No extra fare.
3. The *San Francisco Challenger*, economy train with chair cars, coaches and tourist Pullmans. Dining car, lounge car for tourist Pullman passengers, chair car for women and children.
4. The *Pacific Limited*. Standard Pullmans, club car, dining car. Through Pullmans to Washington.

Los Angeles-Chicago

1. The *Golden State Limited*, now running on the fastest schedule in its history. Streamlined Pullmans and reserved seat chair cars. Dining car, lounge car, coffee shop. Through Pullmans to New York. No extra fare.
2. The new fast *Imperial*, via the Imperial Valley. Standard Pullmans, chair cars and coaches, dining car, lounge car.
3. The *Californian*, economy train with tourist Pullmans, coach, lounge car for Pullman passengers, dining car.

Los Angeles-New Orleans

1. The *Sunset Limited*, now running on the fastest schedule in its history. Standard Pullmans, lounge car for Pullman passengers, dining car and reserved seat chair cars.
2. The *Argonaut*. Standard and tourist Pullmans, lounge car for Pullman passengers, dining car, chair cars and coaches.

So there you have it—a great fleet of Southern Pacific trains, waiting to carry you on your holiday trip north, south or east.

They aren't all fancy streamliners like the *Lark* and the *Daylights*, but you could search the country and not find trains that offer more smooth-riding comfort and friendly service than the *Cascade, Overland Limited, Golden State Limited* and *Sunset Limited.*

Next year you'll see some famous new names added to this list, including the streamlined *Shasta Daylight* between Portland and San Francisco, and the still-unnamed "superduper" between Los Angeles and Chicago.

90,000 Season's Greetings

From the men on the rotary snow plows, bucking the drifts in the High Sierra and Cascades to keep the line open for your Christmas trip...

From the telegraphers in lonely mountain and desert stations . . .

From the watchman at the Pecos River Bridge, and the ferryboat men on San Francisco Bay . . .

From the track walkers and section hands and crossing watchmen . . .

From the dispatchers, trainmasters, conductors, foremen, enginemen and brakemen . . .

From the signalmen, linemen, car inspectors and car cleaners . . .

From the call boys, porters, cooks, waiters and redcaps . . .

From the ticket agents, office workers, baggagemen, machinists and boilermakers . . .

From 90,000 Southern Pacific men and women on 15,000 miles of line...

Best wishes for a Merry Christmas and a Happy New Year.

—H. K. Reynolds

S•P *The friendly Southern Pacific*