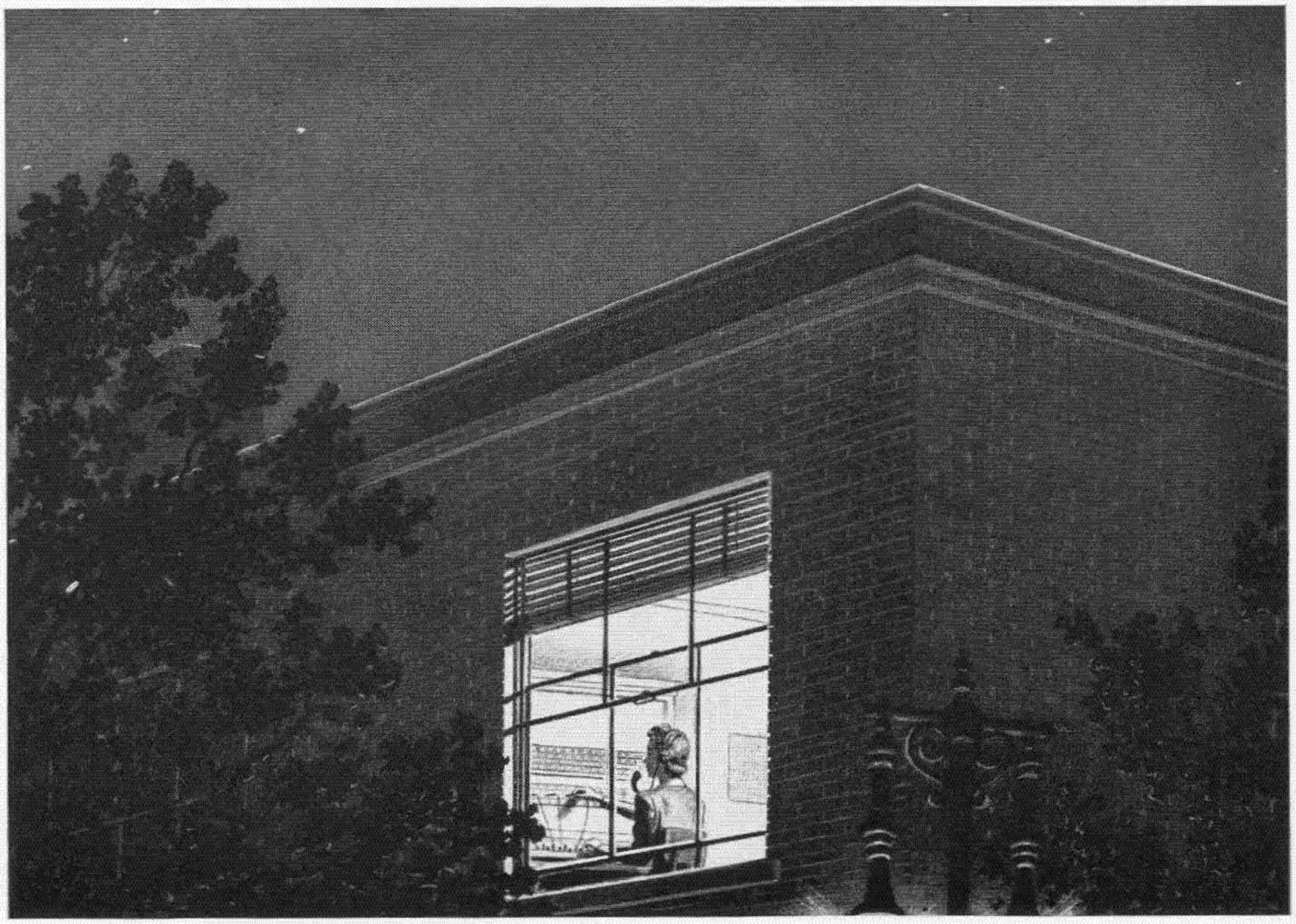
ALUMNI REVIEW

CALIFORNIA INSTITUTE OF TECHNOLOGY

Vol. 4 No. 4 June, 1941



"I judge the telephone company by the people who work for it"

A little while ago a Vermont newspaper editor, John Hooper, commented on the telephone company and its people. His words express so well the ideals toward which we are striving that we quote them here.

"I DON'T know how big the telephone company is, but it is big enough to exceed my mental grasp of business.

"But I don't find myself thinking of it as a business, even in my day-to-day contacts. Rather, my attention is on the voice that says, 'Number, please.' I find myself wondering if that voice is feeling as well as it always seems to, or if it feels just as hot and weary as I do, and would say so if it wasn't the kind of voice it is.

"The first time the business angle really struck home was when I read that my friend Carl had completed thirty years with the company.

"Now it happens that I know something of the details of those thirty years with the company, and I believe they are a credit both to Carl and to the big business for which he works.

"In 1907 Carl was a high school boy confronted with the need for earning money in his spare time. He happened to get a job as Saturday night operator in the telephone exchange. He worked at this job for three years and then entered the university.

"While in college he did some substituting at the exchange in his home town in vacations. After graduation, he was hired full time by the telephone company, not in an 'executive' position which some folks think goes with a college diploma, but as a lineman.

"Within a year he was made wire chief of the district, a job which he held for the next ten years. He was then transferred to a larger city as manager of the office. Then he was promoted to sales manager of the division.

"A year later he was sent to another State, as district manager. In less than a year after this appointment, he was made manager for the entire State.

"I don't know much about the telephone company as a business; I can only judge it by the people who work for it. Just where the dividing line is between a business and the people who work for it, I don't know. I don't think there is any line."

Bell Telephone System

"THE TELEPHONE HOUR" IS BROADCAST EVERY MONDAY. (N. B. C. RED NETWORK, 8 P.M., EASTERN DAYLIGHT SAVING TIME.)

ALUMNI REVIEW

ALUMNI ASSOCIATION, INC.
CALIFORNIA INSTITUTE OF TECHNOLOGY

VOL. 4, NO. 4 JUNE, 1941
PASADENA, CALIF.

Published four times a year — September, December, March and June by the Alumni Association, Inc., California Institute of Technology, 1201 East California Street, Pasadena, California. Annual Subscription $2.50, Single Copies $0.65. Entered as second class matter at the Post Office at Pasadena, California, on September 6, 1939, under the Act of March 3, 1879.

All Publishers Rights Reserved.

Reproduction of Any Material Contained Herein Forbidden Without Written Authority.

STAFF

Hugh Colvin, '36 . . . . *Editor*
Union Oil Bldg., Los Angeles

Robert Barry, '38 . *Business Manager*
5823 Denny St., North Hollywood

George Langsner '31 — Fred S. Scott '30
Albert Atwood '32 — William H. Mohr '29
Bill Birdsey '34 — Lawrence Baldwin '35
Theodore C. Combs '27

CONTENTS

JUNE, 1941

Men In Service

Because so many Alumni hold reserve and other commissions in various branches of the military service, and because friends have a difficult time of keeping track of their location after being called to active duty, the Alumni Review will make a special effort in the September issue to present a list of men in the service, and their current assignments. Please send any information you may have along this line to Fred Scott '30, care Alumni Association, Pasadena.

About Our Authors

Holley B. Dickinson '36, who contributes this issue's leading article, "The Prospects for Air Transport," is well qualified for his analysis of the possibilities and problems of commercial aviation during and after the war. Holley has been engaged in aerodynamic research for Lockheed after coming back to Tech for his M.S. in 1937. He has contributed articles to the Journal of Aeronautical Sciences and has presented papers before several technical groups on aerodynamic subjects. At the 1941 Alumni Seminar Weekend he discussed current manufacturing problems in the Aeronautics Seminar.

One of the outstanding engineering projects of all time is the Colorado River Aqueduct and associated construction work. Bringing water to a thirsty metropolitan area as it does, the Aqueduct not only has important economic and social aspects, but its laying across miles of barren and rugged desert country and its great size presented severe engineering obstacles. **Julian F. Hinds,** Assistant Chief Engineer for the Metropolitan Water District of Southern California, gives an inside picture of the original research on cement, pump, and water problems that made the project successful. Mr. Hinds was one of the speakers at the A.A.A.S. meetings on the Tech campus in June.

Much has been written, and deservedly so, concerning the part that the engineering schools are playing in the gigantic national defense effort. One of the most succinct and analytical summaries, however, was that presented by **Morrough P. O'Brien,** Chairman of the Department of Mechanical Engineering, University of California, at the opening symposium of the American Association for the Advancement of Science meeting held at the Institute. Professor O'Brien's analysis af the aims and problems involved is well worth comprehensive study.

News Notes

Professor Franklin Thomas has been named recently to the national panel of labor dispute arbitrators of the American Arbitration Association. He is one of the six Californians named to the association which has a record of 400 labor cases settled without a following dispute . . . Dr. Richard C. Tolman, who has been in Washington for a year, returned to Pasadena for a short vacation. He was recently named on a special emergency committee for scientific research and development by President Roosevelt.

in other words

by JOHN CLINTON

I have fallen in love with a red headed angel with round blue eyes and skin the color of Golden Guernsey cream. Her name's Judy, and I met her while she was sitting on the lap of a good looking young Minute Man at the Union Oil station at Bishop, Calif.

* * *

Judy, who doesn't look a day over six, was waiting for her daddy who was over at the store buying supplies for a camping trip. The Minute Men were taking care of her.

* * *

"Sure we mind youngsters," said the manager, "and we mind dogs and find lost cats, and we lend campers boots, electric wire and ice picks. We think nothing of finding 2 or 3 purses in the restroom every week, and we still have a set of false teeth waiting to be claimed. Boy, *you gotta be on your toes to be a Minute Man!*"

* * *

I got to thinking about it on the way up to Virginia Lakes—about Judy's red hair and all the things Minute Men do, and I decided that touring is lots easier, safer and more convenient because of these Minute Men you find at Union Oil stations wherever you go.

* * *

So when I start my own oil company I'll be as careful as Union when I pick my men. It's a swell way to sell gasoline, and a swell way to run a company. Next time *you're* driving, drop in and meet a Minute Man. And I wish I had Judy!

THE PROSPECTS FOR AIR TRANSPORT

By Holley B. Dickinson, '36
Lockheed Aircraft Corporation

At this time when the immediate concern of every aircraft manufacturer is rapid expansion and production to meet military needs, the future of the air transport industry is taking shape in the back of the minds of research, development and administrative personnel. While the war may bring to a halt commercial development as such, new research and manufacturing facilities and rapid technical development fostered by the war will accelerate the natural growth of the post-war industry.

Transport development problems are normally attacked on a triple front. The research laboratories, aircraft manufacturers and transport operators all contribute to their solution.

The division of labor between these agencies has been fairly well marked. The research laboratories develop the theoretical background and investigate the basic problems of flight. In addition, they provide many of the facilities with which the manufacturers conduct their research. The wind tunnel of the Guggenheim Aeronautics Laboratory at the Institute, for example, has probably been the scene of more commercial development than any other tunnel in this country.

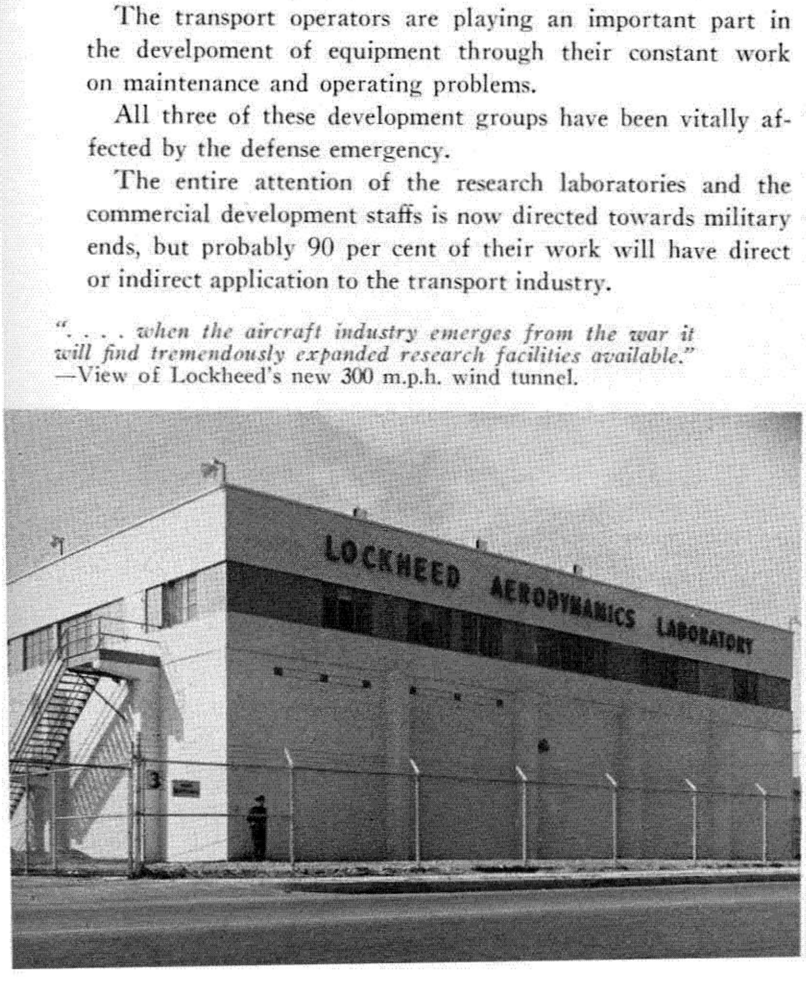
The research conducted by the manufacturers tends towards the solution of the more immediate design problems. Commercial research has, in the past, been concentrated on features which offer promise of early practical application. Under the impetus of the defense emergency, this trend has become more than ever established. In many cases, however, the growth of the industry has recently made possible considerable private investment in long-range research facilties. These investments are evidence of faith in the stability of the industry, and in the dollar value of research.

The transport operators are playing an important part in the develpoment of equipment through their constant work on maintenance and operating problems.

All three of these development groups have been vitally affected by the defense emergency.

The entire attention of the research laboratories and the commercial development staffs is now directed towards military ends, but probably 90 per cent of their work will have direct or indirect application to the transport industry.

". . . when the aircraft industry emerges from the war it will find tremendously expanded research facilities available."
—View of Lockheed's new 300 m.p.h. wind tunnel.



INCREASED RESEARCH FACILITIES

When the aircraft industry emerges from the war, it will find tremendously expanded research facilities available. The huge amounts spent by the German and Italian governments on aircraft research facilities a good many years ago are now being matched in this country. The National Advisory Committee for Aeronautics, whose Langley Field laboratories have been our mainstay of aeronautical research since the last war, is building several new plants, including one for engine and propeller work at Cleveland and an aerodynamics unit at Moffett Field, California. The Army Air Corps' Material Division at Wright Field is being expanded with the addition of a large high-speed tunnel. In peace time, all of the results of the work of these laboratories will be available to the transport industry. There are few industries in which scientific analysis is more essential to growth than it is to aircraft, and the work of the research laboratories is so important that it is hardly to be evaluated in terms of dollars and cents.

The war expansion will have a far-reaching effect upon the ability of the aircraft manufacturer to produce airplanes in quantity. It will likewise influence the materials and methods employed in building future transports.

First, the manufacturer has been forced to learn production methods and assembly line techniques to an extent that would never have been the case except for the vast military requirements. These methods and techniques will be carried over into transport construction and will undoubtedly result in savings in manufacturing costs.

By the time the war is over, a considerable degree of standardization will have been obtained, and more important, its advantages recognized. Heretofore, the industry has been characterized by an almost complete lack of standardization, but under the pressure of the national emergency, this situation can no longer be tolerated. The standardization of purchased parts, for example, will result in a saving in cost and availability. From the operator's standpoint, it will mean much simplification in training of maintenance personnel and a reduction in the quantity of replacement parts that must be carried in stock. Although standardization will never be universal, because of the peculiar requirements of certain specialized aircraft, the trend is inevitable.

The equipment which has been acquired during defense production can be expected to exert considerable influence upon transport design in the future. Machine tools, large presses, assembly jigs and factories themselves have become available to an extent that would previously have been economically unsound. This mass production equipment will make possible design features which, in the past, have been prohibitive. The result will be better ships that can be manufactured less expensively.

EFFECT ON PERSONNEL PROBLEMS

Another influence of "forced draft" production is the effect upon the personnel problem.

The acute need for trained and experienced men is gradually being alleviated. The number of Cal Tech alumni that has been drawn into the local aircraft plants is illustrative of the demand. There certainly need be no fear that the transport industry will suffer for lack of professional experience.

The industry will find that the men who have been trained during the war are familiar with design for production, and their influence will tend to simplify the construction methods used in commercial aircraft. Fortunately, military aircraft design requires an emphasis on performance as well as production. If this were not so, the conditioning of personnel during a war era would have an adverse effect upon the aerodynamic efficiency of commercial designs which follow. Instead, we are developing our ingenuity in producing sound aerodynamic designs that are feasible from a production standpoint.

It is apparent that competition in the commercial aircraft field will be very severe after the war, due to the new factories created during the expansion of the industry and to the fact that many of the military designs developed are readily convertible to commercial types. There will probably be at least eight manufacturers of large commercial equipment in this country alone. All of the above influences indicate that the industry will be capable of producing commercial aircraft faster and more economically.

Like the laboratories and factories, the airlines are having their share of national defense-bred troubles. Many pilots have Reserve Commissions and have been called into active service. Equipment is difficult to replace and expand. Although these shortages are becoming acute, domestic airline operators are continuing to enlarge their services and improve their efficiency of operation.

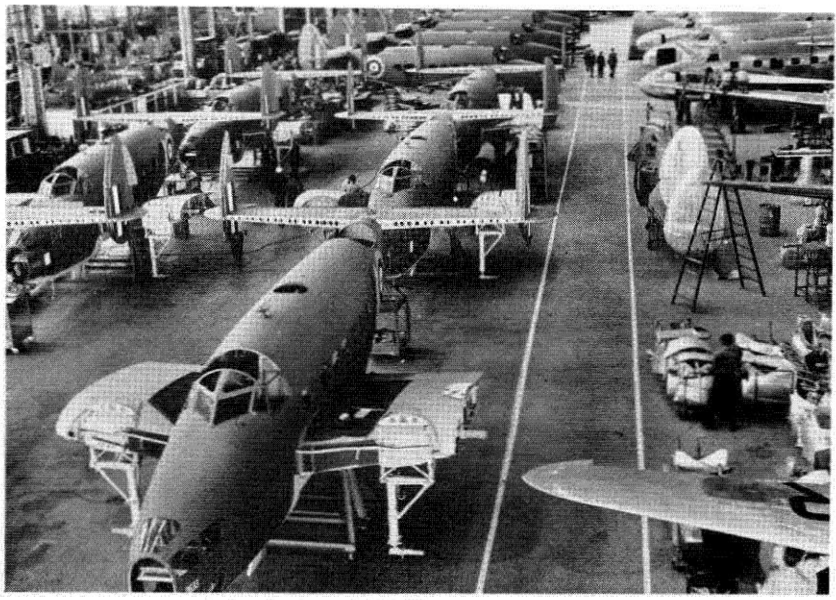
The hard-pressed British government has considered its airlines sufficiently important to their communications systems to maintain operations under difficulties which must make our problems seem trivial. It is reported that the Empire airlines are operating at 90 per cent of their peace time activity, in spite of the war. In this country also, it appears that an effort is being made to see to it that the airlines are not throttled. The tremendous growth in route mileage, passenger miles and cargo carried during the past year represents unusual effort on the part of the operators and is indicative of the commercial expansion that may be expected after the war.

TECHNICAL DEVELOPMENTS

In spite of the growth of factories and laboratories, the transport industry would be hopelessly handicapped if technical development lagged behind that of other countries.

Fortunately, there are similarities between the requirements of a good bomber and a good commercial transport. Both must be light, fast, simple, easy to maintain. The developments that improve the bomber in these respects will also improve the transport. The light, powerful, compact power plant that makes possible today's bomb load and range will make possible tomorrow's low passenger fares. The new airfoil that means another ton of bombs today will mean ten more passengers tomorrow.

Thus, much commercial technical development is the outgrowth of military studies. Nevertheless, commercial development is being directed primarily towards improvement in three



". . . The manufacturer has been forced to learn production methods and assembly line techniques."—Lockheed "Hudson" Bomber final assembly lines.

non-military factors, economy, safety and reliability. (Reliability, as used here, refers to the regularity of completion of scheduled trips.) These three factors are of great importance in determining the extent that air transport is used.

Improved economy can be attained by reduced manufacturing costs, increased aerodynamic efficiency and increased useful load. As we have seen, reduced manufacturing costs will follow directly as a result of the war expansion. Increased aerodynamic efficiency and increased useful load are the subject of intense study at this time in connection with military development. The lesson learned will be directly applicable to commercial development when the time comes.

Several particular design features currently under scrutiny show promise of contributing to increased transport economy. One such feature is the pressure cabin, which is coming into use for operation above eight or ten thousand feet. This device will see more use as cruising altitudes increase. High altitude flight is attractive for a number of reasons. Greater aerodynamic efficiency results from the reduced air density and higher speeds are possible. The air is likely to be smoother and therefore, the flight more comfortable. Pressure cabin airplanes can carry their passengers over the top of storms that are severe enough to make operation at low altitudes impractical. Unfortunately, however, there are a number of disadvantages. First, the useful load that can be carried is less because of the weight of the additional equipment required and the structure necessary to resist the pressure. Particularly in large airplanes where the gauges of sheet metal employed depend upon the loads imposed and not upon the minimum gauges that can be readily handled, the structural penalty due to pressurizing the cabin is considerable. Since the stresses run up rapidly wherever the pressure loads cannot be carried as hoop tension, reinforcements around the numerous openings are heavy. The necessary blowers, regulators, relief valves, air conditioning equipment, etc., are not only heavy and expensive, but also raise maintenance costs.

In order to operate at the higher altitudes, the engines must employ additional supercharging. The power required to drive the blowers may easily amount to several hundred horsepower for each engine, and the result is increased specific fuel consumption compared with low altitude operation at the same brake power. The use of a turbo supercharger has been proposed to alleviate this situation. The exhaust-turbine driven supercharger has been sponsored by the Army Air Corps for military use, and has yet to find commercial application. Whether it will contribute to transport economy is dubious. The added weight and drag will be considerable, maintenance will be difficult and the energy of the exhaust cannot be used for supplementary propulsion.

HIGH ALTITUDE OPERATION

These several disadvantages attendant upon altitude operation balance the advantages so that actually both the operating economy and the range turn out to be about the same whether the airplane cruises at low or high altitudes. On the other hand, the greater passenger comfort afforded is becoming of increasing importance as competition between airlines becomes more intense. Passenger discomfort due to changes in pressure and due to lack of oxygen at moderate altitudes has been of some significance in delaying the adoption of air travel. The elimination of this discomfort will make the airplane so far superior to ground methods of transportation, so far as passenger comfort is concerned, that a steady trend to air travel may be expected for this reason alone. The extreme discomfort of pressure changes, particularly when a passenger has a cold, is a far less trivial item than it would appear to be and can hardly be tolerated in a widely-used means of transportation. It may be necessary, ultimately, to supercharge cabins to sea level pressure for this reason. Perhaps the most important feature of the pressure cabin is its "over weather" operation already mentioned. When combined with highly developed blind landing systems, this feature will contribute appreciably to improved reliability.

Another important development which is proceeding steadily is the increase in size of commercial transports. Better aerodynamic efficiency automatically results; radiator scoops and auxiliary equipment can be placed inside large aircraft more efficiently; the power plant size becomes relatively smaller because its area does not increase linearly with power. The useful load tends to remain a constant percentage of the gross weight so that overall efficiency of the airplane is improved. The higher landing speeds acceptable with larger equipment permit the use of smaller wings which reduce structural weight, and the increase in physical dimension itself makes possible better structural efficiency. These effects offset the rapid increase in weight of items such as the propeller and landing gear. For these and other reasons, greater range with given payload can often be obtained only through an increase in size. As the demand for greater passenger convenience increases, range becomes more valuable since it makes possible the elimination of intermediate stops on long trips.

". . . The possibilities of air freight appear to be virtually unlimited."—Lockheed "Lodestar" in South African Airways' service.

Greater operating economy is being achieved by improved aerodynamic cleanness to which, as time goes on, there appears to be no limit. In the next few years, this will be attained through better power plant installation, improved airfoils possibly with "boundary layer control", and higher wing loadings. Power plant development has been so rapid in the past few years that it seems unreasonable to expect further increases in power output or fuel consumption, but there is little indication of diminishing returns. One of the largest improvements will come from a reduction of the drag of the accessories which now constitutes a large portion of the engine installation drag. Operation at higher altitudes and at higher powers has focused attention upon the efficiency with which the growing list of cooling accessories are installed.

IMPROVED AIRFOIL DESIGN

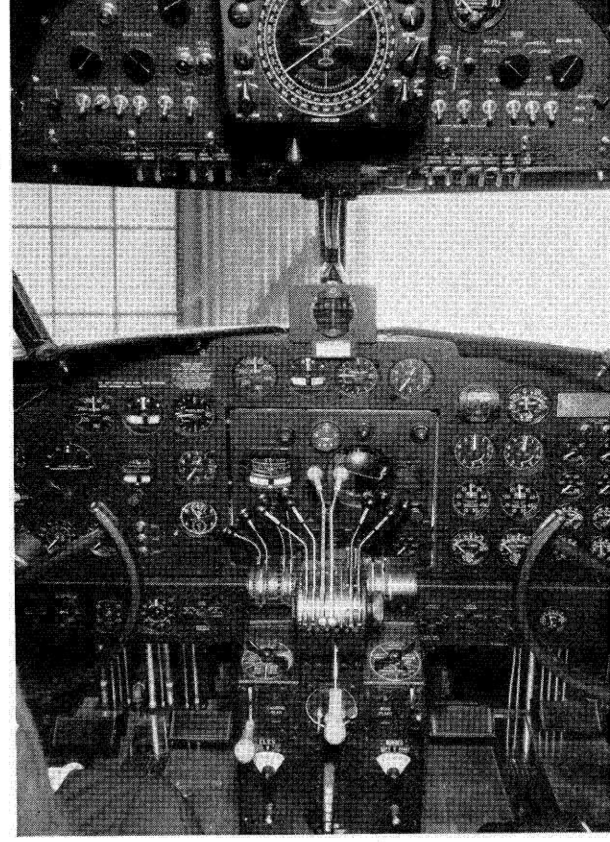
Recent improvements in airfoil design have attracted considerable attention but have not yet been extensively adopted. With information now available, there is no indication that the drag of these new airfoils is lower than conventional airfoils under actual operating conditions. Also, the criterion for airfoil efficiency includes the effect of maximum lift since in order to maintain the same landing speed, an airfoil with a low lift wing section would require a bigger wing. All of the new low drag airfoils must be considered from this standpoint. As aerodynamic efficiency improves, devices like mechanical boundary layer control become of interest. The practical complications involved have heretofore precluded their use. Flush riveting may be considered a form of boundary layer control, and has received widespread adoption. Other possibilities are a modification of contours to give a decreased pressure gradient over an extended forward portion of the airplane. Mechanical boundary layer control employing blowers offers the possibility of increased maximum lift and reduced wing drag. It also appears that the blowers employed for this purpose might be used in connection with engine cooling, cabin pressurization, or for other purposes.

Higher wing loadings which will become possible with further flap development will add to aerodynamic cleanness. Wing loadings being employed on military aircraft are beginning to approach the optimum for commercial operation under certain conditions. The new landing requirements set up by the Civil Aeronautics Board are opening the way to greater operating economy through the use of higher wing loadings. This trend has brought about the development of the "approach" flap, an intermediate setting giving an effectively lower wing loading, making possible lower speeds during the approach before landing. This gives the pilot time to work out instrument approaches and gives adequate rate of climb in the event of an emergency when the flaps cannot be retracted. Improved landing flaps giving lower landing speeds with higher wing loadings appear to be a definite possibility. The new landing requirements regulate the weight at which an airline may be operated in accordance with the airport runway length and obstacles to be encountered and the airplane's emergency climbing ability. The amount of load that can be carried legally will depend upon the airport from which the airplane is operating and the one at which it will land. There is thus a definite correlation between the capabilities of the airplane and the circumstances under which it must operate. A uniform degree of safety will therefore be achieved. Heretofore, a licensed airplane might, at times, have been operated under conditions which were questionable and at other times, restricted unduly. The new requirements also make mandatory a considerable improvement in performance with engines inoperative and in other emergency conditions. The result will undoubtedly be an improvement in both operating efficiency and safety.

Technical development directed towards improvement in safety is one of the most urgent concerns of the research staffs. Strangely enough, the greatest improvement which appears imminent is likely to come not from the airplane designer, but from the instrument designer. It is significant that none of the last five major airline accidents in this country and Canada have offered any evidence of structural or mechanical failure. It must be assumed either that the instruments and navigation aids failed or were inadequate, or that the pilot simply made an error due to fatigue. The sharp upsurge in accidents during winter months clearly indicates whence improvement must come. Fundamentally, airline accidents are caused by one factor — the weather. Navigation aids are then most important; pilot fatigue is next; and mechanical failures last. Navigation aids are developing as rapidly as any phase of the transport picture. An important step will be taken when blind landing systems, now in the advanced development stage, are perfected and receive widespread adoption. It is apparent that the time is not far off when completely blind flight will be a practical reality, when pilots will consider a complete trip, takeoff, flight and landing a routine operation in "zero-zero" weather. The number of airline accidents which have been caused by the pilot's not knowing exactly where he was, both with regard to location and altitude, indicates that navigation is far from automatic. The procedure for "letting down" through an overcast in approaching an airport is a complex navigational problem which must be performed with precision and in an unbelievably short space of time. The use of blind landing systems will add rather than subtract from the responsibility on the pilot and the complexity of the tasks he must perform.

SIMPLIFICATION OF PILOT'S JOB

The switch from two- to four-engined equipment has brought designers to the realization that the pilot's job must be simplified and that more attention must be paid to lessening fatigue and discomfort. The trend is to make the pilot's only concern the actual handling of the airplane. A third and sometimes a fourth crew member will relieve the pilots of the functions of engineer, navigator, and radio operator. On long trips, relief pilots will be provided.



". . . . The pilot's job must be simplified."—Instrument panel in Lockheed "Lodestar" transport plane.

Although operating safety and operating reliability appear at times to be diametrically opposed, the same developments that improve safety will mean greater reliability. Perfection of blind landing systems alone would eliminate the cause of most trip cancellations.

The current cost of air transportation is roughly the same as the premium fares using rail transportation, but the possibilities for increased economy in air travel appear very great. In fact, the indications are that it would be possible, starting today, to design a transport airplane which could compete on a dollar-per-passenger-mile basis with the least expensive rail transportation. The greater speed of the airplane would then be available to the passenger absolutely without cost. To visualize the volume of passenger traffic which such equipment would attract to the airlines would strain the imagination.

AIR FREIGHT

A new field of expansion, the freight-carrying airline, can be shown to be economically sound using present equipment, on the basis of surveys of the volume of freight that would be available at a given cost and speed. As the cost of air transportation steadily comes down, the volume of freight available increases very rapidly. The possibilities again appear to be virtually unlimited.

It is recognized in the industry that no single thing will do as much to make air travel universal as greater safety. The curve of passenger-miles flown is very similar to the curve of passenger-miles per fatality. Fortunately, the latter curve is moving steadily upwards, and there is every indication that its slope will increase sharply in the immediate post-war years.

Everyone who has been two or three days late for an appointment because of an airline cancellation realizes that air transportation will never be the primary means of travel until

(Continued on page 17)

THE RELATIONSHIP OF THE ENGINEERING COLLEGES TO THE DEFENSE PROGRAM

By MORROUGH P. O'BRIEN, *Chairman of the Department of Mechanical Engineering, University of California.*

The part being played in the defense program by the engineering colleges cannot be reported completely by one person because each institution is contributing in ways appropriate to its location, staff and facilities; it *is* possible, however, to present a general view of the situation together with some of emergency measures adopted to meet the increasing demands made upon these institutions.

In a recent issue of "Military Engineer," Charles P. Summerall, formerly Chief of Staff of the United States Army, wrote as follows:

"Modern warfare is the greatest engineering operation in which mandkind has ever engaged. The employment of machines driven by a prodigal expenditure of mobile mechanical power has multiplied a thousand-fold the range, speed, and destructiveness of the implements of war; and has correspondingly added to the magnitude and complexity of the technical problems involved. In the vast total effort that is modern war, there must be mobilized all the skills, techniques, and productive capacity of science and technology to construct and operate a gigantic assembly of machines against an enemy who is equipped with a like assembly of weapons. It can well be that victory will be with the combatant who possesses superiority in technical skill. The change in the tempo and magnitude of miltary operations is the direct result of the mechanized equipment that engineers have put into the hands of soldiers; and, while strategy and command remain the function of the soldier, the engineer has emerged as a key figure in modern warfare. It is urgent that he play the role which destiny has cast for him. Without superlatively good engineering in the national war effort there will be no military victories. . . . The increasing responsibility of engineers in national defense does not end with implementing the nation and its armed forces for the shock of war. Their role in the theatre of operations has ceased to be a mere auxiliary function. Before the days of mechanization, the work of engineers in combat was characterized by makeshift and temporary expedient; now, both in preparation for war and in actual military operations, there must be projected the highest degree of technical skill. The effective employment of the intricate mechanisms now used in war —ranging from the flying fortresses of the air to ships that range the ocean bottom — can not be left to unskilled or hastily trained operatives. The skilled commander will make his dispositions and assign objectives to the mighty array of men and machines that make up his army, but the engineer must follow through to assure that these machines function. It is true that the essentials of the art of war have not changed, nor has the importance of the courage and will to win of the individual soldier lessened, but it is equally true that the introduction of mobile mechanical power to operate a vast mechanical military force of incredible speed, range, and hitting power has made of a battle a joint military and engineering operation. The technical skill with which the mechanism of battle is operated may be the determinant. That this indispensable superiority be achieved is the function of the engineer in battle."

This statement emphasizes the importance of the engineer in both his civilian and military capacities.

Although engineering students form a large percentage of the reserve officers commissioned through the R.O.T.C. units, the engineering colleges do not directly participate in military training. For this reason, I will consider only the civilian functions of the engineer in the defense program.

Scientists are inclined to regard engineering as the mere application of the physical sciences but this conception is incomplete for professional engineering also involves the restraints and limitations imposed by psychological, economic, and social considerations. It is true that engineering education deals largely with science and its quantitative application but, following his formal education, the engineering graduate must serve what amounts to an apprenticeship in order to gain the practical experience necessary to round engineering judgment. The engineering diploma is less a certificate of competence than a permit to start learning engineering practice. This necessary combination of experience and formal education in the development of a professional engineer is a formidable obstacle to an abrupt increase in the number of engineers available to the defense program.

ENGINEERING ECONOMICS

The aim of engineering design, at least in peace time, is to produce machines, processes, and structures which are no more expensive than necessary to perform the desired function with, of course, adequate factors of safety to offset uncertainties in the quantitative specification of this function. To do less results in failure and to do more reduces profits. In the defense program, cost does not play so direct a part in design but a limitation of similar character comes into play. To design beyond the requirements specified is to deny needed materials and labor to other items in the program. In a nation working to the limit of productive capacity in order to supply armament, the greatest offensive power will be achieved by proportioning the number of items of each kind to the military requirements and by designing each item so as to require a minimum of labor and materials. The tempo and the objectives of engineering for defense are different but the principles and methods remain essentially unchanged and the time necessary to prepare for professional responsibilities cannot be materially shortened without impairing the competence necessary to conserve productive capacity. Deficiencies in men and materials are already apparent and the engineer should design even more economically for war than for peace.

Undoubtedly, you are familiar in a general way with the duties performed by engineers. Starting from a quantitative statement of the desired characteristics of the machine, process, or structure, preliminary theoretical or experimental studies may be necessary to decide on the general features of the design. Next comes a detailed consideration of every component part, resulting in drawings which present not only the dimensions but also the materials, tolerances, surface finishes, and all other specifications necessary for fabrication. The production engineers study these working drawings to determine the operations necessary to form each part, schedule the use of existing plant facilities, design special tools as required, and plan the sequence of assembly and the installation of accessories. A good illustration of the volume of engineering work necessary in defense industries is the fact that a typical heavy bomber is made up of approximately 25,000 different parts, each one of which represents a quantitative prediction that it will be adequate and at the same time be as light as possible. As many as 8,000 separate drawings may be necessary to inform the production department of what is required in the construction of a plane of this size.

In engineering design, a functional division of labor is possible. Details are worked out by draftsmen, computers, and other sub-professional workers and engineering design departments provide opportunities for men of varying skill and experience but there is in each industry a limit below which professional skill cannot be safely diluted.

Mechanization of warfare has increased the number of workers necessary to supply each man on active duty. A quantitative statement on this point must stem from somewhat arbitrary definitions but various estimates are roughly in agreement on a present ratio of about eighteen. The ratio of engineers to production workers depends on the industry and the production volume. Considering the engineering department as a whole, including sub-professional workers, the ratio in aircraft plants is around fifteen but is decreasing as production grows. In shipbuilding and in industry generally, the proportion of engineers is much smaller. Taking these figures in connection with the immediate production goal of 50,000 airplanes and 130,000 airplane engines, 40,000 guns, 300,000 machine guns, 380 naval vessels, 200 cargo ships, and 200 cantonments, to mention only the major items requiring a labor force running to millions, the reason for concern over the supply of engineers becomes apparent.

DEMAND FOR ENGINEERS

Because engineering design precedes production, the maximum demand for engineers should be felt early in the defense program and it is expected that the peak will be reached this year. An indication of the number required is provided by a forecast prepared by the Ordnance Department for the period July 1941 to June 1942. The figures are as follows:

Inspectors of ammunition, explosives, and material	7700
Tool and gage designers	105
Chemists and chemical engineers	840
Mechanical engineers and draftsmen	350
Metallurgists	35
Total	9030

The Ordnance Department represents only one segment of the governmental requirements for technical men in civilian capacities. A survey of the aircraft industry around New York City indicated a need for 5,000 engineers. Another estimate gives a total of 40,000 additional engineers needed for the country as a whole, after allowing for all possible shifts from non-defense to defense industries. The 1941 graduating class of recognized engineering schools will not exceed 14,000, of which about 4,000 will be taken by the Army and Navy. The experience of the engineering colleges this year in placing their graduates substantiates the conclusion that the present demand for engineers is two or three times the supply and may shortly prove to be much greater.

MORROUGH P. O'BRIEN

". . . the greatest contribution which the engineering colleges can make will result from maintaining unimpaired their capacity to develop competent professional engineers."

The situation which has developed points clearly to the conclusion that, so long as engineers are needed and students are available, the greatest service the engineering colleges can perform is to continue their normal function. No other activity, however much its publicity value may appeal to administrative authorities, should be allowed to impair their capacity to educate men for professional engineering. Not only should they continue to perform their normal function but strenuous efforts should be made to improve instruction by placing greater emphasis on physical science and the analytical and experimental procedures required for its application while limiting specialized curricula and descriptive courses. Experience is better gained in practice than in the lecture room while the practicing engineer seldom has the time to master a subject involving analytical procedures. The transition from one field of specialization to another, necessary in the defense program, is not difficult for engineers well grounded in fundamentals and the return to normal engineering pursuits after the emergency will be equally facilitated.

PRODUCTION KNOWLEDGE NEEDED

Among the fundamentals which the defense program has shown to be inadequately treated in engineering education is a knowledge of the manufacturing and assembly procedures by which engineering designs are converted into finished products. Being common to all branches of engineering and susceptible to analytical treatment, this subject should be raised from the semi-vocational level in which it now appears frequently in engineering curricula. Many of the bottlenecks in the defense program can be traced directly to failure on the part of the designer to visualize the production process.

A common fallacy in the mind of the layman is the belief that the productive capacity of any given plant is the same regardless of the product. Differences in the permissible leeway, or tolerance, the arrangement and the relative numbers of different kinds of machines, the experience of the workers, and other factors may make difficult a transition to a new product. Careful study of existing facilties has resulted in many conversions from peacetime manufactures to their military counterparts but a large percentage of the armament is being produced in new and specialized plants. For example: it was proposed early in the defense program that abandoned automobile plants be reconditioned for the manufacture of airplanes but investigation showed that even the newest plants were unsuited to the purpose because the accuracy, number, and arrangement of equipment for automobile production do not correspond with the requirements of aircraft. In addition to the design function itself, much engineering work must be performed in preparing for and carrying out the production program but the engineering colleges have not sufficiently stressed this important function, with the result that a large majority of production executives are not college graduates.

EMERGENCY MEASURES ADOPTED

In order to meet the deficiency in engineers, the engineering colleges have adopted a number of emergency measures which will supplement the normal supply of new graduates.

The first need in many neglected or under-developed fields, such as naval architecture and explosives, was for experienced men to assume control of major divisions of design and production. The scarcity became acute immediately because there had been little opportunity during the previous twenty years for engineers to follow these specialties. It is indicative of the need that the civil service age limit for naval architects was raised to seventy more than a year ago. Although it was obviously impossible to *develop* experienced men, the engineering colleges through their formal or informal employment machinery were able to assist in locating the few men available. A similar activity aimed at assisting engineers to find positions better suited to their education and ability. During the years of the depression, many engineering graduates were unable to find suitable employment and a number of institutions circularized their alumni to find men who wished to transfer, either to a different industry or to more responsible positions in other companies. This adjustment of employment served to meet a part of the early need but it no longer represents a substantial supply and probably should not be encouraged at this stage of the program except where the transfer is from non-defense to defense industries.

One suggestion made when the scarcity of engineers first became apparent was that graduation of engineers be speeded up by omission of vacation periods and *non-essential* courses. The attitude of the Army, Navy, Office of Production Management and the Office of Education was not favorable for the reason that the emergency was likely to continue for some time and the regular curricula should not be altered. Practical difficulties of scheduling in large institutions would be serious but not insurmountable. The most serious objection to this plan is that a majority of engineering students must work during the summer if they are to continue their education. Much of this summer work is now in defense industries; these students make a direct contribution to defense and the experience gained compensates for the delay in graduation. Another consideration is that this speed-up program results in only one additional class, after which the number of graduates per year is unaffected.

THE E.D.T. PROGRAM

The most spectacular, and probably the most effective, work of the engineering colleges to date has been the Engineering Defense Training (E.D.T.) program authorized by Congress and directed by the U. S. Office of Education. Parallel to the governmental program at vocational level, the law provides for either pre-employment or in-service training at college level without cost to the student. Recognized engineering schools offer these courses to meet local defense needs and are reimbursed for expenses incurred. Within limitations imposed by the Congressional Act and the regulations of the Office of Education, the colleges administer the program. A recent tabulation showed that 137 engineering schools were offering 1500 courses to 95,000 students, a majority of whom were already employed. Subjects covered range through the whole field of engineering but courses in mechanical or industrial engineering predominate. The subject matter of these courses is generally characteristic of local industry or the lack of it. In the industrial areas, persons competent to take these engineering courses are generally employed and are unable or unwilling for financial reasons to enroll in full-time courses. The in-service program meets the need here for up-grading to permit greater engineering responsibilities. In regions remote from the defense industries, full-time programs appear to be feasible as preparations for migration to the defense production centers.

In California, E.D.T. courses are being offered by the California Institute of Technology, Universities of Santa Clara, Stanford University, University of Southern California, and the University of California. Between four and five thousand students are enrolled. The great majority of these students are employed in the aircraft plants and shipyards. With the exception of the University of California program, these courses are offered "on campus" with a large percentage of the instructors drawn from the faculty. In addition to classes on the Berkeley and Los Angeles campuses, the University of California offers courses at Mare Island Navy Yard, San Francisco, Burbank, Inglewood, Downey, Huntington Park, and San Diego.

The University of California program at San Diego is a typical example of the work done under the Engineering Defense Training program. Thirty-two sections of sixteen courses in such subjects as lofting, drafting, aerodynamics, aircraft inspection, analytical mechanics, strength of materials, airplane structures, metallurgy and aircraft power plant installation attracted a total enrollment of 1250 students of whom 850 were in attendance at the last count. The engineering population of San Diego probably does not exceed 2500. The prevailing working week for engineers is 50 hours and many of the students, particularly the newer employees who need this instruction most, are assigned to the engineering night shift, an arrangement made necessary by lack of space.

The usual course in the University of California program consists of one two-hour meeting per week plus approximately

(Continued on page 16)

ORIGINAL RESEARCH IN CONNECTION WITH THE COLORADO RIVER AQUEDUCT

By JULIAN F. HINDS, *Assistant Chief Engineer,*
Metropolitan Water District of Southern California.

In planning and executing a project such as the Colorado River Aqueduct, great care must be taken to muster all available facts and theories to the end that construction may be carried out in an expeditious and economical manner. All sources of accumulated information must be carefully explored. Books must be studied, plans and specifications for similar undertakings assembled and examined; statistics on rainfall, river discharge, earthquake, and other natural phenomena must be collected, compared, and analyzed; vital statistics must be analyzed, populations and commercial demands predicted, building materials must be sought and judged; manufacturers, merchants, builders, and workers must be consulted; and so on, through an endless list. This constitutes the first and usually the primary research activity of such a project, covering that part of the definition of the term which is designated as a "careful searching out."

Because man's collection of engineering data is incomplete, this search for known facts never yields information entirely adequate for the work to be done. There are inevitable gaps which must be bridged by "assumptions," or improved by a program of experimentation planned to reveal facts previously unknown or imperfectly understood. Such experimentation constitutes that phase of research designated as "experimentation and study directed toward the discovery of new facts or theories."

There is no distinct line of demarcation between these two types of research. The transition from pure book research, at one extreme, to pure experimental research at the other, is gradual. Also, there is much laboratory work that is for the purpose of testing for conformity with known laws and which, accordingly, is not original research. Here, again, the divsion between routine and research is not clearly drawn.

Original experimentation usually requires money, time, and ingenuity. Frequently, one or all three of these are lacking and the engineer must resort to approximations, using his best judgement and precedent as guides. There is always a tendency, under pressure for immediate action, to follow some established "rule of thumb," to save the time required to ascertain the facts, particularly in small matters where a large "factor of ignorance" can be provided at small cost. And it must be admitted that many engineers are bewildered by the thought of research.

As a project increases in magnitude, the need for original research and the opportunity for carrying it out increase. However, the practicing engineer is always under the handicap of having to show that money and effort invested in research will yield dividends on the work in hand, and usually experimentation can be carried only to the point required for this purpose. Increasing the store of human knowledge seldom can be advanced as an argument for increased appropriations.

Because of its magnitude and the special conditions involved, the Colorado River Aqueduct offered considerable opportunity for research, and a great deal of original work was done. Although directed primarily toward the "practical" purpose of solving immediate problems, important contributions to the store of engineering knowledge were made.

It would be impossible to list or describe all these accomplishments. Experimentation with a new type of mucking machine, a canal paver, or an "air washer" for sand, is just as truly research as is the study of more specifically scientific subjects. A large amount of such experimentation was carried on, and notable advances in the art of building were made. Passing by these very important achievements and ignoring an important mass of indivdually small investigations, a brief discussion will be presented of each of the following four principal research projects:

1. Cement composition and concrete manufacture.
2. Curing of concrete under desert conditions.
3. Investigation of pump charactersitics.
4. Study of water softening processes.

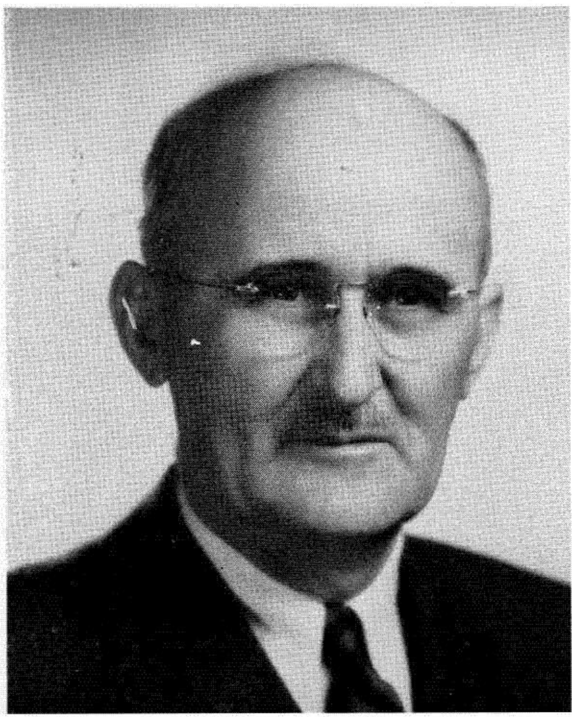
CEMENT COMPOSITION AND CONCRETE MANUFACTURE

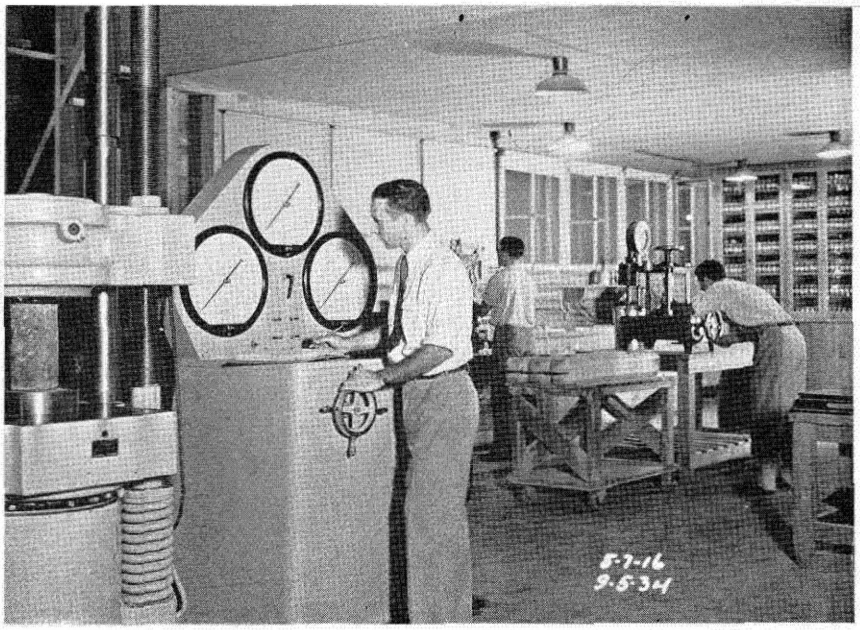
The aqueduct system, as planned, was to contain some five million cubic yards of concrete, requiring for its manufacture seven or eight million barrels of portland cement. This concrete was not to be concentrated in a single mass as in Boulder or Grand Coulee Dams, but was to be spread out in a long thin line across the desert. It needed to be enduring and water-tight to an unusual degree in spite of unfavorable manufacturing and curing conditions.

Concrete aggregates of usual types, i.e., well-worn river gravels, were available at the two ends of the line. At intermediate points, only the partially rounded products of local disintegration were available. It was important that these local materials be tested and used if possible.

Water for curing concrete was scarce. Temperature changes were excessive. It was essential that curing methods, and the cement itself, be adapted to desert conditions.

JULIAN F. HINDS





A view of some of the equipment included in the cement testing laboratory maintained by the Metropolitan Water District in Banning during the aqueduct construction period.

Accordingly, an extensive research program was inaugurated. A laboratory, unusually complete for a construction project, was set up at Banning, California. Cements from local mills were studied, also the materials available at these mills for the manufacture of cement. It was decided to investigate the possibility of utilizing a specially designed cement.

There is always grave danger in using an entirely new product on a project of great magnitude. Some unsuspected latent defect may cause disaster. Recognizing this, it was decided to work strictly within the limits of precedent. Standard specifications of the day for cement permitted great latitude in all variables. They were purposely designed to secure a generally passable product with materials from any section of the country, processed in a wide variety of plants. Although carrying the sanction of governmental and scientific organizations, specifications were largely influenced by manufacturing expediency. It was evident that by restricting tolerances designed to aid far-flung small manufacturers, a distinct improvement could be made with little if any increase in cost.

A series of special cement clinkers were made, covering permissible ranges in composition. These clinkers were ground to several specifications for fineness. Briquets, cylinders, bars, and slabs were made from the resulting cements, and tested for soundness, strength, hardness, density, resistance to alkali, expansion, contraction, resistance to freezing and thawing, curing qualities etc. All of the usual standard tests were made, and many more. Full-sized slabs were cast and cured in the desert, under actual field conditions.

Hundreds of 12-inch by 36-inch by 6-inch slabs were used in special weathering tests. Groups of 50 of these slabs were set up to constitute the walls of an accelerated weathering chamber, and the inside faces (the tops of the slabs as cast) were subjected to upwards of 100 cycles of the following treatment each 24 to 36 hours: Wet heat to 179° F., wet cold to 28° F.; dry heat to 175° F., and dry cold to 26° F. One group of 50 was water-cured in the laboratory at approximately 70° F. for 60 days, and dried for 30 days, before the accelerated weathering. Another group was composed of slabs cast outdoors near the laboratory, 20 in the form of walls (formed slabs cast on end) and 30 on subgrade; all exposed for seven months before the accelerated weathering. A third group was made up mostly from slabs which had been exposed one year in desert locations and included a few one-year laboratory control slabs.

These slab tests were made in addition to many hundreds of more conventional tests, and to other special tests for resistance to alkali action and weatherings.

The ultimate result was special "modified portland cement", promising superior performance under the anticipated conditions. The excellence of the resulting concrete structures amply justifies the test program.

Some of the primary conclusions reached are as follows:

1. Notably beneficial results were produced by limiting some of the theoretical compounds, notably C_3S and C_3A.

2. Pozzuolanic admixtures clearly were not indicated for exposed work in thin sections, as such admixtures accelerated drying, increased shrinkage, and reduced flexural strength. (This conclusion has no relation to the use of pozzuolan cements in more massive structures, and for more favorable curing conditions.)

3. Within the limits of commercial feasibility, fine grinding improved strength, resistance to abrasion, impermeability, workability in placing, and did not materially affect shrinkage.

4. The amount of mixing water per cubic yard of concrete (not per sack of cement) was the principal factor in volume change, particularly shrinkage in drying.

5. Resistance of concrete to disintegration by sodium sulphate in ground waters is most successfully obtained by use of cements with a special chemical composition. A special cement for this purpose was designed and used.

CURING OF CONCRETE UNDER DESERT CONDITIONS

Adequate water curing of concrete was difficult to attain because of extreme aridity and scarcity of water supply. Attention was turned to surface sealing materials, commonly known as curing compounds. There were many of these on the market. As little was known of the actual effectiveness of these materials under desert conditions, a system of testing was devised. Standard 6-inch by 12-inch concrete test cylinders were coated with the various preparations and exposed under actual field conditions. These specimens were carefully weighed from time to time, to determine water loss. They finally were broken for strength comparison with standard moist-cured cylinders. Also, curing tests were carried out on slabs poured and cured under field conditions.

Proprietary compounds, usually composed of asphalt, were found to be ineffectual in a single coat. Two coats gave better results but still did not fully meet the requirements. It was decided to test coal tar, which up to that time was not being offered for that purpose. The results were gratifying. Two coats of coal tar cut-back, the first applied to a freshly finished or freshly drenched concrete surface, gave strength superior to those obtained from standard laboratory water curing.

It is not to be inferred that products other than coal tar should never be used. In fact, the District has made frequent use of commercial products, particularly some of the "clear" coatings, in moderately exposed locations. However, coal tar is much more effective under extreme conditions than any other materials tried.

Coal tar, or any other black coating, has the objection of excessive absorption of solar heat, thus increasing the curing heat of the concrete and subsequent shrinkage. This led to a search for a cheap, light colored material. None was found which approached the curing effectiveness of coal tar. The idea of whitewashing the coal tar was tried. At first the tar ran through the whitewash, but after some experimentation, a formula was found which produced a two-coat job of surprising whiteness and permanence. Some of these coatings exposed to the weather for two or three years are still white.

It was found by test that maximum curing temperatures were 20 to 30 degrees less under whitewashed surfaces than under black surfaces.

The use of whitewash to control temperatures in all kinds of black pipes, during curing and shipping, has spread rapidly and is now in more or less general use throughout the country.

INVESTIGATION OF PUMP CHARACTERISTICS

The location finally selected for the Colorado River Aqueduct required a total lift of 1617 feet for a maximum flow of 1600 cubic feet per second. This lift was divided among five pumping plants with lifts ranging from 146 to 444 feet. General consideration of the practical size of pumps and motors that could be manufactured without departing too radically from established practice, and whose electrical characteristics would fit in best with the District's transmission system, resulted in the selection of 200 cubic feet per second as the nominal capacity of each pumping unit. The initial installation was three such units in each of the five pumping plants, with provision for additional units as the demand increases, up to the ultimate capacity of 1600 cubic feet per second.

No pump manufacturers in the United States had built pumps of the capacity and head required for the aqueduct plants, and there was consequently a great diversity in their recommendations as to the speed, type, head per stage, and inlet pressures. In view of the large power consumption involved and the saving in equipment and building costs possible with the use of higher speed, single stage pumps, it was decided to make a thorough experimental investigation into the efficiencies obtainable with different types of pumps. To this end the District made arrangements to construct a pump testing laboratory at the California Institute of Technology. The principal problems investigated in the laboratory were:

1. Whether the pumps should be the single suction or double suction type. This question materially affected the design and cost of the pumping stations.

2. The maximum practical head per stage for the higher head pumps. The Eagle Mountain and Hayfield stations required lifts in excess of 440 feet, and pump manufacturers were unanimous in recommending two stage pumps for this lift, which would have consisted of two separate pumping units in series. This problem affected materially the cost of the pumps and motors, as well as the size of the pump buildings, the control apparatus, and the arrangement of the water passages to and from the pumps.

3. The proper selection of rotative speed for the lifts at the various stations. The higher the speed the less cost of both pump and motor, but the greater the danger from cavitation and other possible operating difficulties. The question of speed is also closely tied to the proper location of the pump with reference to the inlet water level. The higher speeds require a deeper submergence below the inlet water level.

4. Investigation of the pump control valves and the behavior of the combination of pump and valves in the event of power failure or other emergency shut-downs.

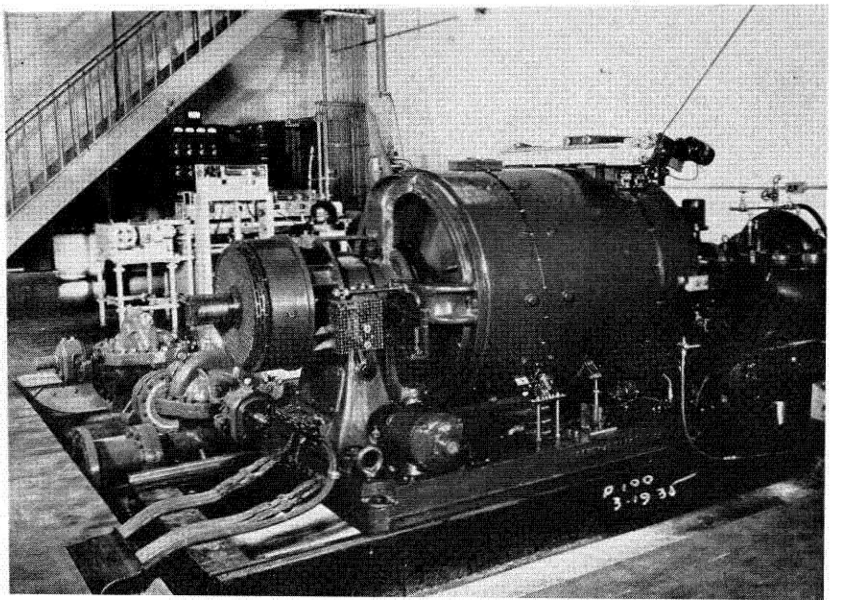
Prior to issuing specifications for aqueduct pumps, models of both single and double suction pumps specially constructed for the laboratory were purchased and completely tested. These pumps covered the entire range of heads and speeds recommended by the manufacturers and necessary for the pumping heads at the various plants. In addition to tests of the actual pumping perfomance, investigations were made with special apparatus of the distribution of pressures inside the pump cases. The results of this first series of tests showed that single suction single stage pumps would give satisfactory efficiencies at the higher heads required at Eagle Mountain and Hayfield, and that rotative speeds considerably higher than those originally recommended by the manufacturers were perfectly safe to use with a reasonable amount of submergence below inlet water level.

The investigation of internal pressures showed that with pumps of this size under certain operating conditions, there are very large unbalanced forces on the pump shafts so that in the final specifications much larger shafts were called for than contemplated in preliminary designs.

Each bidder submitted with his proposal a model pump which was tested at the laboratory to determine whether the guaranteed characteristics could be met. The successful bidders were required to construct somewhat larger models which were also completely tested in the laboratory, and the results made available to the manufacturers for their guidance in improving the performance and efficiency in the final design.

Other work done in the laboratory on both the preliminary and final pump models, was the investigation of pump performance under abnormal conditions of reverse flow which might be encountered during power outages. Direct and reverse flows through various types of shut-off valves were also investigated

Dynamometer and test pump used in experiments conducted at the California Institute of Technology in determining the type of pumps to be installed in the five pumping plants on the Colorado River Aqueduct.



and used in the selection of pump control valves, and the timing of valve operation.

As a measure of the value of this investigation by the District, a comparison has been made of the difference in costs for Eagle Mountain and Hayfield stations; first, using pumps of the heads and stages originally recommended by the leading pump manufacturers and which without laboratory research would undoubtedly have been used as a basis for the purchase of the pumping apparatus; and second, the cost of these stations using the single stage, higher speed pumps which the laboratory research demonstrated to be safe and satisfactory for these two plants.

Including the differences in building costs, pump and motor costs, cost of control valves and control switchboards, the saving due to the single stage, higher speed pumps for the initial installation of three pumps in each plant amounts to more than $900,000.

The total cost to the District of the construction of the pump testing laboratory and its operation for all of the tests required by the District, including consultants' fees, was $144,000.

Thus in the saving made possible on the initial installation alone, the research program was amply justified. As to the actual results in improved efficiencies, there is no such definite yardstick of measurement. Prior to the first pump tests, the maximum efficiencies that the manufacturers in general were willing to guarantee was 88 per cent. During the progress of the investigations, certain of the test pumps under favorable conditions showed efficiencies as high as 92½ per cent. The actual field acceptance tests of the completed pumps showed an average at all plants at 90½ per cent. This is a considerable increase over the 88 per cent originally estimated, and undoubtedly is due in large part to the research investigations.

STUDY OF WATER SOFTENING PROCESS

Colorado River water in its natural state is heavily laden with silt but is otherwise free from pollution. The silt is completely removed by sedimentation in the Boulder Canyon and Parker storage basins. The resulting water is clear but is charged to an undesirable extent with those dissolved solids which cause the quality known as hardness. This hard water is entirely satisfactory for drinking but is less desirable than soft water in the bathroom, laundry, and for industrial uses. Consequently, it is planned to remove a portion of the hardness.

Because of the large amount of water to be handled and the relative expense of the operation, it was considered desirable to thoroughly investigate available softening processes and their applicability to Colorado River water before attempting to design a plant.

Advantage was taken of the very complete small plant which was being operated by the U. S. Bureau of Reclamation at Boulder City, Nevada. The Bureau made all the facilities of this plant available for whatever type of test the District wished to carry out. Because the normal supply of the city could not be interfered with, auxiliary tanks and special equipment were required for many of the tests. The investigations covered the following primary points:

1. The feasibility of the reclamation of lime from the sludge produced during the water softening process;

2. The efficiency of various "sludge blanket" types of mixing and settling basins;

3. A comparison of the commercial zeolites available, and the conditions affecting their efficiency of operation; and

4. The use of barium compounds as softening agents instead of the usual chemicals.

LIME RECLAMATION

One of the principal chemicals used in the softening process is lime. Preliminary quotations indicated delivered costs of $9.00 to $10.00 per ton. The lime added as calcium hydroxide does not remain in the water but combines with calcium bicarbonate already present (one of the elements of hardness) and precipitates as calcium carbonate. Thus, for every pound of lime added to the water, approximately two pounds come out. This precipitate usually is wasted as a sludge. Attempts to reclaim the lime by calcining the sludge generally have been unsuccessful because of the incidental precipitation of other substances, particularly magnesium, which dilute the lime.

By careful study, a system of operation was devised by which a practically pure calcium carbonate could be precipitated. The composition of Colorado River water is favorable for this operation. Also, it was found practical to burn this sludge, producing lime at a fraction of commercial cost.

SLUDGE SETTLING BASINS

A large part of the expense of a water softening plant goes into the construction of settling basins, in which the precipitated solids are permitted to settle out. Notable success has been had in recent years with so-called "precipitators", in which the dosed and flocculated water is caused to bubble up through a blanket of previously deposited sludge. This process seems to speed up the chemical action and remove much of the precipitate by filter action, thus appreciably reducing the space required both for mixing and for sedimentation.

Although apparently efficient for many conditions, this type of clarifier was not found suitable for the District's plant.

COMPARISON OF ZEOLITES

Colorado River water is to be softened by the lime-zeolite process. The zeolite will be of the synthetic or manufactured type, with the exception of two companies, the manufacture of synthetic gel-type zeolite in this country has been developed only recently. As a result, very little reliable information was available on the performance of the various makes of zeolite produced. More or less extravagant claims were made by the various companies as to the excellence of their products. Careful investigation showed little difference in the operating characteristics of several of the leading brands. On the basis of these investigations, the strong arguments put forth by the old-line companies about the poor quality or lack of background of the newcomers could be given proper weight in evaluating bids. As a result, the District purchased 27,000 cubic feet of zeolite at less than $4.00 per cubic foot, instead of about $12.00 which was the price previously quoted for such material.

STUDY OF BARIUM COMPOUNDS

Water is usually softened either by the lime-zeolite process or by the excess lime-soda ash process. In these processes, the lime that combines with the calcium bicarbonate in the water

(Continued on page 17)

ENGINEERING DEFENSE TRAINING AT THE INSTITUTE

During the summer of 1940 it became apparent that the accelerated program of national defense would soon encounter a shortage of trained engineers for defense industries. To meet this situation Congress, on October 9, 1940, appropriated $9,000,000 to the United States Office of Education for defense training on the engineering college level.

In order to coordinate this training with the needs of industry a regional organization was set up. In each region an adviser was appointed. His function was to keep in touch with defense industries in this area to determine their needs for engineering specialists, and to cooperate with the engineering schools of his region in utilizing their special facilities for intensive training.

The California Institute has cooperated in two ways with this Engineering Defense Training Program sponsored by the United States Office of Education. In the first place, R. L. Daugherty, Professor of Mechanical and Hydraulic Engineering, accepted appointment as Regional Adviser for Region 20, which includes Arizona, New Mexico, Southern California, and Texas (west of the Pecos River). Besides carrying out the duties outlined above, Professor Daugherty has been going east at regular intervals for coordinating conferences with the other regional advisers.

In the second place, early in 1941 the California Institute began offering a series of special Engineering Defense Training courses under the general supervision of a faculty committee headed by Professor Franklin Thomas. For all such courses members of the Institute staff serve as supervisors, with the instruction given by other staff members and/or experts drawn from Southern California industries.

During the winter and spring terms ten such courses got under way. They were all "in service" courses. That is, classes were held evenings, the students being employed at regular full-time day work in business or industry in the Los Angeles metropolitan area. The total enrollment for these courses, which are listed below, was 459.

1. Production Engineering. *Supervisor*: R. D. Gray, Associate Professor of Economics and Industrial Relations.
2. Production Supervision. *Supervisor*: R. D. Gray.
3. Radio and Electronics. *Supervisor*: R. W. Sorensen, Professor of Electrical Engineering.
4. Theory and Science of Electric Welding. *Supervisor*: R. W. Sorensen.
5. Machine Design. *Supervisor*: W. Howard Clapp, Professor of Mechanism and Machine Design.
6. Tool Engineering. *Supervisor*: W. Howard Clapp.
7. Explosives — Advanced Course "A". *Supervisors*: Linus Pauling, Professor of Chemistry and Director of the Gates and Crellin Laboratories; and W. N. Lacey, Professor of Chemical Engineering.
8. Naval Architecture. *Supervisor*: R. R. Martel, Professor of Structural Engineering.
9. Physical Metallurgy for Engineers. *Supervisor*: Donald S. Clark, Assistant Professor of Mechanical Engineering.
10. Marine Engineering (including Navigation). *Supervisors*: R. L. Daugherty, Professor of Mechanical and Hydraulic Engineering; and H. N. Tyson, Assistant Professor of Mechanical Engineering and Engineering Drafting.

For the summer of 1941, five full-time day Engineering Defense Training courses have been scheduled. Instruction is just beginning as this is being written, with a total enrollment of 312, including about 150 reserve ensigns assigned by the government to the course in Aeronautics, which will prepare them to serve as ground officers.

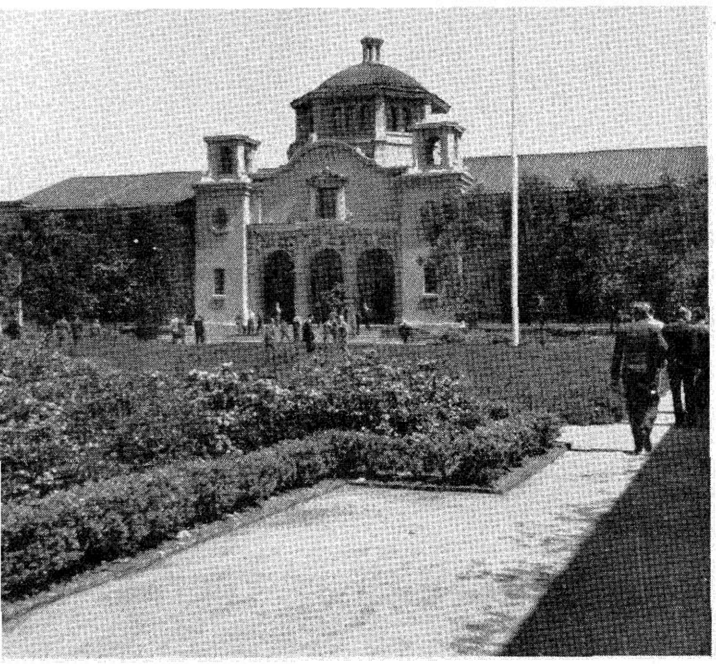
11. Aeronautical Engineering. *Supervisor*: Clark B. Millikan, Professor of Aeronautics. (Also repeated as a part-time night course.)
12. Basic Electric Circuits and Machinery. *Supervisors*: R. W. Sorensen; and F. W. Maxstadt, Assistant Professor of Electrical Engineering.
13. Production Engineering. *Supervisor*: R. D. Gray.
14. Explosives — Advanced Course "A". *Supervisor*: W. N. Lacey.
15. Military Meteorology (for United States Army officers exclusively). *Supervisor*: Th. von Kármán, Professor of Aeronautics and Director of the Guggenheim Aeronautical Laboratory.

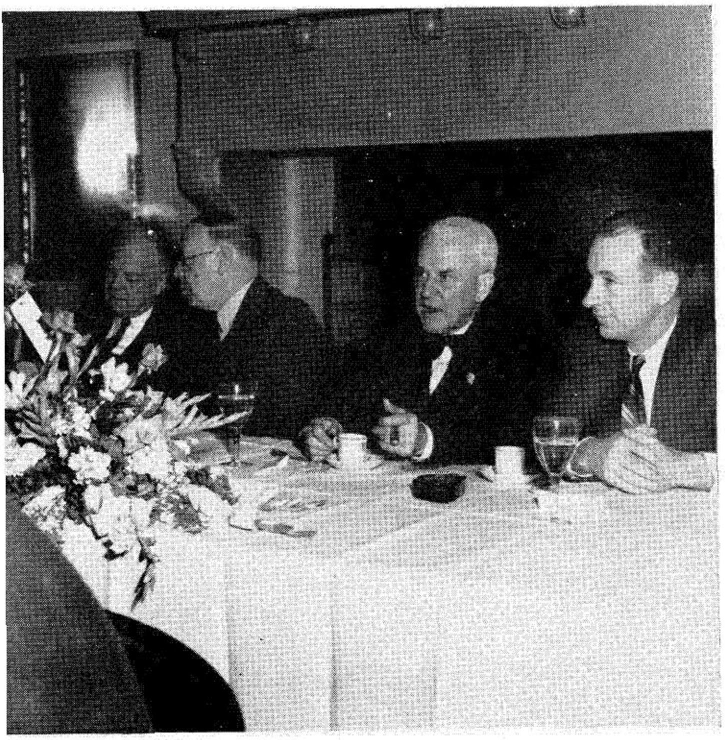
The present appropriation, made for the fiscal year 1940-1941, will provide for all Engineering Defense Training courses until September 30, 1941. While no appropriation has yet been authorized for courses to be given after that date, the matters is now pending, and there is every reason to believe that the program will be maintained, particularly since the defense industries continue to need specially trained engineers. For its part, the Institute is ready to carry on such courses as long and as comprehensively as the national defense requires.

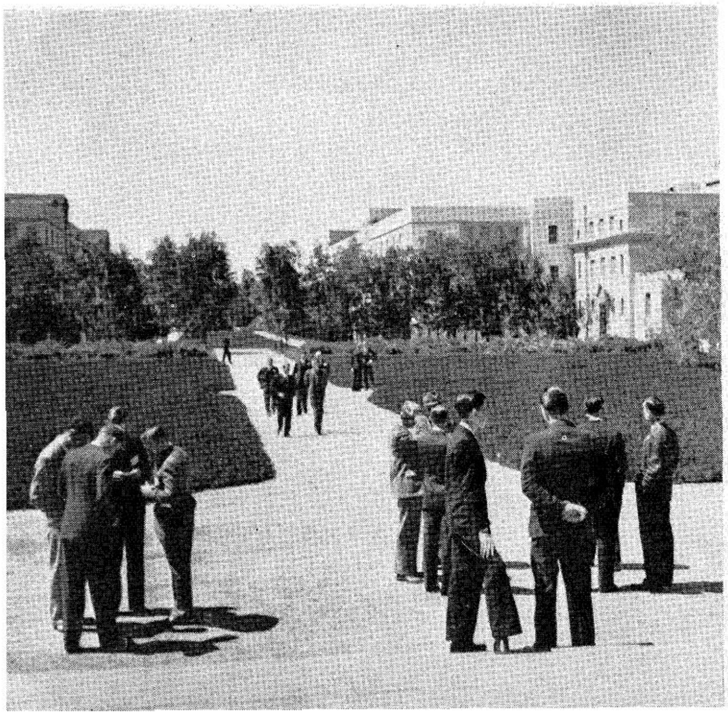
THREE NEW SCHOLARSHIPS

Seventy-five thousand dollars have been given to the Institute for the establishment of three annual Francis J. Cole scholarships, it was announced recently. The fund is a bequest made in the will of the late Mrs. Francis J. Cole, for many years a resident of Pasadena.

Terms of the bequest, as communicated by the Union National Bank of Pasadena as executor of Mrs. Cole's will, requires that the income from the fund be divided equally among the three scholarships, one of which is to be in physics, one in electrical engineering and one in mechanical engineering.







FOURTH ANNUAL WEEKEND

Continuing the precedent set by the three previous years, the Fourth Annual Alumni Seminar held April 5-6 on the Institute campus established another new record for attendance, with well over five hundred graduates and a large number of guests registering for the two-day affair. Making good Dr. Irving P. Krick's promise of clear skies for the Seminar, the weather man came through with bright sunshine after two of the rainiest weeks in Southern California history, greatly relieving the mind of H. Fred Peterson '27, Chairman of the Seminar Board, who had scheduled an outdoor luncheon for the large number of men who could not be accommodated in the student house dining rooms.

In general outline the Seminar program resembled that of last year, except that its scope was somewhat extended to accommodate the larger attendance. The general assembly which started the schedule Saturday morning was followed by two groups of general-interest lectures. Then, after several hundred portions of student house food had been safely stowed away, and another group of general lectures concluded, the session of departmental seminars begun. Winding up, as customary, in a flood of questions and impromptu debates, these seminars were concluded late in the afternoon, allowing men to repair to the Annandale Golf Club for some pre-dinner relaxation.

Dinner at the Annandale was featured by musical entertainment furnished by Jose Arias and his Mexican troubadors. Then after an informal talk by Dr. Millikan, Professor Judy introduced Alfred Noyes, former Poet Laureate of England, honored guest of the evening. Mr. Noyes read several of his poems as a climax to the evening's activities.

Sunday morning chapel services were held under the supervision of John Price, Institute Y.M.C.A. secretary, as the Seminar program started its second day. The services were followed by two concluding groups of general lectures, ending Sunday noon.

RECORDINGS MADE

As at last year's Seminar, recordings were made of several of the principal addresses, for transmission to the Alumni chapters throughout the country and for the permanent archives of the Association. In addition, with the cooperation of Wes Hertenstein '25, motion pictures in color were taken of the campus, participating Alumni, and some of the more interesting demonstrations. These too were dispatched to distant Alumni groups and have been very favorably received.

The Seminar Board was composed of H. Fred Peterson '27, Chairman; Wes Hertenstein '25, Assistant Chairman; Fred Hough '24, Program Chairman; and Donald MacFarlane '26, Assistant Program Chairman.

Comprising the Program Committee were J. C. Scullin '29, in charge of introductory speakers; L. G. Fenner '30, in charge of apparatus and properties; Kenneth Belknap '27, handling luncheon and dinner arrangements; and Frank Bell '28, Leonard Snyder '27, Richard Stenzel '21, Charles Thomas '35, and Frank Wiegand '27, handling the various departmental seminar programs.

ALUMNI SEMINAR HIGHLIGHTS

Carrol Wakeman '24, was Chairman of the Registration Committee; other members of this group were Ernest Maag, Jr., '26, Randal Maass '32, Harry Mason '30, Russell Raitt '29, and Wilber Thomas '18.

George Rice, III, '31 handled the printing arrangements, and Paul Schaffner '37 was in charge of publicity and press releases. Press coverage, incidentally, included all Los Angeles, Pasadena, and many community newspapers.

PROGRAM SUMMARY

Following is a brief summary of the program.

General Assembly, "The Institute's National Defense Program," by Professor Franklin Thomas and Earnest C. Watson — a discussion of the type of work the Institute is doing for national defense, the magnitude of the program, and the problems facing the Institute, its students, research workers, and faculty as a result of the national emergency.

Address, "The Importance of Human Relationships in the Defense Program," by Arthur H. Young, Industrial Relations Department — a discussion of practical personnel problems facing industry today and the ways in which they might best be met.

Address, "Ultra Short Wave Techniques in Airplane Navigation," by Dr. William H. Pickering '32 — an analysis of the adaptation of ultra short wave techniques to airplane flight problems, especially those encountered in landings.

Address, Europe Under Nazi Control," by Professor J. E. Wallace Sterling — a discussion of the stages whereby Europe was brought under Nazi control, the techniques of this control, and the problems of survival encountered.

Address, "An Analysis of the Failure of the Tacoma Narrows Bridge," by Professor Theodore von Kármán — discussion of the preliminary findings of a laboratory investigation of the failure of this highly-publicized bridge, including motion pictures of the actual bridge failure and the action of a rubber laboratory counterpart.

Address, "The Art Treasures of the Huntington Library," by Professor John R. Macarthur — an illustrated lecture on some of the outstanding paintings and statuary owned and displayed at the nearby Huntington Library.

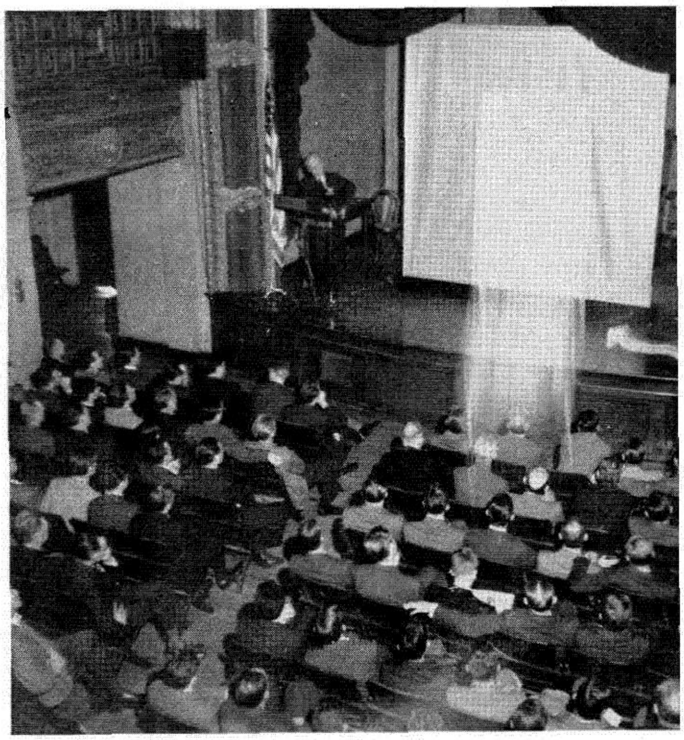
Address, "Heredity and Man," by Professor Alfred H. Sturtevant — a description of the techniques used in the study of the heredity of man, including demonstrations of some of the little-known inherited characteristics used in this study.

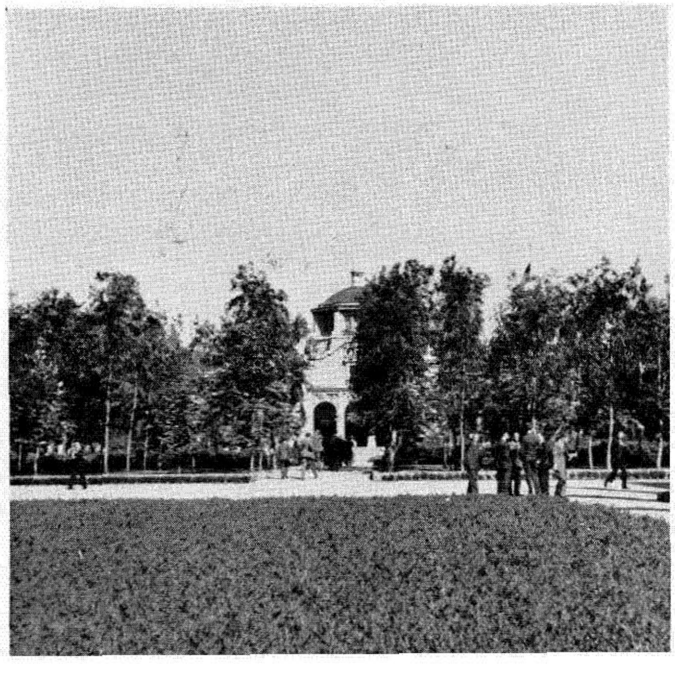
DEPARTMENTAL SEMINARS

Aeronautics — discussion led by Charles F. Thomas '35; talks on research at the Institute by Professor E. E. Sechler '28, and on manufacturing activities by Holley B. Dickinson '36.

Chemistry — discussion on recent developments in chromatography by Professor L. Zechmeister, followed by a talk on military explosives by Dr. E. H. Eyster, Ph.D. '38.

Civil Engineering — meeting presided over by Professor Franklin Thomas; talks on "Foundation Investigations for the





The Relationship of the Engineering Colleges to the Defense Program

(Continued from page 8)

four hours of outside work. Students and instructors have been discouraged from attempting more than one course because of their arduous schedule of full-time employment. With few exceptions, the instructors have been drawn from industry. Frequently, the instructor is the senior engineer in the subject treated and the class is made up largely of his own subordinates. As teachers, these men are surprisingly competent, making up for their lack of experience by enthusiasm and knowledge of the subject. Recruiting almost one hundred instructors for predominantly lecture courses in a period of six weeks might easily result in embarrassing situations but, with the aid and support of the companies concerned and many hours of conversation with the prospective appointees, selections were made which resulted in a quality of instruction very nearly equal, on the average, to that in the regular engineering courses of the University.

In setting up these Engineering Defense Training courses, the immediate defense need has been given consideration and the courses have been outlined so as to carry the students as far as possible in the time available. Most of the students are subject to calls for overtime work and it was decided that scheduled class hours should be devoted as much as possible to lectures on fundamental principles followed by outside problem assignments which the students could work out as time permitted. The student's place of employment and his associations with other engineers working in the chosen field of study were expected to provide the practical examples of the principles discussed. Few of the courses have been devoted to descriptions of equipment and procedures.

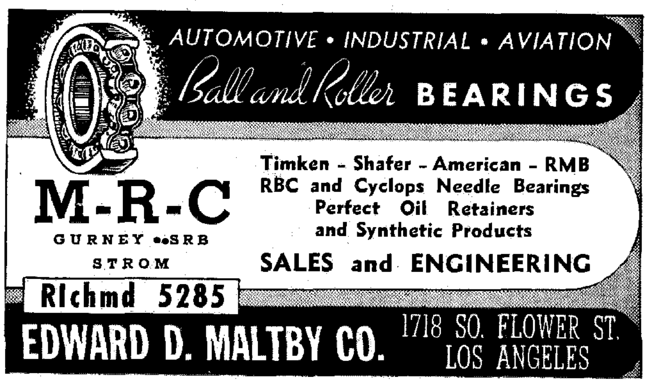
The effect of this program will not be evident immediately but there are some indications of its success. Changes of assignment and promotions are known to have resulted directly from ability demonstrated in these courses. As a result of requests from the companies concerned, student grades and instructors' recommendations are submitted to the personnel offices on written request from the individual students. Senior engineers report that their supervisory work has been simplified because of the knowledge gained by their subordinates. It has been argued that student interest in these courses is not sufficient proof that they meet a defense need. The best answer I can give to this criticism is that students who spend 50 hours per week on the engineering night shift and then devote six to eight hours more to a study show a seriousness of purpose which cannot be ignored and I am sure that the knowledge these men gain is improving their regular work.

POST-EMERGENCY UTILITY

One aspect of the Engineering Defense Training program which deserves greater emphasis is the part which these courses may play, if properly planned and executed, in the transition to other employment after the emergency. My original conception of the function of the program was to aid graduate engineers to transfer to defense industries by giving them concentrated courses covering the special limitations and procedures of their new field of employment. However, examination of students' biographies has shown that this function should be secondary and that the primary objective should be that of up-grading men who have completed one, two, or three years of college work, or who have acquired equivalent knowledge through experience. A relatively large group in the University of California program are men who, in their enthusiasm to learn aeronautical engineering quickly, have been misled into studying at technical institutes offering miscellaneous facts about engineering rather than engineering principles. The technical background of these men is sometimes appalling in the light of their responsibilities. The objective of this program is to meet the immediate and urgent needs of defense. It is my contention that this need is most effectively met by a judicious combination of knowledge immediately useful with fundamental principles of engineering to fill out an irregular and inadequate technical background and thus permit a lifetime of truly professional work.

Research and experimental investigations at the engineering colleges have expanded with the increase of industrial activity but research directly related to defense is surprisingly limited. Individual faculty members have been taken for full-time technical employment in government laboratories but the colleges, as such, have not been called upon generally to mobilize for defense the staff time and facilities available, after meeting the primary requirements of instruction. Questionnaires regarding the qualifications of the staff and available equipment have consumed enough time in the aggregate to complete several research projects. Institutions which volunteered their assistance have encountered what seemed to be the implication in many cases that their effort aimed to serve their own advantage. There is no question but what the engineering colleges would be willing to divert their staff and facilities from present research activities to urgent defense problems, even without additional financial support if they were provided with an authentic statement of desirable projects. The engineering colleges are in a position to render assistance by research, testing, inspection, and consultation but somehow they must be informed of the problems to be solved.

My remarks have dealt with the work of the engineering colleges, a small segment of the defense program. To appraise accurately the importance of their activities requires a view of the program as a whole, which is difficult to obtain under rapidly changing conditions. On the basis of experience thus far, it appears that the greatest contribution which the engineering colleges can make will result from maintaining unimpaired their capacity to develop competent professional engineers.



AQUEDUCT RESEARCH

(Continued from page 12)

effects a straight subtraction, i.e., it actually reduces the mineral content of the water. This is a desirable procedure; also, lime is cheaper than the other softening agents. However, certain hardness-forming compounds cannot be removed by lime but require the use of zeolite or soda ash. These agencies soften by base-exchange, i.e., they remove the hardness compound but leave another in its place.

Theoretically, barium acts on other hardness compounds in much the same way that lime acts on calcium bicarbonate, and effects a straight subtraction. Because of its cost, its suitability for large-scale water softening never has been developed. Large deposits of this mineral are available within reasonable distance of Los Angeles and it was thought possible that its use might be justified. However, a series of tests indicated that much development work will be required before large-scale use of barium for water softening is practical, if indeed it ever is.

All of the investigations described were carried out under the direction of F. E. Weymouth, General Manager and Chief Engineer of the Metropolitan Water District of Southern California.

L. H. Tuthill, Testing Engineer, was in charge of cement, concrete, and curing compounds studies, working with Professor Raymond E. Davis, of the University of California, as a consultant.

The pump tests were carried out by J. M. Gaylord, Chief Electrical Engineer, and R. M. Peabody, Mechanical Engineer, in collaboration with Professors Theodor von Karman and Robert L. Daugherty of the California Institute of Technology. Dr. W. F. Durand was consultant.

The water softening experiments were carried out by W. W. Aultman, '27, Engineer, with the assistance of Messrs. Charles P. Hoover and James M. Montgomery, consultants.

AIR TRANSPORT PROSPECTS

(Continued from page 5)

such occurrences are eliminated. It is encouraging that the means of achieving almost 100 per cent schedule completion are at hand. It will probably take a number of years of peace time development to realize this goal, but the post-war decade will certainly see the airlines moving at any time when ground transportation is moving, and at times when trains and busses are stalled.

The year 1940 saw passenger air traffic up 64 per cent over 1939. Nearly a million more revenue passengers were carried, one-third more miles were flown, and a third more express was carried. Likewise, 1939 had seen similar gains over 1938. This phenomenal growth took place in a period when the attention of research and development groups was diverted to military needs, and therefore gives only a hint of what may be expected from the post-war era.

The air transport industry is hardly out of the adolescent stage. It will attain maturity when it realizes economy, safety and reliability that are the equal of any other means of transportation. These assets are now coming within reach. Speed, air travel's basic inherent advantage, is an ace in an off suit. Only when the trumps have been led will its real value become apparent.

ALUMNI SEMINAR

(Continued from page 15)

Naval Base on Terminal Island" by Professor F. J. Converse, and on "Earthquake Forces in Terms of Design Factors" by Professor R. R. Martel.

Electrical Engineering — meeting presided over by Professor Royal W. Sorensen; discussions by Wendel Morgan '33 on the stability limits of a transmission line, and on "Dynamic Mechanical and Electrical Measurements by Means of a Recording Oscillograph" by George W. Downs.

Geology — discussion led by Professor Ian Campbell with reviews of current research projects; talks by Professor Horace J. Fraser on "The Effect of the National Defense Program on the Mining Industry," by Professor J. P. Buwalda on "Engineering Geology," by Clay T. Smith '38 on "The Chromite Deposits of the Western States, and by Professor Robert M. Kleinpell and Willis Popenoe, Ph.D. '36, on the progress of petroleum exploration in the Philippine Islands.

Humanities — Inspection of the art treasures of the Huntington Library as a sequel to the earlier lecture by Professor Macarthur.

Industrial Relations — meeting led by Professor Robert D. Gray; talks by representative personnel directors in California industries, including Cassius Belden of the Union Oil Company and Robert C. Storment of Lockheed Aircraft Corporation, on the subject of "Validity of Testing Techniques in Personnel Work."

Mechanical Engineering — meeting presided over by Professor Robert I. Daugherty; talks on "Vibration Damping in Metals" by Donald Hudson '38, "Methods and Results of Refrigeration of Quick-Frozen Foods" by Regis Gubser '27, and "Problems in Mounting of the 200-Inch Telescope" by Mark Serrurier '26.

Physics — seminar led by Professor Earnest C. Watson; lectures by Dr. Maurice F. Hasler '29, Ph.D. '33, on "Spectographic Analysis of Materials," and by Professor William V. Houston on "The Electron Microscope."

SUNDAY PROGRAM

Address, "Propoganda Three Centuries Ago and Today," by Kermit Roosevelt, Jr., dealing with the techniques and comparative effectiveness of propaganda today and in the time of Cromwell.

Address, "Some Problems in Modern Astronomy," by Dr. John A. Anderson, covering some of the major problems in astronomy and astrophysics which are currently being pursued by local and other scientists.

Address, "The Economic Consequences to America of a Totalitarian Victory," by Dr. Edwin F. Gay, Institute Associate in Economic History and former Dean of the Harvard Graduate School of Business Administration — a description of the government-controlled barter system employed by Germany in international trade, and an analysis of the problems that may be in store for us.

Address, "Synthetic Gasoline, Rubbers, Resins, and Plastics," by Professor Howard J. Lucas — discussion of polymerization reactions and their relation to modern industrial development and the national defense program.

. . . . OF INTEREST

ALUMNI BANQUET

The 1941 Alumni Banquet, held in the Athenaeum on June 13 following the Institute's Commencement exercises, marked the well-attended reunions of the classes of 1911, 1916, 1921, 1926, 1931, and 1936. In addition, a feminine member of the class of 1896 and an enthusiastic Alumni Association supporter, Miss Diantha M. Haynes of Pasadena, was present to see another year of Association activity rounded out.

Featured speakers at the meeting were Dr. Milic Kybal, who discussed Latin-American relations, and Dr. Charles Mowat of U.C.L.A., who spoke on Canadian-American relations. Both speakers were presented by Professor J. E. Wallace Sterling of the Institute.

Presiding over the Banquet, Loys Griswold '24, retiring president, presented the retiring and incoming officers of the Association, and summarized activities of the past year and plans for the coming one. The 1941-42 roster of officers reads as follows:

- Alfred W. Knight '22, president
- George Langsner '31, Vice-President, Chairman of Committee on Chapters
- Herbert B. Holt '15, Secretary, Chairman Committee on Placement and Campus Relations
- Frank M. Foster '25, Chairman Social Committee
- W. Stuart Johnson '26, Chairman Membership Committee
- Claude W. Sopp '17, Chairman Finance Committee
- Sidney F. Bamberger '33, Chairman Athletic Committee
- Robert J. Barry '38, Chairman Committee on Publications
- Ernest B. Hugg '29
- Albert D. Hall '22, Treasurer
- Hugh F. Colvin '36, Editor Alumni Review.

FOG FORECASTER

Newton C. Stone, Tech meteorologist, recently announced the invention of a device which predicts with uncanny accuracy the lifting of fogs and unbroken cloudiness, two enemies of aviation.

With the apparatus Mr. Stone has predicted to within a few minutes the time at which the overcast above Union Air Terminal, Burbank, would break.

Heart of the new instrument which Mr. Stone has named helionephograph, is a photo-tube or electric eye. By measuring incoming light the device makes it possible also to calculate the amount of heat energy that is reaching the earth. It is this heat that evaporates or breaks up a fog or cloud.

A.A.A.A.S. MEETING

Over 450 technical papers were presented to a total of more than 1300 official registrants at the 5-day meeting of the American Association for the Advancement of Science, Pacific Division, held on the Institute campus June 16-21. After a general symposium on "Science and National Defense", news of current research and scientific activities was presented to a series of groups representing various interests in the fields of science and engineering.

Participating organizations, most of which held special meetings of their own during the week, included: American Association of Economic Entomologists, American Association of Physics Teachers, American Chemical Society, American Meteorological Society, American Physical Society, American Phytopathological Society, American Society for Horticultural Science, American Society of Ichthyologists and Herpetologists, American Society of Plant Physiologists, Association of Pacific Coast Geographers, Astronomical Society of the Pacific, Botanical Society of America, California Academy of Sciences, Ecological Society of America, Oceanographic Society of the Pacific, Society of American Bacteriologists, Society for Experimental Biology and Medicine, and Western Society of Soil Science.

Dr. Paul W. Merrill of the Mt. Wilson Observatory was general chairman of the conclave. Chairman of the principal assisting committees were Professor William R. Smythe, general committee; Dr. Robert A. Millikan, committee on finance; Professor Ian Campbell, committee on program and publicity; Professor Philip S. Fogg, committee on registration and information; Professor William V. Houston, committee on public lectures; Professor F. W. Maxstadt, committee on meeting places and equipment; Professor William W. Michael, committee on local service and transportation; Professor Franklin Thomas, committee on general entertainment; and J. Paul Youtz '17, committee on excursions and exhibits.

YOU CAN'T CRITICIZE THE EDITOR . . .

if you haven't paid your Alumni Association dues . . . and in addition you'll miss out on a lot of other interesting activities and valuable contacts. Send your 1941-42 dues ($2.50) to —

C.I.T. ALUMNI ASSOCIATION
Pasadena, California

TACOMA BRIDGE FALL STUDIED

"Excessive torsional oscillations, due to unforseen aerodynamic instability," resulted in the much-publicized collapse of the Tacoma Narrows bridge last November 7, according to a recent report to the Federal Works agency made by an investigating board of three engineers, including Professor Theodore von Kármán. The report reached approximately the same conclsion and embodied much of the same data that were presented by Dr. von Kármán at the Alumni Seminar on April 5, although the official report had not been completed at that time.

The published report stated that the Tacoma Narrows bridge was well designed and built to resist all static forces, including wind, usually considered in the design of such structures. However, the factor of aerodynamic damping was not taken into consideration in its design.

The behavior of the completed bridge showed that at a certain critical wind velocity the aerodynamic damping coefficient changed from positive to negative; that is, the wind tended to increase any small twisting oscillation of the structure.

Above this critical velocity, the areodynamic damping coefficient increased negatively until the positive structural damping was overcome — after which large oscillations were set up.

During a particularly strong wind excessive stresses were set up in the middle span, causing its collapse. The vertical oscillations of the roadbed, although inconvenient, did not contribute nearly so much to the actual failure of the bridge as did the torsional vibrations.

Simultaneously with Dr. von Kármán's investigations, experiments were carried on with bridge models in the Tech wind tunnel under the direction of Dr. Louis G. Dunn '36.

CRITICAL WIND SPEED

Dr. Dunn's experiments have indicated that the critical wind speed at which the aerodynamic damping coefficient becomes negative increases with the width of the roadbed.

Although it is impossible to eliminate the negative aerodynamic damping effect completely, it is possible to construct bridges such that the critical wind velocity is high enough to insure stability at all wind speeds which are likely to be encountered. Thus there is no doubt that safe suspension bridges will continue to be designed in the future.

According to Dr. Dunn, similar cases of bridge failure have been known for a long time, but no thorough investigation of the principles involved was undertaken before this latest, most striking one.

1941 FOOTBALL SCHEDULE

DAY	DATE	TIME	OPPONENT	PLACE
Saturday	Oct. 4	8:00 P.M.	Calif. Poly	San Luis Obispo
Saturday	Oct. 10	8:00 P.M.	LaVerne	LaVerne
Friday	Oct. 17	8:00 P.M.	Occidental	Rose Bowl
Friday	Oct. 24	8:00 P.M.	Whittier	Whittier
Friday	Nov. 1	8:00 P.M.	Redlands	Rose Bowl
Friday	Nov. 7	8:00 P.M.	Pomona	San Diego
Friday	Nov. 14	8:00 P.M.	San Diego State	Rose Bowl

Telescope Progress Outlined

Announcement that the sag in the 200-inch mirror — "eye" for the world's largest telescope on Palomar Mountain — has been conquered was made by Dr. Max Mason, chairman of the Institute's observatory council, at the June meeting of the American Association for the Advancement of Science held in Pasadena. The threat was one of the major headaches to be encountered in the grinding and polishing of the mirror which has been under way since 1936 on the Institute campus.

According to Dr. Mason, "When the surface of the mirror was brought by polishing to a spherical form it became clear that the disk when tipped from the griding table to a vertical position for optical test, sagged slightly under gravity.

"After months of study, as the polishing continued, this sag was eliminated by installing a system of 24 squeeze levers, operated by counter weights, distributed around the rim of the glass, and thus another major "200-inch headache" was cured.

"This supporting system must operate so perfectly that no bending of the reflecting surface beyond one or two millionths of an inch will occur as the telescope moves.

"It is doubtful if the 200-inch mirror will be of advantage for planetary or lunar photography, where the shakiness of the air, the 'bad seeing' o fthe astronomer, destroys detail more than does the lack of theoretical resolving power of the instrument.

"The work of figuring, or grinding, the mirror has continued for about five years at the optical shop on the Institute campus.

"The immediate stage of figuring the mirror to a spherical surface is nearly finished, and during this process more than four tons of glass have been removed by griding.

"Next, the surface will be changed from that of a sphere to a parabaloid by deepening the concavity at the center by five-thousandths of an inch, and keeping the surface true to one or two millionths of an inch."

At the same meeting, Dr. John Strong, also of the Institute staff, declared that when the 200-inch telescope finally does swing into use, one of its employments will be in the study of radiations from the planets.

Planets not only reflect visible light which they receive from the sun; they absorb and then reradiate considerable quantities of solar energy, largely in the form of the invisible infra-red rays. These will be caught by the great mirror, and analyzed in a number of specially constructed instruments.

"These instruments," Dr. Strong said, "are now being constructed, and the special techniques necessary for their operation are being developed by members of the Institute staff. Much of the information necessary for comparison of conditions on the planets with those on the earth can be obtained only by a more careful and exact study of physical processes taking place on our own planet's surface and in its atmosphere. Determinations, on an entirely new order of exactness, of what happens to earth radiations when they pass through water vapor, carbon dioxide, ozone and the major atmospheric gases, are on the program of research at the Institute."

Incidentally, Dr. Strong pointed out, data obtained in these researches will probably have considerable value to meteorologists as well as to astronomers.

POET'S CORNER

THE SERVICE HOWL

By G. Austin Schroter, '28

You may think the service rough
And the non-coms plenty tough,
When you draw a double-duty on
the roster.
If you want a lead-pipe cinch
And the duty makes you flinch,
Then a little cussin' is your
paternoster.
If you're on the book as sentry
'Stead of minglin' with the gentry
And the cutie waitin' for ya' on
a date —
Then your recourse lies in gripin',
As your rifle you are wipin',
'Cause it's just a waste of time
to supplicate.

If it's bunk-fatigue you seek (1)
To forget some long critique, (2)
And the Top-kick, with his whistle, (3)
rolls you out —
Or you hear the bugle's blare,
With its rest-disturbin' air,
And your forty winks of sleep are
put to rout —
Why there's still the consolation,
Mouthin' forceful imprecation
Of the Army, and your orders to
look smart,
When you're moppin' up latrines
In a pair of G.I. jeans, (4)
You can smartly curse the military
art.

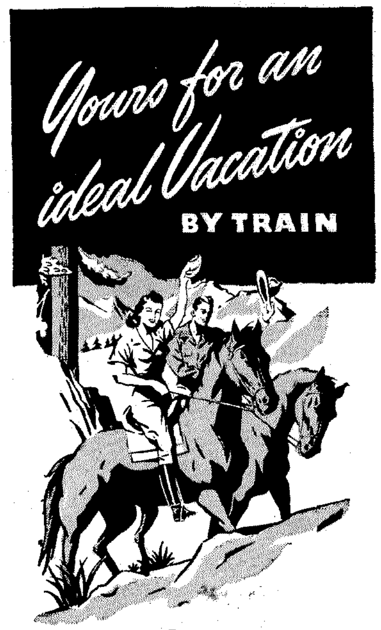
When the section's on the march
And the dust is dry as starch,
And your pack-straps mutilate your
hide like Hell —
When your tin hat weighs like lead
On your poor, old, aching head,
And you're conscious of the column's
sweaty smell —
You can sling your piece around (5)
As your weary feet resound
To a mighty sound of beefin' down
the line.
Yes, it's belly-achin' mister,
When you've got a lousy blister
With eleven hours of marchin' to
malign!

When enlistment time is up,
And you've had your final sup
With the old, familiar chow-time
section mess —
When it's time to settle scores
With the Quartermaster stores,
There's a feelin' that pure reason
can't suppress —
Though civilian-life is fine,
It's an effort to define
Why you slowly tread the way
to reenlist.
So you sign the dotted line,
With a fogey when you sign, (6)
It's the soldier in your blood
you fatalist!

GLOSSARY

1. Bunke fatigue—Army slang for rest, relaxation.
2. Critique—A discussion of a maneuver.
3. Top-kick—First sergeant.
4. G. I.—Government issue, or general issue to all personnel.
5. Piece—The army rifle.
6. Fogey—Period of service to apply on longevity pay increase.

All Rights Reserved



On Union Pacific Escorted, All-Expense Tours you travel the carefree way. Select your Summer vacation from one of the many Union Pacific wonderlands:

All three National Parks, Zion-Bryce-Grand Canyon are so closely grouped that all may be seen on one low cost circle-trip by motor bus from Cedar City, Utah, the railroad gateway.

Zion National Park—See the full grandeur and awe-inspiring beauty of this world famed National Park.

Bryce Canyon National Park—Here nature has slowly sculptured the world's most fantastic and richly colored spectacle... Don't miss this "so different" place this Summer.

Grand Canyon National Park—Here's a sight so grand, so beautiful that for evermore you will carry the picture stamped indelibly upon your memory. Union Pacific maintains a fine hotel, also cottages, where you can enjoy a day, week or month.

* * *

Yellowstone National Park—A veritable wonderland...geysers, waterfalls and fascinating animal life. Union Pacific trains take you right to the Park entrance.

Sun Valley, Idaho—The famous year-round resort in the heart of Idaho's Sawtooth Mountains. Accommodations at a wide price range at Sun Valley Lodge or Challenger Inn.

For complete travel information consult your nearest Union Pacific representative or R. E. Drummy, General Passenger Agent, 434 West Sixth Street, Los Angeles.

THE PROGRESSIVE
UNION PACIFIC

Commencement Stresses War Problems

Tributes to Amos G. Throop, who founded the institution that is now Caltech in 1889, a summary of the progress of the school during the past year combined with a look into the future by Dr. Robert A. Millikan, chairman of the Executive Council, a warning to the country to increase its supply of skilled workmen, and an analysis of war and post-war aims by the Rt. Hon. Richard Gardiner Casey, Australian minister to the United States and principal Commencement speaker, featured the annual Commencement exercises held June 13 on the lawn between the Athenaeum and the student houses. Over 2,000 people watched the exercises, as 297 degrees were given to set a new record high.

Commenting that while a large percentage of the Institute's graduates were destined for immediate employment in national defense industries, the country as a whole is still lagging in its training of skilled workmen through apprenticeships in industry, partly because of improper emphasis in its educational setup.

"The United States is far behind all other Anglo-Saxon countries and the whole of Europe in the provision it makes for the training of skilled workmen through apprenticeships in industry," Dr. Millikan warned.

"Why are we so far behind? Partly because those responsible for the work of the secondary schools have failed to give adequate attention to one of the most vital needs of American education, and partly because we who have the responsibility for the development of our higher educational system instead of setting up adequate hurdles for entrance to the higher schools have worshipped the god of numbers and through the accrediting system have made passage from secondary school to college almost a formality, rather than a careful sifting process designed as far as possible to prevent misfits in life, with their necessary accompaniments of unhappy lives and social unrest."

Regarding the current campus program, Dr. Millikan reported that about 1,000 men, in addition to pursuing their studies, are engaged in solving or trying to solve no less than 65 practical projects, some of them of large magnitude; this cost is provided by the country's industries, or by the government through its defense activities, or by the foundations, or by private philanthropists who seek thus to promote human well-being and know of no place where more results can be obtained per dollar of investment.

WAR PROBLEMS HIGHLIGHED

Highlighting his address, the Rt. Hon. Richard Gardiner Casey, who was a graduate mechanical engineer and a successful practicing mining engineer in Australia before entering public service, declared that post-war problems may prove even more difficult and unpleasant than the mere winning of the war as far as the democracies are concerned. In his own words:

"To those who still cling to the idea of a negotiated peace — we say that this is completely impossible. It would mean nothing more than giving Nazi Germany just the breathing space that she so urgently wants, in order to prepare herself for the final blow that would make for the Nazi conquest of the world. We are fighting Nazi Germany today. We will be fighting the horrors of unemployment after the war. I would hestitate to say which of the two — Nazi Germany or unemployment — is, in the long run, the greater enemy of democracy.

"I believe that, for our individual and collective salvation, in the postwar years, the United States and the British countries — together with all other countries of good will — will have to work closely together, from the financial, economic, commercial and many other points of view.

"I believe that the most formidable task of statesmanship with which the world has ever been faced is just ahead of us at this moment. I believe the problems that I have ventured to outline have to be tackled before the war ends — and that it is none to early to tackle them now, if we are to salvage the postwar democratic world — and if democracy and free institutions are not to become mere words in the postwar dictionary.

"We want to banish war from the world. That can't be done while Nazism remains. Nazism is the ideal organization of a country for waging war. It has but little peacetime significance. Democracy is the ideal type of organization for peace — but it is a slow, inefficient system for waging war. Let us choose which system we want — and know why we want it.

"Please don't make any mistake about it — we didn't go to war because of some European dispute. We went to war because we realized that if every one of us didn't stand by Britain and throw ourselves across the track of this Nazi juggernaut — the writing was on the wall for democracy and for our way of life.

"Given adequate American assistance, I find myself able to be optimistic about the outcome of this war — although we have no illusions about what the future holds for us before the war is won. It will be a long and bitter business.

"But I find myself cast down with doubts and fears about the period after the war — and it is about the postwar era that I now want to speak to you for a little.

POSTWAR PROBLEMS

"It is going to be very much more difficult for the American and British people to work together in peace than it is in war — and yet I believe that it will be just as essential, although for quite different reasons.

"We will have problems to tackle that will appear individually to lack the vital urgency of today's problems of war — and they will be complicated by tariffs, vagaries of international exchanges, the bitter struggle between competing national vested interests, the problems of gold, the problems of depleted purchasing power, the difficulty of disposal of international surpluses, of high and rising costs and prices, of disparity between farm and manufacturing prices, and of problems inseparably connected with the wholesale return of ex-service men to civil life.

"The real serious part of the business will undoubtedly be that these problems will express themselves in widespread and perhaps unmanageable manifestations of unemployment and distress amongst the working populations — of your country and of our countries.

"I believe that neither the United States nor the British Commonwealth of Nations by themselves, and working separately can solve these problems. And if we don't solve them, we are sunk. If we don't go some way toward solving them, I would give the world 10 years at the outside — before we all dissolve in hopeless chaos.

"I believe that many of the previously accepted principles of international contact and international practice will have to be revised, if, having survived the war, democracy is to survive the peace.

"These are some of the problems that you — your generation — will have to face. And probably no generation will have had such vital problems of reconstruction and rehabilitation to deal with. Pray God that your backs will be broad enough and your minds sufficiently unhampered by prejudices and inhibitions to tackle them successfully. May you not be discouraged or dismayed by the prospect."

LIFE PHILOSOPHY ADVISED

Rev. John F. Scott, pastor of All Saints Episcopal Church in Pasadena, gave the graduates another indication of the things they must strive for in these words:

"The really important things in this world are not the kind of beds we sleep on or whether we eat three or four minute eggs; not the degrees you are entitled to write after your name, or whether you get a job with a salary or go into the military service for a year.

"The fundamentally important thing is your philosophy of life: What are you here for? What are you supposed to do about it? What's the nature of this universe? Are there any principles or moral laws that underlie it, any motives that give promise of peace and progress? In the long view

(Continued on page 22)

Alaska Expedition Lures Student

William Shand, Princeton graduate working for his doctor's degree at the Institute, is now in Alaska as a member of an expedition seeking to climb and map the hitherto unscaled Mt. Hayes, whose top towers 13,752 feet above sea level.

The expedition is under auspices of the National Geographic Society and the Harvard Geological Institute and its director is Bradford Washburn of New York, recently featured in "Life" magazine.

Others in the party will be Mrs. Washburn, Henry Hall, Boston, Ben Ferris, New York, and Sterling Hendricks, Washington. Mr. Shand's home is near Lancaster, Pa., and he was associated with others in the group as a member of the American Alpine Club where he won recognition for his skill as a mountain climber.

The party left Seattle July 8. It was planned to take a steamer to Fairbanks and then fly about 100 miles south, landing on a gravel flat at the foot of a glacier. From there the party will begin the ascent of Mt. Hayes, whose summit no human beings ever have scaled.

Some members of the expedition are expert photographers and others have had much experience in map-making, and under the direction of Mr. Washburn it is believed a record of this peak will be secured which will be of great value in geographical circles.

Mr. Shand, who is planning to get his doctorate in chemistry, expects to return late in September.

ADDRESS MISSING

No current addresses for the following men are in the Alumni Association files. Directory cards sent to the last known address were returned marked "No Forwarding Address Known." Information as to the whereabouts of these men will be valuable for the Directory and will assist in keeping the files up to date.

1917

Leo B. Hardiman

1923

Carl Berg — **Richard G. Osmun** — **Glen I. Miller**

1924

Ralph M. Langdon — **Arthur G. Pickett**

1925

Ernest C. White

1926

George Clapp — **Burnett Wisegarver**

1927

Arthur Robinson

1929

H. A. Campbell — **John W. Daly** — **True W. Robinson**

1930

Glenn H. Meyer

1931

John C. Montgomery — **Alvin Tutschulte** — **Oscar M. Newby**

1932

P. B. Brass — **D. E. Marshall** — **Jackson Gregory, Jr.**

1933

Dana Washburn — **Arnold Wilking**

1934

William McFadden

1935

Charles A. Dawson — **Louis T. Rader**
Fun Chang Huang — **Henri Levy**

1936

Edmund Borys — **Dale Van Riper**
Newell Pottorf — **Walter C. Wong**
Simon Ramo — **Chao-Ying Meng**

1937

M. A. Dike — **Willard Pye**
William Ellery — **Frank Rechif**
Shirley S. Miller — **Clark Wiget**
Gordon Wylie

1938

Kneeland Numan — **J. Edward Shreve**
Richard Rowell — **Donald Taylor**
Munson W. Dowd

1939

J. J. Browne — **Harry Majors, Jr.**
Charles Carstarphen — **Harold W. Sharp**
Carr Chia-Chang Liang

1940

Dwight H. Bennett — **Sabin Ustel**
John M. Holloway — **Robert Spielberger**
Carl G. Schrader

Letters To The Editor

33 Walnut Street,
Savanna, Illinois,
June 15, 1941

Dear Sir:

After a year out of the Association, I have decided to give it another try. In my first year out I was a member and was greatly disappointed in the poor average on the members of the Class of '39, '38 and other classes whose members I knew.

I believe much more of the space of the magazine should be devoted to short items about many of the graduates rather than long, too highly specialized, technical articles by just a few of the more fortunate, or in some cases more "long-winded" graduates.

There seemed to be far too little mention made of the fellow actually out "doing something." The usual '39 Class news read something like this:

"Pete ——— has enrolled at the Harvard School of Business.

"John ——— writes he is enjoying the Harvard School of Business.

"Don ——— is at the Stanford School of Business.

"John Doe, Jr. has just been promoted to assistant engineer. He is employed by the John Doe (Sr.) Construction Co.

"Bill ——— flew back to the coast for the Christmas vacation after a term at the Harvard School of Business." . . . and so on far, far into the night.

Are we just a Business preparatory school — or an engineering school? One would think the former by reading the Alumni Review!

Certainly a few of the real points of interest could be brought out. Why with this National Defense Program and you didn't even get in the news that **Al Guillou '40** is with the Army Air Corps.

Also I have failed to see a lot of old school chums of mine because of failure of the Review to report either their or my changes. When I came here I felt it my duty to write a brief note giving a few details on my new position and location— never a word in the Tech Review. My mother reports an occasional Tech fellow still drops by at Bell (Calif.) to "see if I still am with Sterling Electric Motors."

Wish you'd try to see what you can get in the way of news for the Review on such fellows as Jack Black, Devirian, Herb Strong, Lawson, Russ Anderson, Axtman, Crozier, Green, Matthew, Richey, Richards, Norton, etc.

In case it's just your inability to get the news I'll start you off by telling briefly about McClung and myself. We're both still at Savanna Ordnance Depot as operating and plant engineers of this very large ammunition loading and storage depot. Our work consists of developing ammunition loading tools, bomb and shell bundling equipment as well as the engineering in connection with plant layout and production methods. Our Engineer Division has grown considerably from the day in November 1939 when I reported as the Civilian post engineer to today where we have four engineers and eight draftsmen and other employees in addition to 7 N.Y.A. student-draftsmen. Mac has been directing the division since April when the Chief engineer left. I have been in charge of N.Y.A. training and ammunition tool design.

Our new shell loading line will probably be the first of the ones of its type in operation in the country. Part of the program of the depot consists in training explosive operators for the bomb and shell loading lines at the new plants such as Wolf Creek, (Miss.), Burlington, (Ia.), Elwood, (Wilmington, Ill.), and Kingsbury, (Ind.), and Ravenna, (Ohio), all of which will be doing the type of work on which we have pioneered.

Sincerely yours,
Frederick C. Hof, '39.

Mobilgas
SOCONY-VACUUM

Give Your Car a Fresh Start

for Summer

Enjoy a Summer of carefree driving. Have your car thoroughly Summer-proofed for the hot weather days ahead. Ask your nearby Mobilgas-Mobiloil dealer about his "Fresh Start" service.

GENERAL PETROLEUM CORPORATION

Mobiloil-Mobilgas

Commencement

(Continued from page 20)

everything else is secondary to these considerations, for on your answer to them depends what you do with your life and what your life does to the world.

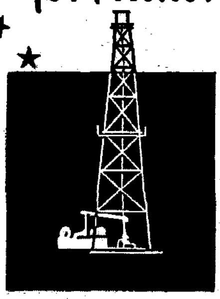
"Do not forget or neglect these spiritual values which are basic in the world of men: Without them all your learning is of nothing worth. Put your native talent, your intellectual equipment, your ambition, your strength under the control and direction of these intangibles: good will, honor, integrity, truth and justice and you can rid our civilization of the evils which plague it; poverty, disease, inequities, and war. Intelligence and religion together can remake the world.

"And enduring civilization must be based on spiritual values: truth, honor, righteousness, justice and goodwill. These are the qualities on which democracy and freedom are built. Unless they undergird our individual lives and the life of our nation, we perish. We can not laugh off that statement today as the raving of a preacher; that is the verdict of history and the voice of experience. It is time we gave heed."

Degrees were presented to the 297 recipients by Dean Frederic W. Hinrichs of upper classmen; Dr. W. R. Smythe, chairman of the committee on the course in science; W. W. Michael, chairman of the committee on the course in engineering; Dr. William V. Houston, acting dean of the graduate school.

The parchments were presented to each graduate by Dr. Millikan.

Oil & Power for National Defense



Electric power helps transform crude oil into the many petroleum products required by modern machines of defense. Electricity drills oil wells, pumps oil from wells and through miles of pipe lines to refineries, and aids many precise refining processes. Delicate electrical instruments help discover new oil fields, hidden far underground. Ample provision has already been made for both present and future needs for low-cost electric power by the vitally important industries of Central and Southern California.

A Community Enterprise — Edison

CHAPTER NEWS

New York

A group of about twenty men of the California Tech Club of New York had the privilege of meeting with Dr. Linus Pauling at an informal luncheon held in his honor at Pappas Restaurant on March 9th. It was also their pleasure to have the company of Mrs Pauling who accompanied her distinguished husband.

Dr. Pauling, head of the Division of Chemistry and Chemical Engineering at the Institute, came to New York to receive the 1941 William H. Nichol medal of the New York section of the American Chemical Society. He was chosen for the honor for his distinguished and pioneer work on the application of quantum mechanics to chemistry in the determination of the size and shape of chemical molecules. Dr. Pauling spoke about recent developments at the Institute. Both the Alumni and invited guests found his remarks highly informative and inspiring.

The annual meeting of the California Tech Club of New York was held Friday, June 13, at Frances Lynn Restaurant. The program included films and sound recordings made at the Alumni Seminar at Pasadena last spring and was greatly enjoyed by the members, some of whom did not recognize the campus with all the recent changes and improvements which have been made. The closeups of Alumni members at the Seminar was also greatly enjoyed. **Ed Thayer** got quite a kick out of seeing himself billed as the "Alumnus from the most distant point". Both recorded talks aroused much interest from the whole group and the hope was expressed that a similar recorded program from the Institute will be prepared at the Seminar next year.

The following officers were elected for the coming year:

Paul Ames '22 .... President
Herb Ingham '31 .... Vice-President
James Davies '35 Secretary-Treasurer
Chester Carlson '30 .... Director
Frederic Moore '38 continues as a director for another year.

Yours very truly,
Chester F. Carlson '30.

San Francisco

On March 31, 1941, our secretary, Francis Wyatt was transferred to Los Angeles and I was asked to assume the duties of secretary-treasurer of the San Francisco Chapter.

This is a rather late report of our activities; however I hope it will be received in time for use in the next Alumni Review.

On March 7, 1941, the San Francisco Chapter, under the leadership of the President, Louis Erb, enjoyed a double feature: a Swedish dinner preceded by cocktails, and lively chatter. After dinner, Dr. J. Scherer gave a talk on the Far Eastern situation, on which he is an authority. The talk was followed by questions and lengthy discussion.

A group of fifty-four members and their ladies, met on May 10th at Howard Vesper's lovely home "Cactus Rock," in the hills of Oakland for an afternoon, supper and evening, the most enjoyable event this Chapter has experienced this year. The soft ball game was the main athletic event of the day, resulting in a score of fourteen to ten in favor of the young grads.

After a fine supper, served in the patio and in the house, the group gathered in

NEWS OF CLASSES

1903

Richard W. Shoemaker recently surprised the New York Alumni Chapter by his presence at one of their meetings. He is connected with the Chase Brass and Copper Co. of Hartford, Connecticut.

1912

F. Curt Miller was killed in an auto accident near Elsinore, California last March 27. He is survived by his wife, Clara Paxton Miller, a graduate of the old Throop Normal School during the presidency of Dr. Scherer.

1921

Ed Champion is now associated with Gibbs and Hill, consulting engineers, New York City. He was formerly with the Ingersoll-Rand Company.

1922

Glen Webster, a Captain in the Army Engineer Corps, has been assigned for a year of active duty as Instructor in the R.O.T.C. unit at Oregon State College.

1924

Grant Jenkins is a Captain on active duty at Camp Callan, serving as staff officer in charge of supplies and chemical warfare service.

James Mercereau has just been promoted to the rank of Major in the Army Engineer Reserves, and called to active duty at Fort Belvoir, Va.

1925

Caryl Krouser was called to a year of active duty as Captain with the 13th Army Engineers at Fort Ord.

O. S. Larabee, Captain in the Army Engineers Reserves, was called to active duty with the Engineer Board at Fort Belvoir, Virginia.

Ed Thayer, former president of the New York Chapter, reports the birth of a daughter, Julie Clark Thayer, September 20, 1940.

1926

Herbert Ingersoll has been assigned to active duty with the 1st Engineers, Fort Devens, Massachusetts, effective May 15. Herb holds a commission as Captain in the Army Engineer Reserves.

Stu Seymour was called away from his insurance business April 15 for active duty as a Captain in the Coast Artillery Corps at Camp Callan. Stu writes that he contacts his family occasionally with the assistance of a San Marino radio operator, **Wasson Nestler '36**, a neighbor of the Seymours.

NEWS

Have you any bit of news about yourself or fellow Tech men? Marriages, births, promotions, job change, papers published, or new honors received are all items of interest to the rest of us so write your information on a penny postcard and address it to the Editor,

CALTECH ALUMNI REVIEW
Pasadena, California

Gordon Mitchell is a Captain in the Army Signal Corps Reserve. He recently received considerable publicity for his coordinating work with the Army as Chairman of the Academy of Motion Pictures Arts and Sciences Committee to work with the Army.

Wayne Rodgers was called to active duty with the 19th Engineers at Fort Ord recently.

Orrin Barnes was called for a year of active duty as a Captain in the Coast Artillery Corps. He is stationed with the 3rd Coast Artillery at Fort MacArthur.

Glen Graham, Banning City Engineer, is acting Engineer for the Idyllwild-Banning Highway Project.

The following personal notes were accumulated at the Annual Alumni Banquet at the Athenaeum June 13, representing the fifteenth reunion of the class of '26:

Robert W. Moodie reports his son Robert is now through the 8th grade and well on his way to Tech. With two girls also in the family, Mr. and Mrs. Moodie are not handicapped by too much spare time.

Mark Serrurier has a 15-months old daughter who keeps her parents wondering what she'll do next.

James Carter has twins James and Mary (10) and another son, Robert (8), to help him save on income tax. Carter says that in spite of all defense activity he remains as an oil sniffer, trying to supply an already overcrowded market.

J. Ed. Kinsey reports three deductees for income tax purposes when needed.

J. F. Voelker, engaged in cement work at Victorville, was glad to see the good turnout of '26ers. He has a young daughter.

Ira Triggs has a 4½-year-old daughter.

John Howell, now making electric motors for defense, reports a 5-year-old daughter for an Oxy coaching candidate and a 3-year-old son for Tech.

Charles Bidwell and wife Laura announce the birth of their first child, a daughter, November 22, 1940.

1927

Ted Combs, former Alumni Association president, was promoted to the rank of Major in the Army Engineer Corps in April. Ted is currently on duty in the Washington office of the Under-Secretary of War, handling supply contracts.

Dick Darling is now serving as a staff officer at the Enlisted Specialists School, Camp Callan, California, with the rank of Captain.

1928

Elwood Ross, 1st Lieutenant in the U. S. Engineers, has been called to a year of active duty with the 19th Engineers at Fort Ord.

Kenneth Fenwick is now on active duty as a Lieutenant, Civil Engineer Corps Reserves, U. S. Navy, at Norfolk, Virginia.

Edwin McMillan and Miss Elsie Walford Blumer were married June 7 at Haycock Point, Massachusetts. McMillan, who holds a doctor's degree from Princeton, is now associate professor of physics at the University of California.

Edward E. Tuttle and his father Edward W. T. Tuttle recently announced the formation of a partnership for the general practice of law under the firm name of Tuttle and Tuttle, with offices in the Title Guarantee Building, Los Angeles. Tuttle had previously been associated with the firm of Farrand and Slosson in Los Angeles.

1929

Bill Mohr, Captain in the Army Engineer Corps, was recently transferred from Fort MacArthur to Fort Belvoir, Virginia, where he is serving with the 34th Engineers Battalion.

Walter Grimes is a Captain in the Army Engineers Corps, and has been on active duty for several months at Fort Belvoir.

Fred Wheeler is now a Lieutenant in the Naval Reserve, and proceeded on March 1, 1941, to the Philadelphia Navy Yard, where he will serve on the new battleship, Washington.

1930

Don Barnes, M.S., '30, was recently promoted to Major in the Army Engineer Reserves and called to active duty at Fort Belvoir, Virginia.

Harris Mauzy passed the recent examination for license as a civil engineer in California.

1931

Jeff Wineland is the proud father of a daughter, Judith Laura, born April 28, in Denver.

Walter Dickey and **Isadore Thompson** were successful candidates in the recent examination for license as structural engineers in California.

Edward Crossman, Lieutenant in the California National Guard, was called to active duty on March 3, and is now taking a training course at Fort Benning, Georgia. Crossman has conducted courses in ballistics at U.S.C., and is the author of numerous articles on guns and marksmanship. His father was attached to Fort Benning as an experimental officer when the infantry school was first developed there, some 20 years ago.

1932

Edward C. Keachie announced the birth of his first child, Stephen Keachie, on May 9. Keachie is a teaching assistant at the Stanford University School of Business Administration.

Bill Shuler is now a captain in the Corps of Engineers and is in charge of the Officer Training School at Fort Belvoir, Virginia.

1933

George H. Anderson, Ph.D., '33, is now director of industrial relations for the Texas Power and Light Corporation.

---

the patio for short-subject sound movies, including a movie of the life of Rudolph Diesel; his invention of the Diesel Engine and the subsequent development of oil in the laboratories of the Standard Oil Company, for use in Diesel Engines. This film was shown through the courtesy of Howard Vesper and the Standard Oil Company, and was most interesting. The entire evening was a great success, under the efficient management of Mr. and Mrs. Vesper and Louis Erb.

Our Chapter wishes to extend an invitation to any of you who may come to the Bay Region. We meet every Monday at twelve, for lunch in the Fraternity Club dining room at the Palace Hotel at New Montgomery and Market Streets, San Francisco.

Alex J. Hazzard '30.

1935

Dick Jahns and his wife, on a vacation from U. S. Geological Service work in Washington, D. C., visited Los Angeles in April. The couple were honored at a reunion banquet attended by **Warren Potter, Elmer Leppert, Herb Woodbury, Chet Davis, Lind Davenport, Hugh Colvin,** and respective wives. Before returning to Washington, the Jahns visited the Pacific Northwest.

Davenport Browne, Jr., and Miss Penelope Anne Freer (Flintridge School) were recently married in Chevy Chase, Maryland, and are now residing in Arlington Village, Virginia.

Adrian Gordon is now stationed with the British Meteorological Service in Bermuda, after service at Gibraltar until June, 1940, and at Barbados until November, 1940.

1936

The announcement of the engagement of **Ray Jensen** to Miss Elizabeth Klocksiem (U.C.L.A.), sister of **John Klocksiem,** was made recently. The couple will be married this fall.

W. Bruce Beckley is now connected with the firm of Boykin, Mohler and Gordon, patent attorneys, with offices in the Crocker Building, San Francisco. Beckley graduated from Stanford Law School in 1939 and passed the bar examination the same year.

Victor Veysey, after a year at Stanford University, will be back as a teaching assistant in the Institute's Industrial Relations Department this fall. Victor is currently teaching one of the full-time summer courses in industrial management under the EDT program at the Institute.

The following men were among those attending the Annual Alumni Banquet held June 13 at the Athenaeum (pertinent personal data appended):

Luther Spalding, research engineer, North American Aviation; no wife, no children.

Ray Jensen, engineer, Hughes Aircraft Company; engagement announced.

Ted Vermeulen, expects to receive Ph.D. from U.C.L.A. this summer; married but no children.

John Klocksiem, chief of stress analysis, Hughes Aircraft; no wife, no children.

Art Frost, engineer, Douglas Aircraft Co.; no wife, no children.

Paul Hammond, Holly Heating Company of Pasadena; married and 7-months old daughter.

Holley Dickinson, in charge of special aerodynamic research at Lockheed; married, no children.

Wally Swanson, assistant to area engineer, U. S. Army Engineers, Ogden, Utah. Married—yes. Children—no.

Peter Serrell became the father of a 6-pound, 7-ounce daughter, Barbara Janet, born March 13 at the Huntington Hospital.

Bob Kent has been transferred by the Dicalite Company from New York to the Chicago office.

1938

Wilson Jones and Miss Hellen Jeffers of Denver were married May 16 at Denver, where the couple now reside.

John McGraw and Miss Margaret Elizabeth Ford (Pomona College) were married May 30, in South Pasadena. **Dave Sherwood** served as best man.

Bill Althouse and Miss Eleanor Mae Beckwith were married May 18 in South Pasadena, where the couple are now living. **Fred Llewellyn** served as best man at the wedding.

Paul Siechert and Miss Ruth Mary Klise (Pomona College) were married June 22 in Altadena, with **Harper North** as best man. The same evening Siechert returned the favor, as North and Miss Carmen Lucille Penwarden (U.C.L.A.) were united in matrimony. The Siecherts are residing at 2630 Lambert Drive, Pasadena, and the Norths at 1162 Lowell Drive, Schenectady, New York.

1939

George Crozier and Miss Marjorie Baker (Occidental College), sister of **John Baker, '39,** were married in Pasadena June 16th.

A second child was born June 20 to Mr. and Mrs. **Alton L. Pabst.** The bouncing baby girl was named Carol Ann by her proud parents. Al is now employed as a sales engineer by Garlinghouse Brothers of Los Angeles.

Philip Devirian and Miss Janice Lee Neumann were married April 9 in Los Angeles.

Edwin Sullivan and Miss Josephine Raefreda Paulson (Occidental College) were married at All Saints' Church, Pasadena, June 30. Sullivan is now working as a civil engineer on the Central Valley Project of the Sacramento River for the Bureau of Reclamation.

1940

Donald Carson and Miss Elizabeth Willmarth (Whittier College) were married June 14 in Pasadena. The couple will reside in Schenectady, New York.

Charles Rose and Miss Doris McMannus were married last month in Pasadena. The couple are building a new home in San Diego where Rose is employed.

Paul Faust and Miss Patty Wammack (University of California) were married early in June and are now living in Torrance.

1941

Ernest G. Chilton, M.S. '41 was recently awarded a teaching assistantship at the Illinois Institute of Technology, where he will study for his doctor's degree in mechanical engineering.

Webster Wilson and Miss Frances Johnson were married July 5 at Oakland.

Alumni Business and Professional Guide

EDWARD E. TUTTLE
'28
ATTORNEY-AT-LAW
GENERAL PRACTICE
411 West Fifth Street — Los Angeles
MAdison 8893

George Rice & Sons
GEORGE RICE III, '31
PRINTED ADVERTISING MATERIAL
Planned and Produced
FOLDERS, BOOKLETS, CATALOGS
DIRECT MAIL — STATIONERY
320 Crocker St. — MI-8363 — Los Angeles

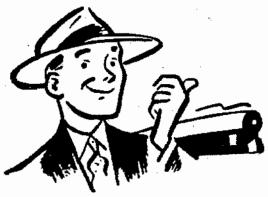
EDWARD S. SIEVERS
SOUTHERN CALIFORNIA REPRESENTATIVE
Associate: JOHN D. FARNEMAN, '38
WESTON ELECTRICAL INSTRUMENT CORP.
417 SOUTH HILL STREET
LOS ANGELES, CALIFORNIA — MICHIGAN 3691

THRIFTY TRIP EAST?

You've heard of "economy" trains? Well, here's one that features comfort and friendliness as well as low cost.

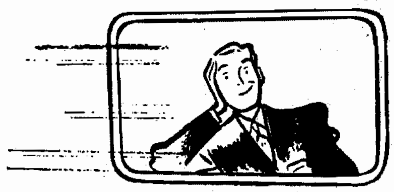
1. Looking for a bargain?...

2. Planning a trip east this summer?...

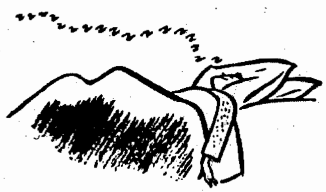


3. SELECT SP's friendly "Californian".

4. ENJOY delicious meals - 35¢, 40¢, 50¢!



5. SEE grand scenery on the Golden State Route.



6. SLEEP soundly in a big tourist berth.

7. STRETCH out in the lounge car for tourist passengers.

and you save money!

OUR SMILING NURSE-STEWARDESS (see at right) says: "More and more folks who could afford *any* kind of transportation are enjoying the friendly *Californian.* They save the difference." The *Californian* leaves Los Angeles each evening at 8 o'clock. For complete information, call one of the offices listed below.

TO CHICAGO

If you don't want a berth -

Rail fare one way	$39.50
7 delicious meals en route	2.85
TOTAL in air-conditioned chair cars	$42.35

If you do want a berth -

Rail fare one way	$49.90
7 delicious meals en route	2.85
Big lower berth	8.95
TOTAL in air-conditioned tourist sleeping cars . . .	$61.70

BIG SAVINGS IN ROUNDTRIP TICKETS

TUNE IN—KNX 9:15 p.m. Wednesday. "All Aboard" with Art Baker

Southern Pacific's

FRIENDLY *Californian*

"Ma Says It Tastes of Coal Oil!"

MA IS probably right. The clerk who had to fit shoes and horse collars, measure out nails and putty, and draw kerosene couldn't always stop to wash his hands before he handled the butter and crackers. And every so often the potato on the spout of the oil can would joggle off.

Today, for most of us, the mixture of food and kerosene odor has ceased to be a problem. More and more of our food, packed by electric machines, comes to us in sanitary containers. Electricity does the work, too, of washboard and carpet beater. Automobiles and good roads have shortened distances to town and work. And because so many of the routine, unpleasant jobs which occupied our parents' time are now only memories, we have more opportunities for enjoying life to the full.

Practically every industry in America has helped to bring about this progress. And every industry, in doing so, has made use of the economies and manufacturing improvements that electricity brings. General Electric scientists, engineers, and workmen have been, for more than 60 years, finding ways for electricity to help raise American living standards—to create More Goods for More People at Less Cost. Today their efforts are helping further to build and strengthen the American way of life.

G-E research and engineering have saved the public from ten to one hundred dollars for every dollar they have earned for General Electric

GENERAL ELECTRIC

952-117C