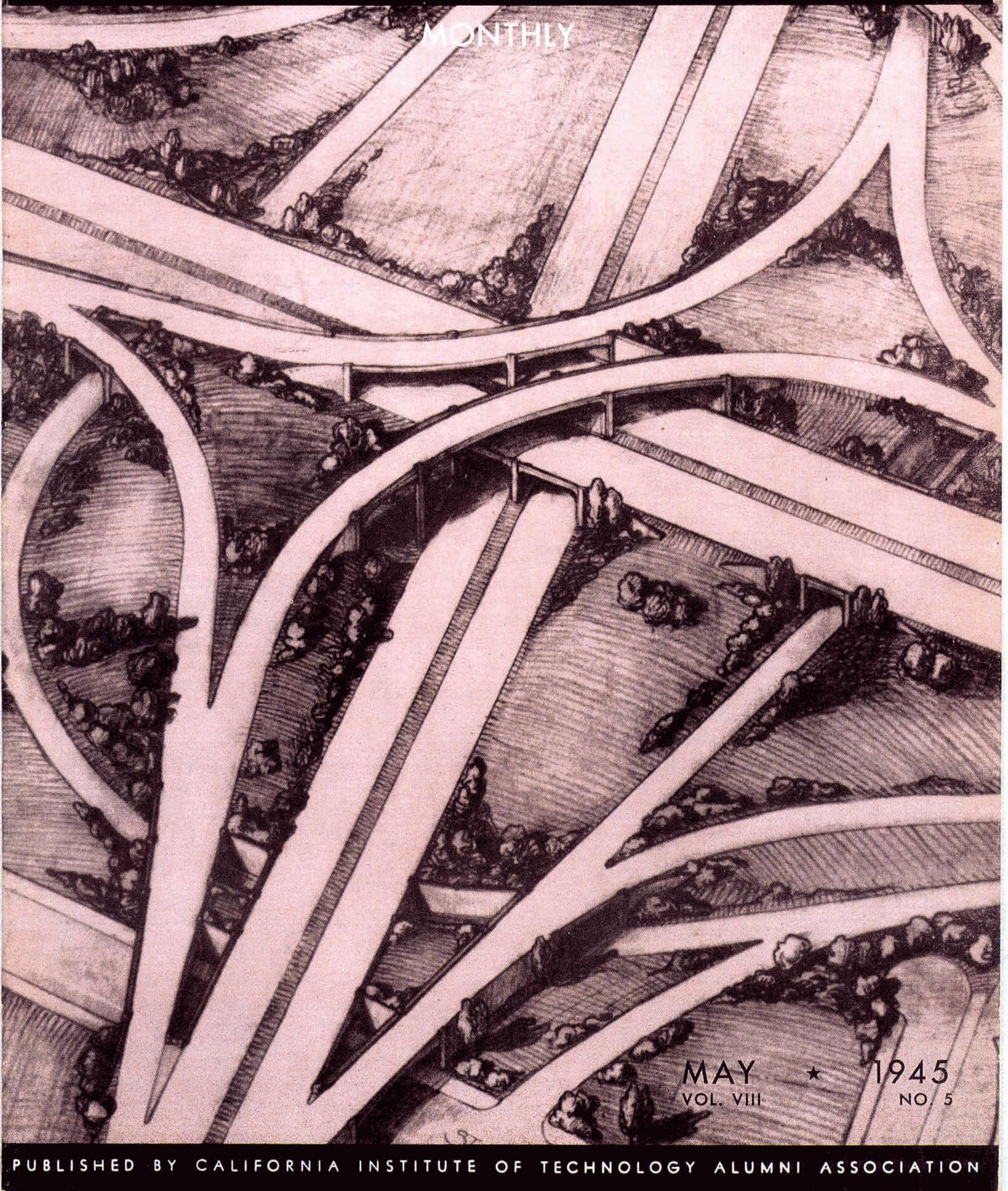
ENGINEERING AND SCIENCE

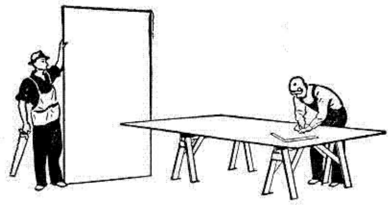
MONTHLY



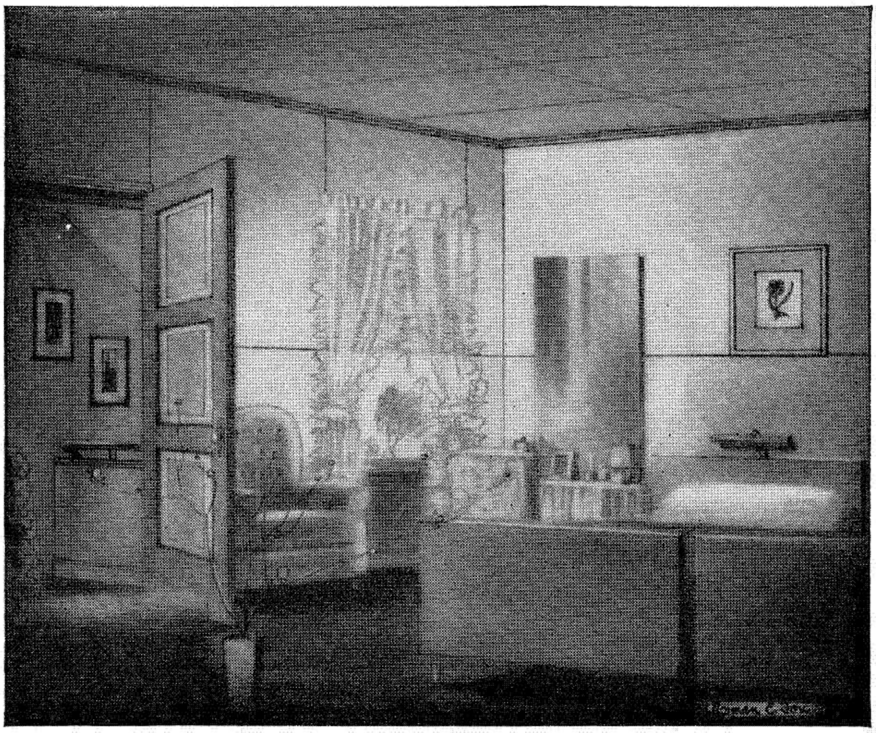
MAY ★ 1945
VOL. VIII NO. 5

PUBLISHED BY CALIFORNIA INSTITUTE OF TECHNOLOGY ALUMNI ASSOCIATION

Large Panels of Douglas Fir Plywood offer Many Possibilities for Attractive Wall Designs



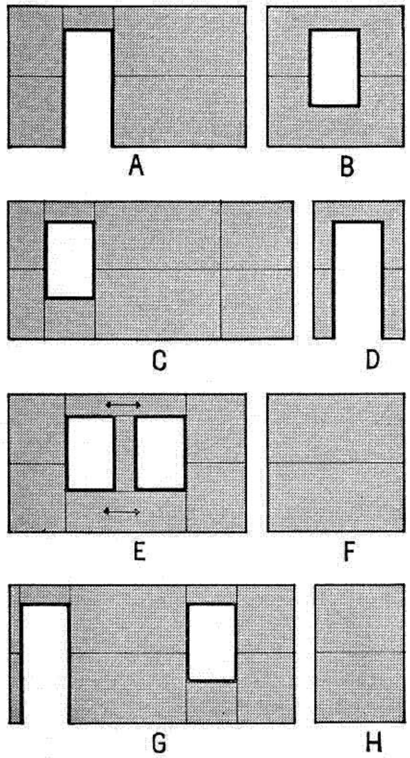
There are three grades of Douglas fir plywood panels made especially for various phases of wall construction. PLYWALL is made especially for standard wallboard use; PLYPANEL is a premium panel used for quality interior work; PLYSCORD is a utility panel made for wall and roof sheathing.



Follow these Simple Suggestions in Planning Wall Designs with Large, Durable Plywood Panels!

No. 5 of a Series

Simple Suggestions For An Attractive Wall Design With Plywood



Large, light, durable, kick-proof panels of Douglas fir plywood offer scores of possibilities for attractive and unusual wall designs. The bedroom illustrated above shows one architect's application of the suggested treatment detailed at the right. A two-panel treatment is used, with panels placed in horizontal arrangement.

IN PLANNING, WORK FROM THE OPENINGS:

In planning a plywood wall treatment, start at the openings with vertical joints and divide the plain wall spaces in an orderly pattern for the most pleasing effect. Vertical joints should be used at each side of the top of doors and at top and bottom of windows, as in Figures A, C and G. If the width of the wall is 10 feet or less, however, panels may be run horizontally with openings cut out, as in Figures B and E.

SUGGESTIONS FOR SPECIAL PATTERNS:

Where special patterns or patterns made up of small panels are desired, the recommended method is to sheath with 5/16" or 3/8" Plyscord placed horizontally, then apply the finish panels (Plypanel or Plywall) as designed. For additional technical data, see Sweet's File for Architects or write the Douglas Fir Plywood Association.

There are three grades of Douglas fir plywood panels made especially for various phases of wall construction. PLYWALL is made especially for standard wallboard use; PLYPANEL is a premium panel used for quality interior work where both sides are to be exposed as in built-ins; PLYSCORD is a utility panel made for subflooring or sheathing walls and roofs, or for interior walls which are to be covered with sanded plywood, acoustical materials, tile or linoleum.

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BY-LINES

EARLE A. BURT

Mr. Burt, chief deputy road commissioner, County of Los Angeles Road Department, received his B.S. degree from Throop College of Technology in 1915. He entered the service of the Los Angeles County Road Department in July, 1915, and has been continuously employed in various phases of road maintenance and construction since.

• • •

LYALL A. PARDEE

Lyall A. Pardee, senior civil engineer with the city of Los Angeles, attended California Institute of Technology from 1920 to 1923 taking courses in electrical engineering. Since that time he has been employed by the city of Los Angeles in the city engineer's office on street, highway and parkway design. He is now the principal assistant to the division engineer in charge of personnel designing portions of the $500,000,000 parkway system for the Los Angeles metropolitan area.

• • •

R. J. BLACKINTON

R. J. Blackinton attended California Institute of Technology and U.C.L.A. from 1934 to 1940, having received a B.S. degree in applied chemistry from the Institute in 1940. During this time he worked at color analysis and control in color motion picture processing at Cinecolor, Inc. Since 1937 he has been associated with Western States Lacquer Company as a chemist in charge of control and development work and in 1944 became a partner in the firm.

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ENGINEERING AND SCIENCE
Monthly
The Truth Shall Make You Free

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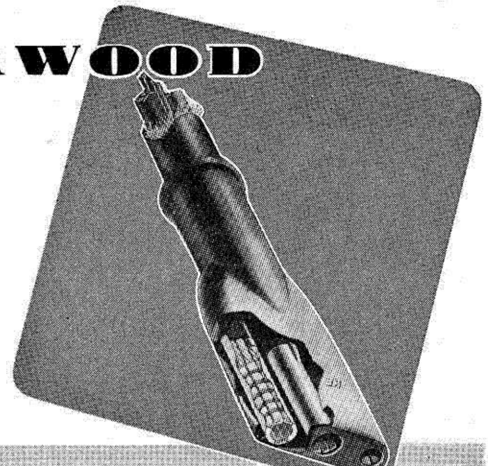

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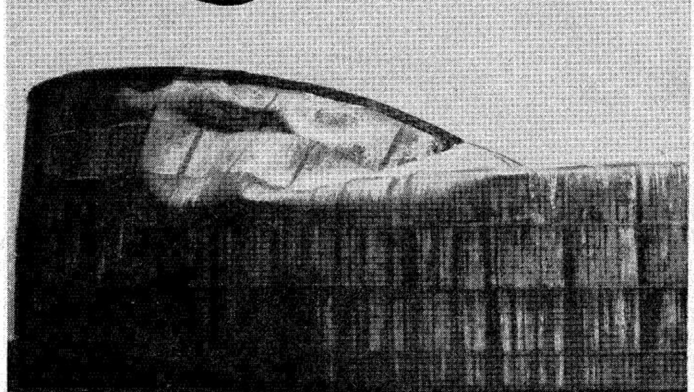

This photograph shows a portion of a steel oil storage tank damaged by fire. Lacy repaired the tank and restored it to service.

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ENGINEERING AND SCIENCE
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Vol. VIII, No. 5 May, 1945

Educational Institutions and Alumni

By E. A. BURT

TO be on guard against jumping at conclusions or taking things for granted is an ever-present responsibility. On occasion, review and appraisal of the situation is often helpful in maintaining a properly focused view of matters which we may be prone to take for granted. The relations and relative positions of an educational institution and its alumni may be illustrative of this type of condition.

In a broad sense, these two groups are a single agency and not separate units or interests. Great educational institutions are successful and beneficial in so far as they are able to provide an environment which fosters the acquisition and compilation of knowledge, while at the same time its application in a wise and intelligent manner is accomplished. These purposes are brought into realization in ways such as the maintenance of general and specialized laboratories, the detailing of men with particular interests and skills to research in special studies, and by other well known methods. It is not enough that one attend such an institution for a specified period and in effect be charged like a rocket and released on a specified day to pursue a fixed or erratic course until exhausted. It should be rather that by constant replenishment by contact with the source that the strength and usefulness of the product be ever increased and made more effective.

All graduates of scientific and engineering institutions probably will agree that their courses taken in college provided them with the basic tools with which to tackle the non-textbook problems in their chosen profession. They probably will agree that their education in the practice of their profession begins upon leaving the educational institution. Having agreed to these, one may conclude that after graduation their alma mater can play no further part in their education and that it becomes only fond memories to be resurrected once in a while at meetings of the alumni association or its chapters. This conclusion is far from correct. The educational institution and its alumni can be a mutual benefit association. This does not include the financial contributions of alumni to replenish the coffers of the college. As the world progresses in its knowledge of science and engineering it is reasonable to expect that a great educational institution devoted to this work will have many opportunities to pass on to its alumni as well as students, the benefits of its experience. Continued association with the institution through correspondence or personal discussion can be helpful to both institution and alumni.

The thought may at times come to the minds of some graduates that due to the highly advanced technical and scientific work of an institution, they are out of step with events and lag behind the trend of affairs. If there are those who have this thought it should be pointed out that even some slight association such as attendance at social gatherings, seminars, or lectures establishes the contact which has unlimited possibilities of growth and development. There is probably no way of determining the degree to which men have been, shall we say, inspired to do things by contact with those who are doing them. An alumni association is one way of maintaining the contacts and making new ones.

While we are thinking of the various advantages to the alumni, accruing from the maintenance of reasonably close contact with the parent institution, let us not overlook the possible contributions which may be reciprocated. Perhaps one of the most delicate problems in educational institutions is the creation of just the right amount of so-called practical contact with the realities of the outside world. In the handling of this relation, the alumni have the opportunity of a very practical contribution. A little thought in retrospect will recall the great void in our minds during undergraduate days, as to the inner workings of many well known scientific and engineering organizations. The opportunity is apparent, so let us each endeavor to encourage the undergraduate to become better acquainted in order that we may at least make this small contribution to improved relations.

These few brief thoughts have been expressed with the hope that they may stimulate an improved condition in the relations between educational institutions and their alumni.

Parkway Plans for Metropolitan Los Angeles

By LYALL A. PARDEE

THE full scope of postwar planning for the Los Angeles Metropolitan area embraces every department of civic affairs, and as the plans are carried into effect, their influence will be felt in every community, and in some measure by almost every individual living in the region.

The Parkway Plan is only one of the parts of this larger program of planning, but its place is near the top in interest, as well as in its importance to the people as a whole. The completed system of parkways will represent a very large investment of public funds, on which it will pay a handsome return in increased efficiency of automobile transportation. It will become a major unit in a mass transit system, thus permitting an even greater number of people to profit by the economy and convenience of parkway travel. And by no means least, its network of parklike rights-of-way will form the physical frame within which the pattern of a sprawling community will find its enduring form.

West of a line joining the east city boundary of Pasadena with the east city boundary of Long Beach, and extending from the mountains to the sea, lies an area of about 900 square miles, all of which is dependent upon and within the zone of direct influence of the city of Los Angeles. It contains a great diversity of peoples, of population densities and land uses, of climate and topography and its government and its local loyalties are divided among 32 civic corporations. Yet its people are one people, and its major problems are regional problems.

THE PARKWAY PLAN

In 1938 the Los Angeles Transportation Engineering Board was constituted for the purpose of studying the traffic needs of the whole community of cities, and recommending proper measures of relief. The members of this Board interested themselves primarily in mass transit facilities, and brought engineers of national reputation to assist in making impartial and comprehensive studies, unbiased by local prejudices. The report of the Board, submitted in 1939, recommended among other things the construction of a system of grade-separated limited-access highways, consisting of about 280 linear miles, and covering the entire region without reference to existing political boundaries.

The plan was often branded visionary, and the type of highway recommended was looked upon by many engineers as being mildly desirable, but wholly impossible to construct on a large scale, in spite of the fact that many miles of such roads already existed in the eastern United States, and had been widely copied in Germany and Italy. It may be owing to the successful completion of the Arroyo Seco Parkway project from Pasadena to Los Angeles that public agencies have come to accept the Parkway Plan as a workable, and vitally necessary, solution for transportation problems. Many engineering and planning bodies, both official and semi-official, have contributed to the plan as it now stands, and the wholehearted cooperation among them has been remarkable, not to say revolutionary.

Progress in construction has been slow, for while New York City was extending its system to about 300 linear miles, Los Angeles City has built 10. This includes the Cahuenga Pass link of the Hollywood Parkway, the Arroyo Seco Parkway from Pasadena to Los Angeles, and the recently opened Ramona Parkway, from the east city limits to the Los Angeles River.

Final plans for 26 miles of future parkways are now being prepared in the offices of the California State Division of Highways and the Los Angeles City Engineer, and not only will contract plans be ready when the war ends, but much of the required right-of-way will have been acquired so that there need be no delay in putting available men and equipment to work. The projects now under design include the Santa Ana and Hollywood Parkways, forming one artery from the east city boundary to the San Fernando Valley, via the Civic Center and Cahuenga Pass; the southerly extension of the Arroyo Seco-Harbor Parkway to Fifth Street, and the Sepulveda Parkway from Ventura Boulevard to Venice Boulevard.

This plan is in line with an orderly program of construction covering a theoretical 10-year period. The entire system was divided into 10 parts, of about equal estimated cost, and, on the assumption that these represented the divisions of a 10-year construction program, the several interested public agencies were asked to assign an order of priority. The answers, independently arrived at, showed complete unanimity as to the first two years. The map, *Fig. 1*, indicates that when this portion of the system is completed, this basic pattern of express highways, roughly cross-shaped, connecting all major areas, will serve as a foundation upon which the remainder of the system may be erected.

FREEDOM IN DESIGN

The design of parkways presents to the engineer a new set of problems, and at the same time offers him a wholly unaccustomed freedom in solving them. Surface highways, and more particularly surface streets, are usually confined within very limited rights-of-way, and good design has often to be abandoned in order to salvage existing improvements or to avoid injury to the rights of abutting property. In the case of limited-access highways, such property rights are somewhat abridged, but in the case of parkways, the abutting property retains no access rights whatever, and the designer has one less handicap to contend with.

Another characteristic of parkways which generally reacts to the designer's benefit is that all crossings are on separated grades. In passing through an existing street pattern, all major streets are carried across, either under or over the parkway, and intermediate crossings are provided at intervals of about one-quarter mile. This arrangement usually results in the parkway grades being 20 to 25 feet above or below the ground level, and in the transition from one to the other the designer can often take advantage of a rough terrain in a way impossible with a surface highway.

To compensate for these advantages, parkways combine most of the old problems with a host of new ones, and the whole sums up to the most interesting job of

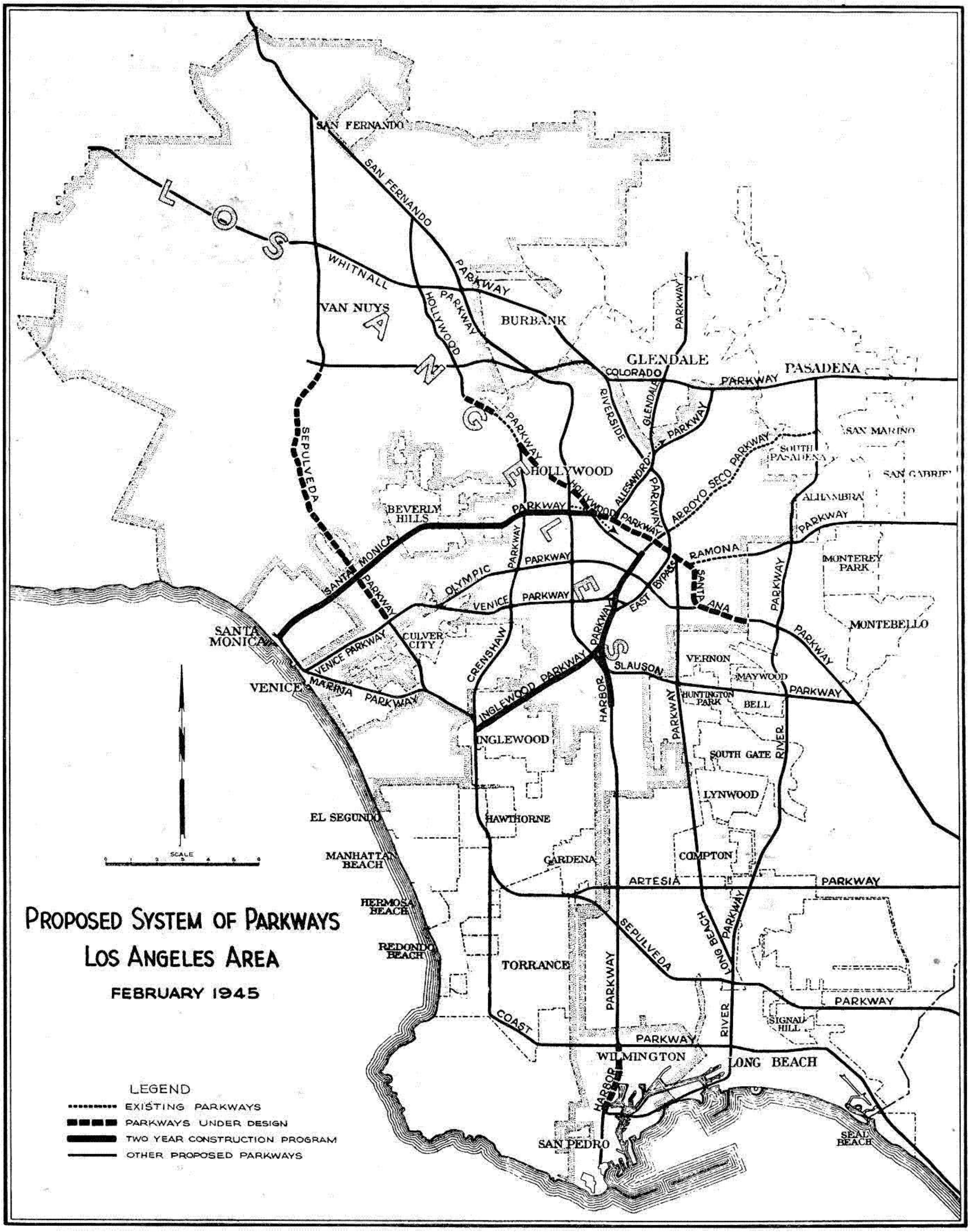
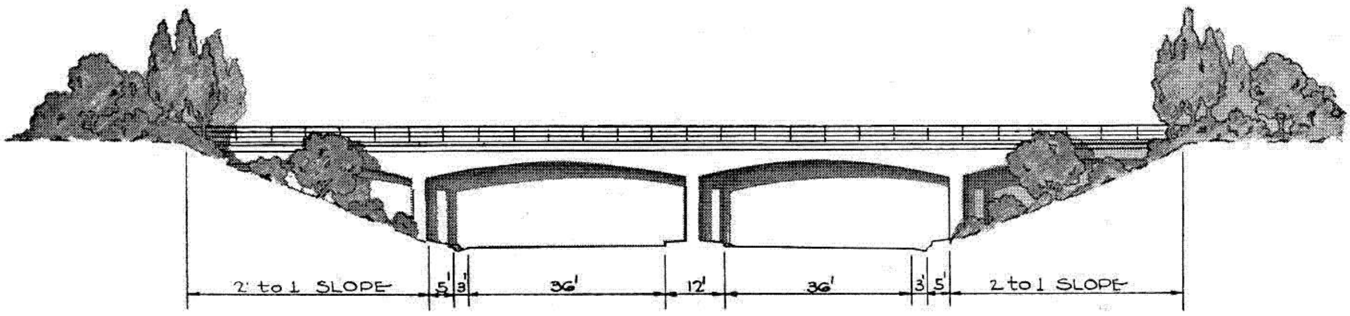


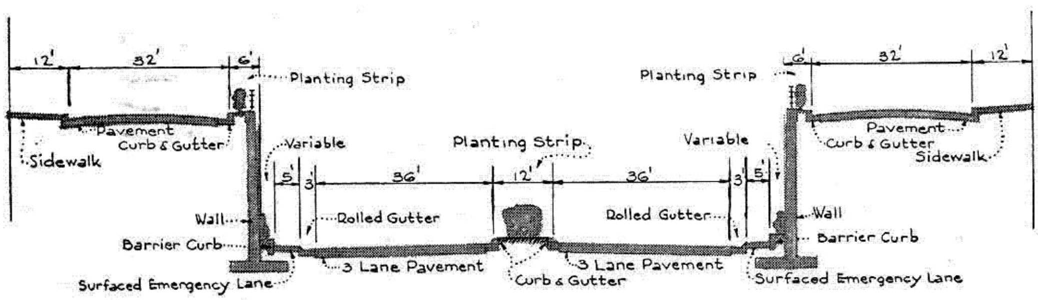
FIG. 1. Map of the proposed Los Angeles Parkway System, showing the order in which construction will proceed.

designing that has ever fallen to the lot of highway engineers. Preliminary design assumes an importance out of all proportion to its former low estate, as it becomes necessary to search out in advance, and find an answer for, every question that will be raised by the proposed construction, and to coordinate, sometimes far in advance, the proposed work with other parts of the system to be built in the more distant future.

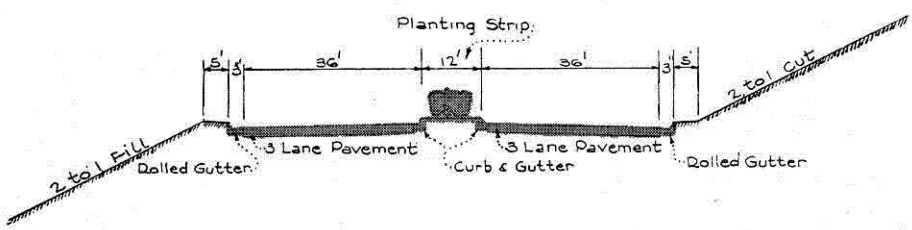
Selection of the general route is the first problem, and it is interesting to note that after five years of



TYPICAL CROSS SECTION
OF PARKWAY IN CUT
SHOWING LANDSCAPING



TYPICAL CROSS SECTION
BETWEEN RETAINING WALLS
WITH ONE-WAY SERVICE ROADS



TYPICAL CROSS SECTION
IN
CUT AND FILL

FIG. 2. Several typical parkway cross sections designed to meet differing local conditions. The middle drawing illustrates the section to be used for the Hollywood Parkway through the Los Angeles Civic Center.

study by many planners and engineers, no major changes have been recommended in the original pattern laid out by the Transportation Engineering Board. There have been many changes in the detail of location, and as studies progress there will be many more, but the basic plan remains unaltered.

INVESTIGATION AND ESTIMATE

Many express highways, and especially interurban routes, are built primarily as a means of getting from one terminus to another, but this is rarely true of metropolitan parkways. The Santa Monica Parkway, for example, will provide means to avoid surface traffic congestion from the central business district to the beach cities, but by far its greatest value will be in the service it will render to Westwood, Beverly Hills, and the Wilshire and East Hollywood districts. It becomes necessary to provide the best possible interchanges between the parkway and surface street systems, without impairing the terminal-to-terminal facility of the former, and in selecting a parkway route, this is a consideration of the first importance.

The present location of centers of population and the highway routes needed for intercommunication among them were largely dictated by geography, and in serving the same general needs, the parkway system encounters few large new problems in topography. Higher standards of gradient and alignment find compensation in the flexibility of an off-surface grade, and in the great economies in excavation costs brought about by recently developed earth-moving equipment. Topography remains a vital factor in location, and in the mountainous sections of the Sepulveda and Hollywood routes, excellent use has been made of aerial surveys in the preparation of photographic and contour maps. This method will no doubt be used even more widely when wartime restrictions are removed.

Owing to the high cost per mile for this type of highway, and to the permanent nature of the improvement, the relatively small expense of a thorough preliminary investigation is well justified. It is not uncommon to explore four or five possible alternates, making complete tentative plans, profiles and cost estimates of each for purposes of comparison, before making a final choice among them. Where costs of land acquisition often equal and sometimes even exceed the cost of construction, this may become a very large item indeed, and will often dictate final alignments. It might be supposed that the proper place for a new parkway would be along the line of an existing boulevard, but as a rule, the required amount of land can be purchased a few blocks off the boulevard at a much lower price, and the boulevard be retained as a useful part of the surface street system. Economy in land and improvement cost is given full value, but is not regarded as the cardinal rule, nor is present economy permitted to outweigh the future safety and convenience of thousands of highway-users.

The same traffic counts and flow charts which proved, in the first instance, that a parkway was called for in a given location are used again to determine the most desirable width, which depends upon the volume of traffic to be carried. Studies of existing traffic in surface streets, combined with source and destination diagrams, modified by estimates of probable increases in automobile use and any foreseen or predicted changes in the local conditions—all these must be weighed, and modified again by estimates of the proportion of all traffic which may be diverted into the proposed parkway. It is evident that the resulting estimate is open to argument, but a higher degree of accuracy, while theoretically desirable, is not necessary in fact. It is possible, by the use of a wide center strip, to provide for the later

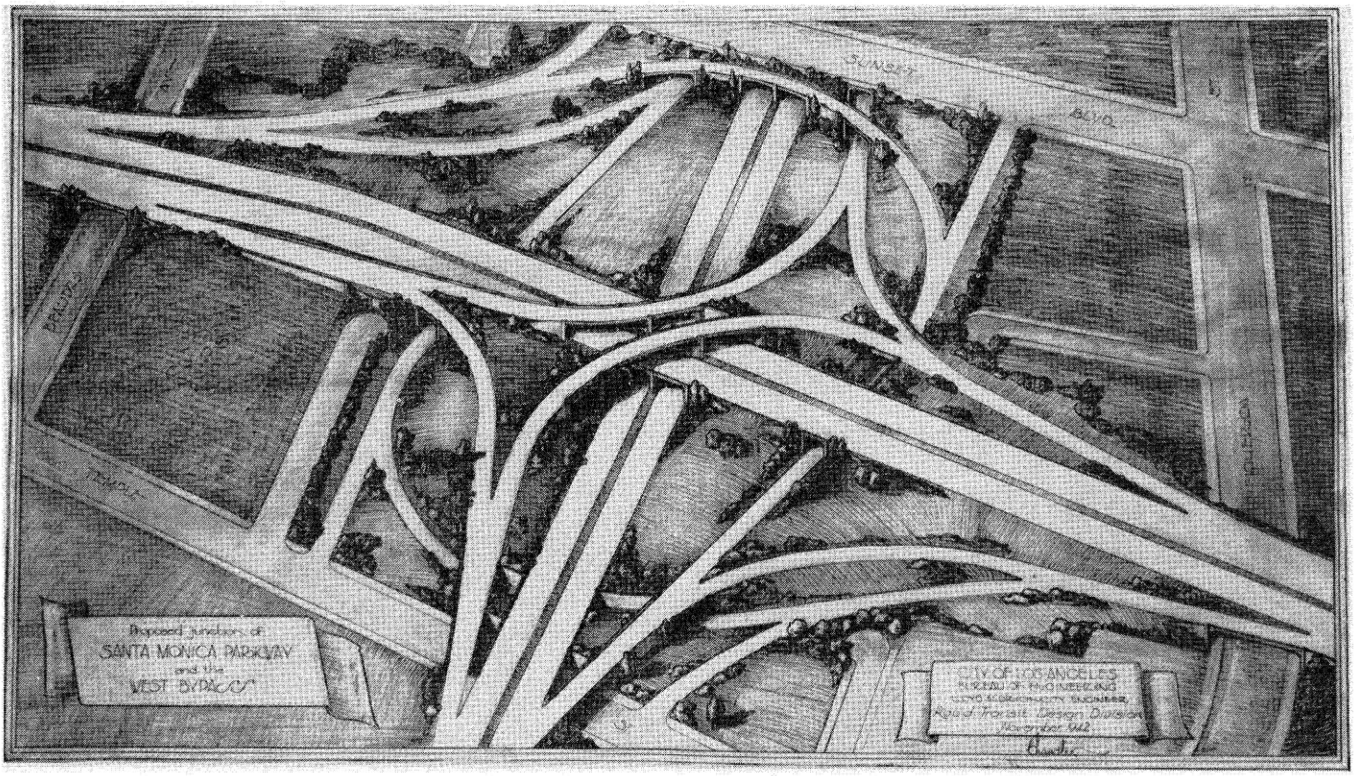


FIG. 3. Perspective drawing of a parkway crossing, all right and left turns being provided for. This design is based on a three-level central bridge.

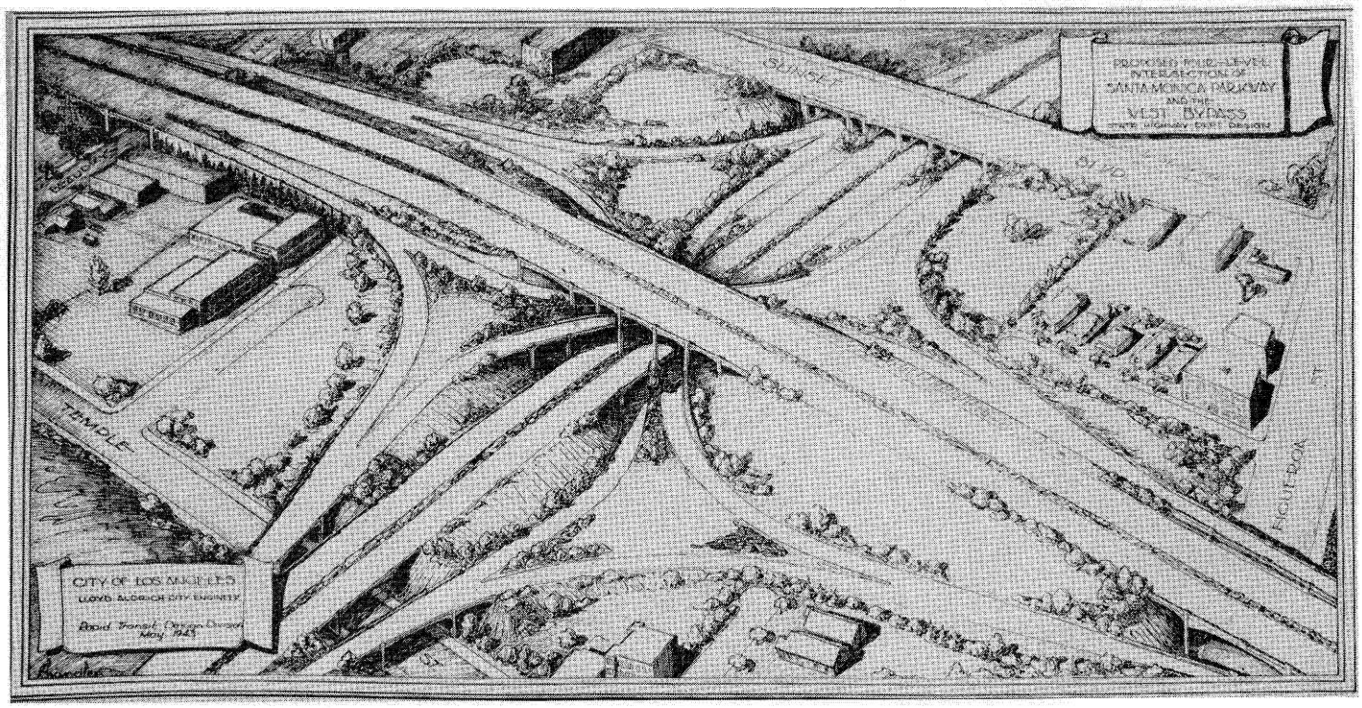


FIG. 4. Same intersection shown in Fig. 3, but with a solution based on a four-level central bridge. This was selected in preference to the other design, and working drawings are being made.

addition of another lane, and in one or two cases, this may be done.

Generally, however, three lanes each way is the optimum width, even though the volume of expected traffic indicates that two might be made to serve. Three lanes allow two for fast through traffic and one for slower cars and for cars entering and leaving the parkway. Four lanes invite weaving by fast drivers, and five are definitely dangerous. If the traffic is too heavy for four lanes, another parkway would seem to be indicated. Plans are being made for four lanes each way in a portion of the Hollywood Parkway, but as a rule three will be used as a standard. The working capacity of a three-lane parkway is estimated to be 31,000 cars in 24 hours, in both directions, and the maximum capacity is said to be double this. So broad a differential does much to compensate for inaccuracies in estimated volumes.

DESIGN FOR SAFETY

To complete the picture of the parkway in cross-section, median strips 12 or 15 feet in width are being designed. The latter is recommended as a standard for interregional highways, and it seems probable that the future tendency will be to widen these strips until they reach 50 or 60 feet, both in the interests of landscaping, and for their light-absorbing value. Lanes are 12 feet wide, and wherever possible, an emergency stopping lane will be provided along the right side, as shown in *Fig. 2.* This will consist of a three-foot gutter with a rolled, mountable curb, and a planted berm not less than five feet wide, and stopping will be permitted only in real emergencies. Rights-of-way are made wide enough to accommodate two-to-one slopes for cuts and fills wherever possible. When width permits, such slopes will be flattened, and in exceptional circumstances they may be somewhat steepened, or even replaced by retaining walls for short distances. In all cases median strips and side slopes will be landscaped, and properly fenced to prevent the entrance of pedestrians to the roadways.

After the volume of traffic, the speed at which it will travel becomes the governing factor. A design speed of 60 miles per hour has been adopted as the parkway standard, with a few miles in the central area, where entrances and exits are frequent, being limited to 50 miles. Thirty-five miles per hour will be the usual minimum for ramps and interchange roads. Uniformity of standards throughout the system is very important, and downward modifications will need to be very clearly marked.

The design speed is taken to be the "safe speed" for the average driver, and all of the elements of surface design will be referred to it. These include degrees of curvature, the introduction of spiral or easement curves, the amount of superelevation on curves, ruling grades and vertical and horizontal sight distances. The American Association of State Highway Officials has lately published, in a series of pamphlets, definitive policies covering these and other matters of design, and preparation of the standards which are now being used by the city engineer and the State Division of Highways was governed very largely by A.A.S.H.O. recommendations. The policies are based on recent and extensive research by many agencies, and this is probably the first time that highway engineers have had available such a complete and authoritative digest of the best in current practice.

The effect of grades up to seven per cent is of much less importance to passenger automobiles than to trucks and buses, and it is assumed that most routes will be used by express buses. Bus stop facilities at parkway level, separated from through traffic, are under design for the Hollywood Parkway at transfer points which are essential to the best operation of the transit system. Desirable maximum grades are set at four per cent on main roadways, six per cent on upgrade, and seven per cent on downgrade ramps or interchanges, but all of these are subject to a one per cent increase when such change is dictated by better overall design or by significant economy.

Drainage facilities will be more extensive than is the practice on surface streets, the intention being to protect the through lanes from any accidental dry weather flow, and to reduce to a minimum the depth and width of flowing water during storms. The low crowns used in parkway design and the elimination of local depressions in the traveled lanes will make many more storm drain catch basins necessary, but the added safety is deemed to be well worth the cost.

Obviously, the introduction of a grade-separated parkway will make serious changes in the pattern of local streets. Some of these will of necessity terminate in cul-de-sacs, while in other cases, circulation can be provided by building new service roads, more or less parallel with the parkway. Studies of local conditions are called for, taking into account the locations of schools, fire stations, bus and car stops, shopping districts and other neighborhood centers. Pedestrian bridges or subways are located between vehicular crossings where necessary, and local convenience is consulted in the location of ramps, service roads and other facilities. The maintenance of existing sewers, storm drains and other substructures raises problems that are sometimes difficult to solve, as in the Civic Center area, where the Hollywood-Santa Ana Parkway crosses the whole system of north-south streets, and the heaviest utility lines must be kept in service.

JUNCTIONS AND CROSSINGS

The most interesting problems, from the standpoint of design, are those involved in the junction or crossing of parkways. Every case is unique in some respects, and not one has yet been found for which a clover leaf proved to be a desirable solution. At the junction of the Hollywood and Santa Monica Parkways, in the vicinity of Vermont Avenue, it was necessary to design a *Y*-type junction which can later be expanded into an *X*-shaped crossing to make possible the east-bound extension of the Santa Monica Parkway.

The difficulties arise out of the necessity for separating all grades, and become most complex at points where all right and left turning movements must be cared for. This is the case at the Hollywood-Arroyo Seco Parkway crossing, where every turning movement may be expected to be heavy at some time of every day. *Figs. 3 and 4* show in the perspective two of the many schemes developed in the course of studying this location. *Fig. 3* is based on a three-level central bridge, while in *Fig. 4* a bridge of four separate levels serves the same purposes at a smaller first cost. Final plans for the four-level bridge are now being drawn, and probably it will be the first structure of its kind to be erected.

A plan view of a multi-level crossing looks like a cross-section of chaos. The perspective drawings, however, clear this up a little, and in the structure itself no great compexity will appear to the motorist. If he wishes to turn, he will leave the parkway on the right, or slow speed side, using an added decelerating lane to adjust from parkway to turning speed, just as he does at all other points in the system except where turning movements are approximately equal in volume. He then turns right or left according to his destination, and enters the other parkway via an accelerating lane added to its right side. He is not called upon to execute a complete right hand loop in order to make a left turn, as in the clover leaf design, and he is presented with only one course at a time.

Los Angeles has set up as a goal a complete metropolitan system of parkways, and this has the indispensable virtue of receding as it is approached, for other parkways, not yet foreseen, will be added to the present system as time moves on. Well within that goal have been set certain limited objectives, and plans are already far enough advanced to provide assurance that they will be accomplished. In the meantime, some new ones will be set up.

THIS MONTH'S COVER

The illustration shown on the cover of the May issue of *Engineering and Science Monthly* repeats the central design of *Fig. 3* shown on page 7, being a perspective drawing of a parkway crossing based on a three-level central bridge.

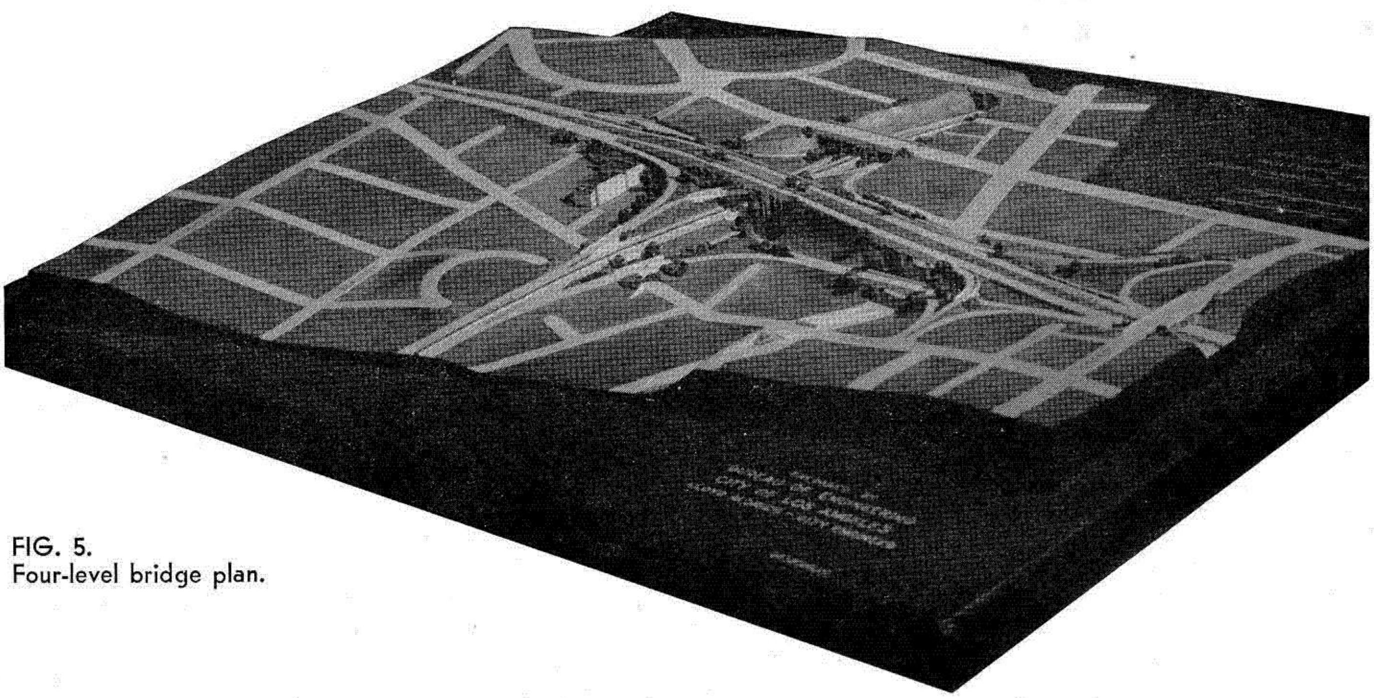


FIG. 5.
Four-level bridge plan.

Some Optical Problems of the

Paint, Varnish and Lacquer Industry

By R. J. BLACKINTON

THE art of making paints is one of the oldest, yet by some quirk of fate one of the latest to be given careful scientific study. Probably the reason lies in the complexity of the chemical and physical problems involved, but more likely is it due to the adequacy and simplicity of the two-component mixture of linseed oil and white lead that has served the general protective coating demands so well for the past two hundred and fifty years. This pigment, basic lead carbonate, acted not only as a light reflectant, but also as an oxidation catalyst or "drier," a buffer to absorb acid decomposition products, a film strengthener, and, after reacting with free fatty acids, as a plasticizer and water repellent.

White lead, however, had two serious handicaps: it darkened badly in sulfurous atmospheres, and it was very inefficient as a light reflector; i. e., it was not very opaque. In attempting to improve on these properties a host of problems were uncovered, both physical and chemical. We shall, however, in this article, cover only the optical problems involved in films of transparent varnishes and lacquers and opaque, pigmented films. The phenomena of gloss, degree of whiteness and hiding power will be discussed. The physical laws governing these problems will be presented and an attempt made to interpret them on a practical level.

GLOSS

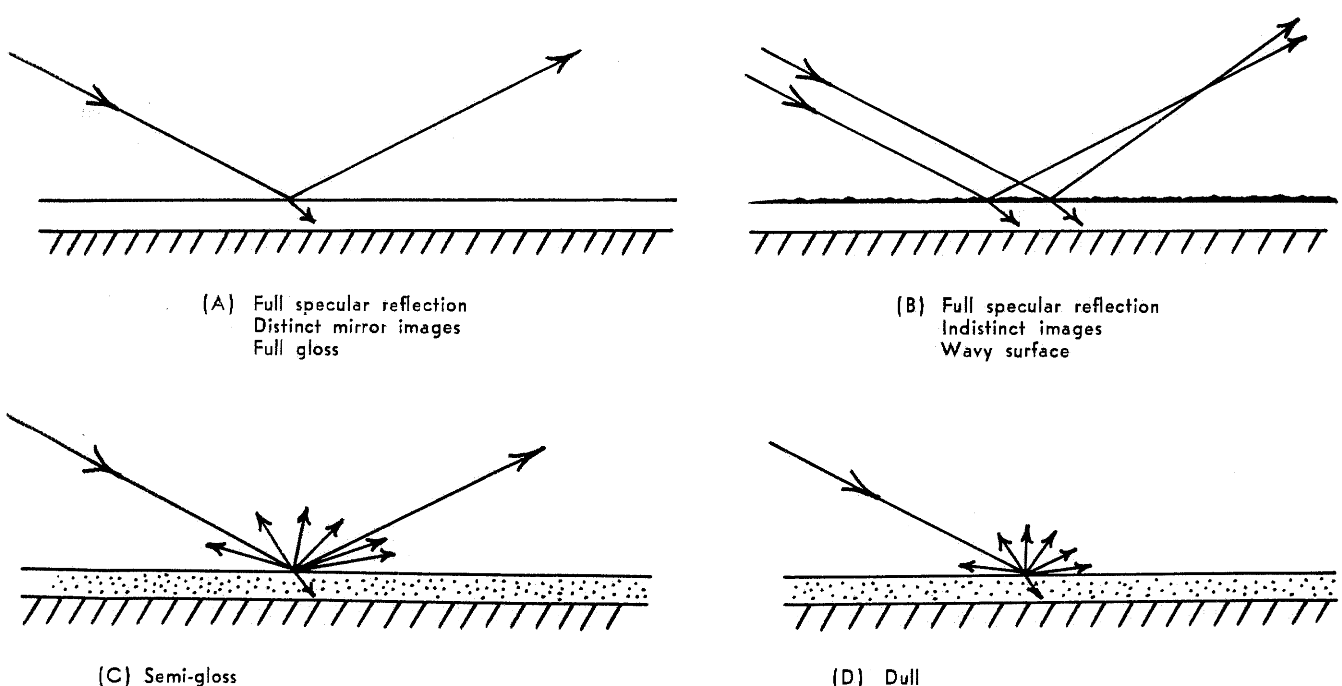
The values of specular reflection are determined by the well-known relations developed by Fresnel, which simplify to

$$\frac{I}{I_o} = \left[\frac{n-1}{n+1}\right]^2$$

when the incident light is perpendicular to the surface whose index of refraction in air is n. For other angles of incidence the function is different, but the constants are the same, so that the gloss of a smooth film at a given angle is determined solely by its index of refraction. For example, the average varnish or lacquer film has an index about the same as a light crown glass (1.52), which corresponds to about 4.2 per cent at 90 degrees. The most refractive commercially used resins are the highly chlorinated diphenyls, which run as high as 1.67, giving 6.2 per cent normal gloss. The available range of true specular reflections for smooth films is therefore rather limited, the highest being only some 50 per cent greater than the minimum.

In spite of this apparently narrow range there is a vast difference in the psychological responses to specular gloss. This field is generally divided into at least three groups: objective gloss, which is the true specular reflection discussed above, subjective gloss, and sharpness-of-image reflection. (See *Fig. 1.*)

Objective gloss is best demonstrated by the visual difference in gloss between two films of the same resin.



(A) Full specular reflection
Distinct mirror images
Full gloss

(B) Full specular reflection
Indistinct images
Wavy surface

(C) Semi-gloss
Distinct images
Partially filled with transparent "pigment"

(D) Dull
No images
Heavily filled with transparent "pigment"

FIG. 1. Specular reflection of clear films.

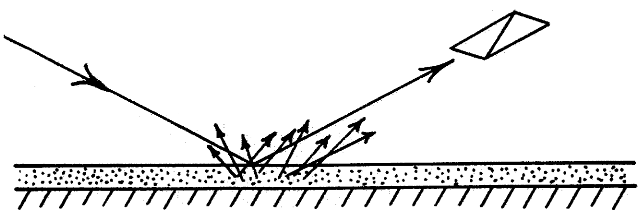


FIG. 2. Measuring subjective gloss with Nicol prism, using background of pigmented film as reference. Specular reflection of opaque pigmented film. Glossy white enamels have low subjective gloss. Glossy black enamels have high subjective gloss.

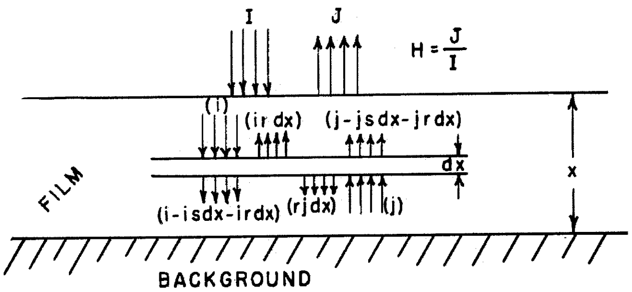


FIG. 3. Derivation of the Kubelka reflectance equation.

one of which is pigmented white and the other black. The latter always appears much "glossier" than the former, although the specular gloss of the two must be equal, and indeed is, by specular reflection measurements. The difference is attributed to the fact that the eye judges gloss by comparing the specularly reflected light with the surrounding field, which is governed by the diffuse reflecting power of the pigment. Various attempts have been made to record this psychological value and some are on apparently sound principles. One rather ingenious direct method is to use a Nicol prism to evaluate the degree of polarity of the light reflected at the average polarizing angle of reflection. This gives reasonably good results, since the specularly reflected light at this angle is largely polarized, while that diffusely reflected is not. (See *Fig. 2.*)

Specular reflection, is reported in terms of approximately absolute values, since the meter is calibrated with polished black glass ("carrara glass") of known index of refraction. Using Fresnel's formula, the specular gloss is calculated for the angle under measurement. The usual angle for specular gloss measurements is 60 degrees incidence and 60 degrees reflection. For many camouflage paints a grazing angle of 85 degrees incidence (5 degrees off the plane of the test panel) is used. This is necessary, since too fine grinding of the flatting agent may give a poor distribution of reflected intensities and may give telltale glancing of sunlight.

The flatting agents or materials used to reduce specular gloss of clear coatings must have approximately the same index of refraction as the dry film in which they are used, in order not to impart opacity along with dullness. Many materials have been used, such as cornstarch, the bi- and tri-valent metal soaps such as calcium, zinc, aluminum and barium stearates, oleates or palmitates. Some hard insoluble natural waxes, such as carnauba, have also been used successfully. One of the most successful materials is a recently developed dehydrated silica gel, so carefully dehydrated that it is nearly an aerogel. This type is desirable, since it is non-settling, chemically inert and close enough in index of refraction to the average lacquer and varnish films to be practically invisible. In use these materials are simply tumbled in a pebble mill with the vehicle until the desired particle size obtains. Extremely fine grinding is undesirable, since the particles must be large enough to give irregularity to the surface of the film; on the other hand they must be kept below the limit of naked-eye resolution in order to give a pleasingly smooth surface.

REFLECTANCE

Considering now the case of diffuse reflectance from pigment particles within the film, investigations have been made into the theoretical aspect of reflectance in terms of film thickness. Many methods of approach have been tried, and one, by Rhodes and Fonda in 1926, arrived at the proper although abridged logarithmic relation by an over-simplified algebraic approach. Kubelka and Munk in 1931* seem to have been the first to derive a comprehensive relation on a reasonably sound basis. Their approach can be most easily explained by the accompanying schematic figure, which represents the various light intensities on a differential element of the film. The incident and reflected light rays are separated from each other for simplicity.

As light penetrates the differential element, part is absorbed, part reflected and the remainder transmitted. This happens to the reflected light coming upward exactly as for the incident light traveling downward. In *Fig. 3*, i represents incident intensity, j reflected intensity, s the coefficient of absorption, and r the coefficient of remission. The latter factor is similar to absorption in that it impedes transmission, but instead of being converted to heat the light is merely reflected. It includes the Raleigh light-scattering effects as well as reflection and refraction from particles much larger than wavelength dimensions.

If we subtract the light intensity traveling downward away from the element from that incident downward upon it, we shall have the differential change in incident light intensity:

$$-di = (i - isdx - irdx + rjdx) - i = -(s+r)\ idx + rjdx$$

and likewise

$$dj = (j - jsdx - jrdx + ridx) - j = -(s+r)\ jdx + ridx$$

By definition, absolute reflectance, H, is the ratio of the total reflected light to that incident on the surface:

$$H = \frac{J}{I} \text{ or } dh = d\left(\frac{j}{i}\right).$$

These are simultaneous first order differential equations relating reflectance to film thickness. The solution is

$$H = \frac{H_\infty - H' + H_\infty(1 - H'H_\infty)\, e^{rx\left(\frac{1-H'H_\infty}{H_\infty}\right)}}{H_\infty(H_\infty - H') + (1 - H'H_\infty)\, e^{rx\left(\frac{1-H'H_\infty}{H_\infty}\right)}}$$

where H_{oo} is the ultimate reflectance of a very thick film of the paint and H' is the reflectance of the background.

Before arriving at the final equation above, it was necessary to solve for the ultimate reflectance. This is done by integrating between limits of "*o*" and "*oo*" for film thickness. This relation is very interesting in that the ultimate brightness is found to be a function only

*"*Ein Beitrag Zur Optik Der Farbanstriche*," Z. tech. Physik, 12, 593.

of the ratio of the coefficient of absorption to that of remission:

$$H_{\infty} = 1 + \frac{S}{R} - \sqrt{\left(1 + \frac{S}{R}\right)^2 - 1}$$

It is apparent that for the ideal white pigment the coefficient of absorption, *s*, must be zero, which means that it would be perfectly transparent if it were in massive form. Since this is not completely realized even with pure chemicals, the value of *r* must be large to give a high reflectance. To get an actual value for *r* it would be necessary to measure the coefficient of absorption on the pigment and on the vehicle separately in massive form and then calculate the composite coefficient from the percentage composition of each in the paint film. The absolute value of *r* would then be:

$$r = \frac{2 H_{\infty} S}{(1 - H_{\infty})^2}$$

The constant, *r*, as pointed out above, is the sum of the individual effects of true scattering, reflection and refraction. As a pigment is reduced in particle size, these three factors change markedly and individually. Reflection and refraction increase as particle size is reduced until wave-length dimensions are reached, say about 0.5 micron; then they must diminish rapidly, since these phenomena depend upon mechanics of complete wave fronts which must comprise at least the dimensions of a single wave. As the particles are reduced in size below this region, the Raleigh scattering commences. Experiments have shown that too fine grinding of pigments reduces the whiteness and hiding power, which is in agreement with the above theory, since the value of *s* must remain constant regardless of particle size. It should be emphasized again that a pigment is white only by virtue of the light acting on the surface of the pigment particle and not inside it, for the particle itself is wholly transparent like glass, if it is a good white pigment.

If $r = o$ we have the condition of absorption without reflection which is typical of dyes in solid solution in varnish film. If the absorption band extends clear across the visual spectrum, a jet black will result. This is a most important factor in making jet black enamels. The average person probably does not realize that the paint chemist has as much difficulty, if not more, in making a really black "black" as is encountered in making "pure" whites. Ordinary lampblack is gray by comparison with a modern jet carbon black.

In the manufacture of jet black carbon pigment it is necessary to burn the gaseous fuel at high heat and deposit the carbon rapidly by impinging the hot flames on cold plates. The fine particles of carbon thus formed must be carefully dispersed in a vehicle which will thoroughly wet the individual particles and remove the absorbed layer of air or gases. Under these conditions the particle sizes are kept down to about 25 milimicrons, which are so small, compared to wave-lengths of light, that the coefficient of remission is reduced considerably, and this, according to theory and practice, gives much less reflection or greater blackness.

Before applying the general reflection equation to the problem of measuring hiding power it would be of interest to mention some of the actual methods in use.

The oldest and still most widely used method of determining the hiding power is to brush the paint evenly over a given-sized checkerboard, or other pattern consisting of black and white areas, until the surface appears uniformly light. The weight of paint required to produce this uniformity is used as the index. But who is to say just when the board appears uniform?

Munsell carried out exhaustive experiments to determine the least difference in brightness which the average eye could detect. The ratio of the least detectable increase in brightness to the total brightness had been assumed to be constant by Bouger a century ago and was set at about 0.015 by himself and later by Fechner, after whom this fraction was named. However, the Fechner fraction—with the normal daylight accommodated eye—was found by Munsell to vary from about 0.8 at the threshold of visibility to about 0.018 at average reading brightness. Its minimum value was found to vary from 0.008 to 0.020 in a group of six individuals. In other words neither the constant in the logarithmic stimulus-response relation nor the logarithmic relation itself (Fechner's law) was valid over the full range of vision. However, over the ordinary working and reading range of light intensities from about 10 to 75 foot candles the Fechner fraction of a given individual was found to be reasonably constant.

Further discrepancies in brush-out tests pointed to the probability of a much smaller average value for the Fechner fraction. Exhaustive tests made by Kraemer and Schupp on various patterns of black and white paint-out boards permitted a statistical method of evaluation in which the particular pattern and its position in a group of the test boards had to be named. This experiment showed that with a pattern consisting only of two halves with a shaded line of demarcation between the black and white halves the classical value of 0.015 was confirmed. But a sharp alternate design was much more easily discerned and an average value of 0.004 was found to hold for it.

The necessity of determining the minimum value of the Fechner fraction can be seen quickly if a plot is made of per cent diffuse reflectance against spreading rate in square feet per gallon. In *Fig. 4* a hiding power value of 83 square feet per gallon would be named by an individual whose Fechner fraction is 0.020, but another observer with an acuity of 0.004 would report only 57 square feet per gallon. Thus, if they were competing on a given specification, the second formulator would penalize himself to the extent of about 50 per cent more pigment cost than the first one.

To overcome this trouble two methods are commonly used. A.S.T.M. prescribes a test board under standardized viewing conditions for comparison only with a standard paint. The result merely designates equality, inferiority or superiority. The other test gives spreading rate *required to give a designated contrast ratio*. The contrast ratio is the ratio of the paint's reflectance over the black base to that over the white base. To determine this value it is necessary to apply the paint over black and over white backgrounds at known rates or film thicknesses and to determine photometrically the reflectance compared to some standard reference. Pure magnesium oxide smoke-deposits are commonly used as the 100 per cent reflectance reference. The logarithms of these two reflectances are plotted against rate in square feet per gallon and the spreading rate is noted where the two convergent lines are separated by a distance equal to the log of the designated contrast ratio. This gives the hiding power in square feet per gallon. A convenient method is to spray a good many tared clear glass slides with increasing amounts of the paint, and then, after

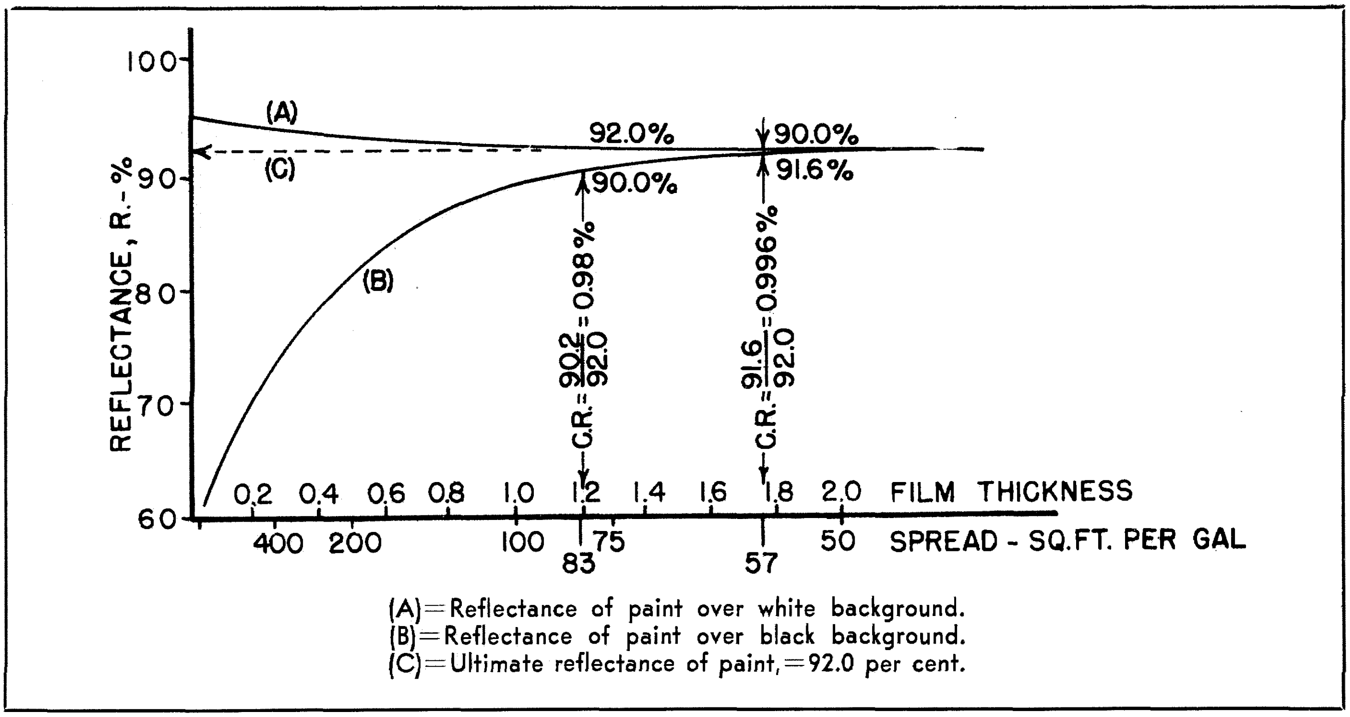


FIG. 4. Reflectance of white paint on black and white bases.

drying thoroughly, to weigh them. The spreading rate may then be calculated from the weight of film, the area, the non-volatile content of the paint and its specific gravity. The reflectance of each slide is then measured by *placing it first over a white background, then over* a black one. The curves are then made as described above.

Another more convenient method than either of the two described above, but less accurate than the photometric method, is the use of the cryptometer. It is a glass plate with pegs at one end so as to form a wedge of the liquid paint when pressed down onto a flat surface. The distance up the wedge to obscure a black and white pattern below is noted. Knowing the slope of the wedge and the distance up the slope, one may read off directly the film thickness and consequently the spreading rate in square feet per gallon. This method suffers the same psychological uncertainty as the visual brush-test. A photometer can be used in connection with the wedge. In this case a straight ribbon filament lamp is used and a sharp image is formed laterally across the movable wedge. The whole wedge assembly can be moved laterally to allow the image to fall first over the black and then over the white section below the wedge. By observing how far up the wedge the filament image lies, one can determine the thickness. The log-reflectances are then plotted against the spreading rate in square feet per gallon as indicated above. Naturally only wet paint can be measured by this method, and there is usually an increase in hiding power when the volatiles leave the film.

The general reflection equation may be modified to give hiding power figures directly, for whites and near-whites. The hiding power is given in square feet per gallon which is secured by solving the reflectance equation for $\frac{1}{x}$ and multiplying by the cubic feet of dry paint in a gallon of liquid paint.

This gives

$$\frac{1}{X} = \frac{r\left(\frac{1}{H_\infty} - H_\infty\right)}{\ln\left[\dfrac{\left(\frac{1}{H_\infty} - H\right)(H' - H_\infty)}{(H_\infty - H)\left(H' - \frac{1}{H_\infty}\right)}\right]}$$

If we substitute the value of the Fechner fraction *F*, for

$$\frac{H_\infty - H}{H_\infty}$$

and let the background be black, $H' = O$, the equation reduces to hiding power

$$\frac{1}{X} = \frac{r\left(\frac{1}{H_\infty} - H_\infty\right)}{\ln\left[\dfrac{1-(1-F)H_\infty^2}{F}\right]}$$

Here we see that all-important principle that the hiding power of a white paint is a function of its ultimate brightness, or whiteness. For the ideally pure white, where $s = o$, the hiding power would be extremely poor. To demonstrate the great effect on hiding power of adding a small amount of black to the white paint to reduce its brightness, a curve is presented in *Fig.* 5 which is based on a Fechner fraction of 0.004; such as when the black background has been lightened up to within 0.4 per cent of the ultimate brightness, the surface is called completely hidden.

Thus the hiding power of one of the whitest paints it is possible to make with present raw materials can be increased 50 per cent simply by adding enough black to reduce the relative brightness from 93 per cent to 80 per cent. The latter brightness would still be called

TABLE NO. I

Pigment	Index of Refraction	* $\left(\frac{n-1.50}{n+1.50}\right)^2$	Hiding Power, Approx. Sq. Ft./Lb.
Silica, SiO_2	1.55	0.0003	
Whiting, Calcium Carbonate	1.60	0.001	1
Basic Sulfate white lead	1.93	0.015	14
Basic Carbonate white lead	1.95	0.017	23
Zinc Oxide	2.02	0.022	28
Antimony Oxide	2.20	0.036	30
Zinc Sulfide	2.37	0.051	45
Titanium Oxide, TiO_2			
Anatase Crystal System	2.55	0.068	65
Rutile Crystal System	2.76	0.087	80

* Average Vehicle index = 1.50

a good white—about the same as average white paper. Actually the tinted paint often appears whiter because it is possible thereby to correct the slight yellow cast which is always present in the brightest enamels. All common white pigments have a slight absorption in the blue end of the spectrum and most vehicles exaggerate this defect. Since in correcting this absorption we are not at liberty to increase reflectance, we must add a complementary shade to pull the whole visual reflectance down to the minimum value in the blue end. The remarkable economy in reduced pigment content of such controlled paints is apparent from the curve in *Fig. 5.*

In connection with the physical significance of the term *r*, the coefficient of remission or scattering, it might be emphasized that this constant gets its value primarily from the relative index of refraction of the pigment and the vehicle. The 90-degree reflection formula of Fresnel's gives a semi-quantitative measure of the pigment's hiding power, since it contributes to the two principal phenomena of reflection and refraction. The true Raleigh scattering effect does not contribute much, since the particle size of a properly prepared pigment is above that required for this effect. Table No. I will give a quick answer to the question of why the titanium oxide industry grew up in such a hurry!

In connection with the hiding power question an interesting case came out of the infrared camouflage paint development. As is well known now, the greens made from Prussian blue and yellow photograph much darker in the near infrared region (7000-9000 Å) than does green foliage of the same visual green shade. To overcome this it is common practice to replace the Prussian blue with ultramarine blue, or, better still, with copper phthalocyanine blue, which does not have the sharp infrared absorption band that Prussian blue has.

Infrared reflectance tests were made by photographing, on infrared plates, the test-panels, which were simply brushed out to give good visual hiding power. Persistent discrepancies between testing agencies finally indicated that, although the hiding power of the visual color was fully complete, in the infrared it was far from complete.

If the hiding power equation given above is referred to, it will be noticed that the coefficient of remission is in the numerator. Now this constant is largely dependent upon the relative difference in index of refraction between the pigment and the vehicle, since that is the contributing factor in its refractive powers. Since indexes of refraction become less with increasing wave-length, the net result is a great reduction in the value of r as the wave-length increases, roughly in proportion to the change in the function

$$\left[\frac{n_p - n_v}{n_p + n_v}\right]^2$$

where n_p and n_v are in the indexes of refraction of pigment and vehicle respectively.

Since the value of the ultimate brightness was made roughly constant by use of the proper pigments, the net result is an indicated decrease in infrared hiding power. This is the converse of the case mentioned in connection with the ultimate brightness-hiding power relation, where r remained constant and the coefficient of absorption was increased by adding black, thereby greatly increasing hiding power.

The use of the equation is in no way restricted to colorless pigments, since the assumptions made as to light-scattering and absorption hold over any band as long as the light intensity is constant over its width. Colored pigments are the same as blacks and whites, except that the coefficient of absorption, s, varies rapidly as the wave-length changes. The only new problems involved are in the choice of the wave-length for measurement and in the value of the Fechner fraction for that wave-length band. Neither of these two questions has been settled as yet, and measurements at present are being made just as in the case of black and white, that is, over the whole visual spectrum.

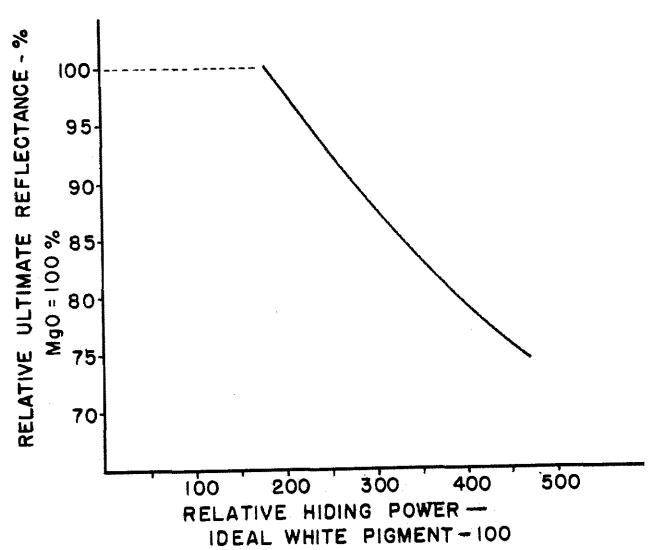


FIG. 5.

C.I.T. NEWS

PRIVATE JOHN ROBERT THOMAS

The alumni will regret to learn of the loss of Private John Robert Thomas, son of Professor Franklin Thomas, Dean of Upper Classmen of the Institute. Private Thomas was killed in action on April 4 in Germany with the 4th Infantry Division of the Seventh Army.

It may be remembered that another of Dean Thomas' sons, Ensign Edward Albert Thomas, Navy flier, was lost at sea off Norfolk, Virginia, two days prior to the attack on Pearl Harbor.

ALUMNI SEMINAR 1945

THE Alumni Seminar Board for 1945 can well be proud of its effort expended upon the Seminar held on Sunday, April 22, on the Campus. Kenneth Belknap, chairman, was assisted by George W. Russell, assistant chairman; Ernest B. Hugg in charge of luncheon arrangements; George Rice III, printing; Ward B. Foster, introductions; W. H. Simpson, registration; assisted by Allen Laws, T. H. Andrews and George Pickett. Some 200 members of the Alumni Association gathered in Throop Hall to register and then proceeded to Chapel in Dabney Lounge. The Chapel was directed by Paul Ackerman, Campus Y.M.C.A. secretary, and the address was given by Dr. E. G. Williams, pastor of the Highland Park Presbyterian Church.

After the Chapel, the assembly moved to the Arms Lecture Hall to hear three excellent speakers. Professor Carl D. Anderson of the Institute staff, as the first speaker, traced some of the developments of rocket ordnance, illustrating his talk with models and cutaway sections of rockets. A motion picture served to show the group the general action and use of rocket ordnance. The alumni were pleased to welcome Professor Horace N. Gilbert, the second speaker, back to the Campus and to learn his opinions about the industrial postwar possibilities of southern California. It is hoped that Professor Gilbert's talk will appear soon as an article in *Engineering and Science.*

The third speaker was Professor Roger Stanton who discussed some of the work of the foods research project which has been under the direction of Doctor Henry Borsook, professor of biochemistry at the Institute. The particular discussion centered around the development of a highly nutritious low-cost meal for use by the United Nations Relief and Rehabilitation Administration. He pointed out that the foods for the Administration must be inexpensive and yet highly nutritious. Furthermore, they must occupy little shipping space and have as long a shelf life as possible and also they must be adaptable to the food habits of different nations. After discussing some of the objectives of this program, Professor Stanton announced that the luncheon for the Seminar was to consist of some of the items which he discussed. Some in attendance probably had misgivings upon this announcement of what they might be served for lunch. However, their fears were allayed when luncheon was served in Dabney Lounge. The meal consisted of: Shepherd's Pie made of an all-purpose meal rich in protein and other necessary food elements to which was added one ounce of meat per person and topped with mashed potatoes. This was accompanied by a salad consisting principally of reconstituted cabbage which might better be known as cole slaw. For dessert, the group was served a high protein chocolate pudding with cookies of special vitamin content. The majority of the alumni declared the meal to be highly successful.

Before the luncheon, the group was given the opportunity of inspecting the new Mechanical Engineering Laboratory under the guidance of Professor R. L. Daugherty. In the afternoon, the group returned to the Arms Lecture Hall and listened first to a short report by Professor Roger Stanton on another phase of the work which has been conducted by Professor Henry Borsook of the Institute staff. The talk was based on the results of a large-scale experiment on industrial efficiency of workers in relation to diet. This work was conducted under the sponsorship of several groups, including the National Research Council's Committee on the nutrition of industrial workers. Professor Stanton indicated that the scientifically administered vitamin-mineral diet supplements resulted in higher work performance, reduced absenteeism, and produced the equivalent of a four per cent gain in manpower at Lockheed Aircraft Corporation where the tests were carried out.

The second talk of the afternoon was given by Professor Linus Pauling, head of the Division of Chemistry at the Institute. Professor Pauling discussed blood plasma and plasma substitutes in his usual admirable manner. He reviewed the general character of certain constituents of blood and in particular, plasma, indicating the character and function of plasma substitutes, some of which have only recently been announced.

Professor Clinton K. Judy, representing Doctor Robert A. Millikan, gave a few closing remarks, indicating a few of the things that the Institute was thinking about with respect to postwar activities and curricula. It was, in general, agreed by all those attending the Seminar that it had been a very profitable day from the standpoint of information secured and also from the point of view of meeting again many fellow alumni.

CHICAGO ALUMNI MEETING

COINCIDENT with the presence in Chicago of Dean Franklin Thomas, attending a meeting of the Board of Direction of The American Society of Civil Engineers, a dinner meeting of C.I.T. Alumni was held at the University Club on the evening of April 17.

To provide for future meetings, Dr. LeVan Griffis was designated secretary of the group, which numbers about 40, including all who are resident in the Chicago area. Those present at the recent dinner were: Harold J. Alwart '37; Roland Budenholzer '39; Beverly F. Fredendall '29; LeVan Griffis '37; Gene B. Heywood '18; Jesse E. Hobson '35; L. E. Medlin '27; F. F. Offner '34; Warren E. Wilson '39; Abe M. Zarem '44; Yung-Chiang Hwang '43.

SAN FRANCISCO MEETING

The San Francisco Chapter of the Alumni Association will hold their next meeting on June 3. This meeting will be the annual Sports Day and Picnic at the home of Howard G. Vesper, located at 6160 Acacia Avenue in Oakland. Any Tech Alumni living in or visiting the Bay Area is invited to attend and bring his wife or girl friend.—*Maurice T. Jones '26, Secretary.*

ATHLETICS

By H. Z. MUSSELMAN,
Director of Physical Education

CALTECH'S Spring sport teams have been winning the majority of their contests and are making fine records in the athletic history of the school.

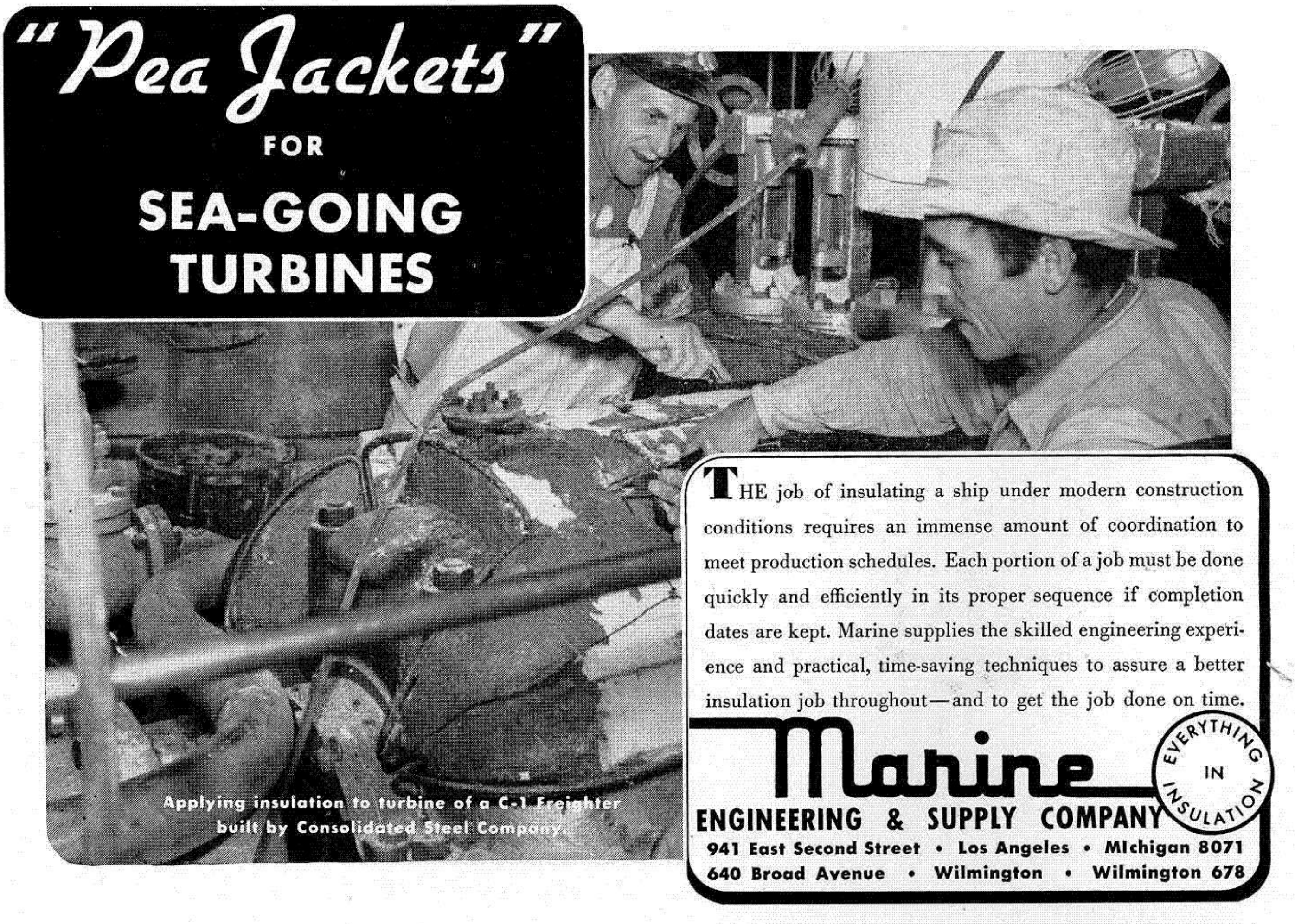
In the feature track meet of the season, U.S.C. nosed out a fighting Tech team 65 2/3 to 65 1/3. Both coaches juggled their entrants to obtain every possible advantage, with several upsets enlivening the meet. Bill Frady and Roger Clapp placed 1-2 in both sprints, with the winning times clocked at 10 seconds and 22.4 seconds. George Gill copped the two-mile in 10 minutes 33.3 seconds, but lost to Elias of U.S.C. in the mile. Stuart Bates nosed out his teammate, Ken Shauer, in the 440 in 51.3 seconds and Shauer again lost by inches to Elias of S.C. in the 880. Don Tillman, still handicapped by a back injury, entered only the discus, where his winning mark of 124 feet 11 inches accounted for the only Caltech victory in the field events. With the pole vault and relay as the last events, Tech needed 8 1/3 points to win. The relay team of Frady, Taylor, Bates and Shauer romped to an easy victory in 3 minutes 27.5 seconds, but Nielsen was forced to accept a tie at 12 feet in the bamboo event, with Carlsen and Halling, both S.C. men, to leave Tech trailing by a fraction of a point.

Spurred on by their fine showing against U.S.C., Tech bounded to new heights to take top honors in the A.A.U. Championship with a team score of 36 8/15 points. S.C. placed second with 26 1/2 points, U.C.L.A. third with 16 1/3, with various service teams trailing. Tech's "Big-3," Frady, Shauer and Gill almost won the meet single handed in scoring 26 points. Frady retained his sprint laurels in winning the 100 in 10.2 seconds and the 220 in 22.2 seconds. Shauer outlasted Bates in the quarter to win in 50.1 seconds and took second in the half. Gill, running the best race in his career, won the two-mile handily in 10 minutes 6.5 seconds and placed second in the mile.

Winning ten first places, Tech rolled up an easy 76 1/3-53 2/3 victory over Oxy. Double winners for the Engineers were Bill Frady with a 10-second 100 and a 22.4-second 220, and Don Tillman with marks of 44 feet 7 3/4 inches in the shot, and 132 feet 6 1/4 inches in the discus. Highlight of the meet was Ken Shauer's time of 1 minute 59.4 seconds in the half mile.

Continuing their winning ways, the baseball team chalked up league victories over U.S.C. 10-9 and Oxy 13-2. In the U.S.C. game, the Trojans held an 8-3 lead in the seventh, but Tech closed the gap when Milt Strauss, right fielder, tripled and John Anderson, first baseman, and John Schimenz, catcher, hit home runs to score four runs. The Beavers rallied again in the ninth, with shortstop Bob Jones singling to drive in the winning run. In the Oxy game, Tech led all the way, and featured a six-man scoring spree in the eighth. Paul Henry, third baseman, led the attack with two singles and a homer. Dick Roettger limited the Bengals to five hits, three of which were infield raps.

Trouncing the strong Cal Poly team from San Luis Obispo 7-6 in a non-league encounter, Tech again came from behind to win. With the Beavers holding a lead throughout the game, Poly scored twice in the ninth to



tie the score at 6-all, but Milt Strauss, first man up in the home half, rapped a homer to break up the ball game.

In trimming Caltech 11-9, the U.S.C. Trojans handed the Engineers their first league defeat. Tech scored five runs in the fifth on singles by Larry Collins and Anderson, Strauss' triple and Schimenz's home run, but S.C. came back in the seventh with six markers to put the Trojans out in front. A belated rally in the ninth, when Jack Leech doubled to drive in two runs, fell short of victory. Tech out-hit the Trojans, but failed to connect at opportune times with men in scoring position.

In the league standings, Tech with three won and one lost is in second place, just a half-game behind U.C.L.A. In non-league contests, the Beavers have won seven, lost one and had one game end in a tie. The team is hitting well and has been playing fine ball against the strongest teams in this area.

Winning handily the first three meets on the schedule, Tech's swimming team appeared headed for an undefeated season, as victories were chalked up over U.S.C. 41-34, U.C.L.A. 51-24 and Occidental 55-20. However when Francis Piemme, the undefeated sprinter, was transferred to Great Lakes, S.C. was able to nose out Tech in the return meet 43-32. The Beavers should win the remaining contests with U.C.L.A. and Occidental and tie U.S.C. for the Conference Championship.

Two Caltech records were broken in the Occidental meet. In the 50-yard free style, Piemme with a 24.8 second mark, erased the 25.3 second record established by John Nelson in 1943, while Rex Cherryman's 1 minute 50.6 seconds time in the 150 yard backstroke broke by 4 seconds the record registered by Bud Olds in 1942.

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AWARDED BRONZE STAR MEDAL

THE Bronze Star Medal has been awarded to Lieutenant Colonel Donald P. Barnes '30 "for his outstanding work in supervising the camouflage and maintenance operations on airfields constructed by the IX Engineer Command in France and Belgium." Colonel Barnes was commanding officer of an aviation engineer camouflage battalion and an airfield maintenance unit during the period from March 30 to December 31, 1944, and it was for his services during that period the award was made.

Colonel Barnes was, during the first part of this period, in charge of training engineer and air-force personnel in camouflage technique. Later, during the invasion of France, he directed camouflage work on airdromes and assumed the command of the maintenance unit. The citation accompanying his award reads, "his careful planning, superior technical knowledge, and untiring personal endeavors have been an inspiration to his superiors and subordinates alike and reflect great credit upon himself and the armed forces."

Prior to entering service, Colonel Barnes was with the U. S. Bureau of Reclamation and was editor of "Civil Engineering."

COMMENCEMENT AND ANNUAL MEETING

COMMENCEMENT exercises will be held on June 22 at which time approximately 155 seniors will receive degrees and about 29 Navy V-12 trainees will receive certificates. The exercises will be held on the Campus of the Institute. As is customary, the annual meeting and dinner of the Alumni Association will be held on the evening of the commencement. The place has not been announced but notices will be sent out in due time. This year reunions of the classes 1915, '20, '25, '30, '35 and '40 will be featured. Class secretaries are urged to assist in getting those members of their respective classes who are in southern California to attend.

PERSONALS

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

—Editor.

1922

FREDERIC A. MAURER, formerly a lieutenant in the Army, has been relieved from active duty and is back in civilian life. He is living at Ontario, Calif.

HAROLD S. OGDEN is an electrical engineer with the General Electric Company, Erie, Pa.

LOUIS H. ERB holds the position of general personnel supervisor (northern California and Nevada area) for the Pacific Telephone and Telegraph Company, San Francisco, Calif.

1923

HAROLD A. BARNETT heads his own engineering firm in Pasadena, as well as being city engineer for the City of San Marino, Calif.

W. L. BANGHAM is a civil engineer employed by Harold A. Barnett.

1924

LIEUTENANT-COLONEL EDWARD D. LOWNES was home on leave in January after serving 26 months in the northwest Pacific. Ed, who is with the Army Engineers, supervised many construction projects during his tour of duty in that area.

FRANK D. TELLWRIGHT is vice-president and general manager of the Pacific Telephone and Telegraph Company at Portland, Ore.

1926

THEODORE C. COLEMAN, vice-president of sales, Northrop Aircraft, has recently returned from a business trip to Washington. While there a luncheon of Tech men was arranged. Those present were: Lieutenant-Colonel Wayne Rodgers, '26; Colonel James Boyd, '27; Lieutenant-Colonel Tom Evans, '28, and Baker Wingfield, '26. All except Wingfield are working in the Pentagon Building in Washington, in the Engineering Corps. Mr. Wingfield is with the Public Building Administration in Washington.

LIEUTENANT - COLONEL JOSEPH MATSON, returning to his post at Honolulu from a business trip to Washington, made a brief stop-over in Pasadena.

ARTHUR C. WERDEN is now assistant superintendent of hydro generation for the Southern California Edison Company, Ltd., Los Angeles, Calif.

MAJOR J. F. VOELKER is liaison officer in charge of two plants engaged in chemical warfare, at Dallas, Texas.

1928

RALPH W. CUTLER was recently appointed general manager of the Los Angeles plant of the Western Pipe and Steel Company.

MAJOR ED JOUJON-ROCHE is serving as executive officer with an Engineer Combat Battalion in the Dutch East Indies.

ROBLEY D. EVANS is associate professor of Physics at Massachusetts Institute of Technology, Cambridge, Mass.

1927

ALAN E. CAPON was recently elected president of the Glendale-Burbank Engineers Club.

D. Z. GARDNER is assistant division engineer (Albuquerque Division) of the Atchison, Topeka & Santa Fe Railway Company at Winslow, Arizona.

LIEUTENANT - COLONEL R. C. BLANKENBURG, formerly of the operating department, general office of the Southern California Edison Company, has had plenty of opportunity to see how utilities are run in France. He states that France is very resourceful in getting repairs made quickly and has had to operate in many instances with little or none of such necessities as protective equipment, meters, telephone communication, etc. Incidentally, he observes they build and operate their systems very much as we do in this country.

ROBERT F. HEILBRON is head of the science department of the San Diego High School.

1929

LIEUTENANT-COLONEL THOMAS H. EVANS, U.S.A., and Eva Katherine Peterson announce their marriage on April 10 at Fort Myer, Va. Lieutenant-Colonel Evans has an office in the Pentagon Building, Washington, D.C.

LIEUTENANT-COLONEL BILL MOHR has been transferred from Fort Jackson to the European Theater of war.

FIRST LIEUTENANT FRED CLINE is in the Overseas Construction Command in the South Pacific.

1930

EDWARD M. THORNDIKE is assistant professor of Physics at Queens College, Flushing, N. Y.

ALEX J. HAZZARD is a technician for the Pacific Telephone and Telegraph Company at San Francisco, Calif.

HOWARD W. WAITE is production engineer for Electrical Development Company, Los Angeles, Calif.

1931

LIEUTENANT (j.g.) MARVIN W. HALL is safety officer at the Naval Air Station at Seattle, Wash.

LIEUTENANT-COMMANDER WALTER DICKEY is in Public Works at Hunters' Point, Calif.

LIEUTENANT BYRON JOHNSON, C.E.C., U.S.N.R., has been in the Navy since 1942 and was stationed at Pearl Harbor Navy yard until a short time ago when he was transferred to the Naval Training Station at Davisville, R. I., for Public Works.

CHARLES A. WILMOT is a chemist for the Ethyl Corporation, Wilmington, Delaware.

WM. FRED ARNDT is a development supervisor for Naval Research Laboratories, U.S. Navy Underwater Sound Laboratory, New London, Conn.

TED JURLING is assistant chief engineer for Byron Jackson Company, Los Angeles, Calif. He was formerly located in Houston and has now transferred most of his activities to the Los Angeles office.

1932

BRIAN SPARKS is an airline captain operating for the Air Transport Command (Army) and is flying the Atlantic to bring back the wounded.

MILLS S. HODGE is personnel manager of Procter and Gamble Manufacturing Co., at Long Beach, Calif.

WILLIAM A. ADAMS is a foreman at Procter and Gamble Manufacturing Co. at Long Beach, Calif.

ALFRED B. FOCKE is a physicist in the Navy Department, Bureau of Ordnance, Washington, D.C.

GRANT D. VENERABLE is the father of a son, Lloyd Dennis, born March 6.

TETSUO IWASAKI is employed as a research and development engineer with a Philadelphia concern which is engaged in the manufacture of aircraft instruments.

1933

MAJOR ROBERT MacDONALD has been overseas for four years and now is stationed in France.

WILLIAM T. WHEELER is a structural engineer with the U. S. Engineers at San Francisco, Calif.

1934

LIEUTENANT WILLIAM EVERETT, U.S.N.R., has been stationed for three years at the mechanical division office of the inspector of Naval material at San Francisco.

PAUL C. ROBERTS holds the position of tool designer "A" at Lockheed Aircraft Corp., Burbank, Calif.

1935

LIEUTENANT WARREN POTTER, U.S.N.R., is engaged in repair and maintenance work at a Navy yard in the Pacific area.

LIEUTENANT F. V. MALONEY, U.S.N.R., after 22 months overseas as a radar officer in the Navy, has been ordered back to the States.

JAMES J. HALLORAN is a transformer design engineer at the Emeryville, Calif., plant of Westinghouse Electric and Manufacturing Co., which plant has been supplying transformers to the Pacific Naval airbases.

NELSON NIES is now employed by the Clayton Company of Los Angeles, Calif.

1936

KENYON T. BUSH is an industrial engineer with the Du Pont Company, Wilmington, Del.

HUGO MENEGHELLI announces the arrival of Leonard Meneghelli on March 26, whom he hopes to enroll at Caltech in the class of '60.

1937

ELLSWORTH W. CORNWALL is employed by the Puget Sound Navy Yard, Bremerton, Wash., as a mechanical engineer. Ellsworth is married and has a little daughter two years of age.

LIEUTENANT ROBERT CAMPBELL, U.S.N.R., is in the industrial department of the Boston Navy Yard.

WENDELL MILLER and Mrs. Miller are the proud parents of Mardelle Jane who arrived on March 27. Mardelle has a little brother two years of age.

R. M. MAHONEY is associated with the United States Vanadium Corporation, of Grand Junction, Colo.

1938

CAPTAIN ARMAND F. DU FRESNE, Air Force Service Command, has been overseas two years in Command organization of maintenance activities as well as being responsible for maintenance of all radio, radar and allied equipment in all fighter aircraft of the Ninth Air Force.

HENRY K. EVANS is traffic engineer for National Conservation Bureau in New York City.

ELLIOTT P. BENNETT is employed by the Donald R. Warren Company, engineers, of Los Angeles, Calif.

1940

LIEUTENANT CHARLES S. PALMER, JR., U.S.A., is with the maintenance division of the Air Technical Service Command. His headquarters are at Wright Field, Dayton, Ohio, but his assignments take him to all the air fields in the States.

BUDD SAMUEL is assigned to work for N.A.C.A., Aircraft Engine Research Laboratory in Cleveland, in a civil service capacity.

LIEUTENANT RICHARD L. WALKER, Army Air Force Intelligence, was united in marriage to Miss Marjorie A. Crehan on April 12 in a formal church ceremony.

1941

JOHN SMALL, having received a medical discharge from the Marines, has returned to the Institute for graduate work in aeronautics.

SERGEANT RICHARD SILBERSTEIN who is with the 1053rd Engineers, port construction and repair group, after duty

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Railroad Noises

An editorial from the San Jose, California, "Evening News". (San Jose is on the main line of Southern Pacific's Coast Line)

WE HAVE always resented those snooty expressions, "across the tracks" or "down by the tracks," with their implication that there was something disreputable and socially low-life about living near railroad tracks. After living many years a block from the Espee's rails, we rise to say that there are many worse places to live.

Living close to the railroad has its obvious advantages when you are a boy. Where is there a more romantic place than the right of way, with wheezing switch engines, puffing freights (which travel so much faster now than they used to) and speeding passenger trains? Morning, noon and night railroading holds attraction for a boy, which is why so many of them go into it, finding a romance which never dulls until they die.

"But how can you stand the noise?" someone asks.

Far from being bothered by the noises, you get so you find them soothing and conducive to repose. You get so you can tell the freight trains from the passengers, and you distinguish the touch on the whistle rope of that individualistic engineman who makes his blasts so short, sharp and distinctive.

The various whistle notes represent to you these giant creatures of fire and steel talking to one another over long distances and on winter nights, when the wind is blowing and the rain is pelting against the windows it is pleasant to think of engineer and fireman, snug in their cab with the fire roaring below them, shunting lines of cars up and down the glistening wet tracks.

If these night noises from the tracks are comfortable and appealing to you during peace they have even more of these qualities during war. You realize that both the wars in which we are engaged are transportation wars and must be won not only in the foxholes and workshops but on the railroads as well. Some of the particularly long trains you hear puffing and snorting these nights are troop trains and others are weighed down with war's materiel. It is comfortable to reflect what a great job the railroadmen are doing, driving their trains and switching their cars 24 hours a day, even while you are asleep.

Back a few years, when trucks and buses started to cut more and more deeply into railroad revenues, with the airplane as an additional competitor just ahead, as a boy living near the tracks you may have wondered a little worriedly if they would put your old friends, the freights and passengers, out of business. It took the war to show that a nation's need of railroads continues, that no nation can be great and strong without them. You are reassured by that, and by the articles and drawings that have been published of vastly improved equipment which will help the railroads get their share of traffic after the war. Such things mean your friends will be able to stay alive and that, drowsily safe and comfortable, you will continue to hear the trains chugging and puffing through the night.

* * * *

We thank the San Jose News *for so beautifully putting into words the way we railroaders, and many other people, feel about trains.*

S•P **The friendly Southern Pacific**

in Wales, England, France and Belgium, is now somewhere in Germany.

LIEUTENANT (j.g.) FRANCIS M. GREENHALGH and Miss Dorothy Jane Lewis of South Pasadena were married in a formal ceremony on the evening of April 13 in Pasadena. They intend to make their home temporarily in San Francisco. Miss Lewis is a sister of Joe Lewis, class of '41.

LIEUTENANT (j. g.) MERRITT EUSEY, U.S.N.R., who has been stationed aboard a baby "Flat Top" in the Atlantic, has recently moved to the Pacific theater.

1942

A. D. PAUL of the General Electric Company has returned from the South Pacific. He was married on April 17 to Mary Lee Brown, sister of Charles M. Brown, '42.

CHARLES M. BROWN, R.C.A. field engineer for the Navy, is in Honolulu.

HASKELL SHAPIRO was married to Miss Alice Goalby on February 14 in a home wedding.

ENSIGN JOSEPH FRANZINI, U.S.N.R. is assigned to the U.S.S. New York to the Intelligence Division, which is an integral part of the Gunnery Department. His ship was one of the many participating in the bombardment of Iwo Jima.

LIEUTENANT WAYNE MACROSTIE has been in Puerto Rico for the past two and one-half years doing base construction and maintenance work with the Civil Engineers Corps. He returned to the States the latter part of April to report to the 12th Naval District for Public Works assignment.

1943

EDGAR P. BRIDGLAND is overseas with the Royal Canadian Air Force. He is a flight lieutenant.

LIEUTENANT (j.g.) JESSE GRANER, U.S.N.R., is stationed aboard a large carrier which has seen plenty of action in Pacific engagements.

Ex. '43

LIEUTENANT (j.g.) CHUCK McDOUGALL, U.S.N.R., who has been flying blimp submarine patrol off South America, visited the campus while enjoying a short leave in Pasadena with his wife and daughter.

1944

PRIVATE RAYMOND SAPLIS has been transferred from Camp Roberts to Officers Training at Fort Benning, Ga.

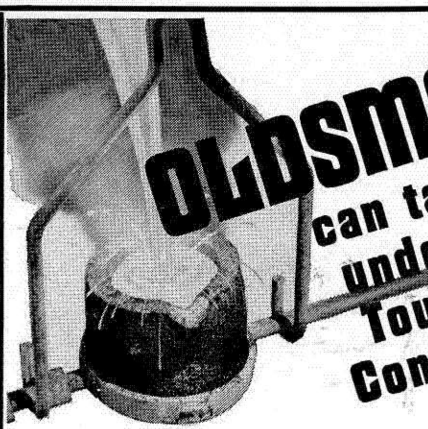
ENSIGN ROBERT G. THOMAS, U.S.N.R., and Miss Ansley J. Newman were united in marriage very recently and will make their home in New York where Ensign Thomas will take further training before beginning his sea duty.

SECOND LIEUTENANT RICHARD H. GILLMAN, U.S.M.C., visited at the Institute en route to the Pacific. He is a platoon commander in a marine engineering regiment and has been in training at La Jeune, N.C.

ENSIGN LEWIS GRIMM, U.S.N.R., is an assistant engineering officer on board a converted destroyer escort in the Pacific.

Ex. '44

PFC. JIM SMITH, who left school in the E.R.C. program in 1943, has had a variety of training, including service with the Paratroops, A.S.T.P. and a year studying electronics at M.I.T. He now is on a special assignment with an Engineer Detachment at Oak Ridge, Tenn. Jim was trying to enroll at the University of Tennessee for special work and thereby be eligible to play football, but the Army turned thumbs down on this idea. From the looks of Tennessee in the Rose Bowl game, they could have used some of Jim's talents.



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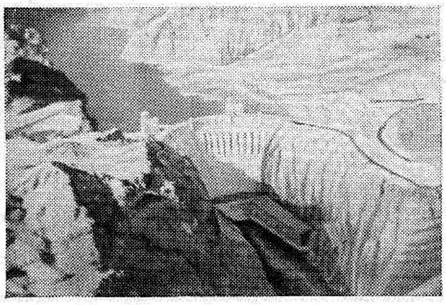

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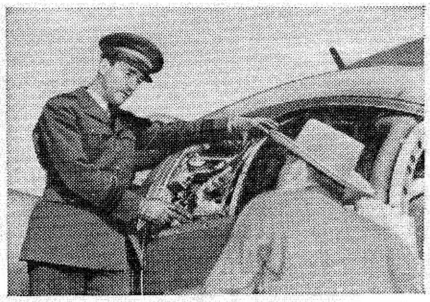
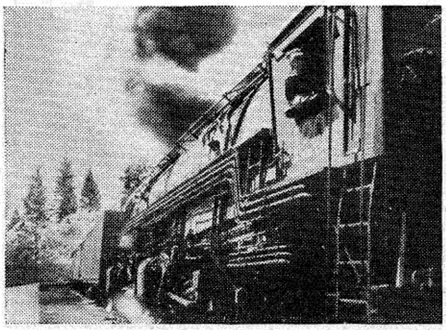


3. No wonder he's eager to hear the pilot tell of a new super-power — such as that of the Wright Cyclone . . . the engine which speeds the great Boeing B-29 Superfortress across the air miles to Tokyo . . . power that makes possible a trans-Atlantic flight every 13 minutes.



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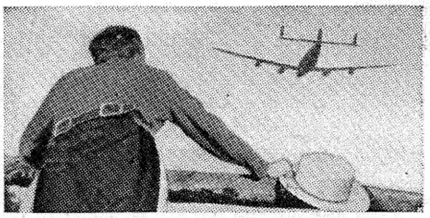

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