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THE TABULAR VIEW

AERONAUTICAL design has become one of the most refined and exacting of the engineering sciences. As Lewis Mumford phrased it in "Technics and Civilization," "the gross oversizing of . . . dimensions, with an excessive factor of safety based upon a judicious allowance for ignorance, is intolerable in the finer design of airplanes; and the calculations of the airplane engineer must in the end react back upon the design of bridges, cranes, steel buildings: in fact, such a reaction is already in evidence." Clark B. Millikan, in his address before the industrial physicists (see page 61) in New York in October, emphasized how aeronautics, as it sets this pace in design, is enriched by and dependent upon the fundamental science of physics, and Edgar S. Gorrell, '17, speaking before the Transportation Conference at M.I.T. last June (The Review, July, 1936, page 401) showed inferentially how economics — an essential factor in all the engineering arts — takes its place along with aspect ratios, lift coefficients, and boundary layers in governing the development of designs on the drafting boards of aeronautical engineers. ¶ At the risk of supererogation we present these references as annotations to Messrs. Hunsaker and Mead's article, "Around the Corner in Aviation," which opens on page 65. In this preview of possible transport planes of the future may be observed the complex interplay of all the factors that enter into aeronautical design and the fascinating procedures that engineers follow in creating the superb equipment that flies our airway systems. ¶ The authors draw upon a rich and varied experience in aeronautics. It has been said that what goes on in the laboratory of GEORGE J. MEAD, '16, is aviation two or three years hence. He is vice-president and chief engineer of the United Aircraft Corporation and is in charge of engineering and research for affiliated divisions such as Chance Vought, Pratt and Whitney, Hamilton Standard Propeller, and Sikorsky. JEROME C. HUNSAKER, '12, designed the *NC-4*, the first aircraft successfully to cross the Atlantic, obtained the first doctor's degree in the field of aeronautics at the Institute, and built here the first wind tunnel in this country. Before coming to the Institute to be head of its Department of Mechanical Engineering and in charge of its course in aeronautics, Dr. Hunsaker was vice-president of the Goodyear Zeppelin Corporation and prior to that had been an officer in the Navy and had conducted research with Bell Telephone Laboratories. He holds an honorary fellowship in the Institute of the Aeronautical Sciences and is the editor of the journal of that society.

HISTORIAN of science, organic chemist, himself an example of a liberal education, Professor TENNEY L. DAVIS, '13, seeks a better understanding of the relationship between science and the liberal arts. His article is timely because of the extensive study that is being given at the Institute to the coördination of humanities with professional subjects. ¶ MARGARET PAIGE HAZEN, Reference Assistant, M.I.T. Library, who prepared the

ANNOUNCING *the* SENSATIONAL NEW 5-R BELT

Pulls heaviest loads at 25% to 50% lower tension without slip

AFTER years of research Goodyear engineers present a revolutionary development in flat transmission belting—a square-edge fabric belt with a *permanent minimum ratio of tension*, or "R," of 5. Hence its name—the Goodyear 5-R.

What that means in terms of belt efficiency non-engineers will find explained in the adjoining diagram. Briefly, it handles any given load at 25% to 50% lower tension without slip and far less stretch!

Highest coefficient of friction

The secret of the 5-R's amazing slack-tension operation is a new Goodyear-perfected non-rosinous rubber compound impregnated through the fabric which gives it a coefficient of friction—a pulley grip — *unexcelled in any other type of belt!* As the surface wears, new friction is exposed with all the grip of a new belt — a surface that will not chatter or ball-up.

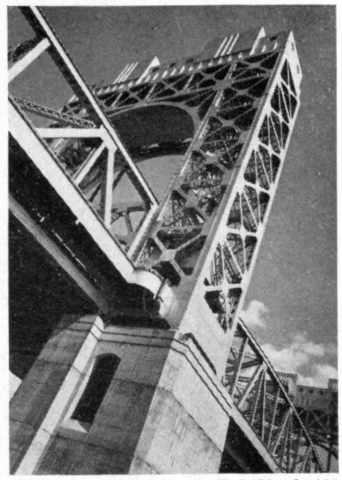
BELTS
MOLDED GOODS
HOSE
PACKING

Months of service in many industries have conclusively demonstrated 5-R's ability to reduce power transmission costs. Armored with a permanent, high coefficient of friction 5-R attacks cost on two fronts. **1.** *Lower tensions* in the belt itself, resulting in longer belt life and greater ability to hold fasteners. **2.** *Reduced bearing pressure*, resulting in longer bearing life, less lubrication problems, less frictional losses. It is now available in roll lots in all popular sizes and widths. The G. T. M.—Goodyear Technical Man—will be glad to give you full data on this unique new belt. To bring him to your plant, write Goodyear, Akron, Ohio, or Los Angeles, California—or the nearest Goodyear Mechanical Rubber Goods Distributor.

The "R" of a belt is the ratio between tensions on the tight or "pulling" side and slack or "returning" side necessary to maintain the effective tension required to operate the drive—and depends upon the coefficient of friction between belt and pulley. For example, an ordinary belt with an "R" of 2 must be operated at 200 lbs. tight side tension and 100 lbs. slack side, or a total of 300 lbs., to deliver 100 lbs. effective tension. The new Goodyear 5-R Belt is so named because its higher coefficient of friction gives it a minimum "R" of 5. To maintain an effective tension of 100 lbs., it requires a tight side tension of only 125 lbs. and 25 lbs. slack side, or 150 lbs. total—reducing bearing pressure and insuring longer belt-life.

THE GREATEST NAME IN RUBBER

GOODYEAR



F. S. Lincoln, '22

One way of seeing one part of New York's Triborough Bridge

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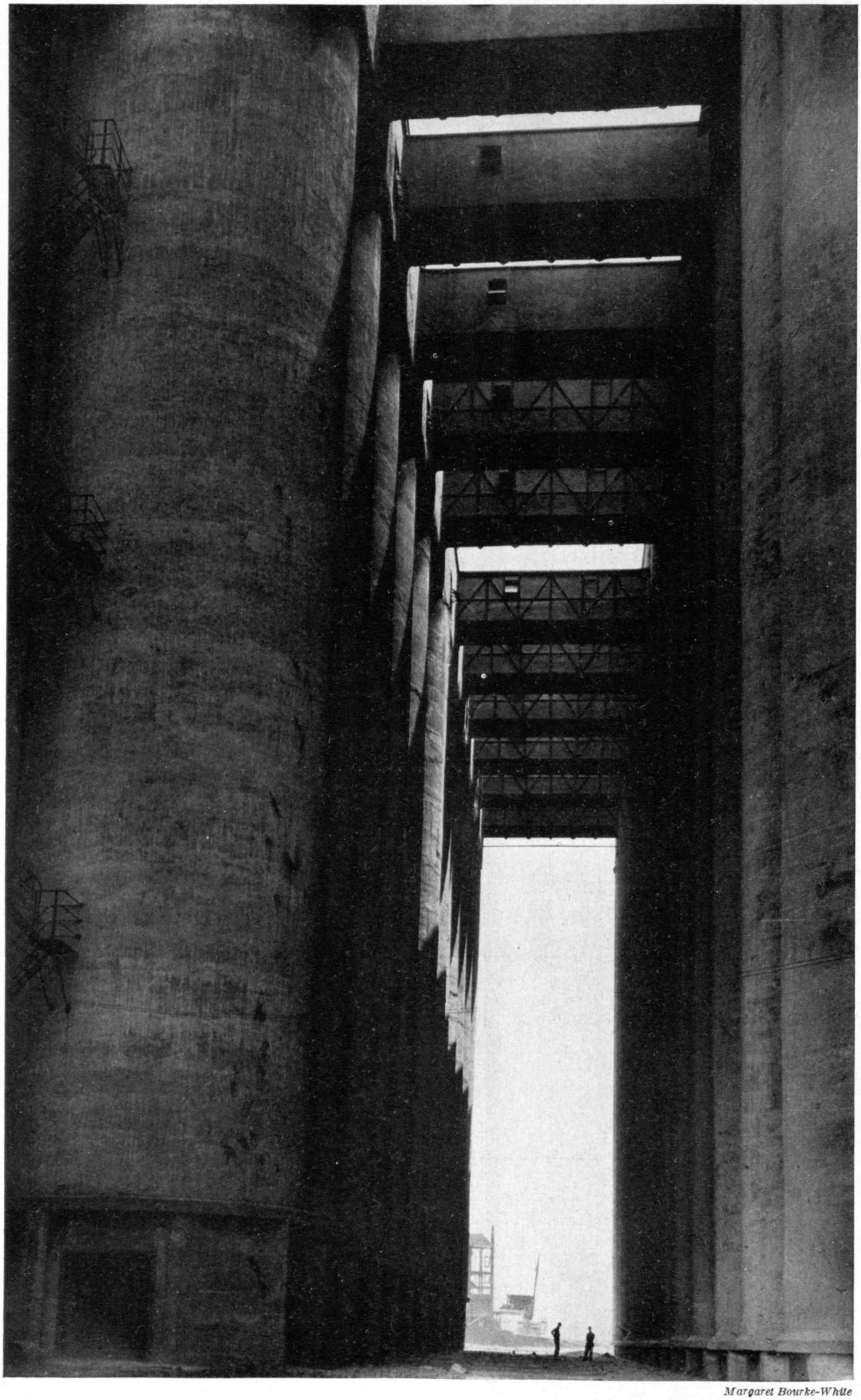

Margaret Bourke-White

GRANARY

Grain elevators, as many have remarked, are yet among the sights of Chicago — which presents so many striking sights to arrest or repel the eye. The colossal scale of these enormous storehouses does not alone account for their effect; there is an esthetic quality in their simple, functional geometry, a dynamic quality in their repetition of basic forms. Into them — if you do not know — "grain is elevated from ships or cars, sorted into grades, and reloaded for shipment, all of the work being done by machinery"

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The Trend of Affairs

New Anesthetics

ANESTHESIA probably calls to mind more often the taking of ether or of gas (nitrous oxide) than it suggests other known means for producing insensibility to pain in surgical cases. Knowledge of the profound physiological effects of nitrous oxide dates back to 1799 and the times of Sir Humphry Davy. Before the middle of the 19th Century ether (sulphuric ether) had been used as a general anesthetic. At the Massachusetts General Hospital in Boston, October 16 is celebrated as Ether Day. On this day in 1846, Dr. J. C. Warren made a public demonstration of the use of ether in an operation. The very success of these two anesthetics over a long period of time has so dramatized their use that newer types of compounds may escape general recognition.

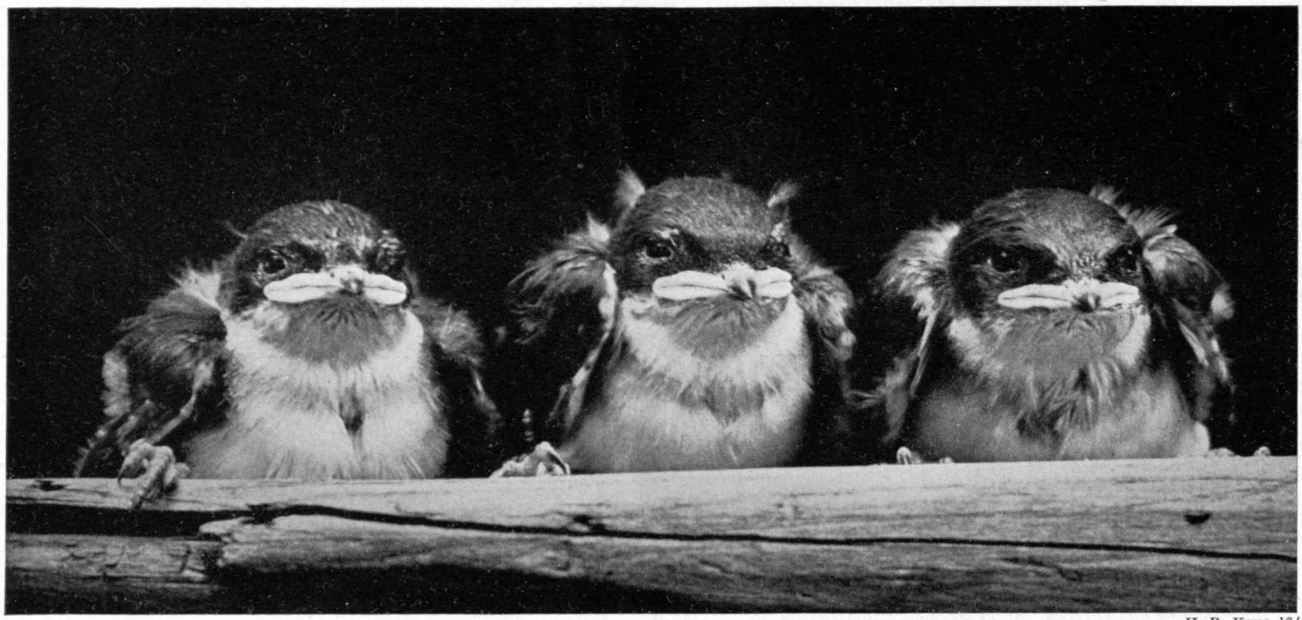
The past decade has seen an increasing use of special agents over the older and ordinary compounds. In one important American clinic the special agents have gained from 16% in 1925 to 52% in 1935, while the ordinary agents have declined in use from 84% to 47%. Practically all of the new agents have been synthesized by the organic chemists and their investigations are continually yielding still other compounds which have promise.

At the present time there are recognized new claimants for inclusion in each of the several general types of anesthetics. To the group of inhalation anesthetics the hydrocarbon, cyclopropane, has been added recently. Improved methods for synthesizing cyclopropane have removed this compound from the category of museum curiosities and made it available not only for the physician but for the scientific investigator interested in far different problems such as symmetry in the structure of molecules. Deep cyclopropane anesthesia is produced readily and is accompanied by very quiet, depressed respiration which is advantageous to the surgeon operating on the thorax or diaphragm. In spite of the value of this compound and of other similar vaporous organic compounds, there exists, always, fire hazard in their use. This fact, alone, greatly limits their practicability where the modern electric scalpel and other electrical devices are employed, and, at the same time, stimulates the search for equally effective but less dangerous compounds.

The class of intravenously injected anesthetics possesses certain advantages in the very method of their administration. Every new suggestion in this field is looked upon as having promise. While new representatives of this class have not shown great advance, the discovery of some very short-acting compounds gives hope that a profitable path may have been broken. These new compounds are derivatives of the barbiturates. Well-known examples of barbiturates are the hypnotics: barbital (veronal) and luminal. By producing certain definite changes in the molecules of known barbiturates the new short-acting compounds were produced. While their adoption by clinicians is not indicated at present, the field will attract further researches.

About 10 years ago Avertin (tribromoethyl alcohol) was thought to be the reward of the quest for a suitable compound for rectal administration. Its early use was attended by few difficulties, but later developments have put it in the class of anesthetics which are rarely best used alone. Its most important use lies in the production of a basal anesthesia, permitting surgery under a supplementary anesthetic of another type. There can be no doubt that other compounds will be sought to fill the need in this group.

Cocaine and novocaine are widely known as local



H. B. Kane, '24

NATURE'S MINSTRELS

Fledgling tree swallows in glum array pose for a theatrical portrait. Missing: two end men

anesthetics; the latter compound has proved to be most successful. In spite of this fact, new representatives of this class are being tried out. Recently a compound named metycaine was found to be very good for local work. Incorporated in ointments, it has been used successfully in treating surface wounds. Metycaine possesses the further advantage of having certain antiseptic properties — a fact which makes it especially attractive to clinicians.

Physicists on Parade

FIVE YEARS ago there were five principal societies for physicists. Most venerable of these, The American Physical Society numbered physicists of all kinds with perhaps a tendency toward emphasis on pure rather than applied science. Separate societies overlapping in membership laid separate emphasis on the applied physics of acoustics, optics, or rheology (deformation and flow of matter). A fifth society included those whose prime interest in physics was educational.

Meanwhile science was getting complex in every direction. With each year the physicists of the various groups tended to grow farther from each other: The Decibelians were becoming suspicious of the Nuclearites; neither understood the other very well; both were forgetting that they were all, under the skin, physicists — while the public looking at all this with some confusion was suspicious of physics altogether. At this juncture one great physicist had an idea. With the help of funds which, curiously enough, he obtained from the Chemical Foundation, he was able to start a new organization with the avowed purpose of reintegrating physics in America. This new organization was and is called the American Institute of Physics. It has, for a young society, achieved remarkably its aim of unifying and correlating the work of the five member societies which became the Founder Societies.

This October at the Pennsylvania Hotel in New York the American Institute of Physics held its fifth anniversary meeting. The theme of the meeting was one never sung before by physics in America. The burden of the lay was emphasis on the coördination of the various branches of physics, while the contrapuntal motif was the encouragement of their joint application to industrial research. Unspoken may have been the wish to demonstrate to the intelligent public that the high priests of physics are not all metaphysicists; that nuclear and cosmic research must and will have impact on the ordinary private citizen in his ordinary private life. The priests of chemistry had long known the merit of beating that particular ceremonial drum, and there seemed some danger that the priests of physics might, if they did not look out, lose some of their congregation.

Hence for the first time in many moons an American scientific society held a general meeting in which applied scientists — in this case industrial physicists — were really the headliners, though, of course, plenty of students in the fields of pure research were there. Many of them gave papers, too, but in these cases there was a conscious effort to relate what they were doing to something that the man in the street could understand.

In the pursuit of all these purposes formally or tacitly set forth, the meeting was admirably successful. The attendance was of the first order, both qualitatively and quantitatively. Successive symposia on the training of physicists for industry, on the applications of physics to seven large industries — glass, metals, oil, building, communication, electrical power, aviation — on optics and acoustics in modern science, and, finally, on the solid state were able to compete on reasonable ground with the simultaneous presence in the metropolis of both major candidates for the United States presidency. The papers for the most part recognized the rôle they were supposed to play: Almost none presented new material; they were not supposed to, as the symposia were more in

H. B. Kane, '24

FOR A NATURALIST'S ALBUM

Above. *Indian pipes, common in New England's late summer woods, and behind them an* obbligato *of moss.* Below. *This tree frog, one of the Hylas, like the chameleon can change color at will, varying from white to black or from brown to green*

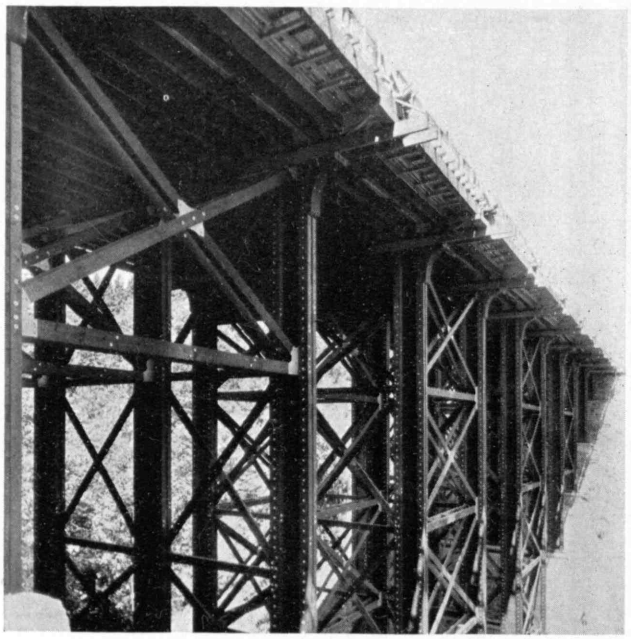
the nature of a review than a revelation. None the less from a large amount of *résumé* material, much of which The Review has discussed before, certain colorful items might profitably detain the reader for a moment.

Both industrialists and educators were agreed, for example, that physicists, to succeed in industry, should be something more than physicists. They should possess the best possible broad basis of culture; should be able to use English so well as to present their ideas to executives not only clearly but persuasively. The suspicion that the scientist who talks well is perhaps no scientist should be dissipated. It was pointed out that while large research laboratories could profitably employ one or two nuclear physicists, they need many more physicists of the more pedestrian type — less spectacular workers in things like electronics and optics. Suggestive as a reason why physics did not enjoy its proper regard by industry was one of three given by Dean Dodge of Oklahoma's Graduate School: Chemistry with its origin in alchemy has almost from the beginning sought tangible goals while physics with its origin in philosophy has tended to create a schism whereby the theoretical physicist or thinker looked down upon the experimental physicist; yet the latter was the man that industry could readily understand. Even Archimedes, said Dean Dodge, for all the practical problem which set him upon his study of floating bodies, set the pattern for the scientific snob. According to Plutarch he repudiated "as sordid and ignoble the whole trade of engineering . . . he placed his whole affection and ambition in those purer speculations where there can be no reference to the vulgar needs of life." From this sort of glory Dean Dodge urged a sensible retreat, and in the balance struck by the American Institute of Physics he found sound sense.

Of widest popular interest in the general symposium were papers by John Ely Burchard, '23, on building, by Dr. Clark B. Millikan on aviation, and by Dr. Jacob Pieter Den Hartog of Harvard on vibration in industry. Burchard enumerated the magnificent things applied physics had done for the equipment of buildings and found implied in present work an almost certain logical requirement that buildings of the future be windowless; he deprecated the little work that physics had done for modern structures, although pointing out the recent achievements in soil mechanics and seismological research, including the work of Ruge, '33, at Technology; he found reason for the lack of much applied physics in the art of building structures in the absence of well-to-do corporations whose major interest would dictate such research programs; and, finally, he pleaded for the brains of one great man — one man of the ability of several of the nuclear physicists — which applied to research in housing might perform a mighty service.

Most dramatic of the several revelations by Dr. Millikan had to do with the wrinkling of metal airplane wings. Millikan first pointed out that the stressed skin construction of the modern metal airplane wing resulted in a highly indeterminate structure so that methods of stress analysis must have recourse to the highly mathematical theory of elasticity. Moreover, the

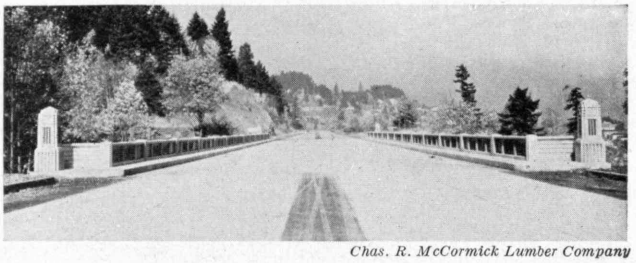
H. B. Kane, '24



A. M. Prentiss

use of the thin skins with the very slender structural members of wings has resulted in tendencies toward local buckling. Such heavy penalties are imposed in airplane design by the mere addition of material to cover factors of ignorance that these buckling tendencies have had to be investigated. As a result it has been found that all buckling need not be prevented; that, contrary to the views of classical design, buckling is not practically synonymous with failure; that kept within reason thin sheets may be permitted — in the language of Wagner — to "go into the wave state" under load without ultimate damage. He remarked that a passenger on a low-wing transport plane might well see waves appearing and disappearing on the upper wing surface as the plane flies in even moderately bumpy air, and he deprecated as being groundless any trepidation that this might cause in the mind of the passenger.

Dr. Den Hartog, an outstanding authority in the field of vibration, particularly in machinery, and an ingenious gentleman in the art of correcting vibration dangers, gave many examples of such corrections. Perhaps the most interesting of those described was the damper, now about a year old, devised for keeping within reasonable bounds vibrations in engines operating over a wide speed range. This consists of a piece of metal weighing several pounds and attached loosely to the shaft by one or more steel pins with a possible field of motion along the shaft of about one-quarter inch. When the engine runs, the loose piece vibrates back and forth rapidly, giving shocks to the shaft; the apparatus is so cleverly designed that these shocks are automatically in opposition to the shocks coming from the cylinders. Also of general interest was the recent work in the prevention of nosing (transverse sway across the track) of high-speed electric locomotives. Study of the problem was carried on with Lionel electric locomotives as models. The phenomenon is now understood and changes have been made to cure the difficulty in full-sized locomotives.



Chas. R. McCormick Lumber Company

DESPITE THE PASSING OF THE COVERED BRIDGE

. . . wood is still being used for highway bridges, as described in the adjacent article. On this and the opposite page are three striking examples of which the one shown above and to the left, the Vermont Street Viaduct in Portland, Ore., of composite concrete and wood construction cost hardly half as much as would reinforced concrete

Arthur C. Hardy, '18, presiding over the optics symposium, remarked somewhat humorously that there might not be any true science of electricity today had optics not been a branch of physics, for the great advances in electricity which had theretofore been a pith-ball science came when the search for high-efficiency light sources began seriously. This led neatly to Dr. Saul Dushman's description of recent work in high-efficiency light sources which has been described in The Review (December, 1935, page 90).

High lights from here and there: Den Hartog's graphic description of how disaster nearly overtook the Graf Zeppelin because of shaft vibration; the statement by German guest star Erwin Meyer (Berlin *Institut fuer Schwingungsforschung*) that vibration periods of a building tend, as you go up the building, to reduce themselves to one single frequency, and his further contribution to soundproofing with a wall made up of many plates separated by air spaces, with sound-absorbing material only at the edges and ends of the spaces; Gregersen and his dyes for the vascular system through the use of which and principles of optics he is able to make many valuable observations of the blood; Langmuir's compact and clear explanation of his thin-film research, of his hydrocarbon chains with their "hydrophilic heads in the water," and of the significance of this sort of work in helping us to know more of the behavior of the cell wall in living tissue; Bridgman's account of high-pressure research and the many changes of state he finds under these pressures with the conclusion that we are unable to make any sound guess as to the constitution of matter in the deep earth beneath us.

The top moment of the meeting, however, came at the annual dinner. That dinner, over which Professor John T. Tate of the University of Minnesota presided, turned out to be a testimonial to the scientist whose thought and enthusiasm had brought about the Institute of Physics — without exception the scientists and their guests rose to acclaim him. That scientist was Dr. Karl Taylor Compton.

Wooden Bridges Stage a Comeback

THE REVIEW has several times commented on the rapid advances made on the West Coast in the structural use of timber. Through the courtesy of R. E. Cushman, '06, of Portland, Ore., who supplies the fol-