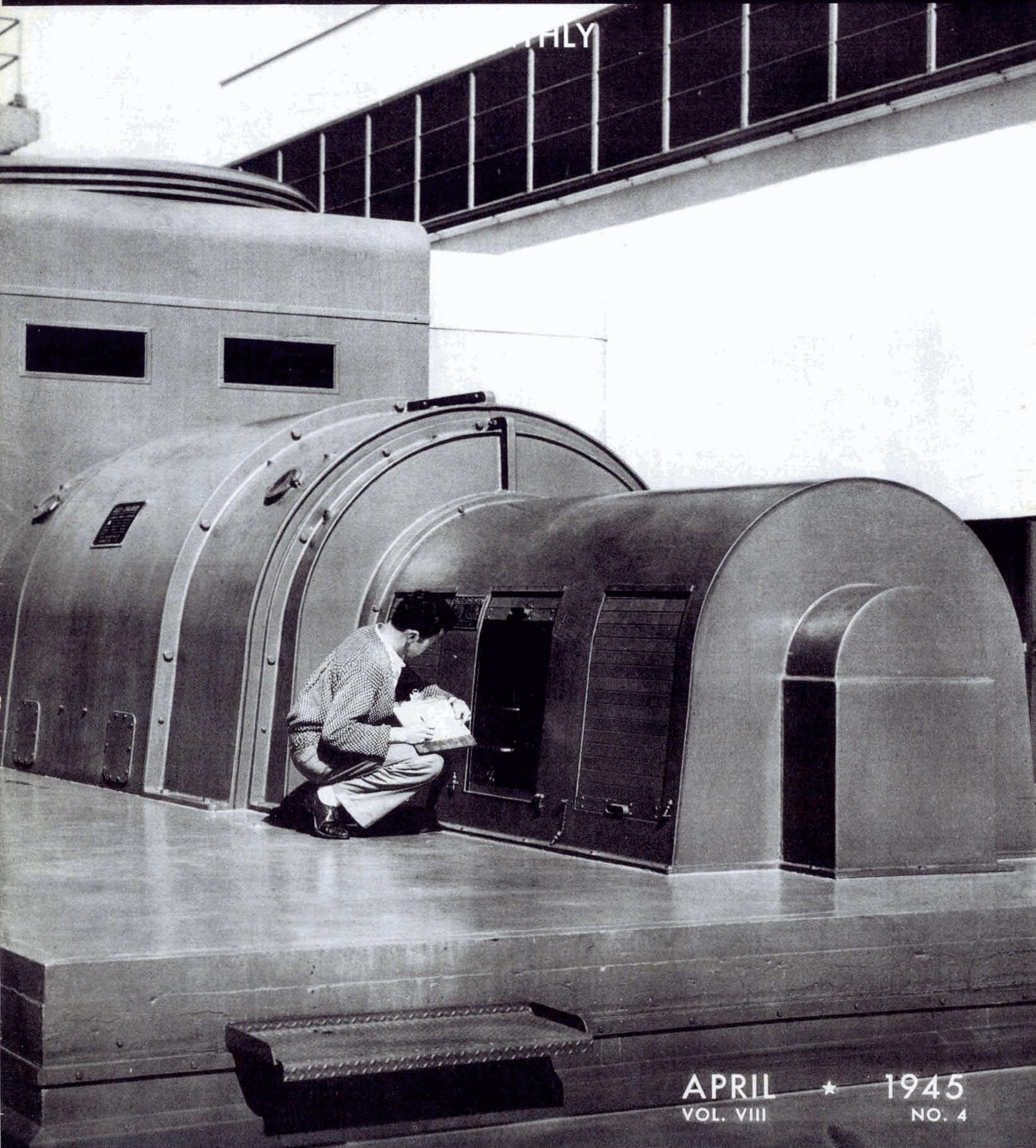
ENGINEERING AND SCIENCE

MONTHLY



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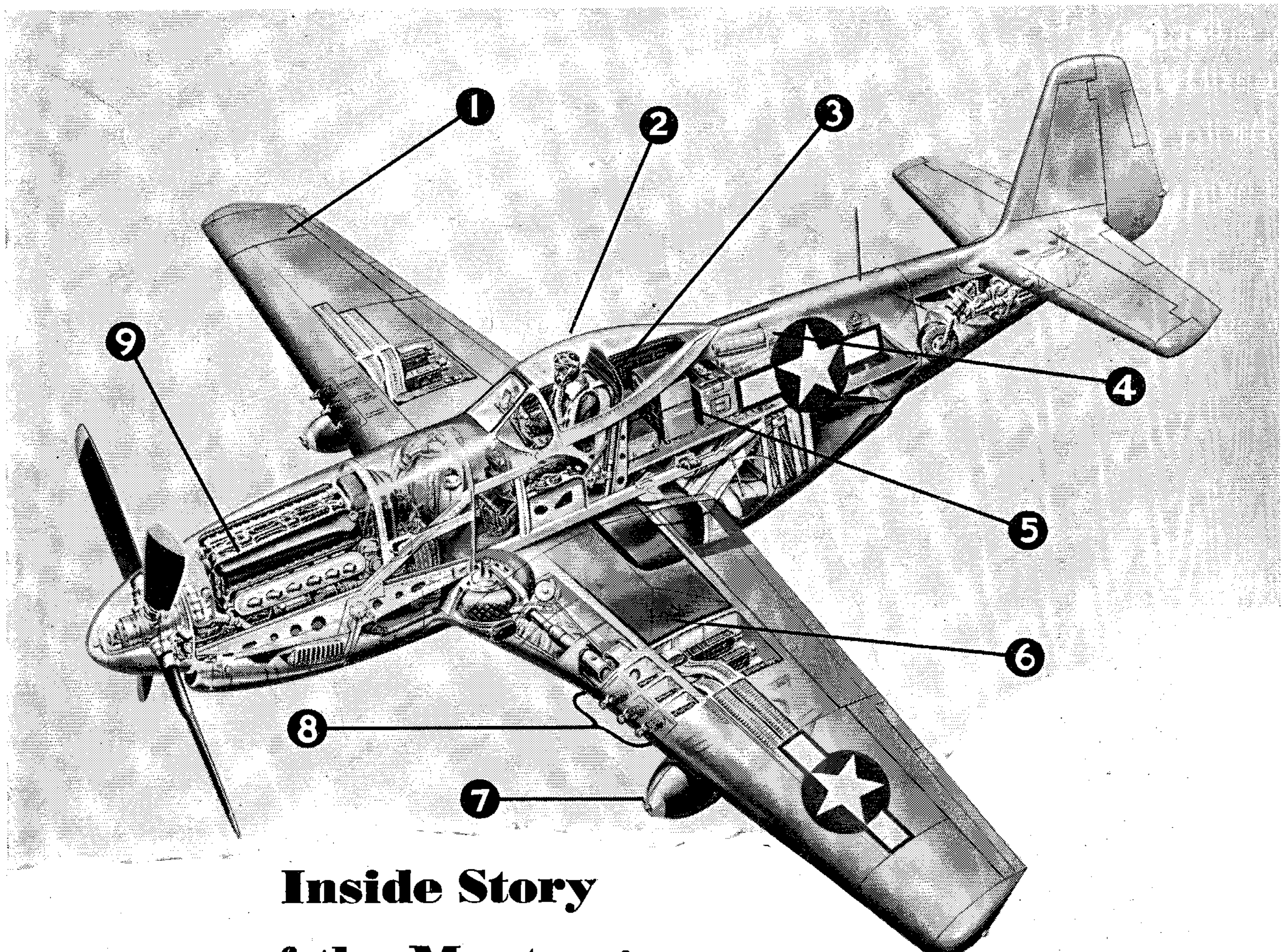

Inside Story of the Mustang

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2. **NO BLIND SPOTS**—full vision cockpit enclosure.
3. **ARMOR PLATE**—this bullet-proof seat back protects Mustang pilots.
4. **FIGHTS EIGHT MILES UPSTAIRS**—these tanks provide oxygen for pilot.
5. **TWO-WAY RADIO**—provides close coordination during missions.
6. **SELF-SEALING GAS TANKS**—an important safety factor in combat.
7. **BOMB LOAD**—1000 pounds under each wing.
8. **DEADLY FIREPOWER**—six .50 cal. machine guns, three in each wing.
9. **SPEED—OVER 425 MPH**—1520 HP supercharged engine and automatic, variable pitch propeller.

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PLANES THAT MAKE HEADLINES . . . *the P-51 Mustang fighter (A-36 fighter-bomber), B-25 and PBJ Mitchell bomber, the AT-6 and SNJ Texan combat trainer. North American Aviation, Inc. Member, Aircraft War Production Council, Inc.*

BY-LINES

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Dr. Millikan, Chairman of the Executive Council of the California Institute of Technology, and Director of the Norman Bridge Laboratory of Physics, has contributed extensively to advancements in the field of physics. He was awarded the Nobel Prize in Physics of the Swedish Royal Academy of Science in 1923.

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Alan E. Capon received his B.S. degree in electrical engineering from the California Institute of Technology in 1927. Following graduation he entered the Westinghouse Electric & Manufacturing Company student course at Pittsburgh, later being transferred to Newark. In 1931 he entered employ of the Metropolitan Water District of Southern California as electrical engineer on duties associated with the Colorado River Aquaduct. Since 1941 he has been electrical engineer with the City of Burbank, supervising electrical design and installation.

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ENGINEERING AND SCIENCE

Monthly

The Truth Shall Make You Free

CONTENTS FOR APRIL, 1945

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ENGINEERING AND SCIENCE MONTHLY

Edited at California Institute of Technology

ENGINEERING AND SCIENCE *Monthly*

Vol. VIII, No. 4 April, 1945

A Year of National Military Service Can Be An Asset to America

By ROBERT A. MILLIKAN

WISE men, wise universities, and wise nations build their advances upon the foundation of the past. If they do not they violate the most fundamental law of evolutionary progress. Obviously, then, we want to go back to much, indeed to most, of the good life we had before the war. For what is the reason we all give for having entered this most terrible war in history? What is our reason for continuing to fight on with every ounce of strength we possess? Does not every one answer: "To preserve our great inheritance from the past, the free American way of life, characterized, first, by free representative local self-government, as distinguished from centralized control, political or economic, i.e., totalitarianism; and, second, by the opportunity to rise through individual initiative, energy and ability, as distinguished from equalitarianism, a philosophy which stands condemned by its historic failures as well as by the great Teacher in His parable of the talents."

We knew we were obliged temporarily to relinquish our freedom in order to fight totalitarian states. We decided to do it because we believe Americans have the capacity to go back to the American way of life after victory. Otherwise we should have joined Hitler at the start and let freedom go forever. It is now our job to recapture our freedom.

But what I am saying now is that we will not, we cannot, after victory recapture that life completely. For every intelligent American learned from Pearl Harbor, if he did not know it before, that our fancied security behind our two oceans was an illusion and that henceforth we must keep ourselves prepared and so organized as to enable us to meet possible external aggression. At a terrible price we have at last learned our lesson, namely, that isolationism and pacificism (in effect these two, despite their philosophical differences, are identical) only breed more wars.

If we are very foolish we will try to defend ourselves alone. If we are intelligent we will in some way combine our forces with those of other peace-loving people for the purpose of defending ourselves against the attacks of the international bandits. This amounts to nothing more than extending the policing type of function which every civilized nation on earth has found that it had to adopt, and to practice within its own borders, as the only historically justified way to hold in check the depredations of its internal bandits. We have now got to do the same to defend ourselves from the external bandit nations. This latter method should cost us much less than would any plan for going it alone.

But simply because we are one of the earth's richest and most powerful nations, our share in that policing, whatever form it takes, is not going to be small. Hence, after this war the United States cannot return to its former undefended condition. It must train and keep trained for service on land, on the sea, and in the air many more fighting men than it has ever had to maintain in the past.

In view of this situation, a bill is now before Congress that attempts to meet this imperative need by requiring of every American boy one year of military service, either in the Army or the Navy.

If this bill, sponsored by the secretaries of the Army and Navy, and vigorously supported, too, by General Marshall and Admiral King, becomes a law, there will be here one very important particular in which the life of every American boy will be notably different after the war from what it has been in the past. Further, this change would have significant repercussions upon undergraduate life at the California Institute of Technology. It is some of these repercussions that I should like to point out and discuss.

Admiral Jacobs, in charge of personnel for the whole Navy, told us here some time ago that so far as the Navy is concerned—and our part in this program is likely to be with the Navy—this year of military service would in general come immediately after completion of the 12th grade, i.e., at the graduation from the high school. This normally comes on the average a little after the passage of a boy's 17th birthday.

The boy to be trained by the Navy would be sent to one of the already existing naval training posts, like the Great Lakes Training Station, just north of Chicago. The first four months of his Navy service would be devoted to naval indoctrination, including discipline, drill, physical training, etc.; in Navy parlance it would be "boot camp" training. The second four months would

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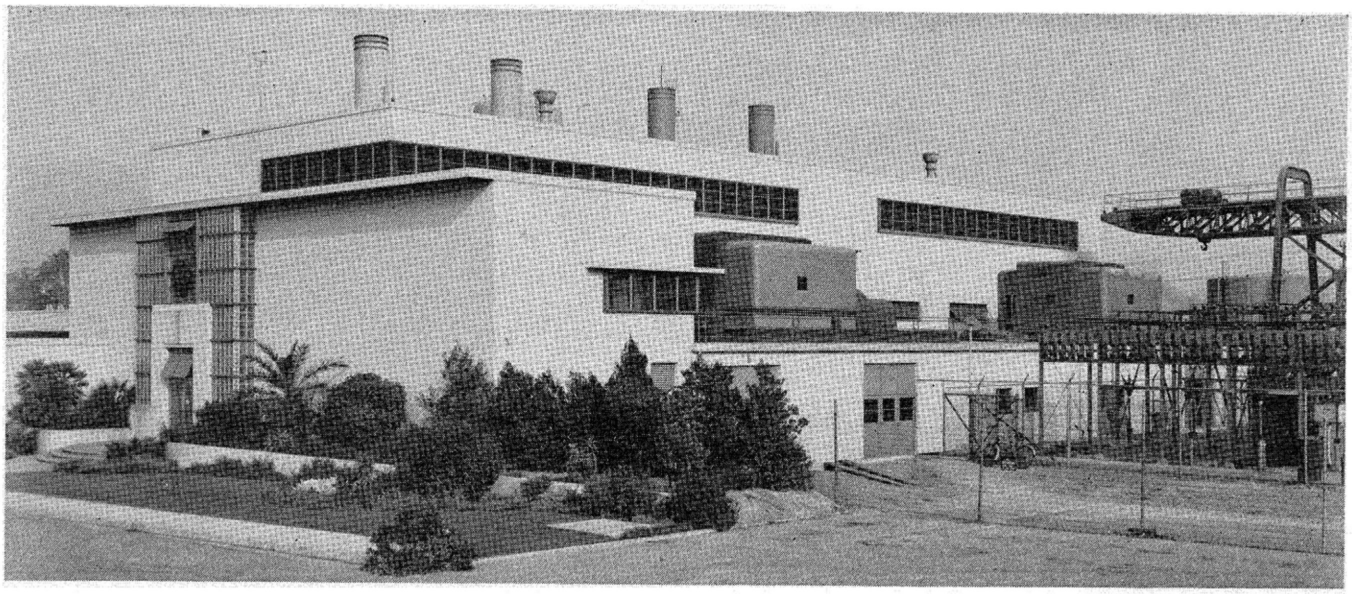


FIG. 1. The Burbank steam plant, a modern semi-outdoor type plant possessing pleasing architectural qualities consistent with economy in design.

WARTIME POWER DEMANDS

By ALAN E. CAPON

THE entire Pacific coast has experienced an unprecedentedly rapid industrial development accelerated by the war. Since in a short article only a small part of this progress can be discussed, it is the purpose here to show the effect produced on the electric facilities in one of the areas wherein the influence of expansion has been keenly felt. The small community of Burbank occupies an area of only 16 square miles, of which approximately 25 per cent cannot be utilized for residential or industrial expansion because of its mountainous character. Although this physical limitation is imposed on the development of the community, few permanent communities have experienced a growth so great as a result of expansion due to production for war. This growth is reflected in the demands on the electric and water utilities which are controlled by the Public Service Department, a branch of city government.

BACKGROUND PRIOR TO PEARL HARBOR

A radical transition has occurred in the type of industrial electric power load served by the Department. Before the war years a portion of the movie industry constituted the principal load, and this, together with a small commercial and residential load, represented quite a low total demand on the system. Commercial airplane manufacture, however, started in this area and was soon transcended by the manufacture of military planes. Even prior to Pearl Harbor a growth in load and population was stimulated by the demand of the Allies for military planes.

The original contractual allotment of firm power from Boulder Dam for Burbank, as determined in 1931, corresponded to a transmission capacity of only 5,194 kilowatts delivered at Receiving Station "B" of the Department of Water and Power of the City of Los Angeles. Later the figure was fixed at 5,109 kilowatts for delivery at the Toluca Switching Station in San Fernando

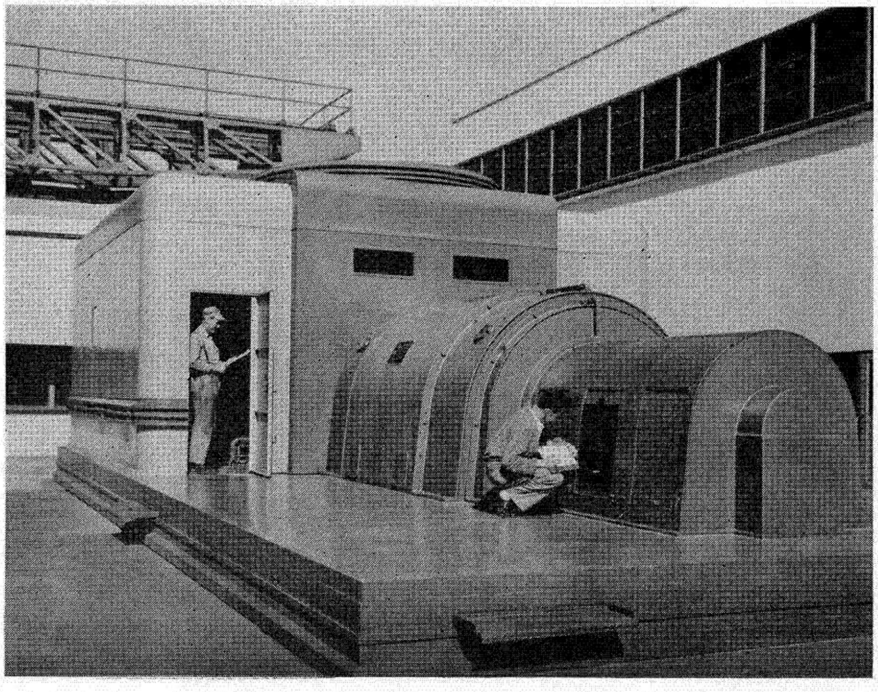


FIG. 2. The turbo-generator units are located on an outdoor deck and enclosed in weatherproof housings but present no serious problem from the standpoint of operation and maintenance.

Valley, where the physical connections between the two systems are actually made. However, preceding the period of the change in frequency from 50 to 60 cycles, power was purchased directly from the Southern California Edison Company and distributed over the municipally owned feeders. A study of the anticipated load growth for the municipality beyond the year 1935 under peacetime conditions, prior even to any consideration of the pressure of war demands, indicated the importance of acquiring an additional power source. It was decided that the installation of a municipally owned steam electric generating power plant to supplement the Boulder Dam supply would be the most economical way of obtaining additional power.

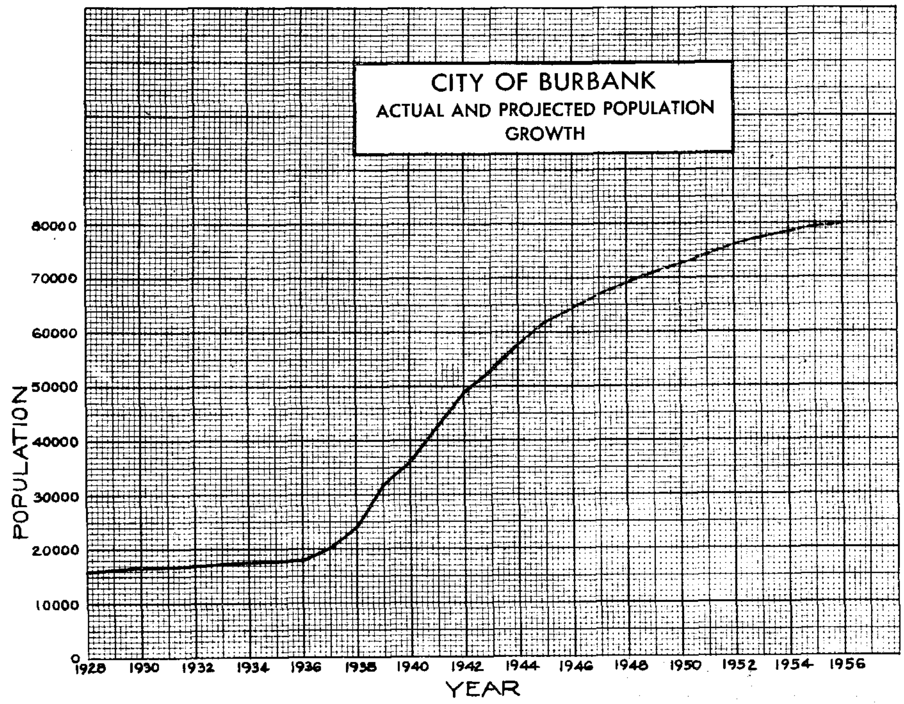


FIG. 3.

The original intent was to install a plant of standby character planned to operate at a load factor of approximately 50 per cent and designed for a high rate of pick up in the event of failure of the Boulder source. However, since the plant went into service, it has operated a good portion of the time at over 90 per cent load factor, except when operating under oil firing.

A MODERN POWER PLANT

The Burbank plant is one of the first modern, fully automatic, outdoor type steam turbine generator installations, the first outdoor turbine unit having started operation in the adjoining city of Glendale a short time prior to Burbank's installation. The turbo-generator units are located on an outdoor deck (see *Fig. 2*), but the auxiliary and control equipment, firing aisle, and control room are totally enclosed. The superstructure of the building is semi-closed and the steam generators are covered with a canopy roof. This semi-outdoor type of construction resulted in a high saving in building cost which has outweighed the disadvantages attendant thereupon. The use of a cantilever type of travelling gantry crane supported on rails alongside the building permitted a structural design of lighter and lower cost, although the cost of the cantilever type of crane was considerably more than that of the conventional bridge type. The building is supported on steel piles 25 to 30 feet deep with a 30-ton loading value, and the main turbine units are on piles and pile cap structures separated from the remainder of the building. The outdoor turbine-generator presents some problems in operation and maintenance. However, maintenance has been performed in bad weather without any unusual difficulties. One of the features of design in the plant has been the emphasis on automatic control of essential plant facilities, which permits load to be picked up quickly and produces ease of operation. A 100-pound compressed-air system is maintained for control use. Transfer to manual control can be made when desired for any of the automatic operations.

There are two 10,000-kilowatt, 4,500-volt, 0.8 power factor, 3,600-*rpm* turbo-alternators fed by three 120,000-pound-per-hour continuously rated steam generators. Each boiler is capable of handling the full output of one machine, leaving one spare boiler. The first turbo-generating unit was designed for maximum efficiency at 50 per cent of rating, but the trend in system demand required that the second unit be designed for maximum efficiency at 100 per cent load. The steam operating temperature and pressure are 825 degrees Fahrenheit and 625 pounds gauge, respectively. These values were selected as representing the lowest cost based upon an analysis of the relative costs of power production for various temperatures and pressures versus plant amortization. The turbines are of the condensing type, each with an 8,000-square foot capacity main condenser. Cooling water for each condenser is circulated through a mechanical draft, induced type cooling tower. The generator is connected by means of a cable system to the 4,500-volt grounded neutral distribution bus. Generating at the same voltage as the distribution voltage on a grounded neutral system is somewhat unusual for central station installations and presents some problems in protection.

The steam generators are of the water tube integral furnace type, equipped with superheaters and air heaters and combination oil and gas burners. Mechanical draft is obtained by duplex fans both forced and induced on one shaft and driven by two motors, one 75-horsepower and one 300-horsepower, connected in tandem to the fan shaft. The small fan motor will carry the air requirements up to 5,000-kilowatt capacity. Automatic adjustment of loading air requirements is obtained by compressed-air-operated vanes, and transfer of motor drive is obtained automatically by air-pressure switches. There is a small accumulator reserve in the boilers which must maintain steam pressure at the turbine throttle for two and one-half minutes to allow time for the combustion control system to respond to the master controller and bring the boiler furnace conditions into balance with the steam demands. A differential pressure between boiler and turbine is always maintained even when the turbine is taking its full capacity steam, so that sufficient pressure exists to correct for sudden load changes over the period between initial impulse of steam pressure drop and response of automatic control. The

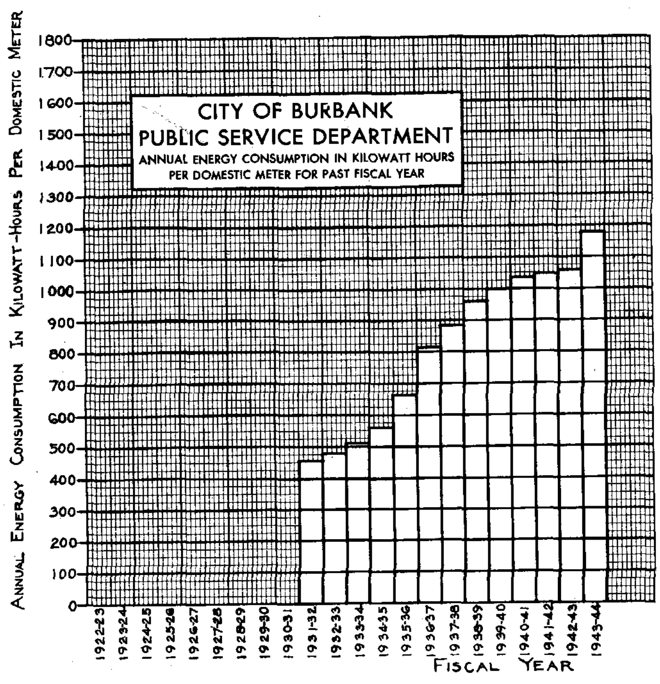


FIG. 4.

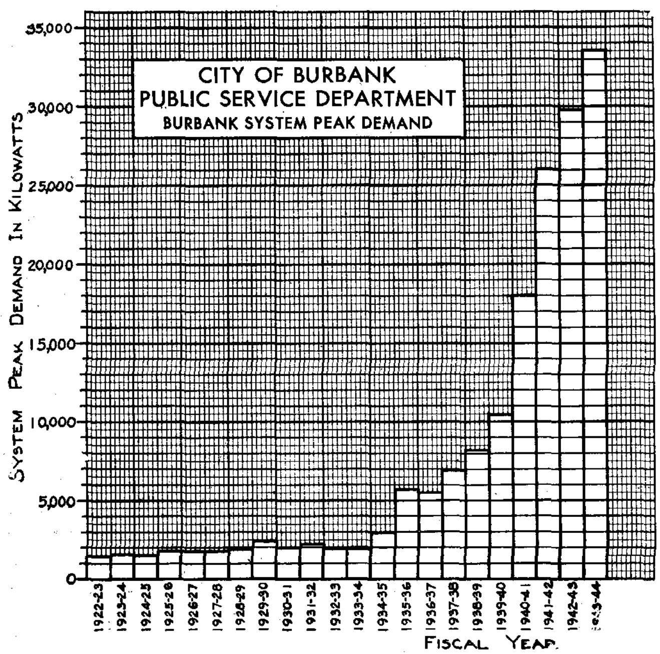


FIG. 5.

feedwater control is operated automatically to provide for changing load simultaneously with the combustion system. Boiler feedwater is conditioned by an elaborate system of softening and treatment to dissolve oxygen and other harmful products. Cooling tower make-up water is softened, and it is further treated with chlorine to prevent the formation of algae in the cooling tower.

All auxiliary drives are electric. Motors up to and including 75-horsepower are 480-volt and higher ratings are 2,500-volt. Each turbine unit with its corresponding boiler and auxiliaries is considered a separate unit functioning independently, although common feedwater and steam headers connecting the three boilers are provided. Flexibility in maintaining continuity of service for the auxiliary equipment is obtained by permitting the transfer of the auxiliary power source for either unit in the event of failure of its normal source. A 750-kilowatt, 3,600-*rpm*, steam-driven house generator capable of coming up to full speed in 19 seconds from a cold start is available in the event of the failure of power source for the plant auxiliaries. This unit will start and pick up load automatically upon drop in voltage on the 2,500-volt auxiliary bus.

The first generating unit was placed in service in October, 1941, and the second unit went into service in July, 1943. A third unit has been proposed, and provision has been made in the plant to permit future expansion to accommodate the additional unit.

EXPANSION DUE TO WAR DEMANDS

After our entry into the war, the system power demands (mostly those required for airplane and parts manufacture) rose tremendously. Industrial expansion in this area was spurred by the advent of war; and the industries were attracted here by low tax rates, low utility rates, and an ample supply of good water. In fact, one of the accomplishments of the Department in 1944 was to further reduce electric power rates. Coincidently with the growth in industrial load came a tremendous increase in population which grew to meet the demand for manpower for the war industries. This increase in population for Burbank is shown in *Fig. 3.* Home building under the sponsorship of the War Housing Authority in permitting the opening of new tracts produced a high rate of increase in added consumers to the system. A peak rate for new domestic meter installations of 332 meters per month was attained. Simultaneously with the increase in the number of residential consumers occurred an increase in the annual energy consumption per domestic consumer, as shown in *Fig. 4,* which was caused essentially during the years before the war by an increase in the number of appliances used in each household and by the installation of electric water heaters and ranges. The sharp increase in energy consumption per domestic meter for the fiscal year 1943-44 is attributed to the lifting of the dimout in the last seven months of that period and by the further curtailment in the consumption of gasoline for private cars, since domestic appliances have been off the market for some time.

The effect of this accelerated growth in industry and population is demonstrated in *Fig. 5,* which shows the rapid rise in the system power requirements, particularly during the past four years to meet the wartime production demands. It is readily seen that with only 5,109 kilowatts allotment from Boulder and 20,000 kilowatts steam generation, the City is obliged to obtain additional power from an outside source to meet the system peak requirements. The municipally owned plant in the adjoining city of Glendale is functioning in a standby capacity on an interchange basis and has contributed to making up the deficit in availability. Fortunately, also, surplus Boulder power becomes available now at a satisfactory rate to the municipality to help out during part of the heavy load period. This surplus hydro power is made available by virtue of the reduction in output of the light metal plants. It is also seen by reference to the system-demand chart that in order to have a true standby power source of reliable and economic character, it would have been necessary to double the present steam generation by installing an additional 20,000 kilowatts of capacity. However, the anticipated postwar trends in power requirements will form the basis of judgment in establishing the size of additional capacity to be installed. Paralleling the rapid rise in system demand requirements, the system kilowatt-hour energy consumption increased approximately 1000 per cent in the past seven years.

As this utility was not in a position to maintain a large investment in capital stock, the expansion had to be met with the idea in mind of avoiding overcapitalization in equipment. Therefore, satisfactory financial arrangements had to be worked out with the expanding industries for handling the power services in order to provide protection in view of the uncertain life of this new war load.

THE PACIFIC SOUTHWEST POWER POOL

The conservation of natural resources in order to divert them to war use became a prime requisite. This meant, of course, that oil and gas fuel had to be used as sparingly as possible for the generation of power, and hydro power had to be developed and utilized to the greatest extent. Steam generation in southern California has lagged behind the development of hydro power, and standby power was lacking in sufficient capacity to maintain a proper balance. As the war industries developed, an impending power shortage became imminent, the condition being made particularly acute by the installation of the metal reduction plants where large blocks of power were used directly for processing. Consequently, several of the utilities in this area realized the need to enlarge upon their steam generation facilities, and forthwith submitted applications to the War Production Board for permission to install additional capacity. Although these applications were tentatively rejected until the postwar period, the need for relief in this area was fully appreciated.

The idea was advanced by the War Production Board under the direction of J. A. Krug, then chief of the Power Branch of the Board, to pool all the power resources in the Pacific Southwest on a cooperative interchange basis. The establishment of such a program was in keeping with the requirements of Limitation Order L-94 of the National Defense Act for curtailment of electric power in the United States. Early in 1942, a thorough survey was made of the available power facilities in southern California. Information concerning current load conditions and load requirements projected through 1944 was tabulated for all systems. As a result of this survey there evolved the formation of the Pacific Southwest Power Interchange Committee and a definite program of action was adopted. The membership of the committee consists of representatives from all the utilities in this area, including the California State Railroad Commission. The power utilities having generating facilities and included in the membership are the Los Angeles Department of Water and Power, the Southern California Edison Company, the California Electric Power Company, the Pasadena Light and Power Department, the Glendale Public Service Department, the Burbank Public Service Department, the San Diego Gas and Electric Company, the Imperial Irrigation District, and the Bureau of Reclamation. Later, representatives of the Metropolitan Water District, because of its interest in the Boulder Dam power allotment, and the Pacific Gas and Electric Company became members of the committee.

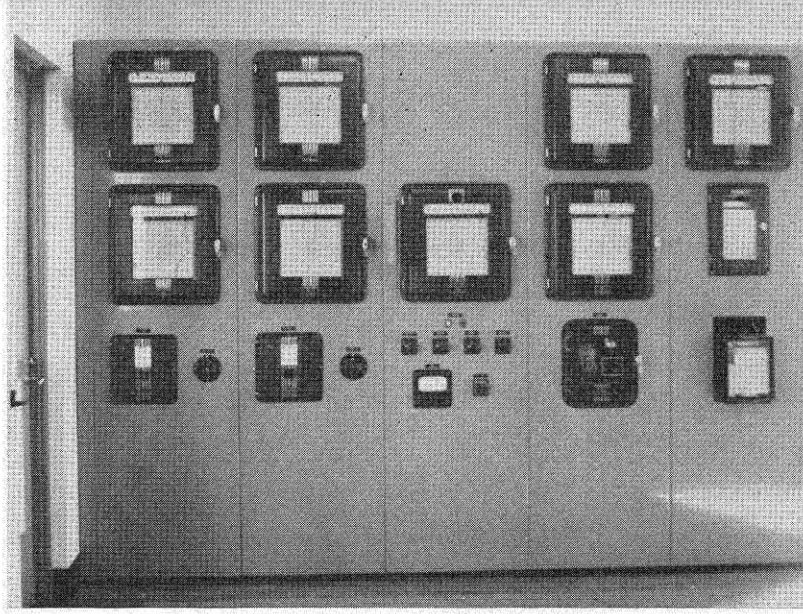


FIG. 7. Telemetering and tie-line load and frequency-control equipment for the Burbank system.

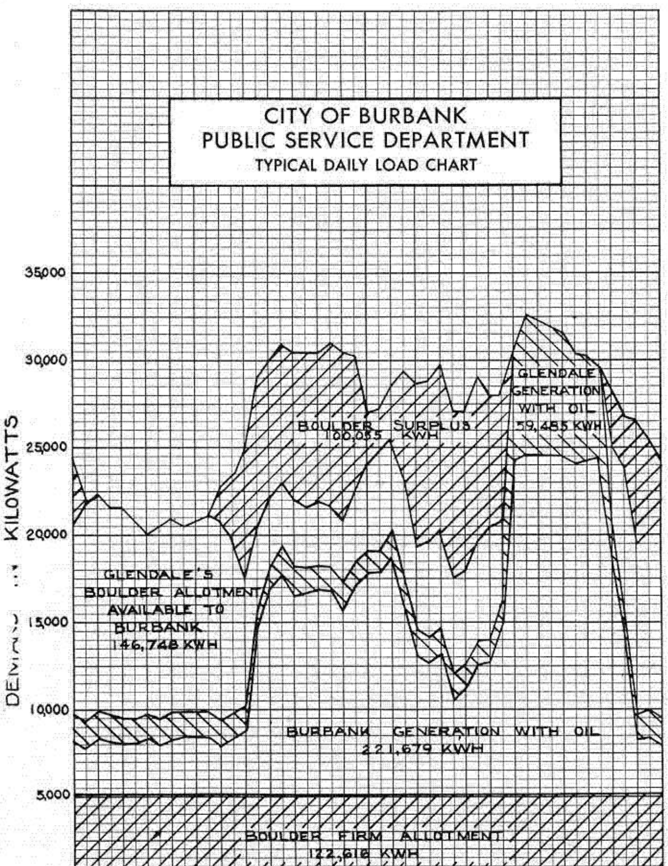


FIG. 6.

The aims of the committee were to insure that maximum use be made of all hydro power to keep the demands upon fuel supply for steam power to a minimum, that the utilities pool their resources for efficient utilization of their combined generating resources, and that additional interconnection facilities be provided to permit maximum interchange of power. It became necessary that all loads be carried with existing generating facilities, and to meet this requirement in some instances new line construction and transformer installations had to be effected to adequately interconnect the systems. In order to put the scheme of interchange on a practical working basis it became necessary to make inter-utility contractual agreements to handle the financing of power interchange, and establish satisfactory rates for energy. Most of these interchange agreements have been completed by now. Furthermore, close operating relations had to be established between the operating departments of the various systems for the proper functioning of the interchange; and maintenance programs had to be coordinated so that cooperative arrangements could be worked out for the shutdown of generating equipment.

The cooperation of the various utilities in working out the interchange program established by the committee has produced very satisfactory results. During the low runoff period in the summer, hydro power must be conserved and stored. This means that steam generation is at maximum capacity then and is usually on gas firing. In the winter and spring when the gas situation becomes critical and no surplus gas is available for generation because of peak consumption for industrial, commercial, and domestic use, hydro power is available for its maximum ultilization. Then oil firing for steam generation has to be used when gas is not available. With the interchange scheme, steam generation with oil firing can be kept to a minimum throughout the year, resulting in maximum conservation of fuel oil.

OPERATING EXPERIENCE WITH THE INTERCHANGE

A practical demonstration of how the interchange of power has worked out between the Cities of Glendale and Burbank and the Water and Power Department of Los Angeles is shown in *Fig. 6*. Although the contribution of the Burbank and Glendale generation to the power pool is small, it is nevertheless important. *Fig. 6* shows an hourly demand chart together with the energy consumption obtained from the various interchange sources for a typical winter day for the Burbank system. The Burbank allotment from Boulder is shown near the bottom of the chart as a flat demand. Next above is the Burbank steam generation with fuel oil firing. On this particular day no gas was available for generation. The narrow band in the third step represents the energy made available to the Burbank system by the Glendale steam plant while burning oil. The fourth step, or the area termed "Glendale's Boulder Allotment Available to Burbank," is that portion of firm power from Boulder Dam for Glendale which it cannot use and which is made available to Burbank at the gas burning rate. Similar to Burbank, Glendale has contracted for a portion of Boulder Dam power for delivery at the Toluca Station of the Department of Water and Power, except that the value of demand was fixed at 18,164 kilowatts. It is seen on the chart that between the hours of 5:30 and 9:30 P.M. for that particular day no quantity of Glendale's apportionment of Boulder power is made available to Burbank. The top area represented by "Boulder Surplus" is that amount of energy released by the City of Los Angeles to Burbank by virtue of surplus hydro generation being available at kilowatt demands varying during different hours of the day. Likewise, between the hours of 5:30 P.M. and 9:30 P.M. there was no surplus available from Los Angeles, and oil-fired generation at maximum output had to be resorted to. All the available power represented by the various sources on the chart totals up to the Burbank system demand in kilowatts as indicated by the top line, and the total of all areas, is the Burbank system consumption of 650,583 kilowatt-hours for that particular day.

OPERATING ECONOMIES

Strict attention is being paid to operating economy of the generating plant. The greatest economy of operation results from firing the boilers with gas. The total cost, including the fixed charges, of operating the plant with gas firing is slightly over 3 mills per kilowatt-hour. This corresponds to approximately 56 per cent of the cost when firing with fuel oil only. Two factors contribute to making firing with oil cost more than gas firing. The rate of fuel cost per kilowatt-hour of plant output is higher for oil and the plant capacity factor is considerably lower when using oil. The cost to Burbank of Boulder power is about 85 per cent of the cost when generating with oil. In addition to a high transmission cost being charged against Boulder power, it is obtained at a relatively low load factor, as it was contracted for at a time when a 50 per cent load factor was considered adequate for the system. These figures for comparative costs are relative only and will vary as fuel oil costs fluctuate. Not only from the standpoint of conservation but also from that of economy, it is highly desirable to generate a minimum with oil and keep the plant operating at a high load factor with gas firing. At times when gas is not made available and it becomes necessary to transfer to oil burning, the transition can be accomplished within a half hour without necessarily dropping load.

The automatic operation of the plant has contributed considerably to the economy of operation. Operating personnel is reduced to four-man shifts, including handling both the steam generating equipment and the electric generating and distribution equipment. Of course, additional personnel for supervision and maintenance is required. Furthermore, load changes can be more closely and capably followed with automatic control. During these times when experienced labor is not readily available the automatic control equipment has been highly desirable.

Since the firm allotment of Boulder power has to be paid for whether used or not, it becomes necessary to use it to the best advantage. The consumption of Boulder energy can be distributed over an annual period so that it is taken in the summer at a low load factor and in the winter at a high load factor. This means that particularly in winter the demand in kilowatts on the 34,500 volt tie lines between the Burbank and the Los Angeles systems is held as close as possible to the maximum available. This is accomplished automatically by a system of tie-line load control incorporating telemetering and control equipment. The transfer of power is metered on the tie lines at a remote location from the steam plant, and the record is transmitted over communication circuits to the recording and control equipment located in the plant. Impulses for regulating the output of the generators are transmitted to the governors, and the generation is varied automatically to maintain a very stable tie-line load transfer. Thus greater utilization of Boulder power is accomplished with the automatic tie-line load control than with manual operation. When operating the plant independently of outside sources, the system frequency may be controlled automatically by the same control equipment. An instantaneous record of total tie-line load, total generation, total system demand, and system frequency is obtained with the telemetering and control equipment shown in *Fig. 7*. The control of tie-line load is important also because at times, when under oil firing, the combined Burbank and Glendale demand from Boulder is taken over the Burbank lines.

CONCLUSION

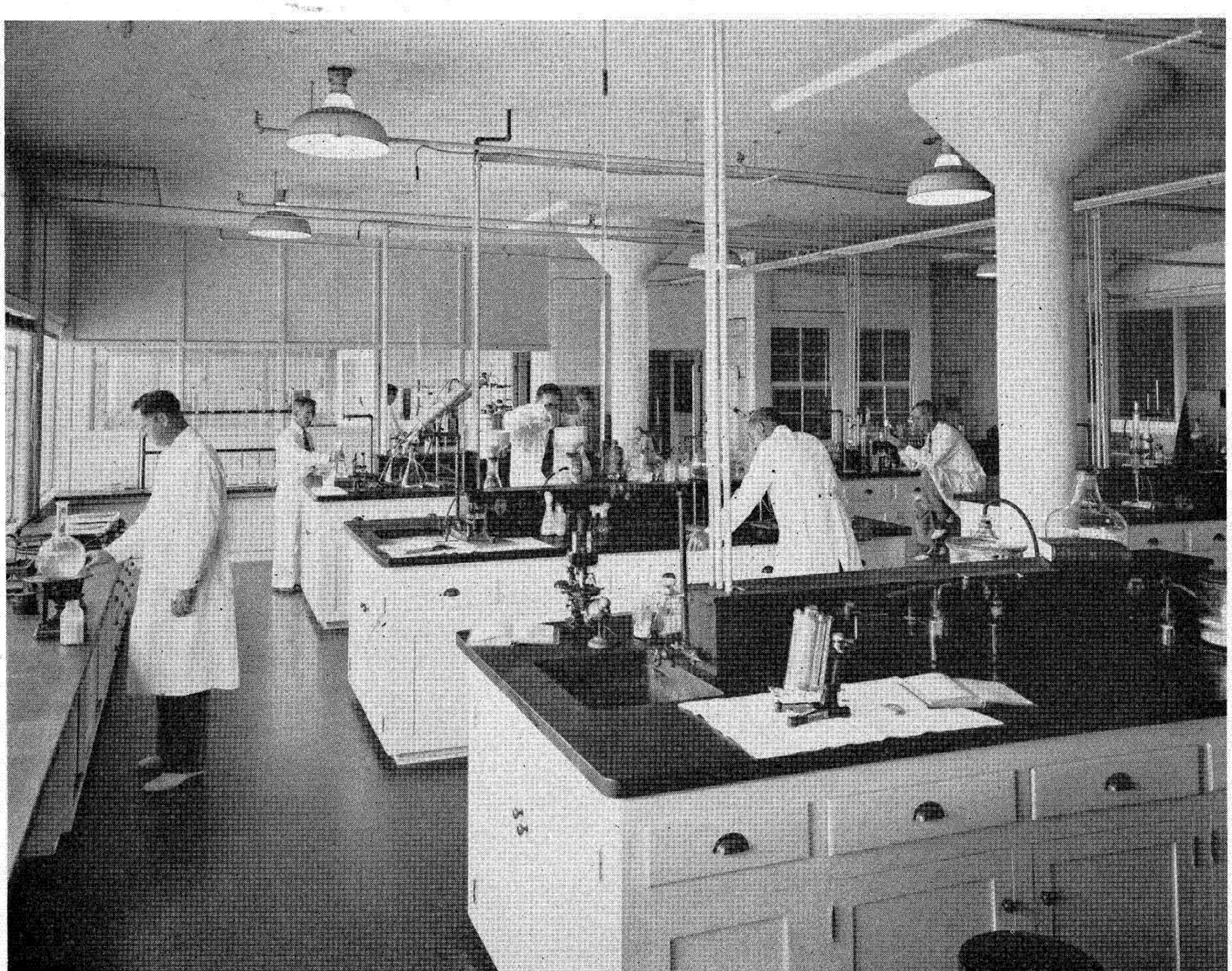
The postwar aspect presents an imposing problem with relation to the future trend in load requirements. Of necessity, a further change in the character of the industrial load served must be anticipated when production for defense requirements can be reduced as victory approaches. The future trend for the West Coast should not be viewed in a pessimistic manner, as we must expect our high-geared defense industrial program to be converted to peacetime production. The West Coast is in a good position to be able to convert to a peacetime industrial economy, since the labor market and the machinery for industrial development are already here.

Research in the Development of
CITRUS PRODUCTS

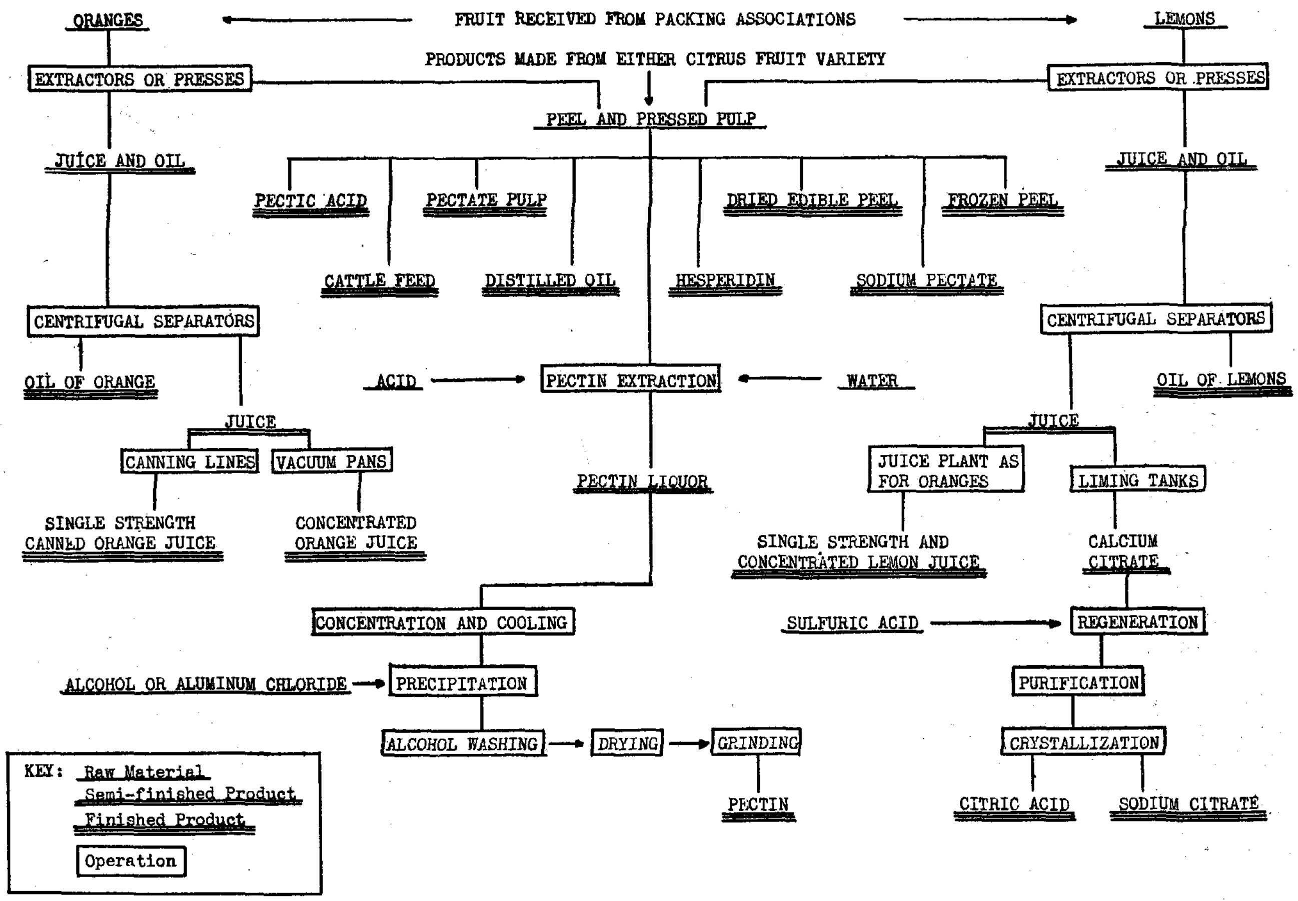
By W. E. BAIER

THE citrus products industry had its inception in Sicily some time in the early eighteenth century. It was then primarily an essential oil industry employing hand labor for expression of the oils of lemon, bergamot and orange. The years since 1900 have seen the gradual transition of citrus products to the status of a real chemical industry. Many of the major chemical developments were worked out prior to 1925, but the volume and variety of products handled have increased steadily up to the present time, with an especially marked growth coming since 1940 or just before our participation in World War II. The expansion for war production has been rapid in the states of Florida and Texas, where previously, except for canning, products development had been less active.

In this discussion we are referring to processed products of all kinds derived from oranges, lemons and grapefruit, but not including the packed fruit as prepared for the fresh fruit market. During World War I, American processed citrus products were not widely known or important to the prosecution of that war. Now, in World War II, quite a different picture is presented. The estimated gross annual value of citrus products made in the United States (still excluding fresh fruit) is about $200,000,000, and the products have been supplied almost exclusively for the three classifications: (1) Lend-Lease to the United Nations; (2) Direct use by our own armed forces; and (3) Use by processors filling Government contracts. So important are these to our war effort, the citrus products industry has at times worked under so-called "set aside orders" issued by War Food Administration, providing that a certain portion



Laboratory of the research department, California Fruit Growers Exchange, Ontario, California.



Abbreviated flow sheet of citrus products, California Fruit Growers Exchange.

(usually 20 per cent) of the entire orange crop be reserved for conversion to products to assure adequate war production.

ROMANCE OF FLAVOR

The story of the citrus products industry might be told in a number of ways, depending upon the dominant viewpoint or field of interest. The place of concentrated citrus juices in "C-vitaminizing" the infants, children and expectant and nursing mothers of war-torn England is a story in itself and a noteworthy example of socialized nutrition necessitated by an emergency.

The economic history of citrus products is equally interesting, recording as it does the several failures attending the attempts to manufacture some one product exclusively while wasting other portions of the fruit. Another possible cause of failure is the conversion by growers' organizations of their fruit into products involving relatively large and speculative purchases of outside materials. Thus the making of marmalade, which necessitates huge investments in sugar, glass and warehousing to care for the fruit normally available for processing, is usually an operation more attractive to the specialty manufacturers and merchandisers (in this case preservers) than to the primary citrus organization (such as the growers' cooperative).

Both the aforementioned nutritional and historical phases as well as others are seasoned with the flavor of romance or, more exactly, the romance of flavor; the mark of the early and continued importance of the rind essences in the world commerce of essential oils. Concerning this, it should be remembered that the study of essential oils more than any other single factor led to the methods and the training of those organic chemists who never fail to astonish with how much they can learn, analytically, with so exceedingly little, complex, and often unstable material.

The remainder of this article has particular reference to the research activities of the California Fruit Growers Exchange, a growers' cooperative, whose early goal it was through products development to avoid the waste and the demoralizing influence on the fresh fruit market of fruit below proper standards of shipping quality.

The accompanying flow sheet will aid one in following the original as well as the improved processes of conversion of oranges and lemons.

When the more modern type of chemical research entered the industry, the classical Scheele process was (and still is) the basis for citric acid recovery. The Scheele process makes use of the insolubility of calcium citrate. The latter is precipitated from heated lemon juice by calcium hydrate and the boiling is continued to increase the particle size, thus facilitating removal by filtration. Regeneration of the citric acid, purification and crystallization follow.

Orange and lemon oils were made by a rather inefficient mechanical process. A clever continuous steam still made possible further yield of the essential oil left in the pulp, giving in this case a different type of oil, less used as a flavor but of value in perfumery. The remaining pulp was largely wasted or turned back into the soil of citrus groves as fertilizer and some was fed wet to dairy cows. The juice of lemons served as the source of citric acid, but orange juice was considered uneconomical for this purpose and was at that time without a suitable market.

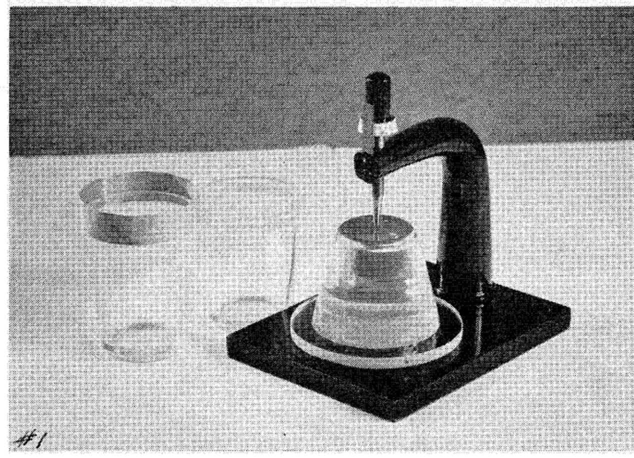
Vacuum concentration of the juice yielded a product which darkened badly on storage and sometimes fermented. The earliest preservatives used were essential oils, notably clove. These, as may be supposed, were not too successful. The earliest use of concentrated juice in carbonated beverage was in filtered or clarified form because all carbonated beverages were clear, and if cloudy juice were used it would clear itself in time, the insolubles separating as an unsightly sediment. Research of chemists and bacteriologists and the efforts of others have brought about changes. Through a controlled process of high temperature flash pasteurization in stainless steel equipment, the juice is at once freed of the adverse effects of fermentive organisms and of clarifying pectic enzymes, and storage life, at reasonable temperature, has become satisfactory. The result is that, in peacetime, concentrated citrus juices are very widely distributed for local bottling of nutritious citrus beverages, both still and carbonated, especially in this country but in many other parts of the world as well.

PECTIN

Perhaps no substance in citrus has given the research chemist more worry than pectin—that interesting material almost universally present in fruits, vegetables, fibers, etc. It must be maintained in status quo to stabilize the cloud in concentrated juices described above, because the process of enzymic or chemical degradation of pectin is used for intentional clarification of various juices. Pectin must be eliminated in the retting of flax; it is recovered in processing citrus fruit to be available for man's needs. It is used in preserving and confectionery because it forms a jelly with sugar; in the transfusion treatment of shock it is one of the most promising substitutes for human plasma and in this case it does not form a gel if it becomes cold, as does gelatin. Paradoxically, pectin is not a good adhesive, but in the form of cold water-insoluble protopectin, it is the cementing substance between the cells in the structural parts of non-woody plants. In this respect pectin is distinguished from water-soluble gums, which are the dried exudates from wounds on certain plants, and from mucilages, which are water-extracted from the seed coats of many varieties. Yet chemically and physically there are often over-lapping similarities among the pectins, gums and mucilages.

Past research perfected the production and use of pectin so that now the United Nations are getting for their annual wartime food and pharmaceutical needs approximately 2,000,000 pounds from California alone, each pound of which would make about 150 pounds of fruit jam. Incidentally, the so-called grade of a pectin is not of the quantity of jelly or jam per pound of pectin, but the pounds of sugar a pound of pectin will carry in a standard jelly of standard firmness. The jelly firmness is now precisely measured and the grade thus determined by percentage sag due to its own weight. The instrument used, shown in the accompanying photograph, is a convenient micrometer known as a Ridgelimeter, which, with a single setting, reads directly in per cent sag. Commercial powdered pectins are standardized by blending and addition of corn sugar to assure uniform performance.

The problems now receiving attention are many. Although pectin is simply carbon, hydrogen and oxygen in fairly well-known proportions, its structure is complex. A better understanding of the physics and chemistry of the pectin micelle will make possible the further improvement of special pectins for jellies low in sugar,



Ridgelimeter for the determination of jelly firmness.

of many useful pectic derivatives analogous to various chemical modifications of cellulose; and of pectin sols for intravenous treatment of traumatic shock.

Concerning the latter, attention has been given shock treatment, because of war needs, far beyond the dictates of any potential market return. This applies equally to manufacturers of other possibly useful blood substitutes. Because they are foreign substances, the effect of intravenous colloids, other than typed blood itself, can only be determined by experiment, first on animals and then clinically. In the case of properly prepared pectin sols, remarkably good results have been obtained with no adverse reactions or permanent accumulation, although temporary spleen involvement is sometimes observed. It is interesting that the degradation product of pectin (galacturonic acid) may not be so foreign, even parenterally administered, in view of the uronic acids found in normal animals. Glucuronic acid is usually assumed the one present in all warm-blooded animals. The possibility is now being considered, however, that in the herbivore galacturonic may comprise a substantial part of the uronic acids of the fluids and tissues. In omnivorous man, glucuronic acid may be synthesized by the body while the pectin-carrying diet (fruits and vegetables) may supply galacturonic acid. Investigators previously had shown galacturonic acid to enter into a protective detoxication process, as glucuronic acid does, but it is not known that the mechanism is the same in the two cases.

RECENT DEVELOPMENTS

The products research program of the Exchange has embraced both fundamental and practical problems. The work of past years has been directed largely toward food products. These probably will always be the most important class, especially in dollar value, considering the potential nutritional need for more widely distributed citrus juice. There is obvious merit also in the idea of striking a balance between outlets in food (including beverages and confectionery as well as feeds) vs. pharmaceutical vs. industrial channels. Recent achievements of the program, some of them the subject of continuing research, include the following items:

Food (and Feed)

1. Low ester pectin for use in low sugar jellies.
2. Improved concentrated juice products.
3. Feed (for ruminants) with enhanced nitrogen content.

Pharmaceutical

1. Pectinum N.F. VII for internal and topical medicine.
2. Hesperidin methyl chalcone, a new drug.

Industrial

1. Pectate pulp in oil well drilling mud chemicals.
2. Pectate pulp dispersion in paper coating and penicillin production.
3. Sodium ammonium pectate as a gum and agar substitute.

It is interesting to note that both possible approaches to a new product are represented in this partial list. There is the case of attempting to develop a product to meet some specific need, and the opposite case of discovering some new composition or constituent and then trying to find a field of use. Incidentally it is the writer's conviction that if a research program functions in these two ways successfully, not necessarily with equally frequent occurrence but at least occasionally, it is a test that the projects are reasonably well balanced as an

(Continued on Page 15)

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

2—Prints of Early Mechanical Road Vehicles*

By E. C. WATSON

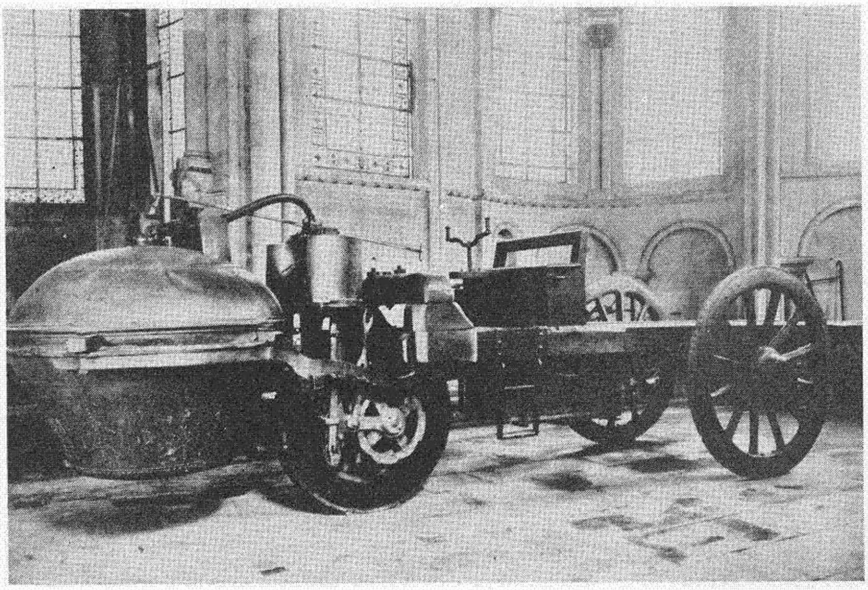


FIG. 1. Cugnot's steam tractor (1769-1770), the first practical horseless road vehicle.

THE first practical mechanical road vehicle was the steam tractor built in 1769 by Nicholas Joseph Cugnot, a French military engineer (1725-1804). It attained a speed of just over two miles per hour on a level road, but the boiler capacity was sufficient only for 12 or 15 minutes of running. By order of the French government a second tractor was constructed in 1770 for the transportation of artillery, but it was never used. It is now preserved in the Conservatoire National des Arts et Métiers in Paris, where the photograph was taken from which *Fig. 1* was made. The following description appears in the *Catalogue* of the collections in the Science Museum, London, where a small-scale model is displayed:

> "It consists of a heavy timber frame supported on three wheels and carrying in front an overhanging copper boiler. The front wheel has a broad, roughened tyre, and is driven by two single-acting inverted vertical cylinders 13 in. diam. by 13 in. stroke. The two pistons are connected by a rocking beam, and their motion is transmitted to the driving axle by pawls acting on two modified and reversible ratchet wheels. The distribution of steam to the two cylinders is performed by a four-way cock actuated by a tappet motion. A seat is provided for the driver, who, by means of gearing, was able to steer the machine, the boiler and engines turning together as a fore-carriage through 15 deg. either way."

The first mechanical road vehicle to make a journey of any length was the steam carriage built in England by Sir Goldsworthy Gurney (1793-1875). The description beneath the print in *Fig. 2* reads as follows:

> "The Guide or Engineer is seated in front, having a lever rod from the two guide wheels to turn & direct the Carriage & another at his right hand connecting with the main Steam Pipe by which he regulates the motion of the Vehicle—the hind part of the Coach contains the machinery for producing the Steam, on a novel & secure principle, which is conveyed by Pipes to the Cylinders beneath & by its action on the hind wheels sets the Carriage in motion—The Tank which contains about 60 Gallons of water is placed under the body of the Coach & its full length and breadth—the Chimneys are fixed at the top of the hind boot & as Coke is used for fuel, there will be no smoke while any hot or rarified air produced will be dispelled by the action of the Vehicle—At different stations on a journey the Coach receives fresh supplies of fuel & water—the full length of the Carriage is from 15 to 20 feet & its weight about 2 Tons—The rate of travelling is intended to be from 8 to 10 miles per hour—The present Steam Carriage carries 6 inside & 12 outside Passengers—the front Boot contains the Luggage."

Although planned for regular service between London and Bath, the coach of Gurney remained in an experimental state. Its chief performances were the climbing of Highgate Hill on June 14, 1828, thus demonstrating the possibilities of steam in climbing a prolonged slope, and the trip from London to Bath in 1829, the first trip of any length to be made by an automobile. Nevertheless it was not successful technically, partly because the mechanism was inaccessible and badly protected.

Between 1827 and 1838 Walter Hancock (1799-1852)

*Reprinted from *The American Physics Teacher 6,* 195 (1938)

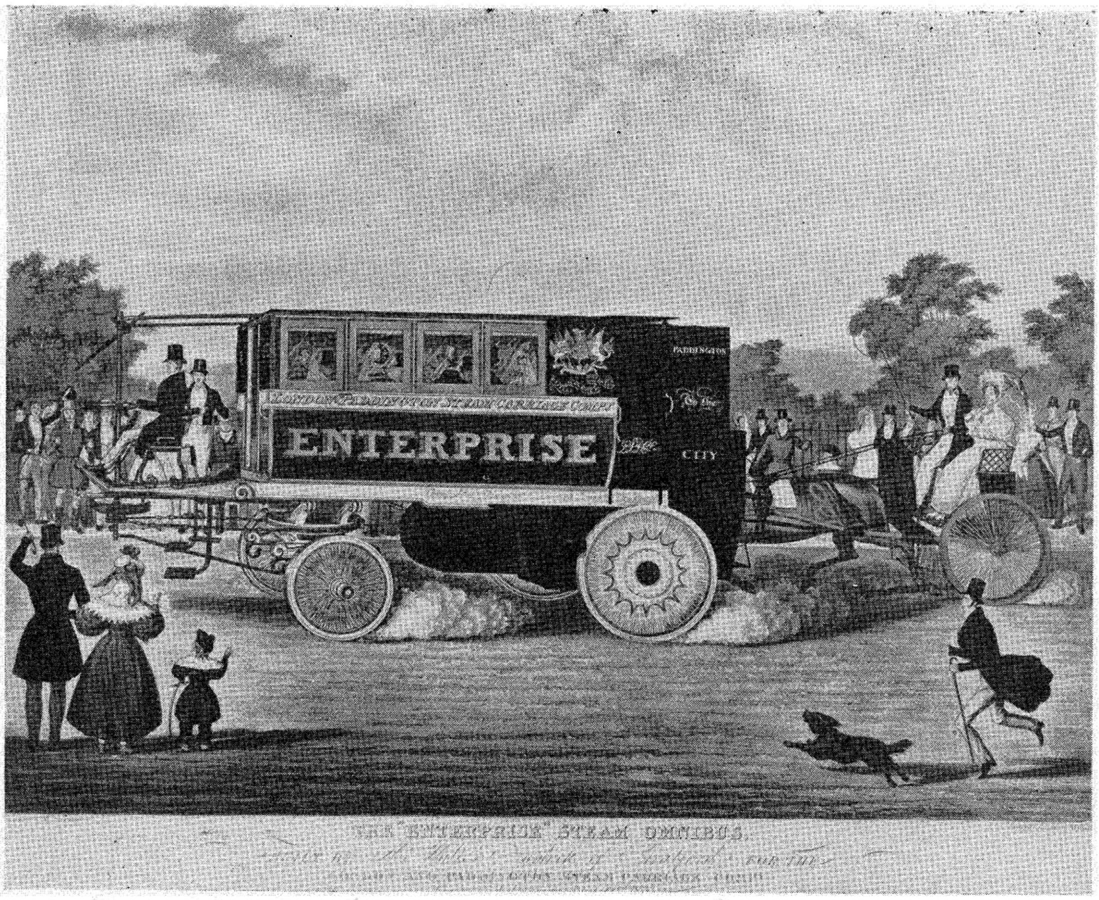


FIG. 2. Gurney's steam carriage (1827-1829), the first horseless carriage to make a long journey. (From a magnificent colored aquatint, 9.5 by 15 inches, by G. Morton and Pyall.)

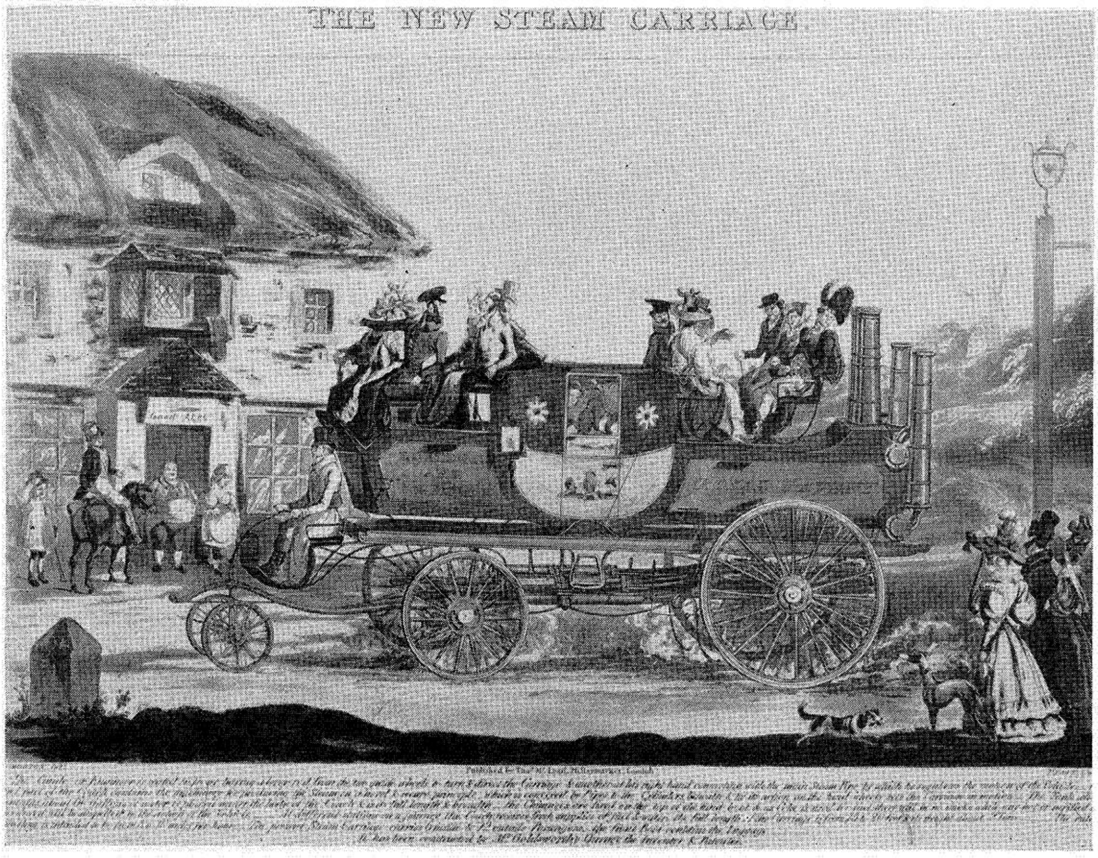


FIG. 3. Hancock's steam omnibus (1833), the first omnibus in regular service. (From an aquatint by W. Summers and C. Hunt.)

FIG. 4. Church's ornamental three-wheeled steam coach (1833). (From an engraving by John Cooke and Josiah Allen.)

of Stratford, England, built nine steam carriages of various types, all of which were mechanically successful. On April 22, 1833, one of these, named the *Enterprise* (*Fig. 3*), was put into regular service between London and Paddington. This was the first mechanical vehicle especially built as an omnibus to be put into continuous service. Being more novel than the horse-drawn coaches, it was favorably received by the public.

Fig. 4 shows a curious coach built in 1833 by William Church. This coach, which ran for a time between London and Birmingham, had wheels with flexible spokes and very broad but elastic rims.

Further details of early road vehicles and their history will be found in the *Histoire de la Locomotion Terrestre*, by Charles Dollfus (*L'illustration*, Paris, 1936) and in the *Catalogue of the Collections in the Science Museum, South Kensington, with Descriptive and Historical Notes and Illustrations. Land Transport. II. Mechanical Road Vehicles* (London, 1925), from which much of the foregoing discussion was taken.

Military Service

(Continued from Page 3)

add vocational training of some sort for every boy, the trainee being permitted to choose the field of his training. At his volition this vocational training could be manual or commercial, just as a similar choice is open to enlisted men now in the Navy. The third four months the trainee would go to sea.

The American Association of University Professors has sent a questionnaire to university professors all over the country asking for votes on details of such a program, but closing with the question: "If you are opposed to universal military training, how do you believe that the national defense can best be safeguarded?" Otherwise stated, what other alternative is there? Granted that isolationism and pacificism, two attitudes which are identical so far as their war-effects are concerned—and those effects have been to prevent us from being prepared either to defend ourselves or to help other nations in putting down international aggression at its inception, as we ought to have done before Poland was attacked—granted that we have learned our history lesson and that these two attitudes are now dead, there then seem to be but two alternatives before us as to method, namely, either (1) to maintain a powerful professional army, navy and air force (the history of Rome and of continental European nations shows how bad an alternative that is) or (2) to train each citizen to take some part in the national defense and in the maintenance of a peaceful world.

Suppose, then, that some form of the universal service bill passes. Look at the values that, if it is properly done, can come from it to life in America and in particular to life at C. I. T.

First, that year of continuous training and toughening of the physiques of the whole manhood of America will tend to form habits of bodily care that can make a healthier America than has thus far existed, and a healthier and huskier group at C. I. T.

Second, on a preceding occasion I have expressed my own confidence in the moral value of the discipline which I found in a recent visit to Annapolis, the training in punctuality, in orderliness, in cleanliness, in gentlemanliness, in truthfulness, in honor, even in religion. Can there be any doubt that subjecting every boy in the United States for a year at the age of 17 to just this kind of training under Army and Navy officers and their chaplains would make a better postwar America and a better postwar C. I. T. than existed in prewar days? The freshmen who entered here at the age of 18 would come here fresh from a year of that kind of discipline.

Third, one main purpose of a *universal* elementary and secondary school system is to train every citizen in the duties, the responsibilities, and the art of good citizenship. Democracies having universal suffrage cannot possibly survive unless at least 51 per cent of the voting population have the background that enables them to cast reasonably intelligent votes. What an opportunity that year would give to teach with all the most modern movie techniques now available the meaning, the methods, and the responsibilities of American citizenship! Imagine, for example, the Chief Justice of the United States standing, in pictures, before all the boys of the nation and talking with them for an hour on the significance of law observance. Multiply that influence say only 50 times—one talk a week for a year by 50 of the most distinguished men of the nation—and what an inspiring course in the fundamentals of citizenship you could have.

Fourth, the giving of every boy in the United States the opportunity, while living under military discipline, to make a beginning in learning some manual or commercial skill could be made to begin at least to rectify the weakest spot in the whole American educational system, namely, the lack of any sort of an apprenticeship system for providing the country with its own skilled workers rather than forcing us to import most of our skilled artisans from abroad, as we have done in the past.

I leave your imagination to fill out the picture. Great possibilities are certainly ahead. Will we have the intelligence to grasp and make the most of them? I should like to come back to this campus 20 years from today to find out.

Citrus Products

(Continued from Page 12)

industrial research program either on the so-called fundamental or the so-called practical side.

Pectate pulp is a product that resulted from research discoveries; after discovery uses had to be found for it. Sodium pectate, made by neutralizing pectic acid, has been known since 1825, as has pectin. They had similar colloidal properties, the pectic acid being perhaps less satisfactory for most purposes than the now highly successful pectin. By a simple change of process the Exchange found a pectate having much higher molecular weight which makes film-forming, viscous solutions. Moreover, it was possible to process the material without separating the cellulose, and the finished low cost material, when dispersed at the point of use, embodies both a highly colloidal sodium pectate and very finely divided cellulose.

But of what use is it? The uses are developing rapidly now, but at first considerable time was spent on some which did not materialize. One such was for quenching in heat-treating steels. Because of the low cost, controlled viscosity and non-inflammability, this appeared attractive and may yet be. However, oil well drilling mud treatment (to prevent water loss to porous strata) and paper coating (to prevent sticking of packaged synthetic rubber) have proven very much more practical than that young hopeful, the modified aqueous quenching medium.

VITAMIN P

An odd sequence of discovery occurred a few years ago regarding so-called Vitamin *P*. The Nobel Prize winner, Albert Szent-Gyorgyi, of Hungary, announced his discovery of this vitamin in lemons during 1936. Vitamin *P* was so named because it corrected excessive permeability of the capillaries and it alleviated hemorrhagic purpura. Several years earlier it had been discovered in California, in connection with spray drying of lemon juice (for cosmetic use), that an unknown constituent of the juice together with boric acid produced a brilliant yellow color. It was later found to be due to a certain group of flavones and of flavone derivatives, the same that are now considered the active materials in the Vitamin *P* substances. Here was a case of finding a color reaction for a vitamin years before the vitamin was discovered!

The research on citrus products has been accomplished in the aggregate by Government laboratories, State agencies, commercial firms, and the Exchange Research Department, which, as already stated, is the activity of a growers' cooperative and is guided by a Research Committee of grower-directors. Although the number of technically trained men employed in the Research Department has averaged about 12, and publication of results is not the objective of the work as it necessarily is in Federal and State laboratories, still the total number of publications refutes any notion that this is an industry where secrecy may have limited the progress. The present total of technical papers, bulletins and patents published is 222, covering a wide variety of subjects. It would be difficult to prophesy the future of citrus products but it can be expected to feel the influence of the same technical and scientific advancement which will guide all postwar industry.

C. I. T. NEWS

HERBERT HOOVER, JR., TRUSTEE

The California Institute of Technology announces that *Herbert Hoover, Jr., has been elected to its board of* trustees.

The son of Herbert Hoover and the late Lou Henry Hoover, Herbert, Jr., was born in London, England, and attended Stanford University, graduating in 1925 with a B.A. degree. In 1929 he won his M.B.A. degree at Harvard University. He was a member of the research staff of the Harvard Business School in 1928 and 1929, and from 1929 to 1931 he was communications engineer for the Western Air Express, followed by three years of service in the same position with Transcontinental and Western Air, Inc. In 1934 and 1935 Mr. Hoover was a Teaching Fellow at the California Institute of Technology.

Mr. Hoover is president of the Consolidated Engineer*ing Corporation and the United Geophysical Company*, both with offices in Pasadena, Calif. He is president of the United Engineering Company of New York and a director of the C. R. B. Educational Foundation. He also is a member of various professional societies, including the American Institute of Mining and Metallurgical Engineers, the Institute of Radio Engineers, and the Society of Exploration Geophysicists.

Mr. Hoover, a resident of San Marino, Calif., is married and has three children, Margaret Ann, Herbert, III, and Joan Leslie.

CHINA IN PEACE AND WAR
As related by E. Harrison King

THE alumni dinner meeting held at the Hotel Clark on the evening of March 8 had as its speaker E. Harrison King, instructor in hydraulics at the Institute. Mr. King vividly described China as he knew it while professor of civil engineering at St. John's University near Shanghai and as an internee in a Japanese internment camp following America's entry into the war in 1941.

Mr. King first told of the general Chinese background by comparing Chinese cities with Chicago, New York, and other American cities. The skyscrapers of Shanghai are high and numerous, reminding one of New York City. At the other extreme of comparison, Mr. King spoke of one city of 130,000 population near Shanghai which has no railroad or highway leading to or from it. The city has a wall and moat surrounding it, the moat joining with canals which permit small sailboats to reach the outskirts of the city. The only other means of transportation into the city is by cart and dirt path.

Mr. King commented that a few of the customs and methods of the Chinese are not understood and therefore not respected by many Americans. However, he stated, if these customs and methods were understood they would be recognized as effective and respectable. Mr. King explained that the attitude of the Chinese is that they can work their problems out in their own way regardless of misunderstanding by peoples of other nations. He expressed the thought that the Chinese have a tough, resilient spirit and little-recognized resources, as amply demonstrated by their long war against Japanese aggression, and that they merit great respect for their endurance.

Mr. King found that life in the internment camp near Shanghai could be made tolerable by resigning one's self to its rigors and trials and by keeping as busy as possible. To keep busy Mr. King spent two hours per day at hard labor and several additional hours each day at learning the Chinese language. As practice in learning the language he spent considerable time at translating a Chinese detective story to English.

ATHLETICS

By H. Z. MUSSELMAN,
Director of Physical Education

WITH inclement weather retarding the men in their training and forcing the cancellation of numerous practice contests, the spring sport teams are entering league competition with untried ability. However, the outlook is bright.

Eight lettermen and a flock of promising recruits give Dr. Floyd Hanes a strong track squad with good balance in all events. The returning lettermen include Don Tillman, who established new Tech records last season in the shot and discus, Ken Shauer, Stuart Bates, Bob Taylor and Gene Bolster, a classy field of middle distance runners, George Gill and Bob Howe in the mile and two-mile and George Wilhelm, javelin. Tillman and Bolster are handicapped by pre-season injuries which may retard their competition until mid-season.

In the opening meet, U.C.L.A.-Caltech-Pomona finished in that order with 80½-65½-16 points respectively in a triangular meet on the Bruin field. In dual meet scoring, U.C.L.A. trimmed Caltech 68-63, while the Engineers trounced Pomona 102-27. Ken Shauer established a new Caltech record of 49.5 seconds in the quarter. George Gill captured both distance events, winning the mile in 4 minutes 40.9 seconds and the two-mile in 10 minutes 46.7 seconds. Other winners were Bob Grube in the high jump at six feet and Howell Tyson with a 42-foot three-inch mark in the shot.

The rainy weather was a distinct handicap to the baseball squad, for with only two veterans, John Anderson first baseman and Dale Austin outfielder, much time was lost in attempting to discover a starting lineup. The material appears better than last year's team, but the strength is spotty. Dick Roettger, pitcher, and John Schimenz, catcher, are valuable additions both in the field and at bat, while Bob Jones, who played at U.S.C. last year, has proved a real find at shortstop.

The Beavers had a field day in trimming Pepperdine 21-5 in the opening league game. Scoring seven runs the first inning, Tech hammered four Pepperdine hurlers for a total of 21 hits. Roettger pitched fine ball and limited the opposition to five blows. In pre-season games, Tech trounced L.A. City College 11-0 and bowed to Pepperdine 12-9.

Captain Stan Clark, Jack Cardall and Bob Bowers, a veteran trio, give the tennis squad a fine nucleus, but the balance of the squad is not so strong. Tech dropped matches to U.S.C. 7-2, and to U.C.L.A. 5-4, with Clark and Bowers winning their singles in both matches.

Golf and swimming are about to open their league season. With the appointment of Bud Lyndon of the Pasadena Athletic Club as swimming coach, interest in that sport has been revived greatly.

SAN FRANCISCO ALUMNI MEET

THE San Francisco Chapter of the Alumni Association held a dinner meeting on Friday, February 23, at the Claremont Hotel in Berkeley. The meeting was attended by 35 Tech men who enjoyed an old-time get-together with old friends and classmates.

An excellent talk was presented by Kenneth E. Kingman ('29), superintendent of lube oil operations at the oleum refinery of the Union Oil Company. The subject was "Petroleum in the War," and Mr. Kingman covered a complicated subject in some detail and gave everyone a much better understanding of the part that petroleum plays in our war effort. The manufacture of 100-octane gasoline, toluene, and many other petroleum products was described with the aid of charts and moving pictures.

The following alumni were present:

Harold L. Albright	'23
Raymond E. Alderman	'25
Marshall A. Baldwin	'27
Ronald B. Connelly	'39
Thomas J. Deahl	'35
Herbert H. Deardorff	'30
S. C. Dorman	'31
Edward Dorresten	'24
Roy O. Elmore	'24
Louis H. Erb	'22
Virgil Erickson	'37
Howard Fisher	'27
Arnold L. Grossberg	'42
N. L. Hallanger	'34
James J. Halloran	'35
David G. Harries, Jr.	'23
Alex J. Hazzard	'30
Lawrence P. Henderson	'25
William L. Holladay	'24
Maurice T. Jones	'26
Douglas W. Keech	'26
William F. Keyes	'35
Kenneth E. Kingman	'29
Hilmer E. Larson	'27
Elvin B. Lien	'34
Jules F. Mayer	'40
F. J. McClain	'34
Donald S. Nichols	'28
D. J. Pompeo	'26
Quido M. Shultise	'39
Eugene W. Smith	'24
Joseph A. Vargus, Jr.	'39
Ted Vermeulen	'36
Edward A. Wilson	'24
Gordon K. Woods	'42

Our Monday noon luncheons continue to bring together a small group of Tech men each week. We invite all alumni working in or visiting San Francisco to join us for lunch at 12 o'clock on Mondays. Our meeting place is the Fraternity Club Dining Room, 345 Bush Street (between Montgomery and Kearney Streets), San Francisco.

Maurice T. Jones, '26, Secretary

VICTIM OF PLANE CRASH

Lieutenant-Commander J. H. Brahtz was one of seven persons killed when a Naval Air Transport plane, carrying 23 persons, crashed 25 miles south of San Francisco in mid-March.

Commander Brahtz was awarded his Ph.D. degree at the California Institute of Technology in 1932 and made his home in Pasadena several years prior to that. While at the Institute, Commander Brahtz majored in aeronautics and minored in civil engineering. He made analytical studies in connection with Morris Dam and was with the U. S. Bureau of Reclamation at Denver, Colo. In 1941 he was called into active service as a Navy reserve officer. At the time of his death, he was post engineer at the Seabee base at Camp Parks, near Oakland.

Commander Brahtz is survived by his wife, who lives at La Jolla, Calif., and one son, Lieutenant John F. Brahtz, of the Navy Bureau of Aeronautics.

UNDERWATER DEFENSE

The underwater defense of the Australian coastline, at the time the Japanese were threatening an invasion of that continent, was the mission of Lynn H. Rumbaugh, Ph.D. '32, from the Naval Ordnance Laboratory. In carrying out this task, Dr. Rumbaugh worked with the U. S. Naval Attache, the Commander Allied Naval Forces Southwest Pacific, the Royal Australian Navy, and the Council of Scientific and Industrial Research.

Dr. Rumbaugh left for Pearl Harbor from Washington soon after December 7, 1941. There he was in charge of 32 engineers from Naval Ordnance Laboratory and various Bureau of Ordnance activities working on underwater ordnance and countermeasures, harbor defenses, and degaussing under the leadership of Captain T. S. Boyd. Dr. Rumbaugh was in Noumea during the crucial Battle of the Coral Sea, and for the next six months he was on a full seven-day-a-week schedule in the southwest and south Pacific areas.

Returning to Washington in the fall of 1942, Dr. Rumbaugh became head of the research unit of the Naval Ordnance Laboratory. At that time its principal work dealt with various phases of mine research and certain underwater ordnance problems, but in 1943 its activities began on torpedoes. Dr. Rumbaugh's division is also associated in research with the Bureau of Ships and Bureau of Aeronautics, as well as with the Naval Petroleum Reserve and various naval degaussing activities.

BLACKMAN, '98, REGAINS FREEDOM

Word has been received by way of the War Department that Roy B. Blackman, '98, has been liberated from Santo Tomas Camp in Manila.

Two months before the outbreak of the war, Mr. Blackman had been ill. His survival through terrific hardships in the internment camp, in addition to his ill health, is indeed a miracle. It is apparent that the rescue of individuals interned in Santo Tomas was particularly timely, as the last year's Japanese policy of slow starvation had just about broken their morale. During this period, Mr. Blackman had undergone a serious operation and lost some 40 pounds in weight. Information indicates that the death rate at this camp had risen to approximately 10 per day at the time of liberation. Mr. Blackman is slowly regaining his strength under the care of Army doctors and the Red Cross.

Mr. Blackman's family, who live in San Juan, while not interned apparently have not been permitted to visit him very often. He is convalescing in the Santo Tomas Camp Hospital and expects to return to his home when he is able.

LIBERATED FROM SANTO TOMAS

Rene Engel, Ph.D. '33, former instructor in geology at the Institute and a prisoner of the Japanese, has been liberated from Santo Tomas prison camp according to a letter received by his wife, who is living in Pasadena. Dr. Engel's physical condition has been impaired, although not critically.

During his three years of imprisonment, Dr. Engel was in charge of education of all the interned children, as well as being in charge of adult classes, directing the teaching of languages, engineering, chemistry, mathematics, and other courses.

Dr. Engel was an associate of Jan Marsman, owner of extensive mining properties in the Orient, and went to the Philippines in June, 1940, to make a survey of mineral resources of those islands.

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.

1921

HORTON H. HONSAKER announced the arrival of a son, Russell D. Honsaker, on March 1. The Honsaker family now has three sons and one daughter.

ERNEST H. MINTIE holds the position of manager and field engineer for the Air-Maze Corporation in Los Angeles, Calif.

1922

COLONEL AND MRS. DONALD F. SHUGART have sent out announcements heralding the arrival of Nancy Lynn on March 5.

LIEUTENANT-COLONEL GLEN M. WEBSTER, formerly traffic engineer with Pacific Telephone and Telegraph Company, is with the Corps of Engineers at Corvallis, Ore.

1923

HERBERT A. GALE was promoted to the rank of first lieutenant in the Army Transportation Corps, as announced at headquarters of the San Francisco Port of Embarkation, Fort Mason, where he is attached to the Ships Complement Branch of Troop Movement Division. In civilian life, he managed a blueprint-photostat business.

Ex-'23

LIEUTENANT-COLONEL VERNON P. JAEGER has been a chaplain in the regular army since 1932 and is now serving overseas.

1924

LOYS GRISWOLD, who has been General Electric Company's manager in Phoenix, Ariz., has joined The American Factors Ltd. and its subsidiary, W. A. Ramsay Ltd., Honolulu, General Electric sales agents in the Hawaiian Islands.

FRED J. GROAT has recently moved to Phoenix, Ariz., where he is with the Bureau of Reclamation. Pending the location of a home, his wife, Peggy, and two children are living with Mrs. Groat's parents, Professor and Mrs. Sorensen, in Pasadena.

1925

LIEUTENANT-COMMANDER CLARENCE A. BURMISTER completed a special mission for the Corps of Engineers, U. S. Army, at the end of 1943 and was working with the Navy during 1944 on special equipment. Lieutenant-Commander Burmister's new assignment will be western Alaska, on a project for Geodetic Survey.

1927

MAJOR EDWARD M. BROWDER, JR., U.S.A., is a senior structural engineer with the Corps of Engineers in the Canal Zone.

LIEUTENANT-COLONEL ALBERT C. BILICKE, U.S.A., is now stationed in Paris, France. He has a son in training at Las Vegas, Nev., as flight officer on a bomber.

1928

LIEUTENANT-COMMANDER KENNETH M. FENWICK, U.S.N., late of Pearl Harbor, was given a furlough after a serious illness and recuperated at his home in Hollywood before returning to his old position.

1929

LIEUTENANT-COLONEL THOMAS H. EVANS is in the U. S. Army Corps of Engineers with offices at the Pentagon, Washington, D. C.

ALPHONSE M. CRAMER holds the position of assistant general manager of the James Graham Manufacturing Company at Newark, Calif.

1930

J. R. LESTER BOYLE holds the position of city engineer for the city of Laguna Beach, Calif.

ORRIN M. ELLIOTT is a water conditioning engineer for the Sun Oil Company at Philadelphia, Pa.

1931

HOWARD E. SHIRLEY is plant manager of the Manistee Salt Works, Manistee, Mich.

EDWARD S. PEER holds the position of research chemist with the Filtrol Corporation in Los Angeles, Calif.

1932

COLONEL WILLIAM SHULER has been reassigned to Fort Lewis in command of the engineers' training section. A Purple Heart veteran of the Normandy invasion, Colonel Shuler was former commander of the 115th Engineers' Combat Division in the First Army.

1933

THOMAS S. TERRILL, who was liberated from Los Banos Camp in the Philippines, has arrived in the States and was greeted at a west coast Army base by his wife. He was an employee of Consolidated Aircraft Corporation, delivering pre-Pearl Harbor planes to the Dutch via Manila, and was captured on Christmas Eve, 1941, when the Japs invaded the Philippine capital.

H. G. SMITS is vice-president of the Pacific Iron and Steel Company of Los Angeles, Calif.

JACK NORMAN SPARLING is chief structural engineer for J. Bordon Turnbull, Inc., Cleveland, Ohio.

RUSSELL N. DOESCHER is a research associate at the University of Southern California, Los Angeles, Calif.

LOUIS H. GOSS is employed by the U. S. Engineers' Office, Los Angeles, Calif., as an associate engineer.

1934

LIEUTENANT-COMMANDER LEE P. MORRIS has recently purchased a home at Manhattan Beach, Calif. He is now stationed at the naval repair dry docks at San Pedro, Calif.

GLENN W. WEAVER is an engineer (section chief) for the Western Electric Company, Kearny, N. J.

N. L. HALLANGER is assistant to division meteorologist for Pan American Airways, Mills Field, San Francisco.

1935

WILLIAM McLEAN is employed by the National Bureau of Standards at Washington, D. C.

DOCTOR LOUIS T. RADER is now head of the department of electrical engineering at the Illinois Institute of Technology, succeeding Dr. Jesse E. Hobson, who is now director of the Armour Research Foundation, Chicago, Ill.

1936

STAFF SERGEANT CHARLES W. BEST, in the signal service corps of the Army, is now on the island of Oahu.

PAUL H. HAMMOND announces the birth of a daughter, Janet Olena, on February 11. Paul is manager of Holly Heating and Manufacturing Company of South Pasadena, Calif.

1937

MAJOR RICHARD T. BRICE, U. S. Army, is an ordnance officer doing investigation and court martial work in the Philippines. Major Brice was stationed on the Russell Islands for over a year and has written an article on the bird life existing there which will appear in the New York Zoological Society magazine.

1938

ROBERT C. THOMAS passed away March 10. Interment was at Forest Lawn Cemetery, Glendale, Calif.

A. M. O. SMITH is aerodynamicist at Douglas Aircraft Company, El Segundo, Calif.

JOHN G. McLEAN is an instructor at the Harvard Business School in Navy Supply Corps training.

LIEUTENANT-COMMANDER R. B. FORWARD, with the U. S. Navy Bureau of Ordnance, Washington, D. C., stopped in at the Institute for a visit while on a business trip to the west coast.

1939

LIEUTENANT (j. g.) JOHN J. BROWNE, U.S.N.R., is back from duty in the Pacific area after 21 months as an engineering officer aboard a destroyer. Lieutenant Browne is to instruct at Cornell University in Diesel engineering.

MAJOR ROBERT W. WINCHELL and Second Lieutenant Mary M. Allen, W.A.C., of Kokomo, Ind., were united in marriage recently in Long Branch, N. J. GARDNER WILSON, '38, was best man at the ceremony.

1940

PRIVATE FIRST CLASS KEITH ANDERSON is in Belgium in communications work with a mechanized outfit. Keith reports the weather as being "colder than heck."

STAFF SERGEANT YOSHINAO NAKADA was a visitor to the Institute last month. He recently completed a one-year course at Harvard, learning the Chinese language.

1941

LIEUTENANT JAMES J. VONK, U.S.N.R., was awarded the Bronze Star Medal "in the name of the President" for combat aerology duty with Vice Admiral M. A. Mitscher's hard-hitting carrier task force in the Marianas, Caroline, Bonin, and Philippine Islands, Halmahera, Formosa, and the Nansei Shoto. The award was made as a result of action when American naval forces tangled with three separate Nipponese fleets in the opening sea engagement of the Philippine campaign. His job with the task force was to "call the elements"; to forecast quick-changing meteorological moods and provide pilots with all-important data on strike and escape weather.

DOCTOR WARREN O. WAGNER is an instructor in mechanical engineering at the Institute.

LIEUTENANT JOHN J. PAULSON, U.S.N.R., has returned after 20 months overseas duty. His new assignment will be as an instructor in radar in the States.

JOHN HENRY CARR and Miss Elizabeth Freund of Meadville, Pa., were married recently in Pasadena.

MAJOR FREDERIC C. ODER, a meteorologist, has headquarters at A.A.F. Weather Wing, Asheville, N. C.

WILLIAM B. HEBENSTREIT is a member of the technical staff of the Bell Telephone Laboratories, N. Y.

1942

COMMANDER ROBERT J. CLARK, U.S.N.R., is stationed in Honolulu instructing in psychology.

LIEUTENANT AND MRS. WILLIAM T. HOLSER are the parents of Courtney T. Holser, who arrived on February 16.

FRED FELDBERG announces the arrival of Stephen Frederick on March 8.

VENKATACHALAM CADAMBE, native of Bangalore, India, is a stress analyst at the Douglas Santa Monica plant. In an interview, Van, as he is known to his friends, says he is completely sold on

Occidental customs and ideas and plans to return to India to instruct his people in the American way. His hobbies are classical music and cooking, his recipes combining American and Indian cuisine.

ENSIGN MARTIN GAYER is personnel officer of a Seabee battalion still undergoing training in Rhode Island. The Seabee battalion to which he is attached has already seen service in the European theater. He was in Pasadena for a short visit to get acquainted with his new son, four weeks of age.

1943

ENSIGN H. A. LASSEN was back in southern California on leave after several months of submarine duty in the South Pacific.

WILLIAM R. FAIR visited at the Institute on his way to Pacific duty as a technical representative for Sperry Gyroscope Company, Inc.

DONALD H. POTTS is a teaching fellow in mathematics at the Institute.

WAYNE HODDER and Miss Margaret George of Pasadena were united in marriage the latter part of December. Wayne is working at the Radiation Laboratory, Massachusetts Institute of Technology. Mr. and Mrs. Hodder are making their home at Cambridge, Mass.

LIEUTENANT JOHN BUCHANAN, U.S.A. Air Forces, attached to an engineering battalion trained in South Carolina, is in charge of a negro construction battalion which has already moved out in the Pacific area.

LIEUTENANT EDWIN G. JOHNSEN, U.S.A. Air Forces, attached to an engineering battalion trained in South Carolina, stopped at the Institute en route to a Seattle port of embarkation for Pacific duty. Lieutenant Johnson will be in charge of a negro construction battalion to build airports.

1944

ENSIGN ROSS DANA, JR., and Miss Mae Summers were married at the Station Chapel, Camp Endicott, R. I., and are now making their home in Providence, where Ensign Dana is completing his Seabee training.

SECOND LIEUTENANT MARTIN L. HAHS, U.S.A., is a meteorologist in the Air Forces stationed at Coffeyville, Kan.

PHILIP BARTLETT SMITH and Miss Elizabeth Young, daughter of Archibald B. Young of the Institute, were married recently in Las Vegas, Nev., then proceeded to New York, N. Y., where they will live.

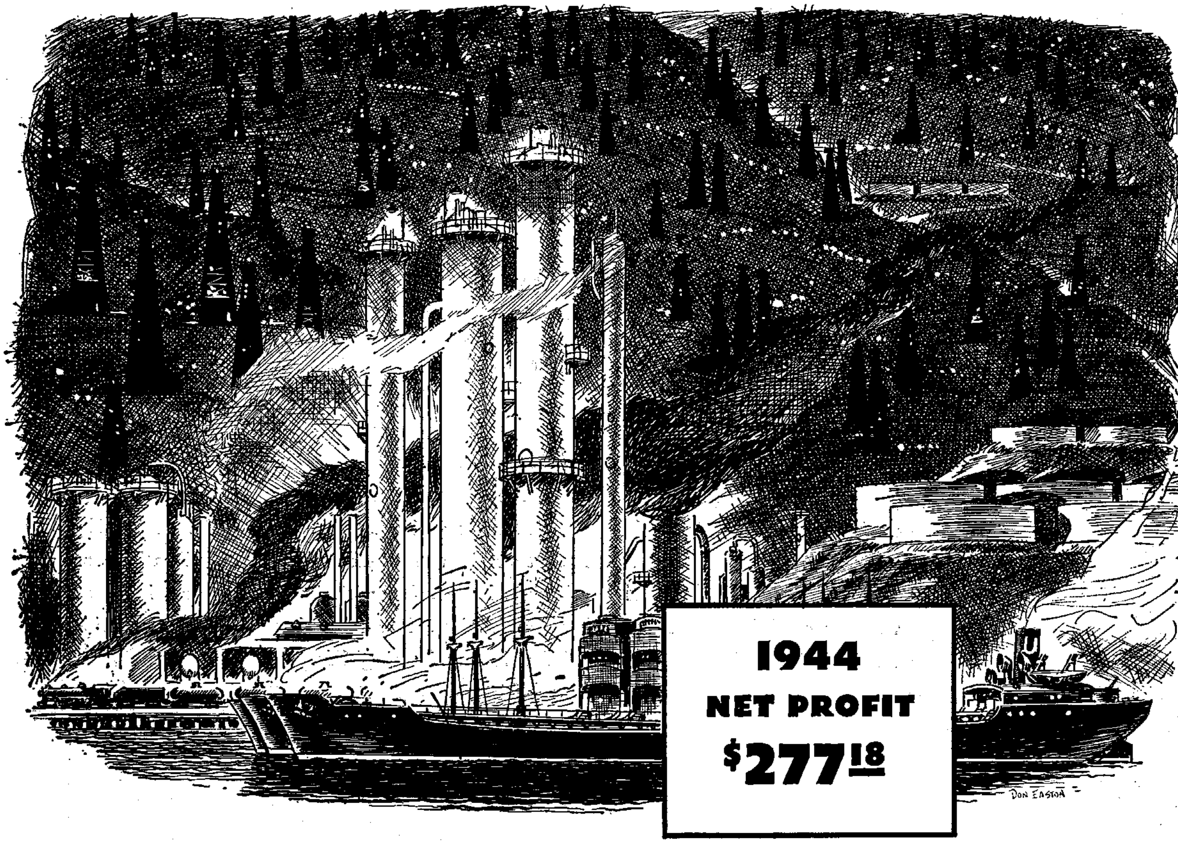
ENSIGN WILLIAM T. COLLINGS flew by plane to his home in Pasadena for a few days leave in March. Ensign Collings is stationed at Camp Endicott, R. I., where he is attached to the administrative staff.

CAPTAIN ROBERT C. BOGERT, U.S.A., and Miss Caroline M. Wilson of San Marino, Calif., were married in a formal ceremony at St. Paul's Episcopal Church at Dayton, Ohio, on February 7. Captain and Mrs. Bogert will make their home at Dayton, Ohio.

CLARENCE WELLEVER, who has been with the Merchant Marine in the South Pacific, stopped in at the Institute before going back to sea duty.

ENSIGNS (SEABEES): LE VAL LUND, NEVILLE LONG, A. J. FIELD, W. D. HINTON, T. A. HUDSON, HENRY JUDD, R. E. KUHNS and F. E. MacDONALD, JR., commissioned at Davisville, R. I., left for Pacific duty as replacement officers in construction battalions.

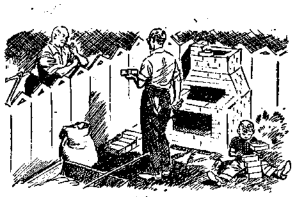
ENSIGN RICHARD J. SOIKE, who is stationed in the Philippines, spent a 13-day leave over the holidays at his California home.



1 Figures can be deceiving. In the financial news of last month, Union Oil's 1944 net profits were listed at $8,932,994. Now that's a lot of money. But what the figures fail to reveal is that this money was divided among *a lot of people.*

2 For Union Oil Company is owned not by one man or two, but by 32,227 individual Americans. Divided among that many owners, the net profits averaged just $277.18 per stockholder. Even this sum wasn't all paid out in dividends. $4,266,724 of the net profits were plowed back into the business.

3 So dividends paid out averaged just $144.79 per stockholder. In contrast to this, the wages and salaries averaged $3298.77 per Union Oil employee for the year. Even government received more from Union Oil's operation than the stockholders. $4,666,270 were paid out in dividends, $6,127,200 in taxes.



4 This is not pointed out as a complaint, but rather to show you that while Union Oil today consists of about 169 million dollars' worth of buildings, oil wells, refineries, ships, etc., it is owned by ordinary Americans like you and your neighbor next door.

5 These owners live in all parts of the country—516 in Oregon, 801 in Washington, 706 in Illinois, etc. 341 are in the military services. 2913 are Union Oil employees. The average stockholder owns 145 shares. Some hold less, some more; but the largest owns less than 1½% of total shares outstanding.

6 So it is not the investments of a few millionaires, but the combined savings of thousands of average citizens, that make corporations like Union Oil possible. And without some such method of financing industry, American mass production, with free competition, could never have been achieved.

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AMERICA'S *FIFTH* FREEDOM IS FREE ENTERPRISE

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