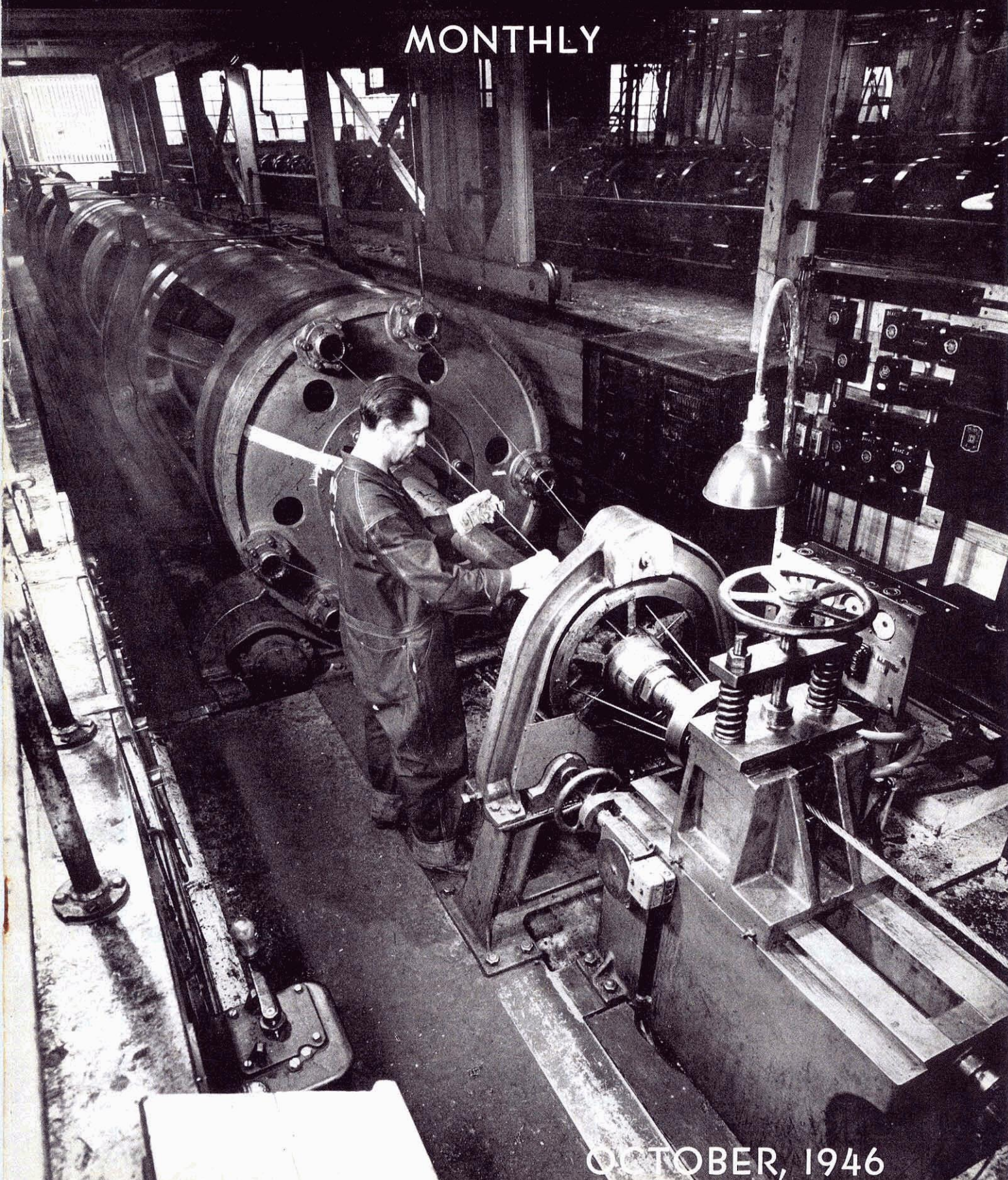
ENGINEERING AND SCIENCE

MONTHLY



OCTOBER, 1946

PUBLISHED BY CALIFORNIA INSTITUTE OF TECHNOLOGY ALUMNI ASSOCIATION

Lifelong Incomes

when General Electric men and women retire

Every General Electric employee with a year or more of service will be eligible to receive a life income upon retirement offered under the provisions of the company's greatly broadened and expanded Pension Plan.

This plan provides a pension for the years already worked, at no cost to employees. For this, the company pays the entire cost, estimated at $100,000,000.

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GENERAL ELECTRIC

BY-LINES

LEE A. DUBRIDGE

Dr. Lee A. DuBridge, president of California Institute of Technology, graduated from Cornell College, Iowa, in 1922, and continued his studies in physics at the University of Wisconsin, where he received the Ph.D. degree in 1926. From 1926 to 1928 he did physics research at C.I.T. as a Fellow of the National Research Council. In 1928 he went to Washington University in St. Louis as assistant professor of physics, later becoming associate professor. In 1934 Dr. DuBridge was called to the University of Rochester as Harris Professor of Physics and chairman of that department. Chosen in 1940 to head the Radiation Laboratory then being established by the N.D.R.C. at M.I.T., Dr, DuBridge served as director of this laboratory until his return to Rochester in February, 1946. In April, 1946, Dr. DuBridge was called to the presidency of the California Institute.

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H. M. WORCESTER JR.

H. M. Worcester Jr. received his B.S. in mechanical engineering from the California Institute of Technology in 1940. After graduation he was employed by the Pacific Wire Rope Company in the capacity of plant engineer. In 1943 he was promoted to his present position of chief engineer.

• • •

ROBERT D. GRAY

Professor Gray was graduated from the University of Pennsylvania in 1930 and continued with postgraduate and research work until 1936. He taught a year at the University's Wharton School of Finance and Commerce, and from 1937 to 1940 at the University of Connecticut. Associated with the California Institute since 1940, Professor Gray became professor of economics and industrial relations in 1942, and continues as director of the industrial relations section.

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COVER CAPTION:

The cover shows a modern, high-speed tubular closing machine in the Los Angeles Plant of the Pacific Wire Rope Company. This machine is capable of making 25 tons of wire rope, in one continuous length, in diameters of from one-half to three inches.

ENGINEERING AND SCIENCE
Monthly
The Truth Shall Make You Free

CONTENTS FOR OCTOBER, 1946

ENGINEERING AND SCIENCE MONTHLY

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ENGINEERING AND SCIENCE
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LOOKING AHEAD

By LEE A. DUBRIDGE

IT IS A pleasure and a privilege on this occasion to extend greetings and best wishes to all Alumni of the California Institute of Technology. As I take up, with humility and considerable trepidation, my new duties at the Institute, I find myself continuously conscious of the fact that I will need to depend heavily upon the Alumni and all other friends of the Institute for advice, encouragement and support in the days that lie ahead.

The alumni of any educational institution are its most important product. The institution, in fact, exists to produce capable alumni. And the institution is judged by the quality of its alumni body, and the leadership which its alumni give to the communities in which they live.

I am already proud of the CalTech Alumni. I was proud of them even before I came to the Institute. I have met them in my travels and duties in recent years through the length and breadth of this country. In every case I have found them to be men of ability and vision — men who hold the highest respect of their colleagues, and their communities. No institution could have a greater asset than such a fine Alumni body. I say this, not in flattery to you, but to assure you of the fact that even an outsider knows that the Alumni of CalTech have assumed a place of importance not only in Southern California, but throughout the United States. The urgent demands of industry for more of our graduates is an impressive tribute to the quality of those who have gone out before.

It will be a pleasure and a privilege for me to become more closely associated with you, and to work with you toward the objective of making the California Institute in the future an even finer place than it has been in the past.

CHARTING A NEW COURSE

A change of administration in any institution is always an occasion for taking stock of where the institution stands, and where it is going. But even if there were no change in administration, it would still be appropriate, at this point in the history of this country and of the world, for us to pause and ask how this Institute can adequately meet the many problems which a changed world has thrust upon us. I have already requested the Faculty and the student body to join with the administration in a cooperative attack on the problem of charting our future course. I should like to take this occasion to invite and urge the Alumni to join with us in this cooperative enterprise. We know that the tasks and responsibilities which lie ahead are great. I know that they can be met only through a **cooperative** effort among all those who are interested in CalTech's future.

THE INSTITUTE'S MISSION

No educational institution could have a finer set of basic ideals and objectives than those upon which the California Institute has been operating for the past twenty-five years. These were formulated by the late Dr. Arthur A. Noyes, and were adopted by the Board of Trustees of the Institute in 1921. Under Dr. Millikan's inspired leadership they have been brought to practical realization. I could do no better than to quote a few excerpts from this statement of objectives.

The primary purpose of the Institute, according to this statement is "to provide a collegiate education which, when followed by one or more years of graduate study, will best train the creative type of scientist or engineer so urgently needed in our educational, government, and industrial development." (And one might add today, "so urgently needed by society at large.")

In order to accomplish this objective, the undergraduate courses of the Institute should provide "a combination of fundamental scientific training with a broad cultural outlook which will afford students with scientific interests a type of collegiate education which avoids the narrowness common with students in many technical schools, and the superficial-

ity and the lack of purpose of many of those taking academic college courses."

It has been said that the true scientist or engineer, or indeed the true specialist in any field is simply "a broad man sharpened to a point." The Institute aims to provide both breadth and "point" in its educational process. It is hardly necessary to state that the world today needs such men more than ever in the past.

In keeping with these educational objectives, the statement goes on to say, "research shall be made a large part of the work, not only because of the importance of contributing to the advancement of science, and thus to the intellectual and material welfare of mankind, but also because **without research the educational work of a higher institution of learning lacks vitality and fails to develop originality and creativeness in its students.**" (Boldface mine.)

It is worth while to pause for further emphasis on this point. The California Institute is not primarily a research institute. Research institutes, disconnected from the educational process, often grow sterile because of the lack of the stimulus which is provided by fresh young minds. It is equally true that a teaching program, on the level on which the Institute is engaged, also grows sterile if the active and inquiring minds of the Faculty are not given full opportunity to carry forward their investigations, and if the students themselves are not brought into contact with the forefront of scientific and engineering progress. At an institution like California Tech, therefore, research and teaching are not two conflicting objectives, but are rather two essential aspects of the same basic objective; namely, to train **leaders** in pure and applied science.

Dr. Noyes' statement goes on to say, "In order that the policies already stated may be made fully effective as quickly as possible, and in order that the available funds may not be consumed merely by increase in the student body, it is the intention of the Trustees to **limit the registration of students** at any period to that number which can be satisfactorily provided for with the facilities and funds available. (This) limitation has the highly important result of giving a select body of students of more than ordinary ability." (The experience of the Institute has shown that there are additional advantages to a relatively small student body, for in a small, compact organization the spirit of friendliness and mutual collaboration can have its full important influence on the effective development of the Institute's program.)

"For the same reasons it is the intention of the Trustees not to allow the work of the Institute to be expanded into new branches of science or engineering until all the existing departments are brought to the highest efficiency, and until the needs of the student life are fully provided for."

Summarizing, one can say that the aims of the Institute are:

1. To train men for **creative leadership** in pure and applied science;

2. To provide a **breadth** of training and the type of student life which will develop men as citizens and human beings as well as scientists;

3. To encourage research as an essential and important part of this educational process;

4. To limit student enrollment to a number that can be effectively handled by existing facilities and staff and to insure the highest quality in the student body;

5. To concentrate attention on a few basic fields of pure and applied science with the aim of attaining superb quality in them before any new fields are undertaken.

I am sure you will agree that the aims stated above constitute the finest possible set of policies and ideals on which the Institute can develop its program. I personally subscribe most heartily to these ideals, and believe they can be made the basis for our further progress.

OUR ASSETS

In charting our course for the future, it is appropriate to take stock of the tangible and intangible assets which the Institution possess, and on which it can build.

The sound ideals which I have already outlined constitute possibly our most important asset. These are supplemented, however, by more concrete ones; the most important of which are an exceptionally fine faculty, an able and spirited student body, and, as I have already pointed out, a great body of loyal Alumni.

Our material assets are no less impressive, although as we shall see, one of the problems facing us is their future expansion. Considering the fact that the material assets of the Institute began to accumulate only 25 years ago, it is truly astonishing, the level which they have reached.

We have, in the first place, a 30-acre campus with a fine set of buildings conservatively valued at not less than $8,000,000. The buildings are equipped with some of the finest facilities for scientific and engineering education and research to be found anywhere in the world.

In addition to our on-campus facilities, the Institute is also operating several off-campus assets of very considerable value. These include, not only certain small experimental facilities, the Cooperative Wind Tunnel and the large Jet Propulsion Laboratory, but, most important of all, the great Mount Palomar Observatory with its 200-inch telescope, scheduled for completion next year. The telescope and observatory were made possible by a grant to the Institute of $60,000,000 from the Rockefeller Foundation, and this, the greatest astronomical observatory in the world, will be operated by the Institute under conditions which will assure close collaboration with its sister institution, the Mount Wilson Observatory of the Carnegie Institution of Washington.

On the financial side, we have a respectable, but not unduly large, endowment of about $17,000,000, which is well invested, and yields a return of slightly over four per cent. In addition the Institute has other sources of income from trusts, from gifts, from the Institute Associates, and from miscellaneous sources which yield amounts which fluctuate between $250,000 and $400,000 a year. Income from student tuitions will, in a "normal" year, yield an additional $500,000.

The Institute's general budget for educational and research purposes, therefore, is in the neighborhood of one and a half million dollars a year. In addition

to this, the Institute is engaged in special research projects, sponsored by industry and the government, which, during the current year, will total nearly $4,000,000. About three-fourths of this goes into a single large project operated under government contracts; namely, the Jet Propulsion Laboratory, operated in conjunction with the Guggenheim Laboratory of Aeronautics as one of the major research laboratories in the country in this field. (It might be of interest to note in this connection that during the war the Institute handled government contracts for research and education which hit a peak rate of nearly $5,000,000 per month, and totaled nearly $85,000,000. Contrary to rumor, however, this was done on a pure "no profit-no loss" basis, as a service to the country on which no financial gain was either expected, desired, or obtained.)

FUTURE NEEDS

An intensive study of the future needs of the Institute is now being undertaken by the Faculty and the Board of Trustees. A few of the more obvious needs, however, can be stated at once.

1. The expansion of the Faculty to make up for losses and deaths during the war, and to relieve the heavy pressure under which present Faculty members operate to carry on effective programs of teaching, research, and administration.

2. An extensive program of increased salaries for Faculty and of higher wages for employees to bring these up to the standards of other institutions, to attract and retain a staff of the highest quality, and to meet rapidly rising costs of living, which have been particularly pronounced in the Southern California area.

3. A considerable expansion of physical facilities to relieve present serious overcrowding, particularly in the engineering departments.

4. Expansion of facilities for student life and activities, including additional dormitories for graduates and undergraduates, a gymnasium, a swimming pool, and other athletic facilities, and eventually a student union building. (The possibility of purchasing Tournament Park from the City as site for these developments is being explored.)

5. Expansion of funds and facilities for teaching and research in all existing departments, aimed at the improvement and modernization necessary for the Institute to keep its position of leadership. There should be special emphasis on the fields of applied science not yet fully developed, and on fields which by circumstances are logical ones in which the Institute should take national leadership; such as astronomy and astrophysics, nuclear energy, chemical biology, aeronautics, etc.

6. Expansion of the Institute's public relations program with the aim of bringing before the Alumni, students, prospective students, Associates, and the general public, more information about the Institute's activities, achievements, and resources, with a view to achieving better appreciation and support of the Institute's program on the part of all interested groups.

These are not easy goals to achieve; some of them may not be achieved for years to come, if at all. But it is necessary to achieve all of them — at least in part — if the institution is to retain its position of national leadership in its field. Their achievement will require the securing of tens of millions of dollars of additional funds for buildings, equipment, and endowment, supplemented by annual contributions by hundreds or thousands of people.

There are those who say that institutions like ours must, in the future, look to the government for support of its activities; that private sources no longer exist. To this view I do not subscribe. It will, no doubt, be true that many of our special research activities will receive support from the government agencies. But such support, on such terms as the Institute will wish to receive it, must come in consequence of, and in addition to, the Institute's own inherent strength. The public now, as never before, is conscious of the urgent needs of society for scientific and engineering research, and for the developing of civic leaders who are trained in the fields of science and engineering. I am confident that with enough energy and imagination public support can be secured.

WHAT CAN THE ALUMNI DO?

It is obvious to anyone, I think, that a program of the magnitude which has been outlined cannot be put into effect without the active encouragement and help of the entire Alumni body. Every phase of the program can profit by Alumni help and participation. Conversely, I believe it goes without saying that every step which is taken to enhance the Institute's reputation and to enlarge the area of its achievements is of direct benefit to each alumnus.

However, the particular ways in which the Alumni can be most effective, the particular phases of the program on which Alumni should be concentrated, the particular mechanisms by which Alumni help will be rendered effective, are problems which had best be left to the Alumni themselves. I would prefer to regard it as my function to outline to the Alumni the present status and future needs of the Institute, the plans which are being formulated for its development, and then to keep the Alumni continuously informed of the progress of our plans and activities. I can also assure you that the Institute urgently needs and greatly desires your support, and that the Institute will collaborate with Alumni organizations in every possible way to bring them into closer touch with the Institute to the mutual advantage, I hope, of both sides.

It was a source of tremendous pride and satisfaction for me to learn, almost immediately upon my arrival in Pasadena, that there was already a spontaneous movement among Alumni toward the more active participation in, and support of, Institute activities. Your Alumni Association is now studying this problem with enthusiasm and intelligence. The Administration of the Institute will cooperate enthusiastically, and wholeheartedly, in any program which the Alumni themselves wish to undertake. With your help, the Institute can look forward to a future even more glorious than its past.

Wire Rope--Past, Present and Future

By H. M. WORCESTER JR.

HISTORY OF MANUFACTURE

HISTORICAL record and research tell us that a form of wire-making dates back to around 5000 B.C. This early wire was not like the wire we have today, as it was made by hammering out thin sheets of copper or gold and shearing off narrow strips. About 4100 years later, it was found that the usefulness of these strips could be increased by pulling them through a half-round, or at least a partially rounded, notch or groove in some hard material to remove the sharp edges.

The assembling of several wires into one strand to make a rope dates back to around 800 B.C. A bronze rope of this period was unearthed at Nineveh in Asia and is now in the British Museum. This rope (or strand) consists of parallel wires bound together at intervals so that they could be used as one unit.

The development of a helical (twisted) rope, formed of helical strands, dates back to about 500 B.C., according to the evidence given by a rope believed to have been made at this time, which was uncovered in the ruins of Pompeii. This rope consists of three strands twisted together; each strand, in turn, consisting of several bronze wires twisted together.

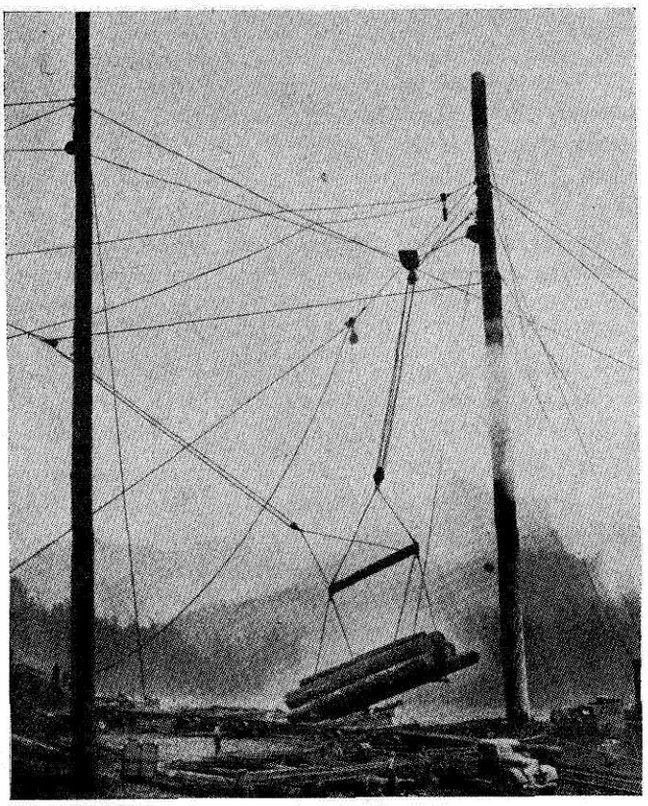


Figure 1. A typical logging wire rope setup

A 15 foot piece of this rope is now in the Naples Museum.

Many years then elapsed before the records indicate any further developments. Sometime between the sixth and tenth centuries A.D. a method of drawing soft square rods through round holes in iron drawplates to form wire was developed. This drawing, however, was done by hand and was a very slow and tedious process. A mechanical method of drawing wire was not developed until 1351. Still later (A.D. 1600), a method of drawing hard steel wire was developed in Germany, although it was still done from square rods, sheared from hammered or rolled sheets. In 1728 a Frenchman, by the name of Fleuer, is said to have made round rods by the use of grooved rolls, and thereby materially aided the drawing of wire.

Around 1830 the use of wire rope was given a big boost by the invention in England of the "Steam Plough," consisting of two ploughing engines which traveled down opposite sides of a field, pulling a plow back and forth by means of a wire rope. The use of these "ploughs" was greatly incrased as better grade and cheaper steel for wire ropes was made available by the development of the Bessemer process in 1855, and the development of the open hearth process in 1862. These "Steam Ploughs," by the way, give us the origin of the term "Plough" Steel (or Plow Steel, as we know it today.)

All of these early ropes were made by hand on rope walks, where a number of wires were laid out, then twisted into strands by men walking along with a device for rotating one end of the group of wires. The process was then repeated on a group of the strands to form a rope. The rope-making process was gradually mechanized and speeded up to the present rates of as high as 5,000 feet of finished rope per hour, in continuous lengths of 40,000 feet to 50,000 feet and greater.

IMPORTANCE IN WORLD WAR II.

Wire rope was used in so many ways by our armed forces that its numerous applications will not be listed here. Instead, the experiences of a hypothetical draftee in his contact with wire rope during his tour of duty will be described.

As our man (we'll call him Joe) arrives at his training camp, fresh from the induction station, he is greeted by the sight of a huge camp under construction. He finds the ground being leveled off by bulldozers, scrapers, and carryalls, operated with wire rope; the buildings are being erected by cranes using wire rope, and supplies and equipment are being unloaded with wire rope slings. As Joe progresses in his training, he comes in contact with wire rope on the parachute training tower, on the desert equipment salvage truck, and on the big "Jiminy," or surf

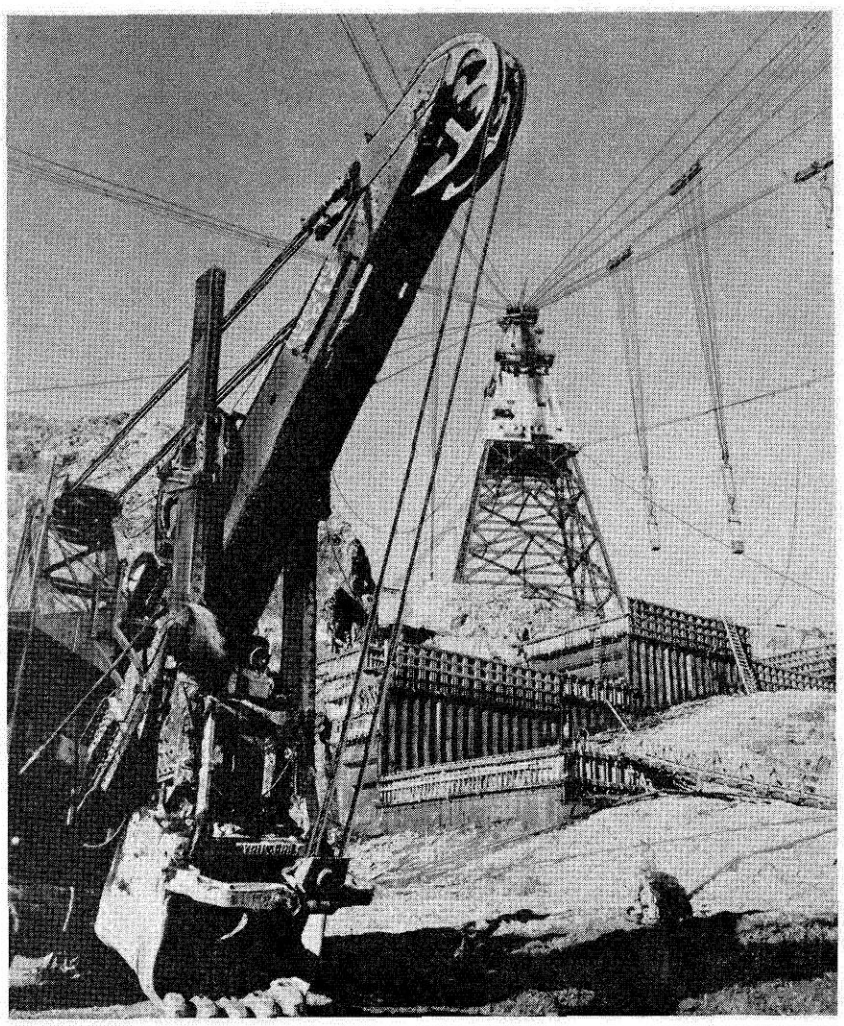


Figure 2. Shasta Dam Head Tower. Note the wire ropes on the shovel in the foreground.

rescue device for landing craft. After he finishes his training he is shipped to a seacoast town to await shipment to the battle zone. As he wanders around the town, he sees enormous aircraft plants camouflaged by artificial hills, built of chicken wire, feathers, and paint, supported by wire rope networks. He sees the Navy and Maritime ships being loaded by wire rope slings, winches, and hoists.

At last, Joe embarks on his voyage on a big transport, which carries him out through the wire rope anti-submarine nets to the open sea, where his convoy is assembled. On the trip the ships are guarded by fast destroyers, D.E.'s, and cruisers. The cruisers launch observation planes by the use of wire rope devices in the catapults, and then pick the planes up again from the sea by wire rope slings and hoists.

After a few days, the convoy reaches the staging area, where Joe sees literally thousands of ships of all sizes gathered for the invasion. Joe is surprised to learn that each ship carries many tons of wire rope in use as mast stays, antenna supports, boat slings, cargo slings, boom hoists, hoist ropes, mooring pennants, towing hawsers, and cargo lashing lines. Finally, the ships have all arrived and the entire fleet gets under way to approach the battle area.

As the fleet nears its objective, the men can hear the battleships and heavy cruisers battering away at the shore installations. Stories are circulated about the minesweepers which have gone in ahead of the "heavies" and towed long special serrated sweep cables through the waters to cut the enemy mines loose from their anchors, so that the riflemen on deck could explode the mines with a few well-placed shots. These plucky little craft had no protection at all from the heavy enemy fire from shore batteries; in fact, they could not even boast a gun large enough to answer the fire.

After the softening up is completed, the transports move toward the shore, and the men are loaded into landing craft, which are lowered into the water by wire rope slings and cranes. The landing craft all head for the beach at the highest speed possible, and, as the shore is approached, an anchor, attached to a winch on the stern of the boat, is thrown overboard to act as a brake to help keep the stern of the landing craft directly into the seas as she goes up on the beach. This anchor and rope, incidentally, are used later to remove the same craft from the beach by merely coupling the winch to the main motor and pulling the landing craft off. After the craft finally reaches the beach, the ramps in her forward end are lowered by the use of wire rope operated mechanisms, and the men and equipment surge forward onto he beach. In this first wave are many combat tanks, which are equipped not only with a wire rope sling, which can be used to lift the tank at any time, but often with a wire rope winch, which can be used to pull the tank out of a hole, or pull another damaged tank out of the line of fire.

After the beachhead has been established, trucks and bulldozers come ashore to carry equipment and clear away the debris in order to make a permanent landing point for materials. These trucks and bulldozers are also equipped with wire rope winches and operating mechanisms. This rope, incidentally, takes a terrific punishment by bending over small sheaves and running with little or no lubrication, and often in sand.

As Joe and his buddies advance, they cross deep gorges on suspension bridges, built by the Combat

Engineers out of wire rope and timber. Farther inland, they come to a large river, which they span by a pontoon bridge, tied together and anchored with lengths of wire rope. After the entire island has been cleared of any active enemy troops, Joe and his buddies return to the shore to watch the tremendous job of salvaging ships which have been wrecked and capsized in the initial landing operation. Some of the smaller craft are actually lifted with wire rope slings and loaded aboard larger ships by the use of heavy cranes.

We may digress for a moment to mention that, after Pearl Harbor, quantities of wire rope were used to salvage the wrecked and capsized U. S. Fleet. The righting of one of our heavy battleships was carried out in miniature to determine the loads involved, and special wire ropes were fabricated, to be attached to the hull and turn it right side up, so that it could be floated and returned to the Navy yard for repairs.

The island on which Joe finds himself is rapidly turned into a supply base for further operations, and as Joe wanders around the camp, he sees wire rope operated carryalls and scrapers clearing off landing strips, and construction crews erecting communication and radar towers, guyed with wire rope and strand. He marvels at the high speed with which ammunition skids are handled, with their built-in wire rope slings for lifting or pulling. Later, Joe is ordered to another part of he island to prepare for the next advance. On the way to his new base, the truck in which Joe is riding becomes mired down in a deep mud hole. The men watch with interest as the driver has the truck ahead turn sideways to the road so that he can hook on his wire rope winch line and let the powerful truck pull itself out of the hole. Before Joe can embark on the next invasion fleet, his orders come through to fly back to the States for special assignment. During his trip, one of the fliers aboard tells Joe that the control system of their big transport contains something over 4,000 feet of wire rope.

By this time, the reader is probably as thoroughly convinced as Joe of the importance of wire rope as a war material; so we will take leave of our wire rope conscious G.I. Joe, and go on to the post-war future of wire rope.

INDUSTRIAL USES

Since the fields of application of wire rope in this post-war period are so broad, the present description will break them down into the major classifications under which the consumers of wire rope can be placed, and give a quick summary of how this rope is used in each industry.

One of the principal consumers of wire rope is the petroleum industry. Wire ropes are used to set up and guy the rig, drill the hole, set the casing, and keep the well cleaned out and producing. There have been two major changes in drilling techniques. First, from cable tool drilling to rotary drilling, and second, from permanent derricks and machinery, which are a familiar sight to most of us, to two new types of equipment. These two new types are, first, the new portable masts and machinery mounted on a special truck, which can be speedily moved from one location to another to drill new shallow wells, or service the old ones, and, second, the so-called "big rigs," which are large derricks and heavy semi-portable machinery units, capable of drilling to great depths. The portable high-speed rigs have now reached depths of 9,000 feet

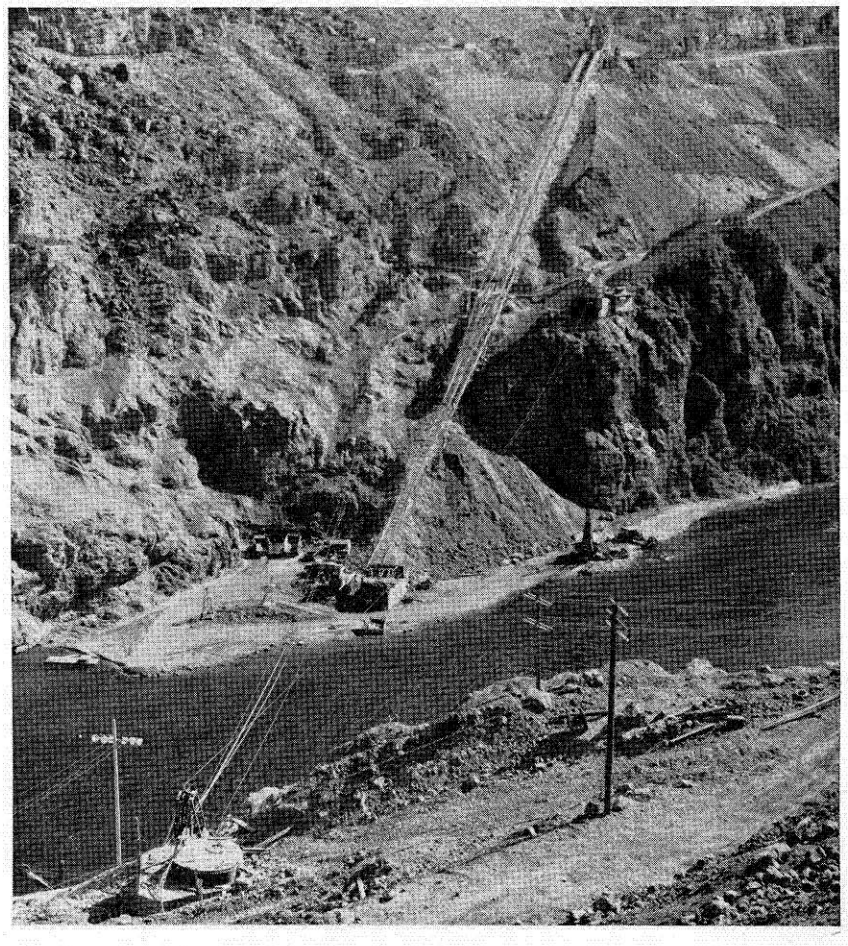


Figure 3. General layout of Guy F. Atkinson Cableway and Incline Hoist. (Note main cable around anchor in the foreground is three inches in diameter.) Courtesy U.S. Bureau of Reclamation, Boulder City, Nev.

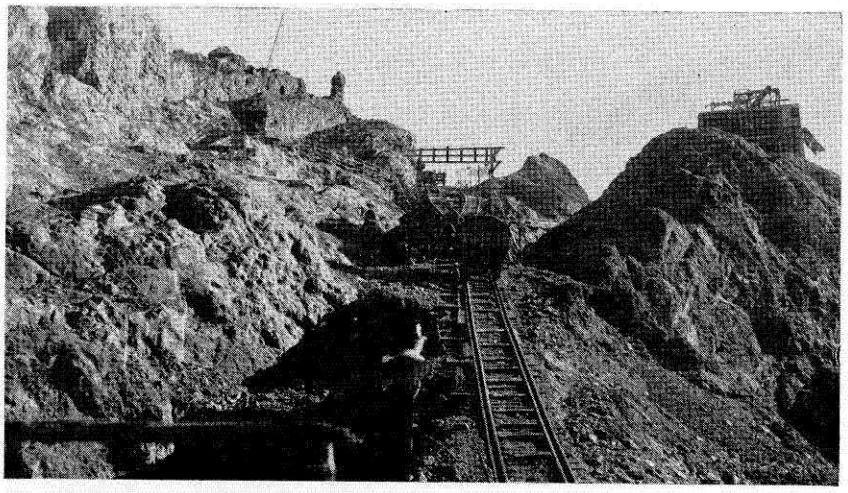


Figure 4. Closeup of Incline Hoist, Cableway Hoist House, and Head Tower. Courtesy Guy. F. Atkinson Company.

in West Texas, and, with planned improvements, they should go deeper. The "big rigs" are now being developed to reach depths of 20,000 feet and more. These changes have necessitated the development of stronger, more flexible wire ropes, adaptable to heavier loads and the high speeds encountered on the new equipment. Thus it may be seen that the problem of designing ropes for maximum service on this industry's equipment is a continuous and important one.

Another vast market for wire rope is in the lumber industry. There are many logging systems, but, essentially, the operation consists of the following steps: the timber is lifter by Choker ropes, wrapped around the log and attached to another wire rope, which is pulled by a tractor or lifted by a hoisting line running over a carriage, supported by a high line of some type, to pull the logs to the nearest transportation. In steep, mountainous areas, wire rope "inclines" are trackways, where flat cars loaded with timber are eased down the slope by cables, are used to get lumber out to the railroads or rivers. Trees are sometimes guided in their falls by wire rope, to protect young trees from damage. Wire rope skidders are often used for yarding the logs or loading them onto flat cars or trucks. When the logs reach the sawmill, they are further handled by wire rope cranes and pulled through the saws by "carriage" ropes, which pull the big sawing carriages back and forth.

Mining and quarrying industries, such as deep shaft mines for coal, copper, and zinc, are entirely dependent on wire rope to move material and men in and out of the hole by the use of large hoists. Incline hoists and aerial tramways, many miles in length, are frequently used to move materials out of inaccessible mines and quarries.

The transportation industry (or industries, one should say, as there are so many related fields under this heading) is a large user of wire rope in the form of slings and hoist lines to lift anything from a spare tire on a motor truck to a full-sized locomotive engine. Railroad maintenance shops would be almost crippled without wire rope for their overhead cranes, crawler cranes, pillar hoists, and equipment slings. Ships would certainly be hampered without wire rope rigging, cargo falls, nets, and slings.

Another industry which depends on wire rope to do many varied jobs is that of construction. For example, the construction of dams, like Boulder or Shasta, requires great quantities of rope for excavating machinery, such as shovels, draglines, cats, carryalls, and scrapers, or for cableways, inclines, and truck cranes to handle the construction materials to their final installation points.

A typical dam construction cableway head tower is shown in Fig. 2. A recent construction job which shows the use of wire rope is the Guy F. Atkinson job at Boulder Dam. There rock is taken out of the river with a dragline, or taken off the bank with a shovel, operated by wire rope, and dumped into a truck which takes it to a cableway. At the cableway, the rock is dumped into a car, which is lifted by hoist lines running over sheaves in a carriage supported by a main cable, and pulled by an endless wire rope running over a power driven "gypsy." It is carried across the river to an incline hoist, where it is dumped into a car which is pulled up the incline by wire ropes. At this point, the rock is dumped into railroad cars for final disposal. Figures 3 and 4 give the general idea of the cableway and incline hoist.

Many government agencies use wire rope and wire rope equipment in the building and maintenance of our highway systems, breakwaters, reservoirs, and sewage disposal plants. Our public utilities companies use wire rope slings and hoists for handling materials and equipment. Most of us realize that large quantities of wire rope are used in the building of a suspension bridge like the Golden Gate Bridge, but few people realize that wire rope is constantly in use for the maintenance of such a bridge. Manufacturing industries of all types call on wire rope to handle materials of heavy or bulky nature.

A few unclassified but important applications of wire rope are as follows: Elevators in tall buildings require special elevator ropes. We all appreciate the importance of these ropes when we contemplate climbing the stairs to the top of some building of 15 stories or more. The manufacture of recreational equipment, such as ski lifts, Ferris wheels, and yacht rigging, is a fertile field for the application of special constructions of wire rope and strand. Agricultural harvesting is developing as market for wire rope. For example, converted clamshell hoists are being used for sugar cane harvesting grabs.

Each new application of wire rope has its own engineering conditions and limitations, which determne the size and construction of rope to be used. Thus, the wire rope manufacturers maintain staffs of engineers to assist the users of wire rope in determining the proper rope for the given job; also to develop special constructions for abnormal operating conditions encountered on new equipment being built for this highly competitive post-war period.

HOW CAN WE IMPROVE INDUSTRIAL RELATIONS?*

By ROBERT D. GRAY

DURING the war most people were irritated and disturbed at times by the problem of labor relations. Many governmental agencies such as the War Labor Board, the War Manpower Commission, and Selective Service tried various solutions, and Congress, under the spur of public opinion, adopted the Smith-Connally Act to prevent strikes. The general opinion was that if we could keep labor relations under some control until the war was ended we would then be able to resume normal employer-employee relations. It should be noted in passing that such a belief was not based upon our experience after any other war, but, nevertheless, it was commonly accepted.

Somehow or other we have managed to struggle through quite a few months of post-war conditions. Labor relations, however, instead of bettering, as they were expected to do, have grown steadily worse. It is hardly necessary to prove this statement. The record of the past, present, and prospective strikes is well known. Union membership has not withered away; instead, it is showing signs of extension among white-collar workers, among professional employees, and among foremen and supervisors.

BASIC CAUSES OF PRESENT UNREST

Two interrelated causes explain much of the present unrest. The first of these is inflation. We still seem to think as though we feared the possibility of inflation. We should not blink at the fact, however, that we have had inflation for some time. An increase of at least 33 per cent in the cost of living during the war indicates that inflation arrived some time ago. Such a change in prices produces very uneven effects in the economy. Many groups of employees are, and have been, better off in recent years than before the war, but many other groups are feeling the pinch. It is relatively certain that we shall have still more inflation within the next year.

The second factor contributing to this general unrest, and one which aggravates the threat of increased inflation, is a reduction in the productivity per worker. We were given the impression during the war that because of our tremendous production of war goods there must have been a great increase in productivity per employee. This widespread belief is true as far as productivity in making planes, ships, guns, and other munitions of war is concerned. But efficiency in making these goods will not help to produce houses, automobiles, and clothing. The fact of the matter is that during the war, productivity per employee decreased in practically every industry manufacturing civilian products.

Such a result is not unexpected. We realized during the war that we were scraping the bottom of the barrel to secure manpower for the armed forces, for war production, and for civilian production. Many persons who had never worked found employment during the war years. They contributed greatly to our winning the war, but their individual efficiency was not high.

*Presented at the Alumni Seminar, April, 1946.

We are now in the midst of a great readjustment in our labor force. Employees in war industries as well as men in the armed forces are being demobilized. We are contracting the manufacture of some commodities and we must increase the output of others. Many employees must be trained and retrained to produce civilian commodities. During this period productivity per employee will undoubtedly remain low.

It is vital, however, that we increase production and productivity. This means that we must continue to apply the principles of work simplication which were known long before the war and which were widely adopted during the war in some industries. Work simplication must now be applied to many other fields of activity.

In improving the productivity of employees, however, we cannot rely solely upon certain formulas or procedures. We must not lose sight of the fact that we are dealing with human beings. We know that by changing the gear ratio on a machine we can make it run faster and turn out more products. But a human being is more complicated. We may simplify his work, we may improve his working conditions, but he will not necessarily become more productive. We must recognize the importance of morale if we are to increase the effectiveness of employees. To increase morale we must undertake a positive program for improving industrial relations.

A POSITIVE PROGRAM FOR IMPROVING INDUSTRIAL RELATIONS

Such a program cannot consist of a single panacea. Our goal cannot be reached by merely wishing for it; there must be action. This action, however, is not to pass a law, because laws usually create problems rather than solve them. The problem of industrial relations in the United States, in California, in Los Angeles, or Pasadena is too big to be solved as one problem, but any big problem may be solved by breaking it up into small ones. The big problem of industrial relations can be solved only by solving the small problems of industrial relations in every company, in every plant, and in every department.

Any employer, or for that matter, any supervisor, can undertake a positive program for improving relations in his company or in his subdivision of a company. Such a program must include two fundamentals.

1. Fulfilling the Fundamental Desires of Employees

In the first place, serious attention must be given to fulfilling the fundamental desires of employees. It may often appear that employees are interested only in higher wages, shorter hours, and better working conditions. Such goals, however, are merely battle flags around which employees may be rallied. Such aims can never be fully achieved, because wages can always be made still higher, hours of work per day or week can be reduced still further, and working conditions can be improved. Any gain along these

lines will not forestall further demands tomorrow, because these goals are not what every employee really wants.

The real aim of every person is to achieve a sense of belonging. It is this fundamental urge which has resulted in so many of us being joiners.

Too little attention has been given by industry to means of meeting this desire. An employee wants to be proud of his work and of the company with which he is associated. But most employees are told very little about how their jobs are related to others in the plant, how their efforts affect the final product. Employees are poorly informed as to the history and reputation of their company and as to what the products of that company contribute to the community. Employees need more and more information about their company when they are hired and while they are working. They cannot feel that they are part of the organization unless they know about its past, present, and future.

A second method of increasing the sense of belonging is to give proper recognition to merit, ability, and long service. It is difficult to feel that one really belongs to an organization when hard work is not rewarded with frequent words of commendation, with reasonable advances in compensation and in promotions to more responsible positions. The employee who stays with the company also may feel that he is part of the organization when he is given some recognition for this continued service, either in the form of appropriate service pins or in increased benefits of sick leave, insurance, or vacation.

Finally, it must be realized that a sense of belonging and a feeling of insecurity are incompatible. No employee who is constantly aware of insecurity arising from accident, illness, death, or old age can really feel that he is part of the organization. Industry under the pressure of workmen's compensation laws has in general done an outstanding job in reducing accidents within the plant. Many industries have developed substantial benefit plans for their employees. The government has established social security. We must not assume, however, that unemployment insurance, for example, adequately meets insecurity in the job itself. Most employees want the satisfaction of doing a fair day's work for a fair day's pay rather than the right to draw unemployment insurance benefits. Every company needs to give serious thought to stabilization of employment. The fact that we cannot give complete security from the cradle to the grave for anyone should not prevent our attempting to increase the degree of security. Relatively few companies have tried seriously to stabilize employment.

Improved morale throughout the organization will reflect the extent to which the industry gives its employees a sense of belonging by (a) providing employees with additional information about their jobs, their company, and its products, (b) recognizing the contributions of each individual, and (c) increasing security on the job. With this improved morale it is inevitable that productivity per employee will increase and that the pie to be divided by a company and by society as a whole will be larger than it is now. The ultimate standard of living enjoyed by employees can be improved only by increasing the size of the national income to be divided rather than by trying to increase the proportion of that income which is paid to the workers.

2. Training

The second part of a program to improve industrial relations is training. In the years immediately preceding the war, training in industry was the exception rather than the rule. During the war we developed many shortcuts in training, and we learned again that many problems can be solved by trained leaders and trained workers which cannot be solved by untrained persons. We are now at a crossroads. We may take the road back to pre-war conditions of a small amount of training. We may continue and improve slightly the training programs developed during the stress of the war period. I hope we take the third road, however, which recognizes the fundamental importance of training.

Industry must understand that training is not something to be endorsed or tolerated, or something which is called upon to meet an emergency. Industry must recognize that no individual organization nor our economic system as a whole can continue without training. The leaders of today will soon be gone, and their replacements must be trained.

At least one company recognized this need as early as 1933 when it first developed its 35 year plan. Since this company has compulsory retirement at the age of 65, it realized that all employees aged 30 or more would have to be replaced within 35 years. Let me quote from the annual report of the Vick Chemical Company, issued June 30, 1945:

"On . . . all our general managers under our 35 year plan were placed the two duties of management:

1. The short-range duty.—'to keep that body of operating knowledge up to date, abreast, or ahead of competitors. The end result of this duty is sales and profits.

2. The long-range duty — to find and train new players — to pass this body of operating knowledge on to them — and have them ready to take over when time takes away the present players.

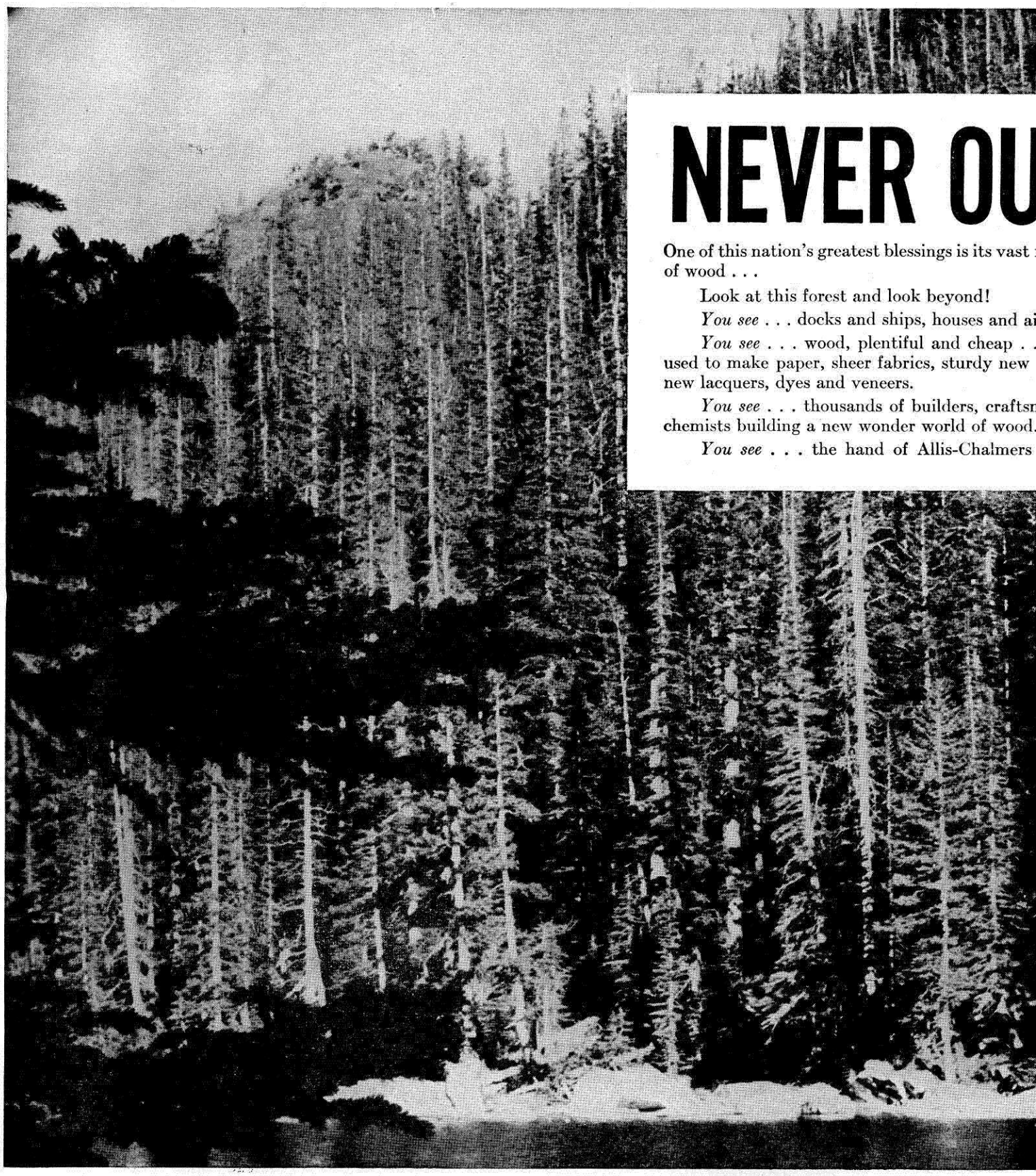
"Obviously, upon the quality of men taken in **now** depends the quality of this team 35 years from now. We are now expecting each executive to find and train an understudy as good or better than the executive himself."

Every organization must recognize the vital fact that only through training can it continue. I am confident that many companies will develop and maintain an adequate training program. But industry must also recognize that it has a stake in training available outside itself. Much of the raw material for industrial training programs must be recruited from schools and colleges. Unless our general educational system provides suitable raw material, the industrial training programs will be of little avail.

Unions too must face this training problem. No union can continue unless new leaders are trained. Unions must, therefore, develope appropriate training programs within the organization, and they too must recognize their dependence upon public and private schools and colleges.

There is, however, one very real danger. Our enthusiasm for training may lead us to believe that anything which is called training is training. Such is not the case. Let me cite, as an example, the present on-the-job training program for veterans. Congress has established a procedure by which all veterans of World War II may receive college training,

(Continued on page 19)



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One of this nation's greatest blessings is its vast
of wood . . .

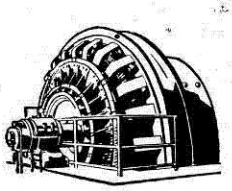
Look at this forest and look beyond!

You see . . . docks and ships, houses and ai

You see . . . wood, plentiful and cheap . .
used to make paper, sheer fabrics, sturdy new
new lacquers, dyes and veneers.

You see . . . thousands of builders, craftsm
chemists building a new wonder world of wood.

You see . . . the hand of Allis-Chalmers



Whether your electric power requirements run to hydraulic or steam turbines . . . whether your needs are for generators, transformers, motors, control devices, or switchgear—expect from every Allis-Chalmers product advanced electrical engineering and design, thoroughly modern efficiencies. Specify Allis-Chalmers.

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es and equipment that help to expand the wood industry—that enrich your life by bringing new world of wood closer to you!

* * *

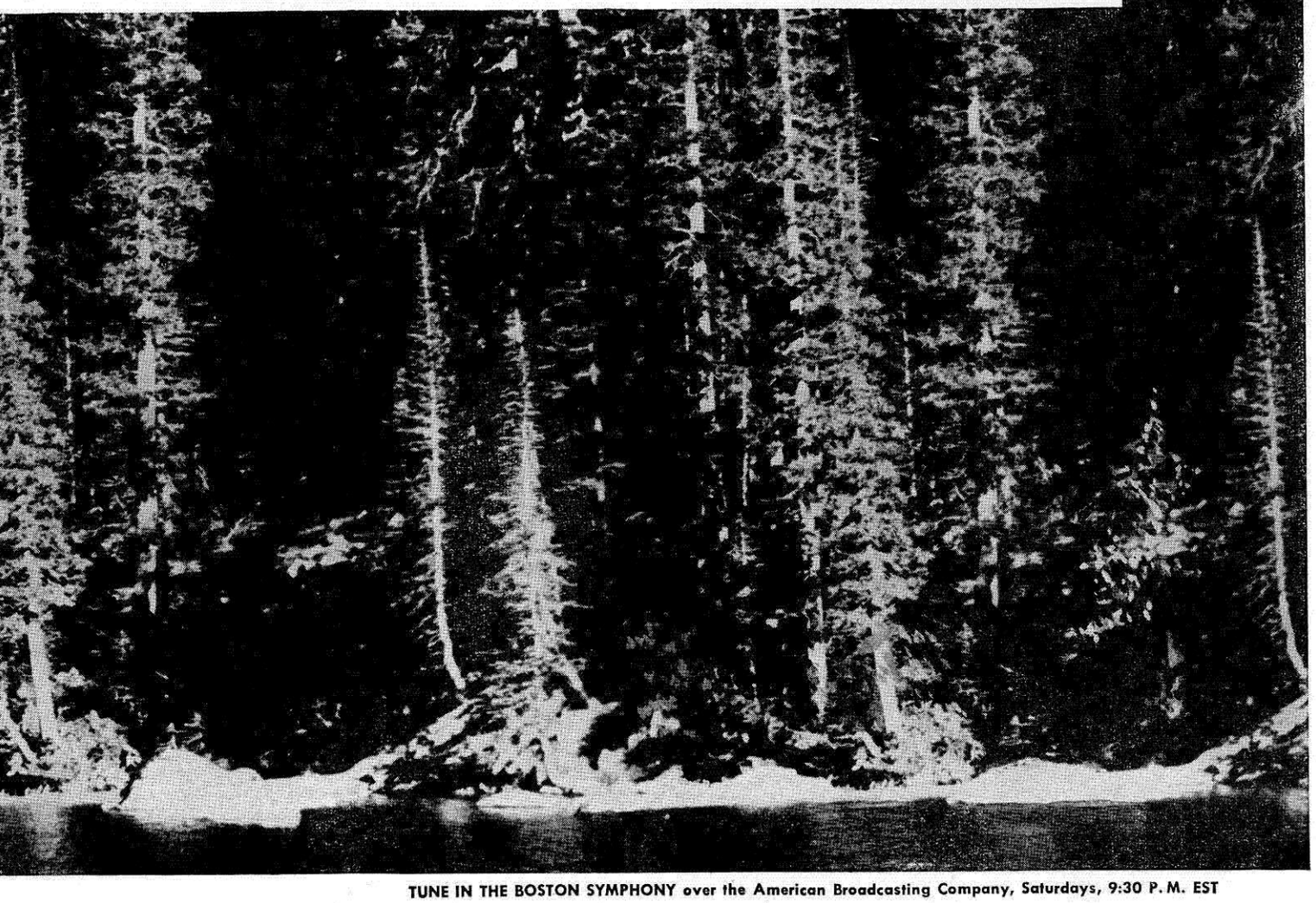
ig is Allis-Chalmers in this picture? Not only a's No. 1 builder of sawmill machinery—but ant source of barkers, chip screens, kilns and equipment for pulp and paper mills—one of the s leading producers of processing machinery for emical industries!

What reason for this bigness? A unique reputation for product engineering and integrity—vast industrial experience—craftsmanship of the highest order—*a reputation known and respected in every industrial field!*

Today, Allis-Chalmers supplies major products for virtually every basic industry . . . has a hand in making almost every machine-made commodity you can name.

Allis-Chalmers is a good name to know!

Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin



TUNE IN THE BOSTON SYMPHONY over the American Broadcasting Company, Saturdays, 9:30 P. M. EST

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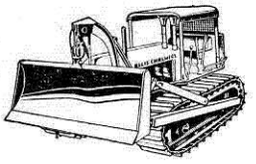


Allis-Chalmers builds tractors like this for the logging industry—mills for making flour—machines for mining and processing ores—pumps for moving almost any fluid—compressors and blowers—welders—speed changers—literally 1600 important industrial products. Call the Allis-Chalmers office in your city.

Freshman Camp, 1946

RUNNING on a fixed schedule, the 1946 frosh camp alternated speeches and free time, advice and question-answering bull sessions. The week-end-long camp clearly showed signs of a full summer's planning by associate dean for freshmen, Foster Strong, and the Beavers. Freshmen, 184 in number, were registered and photographed Friday morning, October 4, at the Institute, loaded into busses that afternoon for the trip to Camp Radford, in the San Bernardino Mountains, 35 miles east of Redlands.

Compulsory attendance, tried for the first time, offered few problems, one reason being that the entire budget for the camp was provided this year by the trustees. This feature permitted faster processing at the Institute, and a certainty that all frosh were exposed to the thorough indoctrination at camp. Class cards were passed out shortly before the camp broke up, sections were assembled and leaders chosen while the class of '50 was still relaxed and unburdened.

The chronologically mature class, averaging 20.5 years of age, consisted of the top 160 of 1100 applicants permitted to take the entrance examination, and 24 men who had entered the service before completing their freshman year at the Institute. That they were a hand-picked lot was impressed upon them, many of whom had previously survived much intensive service screening in the Navy's radio technician training program. Dean Strong emphasized the first night that they would be equipped with the necessary tools to educate themselves. This new generation of Tech men were not to become finished engineers and scientists in four years. However Dean Winchester Jones at the Saturday evening session relieved the not-so-young hopefuls of some of the burdens they were acquiring, by reminding humorously of the theorist reputation accorded C. I. T. graduates by some outside the Tech family.

Given a picture of the present Institute by short, orienting talks on activities and the responsibilities of the class to the undergraduate program during the various lecture sessions, the new students also acquired something of the background of the California Institute which was outlined by Dr. Robert A. Millikan Friday night. Telling most of the story of the early days, the visionary but practical Amos Throop, George Hale, Henry Robinson, and others, Dr. Millikan explained the changed needs and names of the Institute's predecessors, largely omitted his great part in the phenomenal growth of C. I. T., but imbued the frosh with some of the spirit, made them realize that they, too, were pioneers.

President DuBridge the next evening sketched the future, listed developments the incoming class could hope to see, would probably take active part in. Expansion of the faculty, development of the overcrowded engineering departments, and a new student center foreseen in Tournament Park, were pictured as directions for the Institute's continued growth.

The almost 20 faculty members present were introduced Friday night. Saturday morning professor Pickering, in charge of the meeting, turned the procedure over to Lang Hedrick, A. S. B. president, who presented an equal number of student leaders. Lang also reminded the frosh that they were responsible this year for building the school they would attend for the following three years. Offering them promise of immediate participation, he noted that there were only two posts in the A.S.B. government not open to freshmen.

Consolidated Engineering Society, the new focal point of the Institute's five student engineering groups, was explained by Peter Kyropolous of the mechanical engineering department. The new organization will try to give all students, frosh especially, a general, well-rounded picture of the engineering profession through talks by leaders in the various branches of engineering, while the five societies will retain their separate entities and hold meetings of a more technical nature.

Wesley Hershey, Y.M.C.A. secretary, explained the functions of the "Y," told of the book exchange, loan fund, and promised forum groups and luncheon meetings throughout the year.

Highlight of Saturday's morning program was a seminar on "How to Study," conducted by Dean Strong with considerable participation from other faculty members and students. The goal was put at concentration and analytical thinking; the method, to read once over quickly, then to start to learn the details step by step. The importance of scheduling time was emphasized and re-emphasized.

Doctor Lindvall took the lead in explaining the newly reinstated honor system to the students in the afternoon session, followed by Don Mon, president of Ricketts and secretary of the Beavers, who gave details and examples.

A talk entitled "Relax, Relax," outlined Dr. Sorensen's views on extra-curricular activities, and an informal view on the honor system.

Last in the series of meetings which took up one-third of the freshmen's waking hours, was chapel Sunday morning, followed by a talk by Dr. Sterling. "Y" secretary Hershey told of the "Walking Dead" in chapel, insisting that facts alone are not enough; a system of values is essential.

Doctor Sterling, final speaker, explained how an engineer or a scientist could become an effective citizen. The question, as he saw it, is one of security versus liberty, and the student's duty that of being able to evaluate the situation.

Recreation was abundant at Radford, gave freshmen a chance to meet each other and stay warm in the rather chilly fall weather, which produced much speculation on the advisability of draining car radiators, blanket borrowing from a stock wisely provided by camp planners, rearranging of bed clothes to produce maximum warmth from minimum supplies, and extreme envy of those possessing sleeping bags by those equipped only with bedrolls. Touch football was played religiously by members of the football squad who had promised to make up for missing a weekend's practice. Volleyball competition slackened only when light showers or mess calls offered hazards or

(continued on page 18)

C. I. T. NEWS

FRIDAY EVENING DEMONSTRATION LECTURES RESUMED

"RADAR," a lecture by President Lee A. DuBridge on Friday, October 18, resumed weekly Friday evening demonstration lectures discontinued during the war.

The current series of lectures is entitled "Important War-Time Scientific Developments — Their Social Implications and Peace-Time Applications." Besides radar; rockets, jet propulsion, atomic fission, chemical warfare, medical and chemical developments will be discussed. The present series will probably be continued through the end of the year.

Next three lectures scheduled are "Microwave Phenomena" by Dr. Pickering, "Artillery Rockets" by Dr. Thomas Lauritsen, and "High Altitude Rockets" by H. S. Seifert.

These and other events are listed in the California Institute of Technology Weekly Calendar, published every Friday of the academic year except during vacations. The Calendar will be sent without charge upon application to Miss Leonora S. Reno, 201 Mudd Laboratory.

FALL ATHLETICS

Football

FOOTBALL practice, which started a week before school opened with 30 men out, is now in full swing with 50 men showing up for practice. New on the practice field is line coach Pete Mehringer, all-conference tackle from Kansas, who has also seen considerable professional experience.

Conference rules are being relaxed for the 1946 season, permitting freshmen and transfers to play varsity ball. Also, graduates who, under the accelerated program, did not get three seasons of competition, may play this season. This ruling will render several graduate students at the Institute eligible for another year of competition.

A practice game with La Verne College, October 19, will start the season. Since daylight saving time is a thing of the past, floodlights on the field have proved necessary for late afternoon practice, besides giving experience for the four night games scheduled this year.

Cross-country

About to start under the guidance of "Doc" Hanes is cross-country, fall minor sport in which C.I.T. has long received more than her proportion of honors. Runs are scheduled with U.C.L.A., Occidental, and Pomona College for November and December. The season will end December 7 with the conference run on the Rose Bowl course.

Tennis

John Lamb, who coached varsity tennis last spring, is again on the athletic staff. Until the regular season practice commences, Lamb will instruct tennis classes.

Water Polo

Again coached by Bob Merrick '41, the water polo team is practicing nightly in the Pasadena Junior College pool preparatory to meets with Occidental, U.C.L.A., and Compton Junior College.

Intramural Athletics

Starting on October 21 with softball, interhouse athletics will give many men the opportunity to work up a sweat and offer prognosticators a chance to see if the old superiorities of certain student houses prevail.

FOOTBALL SCHEDULE 1946

October 25	*Occidental	at Rose Bowl
November 2	*Whittier	at Whittier
November 8	*Redlands	at Rose Bowl
November 16	Pomona	at Claremont
November 23	*Pepperdine	at Inglewood

*Night Games

This year the intramural athletics will, when possible, be scheduled before the varsity sport, to permit the coaches to scout for latent talent.

Basketball will be run off, starting November 15, giving Coach Carl Shy a chance to organize his squad for practice during December. Varsity basketball will start its league schedule in January.

Y. M. C. A. FORUM SERIES

COMMENCING on Monday, October 28 with a talk by Mr. Harry Flannery, C.B.S. correspondent, **"Eyes Front in a Cockeyed World,"** the Y.M. C.A. is, under the direction of executive secretary Wesley L. Hershey, sponsoring a series of Monday Evening Forums on World Affairs. Except for the first talk, which will start at 8:00, the meetings will begin at 7:30 in room 119 Kerkhoff. These gatherings are open to the general public.

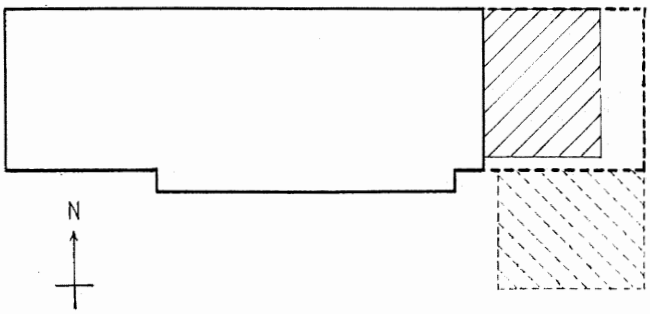
Other topics will be **"China: America's Number One Problem in Asia"** by Professor Allen B. Cole, Department of Far Eastern Affairs, Pomona College; **"Great Britain: 1946 Model"** by Professor Charles M. Mowatt, Department of English History, U.C.L.A.; **"How to Worry About Russia"** by Professor John Vieg, Department of Government, Pomona College; and **"United States Policies in World Prosperity"** by Professor Cecil Dunn, Department of Economics, Occidental College.

GUGGENHEIM ENLARGED FOR HYPERSONIC WIND TUNNEL

NOW under construction is a reinforced concrete addition to Guggenheim Aeronautics Laboratory, which will house a hypersonic wind tunnel, probably the first in the world. The two story wood and plaster structure that was added to the east end of Guggenheim in 1940 and 1942 has been detached. This was originally built to house a 300,000 pound testing machine and a small wind tunnel. Holes were cut through the building just below the window sills, and beams were inserted under the basic frame members. Moved south and turned 90 degrees, this addition is still supported by its window sills, but will be attached to the south wall of the new wing when it is completed.

The new wing will comprise three stories above the ground, and two basements. The hypersonic tunnel will be housed in the two basement floors. Necessary compressors and machinery for operation will be installed in the second basement. Six motors and compressors, totalling 1500 horsepower, obtained from the Kaiser shell plant in Fontana will comprise the power plant for the system.

Not only is the tunnel planned for testing models of projectiles, but it will also be a proving ground for wind tunnel theory. The hypersonic tunnel will produce air speeds of from five to 10 times the speed of sound. Heretofore four times the speed of sound has been the highest velocity obtained. The "hyper" prefix is arbitrarily given to speeds greater than four times the speed of sound.



Daniel Guggenheim Aeronautics Laboratory. Broken lines indicate new constructiona and rearrangement. Cross hatching shows two-story wooden structure.

Government property, the tunnel will be installed to assist in the guided missile research being done at the Institute. Expected to be operating by the end of 1947, tunnel construction will get under way as soon as the two basements are completed, probably early next spring.

EUCALYPTUS TREES BEHEADED

EUCALYPTUS trees planted in two blocks between Bridge and Crellin laboratories have recently suffered the loss of one-third of their height. This is not, as was at first feared, a preparatory step toward their removal. Superintendent of Buildings and Grounds, Wesley Hertenstein '25, assures that within two to three months the trees will put out considerable new growth. Also, in their shortened state, the trees will be less susceptable to damage from spring winds.

LACEY AWARDED CITATION

DR. W. N. LACEY, professor of chemical engineering, and author of nearly 80 scientific articles on physical and chemical properties of hydrocarbons, was awarded the Hanlon Award for meritorious service to the natural gasoline industry for 1946. His citation was received in absentia by Dr. Lacey, who was represented by M. L. Arnold, president of the California Natural Gasoline Association, Los Angeles.

MICROBURET DEVELOPED BY INSTITUTE CHEMISTS

A DURABLE syringe-type microburet for measuring minute volumes of liquids was developed by Institute chemists during the war; one result of a research program sponsored by the Office of Scientific Research and Development to find suitable apparatus for laboratory and field analysis of chemical warfare agents.

The apparatus consists of a syringe holder equipped with a precision micrometer movement. A glass hypodermic syringe is clamped in the holder, and fluids are discharged by turning a graduated micrometer knob. The maximum delivery of the instrument is approximately two cubic centimeters. The volume may be read to one microliter, and selected syringes afford a precision of one- or two-tenths per cent.

WOMEN WIN THROOP CLUB TIFF

AT A MEETING early in October, the men of Throop Club decided that a woman's membership in Throop Club Wives, the auxiliary organization, did not obligate her husband to be a member of Throop Club. This settled, the next decision for the men is that of choosing between samples of upholstery fabric collected by the women preparatory to re-covering the Club's furniture.

Freshman Camp, 1946

(continued from page 15)

diversion. Mountain golf, played up and down hill with croquet-like equipment occasionally broke up other sports as golfers dashed madly after a ball which had missed the green.

Climax to athletic activity came Sunday morning in weather permitting stripping down to only two layers of clothing. A faculty team sparked by Harry Lass, mathematics teaching fellow, in the pitcher's box, and Chuck Auerbach, resident associate of Dabney, who alternated between first and home with Dr. Sterling, held the frosh to a 5-5 tie. Dr. DuBridge, playing second base, and batting well over .300, confounded young cameramen who had three or four lenses trained on him much of the time, when, after getting to first on a clean single, moved to second, and then ran for home when the next batter doubled. After the dust cleared and the president was pronounced safe, cameramen of frosh, soph, junior, senior and graduate standing found that they had failed one and all to get pictures of the event.

CORRECTION

IT WAS stated in the August issue of **Engineering and Science** that "Russel J. Love Heads Research Committee." Mr. Love wishes to correct this statement. The actual head of the Pressure Vessel Research Committee is Mr. Walter Samans of the Sun Oil Company, chairman. Mr. Love is secretary of the committee, and in charge of the office.

How Can We Improve Industrial Relations?

(Continued from page 11)

but Congress also recognized that not every veteran would desire a college training. Congress recognized that training may be done in a variety of ways, including training on the job. A method was established, therefore, by which veterans could in part catch up for years spent in the service, by means of on-the-job training programs. Current developments, however, indicate that the administration of this program is at present in a most deplorable state. The pressure is now to give every veteran a subsidy of $65.00 or $90.00 a month, rather than to train him for more productive work in the future* I am not opposed to the granting of additional compensation to former members of the armed services, but, if such payments are to be made, they should be so labeled and not disguised as training. Training will be discredited in this country if it is so abused.

SUMMARY

We are in one of our most troubled periods of labor relations. These troubles, as indicated by unionization of white-collar workers, and by wide-spread strikes, will probably continue until we have solved the basic problems of inflation and of lowered productivity per employee.

Our problems will not be solved by a simple cure-all or by government fiat. Good labor relations on a national basis can be built only by good industrial relations in every company, in every branch of every company, in every department, and in every unit of every company.

Any supervisor of people, whether, as foreman, he be boss of relatively few men, or, as president of a company, the immediate boss of a few and the indirect boss of many, must build good industrial relations with his immediate subordinates. Every supervisor can carry out a positive program for improving industrial relations by fulfilling the fundamental desires of his employees, all of whom seek a sense of belonging to that group. Any supervisor can supply information to employees about their jobs and the functions of their jobs, he can recognize his employees as individuals with individual problems, he can give them words of commendation for work well done, he can recommend appropriate wage increases, transfers, and promotions for deserving employees. In all of these ways he can improve their morale. Secondly, every supervisor can train the employees under him and train a successor for himself.

Still other parts of this program can be carried out by the company as a whole. The company can contribute further to this sense of belonging by giving recognition in the form of pins or added benefits for long-service employees. It can make plans for stabilizing employment, thus giving added security to the employees. The company can carry out a broad training program, and it must stimulate each supervisor to carry his part in this effort to improve relations between employers and employees.

We must focus our attention on the mutual dependence of employers and employees. We must minimize the points of conflict. We can do this, but will we do it, and will we start to do it now?

*Since this address was given, Congress has modified the Veterans On-The-Job Training Program. It is now a training program, not a general subsidy.

ALUMNI NEWS

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

PHILIP T. DURFEE

COLONEL Philip T. Durfee '28, was killed in the crash of a B-25 Army bomber on September 21.

After graduation in mechanical engineering, Colonel Durfee joined the Army Air Forces, receiving his wings at Kelley Field in 1930.

Returning to the Army in 1939. he spent the next four years in Alaska and the Aleutians, and was coordinator of Army, Navy, and civilian activities in Alaska. Last February he was assigned to Langley Field, Virginia.

Holder of the Distinguished Flying Cross and the Legion of Merit Award, Colonel Durfee is survived by his wife and two sons.

Three others were killed in the crash of the bomber piloted by Colonel Durfee, while two men, both Army personnel, survived.

CHAPLAIN REPORTS

VERNON P. Jaeger '23, lieutenant colonel in the Chaplain Corps of the Army, wrote recently from Korea:

"I am the senior chaplain on duty with the United States Armed Forces in Korea. In this position I am responsible for the supervision of the work of all the chaplains stationed with our occupation forces in this country. As a staff officer of this headquarters I am also involved in the formation of policies and supervision of activities affecting the religious and welfare work being done by our forces among the Koreans. As gradually we permit missionaries to return to Korea it is necessary to have a liaison with their work as our activities are closely related. When the Japanese forces evacuated Korea they left many chaotic conditions. The churches were not exempted from this chaos. We are attempting to help them restore order, rehabilitate their work and regain their many properties that had been taken from them under Japanese duress.

"We feel that we have a hand in processes that will vitally affect the whole future of the Orient and of the World as we work in this strategic location. It is often confusing, challenging and interesting simultaneously. I guess it can be said that I am now a sociological engineer. My Caltech engineering training has always been useful."

DAILY GOES TO M. I. T.

JAMES W. Daily of the Institute mechanical engineering department, has accepted an appointment as assistant professor of hydraulics at M.I.T.

A mechanical engineering graduate of Stanford in 1935, Daily came to the Institute as a graduate assistant in 1936, received his M.S. in 1937, became a research assistant in 1938, a research fellow in 1939, and an instructor in mechanical engineering in 1940. In 1945 Daily obtained the Ph.D. degree.

Having as his chief interest hydraulics, Daily became manager of the hydraulic machinery laboratory in 1937, when the Institute was conducting research for the United States Bureau of Reclamation on the Grand Coulee Pump Project for the Columbia River. With the coming of war, the laboratory was devoted to research for the Navy.

Also to Dr. Daily's credit is much of the planning for the mechanical engineering building, completed in March, 1945, and most of the supervision of laboratory equipment installation.

At M.I.T. Dr. Daily will instruct undergraduate and graduate courses in hydraulics.

M. E. SALSBURY '25 GETS NEW RATING IN CIVIL SERVICE

UNDER a reclassification of his duties by the Los Angeles County Civil Service Commission recently, M. E. Salsbury, C. E. '25, is now senior assistant chief engineer of the Los Angeles County Flood Control District.

Heretofore Salsbury has been known as assistant chief engineer, but he now adds the distinction of "senior" to his title.

It will be necessary for Salsbury to take a civil service examination in order to become permanently established in his new job.

During the war he was the acting chief engineer of the Flood Control District.

C. I. T. MEN AT BROWN UNIVERSITY

PRESIDENT of Brown University, Dr. Henry M. Wriston, announced this month the appointment of Dr. Maurice A. Biot '32 as professor of applied physical sciences, and the promotion of Dr. Chia-Chiao Lin to associate professor of mathematics in the newly established graduate division of applied mathematics.

Dr. Biot, a native of Antwerp, Belgium, was awarded his Ph.D. summa cum laude in aeronautics from the Institute in 1932, following degrees in mining and civil engineering from Louvain University Belgium in 1927, a degree in electrical engineering and the D.Sc. in 1930 and 1931. After service in the Belgian Air Corps as a technical officer, Dr. Biot was a Belgian-American Educational Foundation Fellow at the Institute and the University of Michigan. During 1933 and 1934 he was a National Research Council Belgian Fellow at Delft, Gottigen, Louvain and Zurich Universities. Professor Biot has also been an instructor in applied mechanics at Harvard and a professor of mechanics at Louvain University from 1937 until his entry in 1942 into the Navy, whom which he was discharged in 1946 as a lieutenant commander.

Dr. Chia-Chiao Lin, a native of Fukien, China, studied as a Sino-British Funds Scholar at the National Tsing Hua University, Peiping, China; the Universty of Toronto, Canada, where he received his M.A. degree, and at C. I. T. where in 1944 he was awarded his Ph.D. in aeronautics summa cum laude with a minor in mathematics. Professor Lin came to Brown in 1945 as an assistant professor, after being engaged in confidential war work from 1943 to 1945 at the Institute.

J. KNEELAND NUNAN '38 GIVEN NAVY AWARD

J. KNEELAND Nunan, M.S. '38, was awarded the highest civilian honor bestowed by the Navy at a ceremony in the Los Angeles City Hall attended by Doctors Robert A. Millikan and Royal W. Sorensen.

The Medal was awarded July 30 for "exceptionally meritorious conduct in furtherance of the war efforts of the United States, while serving as Associate Resident Director of the New London Laboratory and as Director of the Pearl Harbor Division of the Columbia University Division of War Research."

J. Kneeland Nunan receives the highest civilian award given by the Navy, The Medal for Merit, from Vice Admiral J. B. Oldendorf. Left to right: Mrs. Nunan, son Jimmy, Nunan, Admiral Oldendorf, and Dr. Millikan.

After receiving his degree, he was assistant professor of electrical engineering and assistant dean of engineering at the University of Southern California for five years. Later he was director of new developments, in charge of commercial activities, for the Aerojet Engineering Corporation in Pasadena.

While nominally in charge of research at the New London Laboratory, Nunan also was responsible for much supervisory work in connection with Pacific Naval activities where his devices were used.

Many of the submarine devices which Nunan helped to develop still are "top secret", and they are credited with a large share of the success of American submarine warfare both in the Atlantic and Pacific.

Under Nunan's "brilliant and inspiring leadership" of a group of scientists, the citation declared, many devices were designed and installed in submarines which "enhanced to a tremendous extent the offensive and defensive potential of units of the United States fleet."

Now West Coast motion pictures sales manager for the Ansco Division of General Aniline and Film corporation, Nunan has a thorough grounding in motion picture research. While a student at the Institute, he was a research engineer for Fox Studios, working on sound projection.

PERSONALS

1924

HAL BECK was recently elected to the position of director of the California Engineers and Architects Association.

MAX W. MOODY visited the United States this summer for the first time since 1939. He has been a contracting engineer in Honolulu for the last 12 years. During the war he had the rank of commander in the Navy and was active in the reconstruction of Pearl Harbor.

1925

TRACY L. ATHERTON is back in Los Angeles as engineer with the California State Division of Lands. For the past three and one half years Tracy has been a captain in the U. S. Marine Corps. He served in the Northern Solomons as intelligence officer with the 14th Marine Air Group.

1926

BURT BEVERLY JR. has returned to Arabia for the next three years.

STEPHEN DETZER is now living at Manhattan Beach, California.

1927

T. C. COMBS has transfered from the San Francisco to the Portland office of Timber Structures, Inc., and will be division sales manager.

1928

BILL BERRY is back as an engineer with California State Division of Water Resources in Los Angeles. During the war Bill was a colonel in the Army Engineers and served with the Ninth Army in Germany.

GUY L. CHILBURG is employed by the Southern California Telephone Company as plant staff assistant. He is assigned temporarily to the general plant superintendent, doing special organization studies.

D. S. NICHOLS and wife Elizabeth are the very proud parents of an eight pound, eight ounce boy named Frederick Allen.

1929

FRED WHEELER is back in Southern California after five years in the Navy and has accepted a position as industrial engineer with the Norris Stamping and Manufacturing Company in Vernon. Fred finished 18 months at Annapolis in the grade of commander and kept the Midshipmen busy studying thermodynamics. Commander Wheeler was chief engineer on the Aircraft Carrier Princeton and was fortunate to have survived the battle in which this carrier was lost.

K. E. KINGMAN is refinery superintendent of the Union Oil Company at Wilmington, California.

1930

WILLIS H. CLARK is now employed by Southern California Telephone Company as an engineer.

GEORGE LANSNER has been made resident engineer on the Terminal Island Freeway, for the State of California, Division of Highways. George is in charge of the construction of this project from Ford Boulevard in Los Angeles to Willow Street in Long Beach. This freeway is to be a six lane divided highway to relieve the traffic congeston in the Los Angeles Harbor area.

1932

JOHN L. COX is now employed at the Naval Ordinance Test Station in Pasadena.

WENDELL R. POLK has recently taken a position with the American Smelting and Refining Company of Los Angeles in the Federated Metals Division.

1933

ROBERT R. MEAD of Seattle, Washington was an Army captain and saw service for 40 months. He is taking up civilian life again by working for the Ethyl Corporation as a tractor and fleet engineer.

MOSES B. WIDESS is now employed by the Standard Oil Company in Tulsa, Oklahoma, as a geophysicist.

1934

ROBERT D. BOSHE of the Institute of Radiobiology and Biophysics at the University of Chicago, paid the Alumni office a visit while he was vacationing in California.

DR. JAMES W. McRAE has been appointed director of radio projects and television research in addition to his duties as electro-visual research engineer with the Bell Laboratories. He received his master's degree in 1934 and his doctorate in 1937.

LEE P. MORRIS, commander in the Naval Reserve was separated from the Navy n April and has returned to the Standard Oil Company Refinery at El Segundo, California.

1935

GREER W. FERVER reports: "Some of my old friends may be interested to know that I am still with the National Iron Works. I saw no war service. but I did get to Australia and New Guinea for a few months in 1944 to help the Army assemble some knock-down refrigerator barges we designed and built for them. The best news is that our little girl has a brother. born on July 22. He is named Robert Greer and doing fine."

WILLIAM G. COX has been placed in charge of distributor and contractor sales for the General Electric's Air Conditioning Department at Bloomfield, New Jersey.

DR. K. S. PITZER will lecture at the Standard Oil Company of New Jersey, on "Spectra as Related to Structure and Thermodynamic Properties of Molecules."

JACK W. SCHWARTZ, commander in the Navy and in the Civil Engineering Corps, is now stationed at the Naval Shipyard at Terminal Island. Jack was a prisoner of the Japanese following the invasion of Guam in December, 1941.

1936

DAVID M. WHIPP, lieutenant (j.g.) in the U. S. Coast and Geodetic Survey is engaged in establishing cross arcs of first order triangulation between existing arcs of first triangulation, and filling in the squares with second order triangulation stations in the Missouri River Valley During the war he was assigned to duty with the Army under the U. S. Coast and Geodetic Survey Commission. He was sent overseas with the 1st F. A. Observation Bn. in August, 1942 and returned in November, 1945. While seeing foreign service he was in all engagements except the Normandie invasion, mostly with the Free French Army. Was awarded the Legion of Honor and the Silver Star by the American Army, and the Croix de Guerre by the French Army.

1937

ROBERT S. CAMPBELL is employed by the Edison Company in Los Angeles.

BRUCE W. DUNBAR has been transferred to the San Francisco office in the Development Department of Shell Oil Company, Inc., after working nine years at the Wilmington Refinery as a refinery technologist.

VIRGIL ERICKSON is now employed by Morrison and Knudsen at Palm Springs and is in charge of survey on towers and other work for the San Jacinto Trainrail.

DANIEL L. GERLOUGH is working at the Menasco Manufacturing Company at Burbank as assistant supervisor of laboratory research operations.

ALBERT H. ZIMMERMAN is employed by the Consolidated Steel Corporation, shipbuilding division at Wilmington, California.

1938

EVAN A. JOHNSON, President of the New York Chapter of the Alumni Association, spent a three week vacation showing his English bride the Pacific Southwest.

1939

CLAUDE H. BROWN JR. is now employed by General Tire and Rubber Company of Pasadena.

GEORGE O. CROZIER announces that his second son was born on August 8. He was named Donald. A future Tech man, no doubt.

RICHARD A. FISCHER is the proud father of a baby girl. She has an older brother, aged three years.

FREDERICK C. HOFF was separated from the Naval service in February with the rank of lieutenant. His last active duty was as officer in charge of Rocket production research and testing at Naval Ammunition Depot Hastings, Nebraska. Fred is now employed as plant engineer at Firestone Tire and Rubber Company.

LIEUTENANT COMMANDER T. R. MATTHEY was recently detached from active duty as a supply officer, Naval Air Station at Pisco, Washington, and is now ordered to Com. Air Pac. for further assignment. He was married on July 29 to Miss Virginia Lee Knight.

ROBERT W. WINCHELL is now employed at the University of Southern California as instructor in electrical engineering.

1940

RAYMOND O. CLINTON is at Rensselaer, New York with the Sterling-Winthrop Research Institute as a research chemist.

JULES MAYER is the father of Paul Edward, born in August.

WILLIAM B. SCARBROUGH has a new position with Standard Oil at Richmond, California as lead engineer.

CARL B. SCHRADER of the Navy Department, Washington, D.C. was recently in California on leave.

1941

ROY ACKER has taken a position with Gilfillan Brothers, Inc., in Los Angeles.

ROBERT F. MYERS was on terminal leave from the Navy where he served as an ensign C.E.C.

NEWELL T. PARTCH is now with the Johnson Company in Berkeley.

CLAUD S. RUPERT was released from active duty with the Navy after four years of service (including training at the Institute, MIT, and Corpus Christi.) He was on duty with the Naval Research Laboratory at Washington, D.C. and field work out of NRL in various parts of the United States and the Southwestern Pacific. Claud is now a graduate student and teaching assistant in the physics department at John Hopkins University at Baltimore, Maryland.

GEORGE I. REIMERS announces the birth of a daughter, Helen Margaret, on July 24.

REUBEN P. SNODGRASS is now employed at Consolidated Vultee at Downey, California, as a flight test engineer.

STANLEY SOHLER is employed at Wright Field, Dayton, Ohio, as production control specialist.

JOSEPH WEISS was released from active duty as a Naval lieutenant in October. Joe spent his navy duty at the Bureau of Ships at Washington, D.C. on special minesweeping equipment and also at the Boston Navy Yard working with ship conversion and repair and personnel work.

1942

VICTOR G. BRUCE informs us of a new position with Willys-Overland Motors, Inc., in Los Angeles.

RICHARD H. COX of Eleele, Kauai, Hawaii has a new position with the McBryde Sugar Company.

CARTER HUNT has a new home address: Knox Hill Farm, Delavan, Illinois. He is employed by Hiram Walker and Sons, Inc., as a chemical engineer with the Research Department.

CARL H. SAVIT was married to Miss Sandra June Kaplan in July in Los Angeles. Carl is now out of the army and back at the Institute as a teaching fellow.

HENRY W. MENARD JR. was married to Miss Gifford Merrill in September.

ARTHUR J. SCHNEIDER is taking graduate work at C.I.T. in mechanical enginnering toward his Ph.D. He was married in September to Miss Jane Owsley in Pasadena. They planned on a motor trip to Northern California.

LEROY A. WELLER will take graduate work at Stanford Graduate School of Business working for M.B.A. degree. During the war he served as an assistant engineer in the Merchant Marine.

GORDON K. WOODS has been in charge of the design section of the plant construction engineering department of the Kaiser-Frazer Company in Michigan.

1943

EDDIE I. BROWN was recently discharged from the army where he was a first lieutenant in the Air Cor-s. While overseas he was stationed, among other places, in Singapore, China and Burma, and flying transports over the "hump."

JOHN W. BUCHANAN was stationed on Okinawa doing army construction and teaching at Okinawa University. He held the commission of captain in the Army Engineers and was discharged in October.

EARLE R. BUNKER JR. was on terminal leave until the middle of October from the Signal Corps.

CLAUDE L. CARTER just returned from Fukuoka, Japan, where he was assigned to the 58th Air Service Group doing aircraft maintenance. He became a civilian this month.

GEORGE D. GRIFFITH has finished his service with the Navy as of June 15. He held the commission of lieutenant.

EDWIN G. JOHNSEN served as a first lieutenant in the Army and spent 18 months on Saipan and Okinawa as an officer in the aviation engineers.

1944

ROBERT F. BLOCKER will take graduate work in civil engineering, working toward his masters degree at the Institute.

JAY R. BORDEN has been discharged from the army where he served as a first lieutenant in the Signal Corps. He will work for his M.S. in E.E.

THOMAS A. CARTER JR. is out of the Navy.

ILIF ROSS DANA JR. was selected for Who's Who in Students of American Universities and Colleges. He is now out of the Navy and will return to Tech to obtain his Masters in C.E.

KENNETH DEREMER will work for RCA Laboratory in Princeton, New Jersey.

RICHARD E. KUHNS was recently discharged from the Navy upon returning from Tutuilla, American Samoa.

HARRY LEW has been employed by Hughes Aircraft.

BILL LOCKWOOD is working with the Continenal Can Company in Oakland as an industrial engineer.

ROBERT McANLIS will be married in October to a Pasadena girl. Bob is working for Johns-Mansville Products in Lompoc.

GEORGE D. McDONALD JR. was released from the Navy as an ensign after doing research on rockets at the Naval Ordnance Test Station at Inyokern. He is now working for the Hall-Mack Company of Los Angeles.

FREDERICK W. MORRIS JR. has left the Army where he was a lieutenant in the Signal Corps, serving as radio, radar and telephone center officer at Fort Monmouth, New Jersey, and Bremerhaven, Germany.

JOHN B. NELSON will take graduate work at M.I.T. in mechanical engineering.

THOMAS W. NORSWORTHY was recently discharged from the Navy and hopes to take graduate work, though he is not sure which school, when we heard from him.

ROBERT J. PARKS is back home after being stationed in Vienna, Austria with a Signal Batallion, mantaning communication with the U.S. forces in Austria Headquarters.

GEORGE F. SMITH is out of the Navy now and upon the completion of his terminal leave will take a position with Engineering Research Associates in St. Paul, Minnesota.

CLARENCE L. WELLIVER has received a license as second assistant engineer in the U.S. Merchant Marine. He expects to remain active until March, 1947.

DOYLE E. WILCOX and Miss Eunice A. Fuller of Pasadena were married in June. Doyle is employed in Pasadena by the Consolidated Engineering Corporation.

PAUL H. WINTER spent 19 months in the Philippines; is now home to stay after his terminal leave expires.

1945

DALE H. AUSTIN will be married to Miss Nancy Lou Peterson in November at San Gabriel. Dale served in the Navy as an ensign and is planning on taking graduate work at the Institute in M.E.

HALCYON BALL will study at the University of Denver for a degree in Business Administration.

EUGENE W. BOLSTER is employed by the Southern California Gas Company.

KENNETH G. BROWN JR. reports that he was married last year to Miss Patsy Ruth Gonn. He is now out of the Navy.

JOHN D. CARDALL JR. will take graduate work at the University of Denver in Business Administration. He was a deck officer in the Navy during the war.

LAWRENCE E. FULLER has been employed by Patterson Ballagh Corporaton in Los Angeles.

RAYMOND C. GERBER JR. has been released from the U.S.N.R. supply group.

RICHARD JASPER is with the Quinton Engineers, Ltd., in Los Angeles.

RICHARD KNUDSEN visited the campus recently.

MARK H. MACOMBER hopes to take graduate work at Tech next year. He is a civilian now after serving as a communications officer in the Navy.

WILLIAM C. McDONELL, while in the Navy, made a cruise to Nagasaki, Japan, Pearl Harbor and Norfolk on an APA as a deck division officer. The ship brought back a load of 10th division Marines who had been doing occupation duty in Japan. Bill will take graduate work at Berkeley.

EMANUEL J. MILLER is employed by C. F. Braun and Company.

RICHARD V. HENRY was recently discharged from the Navy after seeing duty aboard the U.S.S. Gen. H. W. Butner on the China run. Dick has been employed by Lockheed Aircraft.

DONALD D. MacDOUGALL is returning to Tech for an M.S. in either E.E. or Physics.

REUBEN F. METTLER was in the Electronic Field Service Group while in the Navy. He is going to study for his Masters in Electrical Engineering at C.I.T.

WILLIAM F. ROBERTS will be married in the near future, though the date is indefinite. He is out of the Navy after serving as a deck officer and navigator.

R. Y. SCAPPLE will be working toward a Masters in E.E. at Stanford after being stationed at advance bases, Peleliu and Guam with the Navy.

EUGENE SCOTT got in on some of the excitement around Bikini. Though he left a week before "Operation Crossroad," he saw many of the preparations being made.

DONALD W. SINCLAIR spent his time in service with the Navy aboard the Cruiser U.S.S. Providence.

JOHN M. SLYE has accepted a position with the Los Alamos Research Laboratories.

THEODORE B. TAYLOR will take graduate work at the University of California for an M.S. degree in Physics.

DONALD C. TILLMAN was married to Miss Doris Marjorie Last in September in Patterson, New Jersey.

ROBERT G. TROUT served as a line officer with the Navy. He is out of service now taking graduate work at Caltech.

LAWRENCE E. WILFERTH JR. is employed by the Southern California Gas Company.

ROBERT E. WILKINSON is home after serving as an ensign with the U. S.N.R. Amphibious forces.

1946

BENJAMIN AUSTIN is employed at Baker Oil Tools in Los Angeles.

CHARLES A. BERGMAN is working at C. F. Braun, Inc., in Alhambra.

CHARLES DAVIS will be an instructor at John Muir Junior College in Pasadena.

JACK L. JENSEN is out of the Navy.

F. H. LAMSON-SCRIBNER was recently discharged from the Navy.

GEORGE D. MEIXNER JR. saw light cruiser duty in the Atlantic prior to his discharge. George will take graduate work at Berkeley.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

of ENGINEERING AND SCIENCE MONTHLY, California Institute of Technology, published monthly at Pasadena, California, for October, 1946.

State of California.

County of Los Angeles, ss.

Before me, a notary public in and for the State and county aforesaid, personally appeared the editor of the ENGINEERING AND SCIENCE MONTHLY, California Institute of Technology, DONALD S. CLARK, who having been duly sworn according to law, deposes and says that he is the editor of the ENGINEERING AND SCIENCE MONTHLY, California Institute of Technology, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation) etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Alumni Association, Inc., 1201 E. California St., Pasadena 4, California; Editor, Donald S. Clark, 1201 E. California St., Pasadena 4, California; Managing Editor, Wesley P. Bunnelle, 1201 E. California St., Pasadena 4, California; Business Manager, Wesley P. Bunnelle, 1201 E. California St., Pasadena 4, California.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other incorporated concern, its name and address, as well as those of each individual member, must be given.) Alumni Association, Inc., California Institute, 1201 E. California St., Pasadena 4, California; no stock, a non-profit corporation.

3. That the known bondholders, mortgagees, and other security holders owning or holding one per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also in cases where the stockholder or security holder appears upon the books of the company as trustee in any other fiduciary relation, the names of the person or corporation for whom such trustee is acting is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is . . . (This information is required from daily publications only.)

DONALD S. CLARK, Editor

Sworn to and subscribed before me this 7th day of October, 1946.

(Seal) Ida A. Ritchie.

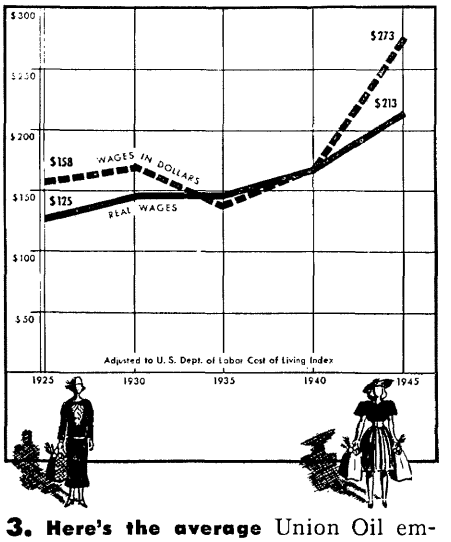
(My commission expires April 9, 1949.)

There's only one way to raise wages

1. Each year a business produces so much income. Part of that income goes for rent, raw materials and other expenses. What's left is divided between the employees and the owners–as wages and profits. Many people think wages can be raised by giving employees a bigger *share* of the income that's left. But in 9 cases out of 10 this can't be done.

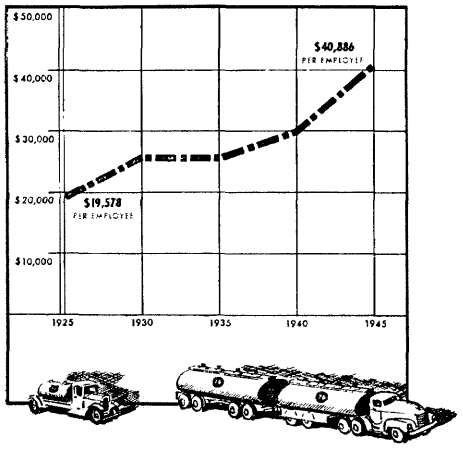
2. In most U. S. businesses the employees are *already* getting a lion's share of the income. Last year, for example, Union Oil employees got 77% of all income the company produced over expenses. (The stockholders got 12% in dividends and 11% was plowed back into the business.) Nevertheless, employees' wages since 1925 have almost *doubled.*

AVERAGE MONTHLY WAGE PER UNION OIL EMPLOYEE



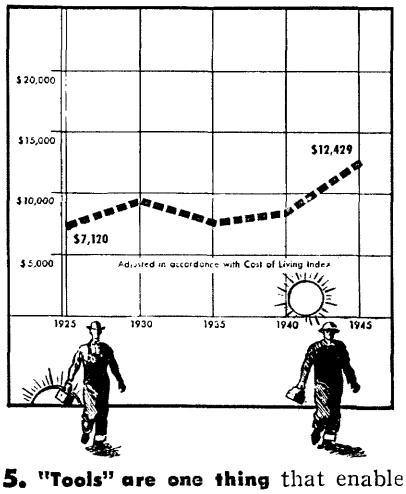
3. Here's the average Union Oil employee's wage in actual dollars per month (dotted line above). Of course $1 today won't buy what it bought–say–in 1935. So we've also converted those dollars into "Real" Wages (solid line). This shows what the U. S. Dept. of Labor Cost of Living Index found the pay check would actually *buy* each year in food, clothing, etc.

DOLLARS INVESTED IN "TOOLS" PER UNION OIL EMPLOYEE

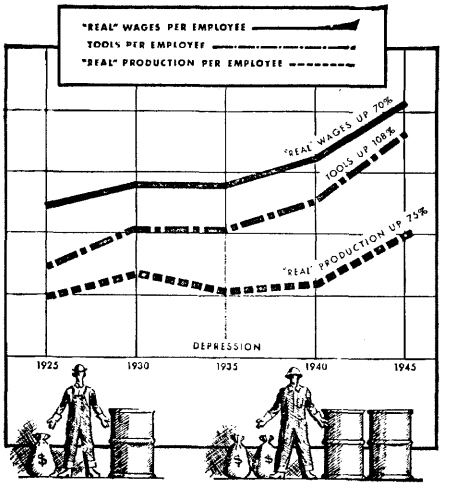


4. Now, if there are only so many "pieces in a pie," how were wages increased that much? Mostly by producing "bigger pies." In 1925 each Union Oil employee had an average of $19,578 worth of "tools"–oil wells, refineries, trucks, etc.–to work with. By 1945 the owners had provided him with $40,886 worth–*twice* as much.

ANNUAL PRODUCTION PER UNION OIL EMPLOYEE



5. "Tools" are one thing that enable people to *multiply the labor of their hands.* Today, Union Oil people work about 35% fewer hours than in 1925. They have better vacation, hospital and pension plans. But because they have more "tools" with which to work, they can *produce* more. And because they can produce more, per employee, they are able to *earn* more.



6. The three charts together show graphically that the only real way to *raise wages* is to *raise production.* But one word of warning: Until recently, stockholders have always had the *incentive* to provide *more* and *more* "tools". Today, much of that *incentive* has been whittled away. Unless it is restored, we're not going to have the progress in the future that we've had in the past.

UNION OIL COMPANY

OF CALIFORNIA

This series, sponsored by the people of Union Oil Company, is dedicated to a discussion of how and why American business functions. We hope you'll feel free to send in any suggestions or criticisms you have to offer. Write: The President, Union Oil Company, Union Oil Bldg., Los Angeles 14, Calif.

AMERICA'S FIFTH FREEDOM IS FREE ENTERPRISE

The Main Line

OCTOBER, 1946

This month the resort and guest ranch season officially opens in Arizona and the Southwest. Obviously we can't list all the establishments in this advertisement. We've done that in a brand new Southern Pacific booklet which you can get free by writing Room 735, 65 Market Street, San Francisco 5, California. Ask for our Guest Ranch booklet.

One of the New Mexico guest ranch operators, Harry Flickinger, particularly intrigued us with this copy from his booklet, which we suspect he wrote himself:

"I don't know what you do when you vacation. If you've got a lazy streak like me, you like to slouch down in an easy chair and listen to your nerves unwind.

"We have a good time. We have our fun the slow, easy way. There's plenty to do here at the Lodge. I've got a nice string of horses—one just your size. And all outdoors for riding, camping, hiking. There's a spring-fed swimming pool right up the hill under the willows, too.

"If it's privacy you want, you can live like a hermit—you have your own private quarters, your own bath, your own spot for sunning. And by the way come winter you can bring your guns for some of the best deer, bear, turkey, quail and dove hunting in these United States."

Say no more, Mr. Flickinger. We're hooked!

Fan Mail

We haven't been exactly deluged with letters as a result of these advertisements, but we have received a few. Sincere thanks to Mr. A. L. Darrow of Oakland, California, for his two long auto-biographical letters which we found intensely interesting. Also to Mr. and Mrs. Frank Horn of Oakland for their nice post card and their compliments about Southern Pacific service. We are happy that Portia Kubicek of Burbank, California, is one of the thousands who have not lost their childhood love for trains. Thanks also to Mr. Joseph Eastburn of San Francisco for his swell letter. Now, how about some mail from the Pacific Northwest?

Peaks and Valleys

Getting back to Arizona, we want to remind you that there are peaks and valleys in both the summer and winter vacation seasons.

After five trying years of war and re-conversion, it seems that everybody in America not only wants a vacation, but badly *needs* one. However, the shortage of resort and transportation facilities makes it a good idea to take *your* vacation when other people are at home.

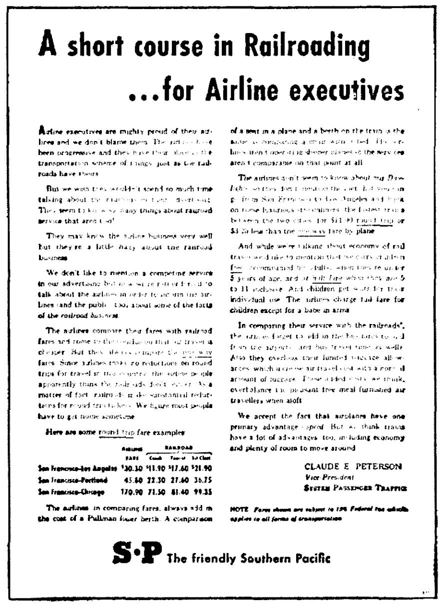
In other words, shoot at the off-seasons. Thus, the earlier you head for Southern Arizona and the Southwest, the better your chances for train reservations and accommodations at the guest ranches or resorts. Similarly, if you can't get space in January, try February, March or April.

We'd like to remind you that Southern Pacific is the *only* railroad to Tucson, and that *only* Southern Pacific has main line train service to Phoenix.

See Twice as Much

If you know the "angles" about railroad round trip tickets, it's really amazing how much extra mileage you can buy without paying one cent extra rail fare. This is especially true if you "go one way, return another" on Southern Pacific's Four Scenic Routes.

For example, suppose you live in San Francisco and want to go to New York and back. For no more round trip fare than you would pay to go both ways via Ogden and Chicago, you can swing down through Los Angeles, Phoenix, Tucson, El Paso, San Antonio, Houston, New Orleans and on to New York. Returning you can see Chicago, the northern United States, Seattle and Portland! All this, mind you, for exactly the same rail fare you'd pay to go straight to New York and back. Stopover anywhere.



Atomic Bomb (jg)

You may have seen our advertisement "A short course in Railroading for Airline executives" which debunked the airlines' claim that it's cheaper to fly than to travel by train. It was written by Fred Tredway, our general advertising manager, and has caused quite a stir. We got hundreds of favorable comments about it. However, three or four letters criticized Southern Pacific for taking a crack at a competitor.

We'd like to point out that for years we have been asking our airline friends to desist from comparative advertising, but they persisted. So we felt impelled to drop a small, good-natured atomic bomb upon them. We believe it has helped to clear the air, and that from now on the airlines will be more inclined to peddle their own potatoes.

In the last analysis, you will decide which form of transportation you prefer. And we will be happy to abide by your decision.

—H. K. Reynolds

S·P ***The friendly Southern Pacific***