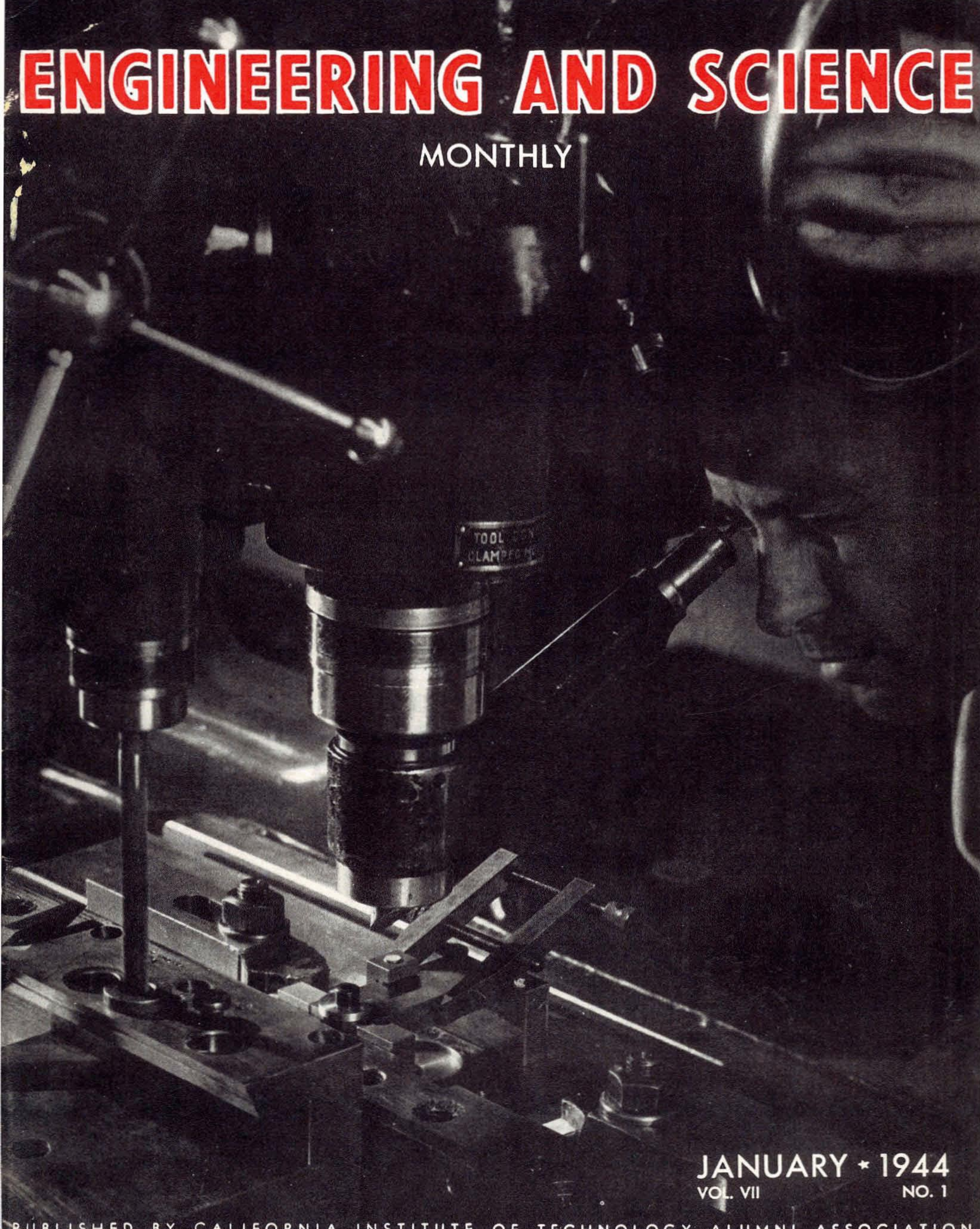
ENGINEERING AND SCIENCE

MONTHLY



JANUARY • 1944
VOL. VII NO. 1

PUBLISHED BY CALIFORNIA INSTITUTE OF TECHNOLOGY ALUMNI ASSOCIATION

"Why shouldn't I buy it? I've got the money!"

Sure you've got the money. So have lots of us. And yesterday it was all ours, to spend as we darn well pleased. But not today. Today it isn't ours alone.

"What do you mean, it isn't mine?"

It isn't yours to spend as you like. None of us can spend as we like today. Not if we want prices to stay down. There just aren't as many things to buy as there are dollars to spend. If we all start scrambling to buy everything in sight, prices can kite to hell-'n'-gone.

"You think I *can really keep prices down?"*

If you don't, who will? Uncle Sam can't do it alone. Every time you refuse to buy something you don't need, every time you refuse to pay more than the ceiling price, every time you shun a black market, you're helping to keep prices down.

"But I thought the government put a ceiling on prices."

You're right, a price ceiling for your protection. And it's up to you to pay no more than the ceiling price. If you do, you're party to a black market deal. And black markets not only boost prices—they cause shortages.

"Doesn't rationing take care of shortages?"

Your ration coupons will—if you use them wisely. Don't spend them unless you have to. Your ration book merely sets a limit on your purchases. Every coupon you don't use today means that much more for you—and everybody else —to share tomorrow.

"Then what do you want me to do with my money?"

Save it! Put it in the bank! Put it in life insurance! Pay off old debts and don't make new ones. Buy and hold War Bonds. Then your money can't force prices up. But it can speed the winning of the war. It can build a prosperous nation for you, your children, and our soldiers, who deserve a stable America to come home to. Keep your dollars out of circulation and they'll keep prices down. The government is helping—with taxes.

"Now wait! How do taxes help keep prices down?"

We've got to pay for this war sooner or later. It's easier and cheaper to pay as we go. And it's better to pay more taxes NOW—while we've got the extra money to do it. Every dollar put into taxes means a dollar less to boost prices. So . . .

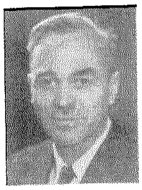
Use it up . . . Wear it out . . .
Make it do . . . Or do without

HELP US KEEP PRICES DOWN

A United States war message prepared by the War Advertising Council, approved by the Office of War Information, and contributed by the Magazine Publishers of America

BY-LINES

ALFRED J. STAMM



Dr. Stamm received his B.S. degree in chemistry from Caltech in 1921, and his M.S. and Ph.D. degrees from the University of Wisconsin in 1923 and 1925. Since 1921 he has been associate chemist to principal chemist, U. S. Forest Products Laboratory, Madison, Wis. He has written over fifty publications on colloidal and physical chemistry of wood and wood constituents.

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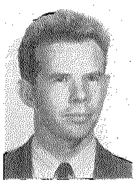

Mr. Veysey was graduated with a degree in civil engineering from the California Institute of Technology in 1936 and received his M.B.A. degree from Harvard Business School in 1938. He was instructor in economics and accounting at Caltech until 1940 and then at Stanford Business School. He is now assistant professor of economics and industrial relations at Caltech and supervisor of industrial management in the E.S.M.W.T. program.

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ENGINEERING AND SCIENCE MONTHLY is published monthly on the 25th of each month by the Alumni Association, Inc., California Institute of Technology, 1201 East California Street, Pasadena, California. Annual subscription $2.50; single copies 35 cents. Entered as second class matter at the Post Office at Pasadena, California, on September 6, 1939, under the Act of March 3, 1879.

ENGINEERING AND SCIENCE *Monthly*

The Truth Shall Make You Free

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ENGINEERING AND SCIENCE
Monthly

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The Month in Focus

By J. E. WALLACE STERLING

The Conference at Teheran

THE importance of the Teheran meeting lies mainly in the simple physical fact that the three leaders met together for the first time. It was the seventh conference meeting for Prime Minister and President. It was the second for Churchill and Stalin: Mr. Churchill had met in conference with Stalin in August, 1942, when he went to Moscow to tell the Russian leader that the western allies could not open a second front in Western Europe that year. But at Teheran, for the first time, the three men were brought together for an all-important exchange of views and making of plans. The weight of official work was somewhat relieved by what seems to have been a convivial celebration of Mr. Churchill's 69th birthday.

Two official communiques were issued from the Teheran conference. Both were dated at Teheran, December 1, 1943. In one, the governments of the U. S. A., the U. S. S. R. and the United Kingdom expressed the desire to maintain "the independence, sovereignty and territorial integrity of Iran," and the intention to "continue to make available to the government of Iran such economic assistance as may be possible, having regard to the heavy demands made upon them by their world-wide military operations." The other communique had to do with cooperation among the governments of the great powers in the prosecution of the war and the establishment of peace.

This second communique was couched, as was to have been expected, in general terms. A short paragraph dealt with war plans. In it, two points stand out: one—and an obvious one—is that these particular three powers concerted their plans for action against Germany; since Russia is still neutral in the Japanese war, nothing was said about any eventual Russian operations against Japan. The other, is that complete agreement was reached "as to the scope and timing of operations which will be undertaken from the east, west and south" of Europe. This agreement would seem to lay at rest the whole "second front" problem over which public opinion of the three countries has frequently been so exercised.

There is nothing new in the Teheran statement that operations "will be undertaken from the east, west, and south." Mr. Churchill made no bones about the prospect of such a three-sided attack on Europe when he spoke to the House on September 22, referred to operations in Italy as constituting a "third front," and said that the "second front" against western Europe was already potentially in existence. Of course, the southern or "third front" may be expanded beyond present operations in Italy, and the "second front" in western Europe may be established at more than one point,—but the fact remains that in broad strategical concepts there was nothing new in the Teheran communique about attacking Germany from three sides.

War Plans Against Germany

The new item in the paragraph on the war has to do with the agreement on the "scope and timing" of these three-sided operations. The Russians have long held that they could not effect a real break-through of the German lines in Russia until 50-60 German divisions had been withdrawn from the Russian front to meet allied offensives in other parts of the continent. The allied invasion of Italy, with its attendant threat to the Balkan peninsula, has not met the conditions of such an offensive. Only some 30 to 35 German divisions are engaged or held down in Italy and the Balkans, and these were not withdrawn from the Russian front. It would appear, therefore, that agreement as to the "scope" of future allied offensives means agreement in the main on the opening of the "second front" in western Europe. And this would mean, if Russian conditions have been met, as they probably have, that operations against western Europe will be on a scale sufficiently large to engage successfully enough German divisions to bring about the desired reduction of German strength on the Russian front.

And agreement as to the "timing" of new offensive operations is likewise significant. There is reason to believe that Russia has staked much on a fairly early conclusion of the war in Europe. She has asked, for instance, that in the matter of lend-lease and other aid heavy priority be given to weapons of war rather than food. One competent observer has interpreted this to mean that Russia intends to meet her needs in food for the immediate future largely from her own resources and by hard rationing and that she is counting on an early victory to relieve the food shortage that her people have experienced for more than two years of war. So, agreement on the "timing" of operations in the west and south may mean that they will be undertaken soon, and will be coordinated with a new and great offensive by the Russian armies.

The statement of the communique as to cooperation in peace repeats previous expressions of the same senti-

J. E. Wallace Sterling

ment and resolve. Indeed, it was anticlimax, following as it did the Joint Four-Nation Declaration issued a month earlier, on November 1, by the Moscow Conference. That four-power declaration, in which China participated, was at once more comprehensive and more specific with regard to postwar organization than the brief, general statement of the Teheran communique. Also, the Statement of Atrocities, signed by Roosevelt, Churchill and Stalin and made public on November 1, went further in dealing with at least one aspect of the German problem than did anything to be found in the Teheran statement of December 1.

Furthermore, the Moscow Conference arranged for the setting up of machinery to deal with various postwar European problems. Such machinery is to be seen in the Advisory Council of European Affairs now established in London, and the Advisory Council in Italy. These two councils presumably supplement the Mediterranean Commission which was set up, at the suggestion of Stalin, after the Quebec Conference of last August.

In short, then, it may be said on the basis of available official sources that the Teheran Conference dealt primarily with the planning of military operations to be taken against Germany in the near future, and, secondarily, reviewed and continued discusson of political matters already brought under consideration at the Moscow Conference.

The Conference at Cairo

The Cairo Conference, which preceded that of Teheran, dealt, of course, with the prosecution of the war against Japan. It was the second conference devoted primarily to this consideration, the first one having been held at Quebec in August. The presence of Generalissimo Chiang at Cairo was a fitting sequel to the participation of China in the Quebec Conference through the person of the Chinese Ambassador to the United States, and to the participation of China in the Four-Power Declaration of Moscow, through the person of the Chinese Ambassador to Russia. The Quebec Conference had discussed in broad outline the matter of intensifying the war against Japan. It had arranged for the establishment of a new Southeastern Asiatic Command under Lord Louis Mountbatten. Since September, the new commander had been exploring the situation in the area under his command, and presumably brought with him to Cairo conclusions reached as a result of these explorations. At Cairo, then, the military staffs were in a position to work out details for further multiple pressures on Japan's extended empire. Inasmuch as pressures from the north, central and southwestern Pacific were already a fact, greatest consideration must have been given at Cairo to the means of developing new pressures in Japan from China and from southeastern Asia.

The Cairo Communique was quite specific as to the fate in store for Japan's empire after her military and naval strength shall have been crushed. It stated that Japan shall be stripped of the empire she has gained since her war with China in 1894. This involves the loss of her island holdings in the Pacific, and the loss of Manchuria, Korea and occupied portions of China. Korea is to be given independence "in due course," a phrase and condition against which Korean spokesmen already have protested with some reason. Manchuria is to be returned to China. No mention was made in the Cairo Communique as to the fate of the British Crown Colony of Hong Kong.

It seems reasonable to assume that this statement on the distribution of territory to be recovered from Japan was made with Russian knowledge and approval. Technically, and by reason of her official neutrality in the Japanese war, Russia had nothing to do with the Cairo statement; but practically, approval of the statement by Russia was indispensable to its effectiveness and political value. If this assumption is correct, it means that Russia has agreed to the return of Manchuria to China. Such agreement would be in accord with previous Russian statements regarding Russian territorial claims and ambitions.

Russia has not yet withdrawn her claims to the territory on her European frontier which she was occupying when attacked by Germany in June, 1941. This territory includes Bessarabia, eastern Poland, Lithuania, Esthonia, Latvia, and a piece of Finland. But on more than one occasion, Stalin and Foreign Commissar Molotov have stated that beyond these territories on Russia's western border, Russia has no territorial claims and ambitions. By these statements, Russian leaders renounced any claim to Manchuria, a vast province which, according to the intent of the Cairo Communique, is to be restored to China. In this particular, then, Russian statements accord with the three-power statement from Cairo.

In comparing the communiques issued respectively from Cairo and Teheran, one is struck with the specific provisions in the one for the redistribution of territory now held by Japan and the absence of such specific provisions with regard to territory now occupied by Germany. A ready explanation of the difference is that agreement in one case was easy and in the other case difficult. And this explanation finds support in the fact that it has been found advisable to set up two Advisory Councils and one Commission to ponder upon the settlement of European problems. It is noteworthy, too, that what many consider to be knotty problems of a settlement in Asia and the Pacific were not dealt with in the Cairo Communique. Some of these knotty problems are those concerning the fate of Hong Kong, of former French Indo-China and of the various islands of the Pacific which had been held by Japan under mandate.

It may be said then, in conclusion, that at Cairo and Teheran, as formerly at Washington, Casablanca and Quebec, the great emphasis was on matters concerned with winning the war. But that at Cairo and Teheran, and including the earlier tripartite conference of foreign secretaries at Moscow, a substantial beginning was made toward the solution of political problems growing out of the war and the allied victory which will follow. It is only a beginning, and as such is not sufficient to please all sections of public opinion. The really difficult problems have not been solved, but at least there is assurance that they are being studied. Compared with the situation on the eve of Christmas, 1942, the situation 12 months later is bright. Allied achievement during the year on both military and poltical front has been considerable and bears in itself the promise of still greater achievement not far ahead.

DECEMBER 15, 1943.

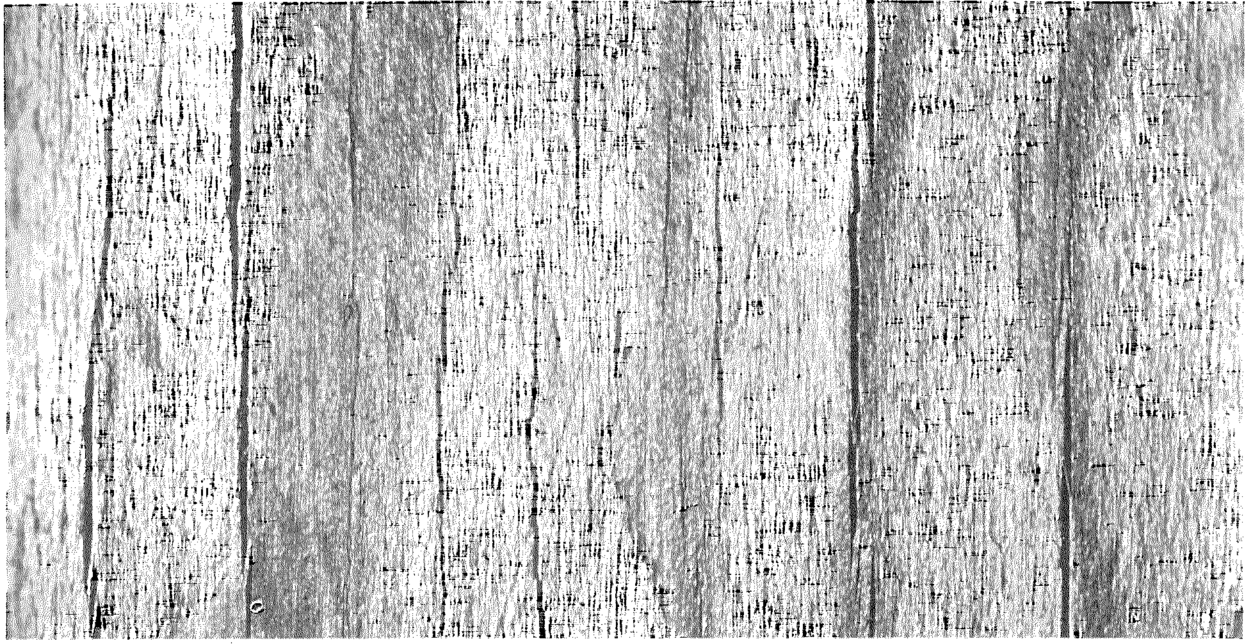


FIG. 1(a)—Face checking of untreated resin-bonded Douglas-fir plywood after six months of exposure to the weather.

Wood- and Paper-Base Plastics

By ALFRED J. STAMM[1]

Forest Products Laboratory[2]

THE Forest Products Laboratory has been actively engaged during the last five years in the development of plastics from wood. Hitherto wood has been used almost exclusively in the forms of wood flour and wood pulp fillers for molding compounds and pulp preforms and in the form of paper for paper-base nonstructural laminates. Due to the efforts of the Forest Products Laboratory, wood is now finding use as the continuous phase in resin-treated, uncompressed wood ("impreg") and resin-treated, compressed wood ("compreg"). The plastic properties of the lignin constituent of wood are beginning to be utilized. Wood is being partially hydrolyzed to free the lignin and remove undesirable hemicelluloses in the making of molding powders which require smaller quantities of critical phenolic resin than do older commercial phenolic molding powders, its resin economy being due to the fact that the lignin serves as a plastic constituent (hydroxylin). Improved resin-impregnated paper-base laminates are being made that have practically twice the strength of earlier commercial paper-base laminates ("papreg").

All these newly-developed materials have strength properties comparable to or well above those of former plastics, and some of them are sufficiently strong for various military and peacetime structural uses.

IMPREG

A number of desirable properties can be imparted to wood by the forming of synthetic resins throughout the structure from resin-forming constituents of low molecular weight that have an affinity for wood. Although the hardness and compressive strength properties of wood can be improved by mechanically depositing any solid material within the structure, permanent dimensional stability and related properties have been successfully imarted to the wood only with a few specific resinoids under specific treating conditions.

Putting preformed resins into the structure merely blocks the entrance and exit of water, and hence, merely changes the rate of swelling and shrinking. Starting with a raw polar resin-forming mix, in a water solution, on the other hand, and allowing this intimately to penetrate the cell wall structure and bond to the active groups of wood, followed by evaporating off the water solvent and then heating to set the resin permanently, reduces the hygroscopicity of wood.

The most effective treating agent thus far found is a phenol-formaldehyde, water-soluble resinoid that is not advanced beyond the phenol-alcohol stage. Resorcinol can be substituted for the phenol or furfural for the formaldehyde without loss of effectiveness. All urea-formaldehyde resinoids tried have proved to be too highly prepolymerized to penetrate the structure adequately, with the exception of dimethylol urea. Even this material when polymerized within the structure reduced the swelling and shrinking on an equilibrium basis to only 60 per cent of normal, in contrast to reductions to 30 per cent of normal effected by phenol-formaldehyde resin. None of the thermoplastic resins or thermoplastic resin-forming systems thus far tried have effectively reduced the swelling and shrinking of wood, presumably because none of them have the desired affinity for the wood.

Difficulty has been encountered in properly distributing resin-forming chemicals throughout the structure of massive pieces of wood. The treatment appears practical only for veneer. The value of antishrink treatments of veneer which is normally built up into plywood might be questioned on the basis that, in cross-banded plywood, the fiber direction of one ply restrains the across-the-

[1]Presented before the Society of the Plastics Industry, New York, November 8 and 9, 1943.

[2]Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

fiber dimension changes of the adjacent ply, thus mechanically reducing such changes. Swelling and shrinking cannot, however, be prevented mechanically. The mechanical restraint merely changes the direction of swelling and shrinking. If the wood is prevented from swelling normally in the sheet directions, it will swell in the thickness direction or internally into the fiber cavities. When normal plywood takes up and then loses moisture, the plies are continually working and, as a result of the unevenly developed stresses, face checking is more serious than in solid boards. Resin treatment, which reduces the swelling and shrinking to about 30 per cent of normal, reduces the stresses to such an extent that checking is practically eliminated. Fig. No. 1 shows two panels of Douglas-fir plywood that were exposed to the weather for six months without any surface finish. The contrast between the resin-treated and untreated surfaces is striking. The face checking of fancy crotch veneer for use in furniture and paneling can be similarly reduced by treatment with a phenolic resin.

The treatment of wood with stabilizing resins also imparts appreciable decay and termite resistance. Fig. No. 2 shows a three-ply piece of Douglas-fir plywood with treated faces and an untreated core. This specimen was immersed for six months to a depth of half its length in a field where decay and termite action on wood are severe. There was little sign of decay, but plenty of termite action. The termites in a frontal attack found the resin-treated faces not to their liking; so they tried a flank attack and, as a result, practically cleaned out the untreated core. Similar specimens that were edge-coated with resin and those in which all the plies were treated were still sound after a two-year exposure. The marked reduction in decay and termite action, it appears, is due rather to the fact that the treated wood will not take up enough water within the cell-wall structure to support decay than to the toxicity of the resin.

The treatment of wood with stabilizing resins increases its electrical resistance as a result of the reduced hygroscopicity. Dry wood is an excellent electrical insulator, but it loses its resistance properties rapidly with an increase in moisture content. At 30 per cent relative humidity the electrical resistance of the treated wood is about 10 times that of untreated wood, while at 90 per cent relative humidity it is about 1000 times as resistant.

Resin treatment also increases the acid resistance of wood, but it does not improve the alkali resistance.

The treatment of wood with 20 per cent of its weight of resin may increase the compressive strength and hardness by as much as 50 per cent. Most of the other strength properties are affected but slightly.

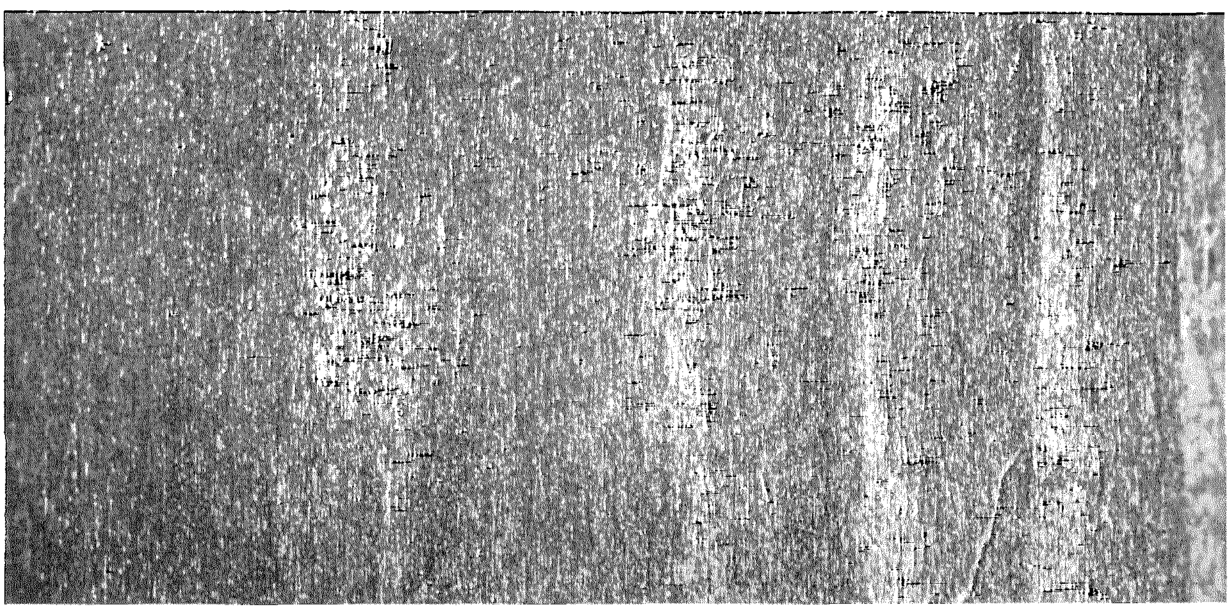
Impact strength is the one property that is adversely affected. As the resin content of wood is increased, it becomes more brittle. Likewise, more uniform distribution of the resin also increases brittleness. Unfortunately, the best treatment from the standpoint of stabilization is the poorest from the standpoint of brittleness. Normal birch has an Izod impact value of nine to 10 foot-pounds per inch of notch, but when treated with a stabilizing resin this value drops to only two to three foot-pounds per inch of notch.

COMPREG

Compreg is resin-treated wood that is compressed while the resin is formed within its structure. Although a number of different resins have been tried in making this material, none has proved as successful as phenol-formaldehyde. There are two types of compreg: 1. The older form, developed in Europe, which is treated with a spirit-soluble phenolic resin prepolymerized to the stage that it does not tend to penetrate the cell-wall structure and bond to the polar groups of the wood and, as a result, does not stabilize wood appreciably. 2. The form developed by the Forest Products Laboratory, which is treated with a water-soluble, phenol-formaldehyde resinoid, as in the case of impreg, so as to form the resin throughout the cell-wall structure of the wood and bond it to the active polar groups of the wood. The latter form of compreg is much more stable than the former but tends to be more brittle; like impreg, it has good decay and termite resistance and good electrical resistance.

Forest Products Laboratory compreg can be compressed to virtually the ultimate compression (specific gravity of 1.3 to 1.4) under a pressure of 1,000 pounds per square inch, using practically any species of wood. The unstable form of compreg, on the other hand, requires pressures of 2,500 to 3,000 pounds per square inch to compress the wood to the same degree. There is a still greater difference in the pressures required to compress the wood of the stable and unstable forms to intermediate degrees of compression. Practically all

FIG. 1(b)—Surface plies treated with 30 per cent by weight of synthetic resin (on the basis of the dry weight of the untreated wood).



the softwoods (coniferous woods) and the softer hardwoods (deciduous woods) such as cottonwood, basswood, and aspen, can, when treated with a stabilizing resin, be compressed to about one-half their original thickness under pressures as low as 250 pounds per square inch. This makes possible the compression of compreg faces and their simultaneous assembly with an untreated or treated and precured core with but slight compression of the core. This type of material, which shows great promise for postwar uses, cannot be made in one operation when the plies are treated with an appreciably polymerized resin, as there is little differential compressibility between such treated plies and the untreated plies.

A high degree of polish can be imparted to any cut surface of the Forest Products Laboratory form of compreg by merely sanding and buffing the surface. The potential finish exists throughout the structure. All that is necessary to bring it out is to smooth the surface. This easy way of restoring the finish would be an advantageous property of compreg or compreg-faced furniture. The natural finish is highly resistant to such organic solvents as alcohol and acetone, which destroy most applied finishes.

The water absorption of Forest Products Laboratory compreg is both small and slow. The water absorbed by a three-inch by one-inch by ⅜-inch specimen (one inch in the fiber direction) after immersion for 24 hours is less than one per cent. The unstabilized or less stabilized forms may absorb six per cent or more of water under the same conditions.

Forest Products Laboratory compreg will swell only four to seven per cent in thickness upon prolonged immersion in water at room temperature. Blocks less than an inch long in the fiber direction—the direction in which moisture absorption is greatest—will hardly come to swelling equilibrium when soaked in water at room temperature for a year. When dried to the original moisture content this compreg will practically regain its original dimensions, indicating that the loss of compression is negligible.

The unstable form of compreg will not only swell about three times as much in thickness as the stable form, but will swell much more rapidly and also lose a large part of its compression. The more rapid swelling is presumably due to the fact that water is sucked into the structure as it recovers from compression, and as a result water is distributed throughout the structure much more rapidly than by diffusion alone. The combined swelling and recovery from compression of the older form of compreg one inch long in the fiber direction may be as much as 20 to 60 per cent in several weeks. One-half to two-thirds of this dimensional change may be due to recovery from compression.

Most of the mechanical properties of the two forms of compreg are quite similar and, in general, vary almost in direct proportion to the compression. When wood is compressed to one-third of its original volume, its tensile strength, modulus of rupture in bending, and modulus of elasticity are about trebled, irrespective of whether the wood contains resin. Resin treatment prior to compression improves only the compressive properties and the shear strength in a plane at right angles to the direction of compression. Neither of these improvements, it is believed, is sufficient to warrant resin treatment unless it is accompanied by other improvements such as that of dimensional stability. Table No. I gives the normal strength properties of compreg in round figures.

The impact strength of compreg, like that of impreg, decreases with an increase in the resin content and the intimacy of distribution of the resin, although impact strength, unlike the other properties, will vary to a certain degree with variations in the processing conditions. Overheating during drying after resin treatment or in the pressing process tends to make the product more brittle. Under carefully controlled conditions, the stable form of compreg can be made from birch with

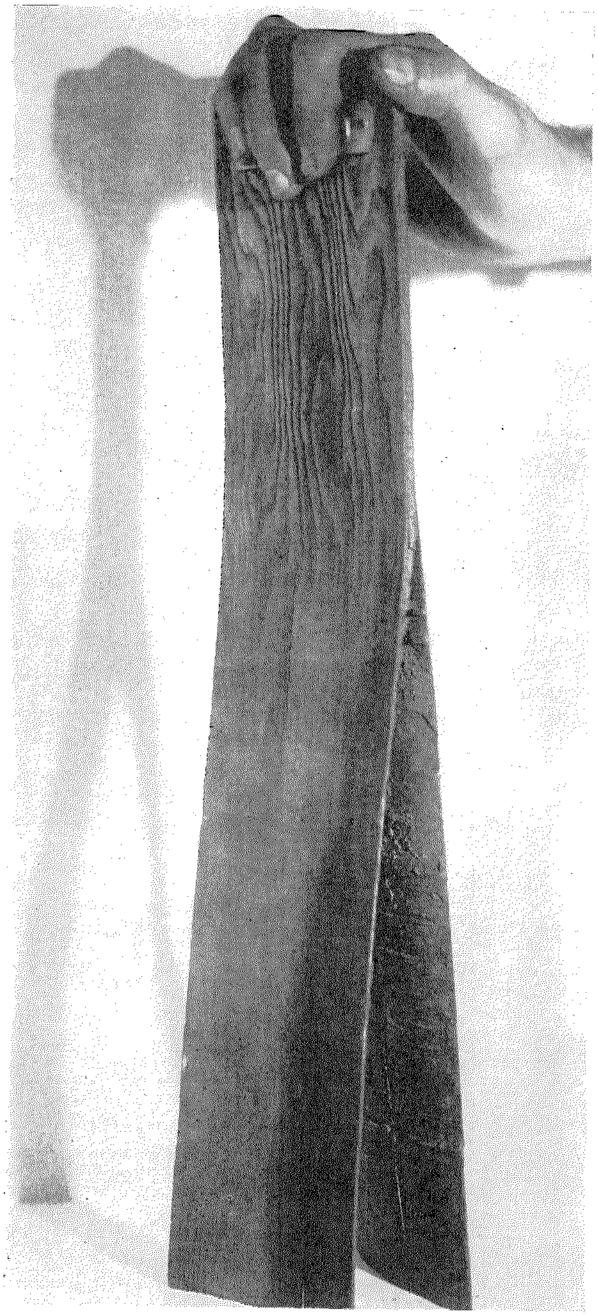


FIG. 2 — Action of termites on three-ply resin-bonded Douglas-fir plywood with faces treated with 30 per cent by weight of synthetic resin (on the basis of the dry weight of the untreated wood) and an untreated core that was immersed to half its length in a termite-infested field. The core has been almost completely eaten out up to the ground line while the faces are perfectly sound.

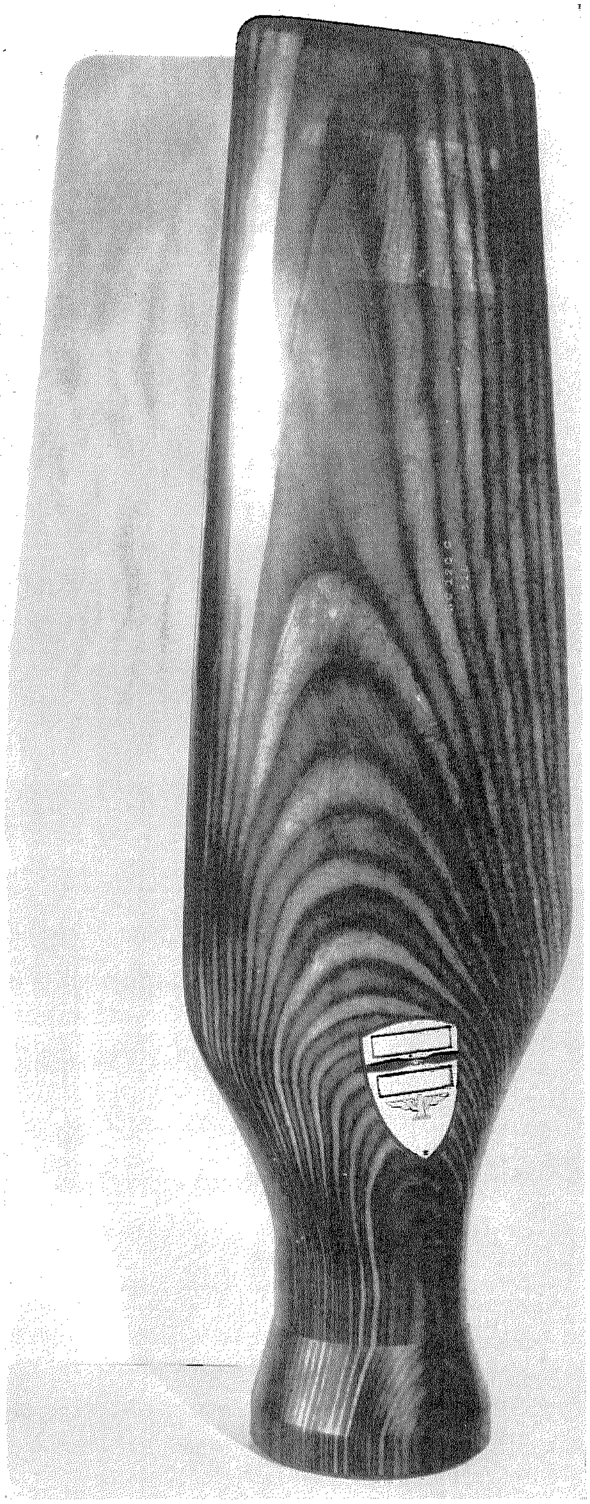


FIG. 3—Molded compreg propeller for testing airplane motors, now being commercially produced by a Michigan company using the process developed at the Forest Products Laboratory.

an Izod impact value of five to seven foot-pounds per inch of notch. The unstable compreg, on the other hand, will have an Izod value of six to nine foot-pounds per inch of notch.

TABLE I—NORMAL APPROXIMATE STRENGTH PROPERTIES OF PARALLEL-LAMINATED BIRCH COMPREG WITH A SPECIFIC GRAVITY OF 1.35[1]

Property	Value
	Lb. per sq. in.
Tension:	
Stress at proportional limit	22,000
Maximum strength	32,000
Modulus of elasticity	3,500,000
Flexure:	
Stress at proportional limit	21,000
Modulus of rupture	36,000
Modulus of elasticity	3,500,000
Compression parallel to grain:	
Stress at proportional limit	16,000
Maximum strength	24,000
Modulus of elasticity	3,500,000
Johnson double shear, parallel to grain and perpendicular to laminations	7,000
	Ft.-lb. per in.
Izod impact:[2]	
Face-notched	3 to 9
Edge-notched	2 to 7

[1]The properties given, with the exception of impact strength, are about the same for both stabilized and unstabilized compreg and do not vary appreciably between species.

[2]Three to seven foot-pounds per inch of notch for stabilized compreg (face-notched). Six to nine foot-pounds per inch of notch for unstabilized compreg (face-notched).

An important feature of compreg is that it can be made from a great variety of woods, including such normally inferior species as cottonwood, and obtain a product with properties which approach the optimum values. The only species to be avoided are the naturally resinous woods, such as southern pine, and those that are extremely difficult to treat, such as oak.

Compreg can be machined easily with metalworking tools but not with woodworking tools. Because of this, it is desirable to rough out the shape of objects prior to compression, using woodworking tools, and then compress them to the final shape in some form of mold. A technique for doing this has been developed at the Forest Products Laboratory. Treated, uncompressed plies are glued up into a blank of the correct size with a phenolic glue under conditions such that the treating resin is not cured and the bonding resin is but slightly cured. The shearing strength of such a block is not great but it is sufficiently strong so that it can be carved or turned in such a manner that the final dimensions are obtained in one plane, but the thickness at right angles to this plane is 1.5 to three times the final dimensions. The carved blank is then pressed in a split mold in the thickness direction. A Michigan company is using this method to mold propellers for the ground testing of airplane motors (Fig. No. 3) and airplane aerial masts. An airplane tail wheel has been successfully molded in this way so as to pass all static tests requirements (Fig. No. 4). The technique could be readily applied in the molding of pulley and gear wheels by stamping out the correct sections in the plane of the wheels from the individual plies and rotating these with respect to each other in the assembly as desired. Although wood is not moldable in the sense that a molding powder is, it is surprisingly subject to molding under proper conditions.

A recently-developed process of which nothing can at present be divulged makes possible the production of a highly stable form of compressed wood without the use of any impregnating resin.

HYDROXYLIN

Lignin is nature's plastic which cements the cellulose fibers of wood together. A mild hydrolysis treatment breaks the cellulose-lignin bond of wood, freeing the lignin so that it can be used to rebond the cellulose fibers together. Wood waste, preferably hardwood sawdust or mill waste, can be hydrolyzed by several different methods. The procedure which has received the greatest attention at the Forest Products Laboratory is a hydrolysis with dilute sulfuric acid in a rotary digester at a steam pressure of 135 to 200 pounds per square inch for 10 to 30 minutes. Besides breaking the cellulose-lignin bond, this hydrolysis treatment converts the hemicelluloses to sugars. These sugars, together with the acid, are washed out of the hydrolyzed wood and may be fermented to grain alcohol, thus giving a valuable by-product. The residue constitutes 50 to 60 per cent of the weight of the original wood. As a result of the removal of part of the cellulose, the lignin content is increased to 35 to 40 per cent.

After drying, the hydrolyzed wood is quite brash and can be readily ground to a powder, preferably of 40 to 100 mesh. Although the lignin in hydrolyzed wood can be made to flow sufficiently for the molding of some simple objects by merely adding small amounts of water and pressing at 375 degrees F., the flow is not adequate to give a product that is sufficiently coherent to stand long water immersion. Very similar results were obtained when nonresinous plasticizers for lignin were used in place of water, even though they did reduce the molding temperature. It was hence found necessary to use auxiliary plastics or plastic-forming constituents, together with a plasticizer for lignin, when the added plastic material did not also serve as such. The most suitable material found in the earlier work that served both functions is a mixture of eight per cent aniline and eight per cent furfural, together with 84 per cent of hydrolyzed wood and a small amount of mold lubricant such as zinc stearate. Molded products with good mold definition, water resistance, acid resistance, and electrical and mechanical properties can be obtained by pressing at 300 degrees F. for three minutes (in the case of small objects) at 3,000 to 4,000 pounds per square inch. Because the product is semithermoplastic, it must be cooled somewhat in the mold.

The flow of this molding powder is not so great as that of the general purpose commercial molding powders. This, together with the fact that the product cannot be drawn hot from the press, led to further research on the plasticizing of hydrolyzed wood. The best flow properties so far obtained have been with a molding powder containing 25 per cent of phenolic resin and 75 per cent of hydrolyzed wood. With this combination, the flow properties and the properties of the product are comparable with those of general-purpose molding compounds containing 50 per cent of phenolic resin and 50 per cent of wood flour. The fact that only half as much phenolic resin is required with the hydrolyzed wood as with the wood flour indicates that the lignin of the hydrolyzed wood imparts plastic properties to the product.

The hydrolyzed wood-phenolic resin molding powders give molded products with flexural strengths ranging from 8000 to 13,000 pounds per square inch, water absorptions of only 0.2 to 0.3 per cent after 48 hours'

FIG. 4—Left to right, half of an airplane tail wheel molded of compreg; a compreg specimen varying in specific gravity from end to end (1.3 to 0.6); a model airplane propeller molded of compreg; a cut panel of birch compreg sanded and buffed to show that the finish exists throughout the structure.

immersion in water, and extremely high acid resistance. It appears to be possible to mold this material into thicker flawless sections than can be made of general-purpose commercial molding powders. Because of these attributes, the material is now being tested in the molding of sizeable objects of industrial importance.

If chips rather than sawdust are used as the raw material and the hydrolyzed product is abraded to a fiber rather than ground to a powder, it can be formed into a sheet on the paper machine. These sheets, with only a small amount of phenolic resin, can be compressed together into thick panels. The panels have considerably higher flexural strengths than panels made from the molding powder because of the reinforcing action of the much longer cellulose fiber.

PAPREG

Paper laminates treated with phenolic resins have been made for years. They have been used chiefly for electrical insulating panels and for other nonstructural uses which do not require exceptional mechanical properties. The manufacturers, in developing these materials, have approached the problem primarily from the resin standpoint. It was hence felt at the Forest Products Laboratory that further development of paper-base laminates, from the standpoint of finding the most suitable paper for the purpose, was a promising field of research. This proved to be the case. Within six months after the research was started, a paper-base laminate was developed that possessed several properties double those of the former laminates.

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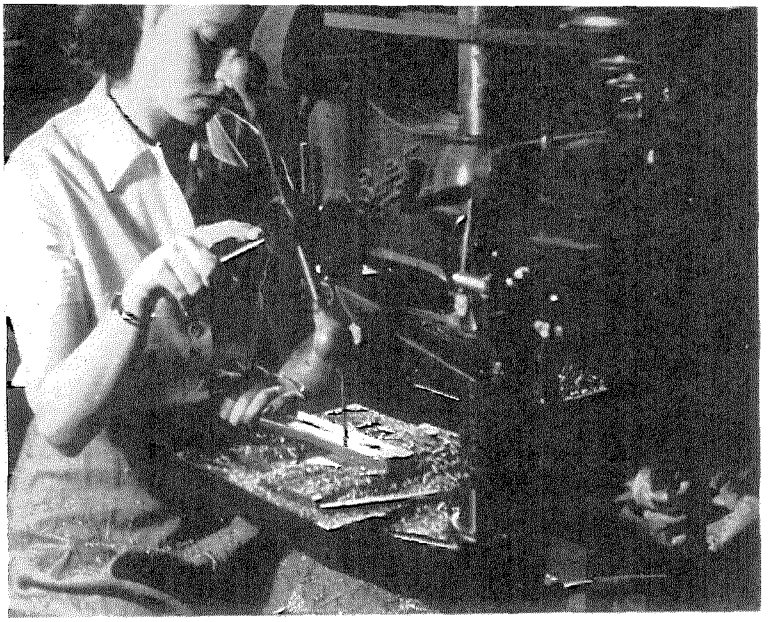


A traditional wage differential exists between the job of the drill-press operator shown above and the lathe operator shown on facing page. Will an incentive plan disrupt this wage relationship?

Wage Incentives

WILL THEY INCREASE WAR PRODUCTION?

By VICTOR VEYSEY

"AN incentive is a carrot held before the donkey's nose." So runs the definition in Mark Spade's humorous description of modern business methods, "How to Run a Bassoon Factory." Unflattering though the analogy is to business management and to the working man, there is much to be learned from the comparison of this age-old application of the incentive principle with its modern counterpart, wage incentives in industry.

So far as is known, the use of carrots as bait for the donkey has neither universally nor permanently solved all of the knotty problems in the relationship between the driver and the cart's prime mover, although the device may have served usefully on many occasions. Likewise, wage incentives have been used with success under proper circumstances, but they have not proved to be a panacea for industrial ills. There is little reason to believe that the widespread and immediate application of wage incentives to the complex problems of production and industrial relations in wartime will increase factory output by 30 per cent to 100 per cent as certain spokesmen of management, labor, and government have claimed. No one would deny that the need for rapid production is pressing, and that the possibilities for improvement exist. The question is: Will wage incentives as they are likely to be applied today, increase war production?

The widespread use of wage incentives is being advocated by management representatives, seeking the same low costs and high rates of output in war plants that have been achieved through the judicious use of incentives in stable, peacetime industries. Unions see in incentive-wage plans a chance to increase employee earnings in spite of "wage freeze" restrictions. Government production men join in on the chorus by advocating a modified, innocuous type of incentive plan for which there is yet little proof of effectiveness. All groups are currently emphasizing the "win the war" possibilities of incentives.

ENGINEERS DEVELOPED PLANS

Students of management in America have been tinkering with wage-incentive plans since 1880 when the American Society of Mechanical Engineers devoted considerable attention to the effects of wages on the output of machine operators. Although a group of engineers pioneered in the development of wage-incentive plans, the subsequent application of the plans has proved to be a problem involving many intangible elements of industrial relations. The idea of buying extra work through a wage incentive appears to be disarmingly simple; the application of the incentive in a practical industrial situation has proved to be full of pitfalls. As we shall see in the following discussion, the use of incentives in war plants will require much preparation before success can be attained.

The action desired from a wage incentive in industry is increased effort by the workman resulting in a high rate of production. There are innumerable neatly packaged plans or formulas through which the compensation of the individual is adjusted according to his production, in order to encourage and reward his effort and ability. These plans range from the simple, direct proposition of piece work, whereby the worker is paid so many cents for each unit completed, to the highly complex empirical plans which rely on intricate tables and charts for the determination of the compensation for a given rate of work. All of these plans are incentives designed to induce the worker to produce more in a given length of time; in certain applications, however, many of these plans have had exactly the opposite effect, have deterred men from working rapidly, have produced endless grievances, and have resulted in work stoppages until the "incentive" was removed.

The application of the incentive principle in industry is much broader than the adoption of a plan; it involves consideration of the immediate and the long-run effects on the employer-employee relations of installing an incentive plan under given conditions in the shop, or of following the alternative, payment on a straight hourly rate.

TIME RATE OR INCENTIVE?

There are at least four important reasons why an incentive-wage plan may produce disappointing results as compared with an hourly-rate-wage plan:

1. The desire of a man to work rapidly is heavily influenced by his feelings toward his job, his supervisor, and his company. Morale is not necessarily purchased with an incentive plan.

2. The incentive effect of extra compensation for extra work is small at the present time because money cannot be translated into an electric refrigerator, a new car, or a new home.

3. A well-designed and properly-administered program based on hourly- or day-rate wages contains many elements of incentive.

4. An incentive-wage plan, applied without knowledge of what is a fair rate of production, will result in inequalities in wage rates which may disrupt production.

Let us examine each of these considerations:

First, is extra money the most important incentive? There are many incentives which may affect the activities of any working man. Certain incentives center in the wage structure; others have little relationship to compensation. One man works hard because he likes his work; another because hard work is an escape from a distressing home problem. One man wants the security of cold coin in his pocket; another wants the power of advancement and authority. At the initial meeting of a class in wage incentives conducted recently for a group of union officials, one of the members introduced his wife and baby boy, explaining, "This is my incentive plan." Certainly a strong incentive is the offer of secure employment with fair treatment both now and after the war.

The Western Electric Company in its celebrated "Hawthorne Experiments" discovered that a man's feelings toward his work, his supervisor, and his fellow employees have a great effect on his production. It was discovered that if a man felt that his job was "right," that supervision was fair, and that his ability and achievement were recognized, he would automatically work rapidly without being aware at any time of the fast pace. This effect was so strong that it outran the influence of an incentive plan of long standing. Men and women will work rapidly if their adjustment to their job is right, but the money of an incentive plan will not buy extra effort unless their basic job relations are acceptable.

Second, how strong is the incentive of money today? In normal times there is, for the working man, a real problem in making his wages stretch to cover some of the luxuries which he and his family desire. In wartime, most employable men and women have jobs paying good wages, with ample overtime. The problem is: What, beside war bonds and essentials, can they buy with their earnings? One of the principles of a sound incentive plan is that the reward should be closely associated with good performance. Today, the real reward must be postponed until after the war when consumers' goods are again available in quantity. This delay negates the incentive effect of added compensation. Most people enjoy the possession of goods much more than they do the accumulation of money which cannot be spent for 10 years.

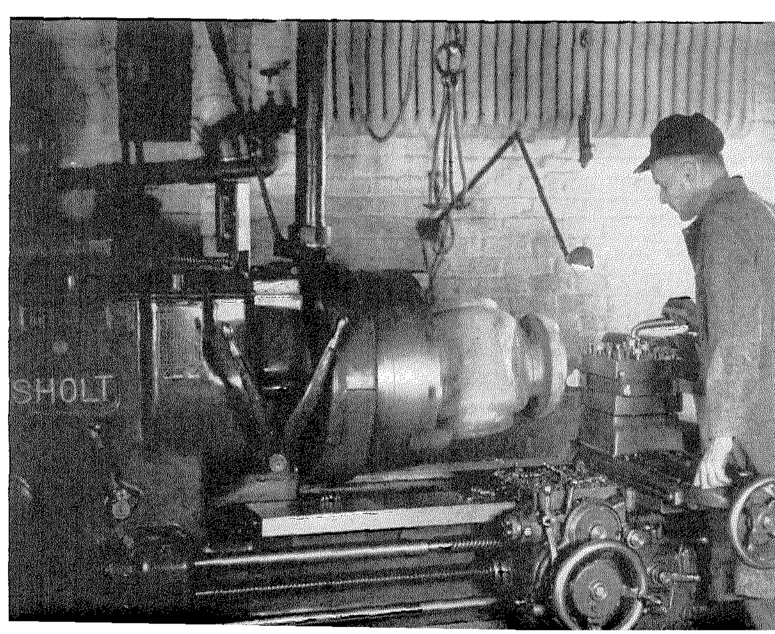
Third, what financial incentive can be offered without an incentive-wage plan? We must not believe that because a certain group of plans for increasing production and lowering costs have been labeled "incentive-wage plans," the more standard hourly wage system does not offer incentive. Any properly-administered wage program offers certain and substantial financial reward for well-rounded achievement on the job. This is accomplished by providing a range of rates for each job so that the competent operator can be paid 20, 30, 50, or even 100 per cent more than the novice on the same job. The individual's hourly rate within this range is established by an appraisal of the employee's worth at regular intervals by his supervisors. Additional financial incentive for good work is provided through transfer of capable employees to more difficult and more important work which, in a well-administered wage system, carries increased compensation. Proper administration will assure that superior performance on the job is rewarded by regular merit increases and by advancement to better jobs for qualified men. This can readily be accomplished in wartime when the pressure of work and the shortage of men cause the employer to greet with shouts of joy and offers of more money any demonstration of ability on the part of an employee.

A sound wage policy calls for financial incentive for all-round performance above standard. This is in contrast to the wage-incentive plans which hang their offer of more money on a single phase of the work, speed of production, with the consequent tendency to neglect quality, careful use of material, proper maintenance and utilization of tools, safety, flow of work, and other essential factors of the job. In most jobs well-rounded attention to all phases of the work is necessary to achieve maximum production. If the operator is coaxed, for example, to neglect quality by placing a money reward on quantity, supervision must be prepared to balance the scale on that job by controlling more carefully than ever the quality of output, and the other de-emphasized phases. Today, supervision is poorly prepared to assume added functions. Wage incentives will mean that management's job is made more, rather than less, complex. Wage incentives can never serve as a substitute for good management, and they can seldom succeed in the absence of good management.

Fourth, will wage incentives disrupt the wage structure? This consideration is particularly significant in plants producing war materials. A consideration of some of the major tests of a justifiable wage structure will reveal that the unsound application of a wage-incentive plan may do violence to the principle of fair wages, a prime essential of good industrial relations. What are the tests by which management and employees, organized or unorganized, may judge the fairness of a wage structure? The following are suggested as a partial list of comparisons:

1. How do the rates paid for various jobs within a company compare with the skill, responsibility, physical and mental application, and working conditions of the job? Are rates internally consistent with the requirements of the job?
2. How do rates paid by the company compare with those paid for the same work by other companies in the industry or area?
3. How do earnings compare with the social needs of the employee to maintain or attain a desirable standard of living?
4. How do wages compare with the ability of the company to pay, in view of its competitive position?

Not all of these comparisons are of equal importance. At one time the discussion over wages may center in



the study of prevailing rates in the area; at another time the emphasis may be on the standard of living. But the first comparison, the internal consistency of the wage structure, is the test which is of great and continuous importance. Every employee easily judges the fairness of his treatment by comparing his rate with that of others doing similar work for the same company. The bulk of grievances in wage matters arises out of this comparison. There is no argument which will adequately defend the payment of widely differing amounts for similar work.

A wage structure is composed of many complex job-to-job differentials which arise out of long usage as a reflection of the relative contributions of the jobs to production. Furthermore, these wage differentials carry with them the mark of social status. A man's worth is, rightly or wrongly, commonly measured in terms of his earnings, and his self-esteem tends to follow this measure. These long-established differentials between jobs cannot be torn up by management without major repercussions in the relationship between management and labor, yet that is exactly what an incentive plan will produce if it is installed without a careful determination of a fair rate of production.

STANDARDS ARE IMPORTANT

Why is this standard or fair rate of production so important? Every wage-incentive plan must be based on some concept of a fair day's work. This means a normal rate of output which is fair to the employer and employee alike. Additional production over this level will be compensated for according to the particular incentive plan which is used. The heart of the incentive plan, then, is the standard. If the standard is set too high, even extreme effort and great skill will not enable a man to achieve standard performance; if the standard is set too low, incompetent men may receive incentive payments, and a capable man using real effort will send his earnings soaring to high levels. There is nothing inherently objectionable about uniform high-incentive earnings, indeed high earnings indicate the power to stimulate production which incentives possess. Workmen certainly do not object to high earnings, and management should not, for high-incentive earnings mean lower total unit costs because output is increased and overhead is consequently spread more thinly. Employees, however, do object, and rightly so, to the disruption of established and tested wage differentials through the operation of an incentive plan based on standards of uneven difficulty on the various jobs.

Suppose that we consider two jobs:

Job	*Rate*
1. Drill-press operator	$ .80 per hour
2. Lathe operator	1.20 per hour

The rates given are accepted by management and by employees as representing the proper relationship between the rates of pay, considering the work performed. If, on this structure, we install an incentive plan based on loose standards for drill-press work, and tight ones on the lathe work, we create a serious problem. The drill-press operator may increase his earnings so that he receives $1.60 per hour, whereas the lathe operator may be unable to earn more than $1.20. This situation, it will be agreed by unions, individual employees, and management, "just doesn't make sense." Yet that is exactly what happens to wages if standards are not accurately set and maintained.

The situation mentioned above is unstable; one of three things is likely to happen:

1. The lathe operators, individually or collectively, will bring pressure to have their standard rate of production relaxed so they can make good earnings to restore the original wage differentials. The drill-press operator's earnings will be used as a lever to pry the whole wage structure upwards.
2. Management may "cut the rate" on drill-press work to restore the traditional differential. This is always morale shattering, and if it happens to many employees the incentive plan will be branded a "speed-up system" under which a man works harder and gets nothing for it.
3. The drill-press operators, fearing management's action, may deliberately work slowly, thereby reducing their earnings and protecting their easy job standard by preserving the original wage differentials.

If these results take place, the incentive plan has brought new troubles to the shop—troubles of a type that causes bitter feelings, work stoppages, and a determination to discredit and eliminate the incentive plan. Production may well be reduced rather than increased.

The real trouble is not in the incentive plan, but in the unfair standards of production. Throughout the history of wage-incentive installations, those which have succeeded have been based on sound and fair standards, and failure has inevitably attended those with haphazard standards.

SETTING STANDARDS

Time- and motion-study men, since the time of Frederick W. Taylor, have worked with the problem of production standards with various degrees of success. Through the stop-watch and the motion-picture camera they have developed techniques which permit the setting of accurate standards, provided:

1. All conditions under which the work is performed are well planned and controlled. This means that supervision must have mastered the problems of training men in a uniform method of doing the work, supplying uniform materials at a constant pace so that the work is not interrupted, providing standard and uniform maintenance on machines and equipment, holding conditions of light, temperature and other environmental factors at a constant level.
2. Designs and methods of performing the work do not change so rapidly that the investment in careful setting of standards is too great to be economically justifiable.
3. Adequate time can be devoted to methods for improvement in advance of installing the incentive.
4. A thorough, competent, and fair job of standards setting is done by an impartial time-study man, uninfluenced by pressure to find a predetermined answer.
5. A well-selected work force is employed so that the range of skill and ability is not too wide on any job.

The conditions called for above do not just happen; they are brought about by long and careful work on the part of management. These conditions obviously are most likely to exist in an industry where product design, equipment, methods, and volume of output are stable. But what are the conditions which exist today in war production? Our worst problems of production exist where companies are producing items of different design from their peacetime line, and where the contin-

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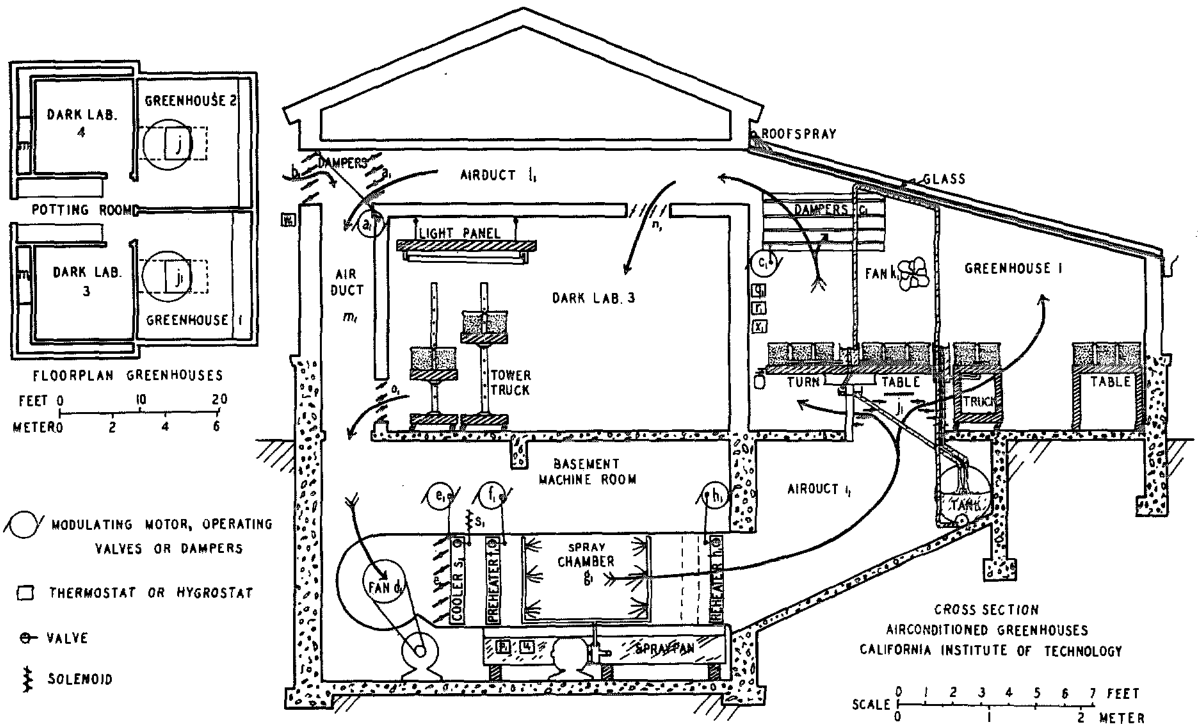


FIG. 1—Floor plan of the greenhouses (left side faces north) and cross median section through house "1" and room "3."

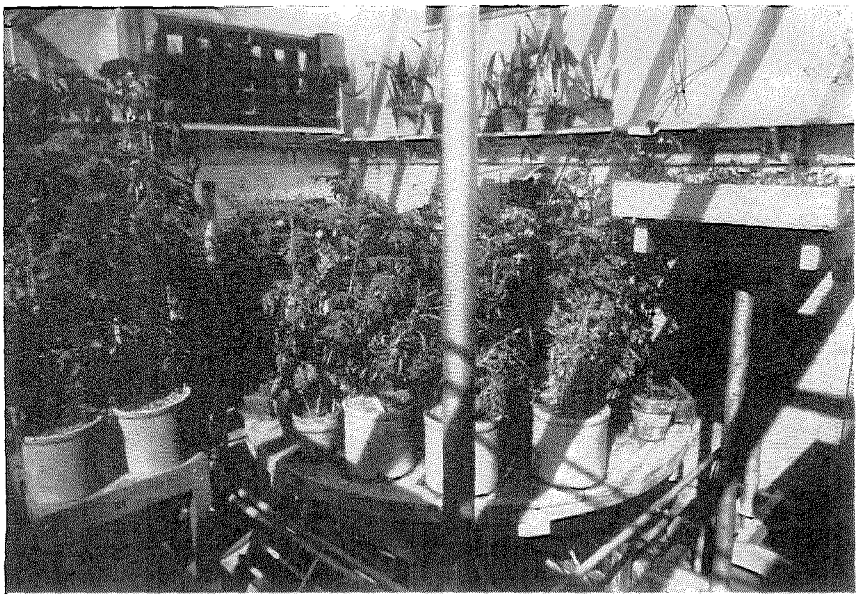
Experiments with Tomato Growing

By FRITS W. WENT

IN THE dim twilight of civilization our ancestors had neither leisure, comforts nor freedom from want; they spent practically all of their time in the procurement of food. Development of the plow, the wagon and draft animals greatly decreased the time required for food production, but even in the colonial period of America a very considerable portion of the energy of the settlers had to be given to the growing of food. During the last century the time required to produce a pound of food has been much reduced, mainly on account of improved agricultural practices, use of fertilizers, control of diseases, development of higher-yielding varieties, and the

AT RIGHT:

FIG. 2—View from southeast on air-conditioned greenhouses. Glass roof of houses "2" (right) and (left) sloping towards left. In east wall of house "2" ventilation opening for air exhaust regulated by dampers "C."



AT LEFT:

FIG. 3.—Interior of greenhouse "I," looking from southeast. Turntable in center. Under it the louvres of the diffuser "j_1." Around it the pipes of the subirrigation system. At right two tower trucks in highest position. At left a small truck with four two-gallon crocks connected with the subirrigation system: behind this truck a tower truck in a lower position. At upper left hand side dampers "c_1" in fully open position, connected with the damper motor. At top center the entrance of airduct "i_1"; below it, just under shelf, thermostat "g_1" with shield.

substitution of labor by mechanical energy. All these improvements were inaugurated during the nineteenth century, and now we are perfecting them. Have we reached already the stage of diminishing returns, where we are approaching asymptotically the state of perfection? Or can our food production horizon still be widened?

Regardless of the enormous progress agriculture has made in the last century, it is a fair statement that the growing of plants still is an art rather than a technology or a science. It is impossible to give such a detailed recipe for the growing of a plant or a crop that everyone can get the same good results when he carefully follows the recipe. This is due both to uncontrollable weather conditions and to a lack of basic information concerning plant growth.

FROM AN ART TO A SCIENCE

In the general endeavor of botonists to raise agriculture from an art to a science, the Plant Physiology Department of the California Institute of Technology started with investigations of the internal factors controlling growth of stems, roots and leaves. To avoid variable effects of climate as much as possible, the work was carried out with seedlings in darkrooms at controlled temperature and humidity. Much was learned about the mechanism of growth control by hormones such as auxin, vitamin B_1, nicotinic acid and traumatic acid. Even though these findings applied to growth in general, it was very desirable to discover to what extent the growth of full grown plants is limited by the same factors as the growth of seedlings.

It became possible to study the growth of mature green plants only after two air-conditioned greenhouses had been constructed, in which temperature and humidity of the air could be controlled within narrow limits. In darkrooms connected with these greenhouses the plants could be subjected to darkness or to artificial light from fluorescent lamps. Figs. No. 1 and 2 give an idea of the construction of these air-conditioned greenhouses. Most plants are placed on small trucks, which can be wheeled from one room to another, making it possible to subject plants to a succession of different conditions. Fig. No. 3.

The tomato was chosen as one of the first experimental plants. This article is concerned with that experiment.

BOTANISTS AND VICTORY GARDENERS

Applying the theoretical knowledge of botany textbooks to growing of tomatoes resulted in fairly sick-looking plants which grew slowly and did not set fruit; or, in other words, we had the same experience that so many new-fledged Victory gardeners had in their first efforts. It became clear that tomato-growing was an art rather than a science. The problem then was to work out step by step the conditions under which tomatoes grew best. Two criteria mainly were used: the stem growth rate gave a good indication of the running condition of the plant; any change in conditions generally was accompanied by a chage in the growth rate. The other criterion was fruit set.

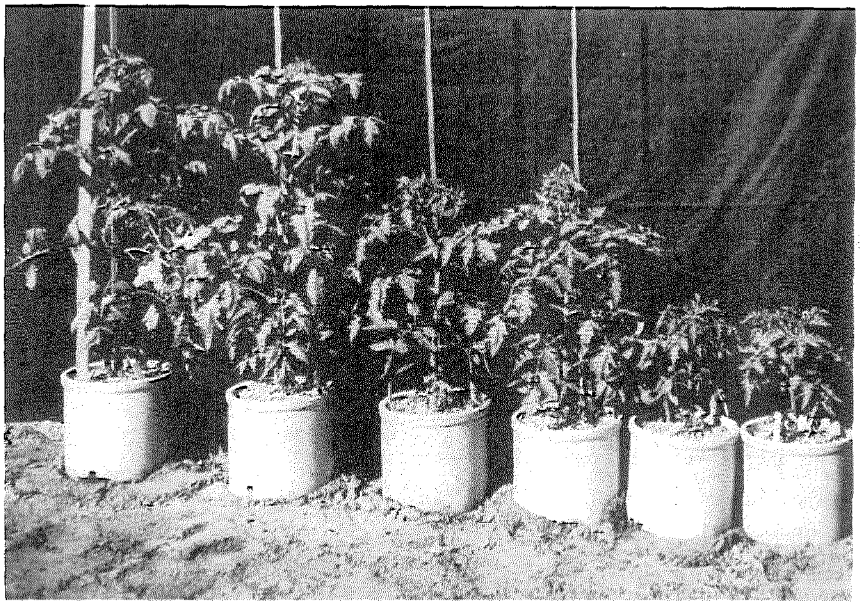
The plants were not grown in soil, since it is practically impossible to duplicate soils in different experiments. Soil is a little understood medium for the roots of plants. It was known, however, that it supplies minerals and water to the roots growing in it. For this purpose, soil is well suited: its colloidal system holds a fairly large amount of minerals loosely bound, which are slowly given off into the water phase, and thus the soil acts as an ideal buffer system. This can be duplicated by growing the plants in some medium like sand or gravel, which is watered daily with a dilute solution of minerals required by plants. This nutrient solution contains $CA(NO_3)_2$, KNO_3, NH_4NO_3, $MgSO_4$, K_2HPO_4 and traces of iron, manganese, copper, zinc, molybdenum and boron. Tomatoes grown with this nutrient solution in sand or gravel grow as well as in the best soil, and this method has the advantage of being completely reproducible.

FRUITLESS RESULTS

To make the results of the investigations still more comparable, all plants were automatically subirrigated with the same nutrient solution. This was pumped from a storage tank into the two-gallon crocks in which the plants were growing. The pump was started three times daily by a time clock, so that all plants received exactly the same amount of the same nutrient at the same time. After the proper adjustment of the nutrient salts and the

AT RIGHT:

FIG. 4—Tomato plants, all grown at a day temperature of 80° F. The night temperatures were: for two plants at left 80°, two in middle 50°, two at right 40°. All plants were eight inches high when treatment was started (height of crocks eight inches).



frequency of feeding, the tomato plants came into their stride and grew vigorously and fast, at the rate of 22-23 mm. per day, when kept at 80 degrees F. both day and night. They kept that rate of growth up for months in succession, until they were too tall to keep in the greenhouses. In a score of experiments in the last three years all plants kept at 80 degrees F. day and night grew at that same rate of almost an inch per day. This means that length of day and intensity of light did not have much influence on the growth rate of tomatoes, provided temperature and nutrition were properly controlled.

Although in general the tomatoes looked healthy, grew fast and were sturdy, there was one thing radically wrong with them: they did not set fruit. In a number of experiments extending over one year, half a dozen fruits were obtained. It was tried to make them more fruitful by increasing or decreasing the nitrate in the nutrient solution, by changing the concentration of the other nutrients, by varying the humidity of the air, the frequency of feeding, the light intensity, the daily duration of illumination, or by artificial pollination, or treatment with hormones. Nothing helped.

TEMPERATURE CYCLE

The solution of the riddle of the unfruitfulness of the tomatoes came unexpectedly, when the temperature in one of the air-conditioned greenhouses was lowered. All plants kept during night in darkness at a temperature of around 68 degrees F. set fruit abundantly. Also growth was improved: by keeping the plants during day in the 80-degree greenhouse, and during night in the 68-degree house the growth rate was between 25 and 30 mm. per day. This was more than when the plants were kept constantly at 80 degrees F. (22-23 mm. per day) or constantly at 68 degrees F. (18-19 mm. per day). The temperature conditions were varied in many ways to discover how the temperature effect came about. Keeping the plants during day at 68 degrees and during night at 80 degrees did not do any good: no fruits were set and the growth rate was 18-19 mm. per day. This indicated that the tomato plant does not need a lower temperature at any time during the day, but that it must be kept cool during the night. This was also proved by experiments in which the plants were kept under optimal temperature conditions (80 degrees during day and 68 degrees during night), but where the plants were illuminated during the night period. This decreased the growth rate and no fruits developed. This proves that the lower temperature must prevail during night: when the plants are kept in light 24 hours per day they are unable to recognize the night period.

Further experiments were carried out at many different temperatures, combined with further variations in growing conditions. It was possible to narrow the effective temperature range during night to the following rule (which of course only holds for the variety of tomato used in these experiments: the San Jose Canner, which is a large-fruited variety grown commercially in the San Joaquin Valley): between 60 degrees and 70 degrees night temperature fruit set is very good, but below 50 degrees and above 80 degrees practically no fruits are formed, and also growth is slowed down. But fruit set is much more sensitive to night temperature than vegetative growth, so that with night temperatures of 50 degrees a fairly good-looking plant can be grown, which is completely unfruitful. (Fig. No. 4).

TRANSLOCATION OF SUGAR

The experiments have shown that while during day a process prevails in the tomato plant which has an optimal temperature around 80 degrees, during night a process with an optimal temperature of 65 degrees limits development. The process during the day undoubtedly is photosynthesis, which at high light intensities has a fairly high optimal temperature, as had been found by many other scientists. But what is the process which occurs during night? The experiments on this question have not been concluded as yet, but all evidence points in one direction: the process limiting growth during night is the transport of the assimilates from the leaves to the growing stem tip, to the fruits and to the roots. The sugar formed in the leaves during the day serves as food for the rest of the plant, and in some plants the translocation of sugar occurs mainly during the night. The tomato seems to belong to this group of

(Continued on Page 18)

Engineering Graduate Study After the War

By ROYAL W. SORENSEN

THE influence of the war upon engineering graduate courses presents problems the answers to which all engineering teachers and others would like to know. A special committee has been appointed by the officers of the Society for the Promotion of Engineering Education to consider this particular problem. As a member of that committee I have been interested in analyzing some of the questions involved. The committee members seem to be of the opinion that at the close of the war there will be a considerable increase in the number of graduate students above the number in attendance at college just preceding the war. The factors contributing to this increase may be analyzed as follows:

(a). There will be released a certain reservoir of students who were planning at the opening of the war to take graduate engineering work, and who in considerable numbers will wish to complete their plans for graduate work which were interrupted by the war.

(b). Many years preceding the war the growing requirements of the engineering profession caused educators to consider lengthening the undergraduate engineering courses to five or even six years. This idea never gained enough support to cause engineering colleges to make the regular engineering courses longer than four years. The recognized need, however, for more time for much engineering training produced what might have been called a normal rate of increase in the number of graduate students. The new devices and mechanisms which have developed in this war and the new things with which engineers have come in contact as they are occupied in the armed services of this war, indicate that a considerable number of men will have a new perspective concerning the value of their college engineering education and will endeavor to return to college for some refresher graduate courses if not for courses leading to advanced degrees.

(c). Service men who did not take engineering courses but were prepared by education in physics and mathematics, have been trained and used for the engineering work required by the war and have no doubt developed an interest in the work of an engineer which was lacking before they entered service. It is to be expected that a number of these men will desire further technical training and that some of them will be qualified for graduate work. Also it is very likely that there will be subsidies for service men who desire further education.

(d). A certain number of young men engaged in war industry are saving a portion of the "big pay" they are receiving. This accumulated money, together with the probability that there will be difficulties of job adjustment, may provide another group desiring further education.

If these indications are correct there will be a stimulated demand for engineering graduate courses. The question which then arises is, what shall be the objective of graduate study immediately after the war. Unless perhaps it be for a very transient period in which colleges are providing refresher courses, I think in general the objectives of graduate study and the courses given should be much the same as they were before the war; viz., courses designed for the further education of men who during undergraduate study have demonstrated their qualifications to do work more complex than can be taught in undergraduate courses and not just additional course work of undergraduate quality. Our established pattern of education has survived many wars. Our universities and colleges have continued regardless of war to teach the essential cultures and sciences of the civilization which, though they cannot be said to follow any single curricular uniformity, have nevertheless been stable enough to resist any material changes in policy because of the wars through which they have passed and in which they have had a very active part. To appreciate this fully one has only to consider for a moment the present relation of Caltech and other engineering colleges to the research and educational activities of the war in which we are now engaged.

The four years generally devoted to peacetime, normal engineering courses, in view of modern demands upon engineers, should contain many subjects of the type that properly fit men for good citizenship. When to this requirement there also must be added the enlarging scope of technical knowledge required for our expanding technical achievements, it is obvious that those who wish to consider themselves master technicians must have one or more years of graduate work.

It seems natural to consider graduate work as being of two types,—one being in character not unlike that of the undergraduate technical courses, but more comprehensive and intensive. The second type of graduate work should lead to a doctors degree. The courses for this degree should have a large content of advanced mathematics and physics, the emphasis being placed upon acquiring basic analytical skill regarding fundamental science and its relation to engineering rather than upon definite methods of engineering design. This means that colleges giving work for the doctorate degree must have not only a strong engineering faculty with good research facilities, but also must have well-developed physics and mathematics departments, well-equipped and manned by research physicists and mathematicians. Both courses should provide equipment and direction for the conduct of research work and training in research methods.

The California Institute of Technology has arranged for programs of both types. For the first group it has provided one-year (minimum time) graduate curricula, the completion of one of which qualifies the student for a Master of Science degree and two-year (minimum time) curricula, the completion of one of which qualifies the student for a Professional degree. For the second group it provides three-year (minimum time) graduate curricula, the completion of any one of which qualifies the student for the degree, Doctor of Philosophy.

Statistics showing the relation of graduate to undergraduate engineering students should be of interest. Yearly statistics compiled by S.P.E.E. show that for the years immediately preceding the war, about 4,700 students were annually enrolled for courses leading to the Master of Science degree. A few over 1,200, or about 26 per cent of these enrollees received the Master of Science degree each year. Taking another base for our analysis, the number of students enrolled each year for undergraduate engineering work, namely, about 106,000, we find that just preceding the war we were graduating in engineering about 13,000 with a degree of Bachelor of Science, roughly something over 12 per cent of those enrolled. About 10 per cent of those who received the bachelor's degree continued for the master's degree, which means that we had about 1.1 per cent of our 106,000 engineering enrollees receiving the Master of Science degree, whereas 4.4 per cent of our undergraduate enrollees enrolled for this degree.

Analyzing the prewar statistics concerning doctorate degrees, we find about 850 students were enrolled as candidates for such degrees, with 100 doctorate degrees granted per year. Thus about 11⅓ per cent of the doctorate enrollees receive the doctorate degree. Referring again to our base of 106,000 undergraduate enrollees, we find about eight-tenths of one per cent of this number enrolled for the doctorate degree work and .095 per cent or less than one-tenth of one per cent of the original enrollees for undergraduate engineering continue until they receive the doctorate degree. As long as such careful sifting of candidates for graduate work in engineering is maintained, there seems little danger that educators will permit the demand for graduate training to destroy a proper perspective as to what graduate courses should be and what qualifications those who take the courses should meet. Experience with undergraduate courses, however, indicates that under the pressure of wartime and immediate postwartime demands a loss of the restrictive measures which have been operative is not entirely impossible. Before the war the E.C.P.D. accrediting committee examiners, visiting engineering colleges, sometimes found that courses in some colleges were not up to designated standards. Also they quite often found that engineering students were relatively technically overeducated, or perhaps we had better say they were professionally undereducated. By technically overeducated I mean that some colleges had graduated a large number of engineering students, who, though graduate engineers, were continuing to be employed for a decade or more after graduation for substation operation, minor jobs as draftsmen, and other positions of like rating. Men who, while in college or better before they enter college indicate that they will be so limited, either because of their own shortcomings or because of lack of available positions, should not be encouraged or even permitted to complete four-year engineering courses with the idea of being professional engineers. It is not fair to them to have them spend the time and money required for a four-year course learning how to calculate long transmission lines, solve ultra high frequency problems and other engineering problems of like advanced nature which they are not qualified to comprehend and make useful in the subengineering occupations in which they have become permanently engaged. Indeed, if we would encourage men who like technical work but who are not well endowed with mathematical and scientific ability, to take shorter and more practical courses, we would eliminate many of the low-salaried and usually dissatisfied men from the engineering profession.

It is well perhaps at this point to remember that one of our outstanding university presidents has definitely instituted a program of granting the degree of Bachelor of Arts to a large number of students after only two years of college work. I am not advocating a two-year course for the standard undergraduate engineering program, but I have a high regard for the two-year terminal type courses conducted by many of our junior colleges. To my knowledge these courses have produced men of fine achievement for such tasks as drafting, plant operation, and production. I realize we are not considering undergraduate courses, but some of the lessons learned by observing the cause of the low-salary group of college-trained engineers should serve well as a reminder that candidates for graduate work should be very carefully selected from the undergraduates who show promise of being able not only to carry on graduate work but also show ability to make use of it.

One of the questions considered is, "Is there any one field of engineering that should have preference as compared to the other fields from the point of view of rendering great service after the war?" I would answer that by saying that graduate study certainly should not have as its objective the training of men for immediate service, but should by all means train for the long pull. No one can be wise enough to predict that some particular engineering field or fields will have more value over a long period of time than some of the other engineering fields. It seems advisable here to emphasize the idea that an individual's choice as to the type of work to be taken up should be largely determined by his preference. He should choose that type of work which will furnish him the most enjoyment as he pursues his preparation for a life program.

In concluding the ideas presented in the above remarks, the attention of a person considering graduate work should be directed to the question, "What kind of an engineering career do I wish to have?" and also to the answer. If the answer is, "I should like to do highly technical analytical research work or be a teacher of engineering," it is quite evident that all the training available in fundamental mathematics and science will be desirable and that the preparation for such a career should normally include a three- or four-year graduate course leading to the doctorate degree. Should the answer be, "I desire to plan, design, construct and operate engineering industries," then the courses incident to the Master of Science or Professional degrees usually will provide adequate preparation.

CALTECH EXPERT SENT EAST

Dr. Royal W. Sorensen, head of the department of electrical engineering at the California Institute of Technology, left the first week in December for New York City on a government research mission which will keep him in the East until the close of the present semester.

Although the exact nature of his work has not been disclosed, it is understood that Professor Sorensen will be associated with Dr. William V. Houston, professor of physics at Caltech, now on leave.

Wage Incentives

(Continued from Page 12)

gencies of combat require frequent and drastic revisions of design. There is not time to standardize on methods, equipment, or work place layout. The flow of materials is uncertain, and substitutes must often be used. The work force consists of anyone who can be induced to work, ranging from highly skilled and experienced hands to complete newcomers and to incompetents. Supervision is inexperienced and badly overloaded. Under these circumstances, can any fair standard of output be set? The average war-production job simply will not hold still long enough to be carefully studied.

Industry has used two compromises to avoid the difficulty of inaccurate standards:

1. A very mild incentive prevents earnings from getting far out of line, even with defective standards. This is generally unsatisfactory because the incentive exerts little beneficial effect.
2. Individual standards are avoided by hanging the incentive on total output of the plant rather than on individual achievement. The incentive effect is doubtful because reward does not necessarily follow effort; the lazy workman is rewarded equally with the energetic and capable man.

LABOR BOARD ATTITUDE

The National War Labor Board, in a recent decision, granted the Grumman Aircraft Engineering Corporation permission to use a plant-wide incentive plan, but included reservations as to the general adoption of such a plan. The Board recognized the underlying principles as untested but stated, "This is no reason for denying a trial of the plan. There is a possibility that in certain situations it may, without an increase in costs, result in an expanded production of urgently needed war materials from present facilities and presently employed manpower. It seems clear, however, that only under an unusual set of circumstances do the plant-wide or company-wide wage-incentive plans offer sufficient promise to invite experimentation with them. The Grumman plan cannot be used as a readymade model for extensive application. On the contrary, it has a highly limited application.".

Pertinent to the issue are the 800 applications for approval of various types of wage-incentive plans received by the National War Labor Board and the Regional Boards since the issuance of Executive Order No. 9328 on April 8, 1943. Many of these applications have been only a means to provide "hidden wage increases" contrary to the national wage stabilization program; many of them have been based on a desire to attract additional manpower rather than to stabilize the existing facilities and manpower; and others have been honest attempts prescribed without fundamental knowledge of wage-incentive plans or have been haphazardly constructed. The Board, which must approve each new wage-incentive installation, is moving with caution in granting permission because it fears that great damage can be done with poorly conceived incentive plans.

Wage-incentive measures, in the contention of the Board, will not automatically result in a startling increase in production. The Board strongly urges management and unions not to approach the incentive wage question as a cure-all for the solution of production problems. The Grumman decision states, "Actually, the fashioning of a wage-incentive plan adapted to the particular needs of any company is a major and a complex problem which requires the combined best efforts of specialists and of top executives. Its adoption is a major policy decision. It is not a casual undertaking. Even a properly designed plan may be likened to a highly specialized tool with a sharp cutting edge. Wielded by experts, it can be highly productive. On the other hand, it can cut off the fingers of the inexpert who attempts to use it. There is also a question of adopting any program to significant changes in operating conditions if the plan is to have a continuing influence on production. This must be anticipated at the time a plan is being developed. The determination to install an incentive wage-payment plan is not a light matter; it is a policy decision of the first magnitude."

WAR PRODUCTION

What, then, is the place of wage incentives in the war production picture? There is real need for development of the incentive principle in industry, but not at the cost of disrupting the wage structure and jeopardizing good industrial relations. Incentives can be developed through a well-administered hourly wage structure, or through the proper use of non-financial incentives. Wage incentive plans are only to be used safely under conditions of careful standardization of the work, and when proper and fair standards of performance have been set. Installation of wage incentives in the absence of these conditions is likely to bring about serious trouble, interfere with production, and result in ultimate abandonment of the plan.

The use of wage incentives in many war plants will only increase the burden on supervision already overtaxed to the breaking point. The manager who adopts wage incentives in the hope that they will substitute for good supervision is likely to find that he has started more than he has finished. Wage incentives cannot succeed unless management has mastered its job.

Let us, then, put first things first. Improve methods, standardize designs and equipment, train employees, develop supervision, and master techniques of control. The possibilities for increasing production in these ways are enormous. After that, incentives can be profitably employed. The wise driver of the donkey mends the broken wheel of his cart before he uses the carrot incentive to produce action.

Tomato Growing

(Continued from Page 15)

plants, and it is this process of translocation which has an optimal temperature of 65 degrees F.

Some further experiments clearly showed the essentiality of both sugar and darkness for growth. Tomato plants were placed in a dark-room. Thirty hours later they had stopped growing, but when their leaves were submerged in a 10 per cent sucrose solution, growth was resumed in about 24 hours, and they reached a growth rate about twice that of plants grown normally in daylight.

LETTUCE AND ORCHIDS

Not only tomatoes show the phenomenon of different optimal temperatures during day and night. Thus far most plants tried in the air-conditioned greenhouses need a fairly high day temperature and a cool night. Very remarkable differences are shown, for instance, by lettuce. Most varieties start to bolt soon after they are transferred to 80-degree night temperatures. In a 70-degree night temperature the plants also do not head properly, but very fine heads are obtained with lettuce kept during night at 45 and 55 degrees. The optimal day temperature for lettuce lies around 65 degrees. Even in tropical orchids the night temperature must be kept well below the day temperature, and most remarkable of all, the optimal temperatures for such orchids very closely approach the mean temperatures prevailing during day and during night in their natural surroundings.

METEOROLOGICAL DATA REQUIRED

If we ask now what these results mean for agriculture in general, there are several answers. In the first place, we gained a better insight into the conditions which determine growth and fruitfulness, so that we can give more precise directions for growing of tomatoes. These directions should include day and more particularly night temperatures. This leads to the second general conclusion: meteorological data, as usually presented to indicate the climate of a region, prominently display the *mean* temperature. This means very little from a tomato's viewpoint. The experiments described above indicate that the most important meteorological value for tomato growing would be the mean night temperature for each month. Extension of this line of research probably would lead to the most practical way of presenting meteorological data for agricultural use in general. In the third place, it becomes highly advisable to select better varieties of agricultural crops not in field trials, but in the synthetic climate of air-conditioned greenhouses. This conclusion is based on the observation that from year to year and from season to season tomato plants perform uniformly in air-conditioned greenhouses. Various synthetic climates, exemplifying main growing centers, could be created, and the best performers could be selected for each climate. Nowadays selection is made under natural conditions, which may mean a warm summer or a cool summer. The plants doing best one year in a warm summer probably will not do so well a subsequent year in a cool summer, so that selection under natural conditions becomes highly complex. By creating special Los Angeles area hot and cool weather varieties, and by utilizing future long-range weather forecasting, many of the hazards of agriculture could be eliminated, through use of the proper variety as indicated by the long-range weather forecast in spring. This would bring agriculture another step from the realm of art into the folds of engineering.

Wood- and Paper-Base Plastics

(*Continued from Page 9*)

Table No. II gives the readily obtainable properties of parallel-laminated papreg (machine direction of sheets all in same direction). Cross-banded papreg will have properties about two-thirds to three-fourths those of Table No. II.

Papreg has strength properties adequate for a large number of semistructural uses and some structural uses. As a structural material, its brittleness seems to be its most serious handicap. Compared to ordinary plastics, it has quite good Izod values, but it is definitely inferior in this respect to fabric and glass fabric laminates. It is, however, superior to fabric laminates in practically all other strength properties.

TABLE II—APPROXIMATE PROPERTIES OF PARALLEL-LAMINATED PAPREG

Property	Value
Specific gravity	1.38
	Lb. per sq. in.
Tension:	
Maximum strength	36,000
Modulus of elasticity	3,000,000
Flexure:	
Modulus of rupture	30,000
Modulus of elasticity	3,000,000
Compression:	
Parallel to grain	17,000
Flatwise perpendicular to grain	40,000
Edgewise perpendicular to grain	15,000
Johnson double shear, parallel to grain, perpendicular to laminations	13,000
	Ft.-Lb. per in.
Izod impact:	
Face-notched	5.0
Edge-notched	0.8
Hardness (Rockwell)	M 100
Water absorption (24 hours)	6 per cent

Because of its low elongation, papreg is not as easily molded to double curvatures as are fabric laminates. It has been successfully used, however, in molding of quite intricate objects with but a limited amount of goring and tailoring.

Work is now underway on incorporating other resins, both natural and synthetic, in paper-base plastics primarily from the standpoint of cheapening the product and also with the objective of building up the toughness without too great a sacrifice in water resistance and other mechanical properties. Details on this phase of the work cannot be given at present.

CONCLUSIONS

It is obvious from this array of products that wood is making an important place for itself in the plastics field. Although wood and its constituents serve mostly as the structural or filler part of these plastics, wood and wood products show promise of invading the resin field. Lignin and Vinsol (a rosin-purification residue) show promise as resin diluents. It is also of interest that phenols, furfural, and other resin-forming constituents are obtainable from wood by destructive distillation and hydrogenation processes. It does not require great imagination to visualize a self-contained wood industry that uses wood almost exclusively in the manufacture of wood plastics.

SOCIETY HONORS DR. MICHAL

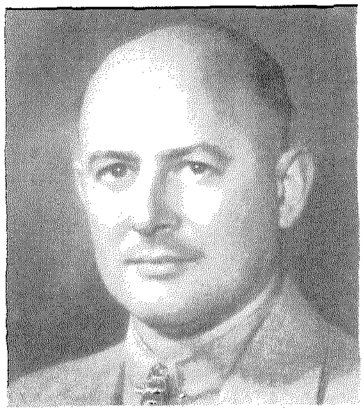
The American Mathematical Society, at its 50th Annual Meeting in Chicago last week, elected Aristotle D. Michal a vice-president. The society is a national organization devoted in peacetime to mathematical research and during wartime to mathematical problems connected with the design of military equipment. Dr. Michal, a member of the society for 20 years, has been at the Institute since 1928 as a professor of mathematics.

C. I. T. NEWS

CALTECH ATHLETIC PROGRAM

By HAROLD Z. MUSSELMAN*

THE opening of the second semester on November 3 found most of the members of the Southern California Conference resuming their intercollegiate sports program. While the Conference itself remains inactive for the duration, at least three of the schools expect to maintain a normal intercollegiate program. Occidental, Redlands and the California Institute are V-12 schools and will meet each other in all sports for the remainder of the year. Pomona, having several Army units, will not participate in an intercollegiate program, and neither will Whittier, which has civilian students only. With Conference rules suspended, all men in school now will be eligible for varsity teams.



HAROLD Z. MUSSELMAN

The California Institute expects to provide schedules in the same sports as last year, providing suitable opponents are available. The program for this semester includes basketball, cross country and water polo. Inability to obtain matches has retarded the organization of soccer. The spring sports, track, baseball, tennis, golf and swimming, will get under way at the opening of the new semester on March 6.

At the opening basketball practice on November 4, Coach Carl Shy was greeted by a record turnout of 75 men. Dean Chapman, center, and Tway Andrews, guard, are the only lettermen returning from last year's championship team, although Andrews, troubled with a hip injury, still has not reported for regular practice. Much material has been found in the V-12 unit and out of the 22 men now retained on the squad, only four are civilian students.

In the absence of a freshman team this year, part of the varsity squad will be designated as a "B" team and will play preliminary games. This group is coached by Chief Specialist Dan Miranda, an instructor in the V-12 unit, who is an experienced coach and player in football, basketball and baseball.

In the opening game, the engineers defeated the strong squad from Camp Santa Anita 49 to 34. In triumphing over a team which was undefeated in six starts, Tech's team looked good and held a lead all the way. Captain Chapman at center played his usual fine game and was high scorer with 18 points, but was closely pressed by Hugh West with 15. West, a sophomore, and Paul Nieto, who started at the other forward spot, both made their frosh numerals at Stanford last year. Junior Iliff Dana, a football letterman from Stanford, and frosh Stuart Bates, from Pasadena J. C., held down the two guard spots. At present this appears to be the starting lineup.

The following week Tech bowed to the Los Alamitos Naval Air Station 62 to 56. Chapman again led the scoring with 25 points while West registered 13. High scorer for the opponents was Omalev, star at U.S.C. last season, with 19 markers.

The team this year is fast, showing far more speed than any previous Tech team. However, the lack of qualified reserves is a big problem for Coach Shy, for so far no substitute can be used without weakening the team.

The schedule for the remainder of the season is as follows:

Jan. 4—Pepperdine.
Jan. 8—*Redlands.
Jan. 14—*U.C.L.A.
Jan. 22—*Occidental.
Jan. 29—Redlands.
Feb. 4—*Pepperdine.

*Home games to be played at Pasadena J. C.

The Water Polo squad, coached by Chief Specialist Arthur Dillenbeck, dropped their opening match to the strong U.C.L.A. squad 7-6. Behind in the score, 7-3, Tech closed with a rush and almost nipped the Bruins at the finish. The Uclans were met in a return match in December, and other matches have been scheduled with North American Aviation and various club teams.

Dr. Floyd Hanes's Cross Country squad dropped their opening meet 21 to 37 to U.C.L.A. on the votors hilly course. In the following meets, Oxy was defeated 22 to 33, and Compton J. C. trounced 20 to 35. Return meets with U.C.L.A., Oxy and Compton J. C. will complete the schedule.

*Acting director, physical education.

CIVILIAN DEFENSE AT CALTECH

The California Institute of Technology is fully prepared to meet any eventuality. The campus of the Institute, classed as one defense sector of the city of Pasadena, is divided into 10 "blocks," each of which is headed by a block warden, who is assisted by two messengers at the block headquarters and by several fire watchers. Three other main divisions complete the corps, the personnel of which is summoned by the warden when needed. Two hundred and fifty students, 50 civilians, and 200 enlisted men from the V-12 contingent, are working as members of the organization.

The first of these divisions, the medical branch, under the leadership of Professor Anthonie van Harreveld, maintains complete casualty and first-aid stations at three spots on the campus, complete with modern equipment, including a respirator. This division maintains, in addition, many smaller casualty stations throughout the campus, the locations of which are posted on the bulletin boards.

Professor Arie Haagen-Smit heads the decontamination squad, which is one of the best equipped corps of its kind in the nation, including rubber suits and the newest decontamination devices in its equipment. The fire-fighting group boasts two fire wagons and is staffed by 100 V-12 men.

The nerve center of the organization, the sector office, is equipped with a radio which is constantly tuned for warning signals. Complete communication with every part of the campus is made possible by telephone and messenger service. An ensign stands at this post day and night.

The entire personnel of the organiaztion has been highly trained and coordinated, and, due to the conscientious efforts of everyone on the staff, the Caltech Civilian Defense Corps is a model organization of its kind. Dr. Edward O. Guerrant, of the Institute staff, acts as Sector Warden and head of the Caltech civilian defense program.

INDUSTRIAL RELATIONS SECTION

THE winter series of E.S.M.W.T. courses in Industrial Relations and Production Engineering will open on the campus and at Huntington Park High School the week of January 17. To date more than 3500 students have taken advantage of these tuition-free evening courses offered on the Pasadena campus. In establising an off-campus center at Huntington Park, the Institute will be bringing its services to the large industrial center southeast of Los Angeles.

Courses offered at the California Institute and Huntington Park High School include:

Industrial Relations for Supervisory Personnel
Labor Relations for Supervisory Personnel
Industrial Management
Selection and Placement of Personnel
Techniques of Training Personnel
Wage and Salary Determination and Job Analysis
Motion and Time Study
Production Control
Cost Analysis and Control
Cost Estimating
Industrial Wage Incentive
Improved Methods and Plant Layout
Materials Handling and Inventory Control

For detailed announcements of these courses and application forms write to the Industrial Relations Section, California Institute of Technology, Pasadena 4, or phone Sycamore 6-7121, or Ryan 1-6751.

In expanding its war-training program this fall the Industrial Relations Section has established evening school classes at El Segundo High School, Claremont Colleges, San Bernardino Valley Evening Junior College and Riverside Junior College with a total enrollment of 400 students.

PATTERNS OF COLLAPSE

ALTHOUGH the Institute's general lecture program has necessarily been curtailed because of war activities, the arrangements have been made to have Dr. G. R. Treviranus, German statesman of the pre-Hitler era, deliver two addresses during the last week in January. The first, "The Fate of the Weimar Republic, 1918-1931," will follow a stag dinner to be given by the Board of Directors of the California Institute Associates.

The second, "Patterns of Collapse: Germany 1918, 1923, 1933 and Tomorrow," will be a public lecture at the Athenaeum at 8:15 p.m., Friday, January 28. It will be open to the staff and the friends of the Institute.

Dr. Treviranus played a very prominent part in public affairs in Germany prior to Hitler's coming into power. Leader of the Conservative People's Party which was formed in 1930 as a protest against extreme German nationalism, he was also a member of the Bruening cabinet (1930-1932), first as Minister without portfolio and later as Minister of Transport. Soon after Hitler's coup, he made his escape from Germany to England, and later settled in Canada.

His present activities include giving special lectures and courses at Canadian and American universities and writing on European affairs. His book, *Revolutions in Russia, Their Lessons to the Western World*, is scheduled for publication in January, 1944.

ALUMNI DANCE

The eighth annual alumni dance will be held on Friday, February 11th, at the Elks Club, 607 S. Parkview, Los Angeles, at 9:00 P.M. Watch for your announcement.

ALUMNI NEWS

LOS ANGELES LUNCHEON MEETING

SOUTHERN CALIFORNIA members of the Alumni Association have been taking an active interest in the monthly luncheon and dinner meetings held in Los Angeles. The November luncheon meeting was held Tuesday, November 23, at Hotel Clark. P. L. Johnson, chief engineer of the Southern California Telephone Company, spoke on the postwar aspects of local and long distance communication.

Current industrialization of southern California, Mr. Johnson stated, indicates rapid growth of population which will put greatly increased demands upon the telephone system in this area. Automatic toll ticketing being tried near Los Angeles promises to aid in meeting increased demands for telephone service. This dvelopment goes far toward the elimination of toll operators' services on "short-haul" toll calls. Probably after the war such equipment will be widely installed throughout the nation. It also appears probable that similar systems will be developed for handling "long-haul" telephone calls after the war. Carrier-frequency telephone systems have been developed which permit the transmission of 480 telephone messages over one coaxial conductor.

Development of telephone systems has practically stopped because of the devotion of almost the entire effort of Bell Telephone Laboratories to war and related research and engineering.

THOMAS S. TERRILL HELD PRISONER

Thomas S. Terrill, who received his B.S. degree in Aeronautical Engineering from Caltech in 1933, is a prisoner of the Japanese, it was announced recently by the Navy Department.

Mr. Terrill was an employee of the American Export Company when it decided to inaugurate a transoceanic air service in 1939. He was singled out by the company to help inaugurate the service and served as first officer and navigator on a giant flying boat when it made three trans-Atlantic "survey flights."

Mr. Terrill then was employed by the Consolidated Aircraft Company and helped ferry 30 big planes to the Bahama Islands. Still later he served as navigation commander of an air crew ferrying planes to the Philippines. He had two trips to the islands and on his third flight was captured by the Japanese in Manila and sent to Santo Tomas prison camp. This was in December, 1941, and his parents have received no word from him since.

RECEIVES IMPORTANT ARMY PROMOTION

COLONEL IVAN L. FARMAN, who received his B.S. degree in 1926 and his M.S. degree in 1927 from the Institute, has been named commanding officer of the Army Airways Communications System wing at Asheville, North Carolina. Colonel Farman was formerly assistant chief of staff for plans and operations of the wing.

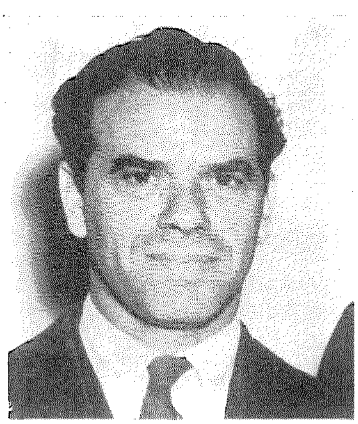
The A.A.C.S. wing provides, operates and maintains airways communications, airdrome traffic control and radio aids to aeronautical navigation all over the military airways of the army air forces. It is one of the most extensive airways communications systems in history—perhaps larger than all previous such systems combined. Its facilities girdle the globe, crossing four oceans, with installations in many foreign countries.

Colonel Farman entered the Army Air Forces as a flying cadet and won his wings in 1929, graduating from the advanced bombardment course at Kelly Field, Texas. He has been engaged in air force communicatons work since that time.

Assigned to the A.A.C.S. wing early in 1941, Colonel Farman served as communications officer on the staff of General Brant in Newfoundland and was engaged in the installation and operation of army airways communications system facilities in the North Atlantic area until his assignment to wing headquarters in North Carolina.

ALUMNUS RECEIVES MEDAL

LT. COL. FRANK CAPRA, '18, noted Hollywood director, recently was awarded the Legion of Merit Medal for outstanding work as chief of an action picture production unit in the European theater of operations. The presentation was made by Lt. Gen. Jacob L. Devers, commander of the Allied troops in this area.



PERSONALS

1917

FRED L. POOLE is teaching at the University of Santa Clara.

1923

DONALD H. LOUGHRIDGE has been on leave of absence from the University of Washington where he is professor of physics, and he has been doing war research and development work at various places throughout the country. Mr. Loughridge is now back in Seattle doing full time war research work.

1925

ALBERT J. FERKEL has been transferred to Port Arthur, Texas, as chief process supervisor of the Port Arthur Refinery of the Atlantic Refining Company. The plant is currently being expanded by the addition of fluid catalyst cracking and hydrogen fluoride alkylation for the production of aviation motor fuel.

1926

ROBERT BOGEN is general manager of the Production Tooling Co. in Los Angeles, a company engaged in manufacturing aircraft parts.

CAPTAIN ROSCOE GLOCKLEY has been assigned to a regiment at Camp Sutton, N. C.

SURLEY G. KNUPP has been employed by Douglas Aircraft Co., Inc., since August, 1942. He is now working in the production design office of the engineering department at the Long Beach plant. In addition to nine hours a day at Douglas, he is continuing his law practice.

C. H. BIDWELL is the father of a son, John Laurence, born August 25. Mr. Bidwell is employed at the Bell Telephone Laboratories in New York in the toll-circuit design department.

1927

LIEUTENANT COLONEL T. C. COMBS is the assistant executive officer and control officer at Camp Claiborne, La.

LIEUTENANT WILLIAM W. AULTMAN is back in the United States after seven and a half months at Dutch Harbor with the Seabees, and has returned to Camp Parks, near San Francisco, for additional training and for reassignment.

WAYNE RODGERS is the father of a son, Bruce Vincent, born November 20.

1929

LIEUTENANT (J.G.) HAROLD A. CORBIN, U.S.N.R., is now in training at Fort Schuyler, N. Y. He will then go to Miami, San Diego and Boston, where he expects to receive orders regarding a permanent location. His three-year-old daughter, who was in the hospital at the time he left for New York, is now well and at home. Mr. Corbin also has another daughter, Barbara Joan, born September 25, two days after he left for training.

GEORGE S. LUFKIN is the father of a second child, George Robert, born in July in New York City.

ALLEN W. DUNN is at Headquarters, E.U.T.C., Camp Sutton, N. C.

NICHOLAS M. OBOUKHOFF, research professor of electrical engineering and professor of mathematics and physics at the Oklahoma Agricultural and Mechanical College at Stillwater, Okla., has had numerous papers published recently. Among these were a discussion published in "Transactions of the American Institute of Electrical Engineers" entitled "*Emergency Overloading of Air-Cooled Oil-Immersed Power Transformers by Hot-Spot Temperature*," and a paper on the subject "*Teaching of Graduate Courses to Undergraduate Students*," published in the Proceedings of the Oklahoma Academy of Science. Dr. Oboukhoff read a paper, "*Relation of Technology to Humanism in Goethe's Faust and in the Works of Saint-Simon,*" before the Sixth International Congress for the Unity of Science which was held at the University of Chicago. He was elected a member of Eta Kappa Nu and has been made a senior member of the Institute of Radio Engineers.

1930

PVT. HARRY S. MASON, JR., has been assigned to a regiment at Camp Sutton, N. C.

SIDNEY ZIPSER is attending photographic school for the Signal Corps in New York and visited the campus recently while on furlough.

1931

CARTER GREGORY is a geophysicist at Shell Oil Company in Bogota, Colombia.

LAVERNE D. LEEPER has been assigned as instructor to the University of Illinois for the Army specialized training program.

EDWARD S. PEER is working for Filtrol as a research chemist, coordinating analytical work with the research program.

1932

CARL F. LIND is now a senior lieutenant in the Naval Reserve, Civil Engineering Corps. Having finished construction of the Naval Air Station at Hutchison, Kan., he is now assigned to the Public Works Department of that station on maintenance and improvement works.

THOMAS E. MATHEWS, JR., post signal officer of the Merced Army Air Field, has recently received his promotion to the rank of first lieutenant. Prior to his enlistment Lieutenant Mathews was employed as rate engineer by the Southern California Telephone Company of San Francisco.

GUY WADDINGTON is on leave of absence from Rollins College for the duration and is now engaged in war work for the Bureau of Mines with an official rating of physical chemist.

1933

COMMANDER HARALD OMSTED, CEC., U.S.N.R., is with the 94th U. S. Naval Construction Battalion. He saw service in the Aleutians last winter as officer in charge of a battalion. He is enthusiastic about the Seabees, and recommends the service to fellow alumni.

LIEUTENANT COMMANDER EDGAR C. CRAWFORD, CEC, U.S.N., is an executive officer with the 94th U. S. Naval Construction Battalion.

TRENT DAMES is the father of a baby girl, Joyce Marie, born September 9.

RAYMOND C. BINDER, associate professor of mechanical engineering at Purdue University, is the author of a book, *Fluid Mechanics*, which was designed for use as a textbook for undergraduate engineering students. It was geared to meet the requirements of wartime courses.

SERGEANT FRED DETMERS, who is attending photographic school of the Signal Corps in New York, visited the campus recently while on furlough.

1934

HOWARD E. GULICK is a non-flying lieutenant in the Air Corps, stationed for the past year at Yuma Army Air Field in the post engineer's office.

T. H. CARRICK was promoted recently to captain, Chemical Warfare Service, U. S. Army. He is stationed at Fort William Henry Harrison, Mont., and his present duty is post adjutant and chemical officer.

DAVE HATCHER, a second lieutenant in the Army Air Corps, was married recently in Hartford, Conn. He had 20 weeks training at Boeing Field, Seattle, and is now stationed in Colorado.

1935

MABRY VAN REED, first lieutenant, C. E., has been transferred from the U. S. Engineer Los Angeles District Office to the Engineer School, Fort Belvoir, Va., where he is instructor in the department of engineering.

1936

DICK H. WALLMAN is now flying as meteorologist-navigator on the Pan-American "Clippers", with headquarters at Jackson Heights, New York. He is in the Naval Reserve, inactive status.

WILLARD L. McRARY has been doing biochemical research on guayule at the Bureau of Plant Industry's experimental station at Salinas.

WALFORD E. SWANSON is with the U. S. Engineer Office in Sacramento.

LIEUTENANT ROBERT M. NICHOLS has been studying electronics with the R.A.F. in England.

1937

RALPH S. BENTON is now an ensign in the U.S.N.R. training for salvage work in New York City.

MAJOR PETER HINES WYCKOFF is at present serving with the Air Service Command, United States Army, with headquarters in Patterson Field, Fairfield, Ohio. From September, 1941, to November, 1942, he served overseas, studying in a British military school and assisting in electronics research. In November, 1942, he married Miss Evelyn Jauquet of Wilkinshurg, Pa., who is employed by the Westinghouse Electric and Manufacturing Co. in East Pittsburgh, in the capacity of receptionist in their research laboratories.

LIEUTENANT (J.G.) JACK KINLEY is a Navy paymaster on a tropical island in the southwest Pacific.

PAUL S. JONES has been in Africa for the past year and a half as a civil engineer on lend lease construction projects for the U. S. Engineer Department, most of the time being spent in Eritrea, but more recently at the engineer headquarters in Cairo, Egypt.

1938

LIEUTENANT WILSON JONES is on active duty with the Seabees.

LIEUTENAT (J.G.) SAMUEL KELLER is with the Seabees, and is receiving his training at Gulfport, Miss.

DAVID M. SHERWOOD is working as a field engineer for Columbia University Division of War Research at the U. S. Navy Underwater Sound Laboratory, New London, Conn.

CHARLES W. CLARKE is chief production engineer for Airesearch Manufacturing Co., Phoenix plant, Phoenix, Ariz.

HAROLD W. SHARP is the father of a son, James Michael, born August 15, 1943.

R. C. DAVIDSON is assistant director of research at the Filtrol Corp.

A. M. O. SMITH and Miss Elisabeth Nelson were married in December.

CARL FRIEND is the father of a baby daughter, Marie Jeanette, born November 6 in Glendale.

1939

ROBERT L. SMITH is a major in the Marine Corps, and has seen action at Pearl Harbor and Guadalcanal.

JOSE P. ORTIZ has been appointed as superintendent of construction of the shipyard "Icacos", located near the port of Acapulco on the Pacific Coast.

1940

WILLIAM J. HOWELL, JR., after leaving Caltech did work at the University of Chicago and later at the Armour Research Foundation while a research fellow at the Illinois Institute of Technology. He was commissioned through the Marine Corps Officer Procurement District in Chicago. He has been commissioned a second lieutenant in the Marine Corps and has reported for indoctrination at the Marine base at New River, N. C.

FREDERIC C. E. ODER is now head of the Weather Division, Army Air Force School of Applied Tactics at Orlando, Fla. He holds the rank of captain.

RICHARD L. SULLIVAN has left Transcontinental and Western Air, in Kansas City, and has accepted the position of chief engineer with Mid-Continent Airlines, Inc., in Minneapolis, Minn.

DONALD E. LOEFFLER has been taking his basic training at Seymour Johnson Field, N. C., and expects to do photographic work in the Army Air Corps.

ENSIGN FRANK W. DESSEL, JR., U.S.N.R., is an aerologist at the Naval Air Station in Bermuda, B. W. I. His wife and three-year-old son, Frank William III, reside in Pasadena. He received his aerological training at Caltech.

CHARLES D. RUSSELL received his doctorate in chemistry from Duke University, worked for the Texas Company at Beacon, N. Y., and is now employed as a research chemist for the California Milk Products Co. in Gustine, Calif.

ROBERT O. COX is chief engineer for the Atlas Aircraft Products Corp. in New York City.

DUMOND STAATZ graduated in October from Michigan Medical School and has begun a year's internship at the Los Angeles County General Hospital. On September 3 he became the father of a baby boy.

1941

JOSEPH F. ROMINGER has been working as junior geologist with the U. S. Geological Survey at Monticello, Utah, since June, when he received his master's degree at Northwestern University.

LIEUTENANT STANLEY J. MITCHELL, who has been with Westinghouse at East Pittsburgh, Pa., is now with the Army Air Force at Wright Field, Dayton, Ohio.

NORMAN Z. ALCOCK is in England for a short visit for the Radio Section, National Research Council of Canada.

JOE LEWIS is manager of industrial relations, Boyle Manufacturing Co., a United States Corp. subsidiary.

GUY STEVER recently returned to the United States from England where he was engaged in scientific work.

ROBERT G. BOWLUS is employed as process engineer with Tidewater Associated Oil Co. at the Watson refinery. He has a daughter, Margaret Anne, born September 6.

1942

CLIFFORD C. HOAGLAND and Miss Louise Allen were married on September 18 at Willow Grove, Pa.

ROBERT N. HALL is the father of a son, Richard Hallock, born August 17 at Schenectady, N. Y.

ENSIGN TOM ELLIOTT is the father of a baby boy born in October. Ensign Elliott recently returned home from the southwest Pacific by clipper, where he has been serving as an aeronautical engineer with the U. S. Navy.

ALAN BELL is attending Johns Hopkins Medical School at Baltimore, Md.

WARREN A. HALL is the father of a daughter, Beverly Ann, born in November.

WENDELL W. HARTER and Miss Madelyn Ruth Pyle of Pasadena announced their engagement recently. The bride-to-be is now attending U.C.L.A. and Mr. Harter is a stress engineer at Northrop Aircraft, Inc. The wedding will take place next summer.

STEWART DAVIS is with Western Electric in New York.

ROBERT D. ALTMAIER is now an ensign in the U.S.N.R. and at present is located at the Bureau of Aeronautics, Washington, D. C.

CHARLES M. BROWN is a field engineer for the R.C.A. Service Company at San Pedro.

LIEUTENANT (J.G.) JOHN A. CHASTAIN is with the Pacific Fleet as a radar officer on the U.S.S. Harris.

1943

ROBERT P. LEVINE is now an aviation cadet in engineering at Seymour Johnson Field in Goldsboro, N. C. He is awaiting shipment to Technical Training School at Yale University.

CHARLES STRICKLAND, former student body president, is now at the U. S. Naval Academy in V-7 training and graduated as an ensign, E-V(G), U.S.N.R., in December.

ENSIGN DAVE ARNOLD is now in Washington, D. C.

ENSIGN DAVID ELMER and Miss Marguerite von Norman were married in Seattle on October 29. Ensign Elmer has been assigned to duty at Caltech.

NICHOLAS BEGOVICH and Miss Joan Deopker, a senior at Occidental College, recently announced their engagement. He is teaching in the electrical engineering department at the Institute.