ALUMNI REVIEW

CALIFORNIA INSTITUTE OF TECHNOLOGY

Vol. VI No. 2 December, 1942

Never Beyond This Shore

HERE at the sea's edge is as near to Jim as I can go. Other women have gone farther than this. There were women on Corregidor; women have gone to Ireland and Australia and Iceland; women have been lost in the Battle of the Atlantic.

But I know I would be foolish to dream of serving as they have. For a woman to go farther than this shore demands a special skill, complete independence—and I have neither.

No, my task is here, here in the little storm-tight house that sits back from the cove, here with my son.

And if I become discontent with the seeming smallness of my task, Jim's words come back to steady me. "I'm leaving you a very important job, Mary. Until this war is won, there won't be any more evenings when we can sit by the fireside and plan our tomorrows together. It will be up to you to make the plans for the three of us.

"Mary," he said, "keep our dreams alive."

★ ★ ★

MAKE no little plans, you who build the dream castles here at home. When you try to imagine the future, after he returns, be sure your imaginings are full of bright and cheerful hues, for that world of tomorrow will be resplendent in things you don't know—never even imagined. Allow for wonderful new developments in such fields as television, fluorescent lighting, plastics. And leave a flexible horizon for the marvels that are sure to come from the new science of electronics. When you're dreaming of your better tomorrow, count on us. General Electric Company, Schenectady, N. Y.

★ ★ ★

THE VOLUME *of General Electric war production is so high and the degree of secrecy required is so great that we can tell you little about it now. When it can be told completely we believe that the story of industry's developments during the war years will make one of the most fascinating chapters in the history of industrial progress.*

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GENERAL ELECTRIC

ALUMNI REVIEW

ALUMNI ASSOCIATION, INC. — CALIFORNIA INSTITUTE OF TECHNOLOGY

VOL. VI No. 2 — DECEMBER, 1942

CONTENTS

Joseph F. Manildi received his B.S. degree in electrical engineering from the California Institute of Technology in 1940, attended the Harvard Business School for one year, and returned as a graduate assistant to Caltech where he received his M.S. degree in 1942. He is now continuing his work towards a doctorate.

William F. Nash, Jr., instructor in physical metallurgy at the Institute, received his B.S. degree in engineering from Caltech in 1938. During his fifth year work in aeronautics, he became interested in metallurgy, and was given an assistantship for research in that field. His thesis for the Ph.D. degree, received in 1942, was on powder metallurgy.

Raymond Cromley, B.S. '33, lived in Tokyo for six years where he was financial editor of the American-owned newspaper, the Japan Advertiser. Prior to December 7, 1941, he was correspondent for the Wall Street Journal. On that date he was arrested and imprisoned "for sending information to the Wall Street Journal which could be used by the United States against the national defense of Japan." He was exchanged for a Japanese and arrived in August aboard the Gripsholm.

J. E. Wallace Sterling, associate professor of history at the California Institute, reviews in this issue . . "the end of the beginning," of which Mr. Winston Churchill spoke in his Mansion House speech on November 10. Professor Sterling's clear analyses of current events have proven the most popular features of the last two issues of the Review.

Fred T. Schell, in the third of a series of articles on "Utilities and the War," presents the war-time problems confronting the eleeirtcal industry, as well as an outline of the contributions of that industry to the war effort. Since receiving his B.S. degree in electrical engineering from Caltech in 1927, Mr. Schell has been associated with the Southern California Edison Company, Ltd., where he now holds the position of Industrial Power Engineer.

EDITORIAL

SCRAP:

The problem of steel scrap is an important one to all who are interested in contributing to the war effort. This month there appears a sketch by Artzybasheff, "Junk Rains Hell on the Axis," which is timely and to the point. We are indebted to the Wickwire Steel Company for permission to use this, and to *Metal Progress,* published by the American Society For Metals, for the cut. It may seem strange that we have to worry about scrap in our back yards when this country has large resources of iron ore.

Scrap iron and steel have always been utilized in the production of new steel, the source being largely steel mill scrap, worn-out machinery and other heavy equipment. In producing sheet and strip steel, approximately 35 per cent of the ingot is scrap suitable for remelting, while in producing heavy products, such as plate and structural shapes, about 18 per cent is scrap. In war-time, the production of light products decreases while that of heavy products increases. *Steel Facts,* published by the American Iron and Steel Institute, stated recently that the production of steel ingots has risen about 27 per cent in the period 1940-1942, while steel plant scrap has increased only 24 per cent. This may not seem very significant, but in tonnage it is important. At the present time the shipbuilding industry is the largest consumer of steel, and about two-thirds of their requirements are plates. Steel production during the first nine months of this year was 64,020,000 tons, which is 2,500,000 tons more than for the same period last year and an all-time high. Some open heart furnaces have actually been shut down temporarily because of scrap shortage. Industry is trying to make equipment last longer by more extensive repairs; hence, much less is being returned to the furnaces. Pig iron production is being expanded, but this is a tremendous job and requires time. Steel is our most important material for the armed forces, and for the war industries. Every bit of scrap will help; therefore, get in the scrap now. Look at the caricature on page 3 and see if you don't find something there that you have and can throw into the fight. What has been said for steel scrap also applies to other metal scrap which is needed.

ADVERTISERS:

Advertisers in this REVIEW make it possible to publish a 24-page issue. Every member of the Alumni Association can help make this a better REVIEW by letting our advertisers know that their ads have been read and by using REVIEW advertising as a guide when buying. Advertisements are showing you what necessities can be purchased now, as well as what your war bonds will be able to buy after the war.

We hope the REVIEW can continue and improve. If you have suggestions or criticisms, send them in, please.

ALUMNI HONORED FOR HEROISM IN ACTION

Lieutenant Colonel Phillip T. Durfee, '28, has been awarded high recognition for heroism in flying battle planes against enemy positions during hazardous flying weather in the Aleutian Islands.

Following Lt. Col. Durfee's graduation from Caltech in 1929, he enlisted in the Army Flying School at March and Kelley Fields, and in 1930 joined the Western Air Express, where he was considered an outstanding pilot. Later he joined the Richfield Oil Company as an aviation engineer, and in April, 1939, rejoined the Army and was stationed at Hamilton Field until December, 1941, when he was sent to Alaska.

Mrs. Durfee and their two sons, Phillip, 6, and William, 4, are living in San Marino.

* * * *

Capt. Thomas R. White, '31, of Haiku, Maui, former interne at Queen's hospital, has been promoted to the rank of major. He served as flight surgeon with the American air squadron that bombed Tokyo and other Japanese industrial centers last April under Brig. Gen. James Doolittle. Major White has been awarded the silver star for gallantry. He has also received the Distinguished Flying Cross and the Military Order of China.

Major White graduated from Caltech in 1931, then studied aviation, and later attended the Harvard medical college. He is still flight surgeon for General Doolittle.

His wife and three children live in Redlands, California.

HANS KRAMER WINS ENGINEER POST IN HAWAII

Brig. Gen. Hans Kramer, former commandant of cadets at the California Institute of Technology, has been named as the Hawaii Department Engineer. He has risen through the ranks of major, lieutenant colonel, colonel to brigadier general in the past two and a half years.

General Kramer's chief of operations is announced as Major Joseph Matson, Jr., '26. Following his graduation from Caltech, Major Matson was commissioned a reserve officer. He was chief engineer for the Waialua Agricultural Company at Waialua, Oahu, when the Japanese made their attack on Hawaii. He was called into active service in January as a captain, and was promoted to the rank of major in June.

IF YOU ARE NOT NOW IN WAR WORK, THE ALUMNI PLACEMENT SERVICE WILL BE GLAD TO RECEIVE YOUR APPLICATION FOR CONSIDERATION.

FORMER R.O.T.C. INSTRUCTOR RESCUED AT SEA

Those alumni who were in attendance at Tech during the late twenties will remember the Assistant Professor of Military Science, then Lieutenant Louis J. Claterbos. Now Colonel Claterbos, he has recently taken over new duties on the Engineer faculty at Fort Belvoir, Va., after an adventurous year of war around the world.

On his way to a new post in Africa last December, his plane was delayed in Honolulu, where he became mildly interested in the "beautiful show the Navy put on," as he wrote his wife on the morning of the 7th. He learned quickly and thoroughly that (1) he was watching no "show" and that (2) he was no longer on his way to North Africa. For two weeks he was Engineer Supply Officer, handling work ranging from gasoline rationing to the conversion of pineapple fields into vegetable gardens.

In January he again left for Africa, by Atlantic Clipper. He went to Eritrea to supervise some of the big U. S. engineering projects for six months, working in temperatures as high as 120°. After that period, he was ordered back to the U.S.A. because of his health, and, for the same reason, was told to take a boat rather than a plane, as "planes are too exciting." Whereupon Colonel Claterbos, following directions, took a boat, which was torpedoed in the Caribbean. The lifeboats headed toward Trinidad, were picked up two days later by a Navy vessel, and last week the Colonel was released from Walter Reed Hospital, ready to join the "gang" at Fort Belvoir.

COVER

The cover is a reproduction of one of a series of beautiful snow scenes taken by the late Ferdinand Ellerman on January 18, 1907, on Mt. Wilson after a record storm lasting three days. Mr. Ellerman was an astronomer at the Mt. Wilson Observatory from the time of its organization in 1907 until retirement in 1937. His death occurred in March, 1940. The staff of the REVIEW is indebted to Mrs. Ellerman for permission to use this photograph.

Watch for the announcements of the

ALUMNI DANCE

February 13 at the
Rendezvous Room
Biltmore Hotel, Los Angeles

CHAPTERS

New York

Cliff Burton, '40, is now Secretary-Treasurer of the California Tech Club of New York, taking the place of Larry Ferguson who is now a lieutenant in the Navy. Cliff is with the Texas Company at 205 East 42nd Street, New York City.

Bill Hainsworth, vice-president of Servel, Inc., showed some motion pictures of skiing expeditions, which he had taken in both western and eastern United States, at the meeting of the New York Chapter on Friday, December 4th, at Hotel Wellington.

San Francisco

Bob Bowman, '26, entertained seventeen members of the San Francisco Chapter and their wives at his home in Concord on Saturday, August 22. The swimming pool which Bob recently built was the center of interest during the warm afternoon. At sundown, the group gathered at the outdoor grill for a supper featuring Bob's hamburgers and tomatoes from his Victory garden. The remainder of the evening was spent discussing the war, and playing bridge and poker. Don Morrell, '24, the new chapter president, helped to organize this party, and Mr. and Mrs. Bowman assured the group of an annual swimming party at their "Rancho." The Chapter invites any Caltech men to join them each Monday noon at the Palace Hotel.

Los Angeles

In view of present conditions, the Social Committee has planned this year to hold several noon meetings. However, a few evening meetings will also be held to accommodate those of us who cannot attend the luncheons.

The first noon meeting was held on Wednesday, October 14th, at the Clark Hotel. Approximately ninety alumni and guests attended. We had an excellent talk on "Protective Concealment (camouflage to you) in Southern California" by Walter Hagedohm, President of the California State Association of Architects, who has been in this type of work for a long time. Arrangements for this program were taken care of by George Pickett '33, who deserves considerable credit for a job well done.

The first evening meeting was held on Wednesday, November 18th, at the Mary Louise Tea Room. The attendance was approximately eighty. The speaker, Mr. Trevor Gardner, is a new member of CalTech faculty in the Industrial Relations Section. He gave us an extremely interesting talk, with pictures, on "Time and Motion Pictures in Industry." Victor Veysey '36 was responsible for this excellent program.

E. Wilbur Silvertooth, '40, was awarded by the Academy of Motion Picture Arts and Sciences a certificate of honorable mention for the "design and computation of a relay condenser system applicable to transparency process projection, delivering considerably more usable light." The award was made last January. Mr. Silvertooth, who has been with Paramount Pictures, Inc., since his graduation from Tech, recently reported for duty with the Army.

Dr. Fritz Zwicky, professor of astrophysics, discovered a nova in the constellation of Cygnus while observing from Mt. Palomar. Observatories all over the world have begun observations upon the remarkable changes in this star's spectrum, which will contribute to the knowledge of stellar structure, and of atomic structure as well.

"JUNK RAINS HELL ON THE AXIS"

ENGINEERS AND THE M. B. A. DEGREE

By JOSEPH F. MANILDI

Graduate Assistant in Electrical Engineering, California Institute of Technology

In a social era universally characterized by its dependence on technological developments and advancements to maintain its existence, a relatively new type of trained men is coming increasingly into demand. This is the man whose fundamental college training has been technical and who has had an intensive course of training in the basic fundamentals of business administration.

As recently as twenty years ago the makeup of a typical manufacturing or technical development concern was divided very markedly into two distinct groups. First, that group of men who had the technical knowledge and concerned themselves only with technical problems, and second, that group whose responsibility it was to handle the administration of the organization, the so-called "business men". There were few men indeed in either of these groups who could understand or were capable of doing the work of the other group. Technical training was strictly technical, and business training, with few exceptions, was only to be had by actually working in a business concern. The result was that the technical personnel were completely ignorant of the problems in economics and human relations which confronted industry, and the administrative personnel knew little of the technical problems which confronted their organization.

When competition in industry began to make itself more keenly felt in the period following the last war, this problem was brought to light. The result was that many technical schools broadened their curricula to include social and economic studies. Schools of business administration, both undergraduate and graduate, were instituted in many major universities. The demands of a fundamental technical training were such, however, that only a limited amount of time and effort could be devoted to non-technical subjects.

The non-technical subjects which began to appear on the curricula of technical schools in the 1920's, however, were directed toward the solution of a more pressing problem, from the standpoint of the engineer. This was the problem of giving the students a social and cultural education which was sadly lacking. The importance of social presentability, personality, and a mental outlook which gave the student a sound perspective on a rapidly changing social and economic structure, was realized. This problem has by no means been solved, although much advancement has been made. As late as 1938 surveys have shown that the greatest number of "failures" in technical fields could be blamed directly to the lack of the qualities mentioned above.

The direct result of this phase of the general situation was that business administration subjects could be justly given only a very small part in technical schools. The segregation of technical and administrative personnel, although really not so acute by 1930, was still an existing problem. The onset of the depression in 1930 brought this problem into increasing importance. The necessity of close analysis of operations, of operating at maximum efficiency, of maintaining satisfactory human relationships, all brought down on the shoulders of the executive group the increasing demand that they be closely familiar with, and have a basic understanding of all phases of their particular industry, including the technical.

It was about this time that graduates from technical schools began entertaining to any great degree the notion of undertaking a graduate course of study in business administration. Most of the men doing so did it with the intention of making administrative work their vocation. Some, however, did it only with the intention of supplementing their technical training.

The response of industry to men trained in this manner was immediate. Foremen, shop superintendents, cost accountants, and even finance men in industrial corporations found a technical background useful in their jobs. Salesmen for manufacturing companies had to have a technical knowledge of their product, and here again the salesmen, and sales executives with engineering backgrounds formed their place.

To appreciate fully the usefulness and applicability of a graduate course in business administration, it will be advantageous to outline briefly the type of training offered in schools similar to the Harvard or Stanford Graduate School of Business Administration. The curricula of these schools are intended primarily to give training in business methods which will be applicable in any organization, rather than to prepare an individual for any particular type of business or industry. The analytic type of approach to a business problem is stressed. In this respect, there is considerable resemblance between the technical and business training. The similarity ends here, however. Business problems are by nature closely tied in with human relations and personal factors. Hence, the analyses of these problems do not adapt themselves to invariable laws.

The course of instruction is broad and designed to cover all the essential fundamentals. Accounting, finance, industrial management, statistical analysis, and marketing are broadly covered. Text book instruction is reduced to a minimum. Case books, compiled from actual business cases, are used almost exclusively. Open discussions are carried on in the classroom, with an attempt toward segregation of the essential and non-essential factors. Emphasis is laid upon developing a systematic, logical, and open-minded method of attack on problems which are in general rather complex. Further, the analysis, to be of value, must lead to a logical set of conclusions.

Specialization in a phase of business, rather than a particular type of business, follows logically from this fundamental training. In the last year of the two-year course the student devotes a larger part of his time to some particular aspect of business activity. Having been grounded thoroughly in the essentials, he is in a position to appreciate and understand fully the specific problems he may encounter in his specific field.

This type of training is one which admittedly must be taken with the long term outlook in mind. The training is pointed toward executive positions, which of course will not in general be obtained upon completion of the work. Initial placement and salary will not necessarily be particularly different from that of an engineering graduate. However, experience has definitely indicated that on the average advancement is much more rapid. The personal limit of attainment is considerably heightened as well. It may be very aptly pointed out that the majority of higher executives today have not had exposure to this type of formal training. However, since formal instruction of this type did not exist 25 years ago, when most of our successful business men were beginning their careers, the above mentioned fact is not pertinent. The fact is that today those men who have had the business training are overshadowing their contemporaries who have not.

It may be readily seen that in a manufacturing, or otherwise technical organization, the business man with an engineering background, or the engineer with business training, is placed at a distinct advantage. The increased intensity with which all our everyday life is becoming involved with technological advancement, be it desirable or not from the sociologist's standpoint, does exist. An immediate result of this trend is the closer intimacy in which technology and business find themselves. This has been, and continues to be, an accelerating process. These generalizations hold for more today than they did ten years ago, and ten years hence will be more generally true than today. One may say without the slightest hesitation, amidst many uncertainties, that the world after the war will be a technical one.

The placement in industry of men with engineering degrees who have graduated from schools of business administration, has been, from the beginning, almost immediate. At present the demand is tremendous. It is generally felt by many executives that when a technical engineering training is supplemented by a broad training in business administration, a man's possibilities in a technical organization are almost unlimited. There are innumerable cases which can be cited of men who have failed to be given top management positions because they have been too technically inclined, and have not obtained a proper appreciation for the sales and financial point of view. Equally important is an understanding of human relations. An understanding of the technical aspects of a business, no matter how thorough that understanding may be, is not sufficient by itself to present to an individual the possibilities of top executive positions.

Placement statistics (Table 1) from the Harvard Graduate School of Business Administration, indicate clearly the fact that more and more graduates are being placed in manufacturing concerns. The percentage of men placed in such concerns has almost doubled in the last ten years. The breakdown of figures indicate a fluctuation of emphasis from Production Engineering to Manufacturing Sales and Research. The man with an engineering background will fit ideally into either one or the other of these categories. The increasing number of men placed in these positions indicates the growing demand for men who are capable of filling positions in technical organizations since manufacturing is basically technical. These figures do not indicate clearly what the demand is, since there is always a considerable lag between a trend in demand and the supply to fill the demand. The rapid trend indicates a much stronger use in demand.

The placement figures for the year 1942 are shown in table II(A). The drop in percentage of men placed in manufacturing positions is clearly a result of the large percentage of men called into the armed services. Table II(B) shows the percentages, excluding those men who were taken into service, which gives a clearer picture of industrial demand.

TABLE I.*

PLACEMENT STATISTICS AS OF OCTOBER 1 FOLLOWING GRADUATION

(Including Midyear Graduates)

Percentages

	1929	*1930*	*1931*	*1932*	*1933*	*1934*	*1935*	*1936*	*1937*	*1938*	*1939*	*1940*	*1941*
Manufacturing (Total)	19.0	20.0	18.6	10.4	19.1	19.5	21.4	26.2	29.0	34.2	39.0	42.7	40.3
Production & Engineering	7.3	7.8	5.5	2.5	8.1	6.4	6.9	4.9	8.9	10.5	8.3	15.4	21.3
Manufacturing Sales & Research	9.2	7.2	7.1	5.1	6.4	7.0	7.6	13.5	9.3	12.7	15.9	14.2	6.2
Accounting & Industrial Finance	0.7	2.2	2.9	1.8	1.5	3.5	5.2	7.0	9.5	8.8	6.8	8.0	7.0
Other	1.8	2.8	3.1	1.0	3.3	2.6	1.7	0.8	1.3	2.2	8.0	5.1	5.8

TABLE II.*

PLACEMENT STATISTICS— JUNE, 1942 AS OF JULY 31, 1942

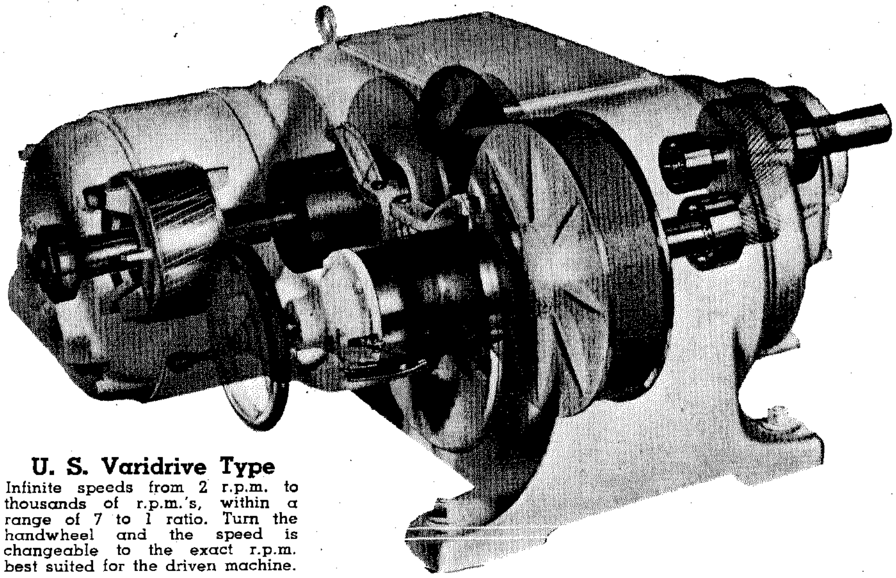
	A.		B. (Excluding service men)	
Active Service		62.8%		
Manufacturing		22.7%		61.1%
Production, Engineering	15.4%		41.5%	
Industrial Sales	1.2%		3.2%	
Market Research	1.2%		3.2%	
Advertising Dept.	.0%		.0%	
Ind. Accounting	3.8%		10.2%	
Other Departments	1.1%		3.0%	
Other Industrial Fields (Finance, Marketing, etc.)		14.5%		38.9%

**Harvard Graduate School of Business Administration.*

The effect of the war is seen quite markedly. The placement in manufacturing concerns has increased markedly over 1940 and 1941. The emphasis, in breakdown, is seen to be definitely in Production and Engineering. This, of course, is a logical result of the nations expansion of production facilities for war effort. More than ever before, the business man with a technical background is in demand. The multitude and enormity of the problems facing industry in a period of such unusual expansion present unlimited possibilities to the technical administrator. More than ever before, the executive is confronted with the necessity of being completely familiar with the technical set up in his particular organization. Much of the criticism which has been levelled at the inefficiency of our industrial system to adapt itself to war demands has been a direct result of the lack of understanding which many administrators have of technical problems, as well as the lack of knowledge which engineers have of administrative problems.

It can be said in general at the present time that if there were ten times as many men graduating from business administration schools with engineering backgrounds as there are now, they

(Continued on page 18)



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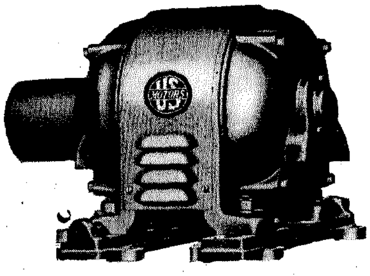

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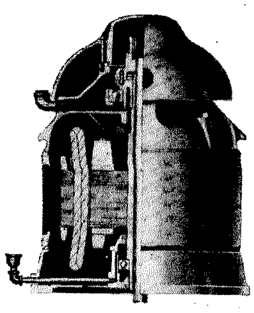

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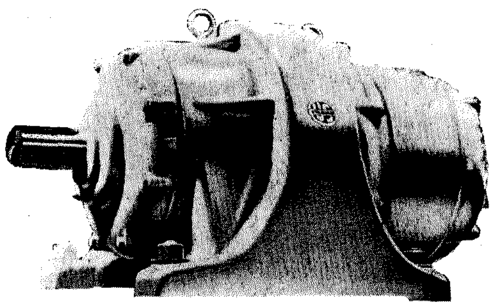

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POWDER METALLURGY

Instructor, California Institute of Technology

By WILLIAM F. NASH, JR.

The utilization of powdered metals for the production of machine parts which heretofore could only be produced by casting or forging a restricted group of alloys has made tremendous strides and has opened new vistas for the fabrication of metals and alloys. For many years tungsten lamp filaments have been produced by sintering compressed tungsten powder. The wide application of this procedure to the fabrication of parts has given rise to a new branch of metallurgy now referred to as "powder metallurgy."

In short, the procedure of making an object from powders involves two steps. The first step is the formation of a compact by the compression of individual, mixed, or alloyed metal powders in a die. The second step is the heating or sintering of the compact to coalesce, alloy, braze, or weld the particles together at a temperature below the melting point of the powder.

Powder metallurgy is divided into two divisions; first, the production of powders and, second, the production of objects from the powders. Metal powders are produced by many different methods. In some cases a powder of 200 mesh screen analysis is produced by stirring the metal as it solidifies. Such a powder is well-suited to pressing and sintering. Powders of iron, nickel, cobalt, tungsten and alloys of these elements have been produced by condensation from the vapor phase. Other methods include chemical reduction of oxides, precipitation from metallic salts and electrolytic deposition.

* * * *

While there are many methods of powder production, the methods of consolidating the powders are limited. Basically there are but two, namely, cold pressing and hot pressing. In either of these methods the pressure can be varied between atmospheric pressure and 350 tons per square inch; but the usual range employed is between 10,000 pounds per square inch and 60,000 pounds per square inch.

In the cold pressing operation the powder or powders are compacted in a cold die under pressure. In this method the powder is introduced into a die of the shape of the final product. The amount of powder is either weighed or measured volumetrically. In high production machines the powder is fed in through chutes. A plunger is inserted and the powder pressed either by hydraulic pressure as in the case of the larger products or by a toggle mechanism as in the case of small, high-speed machines. The rate rate of application of the load depends upon the equipment. Less air is trapped if the load is applied rapidly; however, in the larger presses rapid application of the load is more difficult. The time the load is maintained after application seems not to affect the compact after pressing or during or after sintering.

The die design for cold pressing is straightforward. The die must, of course, have strength sufficient to withstand the pressures applied. Sufficient clearance must be left between die and plunger to allow for escape of gases during pressing, but must not be enough to permit escape of fine powder. Dies and plungers with a slight taper are recommended for certain applications. Galling between die and plunger may occur if the powder adheres to the die wall. This may be minimized by use of a proper lubricant. Cold pressing may be readily adapted to pressing in vacuo or controlled atmosphere by suitable seals on the die; however, such control does not lend itself to mass production, upon which the success of powder metallurgy depends.

Hot pressing involves the simultaneous application of pressure and heat. The same problems of die design are encountered, coupled with choice of material which will withstand high pressure and heat without undue oxidation. The most serious problem is that of cooling the die between pressings, which is necessary to prevent gas absorption if the powder is exposed to the air when introduced into the hot die. In hot pressing, the addition of heat adds to the plasticity of the particles, permitting more intimate bonding and higher density. The higher hardness obtained might be attributed to the higher density, but cannot be correlated with the lower hardness of wrought material which has higher density. Hot pressing is usually used where higher hardness and density are desired.

Cold pressing may be used for producing either porous compacts as are required in some bearings or for high density compacts where strength and hardness are desired. The porosity can be controlled between wide limits (15 per cent to 50 per cent) by proper choice of particle size and applied pressure. Hot pressing is usually used where higher hardness and density are desired.

Pressing of powders serves several purposes. First, the shape of the piece is determined. Second, the particles are brought into more intimate contact, which in ductile materials may mean local deformation of particles to conform with neighboring particles, or in brittle materials, an interlocking of particles. Third, due to movement of particles past one another, absorbed gas films may be broken down locally, leading to a "cold welding" of particles which may be of considerable strength. Fourth, trapped gases are partially expelled.

It has been shown by several investigators that clean surfaces, whether metal or glass, when in contact exhibit a bonding. This bonding occurs with no pressure except atmospheric pressure, but increases if the surfaces are pressed together by an outside force. This phenomenon has been called "cold welding", or sintering. The external application of force probably serves to bring about better contact over a greater area, for no matter how carefully the surface is mechanically polished, surface imperfections would still be very gross when considered on an atomic scale. The simultaneous application of heat and pressure would increase this type of bonding by making more intimate contact due to increased plasticity at elevated temperature and also due to increased atomic mobility and greater diffusion which should increase the strength of the bond. Those compacts produced by cold pressing must be heated to produce a structure which has useful properties.

* * * *

Heating a previously pressed compact brings about structural changes such that equiaxed grains, as found in cast or cast and forged structures, are obtained, without reaching a temperature which would cause melting of the metal or alloy. In many cases some bonding takes place at a temperature as low as one-third the melting point of the metal or alloy.

High melting alloys of tungsten, molybdenum, tantalum and columbium cannot be processed easily by conventional casting techniques. However, these metals in the powdered state can be pressed together and heated in a controlled atmosphere at temperatures somewhat below the melting point of any component to produce alloys. Bonding will take place to such an extent that the alloys can be forged and further heated to produce a sound, strong compact. Contamination by furnace lining, losses by oxidation and undesirable atmospheric components can thus be eliminated or closely controlled.

Electric contacts can be produced exhibiting unusual properties. Silver or copper powders are mixed with tungsten, molybdenum or nickel, pressed and heated. The temperature is kept low so that bonding takes place with little diffusion between the component powders. The silver or copper thus retains its high conductivity while the alloy additions increase the hardness of the "alloy" and reduce the tendency for fusion between contacts.

Another application in which true alloying is not the objective is the production of a so-called "heavy metal." This is produced by compacting and sintering a mixture of 90 per cent tungsten powder, 5 per cent copper powder and 5 per cent nickel powder. The final product has a density 50 per cent greater than lead. It can be used for storage of radium and balancing of moving parts such as crankshafts, variable pitch propellors, vibration dampers, etc.

Cemented carbide high-speed cutting tools are produced by bonding hard, brittle tungsten carbide with tough, shock-resistant cobalt, thus yielding a product having desirable characteristics of each component. Diamond dust also has been mixed with various metals to produce a tough, well-bonded grinding or cutting tool superior in many respects to one in which the diamonds are individually set in a metal matrix.

Unusual structures can be developed by proper control of the particle size, shape and nature of component powders, pressing pressures, and heating or sintering temperatures. Porous self-lubricating bearings are one of the outstanding products in this classification. These bearings are produced by mixing proper proportions of copper, tin and graphite powders, compacting at low unit pressures and sintering so as to leave pores in the compact. These pores or intentional cavities may be interconnecting so that oil may be supplied through the bearing, or, if not completely interconnecting, of such a nature as to act as a reservoir for the oil.

Metals not miscible in either the liquid or solid state can be mixed compacted and sintered to give good dispersion of one metal in the other. Bearings and electrical collector brushes are made from copper and lead powders. Metals having very different melting points may be alloyed with less difficulty by pressing and sintering. Volatilization losses are avoided and desired analyses are more easily produced. Metal objects of high purity can be produced by sintering powders because there is no reaction between a molten metal and refractories, gases and scavengers. The chemical purity of the metal powders used is usually greater than that of metals otherwise commercially produced.

One of the best known items produced from powder metals is the filament in the electric light bulb. Tungsten has all the desired characteristics for a filament, but due to a melting point of 6098°F (3370°C) it is very difficult to melt and cast. Tungsten powder produced by chemical reduction, is pressed and then heated in a controlled atmosphere by passing a high electric current through the compact. After one heating the bond is such that the compact can be forged. By repeated forging and heating an excellent bond is effected and the compact may be rolled and then drawn into wire.

The foregoing applications of powder metals, while valuable, are limited in their extent. The extensive use of powder metals will necessitate the development of forming processes to such a degree that the products can compete on a favorable basis with those produced in the conventional manners, i. e., casting, machining, forging, etc. One advantage in producing objects from powder metals is that the products can be formed to finished dimensions with very little or no machining. Small spur gears are now being so produced, with little or no waste material. This type of application is, however, limited to smaller sizes because of limitations in the processes employed.

The few general applications given show definitely that powder metallurgy has earned a permanent place in the general field of metallurgy. However, it is not a panacea for metallurgical and production problems as there are at present several limitations on the use of the powder metals. First, there is the cost of required equipment. The dies in which the powder is compacted must be able to withstand a unit pressure of 60,000 pounds per square inch and over. This problem, however, is not as serious as that of providing a press which can exert such pressures on an appreciable area. At present there are few such presses; consequently the size of the product is limited. Since equipment costs will be high, powder metal products will fall more nearly into a class with die castings than sand castings, as mass production is necessary to warrant the high initial expense.

Another very serious limitation is the fact that metal powders do not act as perfect liquids under pressure. Due to friction between grains and on the die wall, a difference in pressure is established both parallel and perpendicular to the direction of pressing. This limits the size of pieces which can be made with a uniform structure. A larger pressure differential is obtained parallel to the direction of pressing. Such a pressure differential cannot be eliminated and hence may always limit the size and complexity of pressed powder objects. The importance of uniform pressure is due to the phenomenon of expansion and contraction of pressed compacts during heating. The compacts pressed at high pressures expand on heating, and the compacts pressed at low pressures contract on heating. Expansion or

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JAPAN

By RAY CROMLEY, '33

The Wall Street Journal

Japan's economic strength lies in Japan's ability to regiment every man and woman, every scrap of metal, every machine and every grain of rice for the use of the army and navy. Japan is fighting a total war. Men, women, children, food, ships, schools, factories and farms are pawns, valuable only as they aid in producing battlefront victories.

Japan, because of the war, is willing to sacrifice the health of its women in coal mines. These women work only in the worst mines, in the small seams too narrow for men. The country is sacrificing its peacetime industry for the production of munitions, the health of its children in order to switch more crop areas from vegetables to the production of potatoes for industrial alcohol. Today's food is cut to a starvation level in order to store it against a future blockade.

This may seem brutal. This may seem that Japan is ruining its future citizenry. But it makes Japan terrifically strong militarily now.

Japan's war-time industrial strength lies in the close cooperation between industry and the military. Economic regimentation of Japan was easily accomplished because industry and commerce already was tied up in the hands of less than a dozen major family companies. Efficiently organized, these concerns were able to switch the whole of Japan's production from peace to war in a few years. Their power made possible a nearly airtight control of production, of the use of raw materials, of the use of food and labor and of the use of factories—so that nothing would be wasted on peacetime effort.

Their businessmen have kept up with the latest in industrial and munitions methods throughout the world. The military and industrial leaders, in close teamwork, have worked out methods for using the latest industrial methods for improving military technique. The military has thus been able to utilize the great resources and the brains of Japan's up-to-date private industry.

Japanese industry went further. Japanese ships were built so that they might rapidly be converted into troopships. When the army bogged down in China, the great commercial House of Mitsui stepped in and solved the army's supply problem almost overnight. Mitsui and Mitsubishi advisors were at the right hand of the army and the navy on the advance south to the Dutch East Indies. They had the responsibility of securing for the military the resources and the food of the newly-conquered areas.

Japanese may not be inventive, but because of Japan's bright businessmen and their world-wide commercial interests, the Japanese have not had to be inventive or original. They have had the pick of the world's inventions to use as their own. They have had their choice of the world's engineers. They have traded silk and tea and cotton textiles for airplane patents and industrial and military coaching.

Japan is strong, industrially speaking, because it has been willing to do things the inefficient way. Japanese industry has sacrificed huge profits in past years in order to perfect a self-sufficient war machine that could not be blockaded out of existence.

Japan has not wasted precious machinery and metal if a job could be done by cheap—though inefficient—labor. Japan has sacrificed billions of yen in Manchukuo, building up an inefficient war industry, and other billions in Japan establishing uneconomical war production methods and wasteful substitutes. Iron ore could be bought in the Philippines for less than the Japanese paid in Manchukuo. Staple fiber costs more than cotton and lasts less than half as long. Alcohol is much more expensive than gasoline, but the Japanese pushed alcohol output with all their might. Japanese drove production costs so high that American machinery, produced with highly-paid American labor, cost less than Japanese machinery produced with cheap labor. Japan perfected substitutes that had only the value that they could be produced in Japan. Oil was manufactured from coal at exorbitant cost. Factories were made out of wood. Automobiles were run on charcoal. Whaleskin was used for shoes. *But these same inefficient devices make Japan able to withstand blockade and carry on an aggressive war.*

Japan's war industry is strong despite Japan's comparatively weak over-all production because, cancer-like, the war industry has grown as the expense of the peace-time industry. While Americans were perfecting commercial planes, the Japanese were building war planes which were combinations of the best features of American and European planes produced with the aid of American and European patents. Instead of building automobiles, Japan was building trucks and tanks. Instead of building schools, Japan was setting up training workshops, preparing men for work in the war industries. Japan's war industry is thus new and comparatively efficient, though Japan has never sacrificed output for the sake of efficiency.

All the funds that could be spared during the past few years in Japan have been spent for the importation of raw materials and essential machinery which Japanese mines and Japanese engineers could not produce at home. This has gone into Tokyo's enormous stockpiles. Japan has imported so far in advance and has so channeled its use of essential raw materials and machines to the war industries, that it may be possible for Japan to go on building up its war industry for some time to come. Iron and copper and lead and zinc have not been "wasted" on peacetime factories or jobs. They have all gone to war.

Labor has also been regimented for the utmost effect in war production. Japan's manpower has been thoroughly classified, with every man and woman's vocational, educational and health qualifications listed. Japanese men and women, like Japanese soldiers, can be ordered to war industry or other essential work. I have seen these reports. They are detailed and complete. They make it possible to use Japanese labor to the last man. To take the places of men called up to the front and to industry, I have seen children of perhaps twelve to fifteen years of age working on the railways—taking tickets, fixing the roadbeds. To supplement Japanese labor, Korean and possibly Chinese labor has been brought in to work mines and farms. Japan is determined not to be caught short of workmen.

Japan's industry prepared for the southward move. Plantation mine and industrial overseers, foremen and skilled workmen, were trained in pilot plants in the South Seas, and in training areas in Formosa, the Japanese mandated islands and Japan proper. Japanese businessmen built up close connections with southeastern Asiatic businessmen, gathered important data about key mines, agricultural production, ability of native labor and the "trustworthiness" of the local populations.

And finally, the army and navy, with the cooperation of industry, worked out a military campaign that would utilize Japan's economic strengths and not bear too heavily on its weaknesses. Japan's military strategy to date has reflected the necessity of reaching decisions without too great an expenditure of scarce raw materials, munitions and men. Japan seemingly does not feel ready to carry on a continental war of the Soviet-German type. Its shortages may prohibit this type of war, unless Japan's leaders grow less cautious.

Japan, by its military campaigns, has increased its economic strength enormously, with the oil, the bauxite and the rubber of the Dutch East Indies, the iron and copper ore of the Philippines, the iron ore and manganese and tin ore of Malaya, the lead and zinc and oil of Burma, the rice of Thailand and the corn, rice and phosphates of Indo-China.

But if Japanese industry, by preparing for war, has made itself much stronger than had been supposed, it nevertheless is left with basic weaknesses. These weaknesses will, in the end, open the door for an Allied victory.

America's leading strength in a war with Japan is neither the stupendous amount of its raw materials nor its hugh industrial production. America's war economic strength lies rather in *democracy.*

Democracy in the schools and business has produced the questioning mind. Experimental laboratories in high schools, colleges and the huge research programs of private industry have built up a corps of trained men that Japan cannot match. In order to push through Japan's program of regimentation, the questioning mind has been discouraged. Schools have taught men to believe, rather than criticize. Industries have found it cheaper to buy their new ideas abroad. Japan realizes this mistake now, and is attempting frantically to build up research laboratories and train engineers. But Japan has waited too long. There are good engineers and excellent scientists in Japan. But there are all too few for Japan's needs.

I am convinced that this war will be won by new inventions, new improvements in old inventions, new techniques which take advantage of new instruments and new ways of using for now utilized for photographing and thus condensing for air-mailing the millions of letters which soldiers and sailors and their families will write in this war. This saves essential tons

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". . . THE END OF THE BEGINNING"

By J. E. WALLACE STERLING

Professor of History, California Institute of Technology

On Sunday, November 15, the churchbells of Britain were rung in grateful celebration of the victorious Battle of Egypt. That battle had begun just more than three weeks earlier, on October 23. While the world waited to learn if the reinforced and newly equipped British Eighth Army would this time be able actually to destroy the Axis forces under the command of Field Marshal Rommel, there came the breath-taking news that a great American and British expeditionary force had made landings in French North Africa. It was at once clear to the interested observer that the Battle of Egypt and the landings in Morocco and Algeria were two related parts of the same campaign. Two days after these landings had been made, Prime Minister Churchill spoke at the Lord Mayor's dinner at the Mansion House. He recapitulated briefly the exciting Allied accomplishments of the previous three weeks, and placed them in perspective by saying: "Now, this is not the end. It is not even the beginning to the end. But it is, perhaps, the end of the beginning."

On the next day — Armistice Day, November 11 — Mr. Churchill reviewed for the House of Commons the planning and preparations which made possible the momentous campaigns in North Africa. The speech in which he made this review is the best exposition yet made of what had happened in Allied high places during the first nine months of 1942, especially during the months since June. It throws more light on the "second front" problem than any official statement made heretofore.

It will be recalled that Prime Minister Churchill visited President Roosevelt in Washington late last year, after the outbreak of war in the Pacific. During that visit decisions were made and strategic plans were submitted for further study. Among the decisions made was one already mentioned in a previous article in this series, namely, that the major emphasis of the Allied war effort should be directed first against the European end of the Axis. Both Secretary of the Navy Knox and First Lord of the Admiralty Alexander revealed this decision in public statements during the month of January, 1942; they pointed out that the outbreak of war in the Pacific had not altered the determination of the leaders of the United Nations to deal the first of their heaviest blows against Germany and Italy.

With this decision taken, it remained to determine by what plan it could be most effectively put into effect. How many plans were considered has not been made known, but Mr. Churchill has revealed that two plans were agreed on for further study. One of these plans held in prospect an Allied invasion of French North Africa. President Roosevelt strongly favored this scheme, as did the British. But there were some doubts that operations based on this plan would bring as much relief to hard pressed Russia as would an invasion of western Europe. Consequently, it was decided in Washington at the end of last year that both plans should be studied "with the utmost attention"; meanwhile preparations were undertaken to make possible the carrying out of whichever plan should be adopted.

During spring and early summer it became clear, according to Mr. Churchill, that there would not be available a sufficient number of landing craft for the invasion of western Europe during the "favorable-weather" period of 1942. Consequently, when General Marshall and Admiral King visited Britain in July, it was decided to go ahead with the plan for the invasion of North Africa, while taking sufficient action with regard to western Europe to tie down enemy forces in that sector. From that time on, all energy was applied to complete necessary preparations as quickly as possible; even so, more than three months elapsed from the time of the final decision to the actual invasion.

This decision fitted well with one already taken by Britain to strengthen the Eighth Army in Egypt. Rommel's victorious sweep eastward from his lines at El Agheila across Libya into Egypt occurred in June; by the end of the first week in July he had been stopped some 65 miles short of Alexandria. There he remained for four months, until the Eighth Army attacked in force on October 23. The reinforcements, without which the attack of October 23 would have been impossible, left England in late May or early June, that is to say before Rommel had well begun his advance across Libya; and the heavy guns and the heavily armored and gunned tanks, which the reinforced Eighth Army have recently used to such good purpose, had left England before Tobruk fell to Rommel on June 20-21. As a matter of fact, the fall of Tobruk found Mr. Churchill in Washington. The news came to him as a severe blow, but the blow was somewhat softened by the alacrity with which American aid was made available. Mr. Churchill described what happened as follows:

> They [United States officials] had no thought but to help. Their very best tanks, the Shermans, were just coming out of factories. The first batch of them had been waiting for them. The President took a large number of these tanks back from the troops to whom they had just been given. These were placed on board ship in the early days of July and they sailed direct to Suez under American escort.

Thus the decision to prepare for the eventual defeat of Rommel in Egypt and Libya had been taken in Britain before the final decision to invade French North Africa had been made. Rommel's victories of June took heavy toll of the British Eighth Army and its heavy weapons, so that after July the Allied problem in Egypt was not merely to reinforce but also to rebuild the forces there. When Mr. Churchill visited Egypt early in August on his way to Moscow, he made changes which were designed to expedite this rebuilding process. General Alexander replaced General Auchinleck as Commander in Chief, and General Montgomery was given command of the Eighth Army, formerly commanded by General Ritchie. In addition, General Alexander was relieved of responsibility for the armies in Syria and Persia. These armies were regrouped under a new command placed in the charge of General Maitland Wilson. Thus enabled to concentrate their attention and energies on preparations for the defeat of Rommel, Generals Alexander and Montgomery trained their new troops in the use of improved equipment which began to reach Egypt in August. When Rommel tried to beat the Allies to the punch by attacking their lines on the night of August 30-31, the units being trained in the Allied rear were not yet ready for battle. But Rommel's attack bogged down after three days and he was obliged to withdraw with heavy losses to the positions from which his attack had been launched. Seven weeks later, when the Egyptian moon was near the full, the carefully trained and heavily equipped troops of the Eighth Army went into action. The battle was opened by an intensive artillery barrage from 25-pounder guns distributed along the front, one to every 23 yards. (In weight of metal hurled, this artillery concentration compared favorably with the barrages of 1918 against the Hindenburg Line, when an 18-pounder gun was located every fifteen yards along wide fronts.) After the artillery barrage, the infantry moved forward, clearing a way for the tanks. The tanks themselves were used to exploit the break-throughs made by artillery and infantry. This tactic represented a change from tactics employed in the earlier fighting in Libya, when the initial blows in pitched battle were dealt by tanks. The effectiveness of the new tactic is a credit to the skill and forcefulness of Generals Alexander and Montgomery.

Once the High Command of Britain and the United States had decided on the North African campaign in preference to the invasion of Western Europe, it was necessary that Stalin be informed of the decision. The prime purpose of Mr. Churchill's visit to Moscow was to convey this information. All British promises to Russia have been made "in writing or given across the table in recorded conversations with the Soviet representatives." In accordance with this practice, Mr. Churchill had written to the Russian Government in June stating that Britain could not promise to invade the continent in 1942, although they were speeding preparations to undertake the invasion as early as possible. Unquestionably, however, the Russians had entertained hopes that these preparations would be successful enough to make the invasion possible in 1942. Therefore Mr. Churchill's task of telling the Russians that their hopes could not be realized was not a pleasant one. But, said Mr. Churchill,

> The Russians bore their disappointment like men. They faced the enemy and now they [have] reached the winter successfully, although we were unable to give them help they so earnestly demanded, and had it been physically practical, would so gladly have afforded.

Mr. Churchill also offered an explanation of the much-discussed communique which emanated from him and President Roosevelt in the second week of June. This communique, it will be recalled, stated that Britain and the United States had signed pacts with Russia concerning the prosecution and conduct of the war and that these three powers had reached a full understanding "with regard to the urgent tasks of creating a second front in Europe in 1942." It is now clear that the deliberately vague wording of this communique was in accord with the written statement sent by Mr. Churchill to the Russian government. Neither the statement nor the communique made any explicit promise to invade Europe in 1942, although both held out hopes that such an invasion might be possible. It was not until mid-August that Stalin learned from Mr. Churchill's own lips that the plan for invading Europe had been abandoned for 1942. Mr. Churchill met the charge of having thus allowed Russia to entertain false hopes by explaining that the purpose of the communique was to deceive the enemy. He contended that the Russian ally had not likewise been deceived because of his written statement of June.

Just how the costly Dieppe raid of August 19 fits into this picture is not yet clear. It was, of course, important that the Germans be made to expect an invasion of the continent. Such expectation would have the effect of tying down German troops in the West, some of which might otherwise conceivably have been used in Russia. One possibility is that the Dieppe raid was intended to intensify the threat of invasion, and thereby make doubly sure that the German defensive positions in western Europe would be held in strength. German troops garrisoned in Norway, France or the Low Countries were not available for service elsewhere on short notice,—and elsewhere included North Africa as well as Russia. The Dieppe raid may, then, have been part of the whole plan to deceive the enemy. But the heavy losses incurred by the raiders suggest that a high price was paid merely for a piece of deception. The raid almost certainly had other purposes, such as the testing of landing equipment and tactics, the collection of information about German defensive strength, and about German plans for the use of the Luftwaffe in the event of an allied invasion. If these purposes were served, as Allied officials have said they were, then even the heavy losses may be justified, for the knowledge gained in the raid will presumably be turned to good advantage when the invasion of the continent is undertaken in force and in earnest,—as Mr. Churchill has assured us it will be in due course. If the Dieppe raid was thus undertaken primarily for these latter purposes, it is entirely possible that it was so timed as to make more ominous the threat of invasion implied in the joint British-American communique issued in the second week of June.

When Mr. Churchill credited President Roosevelt with the authorship of the plan for invading French North Africa, he was being overly modest. Mr. Churchill and his military advisors have long recognized the strategic importance of the whole Mediterranean area; and well they might, for their conduct of the war has been seriously handicapped by the fact that the entry of Italy into belligerency made the Mediterranean route unsafe for Allied transport. Great sacrifices were made and high costs paid in order to keep Malta provided with food, equipment, and men necessary for its defense. Similarly, high priority was given to the Egyptian and Near Eastern theaters of war. The successes of the present North African campaign were made possible not only by those who planned it but also by the fact that bases in the Mediterranean area had long been held against great odds. From Malta and Egypt, the airpower and seapower of the United Nations struck heavily at

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THE ELECTRIC UTILITIES AND THE WAR

By FRED T. SCHELL, '27

Southern California Edison Co., Ltd.

The mobilization and intelligent use of the Nation's manpower is being emphasized by our national leaders as of extremely vital importance to the success of our war effort. That this problem would become all the more complex, were it not for the extensive electrification of industry and its resultant use of large quantities of electrical energy, is obvious.

As a result of the many new developments in the electrical field over the past decade, we have become increasingly dependent, in our domestic, social, business and industrial life on an adequate, firm and uninterrupted supply of electrical energy. The necessity of such a supply of electrical energy for the operation of the camps and training centers of our armed forces, to the production of food, to the maintenance of our communication systems, water supply and public health and safety became even more vital with the advent of war. Since industry has been charged with a great responsibility in meeting the production schedules established for war material, its electrical requirements have increased accordingly. In fact, in perhaps no other field of endeavor, is an ample, uninterrupted supply of electricity so essential today to the success of the war effort.

The electrical utilities are the chief source of supply of this electrical energy. Sales by the utilities to industry are indicative of the important function they are performing in the war program. This is readily illustrated by the growth of kwhr consumption by industry from the beginning of the defense effort up to December 7, 1941.

In January of 1938, industry was purchasing approximately 3½ billion kwhrs per month from the utilities. In the spring of 1940 this consumption had risen to approximately 4.6 billion kwhrs per month. By December of 1940 it had increased to 5.5 billion kwhrs and by December of 1941 to approximately 2.3 billion kwhrs since the spring of 1940. This of about 2.3 Billion KWHrs since the spring of 1940. This increase of approximately 61% can be largely traced to the effects of our defense program and our lend-lease agreements. Total energy delivered by the utilities to all classes of customers during the year 1941 was approximately 140 billion kwhrs, representing an increase of 18% over 1940.

With such a trend being established, the electric utilities and government agencies found previous estimates of required generating capacities rapidly being confirmed. Scheduled increases in plant for the year 1941 provided for net additions of pproximately 3,112,000 kw but actual installations fell short of this by 600,000 kw. Delay in completion of some projects was the result of shortages of material, labor difficulties and heavy demands on turbine manufacturers for other products. Peak loads actually increased about 3,250,000 kw but the industry still had a reserve of better than 9,000,000 kw of capacity.

Coupled with these plant increases were the power pools and inter-connections being established throughout the country. In the State of California inter-connection of the systems of the Pacific Gas & Electric Co., Southern California Edison Co., Ltd., California Electric Power Co., the San Diego Gas & Electric Co., the Los Angeles Bureau of Power and Light and some other municipally owned systems had already been established. These inter-connections were later reinforced to provide for the interchange of greater blocks of energy. Similar programs were being consummated throughout the country so that the possibility of power shortages in any area would be reduced to a minimum.

With the announcement of the Japanese attack on Pearl Harbor, no cause for undue concern over the utilities ability to supply power requirements arose. Instead, since no immediate impact was felt—insofar as system demands were concerned, time was available for a recheck on the estimated requirements during the ensuing years of conflict and the ability to schedule new plants to meet those demands. As a matter of fact a resurvey of scheduled additions was made by the industry as of December 1, 1941. The results of this survey appear in Table I.

SCHEDULED PLANT ADDITIONS 1942-44*

	1942 kva	1943 kva	1944** kva
Private Companies	2,384,000	1,958,000	963,000
Municipal Plants	123,000	117,000	90,000
Governmental	1,157,000	671,000	344,000
TOTAL	3,664,000	2,746,000	1,397,000

*For the entire country.

**Incomplete.

Edison Electric Institute Bulletin, December, 1941.

The advent of the war caused further emphasis to be placed on the continuity of service provided by the utilities. Fortunately nearly all utilities had learned through experience the necessity of establishing rather elaborate emergency programs to meet the conditions encountered in major disasters. The disasters of fire, flood, wind and earthquake, visited upon us had resulted in extensive planning and programming of emergency measures designed to restore service as rapidly as possible. Many utilities had already inaugurated two-way radio communciation between dispatching centers, substations and even on patrolmen's cars. Troublemen and line gangs had been schooled in a definite plan designed to restore service first to those customers whose needs were most vital such as hospitals, water supply systems, communication systems, etc. These programs coupled with the automatic switching equipment in use on all major transmission and distribution systems assured the restoration of service in the event of outage in a minimum of time.

The war, of course, brought new problems to be solved to assure the continued maintenance of the high degree of continuity of service already established. Perhaps most significant of these was the problem of providing protection against sabotage. To this end anti-subversive committees, composed of key personnel, have been established by some utilities, especially on the coast. Recommendations of the Federal Power Commission, the F. B. I. and the Army and Navy have been studied. As a result, further protection to plants and facilities have been provided by installing fences and floodlighting and by posting guards around plants and facilities; employees having reason to enter plants and sub-stations have been supplied passes for proper identification; trespass signs have been posted on all properties to keep loiterers away. The use of sand bags and revetments has been utilized to protect important equipment such as switchgear, transformers and rotating machinery from damage resulting from bombing and shelling. In such instances however, precautions have been taken to assure adequate ventilation for the equipment and thus prevent the occurrence of abnormal operating temperatures due to limited air movement. Protection to equipment from incendiary bombs has been provided in some cases through the installation of sloping "Durasteel" hoods over the equipment.

Stocks of major equipment such as transformers, oil circuit breakers, etc., are not as complete as heretofore due to the limitations placed on utility inventories by the War Production Board and the large number of new installations recently made to supply war projects. In order to be in a position to make such replacements as might be necessary in the event of sabotage or damage from bombings and other enemy action, one local utility maintains rather extensive files giving complete data on key installations and other records indicating idle or under-loaded equipment available for use in an emergency. Included in such data are records of primary and secondary voltages of transformer banks, kva of capacity, transformer impedance, physical dimensions, etc. This same utility recently made a survey of any idle and under-loaded transformers on its system for this specific purpose and also to obviate the necessity of making additional investments to supply new loads.

Many other emergency measures have been taken by the utilities, too numerous to mention. Coupled with the entire program, close cooperation with the F. B. I., War Department and other government agencies has been maintained. The importance of such a program becomes all the more obvious since approval can seldom be obtained from the War Production Board to install duplicate facilities even for war production plants.

So much for the contribution to the war effort being made by the utilities in furnishing an adequate, continuous supply of electric service to the public and to all projects engaged in the war program. This of course is their fundamental purpose and their chief responsibility. Nevertheless many other services are being rendered by the electric utilities which are of direct assistance to the nation's war effort.

In the fall of 1941, the utilities of Southern California cooperated with the W. P. B., then the Office of Production Management, in obtaining an inventory of machine tools, both idle and in use, in plants throughout this area. The purpose of this survey was two-fold; first to determine which plants were reasonably well equipped to undertake the production of defense materials and second, to acquire an inventory of idle or isolated machine tools which might be acquired by operators engaged in defense production. The results of this survey were sent to Washington and no doubt influenced to some degree the large volume of war contracts awarded in this area. The local office of the War Production Board also utilized the inventory of plants thus obtained to good advantage as it assisted in locating not only those operators equipped to accept prime contracts but likewise was useful in putting prime contractors in touch with smaller operators capable of expediting the volume production of small parts and specialized items. The entire program of course accrued to the benefit of the utilities inasmuch as it assisted in keeping on the line, loads that might otherwise have become idle. Without question similar programs were carried out by other utilities throughout the nation in conjunction with the W. P. B.

As a further contribution to the war effort, the utilities are supplying their customers with the services of their engineers and other members of their personnel capable of rendering advice on power problems. In some instances engineers have even been loaned to industry at the request of the War Production Board or the Army and Navy.

In this same connection the personnel of the utilities have always included a group of men especially skilled in the application of electric service to industrial processes. It has now become their duty to assist customers in every way possible to utilize their electric service to the greatest and most economical advantage.

Some of the services performed are analyses of customers' power requirements, with recommendations for the most economical method of supply, and consultations on electrical equipment, selection of rate schedules, and maintenance facilities.

The rendering of these services to customers has been extremely valuable in getting plant production under way and in maintaining the continuous and efficient operation of the plant electrical equipment.

A smiliar staff of men especially skilled in illumination problems are maintained by nearly all electrical utilities. This personnel renders valuable assistance to plant operators in designing systems of illumination adapted to the plant's requirements, with special emphasis on speed of production and safety of workers. Similar advice has been given with regard to blacking out industrial plants without impairing production. Systems of protective lighting are designed and recommended to industrial operators by this same group of illumination engineers. Since the dimout restrictions imposed on the coastal areas have created new problems in the control of illumination, this group of men have devoted practically all of their waking hours to advising customers on ways and means of complying with the restrictions and yet retaining adequate illumination where needed. Close cooperation has been maintained by them with the Office of Civilian Defense and Army and Navy officials in order to expedite the accomplishment of the results desired.

The war has of course resulted in the electric utilities being faced with an unprecedented number of new problems of ever changing complexion. Included in these are the problems of plant protection and emergency maintenance already discussed herein. As is probably true of many industries, one of the most difficult problems facing the utilities is that of adjusting their material requirements to the new conditions brought about by priorities. The jurisdiction of the War Production Board over the use of critical materials by the utilities has been so extended that many phases of the business are affected. Some elaboration on these problems may prove of interest.

Under the provisions of Preference Rating Order P-46, assigned to the utilities by the War Production Board, certain limitations are placed on the inventories of material and equipment which may be carried in stock. This limitation has been amended from time to time and is now such that on all major material the utilities are limited to an inventory equivalent to 60 per cent of the aggregate dollar volume of such material as in inventory on December 1, 1940.

Preference Rating Order P-46 does extend priority ratings (AA5) for general maintenance and a higher rating for emergency repairs. It also extends a blanket approval, where the net material value does not exceed $1,500.00 for underground construction and $500.00 for overhead construction, for reinforcing facilities to serve increased loads, for installation of facilities to serve Army and Navy projects, for the correction of overloaded facilities and for the installation of facilities required to serve new buildings and residences provided certain other stipulations are met. In all instances, however, line extensions are limited to not more than 250 feet.

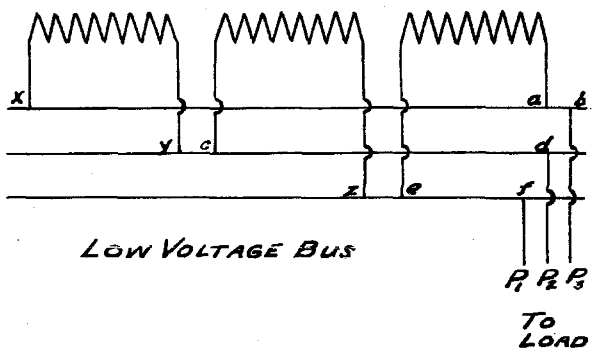
The majority of new loads being acquired by the utilities today, however, are in the heavy industrial classification, and as such require more extensive facilities than permitted under the blanket approval extended under PR-46. Special approval must be obtained directly from the WPB before the installation of facilities to serve such loads can be made. This requires the submission of a special application on each job of that character and, in order to be reasonably certain of approval, necessitates careful engineering in order to utilize as little critical material as possible. This has resulted in a tremendous increase in paper and clerical work and the burden has been spread to the commercial, operating, purchasing, stores and engineering departments of the utilities. Despite this fact, this work is being absorbed in stride by all organizations.

As pointed out in the brief discussion on priorities, new problems in engineering and design have resulted from the war. The solution of these problems rested primarily with the successful substitution of less critical materials where possible, the elimination of some protective devices or the limitation of such devices to a bare minimum, and finally more extensive studies in some instances of the existing load conditions on distribution substations and circuits.

Prior to the war all substations of 450 kva and over installed on, or adjacent to, the customer's property were of steel construction. A concrete pad was required, on which the transformers, and sometimes the oil circuit breakers, were placed. A steel rack structure was constructed to support the necessary high and low voltage busses and in some instances the oil circuit breakers and current and potential transformers. The high and low voltage busses were usually constructed of copper bus. An enclosing fence of steel wire mesh surrounded the completed substation. Today the concrete pad is constructed as usual (with some minor changes in over-all dimensions), but the rack structure is designed to utilize poles, timbers, and cross arms. Stranded copper is now substituted for copper bus.

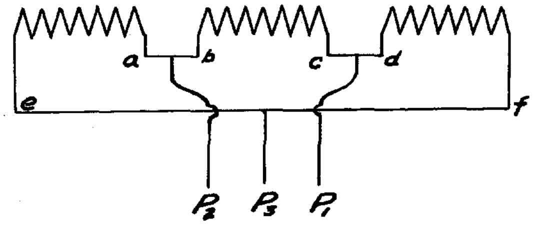
A saving in copper is sometimes effected by connecting low voltage leads of delta connected banks of transformers as shown in figure 2 in lieu of installing a bus as shown in Figure I. In the latter case (Figure I) the conductor sections a-b, c-d and e-f have to carry full line current. Conductor sections a-x, c-y, and e-z need only carry the phase current in each respective phase.

FIGURE I



Since the copper used is usually of uniform size for the entire length of the bus, more copper is used than needed to carry the respective currents and some copper is not actually needed at all. When connected as in Figure 2, short lengths may be used (a-b and c-d) by connecting between low voltage transformer terminals and then by connecting the low voltage services or feeders (P1, P2 and P3) to the mid-points of leads a-b, c-d and e-f, smaller size copper can be utilized as only the currents of the respective phases are carried by these conductors. Feeders P1, P2 and P3 carry full line current in both cases so no reduction in wire size can be made for them.

FIGURE 2



In one substation now under construction by one of the California utilities approximately 20,000 lbs. of steel would have been required for pre-war construction. The use of poles and timbers resulted in the requirement of only a few hundred pounds of steel. While the wood structure resulting is not as durable and is perhaps more subject to damage by fire, it will be adequate under most conditions for at least the duration of the war.

In one instance a utility was requested by the W. P. B. to substitute iron pipe for copper in the low voltage bus of a proposed customer's substation. Investigation revealed that the line current in the low voltage bus would be in the neighborhood of 2800 amperes. In order to use iron pipe it was determined that seven four-inch slotted iron pipes would be required per phase, or twenty-one four-inch pipes to complete the bus. Such a bus would be extremely bulky and undesirable in addition to requiring considerable more material to support it safely. As usual the utility scoured its inventory and located some copper tubing of adequate size which had recently been salvaged, and after designing special supports and connections for it, finally obtained W. P. B. approval to substitute it for the suggested iron pipe.

Rearrangements of conductors of different voltages on poles can result in savings of as much as 5 to 6 feet in height of pole required. Maintenance is usually not as conveniently handled, it being necessary to de-energize one or more of the circuits in order to work safely on other circuits, but it can be and is being done.

In areas where conductors are not subject to salt air and the resultant corrosive action, iron wire has been substituted for copper in some instances. For this purpose, ¼-inch standed galvanized guy wire is used. It is not very desirable as its resistance varies greatly with the load and it is only equivalent in current carrying capacity to about No. 14 copper. So far its use has been limited to short extensions of primary circuits.

Other problems facing the electric utilities are not unique to that industry. The conservation of rubber will be of course of prime importance. Personnel problems have multiplied. Both of these are being met satisfactorily as of this writing however. To conserve rubber, a large number of bicycles are being used for meter readers when working conjested or urban areas. Some utilities are experimenting with a plan to read meters only every two or three months instead of monthly. Others are experimenting with a plan calling for the customer to read his own meter monthly and forward the reading on a specially printed post card to the utility. This latter plan will probably only be applied to rural areas.

Losses of personnel have been incurred as with other industries. These losses are represented by those employees drafted, or volunteering in the armed forcs and thos voluntarily migrating to war industries. This problem is being met by reorganization of departments, employee training and the elimination of as much non-essential work as possible. The number of employees carried on utility payrolls have probably shown a decline to date of about 10% or better but good service continues to be rendered although some of the special customer accommodation services have had to be eliminated.

Although the kwh sales of all utilities, located in or near areas of war production or where the training centers of our armed forces are situated, have risen, revenues have not risen at the same rate. An indication of this fact is found in the following data. The utilities reported kwhr sales to all classes of customers of 10,056,629,000 kwh for September 1940 and 12,122,268,000 kwh for September 1941 or an increase of 20.5%. For corresponding months revenues of $204,434,000.00 and $225,751,400.00 were reported, an increase of 10.4% as compared to the 20.5% increase in kwhrs. An analysis of more recent figures reveals that revenues had only increased about 3% (July 1942 as compared to September, 1941) whereas kwhr sales had increased 8.6%. This can be accounted for when one considers that certain conditions, brought about by the war, have a definite bearing on the revenues of utilities, such as gradual increases in industrial operating hours, industrial expansion, as well as loss of some commercial and industrial lighting loads due chiefly to dimouts and blackouts.

Since most industrial rates incorporated in utility rate structures are of the load factor type and stipulate progressively lower costs per kwhr for increases in consumption in kw hrs per kw of demand, it will be seen that the average rate received for increased industrial sales would be on the downward trend with each increase in hours of use.

Similarly, lower rates prevail where larger blocks of power are involved in a single delivery. This also tends to reduce the average rate earned by the utilities. A typical industrial power schedule is shown in Table 2 and is illustrative of these points.

TABLE II

RATE SCHEDULE

INDUSTRIAL SERVICE

Applicable: To industrial customers for power, heat and incidental lighting purposes. Character of Services: A. C.: 60 cycles; 2,200 volts up to 25,000 volts.

RATE:

DEMAND CHARGE

1st 200 kw of demand or less	$300.00 per mo.
Next 300 kw of demand	$1.00 per kw per mo.
Next 500 kw of demand	$0.75 per kw per mo.
Next 1000 kw of demand	$0.60 per kw per mo.
All over 2000 kw of demand	$0.40 per kw per mo.

ENERGY CHARGE

1st 150 kwh per kw demand per mo.	0.7c per kwh
Next 150 kwh per kw demand per mo.	0.5c per kwh
All over 300 kwh per kw demand per mo.	0.4c per kwh

The monthly bill shall be the sum of the Demand and Energy Charges.

It is apparent therefore that despite substantial increases in sales of energy by the utilities, revenues have not kept pace proportionately. This situation, coupled with rising material costs, increased labor costs and in the case of privately owned utilities, substantial increases in taxes, may result in some instances in a reduction of net earnings. Economies placed in effect, together with a reduction in personnel as a result of the draft, etc., will tend to offset the increased expenses and to equalize the other factors adversely affecting net earnings. No specific conclusion can be drawn, however, with respect to the industry as a whole insofar as net earnings are concerned, since local factors may have a far more material influence on earnings than those outlined herein.

From the foregoing discussion it is evident that the impact of the war has resulted in the electric utilities being confronted with many new and complex problems. The industry has given ample evidence, however, of its customary ability to meet these new problems and to determine through individual and cooperative effort an intelligent and satisfactory solution to them. It is demonstrating once again its ability to perform its obligations as a servant of the public in providing an adequate continuous supply of electrical energy to our civilian and military needs in time of war.

THE ENGINEER AND M.B.A. DEGREE

(Continued from page 6)

could all be placed with great facility. True, this is at present the result of an extraordinary condition—the war—but it is more than reasonable to expect this demand, relative to other demands, to persist after the war.

A question of vital interest and importance at present is the question of where engineering men with business training can best be used in the advancement of our war program. From the foregoing discussion it becomes quite evident that they may be profitably used in any field of industry which correlated directly or indirectly to war production problems. Besides the industrial demand for these men, the Army and Navy are very much in need of men of this type.

The Navy has indicated great interest in them for ordinance work and technical supply billets. A great demand exists at present for them in the Bureau of Ships. In the Army, men with engineering and business administration training are of particular interest to the Quartermaster Corps, the Ordnance Division, the Corps of Engineers, and, above all, the Army Air Forces. The individual would find his usefulness in either administrative or technical work, or a combination of both.

As far as industrial placement is concerned, during the emergency, there is a great demand for men trained in business and technical work in the fields of aviation, heavy metals and metal products field. This demand is present throughout the country. The demand is particularly acute in the west, as far as aviation is concerned, since such a large part of the industry is established on the west coast. It has been impossible, to date, to meet the demands which have been made for men with this training. There are a number of related fields where the business administration, rather than the technical training, would be a primary requisite, but where both are required. For example, the Purchasing Department of Westinghouse Manufacturing Corporation considers the combination excellent, and are on a constant lookout for men with this type of training.

Although this survey indicates the great demand for engineers who have had advanced study in business administration, it does not follow that in the present emergency, graduating or practicing engineers should plan to take extended training in business administration. Technical men are in such demand at present that they cannot be spared from present duties to broaden their training. It is advisable for men, upon obtaining their engineering degree, to offer their services immediately to industry or to technical branches of the armed forces. The war effort will undoubtedly be more benefited by this action at the present time.

The fact still remains, however, that there is a great need, both in wartime and peacetime industry, for the business administrator with a technical background, and for the engineer with an understanding and awareness of business problems. There have been many wrong decisions made and much inefficiency has resulted because executives have not been sufficiently familiar with the technical aspects of their business. Similarly, much time has been wasted in the pursuit of technical problems because the engineer or scientist was not fully aware of the financial or practical limitations to his problem in our industrial structure. This is particularly true at present when the short-term outlook of winning the war is a predominant factor.

It can be reasonably estimated that in the years following the war the need for this type of training will be realized and met. We can sincerely hope that many of the problems facing industry today can then be intelligently dealt with and solved.

POWDER METALLURGY

(Continued from page 9)

contraction is, of course, undesirable since dimensional tolerances cannot be maintained. By "trial and error," pressing and heating cycles have been developed so that dimensional tolerance may be maintained in the direction perpendicular to the direction of pressing, but the pieces have to be shaved to size in the direction parallel to pressing.

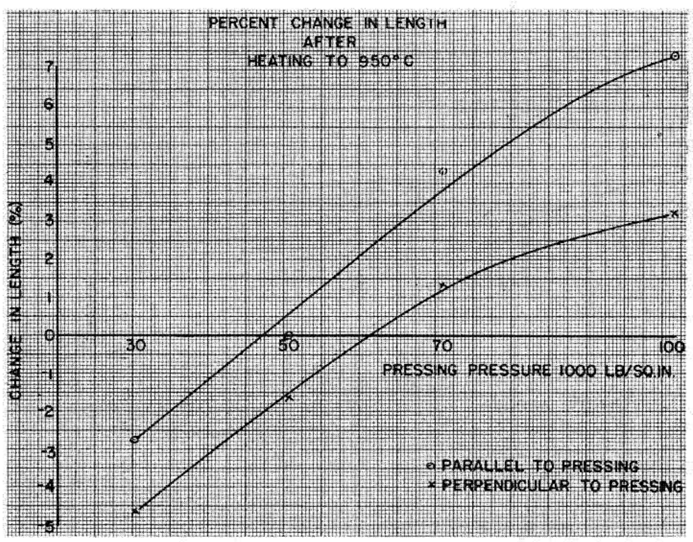


Fig. 1. Change in dimension of pressed copper compacts due to heating to 950° C.

The result of these uneven dimensional changes can be seen in Figure 1. Compacts pressed from 325 mesh copper powder were measured in all directions to 0.001 inch before and after sintering. The per cent change in dimension parallel to the direction of pressing is greater, (when expansion occurs), than the change perpendicular to the direction of pressing, but less when contraction occurs. The compacts from which the data for Figure 1 were taken were quite symmetrical, so pressure differences were small. It can be readily realized, then, that if any marked pressure differential were set up in the specimen, the change in dimensions would not be constant and any attempts by trial and error to allow for the changes would undoubtedly fail. The difficulty encountered is due to the number of factors upon which these dimensional changes are dependent. The phenomenon is dependent upon the size of the compact (larger pieces due to uneven pressure show uneven expansion or contraction), the pressing pressure (high pressures cause expansion, low pressures contraction), the particle size (small particle size causes expansion or contraction to a greater degree), and the temperature (expansion or contraction occurs within certain temperature ranges dependent upon the first three conditions).

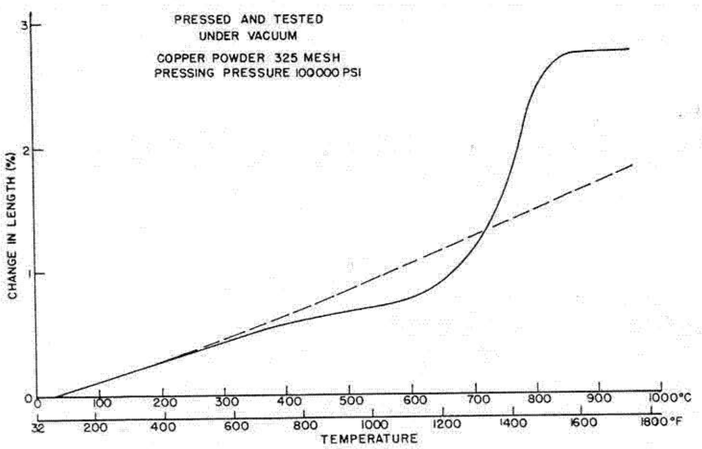


Fig. 2. Solid line indicates dilatation curves for copper powder pressed and heated in vacuo; dotted line indicates dilatation curve for solid bus bar copper.

Because dimensional changes are important, work has been conducted at the California Institute of Technology to determine the influence of pressing pressure, heating temperature, and powder particle size on the density and structure of copper powder. To obtain an accurate indication of change in length with temperature, a dilatometer was employed. Figure 2 shows the results of a test on copper powder of 325 mesh screen analysis pressed in vacuo at 100,000 pounds per square inch and then heated in vacuo. The dotted curve indicates the dilatation of forged, annealed bus bar copper. The expansion mentioned previously should be noted. Figure 3 shows the structure of the powder compact after heating. The well defined grains should be noted. Due to the voids present the specific gravity was 78 per cent that of bus bar copper.

Until these conditions are correlated and the changes in dimension can be controlled, the applications for powder metals will be restricted.

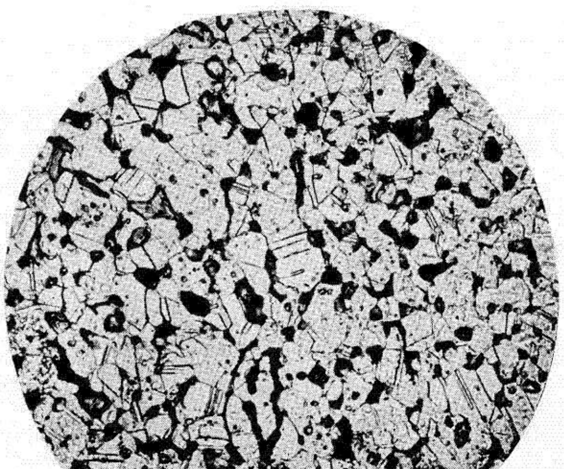


Fig. 3. Photomicrograph of copper specimen pressed at 100,000 P.S.I. in vacuo and heated to 950° C. in vacuo. 500 magnification.

JAPAN

(Continued from page 11)

of baggage space. American techniques have clipped hours off peacetime airplane wing assembly schedules, months off cargo boat production and added miles to airplane bombing ranges. American technique developed the dive-bomber, the torpedo plane and the submarine, which the Japanese have found so effective. Up to now, because in peace-time inventions are shared, this inventiveness of the Americans has done the Axis more good than it has the United Nations. But from now on this will not be so.

The winning of this war depends on America's using its inventiveness in daring ways to outsmart and confuse the Japanese.

" . . THE END OF THE BEGINNING"

(Continued from page 13)

Axis supply lines from Europe to Africa. One-third of the ships the Axis has employed in the Mediterranean to feed its North African campaign have been sunk by Allied planes and ships. These shipping losses obliged Germany and Italy to use one-third of their transport and long-range reconnaisance planes merely to supply Rommel's armies with food, munitions and fuel. And these large Axis planes suffered heavily from attack by Allied fighters.

The British decision to hold Egypt and Malta was taken early in the war. In July, 1940, about a month after Dunkirk, the one armored division left in the British army was put aboard ship and sent around the Cape of Good Hope to Egypt. This move was made when Britain stood alone and inadequately prepared to defend herself against the expected German invasion. This armored division contributed greatly to the success of General Wavell's offensive in December of 1940, when, although his army of 40,000 was outnumbered by more than four to one, he pushed back the Italians from the Egyptian border to Bengazi. Since then the battle of Libya has seesawed back and forth. Some of General Wavell's divisions were sent to the aid of Greece, and with his strength thus depleted he proved no match for the force which Rommel threw against him in the spring of 1941. In a few weeks Axis armies were once more on the Egyptian border, but in November, 1941, Wavell's successor, General Auchinleck, drove Rommel back to Bengazi again. Then late in May, Rommel began the attack which eventually carried Axis forces closer to Suez than ever before, only to be hurled back beyond Bengazi in the present campaign. Had Egypt,—and Malta,—not been held through 1940, 1941, and the nine months of 1942, the present North African battles could not have been fought successfully by the Allies. And had it not been for the valor and tenacity of the Russians, it is doubtful if Egypt and Malta could have been held. But Malta and Egypt, Moscow and Stalingrad *were* held, and while they were being held the Allies generated the power for the offensives which at the moment dominate the battlefields of Europe and Africa. Only the future will reveal how effectively these Allied offensives can be sustained, how long and how intensely their pressure can be kept up. In the Mansion House speech, Mr. Churchill was careful to avoid excess optimism: He stressed the fact that the new and spectacular successes did not mark "even the beginning to the end." But his admission that they might be considered as marking "the end of the beginning" is a source of encouragement and of hope that the "beginning of the end" will not be long delayed.

Book *Review*

LEE'S LIEUTENANTS
By Douglas S. Freeman
(Charles Scribner's Sons—$5.00)

Book Review by Albert B. Ruddock
Member, Board of Trustees, California Institute of Technology; President, California Institute Associates

The essential qualities of high military command can be developed by only a minute fraction of those officers who can perform well the lesser military duties. A good general was a good officer from the time of his first commission. An excellent captain or a creditable colonel does not necessarily become a good general. The supply of competent general officers is not inexhaustible; rather their loss, in the case of small nations, may mean that less competent men will succeed them. The maintenance of the necessary standard of command may depend less on training and combat experience than on the size of the population. Unless there is vast manpower from which to sift and develop soldiers, mere experience may not be enough to assure continuing good field command above the grade of colonel.

Thus Douglas S. Freeman summarizes in his new work, *Lee's Lieutenants,* the development of the higher command in the Army of Northern Virginia. His conclusions suggest a source of reassurance to us in the present conflict where size of population may compensate for initial lack of proven high command.

Dr. Freeman tells us that he was impelled to undertake this further study of the Civil War period, so finely begun in his *R. E. Lee,* by a question that plagued and pursued: "In holding the light exclusively on Lee, had one put in undeserved shadow the many excellent soldiers of his Army?" Jackson, Longstreet, and Stuart have won permanent place in the history of American wars, but a score of other able officers under Lee's command are being rapidly forgotten. Dr. Freeman concluded that, before transferring his many years of study of the struggle to another period of military history "that company of gallant gentlemen should be placed in their proper relationship to their chief." But how was he to avoid duplication of what had been done by others, even though the author had uncovered much new material? Some words of Lee suggested the solution: "Our army would be invincible if it could be properly organized and officered. But there is the difficulty—proper commanders—where can they be obtained?" It was determined that the book would be a review of the command of the Army of Northern Virginia, rather than a history of the Army itself; hence the sub-title, "A Study in Command," the story of the effort to create and maintain competent senior officers against the forces of constant and heavy attrition.

The results, representing six years of so-called spare time, are contained in three large volumes, of which the first now published deals with the period from Manassas to Malvern Hill. Like the earlier *R. E. Lee,* they are a monument to the ability and inexhaustible industry of the author, who has found time for historical research and creative literature of the first order in the midst of a life filled with professional activities of newspaper editorship, daily radio broadcasts, instruction at the War College in Washington and the Columbia School of Journalism, to say nothing of numberless calls for public addresses from one of the leading figures of the South.

The method of treatment of so numerous a company was a serious consideration. The procedure finally adopted was the gradual introduction of the actors, combined with cross references and the assignment of large sections of the work to the more outstanding of the characters. While no arbitrary standard was followed in the allocation of space, each man treated won his place by the extent of his deeds.

It was a task that bristled with difficulties for any but the most skilled, and the degree of success obtained bears witness to the great competence of the author. Again, as in the *R. E. Lee,* we find the same vivid clarity of narrative, the justness of military observation by a highly regarded civilian analyst of war, and the broad grasp of the often confused scene that won for the earlier work the Pulitzer Prize Award. The characters are presented with conviction and authenticity. Dr. Freeman has succeeded to a large extent in giving animation to the least important of the actors, in spite of frequent lack of available detailed material. Some repetition of campaign description is present but it has been held to minimum. Certain operations such as the Valley Campaign, First Manassas and the actions around Yorktown, which received only cursory treatment in the *R. E. Lee,* are developed at length to throw full light on the capacities of Jackson, Magruder, Johnston and others. A valuable feature is an occasional summary analysis of the capacities of the commander under review. For the casual reader seeking a short-cut memory aid to the more important figures, a series of thumbnail sketches and photographs is included.

It must be conceded, however, that even the skill of Dr. Freeman is put to serious test in dealing with so varied a fare. There are moments when the work approaches too closely a detailed recital of military actions. It seems questionable whether so ample an account of the various battles was required in order to arrive at a judgment of the command capacities of the several actors. Selectivity and concentration could possibly have been used to greater advantage. Minor leaders are occasionally permitted to walk the stage and speak their brief lines to the disadvantage of the general flow of the narrative. A certain degree of confusion is produced at times from this over-inclusiveness. One senses a possible reluctance to overlook any candidates worthy of citation. But perhaps this is merely the impression of a non-Southern reader.

The cover carries a reproduction of one of the splendid murals from the Battle Abbey in Richmond by the great French artist, Charles Hoffbauer, who is now an American citizen and residing in Hollywood. It seems an oversight not to have given him credit by name.

NEWS OF CLASSES

1907

Rafael Pimentel died April 18, 1942, in Mexico City at Londres 112, where he lived with his wife and daughter.

1918

Fritz Karge is now with the Flour Corporation in Los Angeles.

1920

Robert Carson Smith is a captain in the Army Chemical Warfare Service, Edgewood Arsenal, Maryland.

1921

Major Smith Lee, U. S. Army, recently visited Los Angeles on his way from Utah to a new assignment on the Pacific Coast. Al Hall, Jerry Lavagnino, Art Spence, Dale Barcus, R. J. Hare, Ray Miller and H. J. Honsaker met with Major Lee for a brief reunion at Rene and Jean's Restaurant.

1922

Jay J. DeVoe is now captain in command of a signal training battalion at Camp Crowder, having been called to active duty last December.

Harold R. Harris, formerly with Panagra, is now stationed in Washington as Chief of the Plans Division in the Air Transport Command, where he says he is enjoying his work thoroughly.

Donald F. Shugart is a lieutenant colonel of the Air Corps, stationed at Fort Bragg, N. C.

Douglas MacKenzie has been promoted to the rank of lieutenant colonel. He was executive assistant to the area engineer in charge of the construction of Cochran Field, Macon, Georgia, the basic flying school which was the first completed by the Corps of Engineers. Colonel MacKenzie was called into service March 17, 1941, and served seven months as chief of Military Construction Division of the Savannah, Georgia District Engineer's Office and later as Area Engineer at Camp Stewart, Georgia. In World War I he served as a private in a training camp at Los Angeles and received his reserve commission as a second lieutenant in 1922.

Paul Ames is now with the patent department of the Standard Oil Company of New Jersey, and his office is in Radio City, New York.

1923

Bernie Evans has accepted a commission as Captain in the U. S. Marine Corps and is now on duty in San Diego.

1924

Vincent Manchee is stationed at the Huntsville Arsenal in Alabama after being commissioned a captain in the chemical warfare service last April.

1925

Oscar S. Larabee is on duty in Washington as a Major, Engineer Corps, with the Air Corps, and from all reports, spends half his time flying around the country.

1926

Arthur Allyne is on active duty as a captain in the Chemical Warfare Service in Dallas, and **J. F. Voelker** is also a captain in the same service in Denver.

Robert Bogen recently became secretary-treasurer of the Production Tooling Company, tool designers and fabricators, located in Los Angeles.

Alvin G. Viney, who is in charge of the United States District Engineer's office in Jacksonville, Florida, has been promoted to the rank of colonel.

Manley W. Edwards is now a lieutenant in the Engineer Corps, on duty at Camp Young, California.

1927

Hilmer E. Larson is now at the University of California at Berkeley, employed as a research assistant.

Ted C. Combs, who was made a lieutenant colonel on October 13, visited the Cal Tech campus in November while on furlough in Southern California. He left greetings for all his friends, and regretted his inability to see them all this trip.

Thomas N. Shaw was named to represent the California Institute at the inauguration of Gregg M. Sinclair as president of the University of Hawaii on October 21. Mr. Shaw is a chemist with the Hawaiian Avocado Company.

Major **Vernon P. Jaeger** is stationed as chaplain at Camp White, Oregon.

David Z. Gardner is the Assistant Division Engineer for Santa Fe at Winslow, Arizona.

M. M. Bower, now a major in the Army, is in the office of the Chief Signal Officer, Washington, D. C.

1928

F. Gunner Gramatky recently was commissioned a Captain in the Army, and is now working with the U. S. Engineers.

Kenneth Crosher recently was promoted to Lieutenant-Colonel, U. S. Army Air Corps.

Walter Grimes, recentlyl made a major, is on duty at Fort Belvoir.

Bill Mohr, a major in the Corps of Engineers, and in command of an engineer battalion at Fort Ord, is the father of a son, Willian Warren, born November 27, 1942.

Allen Dunn received a promotion to major on October 13 at Camp Claiborne, La.

1930

Mr. and Mrs. **Theodore L. Ruff** are the parents of a girl born August 29.

O. Franklin Zahn, Jr. is an instructor in mechanical engineering at the University of Santa Clara.

Henry S. Mason, Jr. recently moved from San Gabriel, California, to Phoenix, Arizona.

Clyde Blohm is now with the Fluor Corporation in Los Angeles.

Lt. **Sprague de Camp** is working at the Naval Aircraft Factory and living in Lansdowne, Pa.

Lt. **Harris K. Mauzy** has been on active duty in the U. S. Naval Reserve since last April. He is stationed at San Juan, Puerto Rico.

1932

Captain **James R. Bradburn**, recently promoted, is the father of a girl, Alice Elizabeth, born June 8. Captain Bradburn is still with the Ordnance Department of the U. S. Army, stationed in Rochester, New York.

Phil Schoeller is now manager of supplies, materials and equipment for all projects of the Contractors, Pacific Naval Air Bases, and is living in Hawaii.

Bob Freeman and his wife sent out cards announcing the arrival of Dale Edward, born October 27.

Millard Barton has accepted a position as professor of aeronautics at the University of Texas, Austin.

Albert W. Atwood is now doing consulting engineering in the electrical field, particularly in power and dust control.

Lt. William R. Bergren is Nutrition Officer at Fort Benning, Georgia.

1933

George Chesson is now a lieutenant (j.g.) in the U. S. Naval Reserve.

Mr. and Mrs. John A. Randall are the parents of a son, born September 18.

1934

Robert Boykin is now working for the Chemical Engineering Department at Cal Tech as a research assistant.

Lt. David E. Cook is a member of the U. S. Army Signal Corps.

Lt. Kenneth A. Willard is attached to the Army Air Service of the United States Weather Bureau in Washington.

1935

Francis R. Gay is now employed at Lockheed.

Jackson Edwards was married to Patricia Burr on November 14 in Los Angeles.

Arthur Engelder, a 1st Lieutenant, enlisted in June, and is now with the Medical Corps, Army Infantry, at Camp Carson, Colorado. After his graduation from Johns Hopkins, Arthur had practiced for a year in Tucson, Arizona.

Nelson Nies is with the chemistry department at Northwestern Technical Institute.

1936

Perry Wainer is with the Aircraft Accessories Corporation at Kansas City, Kansas.

Egor Paul Popov, who worked in the civil engineering department at Tech from 1934 to 1936, recently accepted a position with the Goodyear Tire and Rubber Company in Los Angeles.

Conrad Muller is now with the International Telephone and Radio Laboratories in New York City, and is living in Montclair, New Jersey.

Edwin Getzman is an engineer with Mitts and Merrill, a machine tool manufacturing firm in Saginaw, Michigan.

Michael Mahon is now division engineer with the Southern California Gas Company at Taft, California.

Clarence Goodheart has resigned from the teaching staff of the A. and M. College of Texas, and is now employed by the Naval Ordnance in Washington.

Howard F. Hamacher, of Cambridge, Massachusetts, was married to Miss Jean Chamberlain on October 17th.

William C. Richey and Ann Henck of Skyforest, California, were married recently.

John Austen is still with Ingersoll Rand Company in the Cameron Pump Division in Phillipsburg, New Jersey.

Joseph J. Peterson was advised by Mr. A. F. Duggleby, an executive officer of a Manila mining company, through the Alumni Association, that his parents in Manila are safe and well. This is the first word that he had heard of his parents since last December.

Edward Price, Jr. and Miss Margaret Muckleson were married in August, and are now living in Glendale.

1937

Paul F. Jones is an associate engineer in the Navy Department, Bureau of Ships, Washington, D.C.

Vernon Gevecker is a Major, U. S. Army, acting as Chief of the Research Library Section, Map-Chart Division, at the Army Air Force Headquarters in Washington, D.C. He entered the Army in April, 1941 and served with the engineers until December, 1941, at which time his transfer to his present position was requested by the Air Corps.

Virgil Erickson is a construction engineer with the Morris-Knudsen Company in Kingman, Arizona. He was married on September 10 to Miss Betty Lou Williams of Warrenton, Oregon, in Los Angeles.

LeVan Griffis and his wife, the former Alice Todhunter, are the parents of a boy, Christopher Allen, born November 4 in Chicago.

1938

Janet Patricia was born August 24 to Eleanor and **Bill Althouse.**

Mr. and Mrs. **Lupton A. Wilkinson** are the parents of a boy, Lupton Allemong Wilkinson III, born September 2 in Pasadena.

Hank Evans is now with the National Safety Council in Chicago, acting as consultant to the Rock Island Arsenal on traffic matters in connection with worker-transportation, as well as other phases of the transportation problem.

William Rhett has joined the Atlantic Division of Pan American Airways as a junior pilot and is completing his aviation training before being checked out on the giant ocean-flying Clippers.

1939

George Morikawa is now working at Armour Tech on a research fellowship.

John A. Battle has been transferred from Brownsville, Texas, to Guatemala City, Guatemala, by Pan American Airways.

Duane Beck is the father of a daughter born this summer.

Ensign **Willard M. Snyder** has completed his training at Corpus Christi and has received his wings. He has returned to that field as an instructor. Until the time of his enlistment, Ensign Snyder was with the U. S. Bureau of Reclamation at the Sacramento Valley Project.

Curtis M. Lee writes that he is the father of eight pounds of sheer feminine perfection born June 21 and named Martha Evelyn.

Mr. and Mrs. **J. Eugene Stones** are the parents of a daughter born last January.

Paul Engelder, after a period of intensive training at Philadelphia and Quantico, was commissioned a Second Lieutenant in the Marine Reserves. From there he was sent to Pago Pago, Samoa, in October, 1941. He has shown marked ability as an officer, as is attested by his promotion from second lieutenant to captain in less than two years.

Dr. Hubert Arnold is now a lieutenant (j.g.) in the United States Naval Reserve.

Norman Horowitz is with the biology department at Stanford University.

Warren Wagner, personnel manager for The Contractors, in charge of all phases of personnel, visited Los Angeles in October.

Dr. William Stewart is with the Bureau of Plant Industries, Beltsville, Maryland, as plant physiologist.

Bill Norton was married December 12 to Miss Frances G Lail in Los Angeles. Thy will make their home in La Jolla after January 1.

1940

Willys Lemm is now acting in the capacity of a research assistant at Tech, working under Professor Lindvall. Mr. Lemm left a position with DuPont to take on the work at Tech.

Ensign **James M. Watkins, Jr.,** U.S.N.R., is stationed at the Bureau of Ordnance in the Navy Department at Washington, D.C.

Sherwin Avann is with the Department of Mathematics, Washington University, St. Louis, Missouri.

Edward R. Van Driest is an associate professor of civil engineering at the University of Connecticut, Storrs, Connecticut.

Miller Quarles is now employed by the United Geophysical Company at Clayton, New Mexico.

Robert Wallace is with the United States Geophysical Survey at Sleetmute, Alaska.

1941

Lt. Joe Trindle visited the campus in October after eleven months in England. Most of his time was spent in the Salisbury region in Southern England, where he found the English to be extremely hospitable. Joe is now at Fort Monmouth, New Jersey.

Lt. (j.g.) Donald C. Campbell, U.S.N.R., and Miss Janet Ruth Partch were married September 5th at Silver Spring, Maryland, and are now living at Cabin John Gardens, Maryland.

Newell T. Partch was married early in November to Miss Anne Wagner, and they are living in Berkeley where the groom holds an executive position with an engineering company.

Willis E. Dobbins, a second lieutenant in the Signal Corps, is now classed as a radar technician, and has been sent abroad on a special assignment. He spent last winter in England, returning in June when he acted as instructor for two months at Camp Murphy, Florida.

Mr. and Mrs. John J. Rupnik are the parents of a daughter, Daile Barbara, born November 9th.

Walter Z. Davis and Betty Jean Berg were married on September 12th at Spokane, Washington, where Zeke is employed by Alcoa.

Kenyon Howard is with the Standard Oil Company of California, working as a junior engineer at their El Segundo Refinery.

Charles Roen is with Shell Chemical, doing research work, and is living in North Long Beach, California.

Bill Corcoran and Miss Martha Rogers were married November 7, and are now living at 1776 Oakdale Street, Pasadena.

1942

Charles M. Brown is employed by the RCA Manufacturing Company of Camden, New Jersey, as a field engineer.

Fred Ashbrook, who was married October 7 to Miss Margery Martin of Altadena, is now living in Cambridge, Massachusetts, where he is with the Radiation Laboratory of M.I.T.

Francis B. Brown, known to many of the mechanical engineers in 1941-42, was married to Mary Catherine Marsh, August 15, at Phoenix, Arizona. He is a lieutenant, U. S. Army.

Pichel W. Pichel and Miss Mary Bowles were married September 4th.

Henry V. Roese and Miss Jeanne Nazro were married early in September, and are now making their home at 2015 Locust Avenue, Long Beach.

Richard H. Cox and Miss Virginia Smith of Pasadena will be married December 12.

Charles Pearson and Miss Virginia Mary Ponto were married on October 10, and are now living in Pasadena.

George F. Meyer is attending Harvard Naval Communication School.

Sydney Gold, who is with the Standard Oil Company of California, is enjoying his work in San Francisco.

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

of ALUMNI REVIEW, California Institute of Technology, published quarterly at Pasadena, California, for October, 1942.
State of California,
County of Los Angeles, ss.

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

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Editor, Donald S. Clark, 1201 E. California St., Pasadena, California; Business Managers, David Shonerd, 1201 E. California St., Pasadena, California.

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

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

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

DONALD S. CLARK, Editor

Sworn to and subscribed before me this 22nd day of September, 1942.
(Seal) Ida A. Ritchie
(My commission expires April 8, 1945.)

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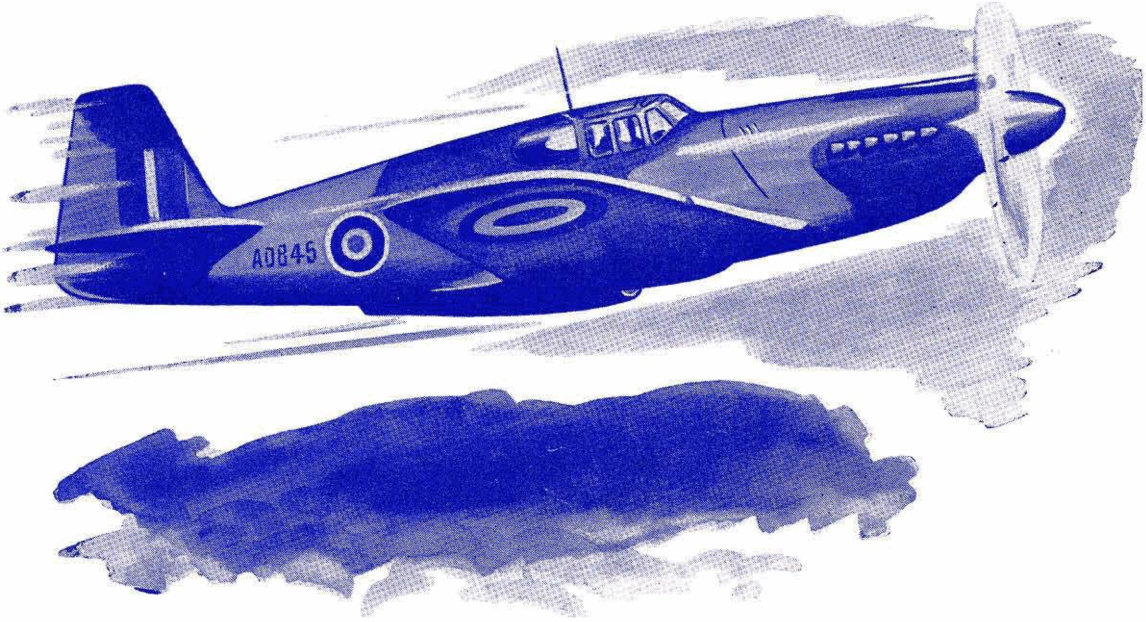

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