# STEEL IN THE WAR

By ROBERT B. FREEMAN

THE war has created many new problems for the steel industry which have been and are being met with success due to foresight and a firm foundation of knowledge and experience established in peacetime years. The steel industry's productive capacity has met the "test" and undoubtedly has played a major part in the Allied victories to date.

### MANAGEMENT PROBLEMS

Aside from the more commonly known problems which have confronted all industries, including the training of new and inexperienced workers, labor shortages, various restrictions, etc., the steel companies have had to operate with no increase in steel prices, due to O.P.A. regulations pertaining to commodities which were well established and at the same time with greatly increased operating costs.

In order to assure availability of specific products at the required time for war production, it was necessary for the government, through the War Production Board, to designate what products should be produced by individual manufacturing concerns and at what time it would be necessary to complete these directions. For that reason certain producers who in normal times have been able to adjust their product mix or variety of products so that a satisfactory return on their investment could be obtained are now meeting government directives which may require them to operate to a large degree on products which are economically undesirable.

### NE STEELS

In spite of these handicaps, and in fact, because of some of the shortages in materials and other restrictions, great strides have been made by the industry in the production of steel. The so-called NE (National Emergency) steels were developed through the joint efforts of the American Iron and Steel Institute and the various steel companies as substitutes or equivalents for the various higher alloy SAE (Society of Automotive Engineers) steels previously used so universally.

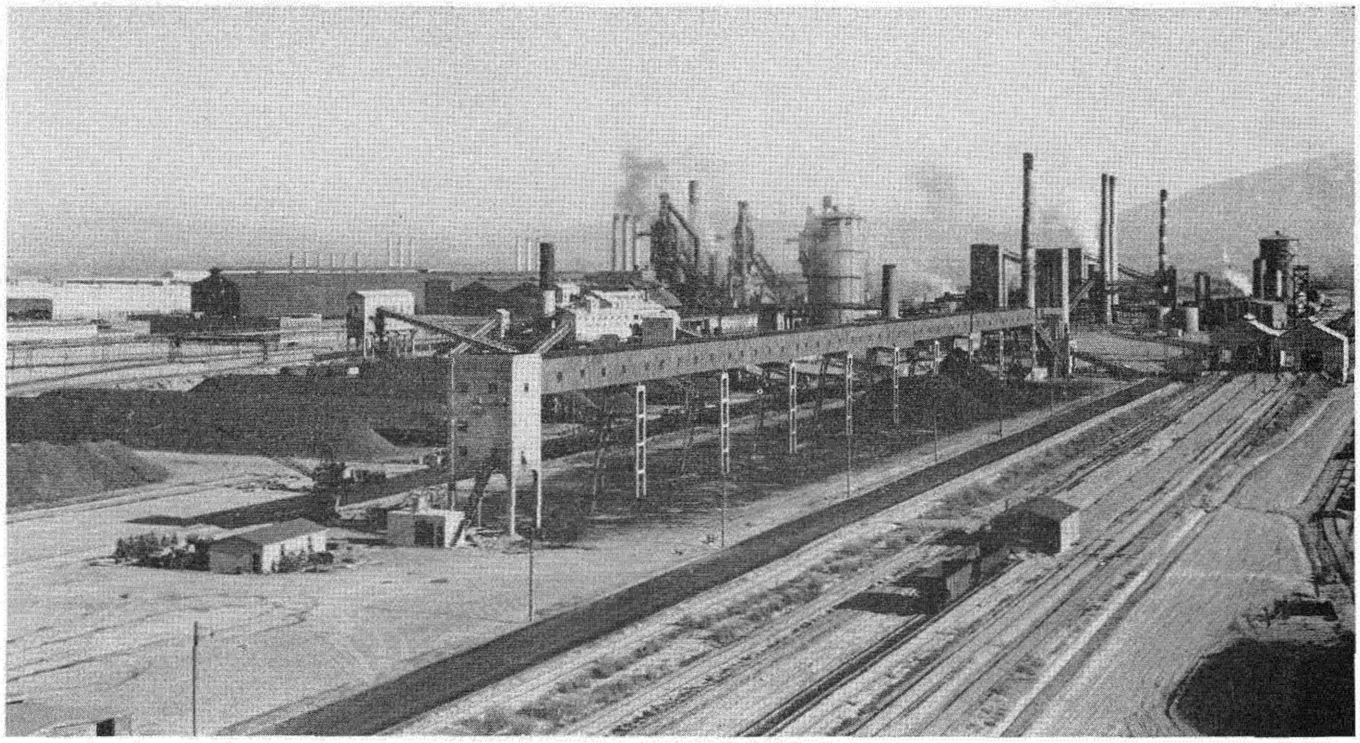
This development was necessitated by the loss of sources of supply of some of the alloys required for the SAE steel analyses and the increased tonnage of alloy steel required for the war program. The basis for these NE alloy steels, which in many cases are called triple alloy steels because they contain three alloying constituents, is that low percentages of several alloys will give the same hardenability or increase in physical properties as larger amounts of one or perhaps two alloys. For this reason, the residual alloy content of steel scrap may be utilized and enormous quantities of virgin ferro-alloys retained or conserved for specific application where the triple alloy NE steels may not be applicable. The latter steels have proven so successful in many applications that they may continue in use in the postwar period. These grades of alloy steels, however, require careful and rigid control in their production as well as in their treatment and fabrication.

Advantage is taken of the alloy content of the scrap steel which is used with pig iron to produce new steel for these grades. On this account, careful segregation of scrap by all users and fabricators of steel in order that it may be returned to the open hearth or electric furnaces for the production of new steel is required. Alloy content in plain carbon steel is as undesirable as the lack of alloy in the alloy steels.

### SPECTROGRAPHIC ANALYSES

In order to obtain adequate control within narrow limits of several alloys in these steels, several plants are using the spectrograph for analyses which are taken prior to the time the steel is ready to be poured. By the use of these instruments great savings in time and economies in operation are effected as well as the improved control of quality. In addition, where hardenability of the steel is of primary importance, hardenability tests are being made on the open hearth or electric furnace floors so that adjustments can be made to the steel prior to pouring in order to obtain the required hardenability of the finished product.

Columbia Steel works at Geneva, Utah.



Close-up view of the steel works, Geneva, Utah.

Scrap receipts are also being checked for alloy content with the use of the spectrograph at several plants where considerable quantities of alloy scrap are available, in order to maintain adequate control of this constituent of the furnace charge. By these means our precious alloys are being conserved and are going into the steels in which they are required rather than into the steels in which they are contaminants.

### SPECIAL ADDITION AGENTS

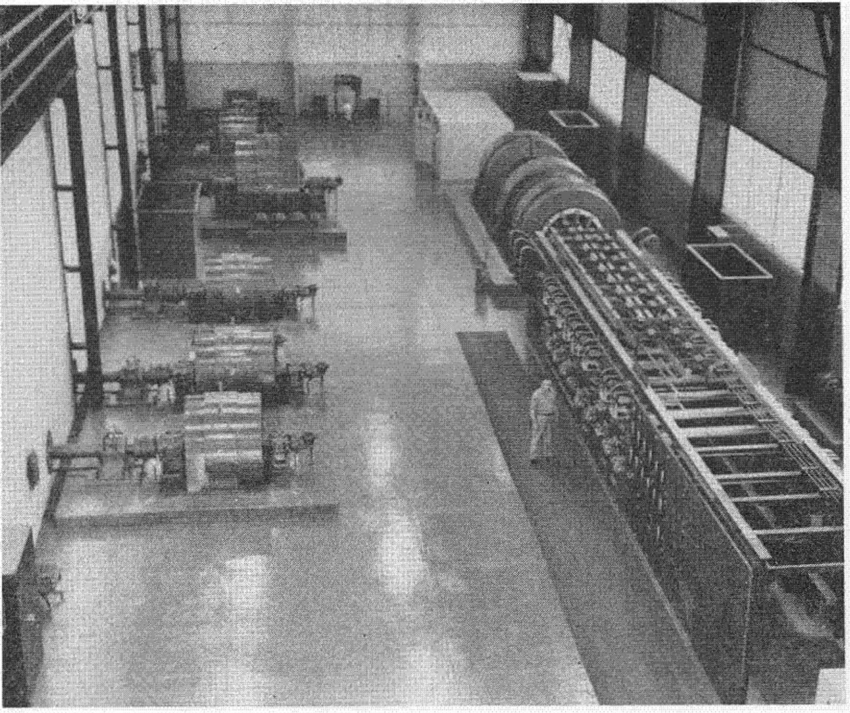
In addition to the NE steels, new developments have been progressing rapidly in the use of special addition agents in plain carbon steel. These agents usually contain boron and are made in various combinations of various elements. Steels treated in this manner can be heat treated to develop higher physical properties with only a very minute amount of the special alloy present. These steels as yet have not been universally adopted because of the difficulty in maintaining close control of the distribution of the minor constituents, which has sometimes resulted in erratic physical properties from bar to bar and heat to heat. Continued experimentation is being carried on with these grades of steels and there is little doubt that satisfactory operating procedure will be worked out to take advantage of these relatively cheap methods of improving physical properties, particularly hardenability.

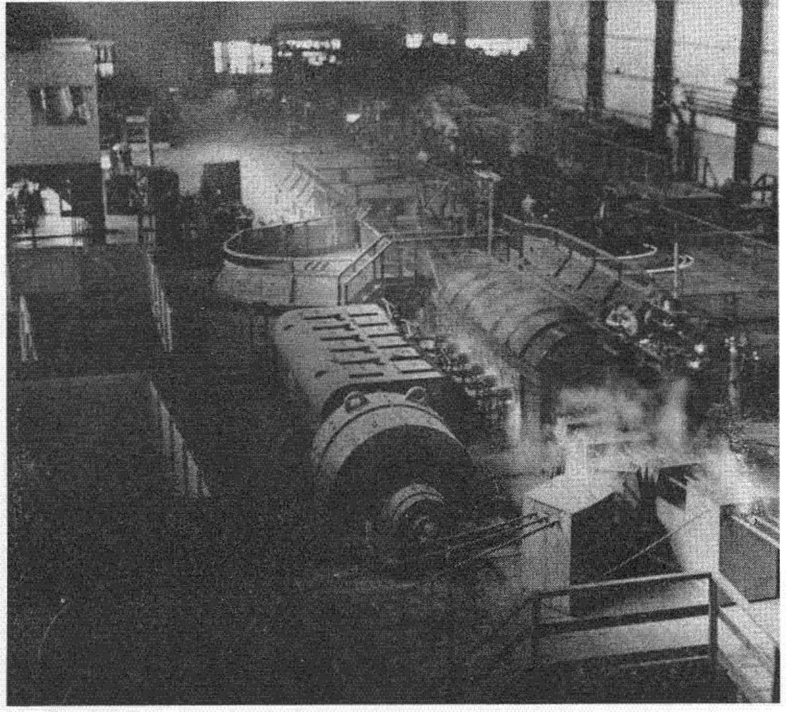
Although, in general, the number of types and grades of alloy steels has decreased on account of the simplification program, several new combinations have been introduced for specific applications. There is no doubt that the war added impetus to the wide and general use of some of the triple alloy steels, affording experience and data which would have been slow to accumulate in normal times. This use afforded an excellent means of proving in a practical way the results of metallurgical research which had been done prior to the emergency.

### LOW ALLOY VS. HIGH ALLOY STEELS

In the writer's opinion, one of the most important contributions is the realization by the metallurgical field at large that the combination of several alloys in low ranges is more effective in regard to hardenability and increasing physical properties than one or even two alloys of considerably higher content. Improved heat treatment control has been required to obtain the minimum requirements with lower total alloy contents.

Progress in heat treatment, therefore, has been rather rapid during the war period, due to the restrictions on the use of alloy steels, particularly in regard to alloy contents for particular applications. It has been the practice in some industries and in many of the smaller manufacturing plants where adequate heat treating facilities for precise control were lacking, to use steels of relatively high alloy content so that the required physical properties could be obtained without precise heat treatment. The additional cost of the alloy content was paid in the absence of adequate heat treating facilities and control. The shortage of alloys made it necessary to prevent this type of operation, and as a result of the restrictions on the various grades of steel it was necessary for improved heat treating practice to be exercised by practically everyone concerned. The foundry industry was an example of this type of practice where normal facilities for heat treatment included air quenching or annealing. Rapid strides in liquid quenching have been made and armor plate as well as other high strength castings has been produced from low alloy steels showing physical properties and characteristics equivalent to those of steels containing considerably more alloy, which had in the past been heat treated by only air cooling or annealing. Since several foundries are now equipped with liquid quenching facilities, there seems little doubt that many small castings will be produced in the future from lower alloy steels, whereas in the past they were produced from more expensive alloys. Because of these savings, for the same physical characteristics in the castings, the foundries having liquid quenching equipment will operate at an advantage. It appears that the foundry industry will take greater advantage of proper heat treatment in the future than it has done in the past.





AT LEFT: Electrical power room, three-strand semi-continuous rod mill, Columbia's works, Pittsburg, California.
AT RIGHT: Steel rods being processed through the looping stands of three-strand semi-continuous rod mill.

The many uses of castings in the war program for ship work, ordnance, engines, hydraulic machinery, etc. have clearly demonstrated the utility of this type of product. Many designs have incorporated castings, forgings and rolled products in one integral unit of welded construction.

### CONSERVATION OF STRATEGIC MATERIALS

Early in 1941, programs for the conservation of strategic alloys were placed in effect by all steel companies. A critical review of all practices was made to effect reductions in the consumption of such alloys as manganese, silicon, nickel, aluminum, chromium, tin, etc. Specifications and practices had to be modified rapidly. It was due to the success of these programs that steel production continued to increase without impairment of quality, in spite of the reduction in the supply of these critical materials.

Mention already has been made of the substitution of NE for SAE steels and the attendant ramifications.

### GALVANIZED SHEETS AND TIN PLATE

Galvanized sheet production was curtailed in 1941 by the zinc shortage and by the increase in requirements for non-ferrous brasses, bronzes, etc. Tin, which had for years been used in amounts from 0.50 to 1.50 per cent in galvanized coatings, has been so critical that its use in galvanizing operations has been forbidden. In spite of the fact that no tin can be used in galvanized coatings, a coating has now been developed without the use of critical alloys which is apparently equal in all respects to the previous spelter composition. Within recent months the zinc situation has eased somewhat, so that a greater variety of products can be produced with zinc coatings now than previously.

Many changes in composition of the brasses and bronzes were required as a result of the shortage of the critical materials, particularly zinc and tin, so that practically every industry which uses moving equipment was affected to some degree. Major decisions were required on suitability of substitutions, particularly on bearings and bushings of heavy equipment, where breakdowns would result in costly delays and serious loss of production. It was through the coordinated efforts of the technical men of the various industries that sound judgment was used in effecting these changes.

Early in the war period limitations were placed upon the amount of tin coating which could be placed upon steel sheets for tin plate. Subsequently the shortage of tin became so critical that the operation of many hot dip tinning plants had to be curtailed or abandoned. Much of the tin plate has been electrolytically tinned since the war started. This circumstance has also resulted in practice improvements, both with respect to electrolytic tinning and other coatings.

### HOT ROLLED STRIP

Practically all of the hot rolled strip mills in the country were converted to the production of ship plate early in the war, and it is only recently that some of the eastern mills are again producing hot rolled strip for sheets. The production of plate steel on the Pacific Coast at Kaiser's Fontana Plant and at the U. S. Government owned Geneva Works, operated without profit by a subsidiary of the United States Steel Corporation, in addition to some curtailment of the ship-building program has made this possible. In spite of this adjustment, there is very little hot rolled strip being shipped to the Pacific Coast at the present time. Columbia Steel Company plants at Torrance, Calif., and Pittsburg, Calif., each have sheet mills and produce a large variety of hot rolled and coated sheets. They have furnished a substantial supply of sheet products for the entire Pacific Coast since the beginning of the war.

With respect to sheet and strip, one of the problems which has been solved during the war period is the production of galvanized strip in coils. This product is now being produced by several different processes either for sheets or in coils.

Another development which will be utilized in the commercial field after the war will be the use of higher tensile steel sheets. Applications will include airplanes, buses, structural uses in building construction, etc. The knowledge gained during the war period with respect to design of metal units, particularly in the aircraft industry, has opened a new field for the use of metal in construction. It is believed that there is a definite place for high tensile products, both coated and uncoated, in many applications. *(Continued on Page 17)*

a sheath break before an interruption of service occurs. the cables are frequently maintained under gas pressure. Nitrogen gas, free from moisture, is used since it is inert, non-toxic, and relatively inexpensive. An underground cable is normally maintained under nine pounds per square inch pressure. Through a Bourdon tube and electrical circuit arrangement, an alarm is sounded in the control office when the pressure in the cable has dropped to six pounds per square inch because of a leak. By making accurate mercury-manometer measurements of the pressure in the cable at a number of points and plotting a pressure gradient curve, maintenance men can determine the location of a leak fairly closely. This method of locating sheath breaks is used when the nature of the break is such that no circuits within the cable have been interfered with. If the normal electrical condition of any circuit in the cable is changed, electrical tests provide a much faster means of determining the location of the trouble. Very small holes leak gas so slowly that many hours, possibly several days, may elapse before the pressure has dropped sufficiently to actuate the gas pressure alarm. However, gas escaping through the sheath break prevents the entrance of moisture, if the hole is small and the water pressure on the cable is less than that of the gas. A desiccant such as anhydrous calcium sulphate or colloidal silica is used to absorb moisture from the paper conductor insulation when a sheath opening is made for splicing or maintenance purposes.

#### SURFACE WATER ALSO PROBLEM

In hilly or rolling country it is necessary to restore the right-of-way after the passage of the plow train to its original condition as nearly as possible. The cut made by the plow share disrupts the normal drainage and creates a soft channel through the earth. Check dams of many types of materials, earth fills, contour plowing, new channels, etc., may be resorted to in order to retard erosion and force the run-off water to follow some course other than along the cable. Quick growing grasses and other vegetation are also used to hold the soil in place. Protective measures may be required for several years after the ground has been disturbed before the situation is again stabilized.

When ravines, streams, marshes, rivers, bays or similar obstacles must be crossed, a number of different methods and types of construction may be used. In certain instances, as has already been mentioned, the cable may be plowed beneath the surface of stream beds. In other cases, one of the many types of submarine cables may be the most practical means of crossing. Anything from a string of floating oil drums to a specially equipped boat or barge may be used in placing submarine cable, depending upon the conditions. Sometimes, instead of using a submarine cable, a land type cable is attached to a bridge or placed on a self-supporting structure of its own. The method of crossing chosen is based on a study of possible causes of damage to the cable, hazards to the continuity of the circuits, economics, and future plans of the public and the telephone company.

#### BURIED CABLES FOR LONG DISTANCES

Buried cables are particuarly adapted to long toll routes involving many circuits. They are used across mountains, plains, agricultural land, and desert areas. Sometimes direct routes are the most economical; hence the cable may not follow highways or railroads but cross country after the fashion of the crow and the airlines. A strange combination of tractors, heavy trailer equipment, and cable reels, far from the beaten path, may seem at first to present an incongruous scene, but it may be just another plow train burying telephone cables for the most progressive telephone system in the world and for the most talkative people in the world.

## Steel in the War

*(Continued from Page 14)*

Specifically with respect to the West Coast, there are now several steel producing plants and many steel fabricators with up-to-date mills and shops which have the latest equipment and facilities for the production of steel and its products. Columbia's new rod mill at Pittsburg Works is considered to be the finest mill in the United States at present. Geneva Steel Company at Provo, Utah, and Kaiser Steel Company at Fontana, California, both have the latest equipment in structural mills. All up and down the Pacific Coast, there are a great many steel, iron, and non-ferrous foundries which can produce practically every type of casting.

With respect to steel fabrication, it may be said that products of practically every type are produced on the Pacific Coast, some in large and others in small quantities, including automobile assemblies, road building equipment, stoves, refrigerators, ships, hydraulic equipment, and many others.

The steel industry realizes that the postwar period will be a challenge. It has great productive capacity which must operate at a reasonable rate to avoid excessive overhead cost and to compete with other metal industries which now also have great productive capacities. Aluminum, magnesium, and plastics are all potential or active competitors with steel in certain applications. New uses will be found for all of these materials, and it is possible that the peacetime markets will be expanded to make them serve the requirements of mankind in ever increasing measure.

# ALUMNI NEWS

### CALIFORNIA TECH CLUB, WASHINGTON, D. C.

THE Washington California Tech Club held a dinner meeting on Thursday, November 16, at the 2400 Hotel with 75 members and guests present. Dr. Robert A. Millikan, chairman of the Executive Council of the California Institute of Technology, and Dr. Frank B. Jewett, '98, were guest speakers. The meeting was planned to coincide with Dr. Millikan's attendance at the Fall Meeting of the National Academy of Sciences of which Dr. Jewett is president.

Both speakers discussed the role of science and engineering in modern war. Dr. Millikan told of the Institute's enormously expanded program for the development and production of the instruments of war, including rockets and anti-submarine equipment. Dr. Jewett, who is a member of the National Defense Research Committee of the Office of Scientific Research and Development, gave a comprehensive picture of the nation's war research organization.

Brief talks also were made by Dr. R. W. Sorenson, head of the department of Electrical Engineering, and by Dr. Theodore von Karman, director of the Guggenheim Aeronautics Laboratory, both of whom are presently engaged in war research work in the East. Dr. Jewett was introduced by Dr. Richard C. Tolman, Dean of the Graduate School, who now is vice-chairman of the N.D.R.C. The meeting chairman was Frederick J. Groat, '24, president of the California Tech Club of Washington. Club Secretary: Baker Wingfield, '28, 613 Knollwood Drive, Falls Church, Virginia. Telephone: Falls Church 2110-J.