ENGINEERING AND SCIENCE

MONTHLY

JANUARY ★ 1945
VOL. VIII NO. 1

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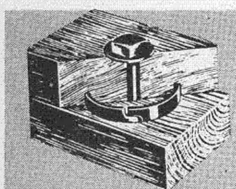

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BY-LINES

HENRY R. FREEMAN

Henry R. Freeman, accountant with the firm of Seidman & Seidman, Los Angeles, attended Caltech in 1921-22 taking courses in civil engineering. Later he studied accounting at University of California, Berkeley. During the period of 1924 to 1937 Mr. Freeman was employed by the County of Los Angeles in the surveyor's office and road department on title work and civil engineering.

. . .

MAX B. ALCORN

Mr. Alcorn received the degree of bachelor of science in mechanical engineering from the California Institute of Technology in 1923. Since that time he has been employed by the Southern California Telephone Company in Los Angeles. For many years he has been working on outside plant construction problems in the office of the chief engineer.

. . .

ROBERT B. FREEMAN

Robert B. Freeman received his B.S. in 1932, M.S. '33 and Ph.D. '36 from the California Institute of Technology. He became associated with Columbia Steel Company and was assistant plant metallurgist at the Torrance Works for two years. In 1941 he transferred to the Pittsburg, California, works and now holds the position of works metallurgist.

. . .

DR. CHESTER STOCK

Dr. Chester Stock, professor of paleontology at the California Institut of Technology since 1926, has guided the progress of paleontological research in the western states and Mexico, and has contributed to the study of early man in America. Dr. Stock has made important fossil discoveries in the California Coast Ranges, and has conducted important field studies under a John Simon Guggenheim Memorial Foundation fellowship.

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ENGINEERING AND SCIENCE MONTHLY is published monthly on the 25th of each month by the Alumni Association, Inc., California Institute of Technology, 1201 East California Street, Pasadena, California. Annual subscription $2.50; single copies 35 cents. Entered as second class matter at the Post Office at Pasadena, California, on September 6, 1939, under the Act of March 3, 1879. All Publishers' Rights Reserved. Reproduction of material contained herein forbidden without written authorization.

ENGINEERING AND SCIENCE

Monthly

The Truth Shall Make You Free

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ENGINEERING AND SCIENCE MONTHLY

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ENGINEERING AND SCIENCE

Monthly

Vol. VIII, No. 1

January, 1945

The Month in Focus

Progressive Education

EDUCATION, like a good many other systems, is obviously getting ready for a postwar overhauling. There is probably no college or university in the country without its postwar policy committee which is earnestly considering revisions of entrance requirements and undergraduate and graduate curricula, and trying to adjust college education more effectively to meet its responsibilities in the postwar world. Along with these specific plans, go controversies over the place of the humanities in college education, the place of the social sciences, and so on ad infinitum.

It is good that these discussions should go on. It is good that higher education should scrutinize itself objectively and critically from time to time. No system or systems of education can be perfect; and as long as we live in a dynamic world, education has the dual obligation of trying to improve itself and at the same time make the necessary adjustments to the changing social, political, and economic complex of which it is a part.

In the present self-examination, however, there is one disturbing factor. A good many of the problems which are perplexing higher education prove, upon analysis, to have originated in certain deficiencies of the secondary school system. That is, the colleges and universities are forced to make one of three choices. *First*, they may maintain what they believe to be satisfactory entrance standards, and in so doing automatically eliminate a large number of potentially desirable but ill-prepared students. *Second*, they may attempt to remedy deficiencies in preparation by making room in their own curricula for work that should have been completed earlier, but this can be done only by sacrificing necessary college-level work. *Third*, they can lower their sights all along the line, take high school graduates as they come, dilute the content and the quality of the college curricula, and make the best of a bad bargain for eight semesters.

For a place like the California Institute of Technology, the problem is particularly serious; and though the first choice is obviously the best, it is not actually satisfactory. It is disturbing to know that the public school systems in two prosperous middle western states do not provide sufficient mathematics to enable their graduates to qualify for admission to the California Institute. It is disturbing to know that throughout the southeastern part of the United States the students of most of the high schools are so ill-prepared that they have little chance of passing the Institute's entrance examinations without special coaching. In general, the service training programs at the college level have shown a woeful deficiency in the preparation of the students assigned to them, not only in mathematics and the exact sciences but in everything that requires application and a reasonable amount of earnest work.

In fixing the primary responsibility for this unfortunate state of affairs, the blame is usually put at the door of "progressive education." But the term "progressive education" can mean a variety of things. In one sense, any education that seeks continually to better its content and its procedures is progressive; and no one can have any quarrel with that kind of progressive education. But, unluckily, in the past two decades the term has been identified with a particular theory of education, applied especially to the grade schools and high schools, the proponents of which gained the advantage of appropriating for their special theories the desirable word "progressive"—a strategem which had the effect of stigmatizing, as an opponent of progress, anyone who questioned them.

"Progressive education," in this specialized sense, has a good deal to say about developing the whole individual and realizing his or her potentialities. In practice, this means using interest as the primary incentive in learning, and learning through doing. At its best, this probably means a wise stimulation and guidance of interest. At its worst, it means a superficial dipping into a variety of subjects, guided by a vagrant and undisciplined fancy that veers to a new interest every time it is threatened with the necessity of real work and study. At its worst, progressive education produces in the high schools the "science course" which consists of an agreeable Cook's tour of chemistry, physics, biology, etc., without the humdrum discipline of problems and laboratory training. It detours around everything that threatens to be "hard," and it produces students who are indignant at being expected to do any work outside the classroom and resentful when they are required, as they say, to "learn something." Unfortunately, the products of progressive education at its best are hardly more numerous than the righteous in Sodom.

Perhaps the liberal arts colleges can take the average product and make something of it. If so, all honor and credit to them. It is more than the California Institute can do, or any self-respecting technical and scientific

(Continued on Page 18)

Progress with Roads

By HENRY R. FREEMAN

"Our road is not built to last a thousand years, yet in a sense it is. When a road is once built, it is a strange thing how it collects traffic, how every year as it goes on, more and more people are found to walk thereon, and others are raised up to repair and perpetuate it, and keep it alive*."

THE volume of information and discussion concerning postwar planning is indicative of the importance and interest in this subject. Much of the material published relates to public works and, in many cases, to the specialized field of highway construction. It may be of interest to consider in restrospect some of the historical developments in roads and road building which have shaped the progress of civilization; and to trace the progress of this field of engineering from the humble trails of primitive eras to the gigantic undertakings of the present time.

The importance of roads in social and economic progress has been recognized by many historians. Adam Smith, in his *Wealth of Nations*, said, "Good roads . . . , by diminishing the expense of carriage, put the more remote parts of the country more nearly upon a level with those in the neighborhood of the town. They are upon that account the greatest of all improvements." This estimate was also subscribed to by Macaulay, who wrote in his *State of England in 1585*, "The chief cause which made the fusion of the different elements of society so imperfect, was the extreme difficulty in passing from place to place." Even a cursory study of the civilizations of the past shows that when empires were growing and thriving, roads were constructed and maintained to all sections of the domain. When they were on the decline, roads deteriorated and fell into disrepair. But, though empires have grown, flourished and faded away, mankind as a whole has steadily progressed upward. Accompanying this upward human progress has been the

*Robert Louis Stevenson, *Vailima Letters.* Address to the Chiefs on the opening of the Road of Gratitude (Samoa), October, 1894.

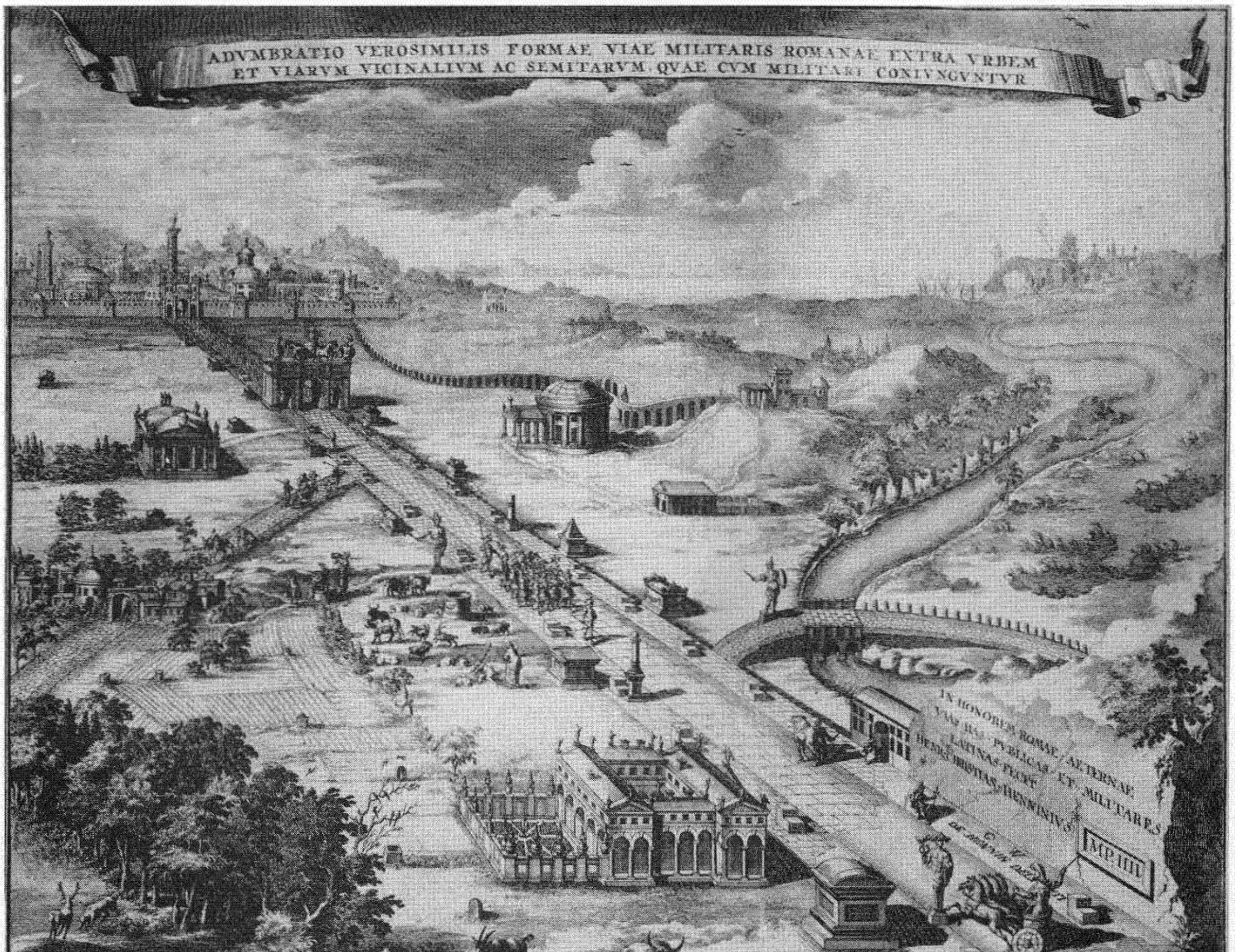


Illustration taken from "Histoire des Grands Chemin de l'Empire Romain" by Nicolas Bergier, Brussels, 1728, showing Roman military highway. (Photos on pages 4 to 7 courtesy of Public Roads Administration).

To this day long stretches of roads built by the Romans 1900 years ago are still in use. This view shows the Appian Way in Italy, circa 1912.

progress in roads. Whether the chicken of social and economic advancement came before or after the egg of better roads is of little moment. What we are really interested in is the historical progress of roads.

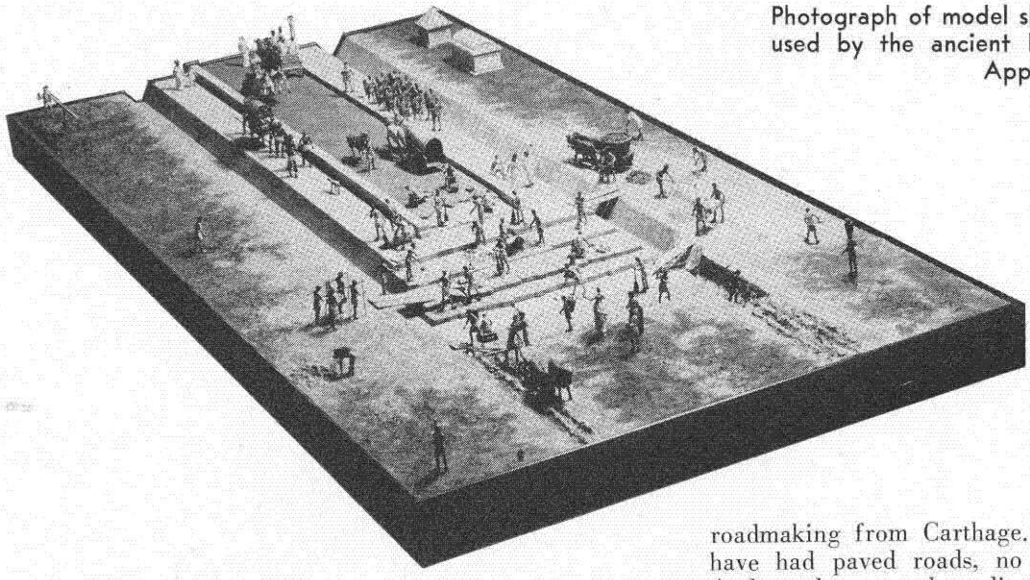
WILD GAME TRAILS

Probably the first roads were the game trails made by wild beasts. Of course this is conjecture, as no road of this type could endure as such; but it is substantiated by explorations in the less civilized countries of today. In the depths of Africa, for example, the elephant trails provide easy paths through otherwise impenetrable forests. And in the early colonization of America, explorers and later settlers followed Indian trails which in turn followed buffalo roads and other game paths. It would be natural for primitive man to follow these paths, for they led him to his primary needs, food and water. Moreover, he was without adequate tools to hew his own roads through the underbrush, even though he might have had the inclination.

As primitive man became fixed in his abode, his early paths became more permanent. Continued passage of man and his domesticated beasts of burden between homes and early settlements gradually beat down the soil and gave us what must have been our first real roads. As definite roads between settlements emerged, it is probable that they first appeared on the higher ground or ridges. This may have been for one or all of several reasons. Water gathered in the valleys, forming bogs and swamps. Trees and underbrush grew thickest in the valleys, making it difficult to clear a road with primitive tools. The more open higher ground gave the traveler greater vision, reducing the danger from ambush by enemies. At any rate, history's oldest recorded roads are along the higher ground in southeastern England, following for the most part the crests of the hills, and are known as ridgeways. Evidence points to the fact that these early roads were of Neolithic date and were made by the people who, during the Bronze Age, built the sun temple at Stonehenge.

Most of these roads are identified today by level stretches of short sparse grass through fields where the rest of the grass grows thicker and taller. The mass action of centuries of travel so compacted the soil that even today vegetation cannot grow with any luxuriance. Where traffic was confined to one narrow course, the track shows up as a groove worn into the ground. The depth of the grooves varies, but on one hard limestone hill near Gloucestershire and Worcestershire the road was cut down in places to a depth of 10 feet. One authority estimates that this wearing down took place at the rate of two inches per century. In his opinion, the road would have been started about 10,000 years ago and was used for 6,000 years.

It is thought by some authorities that these early ridgeways and the later harrow-ways (which followed the easier slopes between the valleys and the ridges) were a part of an early trade route over which tin was transported from the west of England to boats which took it to the coast of France on its journey to the center of civilization around the Mediterranean. This conjecture seems



Photograph of model showing engineering methods used by the ancient Romans in constructing the Appian Way.

plausible because man in his upward climb gradually emerged from the stage of direct appropriation into the pastoral and agricultural stages in which it was necessary that he have a fixed abode. And a corollary to his becoming fixed as to place of habitation is the certainty that he would have to import materials and supplies which were scarce or non-existent in his territory, giving of his own surplus in exchange. At any rate, from the dawn of history there have existed general routes along which flowed traffic for the purpose of trade. Some of these, in addition to the one across England for tin, were the routes across central Europe to the Baltic for amber, routes across Arabia to Afghanistan for lapis lazuli, and the routes across Asia to China and the Far East for silks and spices. Originally travelled by individuals seeking to replenish their own supply of the necessary commodity, and later probably by groups who were sent to obtain a supply for a tribe or clan as they are in Australia today, these routes were established and generally located. Later as trade became a business and large groups of men and animals, or caravans, travelled together, the routes became localized and more nearly approached our conception of a road.

As far as we know, none of these prehistoric roads were improved as we think of improvement today. At the dawn of history, what we have so far termed roads were nothing more than general trails outside the limits of the towns and cities, where the road was beaten out by the traffic itself. And hand in hand with that lack of improved roads goes the fact that no prehistoric civilization left any great imprint of its might.

ROMAN, CHINESE AND INCAN ROADS

Credit for making the first improved road generally is given to the Romans; but there were improved roads before them. The oldest known paved road was built by the Egyptian King Cheops, about 3000 B.C. He needed a solid track over which to convey the limestone blocks of which he built his huge pyramid. The builders of Mesopotamia and Chaldea must have needed paved roads for transportation of their building materials over surrounding soft ground. Short paved roads were built in early times in Crete, the island of Skyros, and at Cyrene. But all of these early paved roads were short and usually served a special purpose. The credit for the first improved system of roads belongs either to the Romans or to the Carthaginians. The latter are reported to have made a system of stone paved roads in the fifth century B.C., and it is said that Rome learned its art of roadmaking from Carthage. But though Carthage may have had paved roads, no physical evidence remains. And so the general credit for the first improved road *system* goes to the Romans. Alexander the Great conquered the known world, but with no roads the empire fell to pieces soon after his death. The Romans also built a great empire by conquest but kept it after the conquest. And the main reason for its long existence was the system of paved roads which linked the heart of the empire at Rome with the outermost reaches of the conquered territory. To this day, 1900 years after they were constructed, long stretches of the roads built by the Romans are in existence, and still in use (although not acceptable for modern motor traffic).

China also had its early system of paved roads, undoubtedly a cogent reason for the greatness of the early empire. The imperial system was paved with large flat stones and included bridges across rivers and tunnels through mountain crests. Slopes of the mountains were climbed by broad flat stairways with steps low enough to accommodate burdened mules, but there is no indication of wheeled vehicles. Connecting this 2,000-mile imperial system were hundreds of miles of well-kept earth roads and bridle paths.

In the western hemisphere the most remarkable of the early roads, considered by some authorities to be one of the engineering marvels of the world, is the Inca road system of Peru. The main road traversed some of the roughest country in the world and extended for 2,000 miles from Ecuador to Central Chile. One modern writer says that it makes "the famed Roman roads appear like mere lanes in comparison." It crossed 15,000-foot mountain ranges by easy grades, tunneled through mountains, crossed deep chasms on suspension bridges, shallow lakes on causeways, and was surfaced for much of its length with a sort of asphalt. In addition to the main north and south road in the mountains, a parallel road extended along the sea coast, and the two were connected by frequent laterals.

MODERN ROAD EVOLUTION

By far the greatest era of road building the world has ever seen is the present. Its development parallels social, political and economic advances which were considered wild dreams even in the early days of our own machine-age. Following the decline of the Roman Empire and during the Middle Ages, road building and transportation were at a low ebb. Apparently most land travel was done on horseback and so paved roads were considered unnecessary. As the wheeled vehicle came into use, it became necessary to do something to stop dust in dry weather and prevent mud in wet. Gravel and loose rock were first used, but were not satisfactory. A hard surface of some kind was needed. It was not until the 18th century that this advancement came. Then Tresaguet in France and Telford and McAdam in England and Scotland developed methods of hand-placing broken stone of comparatively small but uniform size on a prepared road bed or subgrade. With some modifications, this type of surfacing has come down to us in the form of our present macadam pavement.

The use of macadam pavements quite revolutionized road building in Europe in the 18th century and proved entirely adequate for slow-moving, horsedrawn traffic, but with the advent of fast-moving machine traffic the early macadam surfaces failed, and it was necessary to build a more homogeneous pavement. The development progressed to the present hard surfaced road, made basically of sand and rock, but held together by some cementing agent in an integral surface, as seen in our cement or asphaltic concrete paved roadways. Some form of cement or asphalt road may be found in almost every part of the world today.

AMERICAN ROADS

Anthropologists tell us that, in its prenatal existence, the embryo exhibits the entire life history of its species. In the same manner, the entire history of the development of the road can be seen in the growth of our American road system. Early settlers in our country found only game paths and Indian trails, which they appropriated to their own use. As more colonists came and settlements grew up in the interior, many of these early trails were widened and cleared, becoming regularly traveled roads. Braddock's road and Boone's wilderness road are examples of early made roads which followed earlier Indian and game trails. As the frontier pushed further westward and the Pacific coast was settled, regular trade routes appeared. Who has not heard of the Santa Fe Trail or the Oregon Trail or the Overland Route? In the early days, these were not roads as they are today, but just general routes entirely comparable to early historic trade routes of Europe and Asia.

Settlement of the country continued and trails and routes were crystallized into roads, just as dusty and muddy as European roads of the Middle Ages. American roads were ready for paving almost as soon as those of Europe. Outside the cities and larger towns, however, paving of country roads did not take place as soon as in Europe. An English traveller as late as 1891 reported, "The greatest surprise in my visit to the United States was the poor condition of a majority of the roads!" The principal reason for this condition in America was the development of the steam train. The vast distances in our country and the comparative speed and cheapness of travel by rail or water made paved rural highways appear to be unnecessary luxuries away from the larger centers of population.

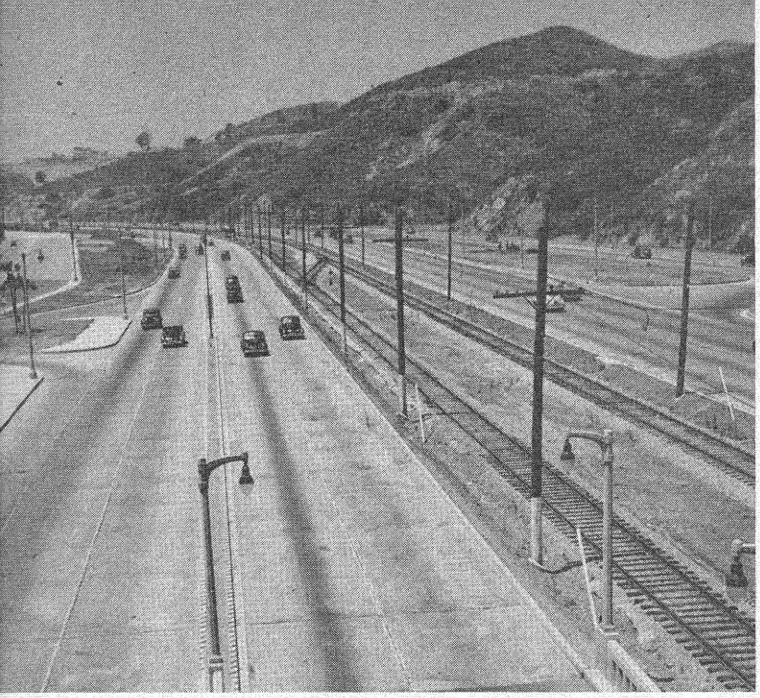
Paving of the American road system did not receive much backing until the bicycle and, almost immediately thereafter, the automobile, captured the fancy of the travelling public in the 1890's and early 1900's. But from that time on the improvement of America's road system has proceeded at an increasing tempo, first by grading and oiling, then by the construction of macadam pavements, and finally by the construction of concrete surfaces. It may be surprising to those who are accustomed to speed smoothly over our highly developed county and state roads today, to learn that the first mile of rural concrete pavement in the United States was constructed only 36 years ago in 1908, in Wayne County, Michigan. Today there are over 400,000 miles of paved roads in the United States, exclusive of city streets. In 1908, a transcontinental trip made in from 60 to 90 days was a fast trip for a non-professional driver.

ROADS OF THE WEST

The tremendous increase in road facilities throughout the United States is typified by the progress made in California toward improvement in transportation. The early use of the automobile brought home the fact that, although there were many well improved roads in the state, they were in isolated and unrelated groups around the larger centers of population. There were no improved

AT RIGHT:

Another view of the Appian Way in Italy, showing the great Roman Road as it appears in the 20th Century.



Cahuenga Pass Freeway—part of southern California's system of modern roadways.

routes joining these larger centers and unifying them into a homogeneous commonwealth. The first step toward correcting this situation in California was taken by the state legislature in 1895 when an act "to create a Bureau of Highways and prescribe its duties and powers and to make an appropriation for its expenses" was passed. The bureau, consisting of three "good road" enthusiasts appointed by the governor, purchased a team of horses and had a special wagon made. During the remainder of 1895 and 1896 they drove over 7,000 miles through every county in the state, studying existing roads and methods of improvement. In 1896 the bureau recommended a system of state highways embodying the basic features of the highway system of today.

Beginning with 65 miles of state road in 1895 (the Placerville-Lake Tahoe Road), the state system has steadily grown to where it now includes approximately 14,000 miles of highway. The continual expansion and improvement of roads has required large expenditures of money. Early construction was financed by meager appropriations by the state legislature, supplemented occasionally by county aid from sympathetic boards of supervisors. However, such appropriations were not adequate to permit the rapid expansion of the system required by the increasing number of motor vehicles. In 1910 the people of California voted $18,000,000 in bonds for paving two main trunk highways extending from Mexico to Oregon. In 1916 an additional $15,000,000 was voted and in 1919 another bond issue was voted for $40,000,000. Even an authorization of some $73,000,000 over a period of nine years did not fulfill the demands for more and better paved roads.

The financing of road construction with bond issues was recognized as inadequate. Several states formulated the policy of obtaining money for roads by taxing gasoline used in vehicles operating on the highways. Oregon instituted this procedure in 1919 and California in 1923. By means of the gasoline tax all the state highway work, most of the county road work, and much of the city street work has been financed.

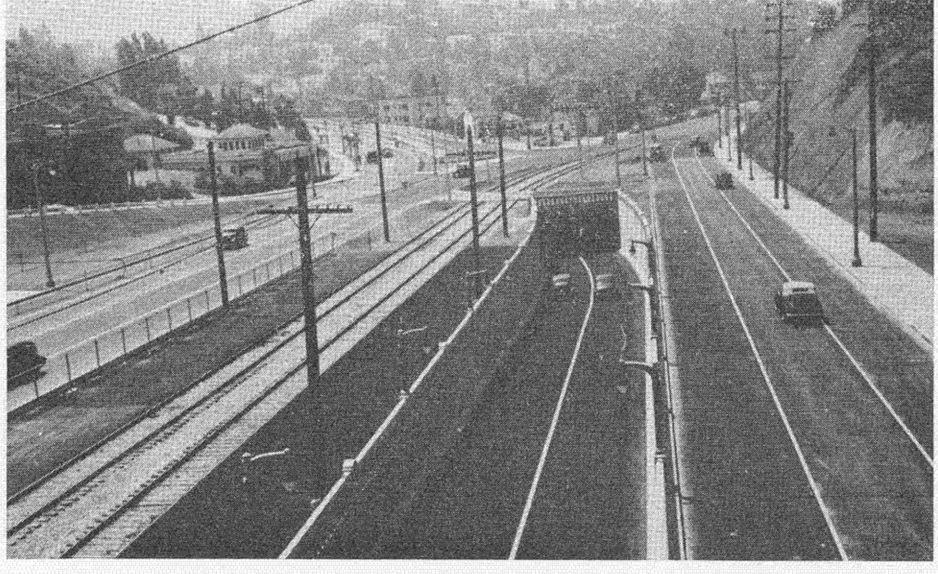
One of the most progressive steps in the development of our modern highway system is the introduction of the freeway or limited access road. This type of design has been brought about through pressure created by the ever increasing volume of motor traffic, just as the original highways were made necessary by the progressive demands for this same means of transportation. These relatively high speed arteries appear to offer material advancement over our previously conceived ideas of transportation. One can even speculate as to their competition in some degree with air transportation. Or it might be better to say they offer the link which will draw surface and air transportation closer together.

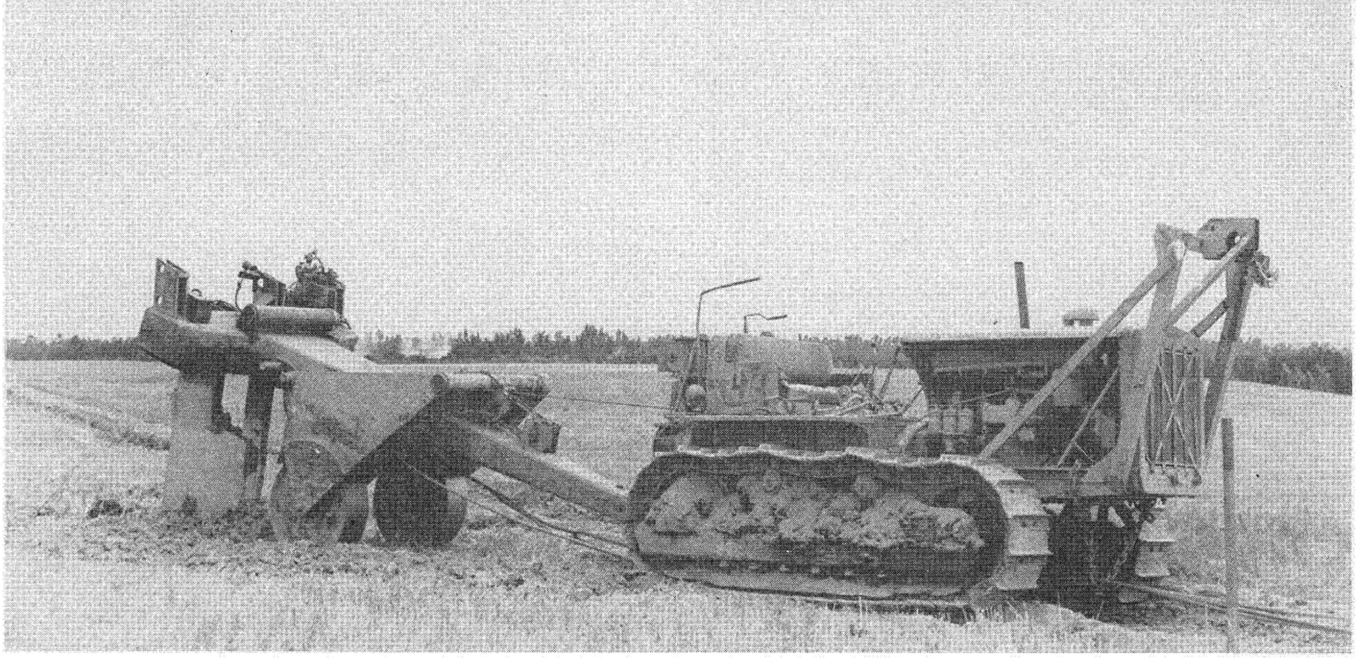
There are still a number of unsolved, unknown, or untried factors concerning freeway design. What are the possibilities in relation to mass transportation? What added features must be included if the freeway is to be used for mass transportation? What speeds may be expected both from the standpoint of safety and from that of postwar automobile and truck design? How far will freeways go in competition with short haul airways? They are exceedingly expensive, so we are concerned with the extent to which they are economically justified. There are, no doubt, many enthusiasts who believe they know the answers, but the more conservative require a more complete demonstration before venturing to write the ultimate formula.

As all types of modern transportation methods progress and develop, we are impressed with the idea of

(Continued on Page 16)

At Right:
In Cahuenga Pass, modern treatment of grade separation and highway intersection.





A special type of rooter plow used in opening a slot and later placing a cable six feet deep. The heavy steel ropes are attached to tractors outside the picture.

Buried Voice Channels

By MAX B. ALCORN

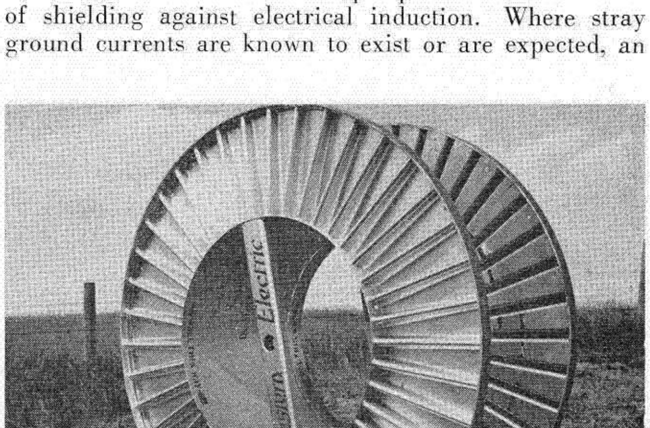
BURIED telephone cables are a logical development from the needs of telephone service and the advancement of telephone art. In the early days of telephony, the need for a cable with many wire voice channels to carry the voice currents within communities was imperative since the practical limit of bare wires on a pole line was soon reached in congested metropolitan areas. After a number of attempts, including the placing of copper wires within individual glass tubes, a cable was developed which provided satisfactory service. Following the pattern set with aerial wires, cables were placed exclusively on poles at first. Then as the telephone system grew, the aerial cables around large central offices became so numerous that they presented a new problem of congestion. The answer, of course, was to place the cables underground. Conduits of various types were used in order to provide for future cables without making a new excavation for each cable. This course of development through the years has resulted in the extensive and expensive underground network of conduits and cables found in all large cities today.

Between the large cities or toll centers somewhat the same history has been repeated in a slightly different form. First, open wire lines carried the messages of those few people who wished to talk long distances. As the city-to-city traffic increased, it became obvious that the number of wires between cities could not economically be increased sufficiently to provide circuits for all those who wished to talk at one time. Carrier systems (a detailed discussion of which is beyond the scope of this article) were developed to provide two or more voice channels per pair of wires. Even though it became possible to transmit as many as 16 voice messages and two telegraph messages simultaneously over one pair of wires, the demand grew to such extent that the use of open wire was no longer economical. Again cable replaced open wire on congested routes.

Cable is less subject to service interference than open wire. Such interference may be the result of storms, accidents, or physical wear. Underground cable, too, normally provides greater service insurance than aerial cable. However, the placing of underground cable is much more expensive because of the conduit system, the resultant short cable lengths, and the high splicing costs involved. As there is less likelihood of service interruption on underground cable than on aerial cable, the logical development in reducing costs was to eliminate the conduit system and place the cable directly in the ground. The ultimate in this direction, of course, is the burying of the cable in the ground without making any excavation in the ordinary sense of that word.

TYPES OF BURIED CABLES

A number of types of buried cables have been produced for different purposes and different conditions. The simplest type of buried cable is made of paper-covered copper wires twisted in pairs and enclosed in an extruded lead sheath which is in turn wrapped in asphalt-impregnated jute. To prevent damage by rodents, particularly gophers, a steel tape about 0.01 inch in thickness may be wound as a helix over the cable sheath before the jute covering is applied. A heavier steel tape is used on another type of cable to furnish more mechanical protection against possible damage from future excavation operations. Both of these steel tapes provide some measure of shielding against electrical induction. Where stray ground currents are known to exist or are expected, an



Stamped and welded sheet metal cable reel. A type commonly used for telephone cable.

insulating thermoplastic coating may be used over the steel tape. Otherwise, electrolytic action may produce holes in the lead sheath at the points where the current leaves the cable and returns to the earth. When the insulation is ineffective or damaged, it may be necessary to maintain the sheath at a negative potential relative to the surrounding earth through the use of "cathodic protection" such as is used on oil or gas pipe lines.

The newest type of buried cable is the so-called coaxial cable. The coaxial cable has conductor pairs which consist essentially of single copper wires in hollow copper tubes. A pair of coaxials can now be equipped to transmit nearly 500 simultaneous conversations by means of different carrier frequencies.

SELECTION OF ROUTE

A number of factors are involved in the selection of the route for a buried toll cable. Such features as accessibility, terrain, right-of-way, cost of construction and maintenance, soil, permanence, other utilities, hazards, etc., must be given full consideration. After a study of available maps, an aerial survey is sometimes made to determine the most feasible route. Aerial photographs, with the modern aids to reading them, have proved to be valuable in engineering cross-country cables. With the approximate route traced on the aerial photograph mosaic, the actual location for the cable is explored and staked on the ground. The normal right-of-way is about 15 feet wide, which allows ample room for plowing in several cables without endangering existing cables. Buried cables may be placed by hand or machine trenching or by plowing. The latter method is the most economical for long toll cables.

CABLE PLACING PLOW TRAIN

The cable plow train consists of several heavy duty tractors, the cable placing plow, and one or more cable reel trailers. The plow used in placing buried cable is essentially a two-wheeled vehicle with a flat share or blade enclosing a tube through which the cable travels. The tube is about three and three-quarters inches wide and terminates at the rear of the share near the base. In principle, the cable slides through the tube and lies on the bottom of the furrow or trench made by the share as it is pulled through the earth. One or two cables one to two and one-half inches in outside diameter may be placed in the same trench at one time. However, the equivalent of four cables may be plowed in when changing reels, since the lead ends of the two new cables are clamped to the tail ends of the two cables already placed. (The overlap of the two cables provides the ends for splicing later.) Besides the four cables, the tube is equipped to pass as many as three copper shield wires at different depths in the trench.

Pneumatic tires normally are used on the plow, but when soft marshy ground is encountered skid plates may be attached and the plow pulled through as a sled. Cables have been plowed into the bottoms of small rivers by actually towing the plow across under water.

If the ground is hard or if the cable is to be placed deep, it is necessary to make preliminary cuts through the earth ahead of the plow train. These cuts can be made by the same type of plow as that used to place the cable or by a special rooter. Occasionally it is necessary to make several passes over the same route in order to cut the trench to the proposed cable depth. A trench six

Preparing to load a new reel of cable among western hills. The gas tank on the side of the plow supplies pressure for the oil sprayer.

feet deep in rather heavy soil required five 110-horsepower tractors to pull the rooter plow. Where the going is easy, the rooter and cable placing plow may be combined in one train and the cable placed in one trip over the route.

The tractors are usually of the 110 horsepower Diesel-engine type, weighing some 40,000 pounds and capable of a maximum drawbar pull of about 30,000 pounds on the lever. One tractor is attached to the plow through a shear pin with a breaking point of 72,000 pounds. This tractor is usually equipped with a four-drum winch, each drum independently controlled and capable of a 6,000 pound pull. Steel ropes on these drums are used to raise and lower the plow share, load cable reels on the trailers, etc.

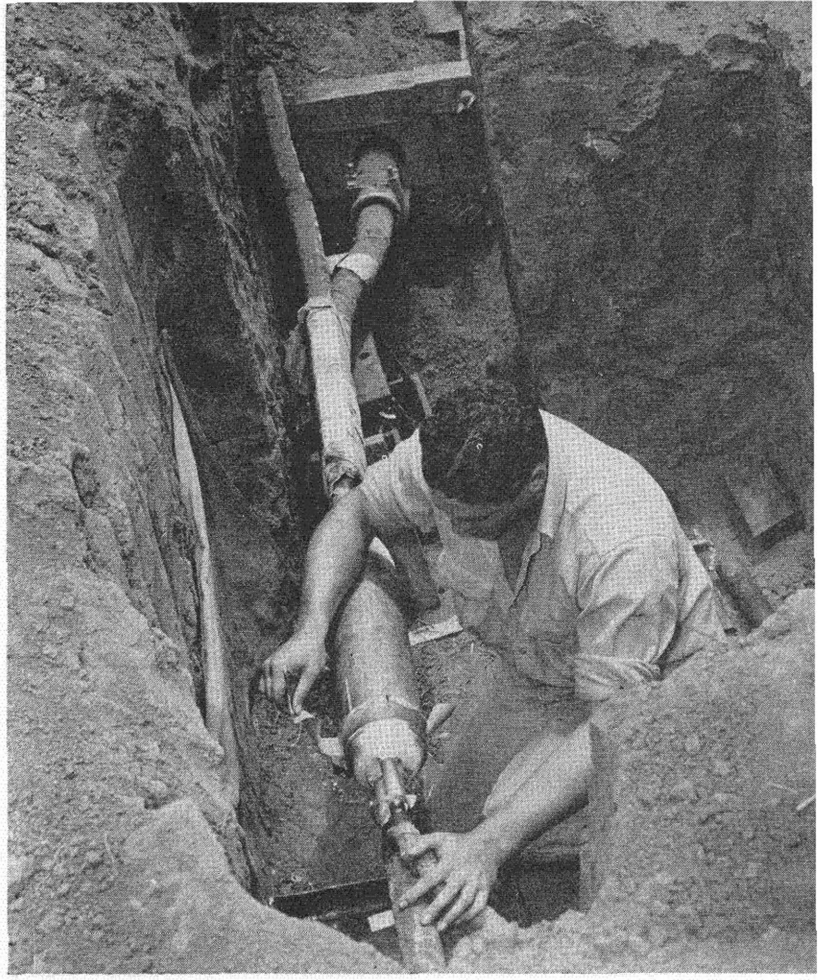
Additional tractors usually are required to pull the plow. When rooting, one tractor may aid by pushing the rooter from the rear. Extra tractors on the front of the train are connected with individual one inch or one and one-eighth inch steel ropes. One tractor is equipped with a large heavy duty winch with a capacity of 70,000 pounds. This winch is used to pull the train across soft terrain. Occasionally situations are encountered which will not provide sufficient traction to move the train or in extreme cases, even support the heavy tractors. In such terrain, the winch tractor is moved ahead to solid ground, anchored, and used to pull the train across. Train speed in either rooting or cable placing is about that of a brisk walk, approximately two and one-half miles per hour or lower. Under good conditions three miles of cable can be placed in an eight-hour day.

The cable reel trailers are towed behind the plow and the cable rolled off the reel directly into the tube of the plow share. The trailers are equipped with track-type treads in order to facilitate negotiation of any type of soil. Cable reels are loaded onto one type of trailer with a winch rope from the tractor winch to a boom which lifts the reel into place. In another type, the trailer has a "jack knife" action which in operation places the saddle under the spindle through the reel and raises the reel off the ground when the pinned members are straightened out again.

The type and size of the cable reel depend upon the type, diameter and weight of the cable. Some reels are sufficiently large to carry approximately 4,000 feet of cable, making a total load of about 10,000 pounds. Wood reels are being replaced with steel reels. One type has the reel rims formed from welded rolled steel shapes, while a second type has sheet metal rims with pressed ribs. Reels of all types make many round trips across the United States from the Eastern cable factories to the Pacific Coast. In prewar times much cable was shipped by boat through the Panama Canal to the western states.

The friction between the impregnated cover on the cable and the plow share tube is sometimes relatively high. This is increased by the inertia of the reel and the friction of the reel turning on the spindle. When two cables are being placed, the one on the inside of the curve going through the plow may show a tension as high as 5,000 pounds as it passes. Such a high value is quite undesirable from both the mechanical and the electrical points of view. To reduce the tension below a safe maximum of about 1,000 pounds, oil is sprayed on the cable as it enters the plow share. Nitrogen or compressed air is used with a pressure feed oil tank to spray approximately four gallons of oil on every mile of cable.

Since the rooter and the plow disturb the soil for some distance on each side of the trench, a mold board is sometimes attached underneath the cable reel trailer to force the earth back into and over the trench. The auxiliary tractor which delivers the cable reels follows the plow train and compacts the earth under its tracks as well as providing extra motive power when required.



Splicer finishing a "wiped joint" over a splice. Cables bending away from the main cable are stubs to loading coil cases which are buried in their shipping boxes. The splice will be covered with a metal mesh and a protective covering before the pit is filled.

EQUIPMENT BURIED WITH CABLE

After the sections or reel lengths have been plowed into place, pits are dug at the junction points and the cable spliced together to form continuous circuits. Elaborate and accurate electrical tests are made at certain splices to assure good transmission characteristics of the circuits when the whole project is completed. At the splice points various supplementary equipment may be added to the cable, such as gas pressure apparatus, electrolysis test wires, or loading coil cases. All of the equipment buried is coated to protect it against the action of soil chemicals. When the work in a pit is finished, the soil is replaced and the location marked with a monument.

Monuments or markers are placed along the route of the cable to identify its position. This is necessary where the cable cuts across country in order that its location may be determined readily by those excavating in the vicinity of the cable and by cable maintenance men in case of trouble. Electrical means of locating the cable are sometimes used, but even then the markers are helpful because they reveal the line of the cable and provide reference points. Vacuum tube equipment is also available to determine the location and the depth of the cable within a few inches, if precise information is required.

CURRENT ON CABLE SHEATH

The normal depth of plowing is approximately 18 to 36 inches. However, several sections have been placed at a depth of six feet. The depth is determined by the type of surface operations which may be expected and the

(Continued on Page 16)

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.

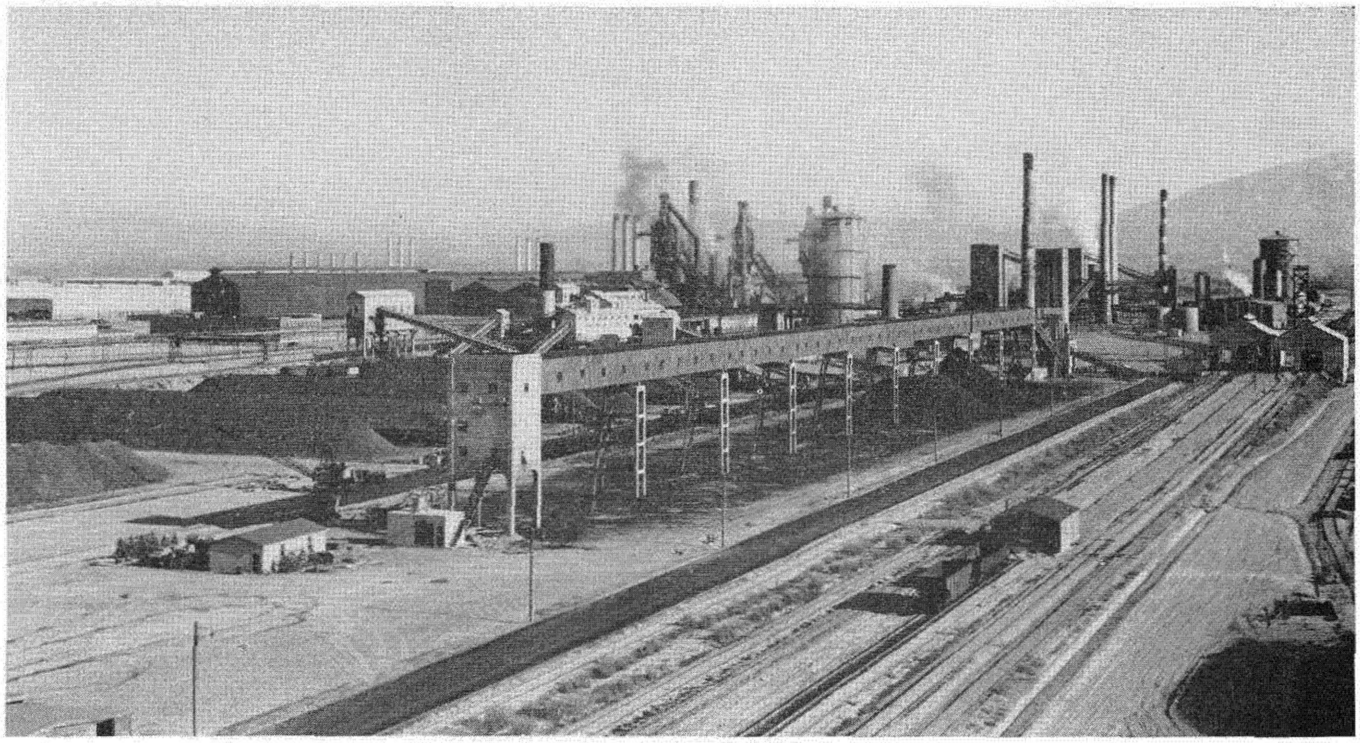
This development was necessitated by the loss of sources of supply of some of the alloys required for the SAE steel analyses and the increased tonnage of alloy steel required for the war program. The basis for these NE alloy steels, which in many cases are called triple alloy steels because they contain 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

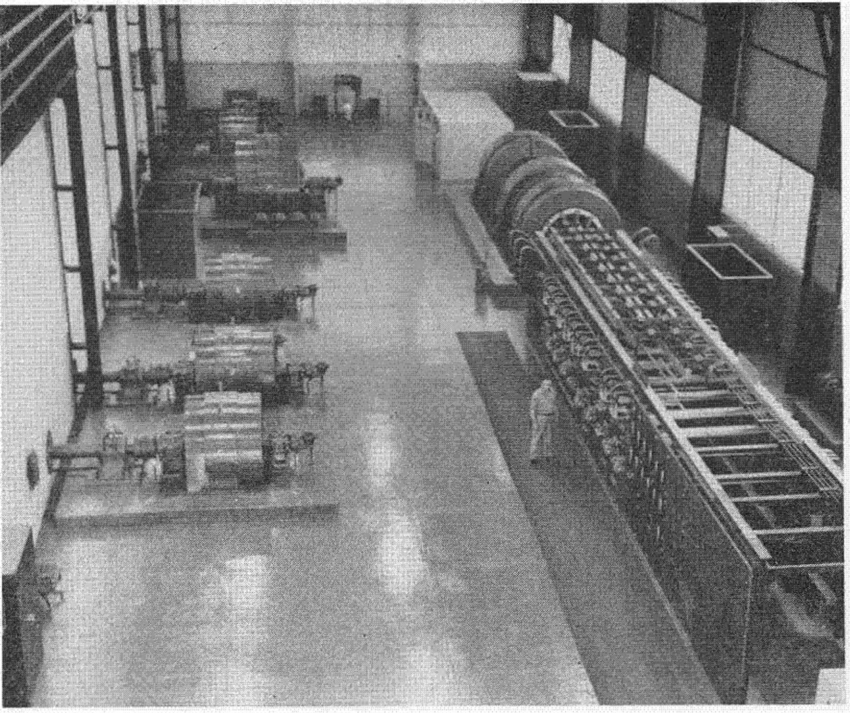
In addition to the NE steels, new developments have been progressing rapidly in the use of special addition agents in plain carbon steel. These agents usually contain boron and are made in various combinations of various elements. Steels treated in this manner can be heat treated to develop higher physical 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.

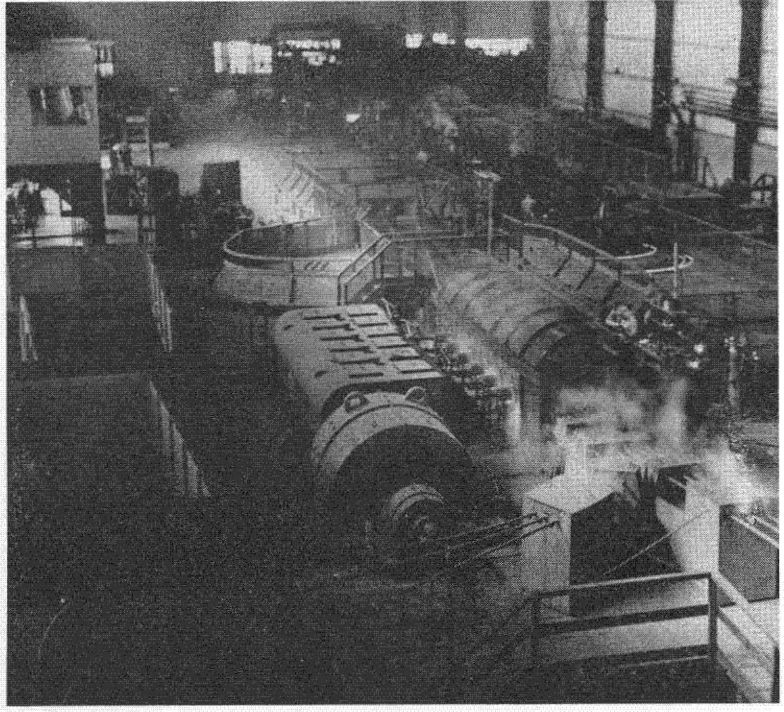
Although, in general, the number of types and grades of alloy steels has decreased on account of the simplification program, several new combinations have been introduced for specific applications. There is no doubt that the war added impetus to the wide and general use of some of the triple alloy steels, 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)*

Neohipparion, A Three-Toed Horse

By CHESTER STOCK

NO other lineage of mammals illustrates quite so clearly or so fully its growth or evolution in geologic time as that of the horse. In the history of the Equidae many forms antecedent to the living animal are now known, each marked by readily identifiable characters in the teeth, skull and skeleton. From *Eohippus*, the "dawn horse" of approximately 50 million years ago, to the equines of today, a score or more different kinds of genera and numerous species of extinct horses have been described. The changes that have produced the large and specialized animal of today from the diminutive and distinctly less specialized Eocene ancestor of long ago are demonstrated by an amazing array of fossil remains, found for the most part in the land-laid formations of the western United States.

Tracing the evolution of the Equidae involves not only a determination of those kinds of horses that were in the lineal descent to modern *Equus*, but, likewise, a recognition of the types that belonged to collateral branches of the family tree. Among the latter are the hipparions and their offspring of the Pliocene. These horses, on the basis of the progressive characters of their teeth, were once regarded as ancestral to the existing *Equus*. They are, however, creatures that have persistently retained three toes in front and hind feet, although the side toes are elevated above the ground and no longer function as supporting elements of the foot. In the retention of the lateral digits the hipparions were distinctly less progressive than the contemporary and monodactyl *Pliohippus*, and it is from the latter that *Equus* is now regarded to have sprung.

The hipparion group persisted through the Pliocene, but disappeared with the coming of the Pleistocene or Ice Age, at least in North America. During the late Miocene or early Pliocene, the true hipparions are found in North America and Eurasia. By the middle of this epoch, perhaps eight or nine millions of years ago, these horses gave way to the larger, heavier neohipparions which were characteristically North American in distribution. They have been found fossil, for example, in Florida, Texas, the western Great Plains, the Great Basin province, California and Mexico. Although described from a number of localities, nowhere has a specimen been found sufficiently complete to permit the construction of a mounted skeleton.

During one of the early expeditions of the Division of the Geological Sciences, California Institute, well-preserved materials of the species *Neohipparion leptode* were uncovered in the middle Pliocene, Thousand Creek deposits of northwestern Nevada. These have now been

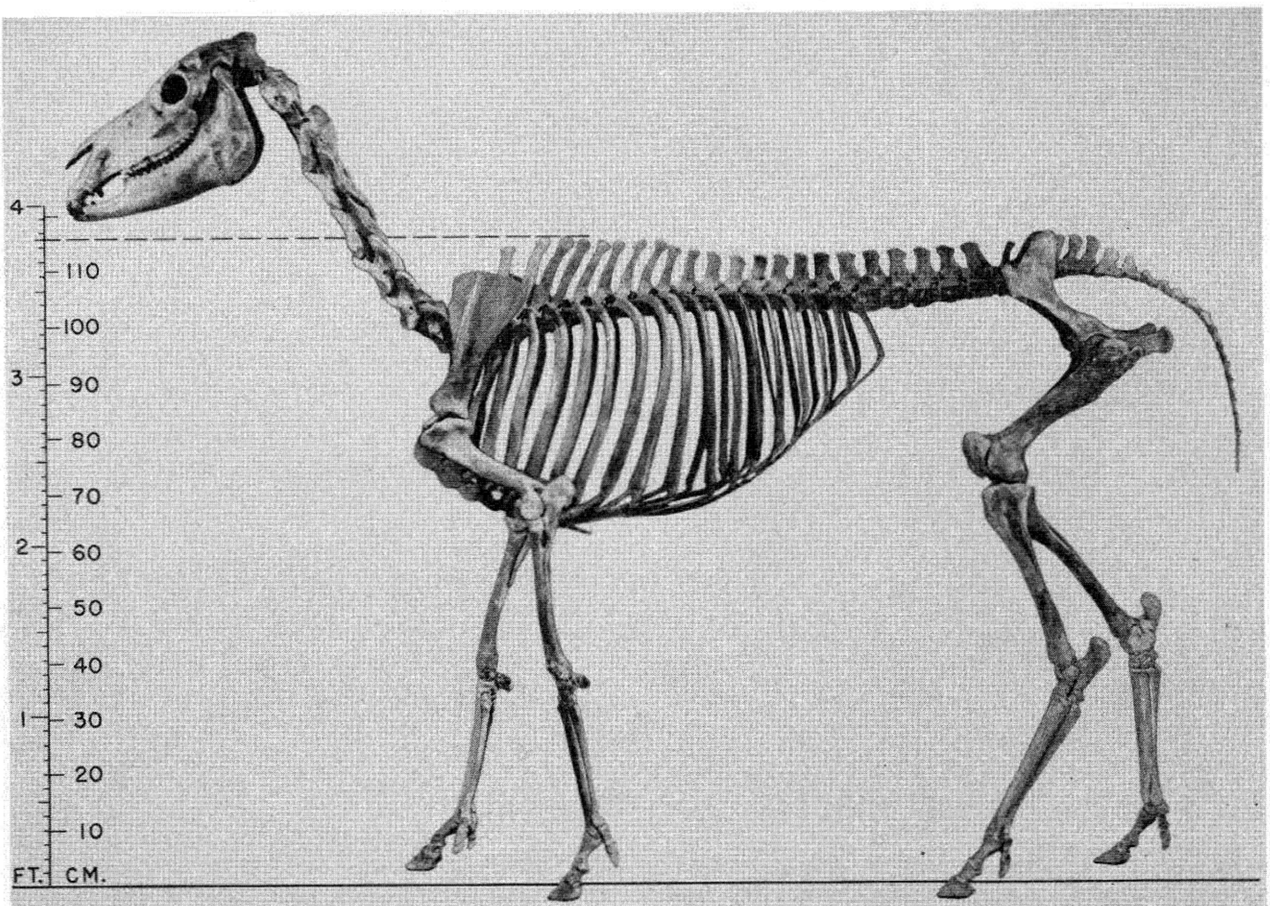


FIG. 1

prepared by E. L. Furlong, and an exceptionally fine skeleton (*Figs. 1 and 2*) the first of its kind, has been mounted by William Otto, preparator in Vertebrate Paleontology.

The skull in this animal is of an adult male. The skeleton as it stands compares in size with that of the Burchell zebra, being a trifle over 3 feet 9 inches, or approximately $11\frac{1}{2}$ hands, tall at the withers. However, the proportions of this Pliocene horse are noticeably different from those of modern *Equus*. A striking difference is seen immediately in the small size of the head. In the fossil specimen the skull is distinctly smaller in relation to the size of the body than it is in the zebra. While the body is proportionately as long as in the Burchell zebra, the sides are flatter, the chest appearing narrower and "slab-sided." The limbs are, likewise, differently proportioned, the principal bones of the fore and hind feet being very much longer in relation to the arm and thigh bones, respectively, than they are in the zebra. This extra length in the feet of *Neohipparion* caused its limbs to be some six per cent longer, in relation to the size of its body than even the highly-specialized limbs of the modern race horse. The side toes are beautifully preserved, and, as shown in the skeleton, are distinctly shorter than the middle toe. They do not touch the ground. The hoof of the third or middle digit is larger than in the zebra, and shows a small median fissure. In running, *Neohipparion* could probably exceed the speed of the zebra, at least for short distances.

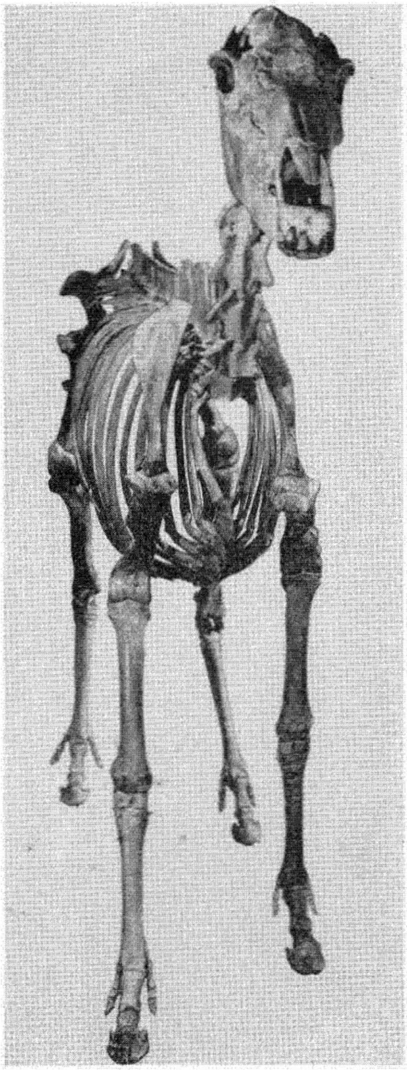


FIG. 2

The mammalian associates of *Neohipparion leptode*, when it roamed the grasslands in what is now the arid Thousand Creek region of northwestern Nevada, were the more progressive horse, *Pliohippus*, short-legged rhinoceroses, large camels, curious twisted-horned antelopes, peccaries, cats, dogs, badgers, and rodents.

Progress with Roads

(Continued from Page 8)

measuring space with time. Perhaps we are confronted with the need of more highly developing a mental process by which, given walking, driving and flying speed, we may arrive at the minimum of time for a given journey. Will this result in improving and increasing our mental ability, with beneficial progress?

PROSPERITY—DEPRESSION

We have seen that many of the notable civilizations of early history, the Egyptian, the Carthaginian, the Chinese, the Incan, and the Roman, during the height of their power, built hard surfaced roads over which the civilizing influences from any portion of the empire could flow to any other portion. All of these early civilizations reached a peak and declined, their road systems deteriorating with them. It is impossible to determine which was the cause and which the effect, but it is interesting to note that a decline of one element accompanied a decline of the other.

In the early 1930's the United States experienced the worst depression in its history. The depression was more than nation-wide; it was world-wide, and many able students marked it as the beginning of the end of our modern civilization. Road building decreased materially in the United States in this period. There was very little new construction, and many existing roads were allowed to deteriorate through lack of maintenance. Later, a definite increase in road building occurred, which in turn, was greatly slowed by war activity. In spite of this check, some major projects, such as the Alaska and Pan-American Highways, have been materially rushed forward, and we have a very practical hope in the years to come of greater and more extended international highway travel than ever. It has often been contended that these international highways may constitute one of the greatest civilizing influences of modern times, and it seems not too much to expect that we may still progress with roads.

Buried Voice Channels

(Continued from Page 11)

amount of protection desired against possible damage to the cable. Even at these depths some little trouble is caused by lightning in those areas where electrical storms are common. A number of installations have been made in which one or more copper lightning-protection or shield conductors have been buried above the cable, but these have not been completely effective. Some consideration is now being given to the use of a copper sleeve covering the normal lead sheath of the cable itself.

To determine the existence of current on the cable sheath, a recent installation was equipped with test points approximately every 3,000 feet. At these locations, two wires permanently attached to the cable sheath, 10 feet apart and insulated from the earth, were brought to the surface and terminated in a housing for the convenience of the tester who makes periodic checks of the current flowing on the cable sheath. Periodic tests are necessary, for, despite the fact that the cable is buried, there are a number of causes for changes in the effectiveness of the insulation, not the least of which are the rodents or pocket gophers previously mentioned. Only that part of the United States roughly east of the Mississippi River, exclusive of an area in the Southeast, is free from these pests.

GAS PROTECTS CABLE FROM MOISTURE

Since the paper insulation of the cable conductors readily absorbs water, every effort must be made to exclude moisture. Even a small amount of moisture reduces the insulation resistance and a little bit more may short-circuit two or more conductors and put circuits out of service. To protect the most important cables from the entrance of moisture and to provide a means of detecting 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.

ATHLETICS

By H. Z. MUSSELMAN,
Director of Physical Education

WITH a third of the basketball season past, Caltech's record shows two wins and three losses.

After opening the season with an 84-36 victory over Vultee, the team dropped close contests to U.S.C. 46-39 and Santa Ana Army Air Base 55-52. Bouncing back in the win column, the Engineers defeated Camp Ross 47-43, but were on the short end of the return match with Camp Ross 58-51.

Coach Shy still has to arrive at a regular starting lineup. Co-Captains Hugh West forward and Paul Nieto guard, together with center Bernie Wagner, have started all games. Stuart Bates and John Schimenz have been alternating at the other forward spot, with Dennis Ahern and Jerry Schneider battling for the guard spot.

The team is playing a fast and aggressive type of ball, and has scored an average of 55 points per game. Hugh West has led the scoring in all games and has an average of 18 points per game. However, lack of height has proved the real weakness of the team, and has been a real handicap, for the ability of lengthy opponents in controlling the ball off both backboards has been a contributing factor in all the defeats.

Coach Dr. Hane's cross country runners placed well in all meets. Victories were registered against Compton J.C. 27-28 and 26-29, U.C.L.A. 18-42 and Oxy 25-32 while Redlands led by Roland Sink, a V-12 trainee and the former U.S.C. distance runner, trounced the Beavers 25-30 and 24-31. George Gill, Tech ace, placed first in all meets except those against Redlands. A four way meet at U.C.L.A. found Redlands again victorious with 31 points, Caltech second with 40, while Oxy and U.C.L.A. tied for third with 72 points apiece.

Progressive Education

(Continued from Page 3)

institution that proposes to maintain decent standards of professional work. When the war is over, the Institute, in all probability, can continue to select from applicants for admission a full freshman class of adequately prepared students. But it can do so only by a drastic process of selection; and unless what seems to be a pretty general trend in high school education is reversed, a larger and larger number of high school graduates who are potentially good engineering and scientific material will be automatically excluded from consideration.

The four-year professional courses are continually working with the problem of not enough time for all that should be done. Surely the solution is not to dilute and superficialize the work of the high schools. Readers of *Engineering and Science* may well give serious thought to this whole problem. As citizens and taxpayers they have a legitimate concern with whether the public schools are giving them their money's worth. If they have children, they have a more immediate concern; and if they have any doubts about the adequacy of the grade and high school education that their sons and daughters are receiving, then let them do something about it.

ALUMNI DINNER DANCE

The Annual Alumni Dinner Dance will be held February 10 at the Oakmont Country Club in Glendale. Bob Mohr's orchestra will provide the music and the party will be informal. Dinner will be served at 8:00 P.M. Dancing will be from 9:00 P.M. to 12:30 A.M. Tariff for dinner and dancing will be $6.00 per couple; for dancing only, $2.40 per couple. Reservations should be made immediately through the Alumni office.

PERSONALS

1921

ALLIN CATLIN is a lead engineer in the North Hollywood district of the Southern California Telephone Company.

1922

K. A. LEARNED is a district engineer in the Alhambra area of the Southern California Telephone Company.

1923

DONALD SCOTT is at the Johnson Foundation of the University of Pennsylvania at Philadelphia, Pa.

1925

M. E. SALSBURY has been made president of the Los Angeles Section American Society of Civil Engineers at a recent meeting. C. W. Sopp, '17, was elected a vice-president and Arthur Pickett, '24, secretary.

MAJOR J. J. DEVOE, Signal Training Battalion at Camp Crowder, was in southern California on business for the government.

GLENN M. SCHLEGEL is now with Union Iron and Steel Company in Los Angeles as assistant manager in charge of operations.

1926

HERBERT V. INGERSOLL, a prisoner of the Japanese, has sent his wife a message, through an intercepted propaganda broadcast from Japan, stating he is in good health, uninjured and is receiving letters and personal boxes.

ERNST MAAG in December was made vice-president of the Structural Engineers Association of Southern California.

1927

CAPTAIN FRANK S. HALE is "somewhere in Belgium" doing photo interpretation which keeps him well informed on our part in this campaign and as he says, "makes him prouder than ever to be an American."

1928

HUGH HOSSACK is a lead engineer at the Van Nuys office of the Southern California Telephone Company.

1929

LIEUTENANT (j.g.) HAROLD CORBIN is on a destroyer in the South Pacific engaged in anti-submarine warfare.

RAYMOND KIRCHER has joined the vacuum tube development department of the Bell Laboratories.

1930

CAPTAIN LAWRENCE NYE, U.S.A., sent greetings on Christmas Day from his station in Australia to his family in Los Angeles.

1931

DR. CHARLES KIRCHER is the father of a new daughter, Josephine McCullom, born in October. Dr. Kircher is associated with the Du Pont Company.

1932

E. C. KEACHIE is a Captain in the Engineers Corps, U.S.A., with headquarters in San Francisco.

THOMAS F. ANDERSON is working with viruses and the electron microscope at the Johnson Foundation, University of Pennsylvania.

PHILIP SCHOELLER is associated with American Arabian Oil Co., Saudi Arabia, having arrived there the middle of September after 45 days of travel. Mr. Schoeller is doing engineering in non-processing construction such as the pier, salt water intake, roads, pipe lines, etc.

ERIC J. MILES is now with Mellon Securities, Pittsburgh, Pa., as assistant to the vice-president in charge of investment counsel.

1934

ROBERT SCHRECK is district engineer for the Orange County district of the Southern California Telephone Company.

1935

ROBERT P. JONES, U.S.N.R., was recently promoted to full Lieutenant. In September he became father to a second son.

PERRY POLENTZ is connected with McKinney and Co., management consultants, San Francisco, Calif.

JAMES N. SMITH, engaged on a war research project for Columbia University, has returned to southern California and is now working for Caltech on a war research project.

DR. JESSE E. HOBSON has taken over the position of director of the Armour Research Foundation in Chicago. He was formerly head of the electrical engineering department at Illinois Tech, during which time he also was director of the Army Signal Corps training program. Dr. Hobson was responsible for the opening of two new college graduate training programs at Commonwealth Edison and Allis-Chalmers in which industrial employees work toward advanced college degrees in their own plants.

1936

WALFRED E. SWANSON has the responsible position of assistant chief of operations with the grade of senior civil engineer in the Sacramento district office of the U. S. Engineers. The district includes central and northeastern California, northern Nevada, Utah, western Colorado, and southeastern Wyoming.

RAYMOND BOOTHE, U.S.N.R., has been made full Lieutenant. Letters from him are V-mailed from Australia.

FRANK BRINK, JR., is at the Johnson Foundation, University of Pennsylvania, Philadelphia, Pa.

1937

ED HORKEY is secretary of the Los Angeles Chapter of the Institute of Aeronautical Science.

WENDELL B. MILLER is outside plant engineer for the Alhambra district of the Southern California Telephone Co.

1938

DR. JOHN C. LILLY for nearly three years has been doing research in high altitude physiology, oxygen supplies, etc., under the committee on aviation medicine of the committe of medical research, of the Office of Scientific Research and Development at the University of Pennsylvania. Dr. Lilly has carried on this work as a fellow in biophysics.

DR. JAMES WATSON, formerly engaged in research at the Johnson Foundation, University of Pennsylvania medical school, has now completed his interneship at the Massachusetts General Hospital in Boston.

STANLEY T. WOLFBERG is the father of Joel Alan, born November 4, 1944.

HERBERT ELLIS was presented with a baby daughter, Jean Palmer, born on December 4, 1944.

ROLAND C. STONE and Miss Barbara Deibert were united in marriage in a formal ceremony at All Saints Episcopal Church, Pasadena, on December 2. 1944. Mr. and Mrs. Stone will make their home at Inyokern where Mr. Stone is employed on one of the Caltech projects.

CAPTAIN A. F. DU FRESNE gives us his impressions briefly of the European countries where duty has taken him. Captain Du Fresne writes that sunshine is "rationed" in England and France on a strict basis but that the people of these countries have given them a reception that has far more than made up for the deficiencies in the climate.

ROBERT S. CUSTER has been transferred back to the New York office of the Texas Company, after several months in Long Beach, Calif.

WILLIAM FREEDE is now an industrial engineer for North American Aviation in Inglewood, Calif.

1939

MAJOR PAUL C. ENGELDER is the father of Paul Coolidge Engelder, born on October 15, 1944. Major Engelder is in the Southwest Pacific with the Marine Corps.

JAMES W. BRAITHWAITE is a mechanical engineer, working at the Caltech wind tunnel and also instructing at the Institute.

JAMES E. STONES is the father of Judy, his third child, who arrived in October at their newly purchased home in Weatherford, Okla.

1940

CHARLES PAYNE became father to a second son born November 11, 1944. Charles is a Seaman Second Class in training at Farragut, Ida.

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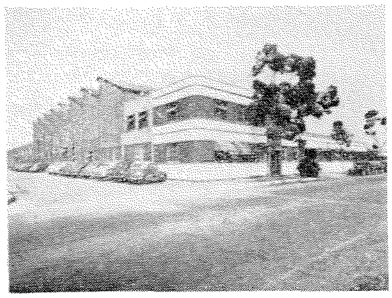

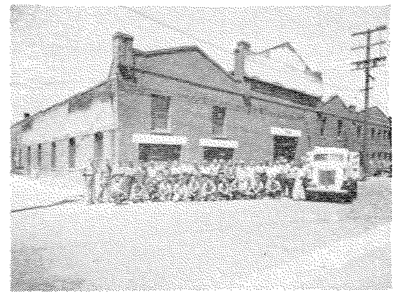

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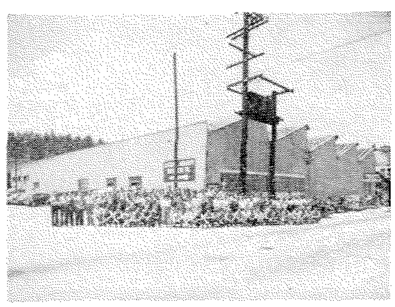

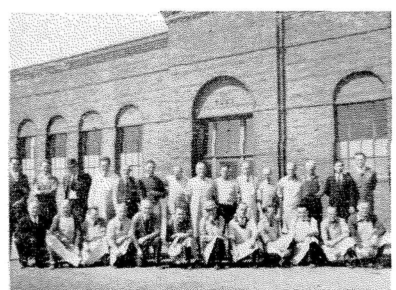

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Roland T. Kinney, Stanford, '22
Bryant E. Myers, Cal Tech, '34
C. Vernon Newton, Cal Tech, '34

Forbes W. Jones, Cal Tech, '35
Leonard Alpert, Cal Tech, '43
B. R. Ells, Throop, '10

"What's a formula, anyhow?"

'Her . . . er . . . formula? What's that? You see, I'm a pretty new father. Nancy's only three months old. My wife brought her up to Portland to see me when I got shore leave. She took sick and is in a Portland hospital. I'm taking the baby down to her gramma's in Los Angeles."

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Passenger Aides are just one of the steps we've taken to improve our service to those who must travel in war time. In a way they represent the type of helpful, friendly service all our people try to give, even though it's hard these days, being as short-handed as we are.

S·P

The friendly Southern Pacific

1941

SERGEANT RICHARD F. SILBERSTEIN, 1053rd Engineers Post Construction and Repair Group, is in Normandy and with his outfit has been engaged in reconstruction of the harbors of Brest and St. Malo.

LIEUTENANT EUGENE A. LAKOS, C.E.C., U.S.N.R., is stationed at the Naval Operating Base, Norfolk, Va., in the public works department.

LIEUTENANT WILLIAM SCHUBERT is stationed at the U. S. Naval Engineering Experiment Station, Annapolis, Md.

ENSIGN NEWELL PARTCH, U.S.N.R., is stationed at David Taylor Model Basin, Carderock, Md.

LIEUTENANT D. C. CAMPBELL, U.S.N.R., is stationed at David Taylor Model Basin, Carderock, Md.

1942

LIEUTENANT WAYNE MACROSTIE, U.S.N.R., after a short training period at Norfolk, Va., in June 1942, was ordered to duty as a Civil Engineer Corps officer in the Caribbean area. Since that time he has been doing construction and maintenance work in that area.

SECOND LIEUTENANT ALFRED LANDAU, Ordnance Department, U.S.A., sends Christmas greetings from Holland.

LIEUTENANT (j.g.) ERWIN LARSON, U.S.N.R., is at the Shoemaker Hospital at Tracy, Calif., recuperating from illness contracted in the tropics. He had been with the Seabees in the South Pacific for 23 months.

LIEUTEANT EARLE A. CARR, U.S. N.R., is stationed at the Massachusetts Institute of Technology, attending radar school.

GORDON WOODS is the father of a son born on November 24, 1944. Gordon is a marine engineer at Kaiser Inc., Richmond, Calif.

1943

ENSIGN E. P. FLEISCHER is stationed at Massachusetts Institute of Technology, after four months at Harvard. When training is completed Ensign Fleischer will be qualified as a radar officer.

ENSIGN O. J. MEAD is serving as an instructor at Massachusetts Institute of Technology, Cambridge, Mass.

1944

ENSIGN WARREN KOTT has been assigned to duty in naval communications at Washington, D. C., but expects transfer to the Pacific area.

ENSIGN WM. P. BAIR was back on a 10-day leave to California to spend the holidays. He has been at Columbia Midshipman's School (Prairie State), took sub-chaser training at Miami, then attended Cleveland Diesel School at General Motors plant. Ensign Bair will return to Chicago to be assigned to duty on a P.C.E.R. as chief engineering officer.

ENSIGN WILLIAM H. BOND, having had the same training as Ensign Bair, is to be assigned on a P.G.M., in Wisconsin.

ENSIGN WILLIS BUSSARD received his commission at Prairie State and is now at submarine school, New London, Conn.

ENSIGN BRUNO PILORZ also received his commission at Prairie State and is now at submarine school, New London, Conn.

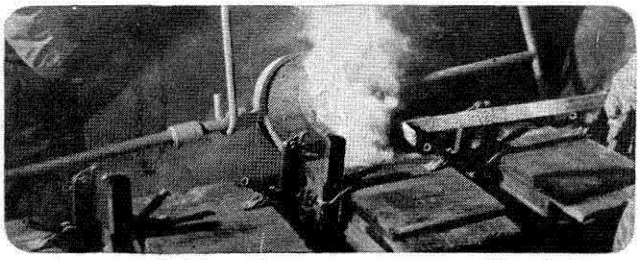
ENSIGN WINFIELD HUGHES, commissioned at Prairie State, is assigned to a destroyer on the Atlantic.

ENSIGN CARL OLSON, commissioned at Prairie State, was on duty on a minesweeper. He is now at the sub-chaser school in Miami, Fla.

R. W. PROTZEN was married on December 8. He is associated with Standard Oil of California in their San Francisco office.

CALL

Olds Alloys



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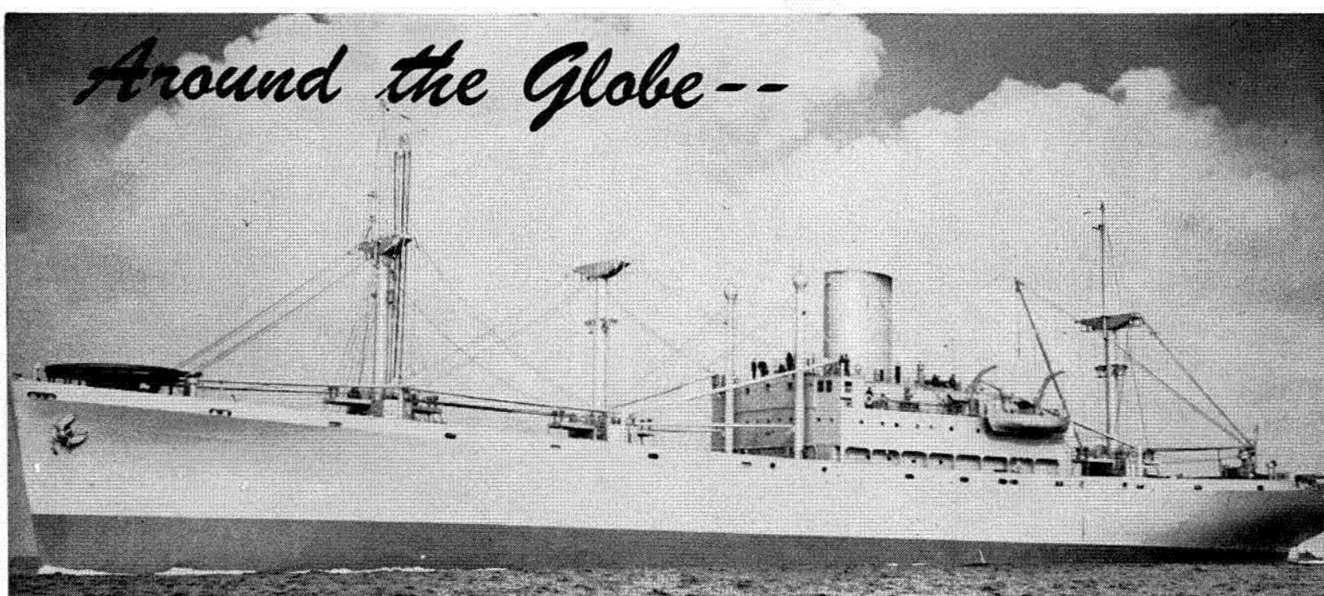

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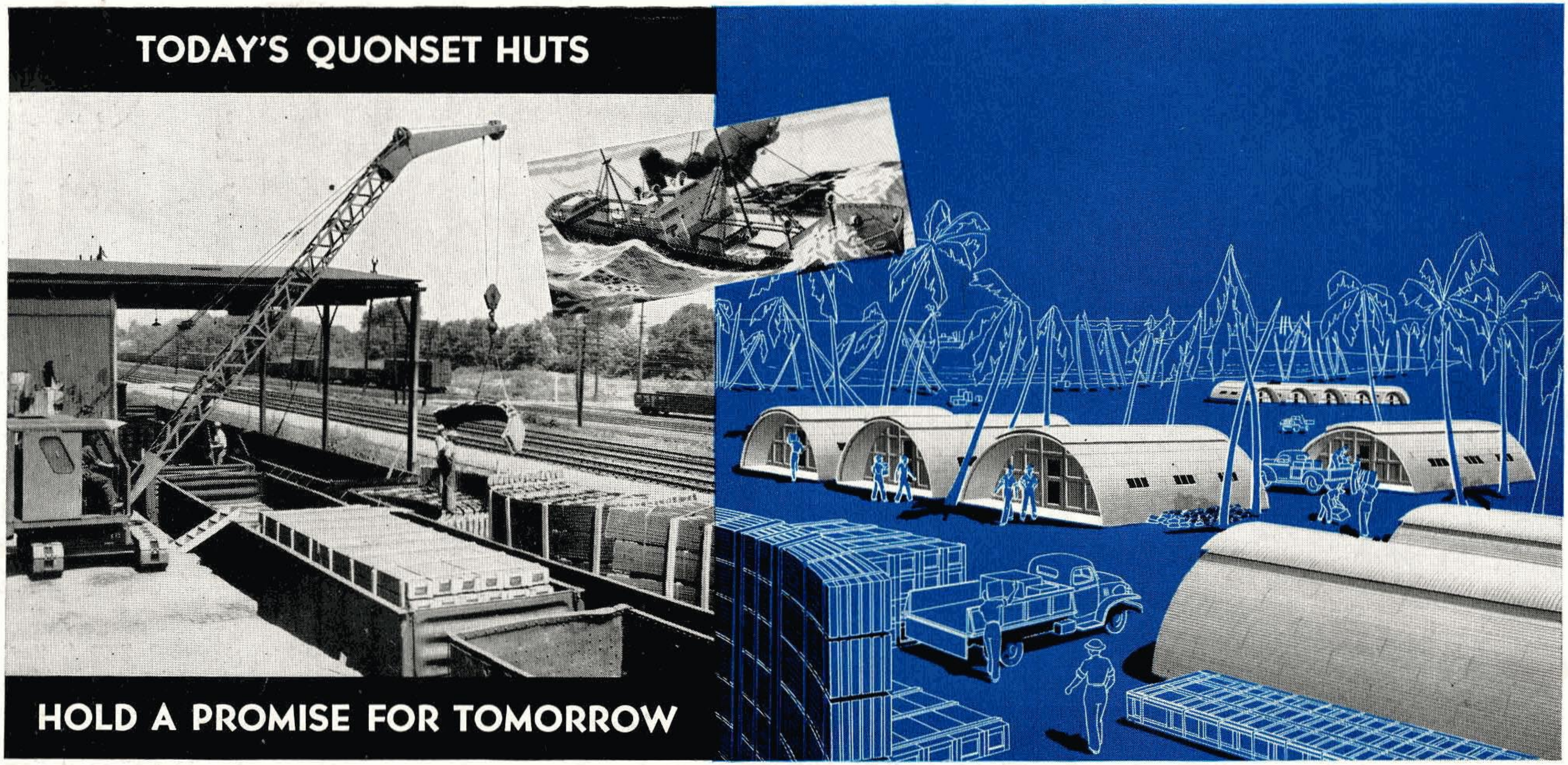

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