Wood Preservation — and the Railways

A review of a relationship that has saved the carriers hundreds of millions of dollars

Preservative Treatment, Preceded by Accurate Preframing, Is Giving Structures Like This a Life of 30 Years or More Today

ONE hundred years ago—on July 11, 1838—a patent was issued to John Bethell covering the pressure process for the treatment of timber to protect it against decay and thereby extend its life. From that beginning there has developed an industry that, in the United States, includes more than two hundred plants which treated 265,000,000 cu. ft. of timber in 1937.

The wood preserving industry is essentially a railroad industry. It was developed to meet the needs of the railways for more durable timber for crossties and more recently for structural purposes, for poles and piling, for crossing plank and for a wide variety of miscellaneous uses, including a slight amount for freight car construction. In the early years of the industry, the railways took almost its entire output; they still take two-thirds today.

At one time the railways owned and operated a large proportion of the wood preserving plants. They still own some 35 plants and operate 23, although the present trend is definitely towards the leasing of these plants to private parties for operation.

By reason of the fact that timber comprises one of the largest items of railway purchases and the further fact that the wood preserving industry has always looked and must continue to look to the railways for its major market, the interests of these two groups are mutual. For this reason it is entirely natural that the *Railway Age* should recognize the centennial of wood preservation, dating from the granting of the Bethell patent, for this action marked the beginning of a development that has already saved the railways hundreds of millions of dollars and can save them many millions more as the possibilities for treated timber are more universally realized.

The nature of this development, the part that the railways have taken in it, the economies that have already resulted therefrom and the further economies that are possible as the treatment is extended to those applications where timber is still used untreated, are presented in the pages that follow.

A Development of Last Century

As far back as history goes, man has used wood for constructive engineering purposes. Yet it was recognized from earliest times that it was subject to decay, sometimes very quickly, which sooner or later caused partial or complete failure of the structures in which it had been applied.

Classical literature contains many references to efforts to prevent decay in timber and to the substances that were employed for this purpose. Among the earliest of these were asphalt, tar and pitch, which were used for coating the wood surfaces. Observing that cedar, larch, juniper, nard, and certain other trees and shrubs were resistant to decay and the attack of insects, and that these woods contained either resins or highly scented oils, means were devised for extracting them and they were applied to the timbers of important structures, and to wooden objects of value, in the belief that they would ward off decay and the attack of insects.

Further developments in the art of wood preservation ceased with the beginning of the Christian era, and for 1,700 years there was apparently little curiosity concerning the causes of decay; at any rate not sufficient to stimulate serious study. About the beginning of the Eighteenth century, fermentation and putrefaction began to attract attention and, although some of the early theories with respect to these phenomena seem absurd in the light of modern knowledge, this period marks the beginning of progress in the control of decay in wood.

How Wood Preservation Got Its Start

Although the causes of decay were still unknown, these studies were soon extended to include antiseptics, and while a number of experiments are recorded, one of the earliest practical applications was that of Homberg, a French scientist, who, in 1705, steeped wood in corrosive sublimate to protect it against insects. While much activity in the way of research, and particularly in the propounding of theories, can be traced through the records of the Eighteenth century, it was not until the beginning of the Nineteenth century that practical progress in wood preservation became evident.

Two factors were responsible for this advance. At that time, England was engaged in a life-and-death struggle with a host of adversaries, in which her very existence depended on her navy and her merchant marine. Yet decay in the timbers of her ships was taking a heavier toll of both her fighting and her cargo vessels than all of her enemies combined. Later, with the birth of the railway, conservation of the timber employed as sleepers immediately became an engineering as well as an economic necessity, for timber was by no means plentiful in England.

For these reasons, what had previously been looked upon as more or less an academic problem, suddenly became a very practical one and technical progress had its start. Kyan's patent, issued in England in 1832, probably was the greatest step in the art of wood preservation up to that time, and for some time his process was by far the most popular method of treating timber. But it had two serious defects; it was expensive and poisonous and could not be made to penetrate deeply by merely soaking the wood in a solution, and it had limited usefulness, being ineffective against marine borers; and the slowness of the process made it applicable for treating timbers on a small scale only. In its day, however, it was an important advance in the technical development of the art of wood preservation.

Bethell Made Greatest Contribution

The most important technical development in the art occurred in 1838, when John Bethell took out his patent covering the pressure process for treating wood. Despite the fact that this patent covered a process rather than a preservative, 18 substances being listed as preservatives to be used with the process, and despite the further fact that there was only incidental mention of creosote, this invention became the origin of the modern treatment of timber with creosote.

In the same year, 1838, Sir William Burnett, who had been director general of the medical department of the British navy, obtained a patent covering chloride of zinc as a preservative for wood. The original method of treatment consisted of boiling the wood in a solution of chloride of zinc, made in the proportion of ¼ lb. of dry salt to 1 gal. of water. This proved to be very slow and tedious and not very effective, and Burnett shortly adopted Bethell's pressure process. His process was still further improved by using steam to prepare the wood for the reception of the preservative.

Passing over literally thousands of experiments with hundreds of substances and the numerous patents that were issued to cover processes of almost every conceivable kind, by 1850 only four of these processes and preservatives remained in common use in England, where up to that time the greatest practical technical advances had been made and where the largest volume of wood was being treated. These were Kyanizing; Margaryizing, in which sulphate and acetate of copper constituted the preservative; Burnettizing; and creosoting. Several other preservatives were still employed on the continent, but they too fell into disuse, generally, in the course of time.

Early Developments in the United States

In the early days of the railways in the United States, timber was so plentiful and cheap that little thought was given to wood preservation, and for this reason the growth of the wood-preserving industry in this country was slow. While sporadic experiments were conducted, beginning with 1838, and a considerable number of treating plants were constructed during the following four decades, the construction of a treating plant by the Louisville & Nashville at West Pascagoula, Miss., in 1875, to creosote timbers exposed to teredo attack, may be said to mark the beginning of wood preservation in an organized way in this country. Although there was a marked expansion in the use of treated wood, and a considerable number of plants were constructed from that time until 1900, the methods employed generally followed European practice, so that during this period there was little advance along technical lines.

This should not be interpreted to mean that wood preservation was at a standstill with respect to either processes or research. The industry was expanding, but the art was so new in this country and there were so many factors demanding consideration that practice was outstripping knowledge, as it had done in England during the three or four decades previously. Again, this country not only had a greater variety of woods to draw from, but a wider range of conditions under which they were being used than had faced the industry in Europe. For this reason, there was little experience that could be drawn upon as a guide to the development

The First Creosoting Plant in the United States, Built by the Dighton & Somerset at Somerset, Mass., in 1865, Is a Far Cry From the Treating Facilities of Today

of methods best suited to the conditions that were being faced in this country. Furthermore, the causes of decay were only beginning to be understood, and in some respects had not yet been fully established.

It is not surprising, therefore, that as the use of treated wood expanded, many examples of unsatisfactory service occurred, and that questions concerning methods, adequacy of treatment, seasoning, preparation of the wood for treatment, character and dependability of the preservatives, penetration and retention of preservatives, their adaptability for different woods and precautions to be taken after the wood was in service, as well as many others, began to arise. All of these and other features connected with the art were investigated, but facilities for intensive research had not yet been built up. Furthermore, in many cases, when a new process or an improvement on an old one was devised, it required years to determine whether it gave satisfactory results. Sometimes valuable information relating to the results of these treatments was allowed to slip away through failure to keep proper records of service.

Industry Struggled for a Foothold

Another factor which must be kept in mind when considering the technical developments which have resulted in permanent improvements in the art of wood preservation in this country, is that during the early period of the industry timber was plentiful, and in many quarters it was considered to be cheaper to use untreated wood and allow decay to progress without artificial hindrance, than to pay the cost of preservative treatment, even though this treatment would extend the service life of the timber two or three times. For these reasons, much time and effort during this period were directed toward the discovery of cheaper antiseptics; toward finding combinations of those already in use, that would reduce the cost of treatment; toward devising means whereby the desired results could be attained with reduced amounts of preservatives; and to the possibility of shortening the time of treatment. While some of these studies were undoubtedly constructive, to some extent they tended to retard real advances in the technical developments of the art of wood preservation.

In the course of time it became apparent that some of the practices which had been successful in Europe and which had been copied in this country were not giving satisfactory results. It required some time and serious study to discover that the reason for this was that in Europe only seasoned timber was given preservative treatment, while here much of the material was freshly cut or only partially seasoned when it entered the retorts, and that entirely different methods would be necessary. Methods for the artificial conditioning of the green wood were devised as a consequence of this discovery and this marked a further definite technical advance, although the ultimate development along this line has not yet been reached.

Although the widespread interest in wood preservation stimulated chemists and inventors to develop an astonishing number of antiseptics and processes for the preservative treatment of wood, in a comparatively short time the bulk of the preservatives in common use had narrowed down to creosote and zinc chloride, although these were combined with other substances in some of the processes, and pressure treatments eventually came to be used almost exclusively, except for poles and posts for which the open-tank method is still employed to some extent.

Efforts Made to Reduce Costs

While both creosote and zinc chloride were demonstrated to be highly effective in preventing decay, the former was the most expensive of all preservatives that had been used to any extent; and the latter, among the least expensive, had the disadvantage of solubility. In an effort to reduce the cost of creosoting and at the same time obtain the full advantage of preservative treatment, several processes were devised which represented technical developments of considerable importance. The first of these, suggested by J. P. Card, consisted of a light injection of creosote, followed immediately by a normal injection of zinc chloride. It was claimed for this process that the interior of the timber would be fully protected against decay by the preservative salt and that leaching would be prevented by the creosote.

This Plant, Built in 1937, Illustrates the Latest in Facilities for Treating Timber for Railway Uses

Another method, known as the Allardyce process, which had the same purpose, that is, low cost and prevention of loss of the zinc chloride, reversed this process, since it consisted of a full treatment with zinc chloride, followed immediately by an injection of about 3 lb. of creosote. A third zinc-creosote process, widely known as the Card process, was introduced somewhat later by J. P. Card, son of the inventor of the first process. This differed from the Allardyce method in that an emulsion of the creosote and the zinc-chloride solution was injected into the wood in a single operation.

The Wellhouse process also marked another step in the technical development of wood preservation at a time when the industry faced the necessity of keeping its cost low to permit it to compete with low-priced untreated timber. This process consisted of a normal injection of a solution of zinc chloride, mixed with glue, followed by the injection of a solution of tannin, the theory being that the glue and tannin formed an insoluble compound which filled the pores of the wood and kept the zinc chloride from leaching. Later this became a three-movement process which required considerable time and involved much inconvenience.

As the supply of timber dwindled, and practically disappeared in some sections, prices advanced to the point where higher costs for treatment could be justified. Up to this time the Bethell, or full-cell, process had been employed universally for the straight creosote treatment. Then, as now, ties constituted the bulk of the timber treated, but as there was no well-developed means for protecting them from mechanical damage in service, a large percentage failed from this cause long before their service life would have been terminated by decay.

The Louisville & Nashville Plant at West Pascagoula, Miss., Built in 1875, Marked the Beginning of Wood Preservation in the United States As It Is Known Today

New Processes Developed

For this reason, the belief grew that creosoting was an uneconomical process, since a considerable part of the cost of the treatment was lost through early mechanical destruction of the ties. At this point two methods of treatment came into use, which represented distinct advances in technical development and which have had a profound influence on wood preservation. These are known as the Lowry and the Reuping processes, designed to give the same penetration of the wood as the full-cell process, but reducing the amount of creosote retained by expelling some of it by means of air compressed in the wood cells.

From the beginning, ties treated with zinc chloride gave trouble from checking and splitting, particularly in the arid regions of the West and Southwest. To overcome this difficulty, a method was developed in which the treatment with zinc chloride was followed by an injection of petroleum. While this was successful in part, and a considerable number of ties were treated in this manner, further developments led to the adoption of other methods, for while the cost of the preservative and the oil was low, the double treatment slowed down the output from the retorts.

In the beginning Bethell used coal tar as a preservative, but was unable to inject a satisfactory amount into the wood. He then tried "dead oil of tar" or creosote as a thinner. Later, coal tar was used as a diluent for the creosote to reduce the cost of treatment, and this practice is being followed to a large extent today; although coal tar alone is still in use for preserving wood. The most recent development in the dilution of creosote when used as a preservative is the addition of petroleum to produce mixtures in which the proportions of the constituent oils are varied to correspond with the kind of wood, the purpose for which the timber is to be used, considerations of the cost of treatment and other factors which may be taken into account.

It was early recognized that creosote is a complex and variable substance, and for many years controversy raged as to the preservative value of the light and heavy constituents of the oil; in fact, this discussion is still in progress. Out of these disputes, however, has grown an immense amount of research and an accumulation of knowledge relating to the use of creosote as a preservative. While it would be tedious even to list the many items that have been under study, out of them there is growing a better understanding of the preservative action of creosote of the methods best adapted for its use in the treating process, and of what happens when the treated wood is exposed to the elements during service. As a result, there have been marked changes in the treating processes, which are also reflected in those in which preservative salts are used, as is witnessed by the specifications for various kinds of treatment that have been prepared by the American Wood-Preservers' Association and the American Railway Engineering Association.

Within recent years increased interest has been displayed in salts other than zinc chloride, induced in part by the increasing demand for a "clean" treatment, and several preservatives of this character have come into extensive use. These include chromated zinc chloride, Wolman salts and zinc meta arsenite, all of which have come into sufficiently widespread use to be given individual classifications in the last compilation of preservative statistics issued by the Forest Service, United States Department of Agriculture, in co-operation with the American Wood-Preservers' Association.

Decay Is Investigated

Since a knowledge of the causes and processes of decay is of prime importance in wood preservation, these matters early became subjects of intensive study, and while these matters are more fully understood today, the studies are still in progress. They have been stimulated in recent years by the American Wood-Preservers' Association, by the Committee on Wood Preservation of the American Railway Engineering Association, and by the establishment of the United States Forest Products Laboratory, although research along these lines is also being carried on in many quarters by independent investigators. As a result of these studies, there has been marked progress in the technical developments relating to the production and handling of timber prior to treatment, through which stringent regulations have been devised for keeping the timber under aseptic conditions from the time the tree is cut, through the seasoning period and until it is placed in the retort. Furthermore, the benefits of this expanding knowledge have extended to the care of the treated wood in service, in ways that have added materially to its service life.

Up to a relatively short time ago, little thought was given to the preparation of timber for treatment, except so far as it related to seasoning and the prevention of decay prior to treatment. But crossties, bridge timbers, poles, etc., too frequently failed from decay despite the closest control of the treating operations and heavy injections of preservatives. Studies indicated that much of this trouble arose from the fact that timbers were framed and bored and that ties were adzed and spiked after treatment, thus destroying the protective zone of treated wood, and exposing the untreated interior to attack by decay-producing organisms.

With the advent of large tie plates, the machine adzing of crossties to produce a better and more uniform bearing for the rail became a prime necessity, and equipment was designed to do the adzing before the ties were taken to the retorts. Machines were also designed to prebore the ties to insure a zone of treated wood around the spikes. While preadzing and preboring have not yet become universal, these practices are gaining favor.

Although the value of preframing structural timber was admitted, many difficulties, some actual and some imaginary, were foreseen in its accomplishment. In the first place, no machines existed for the framing of large timbers, and while a few progressive roads undertook to preframe their bridge timbers by hand, they found it to be a slow and expensive operation. Here again, machines were developed for this purpose. While the preframing of timbers has by no means become universal as yet, not a few roads are now preframing all material that is to be treated for use in both bridges and buildings, and find it both practical and economical.

Thus step by step, the art of wood preservation has been developed—through the perfection of processes for the introduction of the preservative into the timber, through the testing and refinement of preservatives to determine those most effective for different conditions, through the selection and care of the timber both before and after treatment to insure that the preservative will be given the most favorable opportunity, until treated timber today is accepted as a dependable constructional material with characteristics approaching those of permanency.

What Wood Preservation Owes to the Railways

Since wood preservation was first introduced into this country, the railways have been the backbone of the industry. It was a railway that used the first timber treated in the United States. It was the unorganized efforts of individual railways that kept interest in the subject alive at a time when timber was so cheap that there was no general demand for the preservative treatment of wood. It was a railway that built the first creosoting plant in the United States. It was a railway that built the plant which marks the beginning of preservative treatment in an organized way. It was the railways as a whole that sustained the infant industry when it was struggling in the face of seemingly insurmountable difficulties to gain a foothold and which, without the encouragement and aid they gave, would have suffered ignominious defeat. From the beginning the railways have consumed an overwhelming proportion of the products of wood preservation, and even today, with the greatest diversification in the use of treated wood since the industry came into being, they still use more than two-thirds of all the wood that is being given preservative treatment. Furthermore, the railways still offer the largest concentrated market for the further use of treated timber in many diversified forms.

If the railways had not persisted in their belief in the economic value of preservative treatment, despite the many failures of treated timber to live up to expectations, it is doubtful whether wood preservation could have reached the position it now occupies in our national economy. Likewise, if the railways were now to discontinue the use of treated timber, the wood preserving industry would receive a blow from which it could recover only with the greatest difficulty.

In view of the important position which the railways occupy with relation to the wood preserving industry, it will be instructive to review the part they have played in its development and to ascertain the reasons why they maintained their interest in treated wood in the face of its many failures to meet expectations with respect to service benefits and longer life. This interest was aroused initially by an apparent approaching shortage in the timber supply as lumbering operations depleted the forests and settlers moved in along the new railways that were being constructed, thus creating a continually increasing demand for timber in the face of a diminishing supply.

First Ties Treated

Envisioning the time when it would be difficult to obtain ties at a reasonable price, a number of roads early began studies to determine ways in which their service life could be extended. In 1838, the Northern Central, now part of the Pennsylvania, steeped enough chestnut ties in corrosive sublimate (Kyan process) to tie one mile of track. These were laid together and compared with untreated chestnut. In a report dated in 1849 it was stated that after 11 years the treated ties were still sound, showing few signs of decay, although the untreated ties had lasted only 7 years. This was the first attempt in this country to use wood that had been given preservative treatment and, although the experiment was considered a success, the process was abandoned because of the reported detrimental effect of the mercury salt on the men employed in the treatment and handling of the timber, as well as because of the slowness of the process.

Similar experiments were conducted by the Louisa (Chesapeake & Ohio), on oak ties, in 1840, which were reported to be successful; and by the New York Central, on hemlock ties, in 1849, which after 10 years were reported to be in good condition, although untreated hemlock was good for only 3 to 5 years. Unfavorable results were obtained by the Baltimore & Ohio, in 1842; by the Old Colony, in 1845; by the Providence & Wooster, in 1847; and by the Boston & Providence, in 1856; partly because of faulty treatment. In 1846, the Eastern Massachusetts, using the pressure process, Kyanized a lot of spruce and oak longitudinal timbers for supporting the rail, and continued to do so for several years. This road abandoned the process later, partly because of the cost and partly because it had been decided to use ties instead of longitudinal timbers under the rails. While reports of the results were not consistent, it was claimed that some of the spruce timbers lasted as long as 20 years.

Bridge Timbers Treated

Experiments with Kyanizing were not confined to ties, however, for the Philadelphia & Reading, in 1850; the Fitchburg, in 1853; and the New York & New England, in 1854; treated timbers by this method for the construction of truss spans, all of which were reported to be successful. These bridges remained in service for periods ranging from 20 to 28 years, until they were dismantled to make way for heavier structures, at which time the timbers were still sound. The testimony is unanimous that the life obtained from the treated timbers was greater than could have been expected from untreated material, and it was not overlooked that, so far as decay was concerned, the timbers could have remained in service for an undetermined number of years.

The record of these experiments, which are so termed because in only a few instances were they developed into settled practices, has been given to show the early and widespread interest of the railways in the preservative treatment of wood. This interest is emphasized when it is considered that of the 16 experiments that have been dependably recorded, 13 were carried on by railways, 2 by the federal government, and 1 by the Lowell Canal Company, and that even in these experiments the amount of treated wood used by the government and the canal company was negligible when compared with that by the railways.

Since Kyanizing was an open-tank process, it had two serious drawbacks in addition to the corrosive and poisonous character of the preservative for little penetration was obtained, so that the untreated wood was easily exposed, and the process required so much time that a plant of reasonable size was unable to produce the amount of treated material required in railway maintenance. For these and other reasons, attention was turned about 1850 to treatment with zinc chloride by the Burnett process. As this was a pressure treatment, the results were much better and the process was received with more favor, completely displacing Kyanizing within a few years. The use of this preservative was initiated by the railways and they were foremost in the development of the process in this country.

Railways Turn to Zinc Chloride

During the early period while the use of the Burnett process was being developed in this country, a number of railways erected their own plants, but owing to the sizeable investment involved and the inconvenience and annoyances attending their operation, most of them preferred to rely on commercial plants, the greater part of the output from which went to the railways. In fact, it has been estimated that during this period of development, say to 1880, about 95 per cent of the total amount of wood treated was consumed by the railways, the remainder going generally into wharf construction and pavements. During this period also, while ties constituted the bulk of the timber treated, there was considerable expansion in the use of treated timber in railway bridge construction.

Many examples of early and complete failure are recorded for both ties and construction timbers. Where these failures were traced to their source it was found that they fell into two classes with respect to the cause. One of the most common complaints was that where the timber was exposed to moisture the preservative salt leached out; yet the testimony is general that even where this happened, the life of the treated timber was longer than that of untreated timber exposed to the same conditions, provided the treatment had been applied properly.

The second class included poor work, some of the causes of which were treatment without preliminary steaming; holding ties in the field so long that decay was present before treatment; efforts to treat green timber that was frozen; taking the timber directly from the stump to the retort; hurrying it through the retort, with the result that it was inadequately treated; and failure to apply sufficient pressure to obtain satisfactory penetration. In fact, in a discussion of the period, it was stated that so great was the impatience of railway officers to get timber through the plants that "pressure was applied to the operatives, instead of to the cylinders," with disastrous results to the treated product. Another cause of failure that, while less common, was of sufficient importance to merit mention, was the use of too strong a solution of the zinc chloride, with the idea that if some of the salt did leach out, enough would remain to prevent decay. This apparently destroyed the strength of the wood, causing it to become "as brittle as a carrot," so that ties subjected to treatment with saturated solutions of the salt frequently broke in unloading.

A Section of the Cleveland, Tex., Test Track Established by the Santa Fe in 1902—One of the Outstanding Proving Grounds for Preservatives and Treatments

Despite the many unfortunate experiences, enough examples of increased life and satisfactory performance of treated timber were recorded to convince railway officers that preservative treatment could be made an economic success by further perfecting the technique of the process and by insisting on better work. This opinion was confirmed by the development of several processes, such as those of Wellhouse, Allardyce and Card, which were designed to increase the efficiency of the treatment and to reduce leaching. It was the examples of successful treatment, the active efforts to improve technique and processes, and the continuing rise in the price of timber that induced the railways to adhere to their faith in wood preservation in the face of almost limitless discouragements.

Railway Builds First Creosoting Plant

It was soon discovered that piles treated with zinc chloride were not immune to teredo attack. For this reason, in 1865, the Dighton & Somerset (Old Colony, now the New York, New Haven & Hartford), erected a creosoting plant at Somerset, Mass., in which 700 piles were treated for the construction of a bridge across the Taunton river, where teredo infestation was relatively severe. Although the treating was done hurriedly and some carelessness was permitted during construction, in that knots were trimmed off and some adzing was done to obtain a better fit for the bracing, with the result that the piles thus misused were attacked and about 200 were replaced during the next few years because of teredo damage, the job was considered a success and attracted wide attention.

A number of commercial creosoting plants were constructed during the next decade and considerable creosoting material was placed in service by the railways in structures in tide water. Much of the experience with this product was unfavorable and for this reason as well as because of the high cost of creosote, this process made little headway. Creosoting received a decided impetus, however, when the Louisville & Nashville constructed its plant at West Pascagoula, Miss., in 1875, to treat piles and bridge timbers for use in the teredo-infested waters along the Gulf of Mexico. Treatment at this plant was done so thoroughly and the results were so satisfactory that the railways became convinced of the efficacy of the process when it was carried out carefully.

Creosote treatment, however, suffered its share of failures which, in general, could be traced to the same causes as those of zinc chloride, that is, poor work. Prior to the construction of the West Pascagoula plant, consideration had been given to the practicability of contracting for the treatment of the material that was needed, for a number of commercial plants were then engaged in treating timber with creosote. Examination of these plants and their products was undertaken and a report of this investigation states that "examination of their products and of the oldest creosote work that could be found was convincing that if creosoting could be done properly, it would be good and effective; but it it could not be done better than anyone was then doing it, it had better be left alone." On the other hand, "wherever a piece of timber could be found that had been saturated with oil, it was perfectly sound, and these isolated specimens were evidence * * * that creosote was a specific against decay and the ravages of marine animals, if properly used."

While the belief grew that creosote properly applied would give the best protection against decay of any known preservative, the conditions that were mentioned in the reports made the railways chary of using it extensively, although they did adopt it to some extent. In fact, in 1880, the Houston & Texas Central erected a plant at Houston, Tex., with two cylinders for the treatment of ties, bridge timbers and tank frames; and the New Orleans & North Eastern built one at Slidell, La., primarily to treat material for the Pontchartrain trestle. Another consideration which retarded the adoption of creosote as a preservative was its high cost compared with other preservatives, particularly zinc chloride. Ties were cheap, and prices for other timber had not yet reached the level where it was considered economical to pay for the higher-priced treatment, particularly as at this time a large proportion of the treated ties were failing from mechanical destruction rather than decay.

Railways Expand Use of Treated Material

For these reasons the railways turned largely to zinc chloride and during the three decades subsequent to 1880 there was marked expansion of its use. It was during this period that efforts were made to combine creosote and zinc chloride for the dual purpose of reducing the cost of treatment with the former and to obtain full benefit of the antiseptic qualities of the salt by the elimination of leaching. It should not be lost sight of that while some treated wood was being used outside of the railway field, substantially all of the activity of this period connected with developments in treating processes and the construction of wood preserving plants, was carried on either by the railways themselves or in their behalf. In fact, a great deal of the effort was directed to improvements in the service characteristics of ties. During most of this period ties alone represented about 90 per cent of all material treated, although up to 1904 less than 10 per cent of all ties used were given preservative treatment.

While the product of the treating plants was gradually improving, the results were as yet far from satisfactory. Many of the factors that were causing failures were not yet fully understood and there arose a belief on the part of not a few railway officers that they did not have sufficient control of the treating operations in commercial plants, and that they could overcome their troubles only by building and operating their own plants.

Another factor that had a definite influence on the trend toward the construction of treating plants by the railways was that of continuity of supply. When a railway once adopted the practice of using treated wood, its demands in terms of volume were likely to be large until such time as all untreated timbers were replaced. Deliveries of orders placed with commercial plants were often delayed to permit completion of prior orders, much to the exasperation of the officers who needed the material. While this situation was often the fault of the railways themselves, it did not lessen the impatience of the officers who were waiting for the material.

The combination of these and other factors, including examples of poor work; failures, the causes for which remained undetermined; disputes with operators of commercial plants with respect to the technic of the processes; desire to have full control of all operations, including the period of seasoning; the belief on the part of a few that they were better qualified to run the plants than the owners; a growing belief that the managements of commercial plants were not fully alert to developing better technic in their operations; a widespread suspicion that treatment was being slighted in the interest of production; and inability to get deliveries as desired; as well as the lack of commercial plants in certain sections, exerted a strong influence on the attitude of railway officers with respect to the operation of treating plants. There was also a desire in some quarters to eliminate the item of profit which a commercial plant must of necessity include in the price of its product. Again, the success of the treating plants that were being operated by the railways at Pascagoula, Slidell, Houston, and Las Vegas, N. M., provided an added impetus to the movement toward railway-owned and operated treating plants, and especially toward the use of creosote as a preservative.

Indicating the magnitude of this trend, by 1903 there were 27 pressure-treating plants in the United States, of which 13 were owned and operated by the railways, while a number of the remainder were operated by commercial companies either wholly or primarily for the railways upon which they were located. The impetus of this movement continued for two more decades, during which period the number of railway-owned and operated plants more than doubled, while as many or more plants were constructed by commercial treating companies under contracts that required them to treat timber solely for the railways upon which they were located.

It should not be assumed that these 27 plants which were in active operation in 1903 represented the total number that had been constructed up to and including this date, for a far greater number had passed out of existence. In fact, one of the plants in operation at that time was the third that its owner had built, the other two having been replaced because of obsolescence. These were only the plants that had survived the ravages of time, the continued developments in processes and equipment and the need for greater capacity.

Railways Reverse Policy

Plants owned and operated by the railways continued to increase in number until 1922, when 32 were in active service. Since that year, however, this number has gradually declined, until in 1937 there were only 23 railway-operated treating plants. In addition, some of the commercial plants were released from their obligation to treat solely for the railways upon which they were located. It becomes of interest, therefore, to examine the reasons for this reversal of policy. It is obvious that it did not result from a cessation of the use of treated wood, for the railways are today more firmly committed to the use of treated wood than ever before, and are still consuming more than two-thirds of the wood that is being given preservative treatment. It will be necessary to seek further for the cause.

In the intervening years there have been marked changes in the wood preserving industry. It has been put on a sounder and more dependable basis, in that it has largely purged itself of unethical practices. The companies now engaged in commercial treatment are striving, as many of them did previously, conscientiously to improve their product. Many of them are constantly engaged in research with this objective in view, and all are alert to take advantage of new technical developments which will accomplish this. Again, in recent years, some phases of the technic of the preparation and treatment of the wood, and of the preservatives, have become so complex and highly technical that they can be kept under study only by specialists. For this reason, in recent years, the railways have been content to leave these matters to an increasing degree to those engaged in the field of commercial treatment.

Moreover, in the majority of cases, railway treating plants were built with sufficient capacity to meet the needs of a period when treated wood was being used to replace untreated material. As the amount of untreated material in service declined, the demands on the plants decreased correspondingly, until today, on some roads this demand is confined largely to the replacement of the longer-lived treated material. For this reason, these roads have been confronted with surplus capacity. There has, therefore, been a definite trend toward turning these plants over to commercial-treating companies, which are able to sell this surplus capacity. Both the railway and the commercial treater gain by this arrangement, the latter because he is assured of a stable market up to the limit of the needs of the railway; and the railway in that it is relieved of an inefficient operation and is benefited by the additional freight that is brought to it through the use of the surplus capacity.

This trend from railway to commercial ownership of plants does not indicate any lessening of interest in treated wood on the part of the railways. On the contrary, there has never been a time when they have used it for a greater diversity of purposes. Originally, and even up to a few years ago, ties constituted from 90 to 95 per cent of this use, the remainder being piles and timbers for bridges and marine structures. Today, the railways uses include ties and tie plugs; piles and struc-

A Modern Wood Preservation Plant Requires Ample Facilities for the Seasoning As Well As the Treatment of Timber

tural timbers for bridges, dock, piers, overhead highway structures, bulkheads; buildings, platforms, etc.; tanks and tank frames; fence posts, crossing plank, trunking and capping, conduits and culverts; car material; cradles; scows; wood blocks for shop and freight station floors; and material for a variety of other purposes. Furthermore, they are constantly finding new uses for treated material, as for example, the recent installation by the Missouri Pacific of sub-ballast grillages of treated timber to overcome soft spots in the track.

Part Railway Men Have Played

No discussion of the part that the railways have played in the development of the wood preserving industry would be complete without mention of some of the railway men who have taken part in this development and who, by their pioneering efforts not only raised the standards of their own day, but pointed the way to still higher standards, and who have thus been instrumental in bringing the industry to the place it now occupies. Passing over men of the earlier period who collectively kept the spark of interest in wood preservation alive, but who did not contribute individually in any large measure to the development of higher standards, we come to those who initiated the modern era of timber preservation and played important roles in its development.

The first of these was J. W. Putnam who built the L. & N. creosoting plant at West Pascagoula, Miss.; who did such a splendid job of treating the piles and timbers for which the plant was built, that he demonstrated for all time the value of creosote as a preservative; and who, still later, was in charge of creosoting the piles and timbers for the bridge over Lake Pontchartrain. Putnam stood practically alone in the short period which he represented, but which sharply defines the transition from four decades of experimental work to the era in which wood preservation began to be established on a sound basis and the growth of the industry as it is today had its beginning.

Among the railway men of the period shortly following that of Putnam who made outstanding contributions to the art of wood preservation was John D. Isaacs, consulting engineer of the Southern Pacific, who in 1892, jointly with W. F. Curtis developed a portable treating plant and in other ways did much to develop means for the treatment of Douglas fir and other refractory woods of the West Coast. In the period from 1897 to 1918, E. O. Faulkner, tie and timber agent of the Atchison, Topeka & Santa Fe, saw in wood preservation a means for overcoming the heavy drains that were being made on the forests of the country to meet railway requirements for ties and other timbers. Among his many activities, he did much to stimulate the development of preservatives and practices adapted to the climatic conditions of the Southwest, being instrumental in the development of test sections for determining the merits of various preservatives and methods of treatment; their value when applied to different species of wood; and the performance of treated timber under a variety of climatic conditions. The most outstanding of these test sections is the one established at Cleveland, Tex., in 1902, where a wide variety of wood treated by various processes and preservatives is still being kept under constant observation. Working along similar lines, F. J. Angier did much to promote knowledge of tie service, largely in the Middle West and the Northwest, by establishing test sections of ties on each operating division of the Burlington in 1909 and 1910.

Another pioneer who did much during the formative period of modern wood preservation to raise the standards of timber treatment, by insisting that only sound wood should be treated, was George Rex, manager of treating plants on the Santa Fe from 1909 to 1920. With others, he early recognized the necessity for getting ties and other timbers out of the woods as quickly as possible after the trees were cut, to remove them from the decay-producing conditions which prevail in the forest, and the importance of providing for storage during the seasoning period on yards carefully laid out, drained and kept free of vegetation to minimize the chances for infection. He also initiated the use of cut-off saws to facilitate the examination of the interior of timbers and avoid the treatment of timber in which decay was already advanced.

Coming to the present generation, John Foley, forester, Pennsylvania, will long be remembered for his constructive work in the field of timber production during the days of federal control of the railways and since, in creating an appreciation of the importance of proper manufacture and seasoning and adequate size of timber, especially crossties, preliminary to its treatment. Many other railway men of the present generation are as alert as those of former periods with respect to improvements in wood preservation, and are continuing a relentless campaign for better preservative materials and practices.

The railways are today, as they have always been, the proving ground for old processes and preservatives as well as for new developments in both. Through literally hundreds of test sections, such as those that have been mentioned, they are determining the merit of new preservatives and demonstrating the necessity for modifications in the use of old preservatives and processes. With the sustained interest of the railways, their persistent faith in the value of preservative treatment and their continued support through the use of large quantities of treated wood, it is to be expected that the treatment of timber for railway use will expand until it becomes all but universal.

What Wood Preservation Has Done for the Railways

Is it worth while to save $150,000,000 a year? This may be a startling question. Yet this is a conservative estimate of the amount that the railways are now saving through the use of treated timber. Still more startling, it is much less than they will be able to save eventually when they extend the use of treated timber to those additional applications where its use may also be justified. In making these statements it is realized that they are not susceptible of direct proof, for it is impossible to determine what the price of timber would be today if wood preservation had not stepped in and, by reducing the drain on the forests, kept prices at a reasonable level. In this article an effort will be made to evaluate some of the savings that have been and some of the further savings that can still be made through the use of treated timber, and to show that wood preservation has an economic value for the railways far greater than is generally realized.

When wood preservation first attracted the attention of the railways, timber was plentiful and cheap and the preservative treatment of wood made no appeal to railway officers as a measure of economy. They looked upon it primarily as a conservation measure whereby they could assure themselves of an ample supply of timber to meet their future needs. So deeply was this viewpoint impressed upon railway officers during the early period of wood preservation that it is still an important influence in their attitude towards timber treatment.

Realization that wood preservation had an economic value far beyond that of conservation of natural resources alone, came slowly. Railway officers were constantly expecting complete exhaustion of the forests and higher prices for timber. However, as new lines were built into virgin territory, new forest resources were tapped and prices for timber remained nearly constant or rose so slowly that there was little incentive to study the economics of wood preservation.

Eventually the cost of timber rose until by 1880 it was beginning to give concern. At the same time, as the mileage of new lines continued to increase and add to the drain on the forests, it became evident that the more enduring woods were becoming scarce and that to keep maintenance costs within reasonable bounds, it would be necessary to turn to inferior woods, particularly for ties. It was also recognized that these woods were not enduring and that if used without treatment their service life would be so short that this change would be little less than a calamity.

At about the same time bridges began to give equal concern, for with rising prices and increasing difficulty in obtaining the large dimension timbers of the species then in common use, the cost of bridge maintenance was increasing rapidly. Piles treated with zinc chloride and subjected to moisture gave little better service than untreated piles. Partly for this reason and partly because of the impressive performance of the material that had been treated at Pascagoula, Houston and Slidell, creosote was adopted universally as the preservative for bridge timber. Prior to the general adoption of treated timber in bridge construction, all trestles had been of the open-deck type, but with the knowledge that with preservative treatment, repairs and renewals of these structures would be less frequent, the ballast deck came into use and this has added further to the economy of bridge maintenance.

Wood Preservation Holds Prices Down

These then were the conditions which confronted the railways in 1880, namely, approaching exhaustion of the more desirable species of wood, rapidly rising prices for timber and the resulting necessity for turning to inferior and less durable woods. These conditions pointed very definitely toward the need for a wider use of treated timber than most railway officers had thought would ever be necessary. It will be of interest, therefore, to study the record and determine whether the preservative treatment of wood has been of benefit to them.

While the price of timber has increased measurably during the 60 years since 1880, when prices were rising so rapidly, it is indisputable that the rate of this increase has been greatly reduced, compared with the rate immediately prior to 1880. During this 60-year interval the supply of the so-called inferior woods has been ample to meet all demands, and by relieving the pressure on the more desirable woods, has tended to keep prices down all along the line. Moreover, when the demand for certain species of the inferior woods has reached the point where prices began to rise, the railways have turned to others, and in this way also prices have been kept at a reasonable level. This in itself is an economic benefit of no small importance, not only to the railways but to all users of wood.

During this 60-year interval the fear of complete exhaustion of the forests has never fully subsided, and there have been recurring periods when this fear has been greatly intensified. During one of these periods, before the use of treated timber became as widespread as it now is, E. O. Faulkner, tie and timber agent of the Atchison, Topeka & Santa Fe, went to points as remote as Japan and the Philippine Islands to develop new sources of supply, and he imported more than a million ties from the Philippines. That this was not an isolated

One of the Many Hundreds of Test Tracks Through Which the Railways Are Studying Processes, Treatments and Tie Life

case of concern about the domestic supply is indicated by the investigations made by several eastern roads of the possibility of securing ties in Central and South America to make good the expected shortage of domestic ties. It is significant that none of these roads imported ties, except a few for experimental purposes, for wood preservation came to the rescue, since through the more widespread adoption of preservative treatment, sufficient additional life has been obtained from domestic woods to make importation unnecessary. This, too, is an economic benefit, the value of which can scarcely be estimated.

What the Savings Are

No one can fix a definite figure on the value of the benefits which the railways have realized from this stabilization of prices and the elimination of the necessity for imports for no one can say what the cost of timber would have been today without the equalizing influence of wood preservation. On the other hand, there are direct savings that can be evaluated. As an indication of the magnitude of these savings, there are approximately 1,250,000,000 ties in the maintained tracks of the railways of the United States and Canada. Experience has shown that the average life of the untreated inferior woods available for tie purposes today is 5.6 years, but that this life is being increased to 20 or more years by preservative treatment, while some roads are getting nearer 30 years' service life from their treated ties.

If, therefore, all ties were untreated, the annual renewals would approximate 225,000,000 ties. Likewise,

After 55 years, More Than Half of the Original Creosoted Timber Still Remains in the 5.82-Mile Trestle of the Southern Across Lake Pontchartrain, in Louisiana

on the basis of a service life of 20 years if all ties were treated, the annual renewals would approximate 62,500,000 ties. Again, if the cost of an untreated tie in the track is $1.40 and that of a treated tie is $2, when all ties in service are treated ties the annual saving will approximate $180,000,000, compared with the universal use of untreated ties. On this same basis, taking the 27 roads reporting to the Committee on Wood Preservation of the American Railway Engineering Association and to the Committee on Tie Service Records of the American Wood-Preservers' Association, and comparing the average renewals per mile of maintained track for the five-year period ending with 1911, with the five-year period ending with 1936, it will be found that individual roads in this group are saving from two to four million dollars annually through the use of treated ties.

In papers presented at recent conventions of the American Wood-Preservers' Association, H. R. Clarke, engineer maintenance of way, Chicago, Burlington & Quincy, and R. H. Ford, chief engineer, Chicago, Rock Island & Pacific, estimated the savings on their respective roads through the use of treated ties at $2,880,000 and $2,341,000 annually. These specific examples might be extended to include a much larger number of individual roads, but those that have been given are sufficient to show that the savings realized from the use of treated ties are real and substantial.

How Wood Preservation Affects Trestles

Turning to bridges, A. F. Robinson, then bridge engineer of the Atchison, Topeka & Santa Fe, stated in a paper presented at a joint meeting of the American Wood-Preservers' Association and the Western Society of Engineers at Chicago in 1922, that "even when we had good white oak piles, we had to spend from 5 to 50 cents per month per foot of bridge for maintenance after a few years, while our creosoted ballast-deck bridges have stood for years and years and after that have not cost $10 per 100 ft. of bridge per year." Likewise, at a similar joint meeting in 1933, Earl Stimson, then chief engineer maintenance of the Baltimore & Ohio, referred to a creosoted, ballast-deck, pile trestle which was constructed in 1910, and which up to 1933 had required no expenditure whatever for maintenance. He also stated that a recent inspection had indicated that no replacement of any of its members would be required for an indeterminate number of years additional.

In 1894, D. K. Colburn, then bridge engineer of the Southern Pacific Lines east of El Paso, stated that "the first creosoted work that I put in this section about 20 years ago is still in . . . I suppose that about 35 per cent of our bridges are creosoted, and the economy of this practice is being demonstrated today by the decreasing amount of timber we use each year." Again, 41 years later, in 1935, George W. Rear, bridge engineer of the Southern Pacific, Pacific Lines, said in a paper which he presented before the American Wood-Preservers' Association, that "records indicated that by 1895 the Southern Pacific had more than 50,000 lin. ft. of ballast-deck creosoted trestles. Many of these structures are still in service and in condition to last for many more years." Similar testimony as to the economic value of wood preservation in timber bridge construction has been given by other bridge and maintenance engineers. These statements afford ample evidence of the character and magnitude of the benefits the railways have obtained through the use of treated material in bridges.

These results were not obtained without attendant

The Illinois Central Used Treated Timber Throughout in the Construction of Its Double-Track Trestle Built Over the Bonnet Carré Spillway, Near New Orleans, La., in 1933. This Structure Is More Than 11,000 Ft. Long and Required Approximately 10,000 Piles

difficulties, for many of the early structures built of treated material failed from decay about as quickly as those in which untreated material had been used. Holes were being bored and timbers were framed to fit in the field, exposing the untreated material beneath the zone penetrated by the preservative, thus completely nullifying all of the benefits of the preservative treatment. To eliminate this form of damage, numerous other roads, including the Baltimore & Ohio, the Erie, the Union Pacific and the Chesapeake & Ohio, are preframing the timber for trestles. On the latter road all material to be treated for building purposes is included. Plans for preframing the structures are prepared as carefully as for steel structures, and no difficulties have been experienced in assembling the preframed material in the field.

There are at present approximately 2,500 track miles, or more than 13,000,000 lin. ft., of timber trestles in service on the railways. Even with the best material available, the life of an untreated trestle ranges from 4 to 20 years, depending on its location, with the average for the country as a whole about 8 years. In contrast, the life of creosoted trestles may be conservatively estimated at 25 years, while the cost of maintenance is correspondingly reduced. On the basis of these figures, the savings that can be effected through the universal use of treated timber for trestles, including both replacement and maintenance costs, exceeds $20,000,000 a year.

Creosote Stops Teredo Damage

A phase of wood preservation that does not have as wide application as those that have been mentioned, but from which benefits of almost indeterminate magnitude are realized by the railways, by reason of their large ownership of wharves and piers at ports, is the treatment of timber for use in coastal waters. Evidence that in this application wood preservation has an economic value of great magnitude is found in Mr. Rear's paper already mentioned in which he said that "with the advent of creosoted piling, our trouble with marine borers became of small moment." Citing the Oakland Long wharf in San Francisco bay, in which 14,000 piles were driven in 1890 and removed in 1919, he said that, "after 29 years of service most of these piles were suitable for redriving in salt water, although the marine-borer infestation is so severe that untreated piles are destroyed in about two years." The life of creosoted piles in the waters of the Gulf of Mexico is not always so favorable as on the Pacific Coast, but even in the heavily infested waters of the Gulf, many excellent records have been established, and the life of well-creosoted piles is from 10 to 20 times that of untreated piles.

Wood Preservation Prevents Termite Damage

Another form of protection against the destruction of wood, in which the preservative treatment of timber has demonstrated a high economic value is that against termites and wood-boring insects. These insects find a supply of food in wooden buildings, including such railway structures as depots, warehouses, locomotive roundhouses, etc. While many means have been tried to prevent their damage, nothing has yet been found to be as effective as preservative treatment of the timber that goes into these structures, including posts, poles, piles, structural timbers and lumber. While no data exists from which a definite evaluation of this application of preservative treatment on the railways can be made, it is evident that it is high.

In still another field, the railways maintain more than 4,250,000 poles in signal, telephone, power-distribution and telegraph lines. On the assumption that the average life of untreated poles is 10 years and of treated poles is 25 years, the railways are saving more than $10,000,000 a year through the use of treated poles, including material, labor costs and replacement of poles and crossarms.

The foregoing figures do not by any means complete the picture of the economies that the railways are realizing from wood preservation, for they are using treated wood for a wide variety of other purposes, including culverts, fence posts, crossing plank, flooring, water tanks, etc. On the other hand, they have not yet taken full advantage of the benefits that can be realized if the use of treated wood is made universal, particularly in buildings and freight cars. The savings that are being and that can be realized are emphasized when it is understood that even with all of the economies that have been effected by preservative treatment the railways normally still spend $170,000,000 annually for forest products and use almost 20 per cent of the annual cut.

What Wood Preservation Can Still Do

This year marks the completion of a century of the use of treated timber by the railways. For 100 years they have led in the development of wood preservation. For 100 years they have consistently used an overwhelming percentage of the timber that has been given preservative treatment. Today, despite a wider use of treated timber by other industries than ever before, they still use more than two-thirds of all of the timber that is treated in this country. During this long period of consistent use, they have gained an intimate knowledge of the economies that can be effected through the use of treated timber by reason of its longer life and the reduction in maintenance expense which ensue. With this background and knowledge of the benefits that can be derived from wood preservation, it might naturally be assumed that they are using it universally. Yet this use is far from universal.

Even if preservative treatment is not applied to all timber for the numberless purposes for which the railways use wood, one might expect ties to be an exception, for ties have always constituted the bulk of the timber that has been given preservative treatment, and treated ties have been used longer than any other form of treated material. Yet untreated ties are still being used to an extent that few realize, more than 9,600,000 being installed by class I railways in 1937. Among these roads 14 used untreated ties exclusively; 24 used untreated ties for more than half of their renewals during the year; 12 other roads inserted from 25 to 50 per cent of untreated ties; and others used smaller percentages of untreated ties. Thus, despite the fact that approximately 45,000,000 ties were given preservative treatment in 1937, it is evident that there is still opportunity for railways to effect attractive savings by the further use of treated ties.

This recalls the estimate made in 1927 by C. C. Cook, then maintenance engineer of the Baltimore & Ohio, that while the railways were then saving $53,000,000 a year through the use of treated ties, this saving could be doubled by treating all ties to give them a life of 20 years. It should not be overlooked in this connection that through improvements in treating processes, many roads are now obtaining considerably more than 20 years' service from their treated ties, compared with from 5 to 10 years from untreated ties, thus adding an appreciable amount to the potential savings stated by Mr. Cook.

After ties, the next largest present use of treated material by the railways is in bridge construction and maintenance: yet in this application the use of treated material is as yet far from universal, despite its proved economies.

Freight Cars Offer An Almost Virgin Field in the Use of Treated Timber

Although some roads are using treated material exclusively for their timber trestles, others are still using large quantities of untreated materials for this purpose. Since the average life of an untreated trestle is about eight years, and the cost of maintenance is high during the latter part of its life, while there are records of many treated trestles that have given from 30 to 40, and even more, years of service life, with relatively small maintenance charges even in the later stages of their existence, the economic advantages of the preservative treatment of timber for bridges are obvious. For this reason, bridges offer a large opportunity for further economies through the more extensive application of preservative treatment.

In considering the benefits which the railways are not yet realizing through failure to fill all of their needs for

Many Advantages Can Be Demonstrated for the Use of Treated Timber in Railway Buildings

wood with treated timber, it should not be overlooked that the savings which result from the use of treated timber are not confined to the material alone, for if the life of the structure or tie can be extended from 6 to 8 years to 30 or 40, the savings in maintenance and the labor cost of several renewals may be as great as the saving in material.

Poles and Posts Provide Attractive Outlets

While the railways are now using many treated poles, they are not yet taking full advantage of the opportunity for economies that are inherent in this field, for only a part of the 3,500,000 poles they maintain are treated. The cost of treatment is so small a part of the cost of the pole in the line that this cost will be repaid by only a few years added life; yet the average service life can be extended from 10 to 25 years by preservative treatment.

Another field in which wood preservation can still do much for the railways is fencing. The railways maintain 500,000 miles of right-of-way and other forms of fencing, in which there are more than 160,000,000 fence posts. Although a large number of steel and concrete posts have been installed in recent years, wooden posts, largely untreated, still predominate. The requirements for renewals amount to 12,000,000 posts a year. The life of an untreated post of non-durable wood usually does not exceed 5 years, and in many localities it is as short as 3 to 3½ years; yet the life of such a post can be extended to 20 or 30 years through adequate preservative treatment. While the railways are using many treated posts, the percentage is small, and to a considerable extent this is, therefore, as yet a new field for the use of treated timber. The universal use of treated posts would reduce their requirements to some 8,000,000 posts annually.

An Opportunity in Grade Crossings

A use of treated wood which has as yet been given only minor consideration by the railways and is, therefore, practically a new use of this material, is in highway grade crossings. Despite the activity in grade-crossing elimination during the last few years, more than 230,000 highway crossings remain at grade. While many types of crossing materials have appeared on the market in recent years and some have been received with favor for the more important crossings, including concrete, steel, malleable iron and bituminous products, the wood plank crossing still predominates.

Crossing plank is subject to severe wear at a busy crossing, and the life of untreated material is usually determined by wear rather than decay. Largely for this reason, few railway maintenance officers have thought it worth while to use treated material. As a consequence, prior to 1935, more cubic feet of wood were treated for tie plugs than for crossing plank, the ratio in 1934 being about 15 to 1. In 1937, although the relative positions had been changed, the volume of crossing plank was still only about 1½ times that of tie plugs.

Experiments have shown, however, and experience has confirmed, that through careful selection of the species of wood and thorough treatment, much of this wear can be avoided and a satisfactory service life can be obtained from treated crossing plank. A number of roads prefer black gum for this use because its closely knit fibre resists wear better than most other woods and there is no tendency to fray and splinter. This wood is entirely unsuitable for use untreated, however, because it decays rapidly. Decay is eliminated by preservative treatment, which has been found also to increase resistance to wear and to reduce greatly the tendency to warp, a fruitful source of trouble with ordinary crossing plank. These facts indicate that wood-preservation can still do much for the railways in this application and that it presents a real opportunity for expansion of the use of treated wood, especially as the present consumption of crossing plank is in excess of 50,000,000 ft. bm. annually.

Water Tanks

More than 26,000 tanks of 50,000 and 100,000 gal. capacity are required for the storage and softening of water to be delivered to locomotives. Wooden tanks still predominate in this service, although for many years the railways have been erecting steel tanks, largely because the supply of wood suitable for tank construction in its untreated state is so limited in quantity that prices are excessive, while the natural life of inferior woods is too short to make their use practicable. Faced with this situation, and having used creosoted tank frames since 1903, the Illinois Central began to use creosoted water tanks in 1916, usually of 100,000-gal. capacity, employing for this purpose some of the so-called inferior woods which could be obtained at a reasonable price. Today, this road has almost 200 such tanks in service, none of which have required the renewal of any of their parts. This is a field for the use of creosoted timber which has been given practically no consideration except on this one road, in which wood preservation can be made of considerable benefit to the railways if they will take advantage of the opportunity it affords.

For the more important grade separations on arterial highways where the highways are carried over the railways, particularly where long spans are required, wooden bridges are seldom suitable. Yet there are many such separations on less important highways where timber is as well adapted for the construction as other materials. Certain states permit a design for these situations, in which treated piles or framed bents support the stringers carrying the roadway, which may be finished with concrete or bituminous material. An extension of this or some similar type of construction would be of considerable benefit to the railways because of reduced costs, while it would provide substantially permanent structures requiring a minimum of maintenance.

Rarely Applied to Buildings

When one turns to railway buildings he finds almost a virgin field for preservative treatment for, despite long familiarity of building engineers with the merits of wood preservation and the economies it can effect, the use of treated material has made no appreciable headway in building construction, primarily because of objections to the odor of creosote and the possibility of staining from contact with it. Yet creosoted wood has been used extensively for parts below the first floor subfloor in residential, school, church and other buildings in such areas as Los Angeles, Cal. More particularly, "clean treatments" are available with salts that do not stain, and lumber so protected takes paint with the same facility as untreated wood. In many structures these salts are also used for treating the lumber that goes below the floor line.

One of the serious problems confronting building engineers is that of floors for piers and pier warehouses. These buildings alone contain approximately 50,000,000 sq. ft. of floor areas and approximately 8,000,000 sq. ft. are renewed annually. Untreated material decays rapidly under the moist conditions of the waterfront, and soon wears too rough for trucking. Black gum is one of the most resistant woods to wear, and installations treated with creosote and with salts have been highly successful from a trucking standpoint. As with crossing plank, the experience has beeen that when treated, the wood wears much more slowly than when untreated. Its use, therefore, affords an opportunity for the railways to obtain still further benefits from preservative treatment, which they have not previously realized.

Since the railways maintain and use more than 370,000 buildings, most of which are of frame construction while others employ wood in varying quantities, and since in normal times they spend more than $90,000,000 a year to maintain them, the opportunities to benefit from the installation of timber that has been given preservative treatment are obvious. It might be mentioned in passing that if the fullest advantage had been taken of preservative treatment for building lumber prior to the depression, the magnitude of the problem which now faces the railways with respect to building maintenance would be greatly lessened.

Grade Crossings, Which Require More Than 50,000,000 Ft. B. M. of Plank Annually, Offer a Large Field for the Effective Use of Treated Timber

In frame structures, the parts below the first floor are more subject to decay and require more frequent renewal than other parts, except the roof. If, through preservative treatment, the life of these parts can be increased two or three times, an attractive saving in maintenance costs can be realized. Another benefit accruing from preservative treatment is the protection it affords from termite damage, by no means a negligible matter, as some roads are now aware.

Can Be Used in Cars

Freight car construction and maintenance is another field in which wood preservation has been practically ignored. A detailed record kept some time ago by a large railway of the reasons necessitating the removal of every part of all of the wooden cars passing through its most important repair yard for a specified period showed that of approximately 270,000 parts replaced, more than 82 per cent had failed by reason of decay and that less than 18 per cent were clearly mechanical failures, indicating that preservative treatment would have avoided the necessity for many of these repairs.

In this connection the experience of one of the large coal-mining companies with its mine cars is illuminating. These cars, ranging from 3 to 5 tons in capacity, are used for hauling coal and mine refuse from the working face to the surface. The refuse consists principally of slate and heavy rock, both broken irregularly with sharp edges. The cars have wood floors and sides, and abrasion is so severe that the average life of the untreated timber in the cars was about 3 years, with a maximum of 5 years. Decay is especially severe in the underground

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