History of Railroad Tie Preservation
by Jeffrey A. Oaks

The history which begins on the next page comprises pages 19-75 of my book *Date Nails and Railroad Tie Preservation* (3 vol.; 560 p.), published in 1999 by the Archeology and Forensics Laboratory, University of Indianapolis. I am making the history available in response to Mark Aldrich's article "From Forest Conservation to Market Preservation: Invention and Diffusion of Wood-Preserving Technology, 1880-1939" (*Technology and Culture*, April 2006, pp. 311-340).

My notation for references is common in mathematics articles, but it will appear a bit odd to people outside the sciences. For a list of references, see the end of the introduction to my book, which appears in this file after the history.

Most of the first two volumes of my book is taken up by individual railroad listings. I compiled what I know of the tie treating and marking practices of over 250 North American railroads. This alphabetical listing occupies pages 91 through 344 of my book, and serves as the foundation for the history. A sample listing, for Union Pacific, completes this file. If you would like a listing for another railroad, or if you have any comments or questions, send me an e-mail
note at oaks@uindy.edu.

For a better description of the book, got to my website:
http://facstaff.uindy.edu/~oaks/DateNailInfo.htm

My published response to Aldrich's article is a drastic condensation of my original response. My 22-page version, in which I review the broad history of tie preservation in North America to show that Aldrich's thesis is untenable, is just too long for the journal. Many of the points Aldrich raises in his response to my published response are covered in the long version (which he had in his possession!). For this reason I have put my original response online:

html version:
http://facstaff.uindy.edu/~oaks/Articles/Response.htm

original MSWord version:
http://facstaff.uindy.edu/~oaks/Articles/Response.doc

History of Railroad Tie Preservation

Contents

0. Introduction

The 153,703,000 crossties purchased by U.S. railroads in 1907 amounted to 7.5% of this country's output of forest products for the year. Of all these ties, barely 1 in 8 was chemically treated to resist decay. The remaining ties were expected to be removed and discarded within a decade. This was an enormous waste, considering that our forests were being cut at a rate three times faster than they were growing, and that America's once vast woodlands had been reduced to a scattering of forests in only a few regions.[1]

This problem had come to the attention of the railroads in 1880, and for a half century railroad officials often declared it to be an impending, if not an immediate emergency. In this history we will follow the railroads' responses to this crisis by tracing the development of tie preservation in North America, with special emphasis on record keeping.

1. Early wood preserving

Wood rots. When placed in the ground it can be eaten away by various mold-producing fungi, or it can be the victim of ants, termites, and beetles. Woodpeckers weaken wooden structures in the air while shipworms such as the dreaded *Teredo navalis*[2] devour piles in coastal waters.

Seen another way, such persistent and blatant destruction is really necessary for the continuation of life. Just imagine a forest after 20,000 years if dead wood did not rot! It is a good thing that the decaying log is converted to fertile soil for new plants. Only we humans[3] have a reason to prevent the natural breakdown of wood. When we pressure treat lumber we are repeating a process much like the ancient Egyptians did with their royal dead. Our motives may not be so other-worldly, but it remains a fact that we embalm pieces of dead trees to somehow preserve their strength and resilience, to delay their re-entry into the cycle of life and decay.

Wood preserving had a long history before railroads began to take an interest in increasing the longevity ties and other wooden structures. In antiquity it was known that charring wood before placing it in contact with the ground delayed its decay, and wood was often given a coat of oil to prolong its life.[4] Also, salt became a common preservative after it was noted that the wood used in salt-carrying ships and in salt mines lasted longer than wood used for other purposes.[5]

The earliest known scientific process was developed by the German chemist Johann Glauber

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[1] [AREA '10, 749]['11, 215, 221]

[2] These and other marine borers are so removed from our daily lives that they carry only their Latin names, like *Xylotrya*, *Sphaeroma*, and *Limnoria*.

[3] and perhaps beavers

[4] [Boulton, 13]

[5] [ASCE 6-01, 532]

in 1657. His method involves carbonizing the wood by fire, coating it with tar, and then dipping it in pyroligneous acid. Other methods came after Glauber's, but progress in wood preserving was sporadic until the end of the eighteenth century. At that time chemists began more intensive investigations: between 1798 and 1831 over a dozen treatment methods were developed, most of them in England. These methods generally employed various salts, oils, and tar, and none of them came into long term general use.[6]

Beginning 1832 progress was more rapid. By the end of the decade over twenty new methods were developed. This research was driven largely by the shipping industry, but it was also beneficial for docks, buildings, fences, and other wooden structures. Three of these new methods became common for tie treating in the U.S., and these are described now.

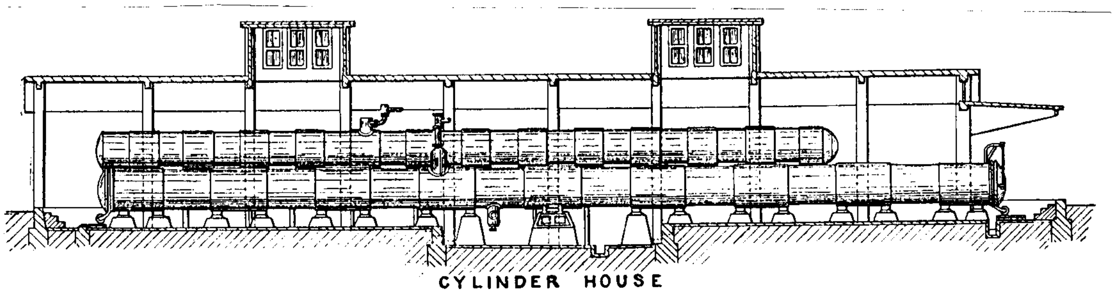
• Kyan's method. In 1832 John Howard Kyan, continuing the work of MacBride and Bordenave, patented the use of mercuric chloride ($HgCl_2$, also called corrosive sublimate) to treat wood. His process involves simply immersing the lumber in an open vat of solution until enough sublimate is absorbed.[7]

• Bethell's method. John Bethell patented his use of pressure for treatment in 1838. The patent is titled "Rendering Wood, Cork, and Other Articles more Durable, &c."[8] Although he claimed his process will work with just about any chemical, his method is best known for making creosoting practical. Because of this, the "Bethell" process usually refers to the pressure treatment of wood with creosote.

Together with some modifications, Bethell's is to this day the principal method of preserving ties and other timbers. In order to describe how it works, I will go over some tie treating plant vocabulary now. A *retort*, or *treating cylinder*, is a long steel cylinder, usually at least six feet in diameter and anywhere from 70 to 160 feet long. There is a narrow gauge track which runs inside the cylinder for its entire length. This track is connected to yard tracks through a door at one end of the retort. Ties are loaded on *retort cars*, secured, and are run into the retort. For a 100 foot treating cylinder, about ten carloads of ties can be treated at once. The steps in Bethell's process are:

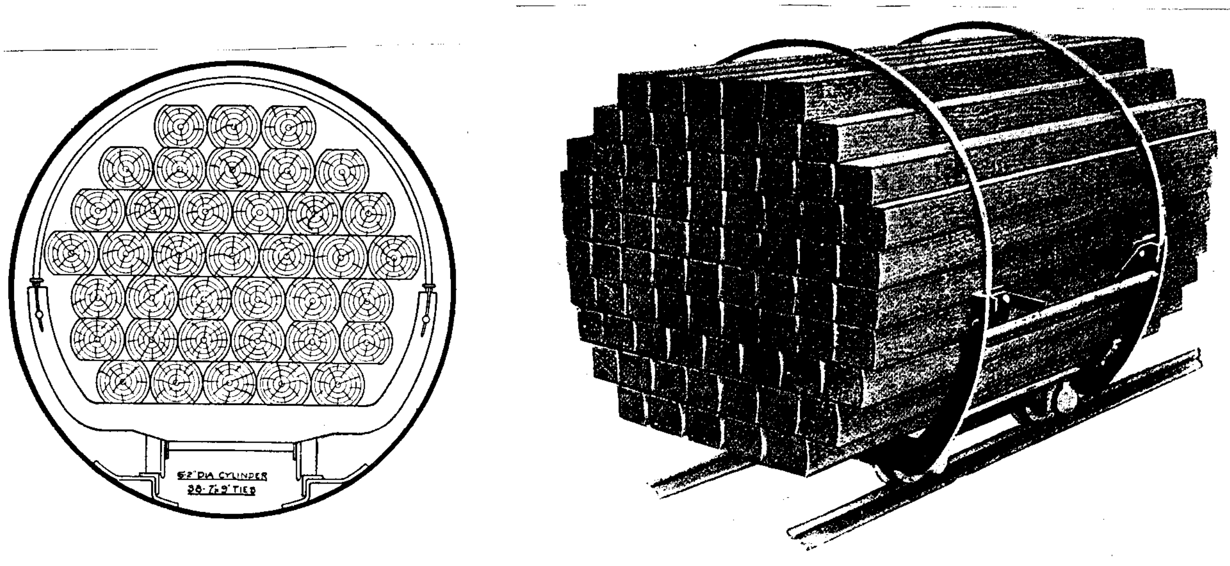
[6] ['13, 180-183]
[7] ['14, 239]
[8] [Bethell]

(1) The ties are sent into the treating cylinder on retort cars,
(2) the cylinder is closed and a vacuum is introduced to draw some of the air from the ties,
(3) the cylinder is filled with creosote (or another preservative), and pressure is applied to the retort,
(4) the pressure is released, the preservative drained,
(5) the cylinder is subjected to a final vacuum,
(6) the door is open and the cars are removed.



Side view of a retort. In this drawing there is an extra "Rueping" tank (to be described later) above the retort. [Wallis-Tayler, 143]

Without the final vacuum the ties would continue to drip creosote for hours. The vacuum speeds up the natural expulsion of excess preservative due to expansion. The total time for one treating cycle was typically about eight hours.[9] Some retorts had doors at both ends for ease in switching, and some newer retorts, such as the 1924 National City facility of the Atchison, Topeka & Santa Fe (hereafter Santa Fe), were large enough to accomodate standard gauge track.[10]



Retort cars filled with ties. [Wallis-Tayler, 139, 146]

[9] [H&G, 207]
[10] [RA 8-30-24, 360]

• Burnett's method. Sir William Burnett in 1838 perfected a method of treatment with zinc chloride ($ZnCl_2$). Originally he soaked the wood in an open vat, but in 1847 he adopted Bethell's pressure treatment for the chemical.[11] Since then the "Burnett" treatment has refered to pressure treatment of wood in a zinc chloride solution.

2. The invention of ties

Concidentally, just as sound wood preserving methods were being developed, ties were invented. The first railroads spiked each rail to a sequence of square stone blocks. In late 1832 a shipment of these blocks to the Camden and Amboy RR in New Jersey was late. As a temporary fix, Robert Stevens, president and chief engineer, had logs spiked perpendicularly under the rails. This quick solution was immediately recognized as superior to the use of stone, and soon other railroads constructed or rebuilt their tracks using wooden crossties.[12]

3. Tie treating abroad

With treatment methods being patented mainly in England and other European countries, it is no surprise to find railroads there experimenting early. In England the use of mercuric chloride on ties was implemented about 1838, and quickly gained wide acceptance. Sulphate of copper (Margary's method of 1837), zinc chloride, and creosote also came into general use, and the four chemicals were "in active competition"[13] until 1853, when Henry Potter Burt read his "Paper upon Timber Preserving"[14] to the Institute of Civil Engineers. Burt's paper, and the discussions which followed, revealed that creosote is the superior wood preservative. Eventually, perhaps by about 1865, Bethell creosoting had replaced all other methods in England, despite the fact that creosote is also the most expensive preservative.[15]

French railroads did not embrace creosote quite so early. This is partly because it was more expensive there, and also because the French favored the method of their countryman, Boucherie, who had developed a novel way of treating freshly cut timber with copper sulphate.[16] Zinc chloride was also used in France to some extent. Creosoted ties, imported from England, were first used on France's Western Ry in 1859. Creosote was adopted for general use on that line in 1864,[17] and

[11] [H&G, 10]
[12] [Watkins, 670]
[13] [Boulton, 19]
[14] [Boulton, 12]
[15] [Boulton, 20-21]
[16] In this process the solution "is forced into the wood by gravity. The timber to be treated is set on end covered with a water-tight cap, and the solution, consisting of 1 part of sulphate of copper to 100 parts of water, is delivered into this cap from a tank placed at a considerable height by means of a flexible pipe. The sap of the wood is forced out at the lower end, its place being taken by the solution." [Wallis-Tayler, 15]
[17] [Boulton, 95]

by the end of the decade the majority of French railroads were using the Bethell process.[18] Some railroads were still using other methods late in the century, but by 1900 creosote was used by all lines save one, the State Ry, which was treating ties with a mixture of zinc chloride and creosote.[19]

The use of creosoted ties in India began with the construction of their first railroads in 1851. The British found it cheaper to import creosoted Baltic timber into the country than to use the indigenous woods.[20]

Originally German lines treated ties with either mercuric chloride, copper sulphate, zinc chloride, or creosote, "but gradually there was an evolution which curiously recalls that of the Pullman Car Company in the United States. Mr. Julius Rütgers' father, who had learned the business in some French tie-treating works, erected a plant or two, took his son in with him, and did so much better work than the railroads did for themselves that the business gradually came into his son's hands. At the present time Mr. Rütgers controls some twenty plants, while the Prussian State Railroad has four, and there are five more in other hands."[21]

The preceding quote dates from 1900. Rütgers' method, introduced in 1874,[22] involves treating ties with a combination of zinc chloride and creosote. At the turn of the 20th century just over two thirds of all ties used in Germany were treated by the Rütgers method. The remainder were treated with straight creosote by the Bethell process.[23]

Other European countries which began creosoting ties before 1900 include Belgium, Holland, Denmark, Switzerland, Spain, and Portugal. As of 1900 Russia and Roumania were switching to creosote. Chanute wrote in 1900 "...ample experience for 60 years has now been gained abroad, and the economy and expediency of tie treating is so well established that a railroad manager abandoning it there would occupy about the same position as a railroad man in America who went back to iron rails."[23]

My information on record keeping in Europe is sketchy, and is restricted to date nails. It is difficult to say whether these marked nails were first used to date ties in England or France. I found nails dating back to 1870 in Eastern France in 1988.[24] In England no nails are known before 1900, though they were certainly used. The English clean up their discarded ties quickly for other uses, while in France old ties are commonly reused as fenceposts near the railroad. Also, the French used

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18 [Boulton, 18, 21]

19 [ASCE 6-01, 502-503]

20 [Boulton, 24]

21 [ASCE 6-01, 506]

22 [Wallis-Tayler, 207]

23 [ASCE 6-01, 505-506]

24 From ties reused as fenceposts I pulled 70, 74, 76, and two 77's. From ties in an abandoned yard I found five 79's and a few 81's. I also got an 83, 84's, 86's, thirteen 88's, and dates in the 1890's were fairly common. I passed up at least a dozen 99's.

more creosote in their ties, getting a longer life out of them.

By the end of the 1800's date nails were the norm in Europe. They were used in every treated tie on railroads in France, Germany, Luxembourg, Belgium, and certainly England.[25] This use of nails has persisted for over a century. Anyone who has travelled to Europe to find nails is amazed at their abundance. In 1987 in Luxembourg I found 1986 nails in many ties (I did not pull them!), but 1980 seems to be the last year for Italian nails.

4. Early U.S. experiments, 1838-1880

When treatment methods were first introduced in Europe in the 1830's, a few U.S. railroads began conducting experiments. Very little was known about the life of treated ties, or if treatment would be cost effective. While in Europe it was quickly found that treatment on a large scale was desirable, the large and cheap timber supply in America meant that railroads were hesitant to commit themselves to treating ties long term.

What I have found on early tie treating in America is contained in Table I (page 64). Right from the start railroads were experimenting with wood preservation. The South Carolina RR treated its structural timbers even before ties were invented (1830-33). 1838 saw the first use of mercuric chloride: that year the Northern Central RR near Baltimore installed a test mile of $HgCl_2$-treated ties, and the South Carolina began regular use of the preservative, which they kept up through 1841. Kyan himself came to the U.S. soon after he patented the use of mercuric chloride, and his visit may have prompted some of these early experiments. Others include the 1840 test by the Louisa RR in Virginia, and the 1842 Baltimore & Ohio experiment. Mercuric chloride was the subject of nearly all the early tests through 1851. The process was not used after 1856, except for the Eastern RR revival in the 1880's, which I shall review soon. The reasons given by the Northern Central for not adopting mercuric chloride were its high cost and severe toxicity. On other lines it was noted that the solution leaches out of the wood in wet locations.[26]

Zinc chloride, another metallic salt, was introduced in this country at Lowell, MA in 1850 for bridge and building material.[27] It was first used on ties in 1855 by the Union RR in Cambridge, MA. $ZnCl_2$ is not poisonous like mercuric chloride, and is much cheaper. The Vermont Central (1856-59) and the Erie (1861-69) used Burnett's process regularly for some time, but after 1868 this process was abandoned as well. Delays and capacity problems plagued some railroads.[28] Others got

[25] In Luxembourg I found a 97 (1897). Nails were in use in Belgium by 1892 [AREA '26, 700]. German railroads were using nails by 1894 [Trat II, 224].

[26] [ASCE 7-85, 256]

[27] [ASCE 7-85, 257][HWP, 7]

[28] Delays: Vermont Central [ASCE 7-85, 269]; plant not large enough: Union Pacific [ASCE 7-85, 262]

poor results because the ties and timbers were treated green,[29] treated too hastily,[30] or with too strong a solution, which caused the wood to become brittle.[31] Even when done properly, treatment would not pay because timber prices were still just too low.

Creosote was first tested on ties in 1868 on the Chicago, Burlington & Quincy (CB&Q). Charles Seeley developed an open tank method in which unseasoned ties were given a partial dose of the preservative. The advantage of this, of course, was the low cost. Unfortunately the Seeley-treated ties used by the CB&Q in 1868-69 and the Chicago, Rock Island & Pacific (Rock Island) in 1872 rotted as fast as untreated ties.

The Central RR of New Jersey (CRR of NJ) tested ties creosoted by the Hayford method in 1872. The Bethell process was first used on ties in test sections of the Houston & Texas Central (1877), Louisville & Nashville (1878-79), and the CRR of NJ (1879). The Bethell process was used on all subsequent creosote tests.

There was some interest in copper sulphate in the late 1870's. Thilmany's process was employed on experimental ties of four Eastern railroads in 1877-79, but it was a failure.[32] Other chemicals and methods were tested in the period 1838-1879, but none was successful.

5. The Wellhouse process

Zinc chloride is a reasonable alternative to creosote. It is cheaper and easier to obtain, though it does not protect the ties quite as well. The big problem with $ZnCl_2$ is that in wet conditions it dissolves out of the ties. Unlike creosote, zinc chloride is water soluble.

This problem was overcome by William Wellhouse and Erwin Hagen, who in 1879 patented a two-step method for treating ties. First the ties are treated under pressure in a solution of zinc chloride and gelatin (or glue). After the pressure is released and the chemical drained, the ties are treated again, this time in tannin. The glue and tannin mix to form a kind of artificial leather which clogs the pores of the wood, preventing the zinc chloride from leaching out.[33]

The new process became known as the Wellhouse, or zinc-tannin method. It was first practiced by Joseph P. Card at his works in St. Louis, and railroads in the area quickly established tests of crossties with the new treatment in 1879-1880.[34]

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[29] Erie RR [ASCE 7-85, 260]

[30] Erie RR [ASCE 7-85, 260-261]

[31] Philadelphia, Wilmington & Baltimore; Reading; Union Pacific [ASCE 7-85, 262]

[32] ['16, 328][Weiss, 259]

[33] [H&G, 211]

[34] In addition to the tie tests, the St. Louis Bridge RR tested pine bridge stringers and gum blocks treated by the Wellhouse process in 1879. [ASCE 7-85, 258]

6. Which chemical is best?

In 1853 the superiority of creosote as a wood preservative was established. Creosote is more expensive than inferior chemicals such as zinc chloride, and partly for this reason its general use on ties in the U.S. happened much later than in Europe. It is the ratio between the price of timber and the price of the preservative (and labor) which determines the economy of treatment. If ties are really cheap, it is not worth wasting even zinc chloride on them. If ties are moderately expensive, the extra life they gain from $ZnCl_2$ is enough to cover the cost of treatment. Finally, if ties are very expensive, the use of creosote is the most economical solution.

Octave Chanute[35] wrote in 1885 "creosoting is notoriously more expensive here than in England." "...the supply [of creosote] in this country is not equal to the demand, so that it has to be imported from England."[36] The reason for this discrepancy is explained in the 1913 AWPA *Proceedings*:

> The production and composition of domestic creosote are regulated to a large extent by the demand for pitch, which is the primary product for which coal tar is distilled. Creosote is a by-product of insufficient value in itself to pay for the cost of manufacture. The pitch takes out a large proportion of the heavier constituents of the tar and leaves a proportionately increased amount of light oils.
>
> In Europe the conditions are quite the reverse. There is little demand for pitch, but a large demand for the lighter constituents of the tar, which are used in the manufacture of the aniline dyes. Hence the lighter constituents are removed and the heavier left in the creosote. In the United States these heavier constituents are considered the most valuable components of the preservative, and consequently at the same price the foreign oils are preferred.[37]

So the small amount of creosote which *was* produced in the U.S. was of poor quality. This was a problem which persisted into the 1920's.

The other variable in the economy of treated ties is the price of wood. At the turn of the century an untreated pine tie cost about $1.40 in Germany and about 30 cents in the U.S.[38] The difference was certainly just as pronounced in the mid-19th century. With expensive ties and a ready creosote supply, the Bethell process came into general use early in Europe. In North America most railroads would continue to allow untreated ties to rot in the tracks well into the 20th century.

7. Creosoting bridge timbers

There is one type of structural timber which needed creosote: bridge piles. Whenever wood docks or bridges are built in salt water, the teredo and other shipworms feast on them. The destruction is less pronounced in northern waters, but along the Gulf of Mexico bridge piles have

35 See the brief biography of Chanute after this history.
36 [ASCE 7-85, 290]
37 ['13, 41]
38 [ASCE 6-01, 509]

been eaten to the point of collapsing in under two years.[39] It is far more expensive to replace all the piles in a bridge than it is to renew a few ties, so railroads in the U.S. began pressure-treating these timbers with creosote in the 1860's. Salt solutions like zinc chloride are not suitable for marine use because they are water soluble.

The first use of creosote for preserving wood in North America occurred on the Old Colony RR. The railroad erected a treatment plant at Somerset, MA in 1865 for creosoting bridge piles by Bethell's process. The first wood treated were the 700 piles used in the bridge over the Taunton River, and despite trimming after treatment, it was considered a success. The works still operated as of 1885, but had been abandoned by 1901.[40]

The first permanent railroad treating facility in North America was the Louisville & Nashville's West Pascagoula creosoting plant. In 1875 the railroad decided to pressure treat all bridge piles along the gulf coast with creosote, and the new plant opened the next year. The railroad had tried boiling timbers in an open tank of creosote as early as 1869, but the penetration was not enough to protect the wood.

Soon other railroads were creosoting bridge timbers. The New Orleans & North Eastern built a plant for creosoting piles and timbers for a bridge over Lake Pontchartrain in 1879. When the work was completed, the plant was abandoned. The Houston & Texas Central (H&TC) first used creosoted piles in 1876, but they did not begin to treat them regularly until 1883. Other railroads, such as the Chesapeake & Ohio (C&O) and Lehigh Valley (LV), began treating piles by the Bethell process in the 1880's. At the same time treating plants were built along the coast to handle the lumber used in other types of marine construction, such as docks. These can be identified in Table II (page 65).

The H&TC (1877), L&N (1878-79), and the LV (1886+) did treat some experimental ties at their creosoting plants, but, as Tratman wrote of the L&N in 1890, "...with ties at 23 to 30 cents apiece the additional expense [of creosoting] would not be justified."[41]

8. Zinc chloride in the West, 1881-1897

The railroads' tepid attitude towards tie treatment changed about 1880. At that time the price of timber was on the rise, and America's once vast forests were revealing that they were not the unlimited resource they once seemed to be. The 1880 census report, released in 1881, validated what railroad engineers already knew: unless measures were taken to curtail consumption, the U.S.

[39] [WPN 3-41, 32]
[40] [ASCE 7-85, 267-269]
[41] [Trat I, 31]

would suffer a severe timber shortage.[42]

In response to the potential crisis, in 1880 the American Society of Civil Engineers created a committee to study timber preservation. Progress was slow at first, so they appointed Octave Chanute to take over as chair of the committee in 1882. For the next three years they compiled information, and on June 25th, 1885 Chanute delivered his address "The Preservation of Timber."[43] His report lists every known American use of treated wood, most of them ties, together with explanations of failure or success. Included is a general evaluation of the methods tried, and of the economic advantages of treatment. The report deals very little with European wood preservation. The conclusion of the committee was that some U.S. railroads could benefit from the use of preservative chemicals, in particular from zinc chloride. Even apart from our low-cost timber, the high price of creosote, and the difficulty in obtaining a constant and sufficient supply, obviated its use.

The Santa Fe began serious experiments with tie treating in 1881, when Joseph P. Card of St. Louis supplied the railroad with 384 Wellhouse treated crossties. They were laid in 1881-82 at Topeka, KS and La Junta, CO. Careful records were kept, as indicated by the fact that on the La Junta test section the ties were labeled with numbered brass tags. The success of these experiments led the Santa Fe to construct the first permanent tie treating plant on the continent. The works were erected at Las Vegas, NM under the supervision of Octave Chanute, and they began treating ties by the Wellhouse process in July, 1885.

Treated ties were used on four divisions: Rio Grande, New Mexico, Western, and Colorado. The Santa Fe treated 111,503 ties in 1885, and an average of about 250,000 ties annually through 1897. This is much less than the number of ties required for the maintenance of 1,000 miles of track. In this period the railroad was placing treated ties only in regions where ties decayed the fastest. Untreated ties were still the norm on the other divisions.

Other tie treating plants appeared in the next couple years. In 1886 the Rock Island began long term use of zinc-tannin treated ties. They bought their ties under contract from Octave Chanute's and J. P. Card's newly formed Chicago Tie Preserving Co. The plant, located in Chicago, treated ties which were used only on divisions where untreated wood was exceptionally short-lived.

In 1886, using William Rowe's plans and under the supervision of the Chicago Tie Preserving Co., the Union Pacific (UP) built a plant at Laramie, WY. For two years they treated ties with zinc-tannin, after which the plant was abandoned for short-term savings. UP officials were not

[42] [ASCE 7-85, 133]
[43] [ASCE 7-85, 133ff]

convinced that treatment would pay.[44]

"In 1887 the Southern Pacific Company leased the creosoting works of the Houston & Texas Central Railway, at Houston, Tex., and began "Burnettizing," or the injection of chloride of zinc by itself, without subsequent treatment."[45] The SP built its own treatment works near Houston in 1891, and they constructed a portable plant for use in California and Oregon in 1894. From 1887 to 1894 treated ties were used only on the Atlantic System (lines east of El Paso). The Pacific System first received treated ties when the 1894 plant opened.

After the UP plant shut down, the Santa Fe, Rock Island, and Southern Pacific were alone in pursuing tie treatment on a regular basis up to the end of the century. Timber prices did not climb after 1880 as was predicted, so other railroads continued to use and discard untreated ties as regular practice. We might, however, consider two minor exceptions: the Eastern RR in Massachusetts and the Pennsylvania RR. From 1881 to 1891/92 the Eastern RR used about 800,000 Kyanized ties. This is the only known use of mercuric chloride after the 1856 test of the Boston & Providence, apart from a small experiment by the Forest Service in 1911. The Pennsylvania RR bought nearly 200,000 Wellhouse treated ties from the Chicago Tie Preserving Co. in the period 1897-1902. In all, the PRR used over 300,000 ties treated by either the Wellhouse, Burnett, or Bethell process during 1892-1903. These were still just used in test sections, though some tests were quite extensive.

9. Tie tests by other railroads, 1881-1897

The quick adoption by the Santa Fe and the Rock Island of the Wellhouse process attracted some attention, and there were a few tests of zinc tannin by other lines in the ensuing years. The process was tested by the Erie in 1882, perhaps because Ocatve Chanute himself was Chief Engineer there. The Chicago & North Western (1888), Duluth & Iron Range (1890), Delaware & Hudson (1892), Norfolk & Southern (1897), and the Pennsylvania (mentioned above) all conducted tests of zinc-tannin treated ties.

At least seven Eastern railroads[46] conducted tests of creosoted ties in the last two decades of the century, while the Santa Fe, Illinois Central, Pennsylvania, CB&Q, and Norfolk & Southern all dabbled with Burnett's process. Some lines[47] experimented with Vulcanized ties. This method involves subjecting the ties to high heat and pressure, which chemically alters the wood making it unsuitable for fungi and insects. In 1894 the Galveston, Harrisburg & San Antonio was the first to

[44] [Rowe, 328][RG 10-29-86, 737]
[45] [AREA '01, 106]
[46] NYC, LV, ACL, NYNH&H, PRR, CRR of NJ, and N&S.
[47] Metropolitan (1883); Delaware & Hudson (1892); Norfolk & Southern (1897)

try a combination zinc chloride–creosote treatment.

10. Record keeping and experiments

Even before they adopted tie treating, railroads had always kept records of how long ties lasted. By knowing how many ties are renewed per mile of track per year, the average life of ties can be found. For example, if a railroad replaces on average 400 ties per mile, and they have 2,800 ties in each mile of track, then they are replacing $\frac{400}{2800}$, or one seventh of their ties every year. That means that the average tie lasts seven years.

When the Santa Fe and other railroads began using treated ties, such an average could not reveal how long treated ties were lasting compared with untreated ties, nor whether ties in one year were outlasting ties inserted in another year. To answer these questions, the year of treatment was hammer stamped into the ends of ties at the treating plant.

The Santa Fe began stamping the year of treatment when the Las Vegas plant opened in 1885, but they did not commence keeping a record until 1897. The Southern Pacific did better. They began stamping the date in 1887, and began a record that year, keeping track of the dates on ties removed each year. In 1892/3 three railroads owned by the New York Central[48] began stamping the date, probably in untreated ties.

Through stamps the Santa Fe found that its Wellhouse treated ties were lasting on average twelve years.[49] They even got more specific information, like the fact that treated ties laid in the period 1885-1888 experienced an immunity to checking which later ties did not have. Also, the earlier ties rotted from the bottom while later ties showed no particular pattern of decay.[50]

Early test sections were designed to answer the question "How long will ties last if treated with this chemical?" It was necessary only to place a lot of ties in one stretch of track and wait. No markings on the ties were necessary. As the price of ties rose and railroads gained some experience with treated ties, some companies refined their tests to answer more specific questions, usually about the type or amount of treatment, the kind of ballast, or the species of wood. As mentioned above, when the Santa Fe laid ties of four species of wood at La Junta in 1881-1882, they used numbered brass tags to mark the ties. The records certainly pertained to the species of wood, but may also have contained other information.

In 1881 the Allegheny Valley RR began careful records of untreated ties, and from 1883 to 1887 they dated their ties with notches. The position of the notch indicated the year.

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48 Big Four Route; Lake Shore & Michigan Southern; Michigan Central.
49 [Rowe, 87]
50 [RG 8-21-03, 606]

The Delaware & Hudson established a test section in 1892 consisting of hemlock and yellow pine ties, both untreated and treated two different ways. They were testing different track fastenings—the Davies spike, Servis tie plates, and rail joints—as much as they were the treatments.

On the Pennsylvania RR in 1892 two test sections were established to determine the relative merits of rock vs. gravel ballast, and zinc-tannin treated hemlock and tamarack vs. untreated white oak. Beginning in 1894 and continuing into the 1900's they conducted various tests of different woods treated with wood tar creosote, zinc chloride, and zinc-tannin.

The Norfolk & Southern in 1897 laid several hundred ties on their Norfolk Division, testing four species of wood treated four different ways, along with untreated ties. Some ties were hewed while others were sawed, and some were placed on curves and others on tangent track.

11. Cost

Railroads were not going to invest money in tie treating unless ties became more expensive. Even in the face of predictions of the deforestation of America, the decision of whether or not to treat ties, and which process to use, always boiled down to cost. It was economic considerations which led Chanute in 1885 to recommend treatment to *some* railroads. The Santa Fe, Rock Island, and Southern Pacific were not so much the first to become concerned with the preservation of our forests as they were the first to find treatment economical. Their ties had the shortest lives in the track. For example, while the Santa Fe got about 4.5 years out of an untreated Rocky Mountain pine tie, the New York Central was getting 11.5 years from untreated yellow pine. Also, the NYC had a closer and cheaper timber supply. Major railroads kept tabs on the price of ties, the price of treatment, and the long term savings, if any, of treatment.[51] Just how much woodland remained in America and how long it would last were only of interest in predicting the price and availability of timber.

For those railroads with permanent treatment works, the extra investment paid off. In locations where the Santa Fe used treated ties, they saved in the long run about $150.00 per mile of track each year. Tie expenditures on those divisions were cut in half, and the savings in one year were enough to cover the cost of building the Las Vegas plant.[52]

Burnettizing on the Southern Pacific also paid off. "The untreated pine ties cost about 50 cents each when *laid in the track* in their natural state, and last some 4 years; this produces a charge of $12\frac{1}{2}$ cents a year per tie, while if, when treated, they cost, say 66 cents each when laid in the track,

[51] Unfortunately, as in the case of the UP, they did not always make the best decisions.
[52] [Rowe, 87]

and last at least 8.25 years, they then produce an annual charge of 8 cents per tie."[53]

12. The rise in the price of timber, 1898-1905

The great rise in the price of timber which was predicted by the 1880 census came suddenly in 1898. The cost of a quality tie nearly doubled from 1898 to the beginning of 1900. Naturally the inflated price was a reflection of the scarcity of woodland. Samuel M. Rowe wrote in January, 1901 "In the last 30 years we have seen such destruction of our great forests as seems appalling. With the exception of a small territory in northern Maine, some small areas in the South and the region of the extreme Northwest, the forests have been invaded and the most valuable timbers have been more or less cut away."[54] These valuable timbers were white oak, cedar, and other durable species which are suitable for use as untreated ties. What remained untapped at this point was a large supply of pine, red oak, and other species which would give satisfactory service if treated.

By the end of 1899 a few new tie treating plants emerged. The Santa Fe began treating ties for the majority of its divisions in 1898 with new plants at Somerville, TX and Bellemont, AZ. These were built before the big price jump. It may be that by 1897 timber prices had risen just enough since the 1880's to justify their construction.

In 1899 the Chicago Tie Preserving Co. completed the construction of a portable plant at Mt. Vernon, IL for treating Chicago & Eastern Illinois (C&EI) ties by the Wellhouse process. Here Chanute continued the kind of work he was already doing for the Rock Island in Chicago.

Also in 1899 the CB&Q built a plant at Edgemont, SD. Frank J. Angier, Superintendent of Timber Preservation, built the plant for lack of an outside company to do the job. The facility opened in November and treated ties for Western lines by the Burnett process.

The Great Northern began using large numbers of treated ties in 1899 from a temporary plant in Minnesota. They built their permanent plant in 1901-1902 at Somers, MT, where ties for Western lines were treated with Chanute's three-step modification of the Wellhouse process.

While these companies reacted quickly to the timber situation, other railroads which could have benefitted from treated ties were slower to respond. This was probably due as much to lengthy administrative red tape as it was to the suspicions many railroad engineers still had about the value of wood preservation.

By 1903 at least twelve more companies had adopted either the Wellhouse or Burnett process for their ties. After 1903 there was a shift away from the Wellhouse process. Several lines switched to the Burnett method, probably on account of cost (see Table III, page 68).

53 [AREA '01, 108]
54 [RG 1-4-01, 7]

13. Cooperative efforts

The appointment of an ASCE committee to study wood preservation in 1882 was prompted by the threat of a serious shortage of lumber for ties, and by a moderate price jump. In Chanute's 1885 report he spoke of the treatment methods tried by American railroads. Little reference was made to European practices, despite the fact that British, French, and German railroads were far advanced over their counterparts in the U.S.

The new jump in prices at the end of the century prompted Chanute to look into tie preservation again, and in October, 1899 he went to Europe to study timber preservation. In particular he wanted to investigate the possibility of treating ties with a combination of zinc chloride and creosote. He had always considered the water resistance of the Wellhouse process superior to straight zinc chloride, and substituting creosote for the glue and tannin would not only answer to the moisture problem, but would further help protect ties from decay. His trip was again sponsored by the American Society of Civil Engineers. Chanute collected data in England, France and Germany, and he was back in the U.S. that December. He wrote after his return:

> . . .it would cost 45 cents each to creosote according to the English practice, and 15 to 16 years' life would be obtained; it would cost about 85 cents to creosote after the best French or German practice, and 27 to 30 years' life would be obtained in thoroughly drained ballast; but it would not be economical to spend them upon ties costing 20 to 40 cents each untreated, while it is economical to spend them upon ties costing from 90 cents to $1.50 each abroad.
>
> We must be content, therefore, either to allow our cheap ties to decay in the good old way, or to adopt for the present some of the cheaper and inferior methods which will produce shorter lives than obtained in Europe. By the light of past experience, those cheaper methods may be said to be three in number: 1st, straight Burnettizing; 2d, the zinc-tannin process, and 3d, the zinc-creosote process.
>
> The writer is satisfied that the zinc-tannin process, as modified by himself in 1896, is superior to straight Burnettizing, and that the record of the next few years will demonstrate this, yet he is desirous of doing still better work, and he went abroad chiefly to investigate the zinc-creosote process. He now thinks that it is probably superior to the zinc-tannin process, although part of the greater life shown by records is attributable to other causes, such as the better ballast and drainage, and the better modes of fastening, as well as the climatic conditions. There are, however, some serious difficulties to be overcome before the process can be introduced here. Suitable tar-oil, as described in the specifications of Appendix C, is just now very scarce and high in price, so high that the freight, the leakage and the cost of the barrels render the cost almost prohibitory.[55]

So the two factors which prevented American railroads from adopting creosote—high price for the chemical and cheap timber—would render even zinc-creosote unviable, at least for the time being. Even after the recent price increase of timber, ties here were still too inexpensive for creosote.

In March of 1900 the newly formed American Railway Engineering and Maintenance-of-Way Association held its first meeting in Chicago. (The name changed in 1916 to the American Railway

[55] [ASCE 6-01, 509]

Engineering Association, and I refer to it as the AREA from now on.) The *Proceedings* of the annual meeting consisted of reports from nineteen committees which covered every topic from Ballast to Iron and Steel Structures to Electricity. With both a Tie Committee and the Wood Preservation Committee, the AREA became the first forum in which railroads could share information on ties and tie treating. The 1900 volume is rather slim, but from 1901 on the AREA put out an impressive collection of information. Some of the work done by the AREA was to compile and publish wood preservation statistics, to report on experiments done by various railroads, and to establish standards.

The Bureau of Forestry of the U.S. Deptartment of Agriculture became involved in 1901. That year they planned a large test section of treated ties on the Santa Fe in Texas. It was desired to know the relative values of various preservatives, and to see how they performed on different woods. At a location near Pelican, TX on which ordinary untreated ties lasted only two years, 5,481 ties treated six different ways were installed from February to March, 1902. Treatments included Burnett (straight zinc chloride), Wellhouse (zinc-tannin), Allardyce ($ZnCl_2$-creosote), Hasselmann (Barshall salts), spirittine, and zinc chloride & oil. Thirteen species of wood were tried, and results of the tests were appearing as early as 1903.[56] The test was organized by two special agents of the Bureau of Forestry: Hermann von Schrenk and Gellert Alleman. The energetic Von Schrenk was twenty-eight years old at the time, and he would continue to have a major impact on tie preservation into the 1950's.[57]

In 1905 a second organization was formed which would be invaluble to tie treaters. In January the first meeting of the Wood Preservers' Association was held in New Orleans. The annual meeting, published each year, offered treating engineers a more focused outlet for their research. The name was changed in 1912 to the American Wood-Preservers' Association. Without the *Proceedings* of the AWPA and the AREA, this history would not have been possible.

On June 4, 1910 the Forest Products Laboratory (FPL) opened in Madison, WI.[58] This lab was operated in connection with the University of Wisconsin, and they still conduct wood preservation research today. The lab initiated many test sections on railroads throughout the U.S., most notably on the Chicago, Milwaukee & St. Paul (Milwaukee Road) in 1911 and from 1916 to 1940. The FPL also had tests on the Northern Pacific, the Union Pacific, the Indianapolis, Columbus & Southern Traction, and the Tennessee Coal Iron & RR Co.

56 [AREA '01, 119][DNC, 21][AREA '10 II, 768]
57 See his biography by Cronin, which I discovered too late to incorporate into this history.
58 ['11, 25]

14. Record keeping: the introduction of date nails

E. E. Russell Tratman noted the need for accurate records of ties in 1894: "It is an excellent plan to mark the ties in some way so that their length of service can be seen at once, and a record kept of them. Then, if ties are found to be taken out after only a few years' service, the reason should be investigated." After describing the hammer stamps used by the Big Four he wrote "In Germany it has been found that the impressions made by such hammer stamps on preserved ties became effaced before the time for renewal, and nails or tacks with distinguishing letters or marks were therefore substituted."[59]

At the 1900 AREA meeting Tratman again mentioned date nails: "Very few records are kept, unless the ties are of special importance. I think Mr. Kittredge [of the Big Four] tried marking them with hammers. I do not know whether those marks remained long enough, but it seems to me some system of marking with tacks or tags should be used if you are going to keep accurate records."

In fact the Big Four's stamps did not work, as George Kittredge replied: "We did not find that it worked very well, because at the end of a few years, a great many of the marks were effaced and the practice was discontinued..." W. C. Curtis of the Southern Pacific added "I think it important that the life of ties should be determined in some such way. I think the better way may be to use a galvanized tack, such as our friend here, Mr. Chanute has devised, with date on the head..."[60]

These suggestions were put into practice by Octave Chanute in 1899. Date nails were driven into all ties treated at the Chicago Tie Preserving Co.'s Mt. Vernon, IL plant beginning with its opening that July. He had tried in 1889 and 1893 to get the Rock Island, his principal customer, to adopt date nails, but the railroad balked at the cost. Chanute, writing from Chicago in 1900 on the marking of ties, told the reason he initiated the use of date nails:

> It is not sufficient to do this with the stamping hammer. That is what we are doing at the works here, but at our new works at Mt. Vernon we are not only stamping the tie with a hammer, but we are furnishing at our own expense a galvanized nail for the purpose of dating the tie, in order to be dead sure to be able to identify it 10 or 15 years hence. We do that because we found that upon one of the railroads here the records as to where the ties had been laid had got into such condition that there was no telling what was the age of those in the track, and the report went out among the men that our ties were giving out in three or four years, and, at the maximum, in seven years. The question was only settled by the heroic measure of having the ties counted in the track, twelve millions of them, whereupon it appeared that the statements that had become prevalent upon the road were not correct, and that, knowing the number that had been furnished and the number that was still in the track, it was proved that they were lasting, instead of five or six or seven years, an average of nine or ten years—although that, I think, is not enough; we want to do better. So in order to preclude the possibility of any such questions coming up hereafter, we have undertaken, in new contracts, to furnish the nails at our own expense, so that there

[59] [Trat II, 222-224]
[60] [AREA '00, 76-77][DNC, 8-9]

> shall be no question as to the age of the ties.[61]

The railroad in question is the Rock Island, and the date of the incident is given in another article as August, 1898.[62] Chanute's Chicago Tie Preserving Co. had been stamping the date into Rock Island ties since 1895.

We have here two threads on the introduction of date nails: one from Tratman, the other from Chanute. According to Tratman, nails are a more permanent mark than hammer stamps. For Chanute, the statement "in order to be dead sure to be able to identify it 10 or 15 years hence" agrees with Tratman's evaluation. The stamps used since 1895 on the Rock Island were not good enough to maintain a reliable record.

But while hammer stamps on the Big Four, the Rock Island, and in Germany were not permanent, the Santa Fe and Southern Pacific reported no problem with them. Both railroads maintained a reliable record of treated ties removed from the track from stamps which dated back to the mid-1880's.[63] Nevertheless they too became convinced of the superiority of nails. In 1901 the Santa Fe stopped stamping its ties and introduced date nails. The SP began using nails in addition to stamps no later than 1903.

Even before the timber crisis began, the Mississippi River & Bonne Terre (MR&BT) was using date nails. Despite the fact that I have encountered no record of this railroad in the literature apart from a 1902 test section, MR&BT nails have been found for each year 1897 through 1900. This is the first known use of date nails in America.

In 1899 both the Great Northern and the CB&Q began using date nails. It is only by chance that we have an account of the nails used by the Pittsburgh & Lake Erie beginning 1899—and we have no firm evidence that the ties were treated. See Table X (page 70) for the years other railroads began using nails.

Hermann von Schrenk saw to it that date nails were used in the 1902 Pelican test section, and George Kittredge, president of the AREA, strongly recommended nails thereafter. From a November 12, 1902 circular addressed to "the Managing Officers of American Railroads" Kittredge wrote

> The plan proposed is similar to that adopted by the United States Department of Agriculture in a section of experimental track laid in the State of Texas, and briefly described as follows: Each tie is marked with a dating nail; this is placed between the rails on top of the tie, generally at a specified distance from the rail. They are of steel, covered with zinc or tin, and have the year stamped in the head.

[61] [RG 7-27-00, 507]
[62] [AREA '05, 776-777]
[63] [RG 9-19-02, 720], [AREA '04, 70]

> When renewals take place, the date at which each tie was laid is noted, and in this way an absolutely reliable record is obtained. The nails cost very little (about 6 cents per pound—thirty nails), and when put in by the section gang, the labor is slight. Several American railroads have already adopted this plan, and it is to be hoped that the practice will eventually become general. Accurate statistical information in regard to the life of treated and untreated ties, a comparison of the different kinds of wood used for crossties under varying conditions of soil and climate, etc., is essential to the proper study of the tie question. For the purpose of making data of this character available and presenting it from year to year, a series of blank forms has been prepared by the Committee on Ties, which have been adopted by the Association as standard, and it is suggested that each road take the necessary steps to at once inaugurate the system of keeping tie records in the manner proposed by the Committee.[64]

And most railroads which treated their ties *did* use date nails in these years, though the nails were not always of galvanized steel, and were not always driven between the rails.

Just as the methods of treatment did not change after the 1898 timber crisis, the switch from hammer stamps to date nails for record keeping did not involve a change in the nature of the records. U.S. railroads continued to record the dates of treated ties removed from track, and apart from a couple rare instances,[65] no effort was made by individual railroads to determine the relative values of different treatments, or to distinguish between species. This should not be too surprising. For treatments, there were realistically only two to choose from: Burnett and Wellhouse. This fact was reiterated by Chanute in 1900. Also, most railroads used only one or two species for the vast majority of their ties, and in most cases the look of the wood gave it away.

The Santa Fe expanded their record keeping somewhat in 1904. That year they began to keep track of all ties put in and taken out of track, including untreated ties. The type of information they got from such a record did not differ qualitatively from that obtained by their former plan, however.

15. Lowry, Rueping, and the rise of creosote

The new tie treating plants which popped up in the period beginning 1897 operated on the standards set over a dozen years earlier by the Las Vegas, Chicago, and Houston works. Chanute's European tour revealed no new economical ways to treat ties. American railroads remained satisfied with the results obtained by the use of zinc chloride, which was proven to more than double the life of an untreated tie. Creosote was too expensive, and other processes were avoided mainly because they were untried. Few railroads were willing to invest large amounts of capital into methods which were not yet proven cost effective. This stability, the culmination of a slow yet definite progress

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[64] [AREA '02, 99-101][DNC, 22-23]

[65] CB&Q used the nail "H" to designate Hasselmann treated ties as of 1903; beginning 1904 the Great Northern used nails which designated both the wood and year treated.

with zinc chloride sanctioned by low cost lumber, would be shattered unexpectedly in the years beginning 1905.

By regulating the pressure and the amount of time ties remain in the retort, treating engineers can control the amount of preservative which ties absorb. In France, some companies treated ties to refusal, which means that they maintained the pressure until the ties could absorb no more creosote. About 29 pounds per cubic foot of creosote went into beech ties this way.[66]

In 1878 the Western Ry Co. in France decided to diminish the amount of creosote absorbed by each tie by about a third. The result was that the lives of these ties was proportionally reduced, and the railroad reinstated its policy of treatment to refusal in 1885.[67] The experience of the Western Ry as well as others showed that the more creosote a tie received, the longer it remained serviceable.

Just as the price of timber was shooting up in the first years of the 20th century, two men, Max Rueping of Germany and Cuthbert B. Lowry of the U.S., developed methods which would give a long life to ties with little creosote. The problem with earlier small-dose methods was that the creosote only penetrated the outer shell of the tie, leaving the interior unprotected. Bethell's process works because the penetration of the oil is deep, and not because a large amount of creosote is used. Lowry's and Rueping's methods ensure that the cell walls are coated with creosote to a reasonable depth, but most of the creosote in the cell spaces is left empty. Thus they were termed "empty-cell" processes. The Bethell process became known as the "full-cell" process because creosote fills all the empty space in the wood.

I will describe Lowry's process first. C. B. Lowry, a native of Lexington, KY, was involved for a number of years in the lumber business before 1900, and was part owner of the Slidell, LA creosoting plant. About 1901/02 he traveled to Germany where he studied methods of wood preservation. In September, 1902, back in the U.S., he formulated the idea of a new treating method, which was perfected in experiments he conducted in 1903 and 1904.[68]

Here is the process:

(1) the ties are placed in the treating cylinder,
(2) the cylinder is closed and filled with creosote at atmospheric pressure,
(3) pressure is applied to the retort,
(4) the pressure is released, the creosote drained,
(5) the cylinder is subjected to a "quick, high vacuum" for 1 1/2 to 2 hours.

There are two differences between the Lowry and Bethell processes. In the Lowry process creosote is pumped into the cylinder at atmospheric pressure, while in the Bethell process an initial

66 [ASCE 6-01, 503]
67 [AREA '07, 490]
68 [Rowe, 272][Goltra I, 49]

vacuum withdraws air from the wood prior to the admission of creosote. Also, Lowry's final vacuum is quick and high because it needs to assist in drawing out excess creosote. It is the air trapped in the ties during treatment which pushes the excess creosote out during the quick vacuum. Lowry maintained in his Patent application that "This saving is made possible by the quick production of the vacuum, thereby enabling the oil to be withdrawn from the cells or pores of the wood before the air can escape through the oil forced thereinto."[69]

I believe that this point has caused lots of confusion, and may have been partly responsible for the later controversy surrounding empty-cell treating. Lowry meant that without a *quick* final vacuum, the air which was compressed in the ties behind the creosote would leak to the surface without forcing out much oil. The vacuum assists the trapped air in expelling creosote. It is not the sole reason the Lowry process works.

George Kittredge of the Big Four Route was impressed by all this, and Lowry secured a contract with the railroad in February, 1904. Lowry's newly formed Columbia Creosoting Co. built a treating plant at Shirley, IN to treat 550,000 ties annually by the new process. The Big Four became the first U.S. railroad to use creosoted ties on a regular basis when the plant opened in the Spring of 1905. In 1904 the railroad had become the first U.S. line to use large numbers of zinc chloride–creosote treated ties. I will discuss that later.

Other contracts followed. Lowry established the American Creosoting Co. to build plants for the Rock Island, St. Louis-San Francisco (Frisco), C&EI, Monon Route, and others. By 1912 an incredible fourteen creosoting works had been built to treat ties by the Lowry process. As of 1910 the method was used on a third of all ties treated in the U.S.[70] (see Table IV, page 68).

Lowry himself advanced quickly to leadership within the wood preserving world by his election to First Vice President of the AWPA in 1905, to President in 1906 and 1907, and again to FVP in 1908. He died in a railroad accident near New Orleans on November 11, 1908.[71]

The other empty cell method was developed by Max Rueping of Germany. He obtained a patent for his method in 1902, so we may presume his discovery predates Lowry's.[72] The Rueping process consists of the following steps:

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[69] [Goltra I, 44]
[70] [Goltra I, 45]
[71] ['09, 7, 11][Goltra I, 42]
[72] [Goltra I, 46]

(1) The ties are placed in the treating cylinder,
(2) the cylinder door is closed and the ties are subjected to pressure.
(3) Maintaining pressure, creosote is admitted to the cylinder,
(4) higher pressure is applied to the retort,
(5) the pressure is released, the creosote drained,
(6) the cylinder is subjected to a final vacuum.

Here the air which is forced into the ties at step (2) will assist in pushing out excess creosote after the pressure is released in step (6). With the Lowry process there is less air in the ties during treatment, which is why a *quick, high* vacuum is necessary. More creosote oil can be extracted by the Rueping process, but the disadvantage is that it requires extra equipment. Creosote is pumped into the retort under pressure, so an extra "Rueping" tank is required to hold the creosote under the same pressure before step (3) is performed. In general, ties treated by the Rueping process retained about 5 to 6 pounds per cubic foot, while Lowry treated ties retained about 7 to 8 lb/ft^3. Their depth of penetration was about equal.

The Rueping process was introduced to the U.S. in 1904 and 1905 in test sections on the Santa Fe. In 1905 the railroad purchased and rebuilt the Texas Tie & Lumber Preserving Co.'s Somerville, TX plant. Early in 1906, when the plant reopened, the Santa Fe switched entirely to the Rueping process.

Other railroads soon began treating ties by Rueping's method. The El Paso & Southwestern (1906), Illinois Central (1907), Rock Island (1908), Missouri, Kansas & Texas (1909), Pennsylvania (1909) and others adopted it. By 1915 at least nine railroads in the U.S. were using Rueping treated ties. The process was also used extensively in Germany, and possibly other countries in Europe as well (see Table IV, page 68).

In most cases railroads which used Rueping treated ties operated their own plants and paid a royalty to the company with the patent rights, Messrs. Halsberg & Co., M.B.H. of Germany. Railroads using Lowry treated ties leased a plant from Lowry's company, with the exception of the Northern Pacific.

16. Initial reaction against empty cell creosoting

The quick and magnificent rise of Lowry's and Rueping's processes in the wood preserving world was not accepted without criticism. Chanute, the revered past-president of the ASCE, the pioneer who was largely responsible for the introduction of the Wellhouse process, had gone to Europe in 1899 and concluded that creosote was too expensive for U.S. ties. Lowry traveled to Europe on Chanute's heels and returned claiming creosote is the best treatment. This, combined with Lowry's brash tactics, seemed to be a slap in the face of those careful engineers dedicated to the use of zinc chloride.

Samuel Rowe, who had been in the business since the 1880's, was appalled at Lowry's success. On April 30, 1905 Rowe wrote a letter to A. A. Robinson:

> [Lowry] goes to Germany about three years ago and talks with the timber treaters there, returns and immediately enters the field as an expert in the business and also immediately concludes that the chloride of zinc treatment was a failure in this country.
>
> One of the hardest things to understand is that he, through government backing, impliedly, if not actually succeeded in holding up the whole business in this country in a measure, and not only this, to throw discredit, both on the many workers and upon results obtained. Not only this, but the schemes of various promoters have been taken up, and exploited some nonsensical and some that when properly proven by time, may be of value, but that any one with so short an experience should set himself up as an authority is almost incredible and shows but little conception of the broadness of the whole question.
>
> ...I must beg your pardon for this long dissertation but you must understand that is done under severe provocation and in a case where a man feels like sharing the stress with another.[73]

Lowry tried to play down the conflict. On January 15, 1907, in his opening remarks at the AWPA meeting, he said:

> A question occurred to me in a talk with one of the gentlemen now present. There are two elements of wood preservation represented in this association and throughout the world: the creosoting method and the zinc chloride method. Some people are short-sighted enough to believe that there is serious conflict in the two forms of treatment. In my judgement, this is not true; they are distinct in their uses and in the conditions under which they are to be used, and the only conflict that can occuris the unwise attempt of an advocate of the one insisting on using it under conditons to which the other method is peculiarly adapted. They each have their uses, and they have come to stay.
>
> ...This country is so vast, its climate so varied and the conditions so widely separate, and yet contiguous to each other, that, in the language of Admirable Schley, "there is enough glory for all."[74]

It did not work. Octave Chanute himself expressed distrust of empty cell creosoting in 1907. He brought up the experience of the Western Ry of France to show that when less creosote is used, the life of the tie is shorter.[75] His example tells us that he did not believe that the Lowry or the Rueping process does what its promoters claimed.

The 1908 AWPA meeting must have been volatile. The *Proceedings* were never published. This explanation was given at the 1909 meeting by President Walter Buehler: "There is really very little to explain. The minutes consisted of about eighty pages; everything was in there from remarks as to the purchase of postage stamps, to side remarks by Mr. Berry. We had a stenographer work on them about two weeks, gathering together what each man said, the resultant piece of literature we thought rather dangerous to print."[76] I am trying to acquire these *dangerous* minutes from the

73 [Rowe, 271-276]
74 ['07, 4]
75 [AREA '07, 489]
76 ['09, 7]

AWPA now.

A reaction was taking place. In all likelihood Lowry had directed the AWPA in its first four years in a very partisan way. He had declared zinc chloride a failure, and was stealing the business of many treating companies. It is not surprising to see a man like Rowe provoked under stress at the beginning of Lowry's rise. And once Lowry was personally removed from the scene by his unexpected death, we can understand the reaction of men who had for the past twenty years successfully built up the Burnett and Wellhouse processes.

17. Others fail at replicating empty-cell creosoting

Then there were the engineers who failed to reproduce the results of Lowry and Rueping. This caused many to conclude that empty cell creosoting simply does not work, and consequently that companies promoting these processes were committing fraud.

Joseph B. Card, son of Chanute's partner J. P. Card, attempted both the Lowry and Rueping processes at the Terre Haute plant of the Chicago Tie Preserving Co. in 1906. In his try at Lowry's method, he could not extract enough creosote. With Rueping, he could not inject enough creosote into the ties in the first place.[77]

In 1908 or 1909 F. J. Angier tried to treat ties by the Lowry process at the CB&Q plant at Galesburg. He failed to extract much creosote with the final vacuum.[78]

In a 1911 paper published in the *Proceedings* of the AWPA, Charles D. Chanute, Octave's son, reported his failure at treating ties by the Lowry process in an experimental retort. He gave a thorough explanation of his procedure, and I find that his problem was that his vacuum was anything but quick. After the pressure was released and the creosote drained, Chanute removed the ties from the retort and let them drip for some time. Then he placed them back in the retort and applied the vacuum. He extracted from 5.4% up to 15.6% of the creosote injected, depending on the species.[79]

F. H. Weiss of the Forest Product Laboratory conducted a preliminary experiment of the Rueping process which he reported to the AWPA in 1912. He was unable to extract much of the preservative. Evidently he was not convinced by his experiment because in 1913 he wrote an article tacitly supporting empty cell creosoting.[80]

It was Angier's failure which had the most impact on wood preservers. The Galesburg plant

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77 [Rowe, 279]
78 ['10, 115]
79 ['11, 163-165]
80 [Goltra I, 52-54]['13, 71-83]

was state-of-the-art and Angier was experienced and respected. At the 1910 AWPA meeting the result of his experiment spurred a short discussion on the topic. J. B. Card, Walter Buehler (Kettle River Co.), and D. Burkhalter (Santa Fe) were lead by C. W. Berry (Union Pacific) in expressing very serious doubts about the effectiveness of Lowry's process. Octave Chanute restrained from criticism.[81]

At the same meeting Angier compared the new empty cell methods with the Seeley method. The latter was the small dose open-tank creosoting method which proved a complete failure on the CB&Q in 1868. A year later Angier's firm belief in the impossibility of empty cell methods is evident in this statement:

> ...is it not possible that we are making a mistake in treating with what we call "empty cell processes"? We know that thousands of ties are being treated with small doses of creosote, in many instances ranging from twelve to twenty pounds per tie, with only a superficial penetration. With many of our inferior woods now being used for crossties, the heartwood remains practically untreated, and with the more refractory woods, even the sapwood is not entirely impregnated.[82]

18. Later criticism: William Goltra

After 1910 the invective against Lowry and Rueping intensified. John T. Logan, of the National Lumber & Creosoting Co. in Texarkana, spoke at the 1911 APWA meeting against railroads who do not use treated ties, and especially against empty cell methods:

> The most demoralizing and dangerous elements to meritorious wood preserving in existence today are such make-shift concerns as those bearing to our worthy institutions the same relationship which the notorious quacks bear to the medical profession. The public is afforded means of detecting the quack and shunning him, and this Association's mark of condemnation it seems should be placed on "coffee pot" and "paint brush" methods, being exploited by concerns posing under the dignified name of "Creosoting" and "Wood Preserving" companies. One carload of the meretricious bogus product of these "get rich quick" concerns, by its early proven worthlessness can influence hundreds adversely to their own interest, and to that of the legitimate wood preserving industry. Such concerns should be branded as things apart from our profession, and this association I am convinced should go on record accordingly, and in its practices, and by the roster of its membership live up to such principles."[83]

At that meeting Logan was elected President of the AWPA. No one defended Lowry or Rueping.

The most vocal and ill-mannered opponent of empty cell methods was William F. Goltra. I will spend some time discussing him and his book not just because he had a colorful, foot-stomping, fist-shaking personality, but because he was very influential in the wood preserving world in these years. Goltra's voice was heard in almost every discussion at AWPA meetings. He edited the wood

[81] ['10, 115]
[82] ['11, 125]
[83] ['11, 146]

preservation statistics for the AWPA from 1913 to 1915, and he published several accounts attacking empty cell creosoting on a number of points. These he collected into a book which was published in 1912-1913 titled *Some Facts About Treating Railroad Ties*.

Goltra was General Tie Agent for the Big Four Route from November 1, 1907 to November 1, 1910. In that capacity he observed the workings of Lowry's Shirley/Indianapolis plant which treated the railroad's ties. After leaving the Big Four he established the Goltra Tie Company in Cleveland.[84]

He wrote in the preface of his book

> The most demoralizing and dangerous elements to meritorious wood preserving in existence today are concerns which have foisted their worthless processes for treating railroad ties on some of the railroads of this country. I cannot patiently accept the present situation or allow their unwarranted assumptions to go unchallenged.[85]

We will see just what types of dishonesty this man committed besides plagarizing. He, like Rowe, was offended at the rapid success of Lowry's and Rueping's methods: "The sum of acquired knowledge and the experience of many years is thrown aside scornfully and has been replaced by untried methods having absolutely no record as to their value as preservative treatment."[86]

Goltra's argument against empty-cell treating had several sides. He maintained that sorting timbers by species, time of year cut, or by seasoning is entirely useless. Even in a completely homogeneous lot of ties, some ties will absorb much more preservative than others. For this reason it is impossible to treat the ties in any lot with only 2 1/2 gallons per tie, as Lowry's company claims it did. In reality many ties will have practically no creosote while others will be saturated. Goltra maintained that only treatment to refusal will ensure that all ties are thoroughly treated.[87]

On this point he was going against the standard practice of possibly every timber preserving plant in the U.S., including those run by people opposed to empty-cell treating like Angier, Berry, and Chanute. It was standard practice for ties to be sorted, even if they were to receive a full cell dose of zinc chloride.[88] Octave Chanute even questioned Goltra's statistics on this point at the 1910 AWPA meeting.[89]

Goltra also denounced the Lowry process because it omits the preliminary steaming which is common for ties treated by the Burnett process.[90] Rowe also complained of this in his letter

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84 [Goltra I, 70]
85 [Goltra I, 5]
86 [Goltra I, 5]
87 [Goltra III, 22]
88 ['10, 105]
89 ['10, 115-116]
90 [Goltra I, 75ff]

to Robinson. Steaming was performed just prior to treatment to loosen the remaining sap in the wood, and to accelerate seasoning. Goltra did not even hint in his book that steaming was a highly controversial topic. The problem is that it weakens ties. The debate of its effects would continue for years: by the 1920's the negative effect of steaming on the strength of Douglas fir was known, but the damage done to pine was only fully recognized in 1960.[91]

In France full cell creosoted oak and beech ties last at least 25 to 30 years in main line service. This fact is stated in many reports, including Chanute's 1900 address to the ASCE: "...the creosoted oak lasting 25 years, and the creosoted beech being estimated to last 30 years in the track, as evidenced by data for 27 years..."[92]

Now listen to Goltra: "It is currently reported that in France and England creosoted ties have been known to last thirty years. This is true, but it must be borne in mind that this is not the mean or average life; in fact, we are reliably informed that only two or three ties in one hundred last that long. The average life of oak or beech ties, treated in France and England, with creosote oil, to refusal, adzed and bored and warmed in ovens, prior to impregnation, as near as we can judge from available data, is about fifteen years."[93]

Goltra was lying. He was twisting the words which echo in engineers' minds about the durability of French ties. Naturally he did not name his supposedly reliable source. The reason he wanted to discredit the record of full cell treating is that if it is believed that the France ties last only fifteen years, then empty-cell creosoted ties cannot last longer.

He attacked the Lowry and Rueping processes directly:

> It has been clearly demonstrated time and again that the promoters of the Lowry process cannot do what they claim. The claim is that they can withdraw from the wood any desired amount of oil by means of a "quick high vacuum," applied at the end of the treating operation. The proposition is most absurd, yet many people believe it. The oil is not drawn out by means of a vacuum, but it is forced out by the expansion of the air, which is compressed in the cells of the wood simultaneously with the injection of the fluid.[94]

Of course it is the air which forces out the oil. The quick vacuum ensures that *enough* oil is expelled.

> It is a well established fact that the amount of fluid expelled by the expansion of the air, which is compressed simultaneously with the fluid, is directly proportional to the amount of fluid injected in the wood, and neither an initial pressure, as in the Rueping process, or a final vacuum, as in the Lowry process, can materially change the natural phenomenon which always takes place when timber is treated under pressure. The application of a final vacuum to dry ties after treatment while still dripping in the impregnation retort was practised in this country long before Mr. Lowry was in the treating business. It

[91] See the discussions in the 1905 through 1909 AWPA *Proceedings*. [Graham, 19]
[92] [ASCE 6-01, 505]
[93] [Goltra I, 65]
[94] [Goltra I, 40]

> is common practise to apply a final vacuum at nearly all of the plants in this country. No matter how quickly the vacuum is applied or number of inches obtained, the vacuum can only assist the escape of the compressed air. . .[95]

Against Rueping:

> Experiments have clearly demonstrated that nothing of the sort is accomplished by an initial pressure and the burden of the proof of the claim is upon the patentee, and the sooner these people get the idea out of their heads that the application of an initial air pressure will diminish the quantity of antiseptic necessary to thoroughly impregnate the timber, the sooner we will have an age of reason in wood treating business.[96]

To sum it up, Goltra claimed that

> . . .the Lowry and Rueping processes are as much "full-cell" processes as the Bethell process. There cannot possibly be any distinction between these several processes, because the expulsion of the liquid by the expansion of the air in the wood when the fluid pressure is released occurs the same in all of them. The advocates of these two processes have invented a lot of awe-inspiring words and phrases, such as "full-cell," "empty-cell," "coated walls," "painted walls," "coated cells," "compressed air bubbles," "air plugs" "quick high vacuum," "heavy and long pressure," and other imaginary words, intended to mystify, hoodwink and bamboozle the uninitiated.[97]

Now he must explain just how half the treating industry got hoodwinked and bamboozled. He did this by claiming that "The salesmen of coal tar creosote are more industrious than the zinc salesmen."[98] Additionally, he complained of the long term, exclusive contracts which Lowry made with railroads. Once signed, the railroad had no way to change treatments.[99] Goltra's book is full of accusations of conspiracy and concealment of facts by those who profit from empty-cell methods.[100]

Here is another example of Goltra twisting facts to meet his needs. In an August 17, 1912 editorial in *Railway and Engineering Review* (reprinted in his book) he quoted old C&EI statistics which showed that of the zinc chloride treated ties laid in 1900, only 2% had been removed by 1910. But, as Goltra well knew, Angier had demonstrated these statistics to be completely inaccurate in January, 1911.[101]

In every volume of the *Proceedings* of the AWPA is a list of timber preserving plants in the U.S. Through 1912 the processes employed at these plants is part of the included information. We can tell if a plant was using the Bethell, Burnett, Lowry, or Rueping process because it is listed right there. Goltra was editor of the list from 1913 to 1915, and he changed this feature. Instead of

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95 [Goltra I, 40-41]
96 [Goltra I, 52]
97 [Goltra I, 56]
98 [Goltra IV, 24]. This isn't his quote, but he agreed with it.
99 [Goltra IV, 25]
100 [Goltra I, 40, 42]
101 [Goltra I, 38-39]['11, 123]

providing a description of the processes in use, he included information which tells which processes the plant is *capable* of performing. Because no extra equipment is required for the Lowry process, he lumps under the same category plants which use the Lowry, Bethell, and Burnett methods. The Rueping process requires an extra tank and pump, so they have a separate designation, but they are are listed as capable of the Bethell process also. Beginning 1916 no information is provided on method of treatment.

Naturally in his book Goltra included some statistics on the relative economies of the various methods to show that zinc chloride is best. These statistics rely on his estimate of the average life of treated ties, which he gave as follows:

Creosote full-cell to refusal (Bethell): 12 years
Lowry treatment: 10 years
Zinc-creosote: 12 years
Zinc chloride (Burnett): 11 years.[102]

Perhaps he estimated full-cell creosoted ties at 12 years instead of his 15 year estimate for French ties because traffic in the U.S. is heavier than that in Europe.[102] No matter: his estimate is wrong.

Goltra's 10-year estimate for Lowry treated ties is likewise absurd. In the preface of his book he even claimed that Lowry treated ties will decay faster than untreated ties![103]

His zinc-creosote figure is low also. Only the estimate for Burnett treated ties is accurate. It is no wonder, given these numbers, that he can conclude that the economically sound choice is zinc chloride.

Consider Goltra's language. He called the promoters of empty-cell methods "mountebanks," "impostors," "false teachers," "bogus reformers," "shell gamesters," "grafters"; that they are like the "idolatrous Athenians of old."[104] He wrote these words in the same volume as his statement "It is our desire to give a conservative view, and as we are searching for the truth, we can hardly afford to deceive ourselves or the interested public and those specially concerned."[105]

William Goltra must have believed that empty cell treating does not work. He knew that in a very short time the record of Lowry and Rueping treated ties would reveal the truth or falsehood of his statements. Knowing the Truth, he felt that any tactic to discredit empty cell treating,

[102] ['11, 124]
[103] [Goltra I, 6]
[104] [Goltra IV, 6-7]
[105] [Goltra I, 62]

even lying and distorting the record, was legitimate. Unfortunately for him, the methods he was attacking *do* work, as we shall see shortly.

It is easy to poke fun at Goltra, but I do not want to imply that other engineers who opposed empty cell treating were like him. Angier, Chanute, Rowe, and others were, as far as the record shows, honest engineers who were steered the wrong way by improperly conducted experiments. I have seen no evidence that they ever resorted to the kind of back-handed antics characteristic of Goltra.

No railroad which had adopted either the Lowry or Rueping process backed off and returned to zinc chloride, but there were some railroads which delayed the introduction of creosote based on the arguments of men like Angier, Berry, and Goltra (see Table VIII, page 69). Some continued to use Burnett treated ties. Others, as we shall see soon, went first to the Card process, which is a mixture of zinc chloride and creosote injected full-cell. The CB&Q, Angier's road, used the Card and Burnett methods into the 1920's. In 1910 Angier went to work for the Baltimore & Ohio, devoting that railroad to Card's method. Berry's line, the Union Pacific, did not begin using creosoted ties until 1927. The Milwaukee Road, the Missouri Pacific, the Southern Pacific, and the Great Northern are the other railroads I have identified as not adopting creosote until the 1920's.

19. Zinc creosote methods

We have to back up now. Recall what Octave Chanute said in 1900: that zinc-creosote might be economical, but creosote was too hard to get, and the price of lumber was just not high enough. This was an invitation for treating engineers to at least begin thinking about zinc creosote methods.

The history of emulsion processes involving zinc chloride and creosote date back to 1874 when Julius Rütgers introduced his method in Germany. His process involves mixing an 80%-20% solution of zinc chloride and creosote and injecting it in one step into the ties. In the U.S. it was in 1882, just when some Western railroads were beginning to consider tie treating, that Joseph P. Card patented a two-step process in which zinc chloride, then tar oil is injected into wood.[106] Neither Card, nor his subsequent partner Chanute, could make the process work in a satisfactory way. A process similar to Card's which was tried in an 1894 test section on the Galveston, Harrisburg & San Antonio. No other American test involving zinc chloride and creosote is known until 1902.

About 1902 R. L. Allardyce, working at the International Creosoting & Construction plant in Texarkana, developed a zinc-creosote method in which ties are first injected with $ZnCl_2$, then a

[106] [ASCE 6-01, 511] ([H&G, 210] claims that it is the creosote which is injected first, and that the date of the patent is 1885. Card was issued patents in both 1882 and 1885, so both sources might be right. [Weiss, 278])

second time with creosote. The process was tested by various railroads in the period 1902-1911, but it was abandoned as too expensive. In order to work properly the ties need to be seasoned between injections, which drove the cost up (see Table XIII, page 71).[107]

By 1904 lumber prices had advanced enough to make one-step zinc-creosoting economically viable. That year the Chicago Tie Preserving Co. built and put into operation a plant at Paris, IL for treating ties by Rütgers' process. In 1904-05, and possibly later, they treated 693,324 gum and oak ties for the Big Four Route. This is the first commercial use of a $ZnCl_2$-creosote method in the U.S.

Joseph P. Card, Chanute's partner, died before the turn of the century, and his son, Joseph B. Card, became an active tie preservation engineer. Working with the Chicago Tie Preserving Co., he was able to build on the decades of experience of his father and Octave Chanute. J. B. Card, who was involved with the treatment of the Big Four ties just mentioned, experimented vigorously with zinc-creosote methods. The fruit of these investigations was the Card process, which was patented in 1906. It is very similar to Rütgers' process, the biggest difference being the manner in which the two substances are kept mixed.[108]

It was not until 1908 that Card's method came into common use, though the Cotton Belt may have been treating ties by Card's or Allardyce's method since 1905. In 1908 the C&NW, the CB&Q, and the Milwaukee Road initiated the use of Card treated ties, and the B&O followed sometime in the period 1908-1911. With high timber prices and the belief that empty cell treating was a fraud, these railroads were looking for a better method than Burnett's.

The CB&Q built their second plant at Galesburg, IL in 1908 specifically to treat ties for Eastern lines by the Card process. Western ties were still treated with zinc chloride at Sheridan, WY. The Milwaukee Road had a similar east-west policy beginning 1908. They purchased their Card treated ties from J. P. Card's newly-formed Chicago Tie & Timber Preserving Co., in Waukegan, IL. The C&NW converted their Escanaba, MI plant from the Wellhouse to the Card process in 1908. When Frank Angier left the CB&Q for the B&O in 1910 he made sure his new line used the Card process. The B&O may have already begun using it in 1908, however (see Table V, page 68).

20. Many railroads abandon the date nail for test sections

In 1905 the recommendation of the AREA to railroads for tie record keeping began as follows:

> Section foremen are provided with daily record blanks having space for each day of the month to record the number of treated ties put into track that day, the latter being divided according to the cause

107 [Weiss, 63]
108 [Weiss, 61]

necessitating their removal, whether rotten, broken, burned or rail cut. The section foremen must make these records each day. They must also show the year in which these ties were treated as indicated by the stamp and by the dating nail. These records must be entered up each day, and at the end of each month the daily record must be forwarded to the proper superior officer. If no treated ties have been taken out or put into track during the month, section foremen must note so on report.[109]

Does that sound like a lot of record keeping? It was, and some railroads experienced great difficulty in getting it completed. F. J. Angier was the first to bring up the inaccurate records provided by date nails, and to offer a solution to the problem. He presented a paper at the 1911 AWPA meeting titled "Some results obtained in this country in prolonging the life of railway cross-ties by preservative treatment as shown by the records that have been kept; and a better method of keeping these records."[110]

He described the failure of date nails on the Burlington:

> After all the trouble and expense of keeping this record, the results show that only 102,000 ties out of a total of more than five and one-half million—less than 2 per cent—had been removed for all causes. On one division this record shows five ties removed in ten years, although 435,000 had been put in track. You say this is absurd: then of what use is this record? It is needless for me to say to you that it was discontinued and another method adopted to ascertain the life of treated ties.[111]

On the C&EI the record was no better:

> A statement taken from the Chicago & Eastern Illinois Company's records, made December 31st, 1909, shows only $9\frac{1}{2}$ per cent removed, account of decay, from a total of 111,816 ties treated in the year 1899. From a total of 1,647,605 ties laid during the years 1899 to 1909 inclusive, the records show only 1.1 per cent removed due to decay. This record was made by placing a dating nail in each tie as treated and laid, and depending upon the section foremen to hand in correct reports of ties put in and taken out of track. It has proven an unsatisfactory method of keeping a record and doubtless many inaccuracies occur.[112]

He further described the problems on the CB&Q:

> From the foregoing it can be readily seen that, for a correct and complete record, everything depended absolutely upon 1,500 section foremen. The average section foreman is not a clerk, and not much dependence can be placed upon him to give in reliable data. Even were he able to make the finest kind of a report, he will be unable to decipher the figures on the heads of thousands of rusty and battered dating nails, and he either guesses at the correct date, or writes in his report "illegible." Then again, no matter how many letters of instruction are written, or how often you talk in person to these men, there will be thousands of ties placed in the track without dating nails in them, and other thousands of UNTREATED ties bearing dating nails which should not have been driven in them.[113]

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109 [AREA '05, 769]
110 ['11, 122-130]
111 ['11, 122]
112 ['11, 123]
113 ['11, 128]

But it was not only the inaccuracy of the record kept by date nails which prompted Angier to stop the practice in 1909. He needed a more detailed kind of record:

> For the sake of argument, we will assume that every section foreman sends in reports absolutely correct; that whenever he removes a tie he puts in another, and in every case he shows the year treated correctly. Under such conditions, what kind of a record have you when every tie contains a dating nail? A tie is a tie, it matters not whether it is made of oak, pine, chestnut, maple, beech, or any one of the twenty other species of wood. Your record then cannot show you which kind of wood is giving the longest life. There may possibly be some particular wood that is giving only one third or one half the record of other treated wood, but how are you to know from the record? Your record shows that so many ties are taken out each year, some for decay, others for rail-cut, breakages, etc., but does your record say that gum ties are breaking in greater numbers than hickory, or that maple ties are being destroyed much more by rail cutting and spiking than beech or ash ties? These are questions you want answered, and they never can be answered by the present method of putting a dating nail in every tie, and depending on the nail and the section foreman to give you a report.[114]

Angier found a way out of this record keeping mess. He and A. W. Newton, General Inspector Permanent Way and Structure, devised a plan to institute nineteen special test sections on the CB&Q, one on each operating division, in which ties of various woods and treatments would be laid together. The tests were implemented beginning in the Spring of 1909, and the last was completed in 1910. Generally 1,000 ties were laid out of face[115] on each division. Each tie bore date nails specifying the year of treatment, the species, and type of treatment. Twenty kinds of wood were used, and the different treatments employed were Burnett, Card, Creosote (full cell), and untreated. Believing that empty cell creosoting was a fraud, Angier included no Lowry or Rueping treated ties in his tests. Now only nineteen section foremen instead of 1,500 would be depended upon.

There are two features of this plan which make the Burlington test sections different from those which had been conducted before. First, a large variety of woods and treatments were placed in the same stretch of track. In test sections before 1909, railroads usually placed a single wood and treatment together in order to determine the viability of the treatment. Second, nearly identical tests were scattered around the system to find out which combinations of wood and treatment were best for each territory.

There was some precedent for the first feature. In 1897 the Norfolk Southern tested five treatments on five species, and In 1905 Herman von Schrenk established a test section on the CB&Q with two woods treated six different ways. The most important early test of different woods and treatment was the 1902 Pelican, TX test described earlier. But these were all isolated experiments,

[114] ['11, 128] Some railroads stamped this kind of information into ties beginning no later than the mid-teens, but only so ties could be sorted properly for treatment and sent to the right track. The stamps served no purpose after the ties were inserted. [W-P Apr-Jun '15, 27-28][W-P Oct-Dec '15, 69]

[115] that is, they were laid in a continuous stretch of track at the same time

which held little influence on railroad tests in general. The second feature was new. No railroad had ever placed similar test sections on different parts of its system.

It was the price of timber, not the availability of new treatments, which was responsible, along with the failure of the date nail, for the introduction of the CB&Q tests. What Angier did was to open the door to quite a few inferior woods which had hitherto been ignored.

He finished his 1911 talk by stating the savings that such a specialized record would provide.

> To put a dating nail in every tie treated on the Burlington (about 2,300,000 per year) would cost in round figures $8,000.00 a year for labor and material. In ten years this would amount to $80,000.00. To make the special tests, placing 5,000 ties on each division[116] once during the ten years, would cost about $5,000.00. The savings in ten years would be $75,000.00, plus interest.[117]

Many railroads were swayed by Angier's statements and efforts. Very quickly one railroad after another abandoned the date nail in favor of specialized test sections. The Santa Fe was first to follow. In 1910 they stopped using date nails except on 26 section foreman's districts. The nature of the Santa Fe tests was different. Instead of laying ties of various woods and treatments out of face, they decided to maintain the same type of record which they had endeavored to keep on the entire system, only in miniature. They kept track of ties inserted and removed in the natural course of renewals in these 26 test sections. Special tests of treated and untreated ties were also made, but their record was kept separate.

Table XI (page 70) lists railroads I have found which stopped using nails and instituted CB&Q-style tests on the years folowing 1909. By 1914 at least twelve railroads were concentrating their attention on test sections. Some of these lines, like the C&EI and the Monon, established only one test, because their territory was small. Most railroads did not test such a wide variety of woods as the CB&Q.

This movement found its voice in 1911 in an official recommendation by the Wood Preservation Committee of the AREA. They advocated exactly what Angier did on the CB&Q. The use of nails in all ties should cease, and railroads should concentrate on test sections. In fact, every argument put forth by Angier, and every change he made on the Burlington, is contained in the recommendation. He may have written it.[118]

There were other problems with nails. Recall that the date nail was introduced because railroads had a difficult time with stamps in the ends of ties. They believed the date nail to be a more permanent mark. Now we hear Angier saying that the nails become rusty and defaced. F. S. Pooler

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116 He is stating the extreme case here—most divisions received 1,000 ties.
117 ['11, 130]
118 [AREA '11 III, 434]

of the Milwaukee Road said after Angier's talk "...roadmasters tell me the men cannot read these figures [on date nails], and in some cases probably do not take the pains to clean off the top of the nail."[119]

Some railroads disagreed with Kittredge's suggestion that the nails be driven by the section gang, because the nails would be driven into the wrong ties, or would not be driven at all. Mistakes of this kind were occuring on the Wabash by 1905,[120] and plagued both the C&EI and the L&N in their first years of dating ties with nails.[121] C. W. Berry of the Union Pacific wrote in 1904 that nails should be placed in ties before they leave the treating plant.[122] Angier had his men on the CB&Q drive nails at the track from 1899 to 1907, after which they switched to the UP practice.[123]

While nearly every Western and Midwestern railroad was persuaded to quit using nails after 1909, several companies in the Northeast were satisfied with date nails. In 1914 the New York Central believed that 90% of the reports on the lives of their ties were correct, and they intended to continue using a date nail in every tie.[124] The Buffalo, Rochester & Pittsburgh kept a record of every tie on its system with date nails beginning 1910. Up to 1925 they had tracked the lives of over a million and a quarter ties. Their record, which was quite good, appeared in a 1926 issue of *Railway Age Gazette*.[125] The Delaware, Lackawanna & Western was also happy with its record from nails[126] (see Table XII, page 71). The only Western railroads I have identified which continued to use date nails in all treated ties are the Union Pacific and Southern Pacific.

As for Angier's complaint that nails only recorded the date, there were a few railroads before 1920 which used special nails to give more information. The CB&Q itself was using a second nail bearing the letter "H" in 1903 in ties treated by the Hasselmann process. Several companies used nails with different shaped heads to indicate treatment. The Santa Fe in 1904 began using nails with diamond shaped heads (and shanks) in untreated ties. In 1905 the Big Four began using diamond nails in ties treated by the Lowry process at the Shirley/Indianapolis plant, while round nails were used in other treated ties. The El Paso & Southwestern (1908), Oregon Short Line[127] (1910), New York Central (1911), and Chicago & Eastern Illinois (1912) established similar plans. On the Rock

119 ['11, 136]
120 [AREA '07, 495]
121 [AREA '22, 1167]
122 [AREA '04, 70]
123 ['11, 127]
124 ['14, 402]
125 [RAG 1-9-26, 175-180]
126 [AREA '22, 1167][DNC, 33]
127 or its subsidary the Oregon RR & Navigation Co.

Island round, diamond, and square nails were used with different treatments beginning 1907/08. Nails on the Milwaukee Road carried an extra letter to indicate treatment from 1908 to 1910.

On the Great Northern an extra letter was used to specify the wood in the period 1904-1911, and the Pennsylvania did the same from 1909 to 1911. From 1910 to 1932 the Buffalo, Rochester & Pittsburgh used two nails, one bearing the date and the other with letters indicating the species of wood.

21. Vindication of empty cell methods

In 1912 Goltra wrote "The value of any treatment can be judged only by a careful record of conditions from year to year."[128] It was the compilation of such records which led to the general acceptance of empty cell methods. In 1915 the AWPA published in its annual *Proceedings* a table of the results of test sections on various railroads. The list appears in a fold-out table. This single page covers ties from all over the U.S., with treatments ranging from creosote to zinc chloride to copper sulphate to mercuric chloride. Some Rueping and Lowry tests are included. On the Illinois Central, of 6,080 Rueping treated ties laid in 1907, two were reported to have been removed by 1914. The other empty cell tests also had a strong record.[129] The same year the AREA published a six page list of tests in fold-out tables, along with a two page summary organized by treatment. There the Rueping tests of the Galveston, Harrisburg & San Antonio, the Mexican Central, and the Frisco showed very promising results—only three out of 1,454 ties had been removed, and all had been in service at least seven years.[130]

These pages attracted some attention, and for the 1916 AWPA *Proceedings* the Committee on Service Tests of Cross Ties put together a comprehensive 72-page report on vast numbers of tie tests throughout North America, and they even included many foreign tests. The table is arranged by wood, then is broken down by treatment. Many Rueping tests are included, and a few Lowry tests. It had been a decade since the Big Four and the Santa Fe began using creosoted ties, and from the collected data the Committee wrote

> *Empty Cell Creosote Treatment.*—This tabulation includes records on ties treated respectively by the Rueping and Lowry processes. It is of interest to note that of the total of 54 records of ties treated by the Rueping process none are yet completed.[131] All of the records are covered by seven railroads, the I. C., and the A. T. & S. F. furnishing most of the records. The longest service so far reported is no removals of 146 pine ties after $9\frac{1}{2}$ years in the Mexican Central Railway. The remaining records are on ties which have been in place from one to 11 years. The removals vary from nothing up to about 9%.[132]

128 [Goltra I, 5]
129 ['15, table]
130 [AREA '15, table, 879-880]
131 i.e. not all ties have been removed from the track yet.
132 ['16, 259-60]

They continue by describing the Lowry records, which also showed a long life. Elsewhere in the 1916 volume we find "the empty cell treatments [are] suitable for all pine and other easily treated track ties used in moist climates, under service conditions which give a mechanical life in keeping with the anticipated life for decay..." But two paragraphs up they acknowledged that there were still people who were opposed to the treatments: "While definite deductions may be drawn from theoretical consideration of the two processes [Lowry & Rueping] and divergent opinions are held, it is not for the Committee to pass judgement, and the fact remains that both processes have received wide recognition."[133]

No hint that anyone had ever questioned empty cell methods appeared after this in the literature. The AWPA buried its mistake in silence.

Extensive lists of test sections also appeared in the 1917 and 1920 AWPA *Proceedings*, as well as in subsequent AREA volumes. The record of Lowry treated ties on the Big Four, published in 1926, showed an average life of over twenty years, as calculated (ironically) by the Goltra method.[134]

22. The wartime creosote shortage

If the vigorous arguments against Lowry's and Rueping's processes did not convince any railroad to stop using the methods, the creosote shortage caused by the First World War did. Even though domestic production was on the rise, much of the creosote used in the U.S. was still imported from Europe. Railroads could not afford to diminish the amount of the oil used in bridge piles and timbers, but ties could be treated with zinc chloride again, and that is exactly what happened on many roads.

I have information on only a few railroads which were forced to switch from creosote to zinc chloride. In mid-1914 the Fort Worth & Denver City (FW&DC) reverted to $ZnCl_2$, and the Santa Fe readopted the Burnett process in 1915. The C&O, which had begun using Lowry treated ties in 1915, switched to zinc chloride in 1920. The Pennsylvania simply cut back on tie insertions in these years. Several other railroads either cut back or switched.[135] The rarity of date nails from the late teens on the Erie and on the New York, New Haven & Hartford could be due to a cutback in creosoted ties. Both these companies probably previously used ties treated by the Rueping process.

The Santa Fe continued to treat bridge timbers with creosote. In an effort to improve the Burnett process, they conducted large tests of ties injected with zinc chloride mixed with other

[133] ['16, 179]
[134] [WPN 11-26, 148]
[135] Chicago & Northwestern; Illinois Central; Los Angeles & Salt Lake; Michigan Central; Pittsburgh & Lake Erie; Rock Island Lines.

substances: crude oil, petroleum, and a creosote-petroleum mixture.[136]

Some companies using Lowry treated ties only cut back a little, if at all. From published statistics as well as nail finds it is clear that the New York Central, the Big Four, the Delaware, Lackawanna & Western, and the Lehigh Valley continued to use large numbers of creosoted ties throughout the late teens. The Buffalo, Rochester & Pittsburgh, which by about 1913 may have switched to an empty cell process, also used creosote in this period, though they did use about 200,000 zinc chloride treated ties at one time[137] (see Table XII, page 71).

23. 1920's: revival of creosote, with coal tar or petroleum

It was not until around 1923 that the creosote supply was restored. We know that that year the Santa Fe, the C&O, and the FW&DC returned to creosoted ties. Also in 1923 the Southern Pacific finally abandoned zinc chloride and began treating ties by the Rueping process. The Pennsylvania had begun again to use large numbers of creosoted ties in 1922.

Gradually during the 1920's those railroads which had shunned creosote began using empty cell treated ties. The SP was the first of these, and by the end of the decade the Baltimore & Ohio, the Burlington, the Great Northern, and Milwaukee Road all began to use creosoted ties. Some of these lines continued to treat large numbers of ties with zinc chloride, however.

In New England the New York, New Haven & Hartford and the Boston & Maine began using creosoted ties in large numbers in 1922. In this case it was not solely the availability of creosote. The reason given in an AWPA report was this: "The shift in source of supply which follows changes in transportation costs is exemplified in recent developments in the New England States. Most of you probably know that the Boston and Maine Railroad and the New York, New Haven and Hartford Railroad have undertaken to give preservative treatment to their ties and timbers. They immediately turned to local sources of supply of woods they had not heretofore been using. They did not treat them before because the cost of pine ties shipped from the South Atlantic States had not been high enough to justify the use of local woods with the price of preservative added."[138]

Another report attributes the construction of the New Haven plant to a blight of the chestnut tree, which had up to then been used untreated.[139] Whatever the reason, local conditions affected all New England roads. The Boston & Albany began using large numbers of treated ties in 1923/24, and the Barre & Chelsea/Montpelier & Wells River began about 1925.

136 ['41, 196]
137 [RAG 1-9-26, 177]
138 ['23, 216-217]
139 [NH]

The Canadian National was organized out of several smaller Canadian railroads in 1923, and they began the slow process of converting from untreated ties to creosoted ties the next year. In this case the shift to creosote came as much from corporate reorganization as it did from the new availability of the chemical.

George J. Ray of the Lackawanna stated the case for roads in the Southeast in 1928: "In many parts of the South, where yellow pine ties are extensively used, the normal life of the untreated tie is very much less than it is in our Northern climate. The cost of the tie is low compared with the price of ties delivered along Northern lines. ...there is no reason why a properly treated tie should not last just as long in our Southern climate as they do in our Northern climate, so far as the matter of decay is concerned. It is my belief that the saving to be accomplished by treating yellow pine ties in the South will be found to be greater than can be expected in the North."[140] Most railroads in the South were still using untreated ties when Ray spoke, though the N&W had switched to creosote treatment in 1921, and the Southern was evidently treating its ties by the early 1920's. The Atlantic Coast Line built a tie treating plant in 1912, but judging from date nail finds they may not have treated large numbers until 1930. By the same reasoning the use of creosoted ties on the Seaboard Air Line might not predate 1928.

From Histograms I and II (page 73) it is apparent that many, many railroads began using treated ties in the 1920's. Even short lines like the Fonda, Johnstown & Gloversville in New York and the Copper Range in Michigan went to the expense of treatment. This new found popularity came with a price: the creosote supply, though restored by 1923, was not enough to keep up with the new demand. This may be the reason several of the larger lines continued to use zinc chloride into the 1930's. As of 1935, for instance, the Great Northern was still treating the majority of its ties with zinc chloride.

By the 1920's railroads were mixing either coal tar or petroleum with their creosote. The empty cell processes enable treating engineers to obtain a thorough penetration of the wood using little creosote, and diluting the oil with another liquid helps stretch it even further. The earliest record I have found of the use of a creosote-coal tar solution is on the Rock Island in 1908. It seems from test sections that the railroad adopted the combination for general use when they switched to creosote in late 1907. By similar reasoning, the Northern Pacific began using a creosote-coal tar mixture at the same time.[141] Such emulsions came into general use on the C&EI possibly as early

[140] ['28, 121]

[141] Later reviews of the use of coal tar give 1908 as the first year in which the mixture was used. See in particular Hermann von Schrenk's article "An Historical Statement on the Use of Straight Coal Tar for Tie

as 1912. We have definite information that a creosote-coal tar solution was the treatment used by the C&O, the Detroit & Mackinac, Lehigh Valley (beginning 1920), and the Toronto, Hamilton & Buffalo.

The Santa Fe had begun experiments with a mixture of creosote and petroleum as early as 1909. Different proportions were tested in the ensuing years, and when the railroad returned to the Rueping process in 1923 they used a 30%-70% creosote-petroleum mixture. Railroads which began using a solution of creosote and petroleum in the 1920's include the CB&Q, C&NW, Great Northern, Southern Pacific, and Union Pacific.

I lack information on other railroads, but it seems that in general ties treated at American Creosoting Co. plants (using the Lowry process) employed creosote-coal tar mixtures while ties treated by the Rueping process were more likely to be treated with creosote-petroleum.

24. Other treatments

An insignificant number of ties were treated with methods and chemicals other than empty-cell creosote and zinc chloride in the first decades of the century. I will mention some of them here for the sake of being complete.

In 1906 the Oregon RR & Navigation Co. began treating ties by the Bethell (full-cell) process. The process became somewhat popular in 1909-1912 with at least six more lines joining in (see Table VI, page 69). We can guess that these railroads did not believe empty-cell methods work, and that they wanted something better than the Card method. Probably all of these lines switched to the Lowry or Rueping method by the 1920's.

In the period 1910-1919 many ties were treated with water gas tar. The Public Service Railway Company of New Jersey used the substance from 1910 to at least 1914. The B&O, CB&Q, C&NW, Pennsylvania, Reading, and the Forest Products Lab used or tested water gas tar treated ties mainly in the period 1914 to 1919. Use of the chemical for treating ties seems to have died after 1914, however. In its peak year fewer than 7% of all treated ties received water gas tar.

Tests of ties treated with zinc-meta-arsenite (ZMA) were conducted by the Forest Products Lab (1928), CB&Q (1929), Illinois Central (1929), and Canadian National (1930). It was used regularly along with creosote and zinc chloride by the Great Northern beginning 1932. To 1936 ZMA treated ties never accounted for more than 2% of all treated ties in the U.S.

Carbolineum was tested by the Honolulu Rapid Transit (1900-1903), Mexican Central (1905), Oregon RR & Navigation Co. (1908), and Soo Line (1913-1914). Other 20th century preservatives

Treatment" in [AREA '49, 387-400].

include cresol-calcium, cresoil, sodium fluoride, and Penta, the latter being a pesticide tested in the 1940's (see Table XIII, page 71).

25. Boring & adzing machines

Along with all the attention paid to preventing decay came increased efforts to reduce the mechanical wear of ties. It is pointless to creosote a tie which will be badly rail cut after five years, or if the spikes will wear loose in a short time. More and more railroads were using tie plates, and beginning about 1911 some railroads installed boring and adzing machines in their treating plants. With these machines spike holes were pre-bored, and the seats for the ties plates were adzed to a level, flat surface.

One advantage of a boring and adzing machine is that with the ends of the ties cut flat, information can be stamped there. Goltra described machine stamping: "a pneumatic branding device, consisting of two opposite cylinders with pistons, provided with dies for stamping dates, or any other information, and controlled by automatic air valves, may be placed directly behind the boring spindles and so timed to the machine feed that when the tie moves to the proper position, the dies advance and leave their deep sunken impression in both ends of the tie."[142]

Unlike the hand stamps of the 1800's, machine stamps are nearly permanent. Not only was the stamp deeper, but it was placed on a more even surface. Also, the use of mauls and picks in track work had basically stopped, making stamps last longer.[143]

Not only the year of treatment, but other information, such as species, grade, weight of rail, and treatment specifications can be stamped into the ties. This answers to Angier's complaint about the limited information conveyed by nails, and it led to a decline in the creative use of odd date nails recording special information. The railroads which continued to use different head shapes and extra nails did so for convenience. All the necessary information could be found stamped in the ends of the ties.[144]

In 1911 the Delaware, Lackawanna & Western, the Northern Pacific, and the Santa Fe became the first railroads to employ such machines. The DL&W was using screw spikes, which require pre-bored ties. In 1912 a boring and adzing machine was installed in the Port Reading, NJ plant, which treated ties for the Central RR of New Jersey and the Reading. Boring and adzing machines began working on ties for the C&O in 1925, and for the Illinois Central in 1923 (at Grenada, MS) and 1928 (at Carbondale, IL).

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142 [Goltra II, 82]
143 ['14, 406-407]
144 See CB&Q for a detailed explanation of the machine stamps on their ties in the 1950's.

In a questionnaire dated June 15, 1921 and answered by 82 railroads, only four were machine adzing their ties. These were the CRR of NJ, DL&W, NP, and Santa Fe.[145] In 1932 forty-one railroads responded to another questionnaire. Again four of these branded their ties by machine, while one was stamping information by hand.[146] Evidently two of the six railroads named above did not respond to this one. It seems, then, that as of 1932 no other railroads utilized the machines. Then Hunt and Garratt wrote in 1938 "Adzing and boring machines are a necessity in practically every fully equipped tie-treating plant..."[147] Tentatively, then, it appears that these machines came into common use during the 1930's.

26. 1920's: revival of the date nail

In 1921 the Santa Fe returned to using date nails in all treated ties. The reason for this can be seen in this short discussion at the 1923 AWPA meeting initiated by William Steen: "Which is better, a dating nail or a stamp?" S. D. Cooper of the Santa Fe responded "I think they are both of great advantage, because in a dry country where you put in a pine tie the tie is liable to check and you are liable to lose the nail, but you never lose the mark on the end of the tie. Of course, the advantage of the nail on the top of the tie is that it makes the inspection so much quicker. If there is any doubt the stamping is as distinct as the date it was put in."[148]

Another minor reason it was desired to resume the use of date nails on the Santa Fe is that sometimes ties would not be used until one or more years after being treated, so the date stamped in the end would not be the date the tie was inserted in the track.[149]

The Santa Fe, as we saw, was a special case in that they were already stamping information in their ties at this time. For the majority of American railroads in the early 1920's, the lack of date nails meant no record at all for ties outside test sections. In 1922 the Tie Committee of the AREA voted to reinstate its recommendation that date nails be used in all treated ties:

> The Committee is almost unanimous on the question of dating all treated ties that go into the track and we hope that there will be more of it done. Like all other programs of checks on railroad work there have been failures, but these failures are largely due to lack of initiative or lack of control. We have found railroads that have been successfully using dating nails for seventeen years, and who would not give them up. They figure that the moral risk that a section foreman wants to assume if he takes out treated ties before they have given their full service will be much greater if he knows that there are dating nails in those ties, and that they will be checked up by someone in authority to see why the ties did not stay their full life.[150]

145 [AREA '23, table]
146 [AREA '32][DNC, 36-37]
147 [H&G, 364]
148 ['23, 331][DNC, 337]
149 [SFe, 3]
150 [AREA '22, 1164-65]

The one member who prevented unanimity on the subject was Frank Angier. He still maintained that test sections are the only way to get reliable records, and he vehemently defended his ideas. But the bad results of two railroads did not prevent other engineers from seeing the value in dating every treated tie.

The "moral risk" in the recommendation refers to the psychological effect of date nails on the section men. In response to an AREA questionnaire Hermann von Schrenk wrote in 1926 "I have had any number of experiences with the section men who feel that the dated ties will last for so many years that they will not remove them. The increase of interest of the men in dated ties brings about a method of handling which undated ties would hardly receive."[151] In fact, twenty of the thirty-two engineers who responded in a definite way to this particular question agreed that the men responsible for determining tie removal will give more consideration to ties with date nails.[152]

Just as those railroads which had embraced zinc chloride slowly switched to creosote in the 1920's, many lines which had abandoned the date nail reinstated their former policy. The C&NW took up the use of nails again in 1923. The Great Northern joined in the next year, and in 1927 the Milwaukee Road returned to nails. In 1928 the CB&Q also reverted to their former policy, but judging by nail finds, they returned to the practice of using nails only in test sections in 1931.

Even with automatic branding machines stamping all kinds of information into the ends of ties, the kind of record kept for the vast majority of ties was essentially the same as that of the late 1800's on the Southern Pacific, Santa Fe, and Rock Island. The dates on ties removed from track was recorded, along with information on the cause of removal and sometimes the species. This was enough, since few lines were using more than one treatment. The Big Four and the Buffalo, Rochester & Pittsburgh published their results from such a record in 1926.[153]

27. The 1930's and after

The number of ties treated annually in the U.S. rose dramatically during the 1920's, but suffered a severe plunge after 1929. The depression hit the railroads as hard as any industry, and its effect can be seen clearly in Histograms III and V (pages 74 & 75). Recovery began in 1934, and any decline after that can be attributed to two factors: (1) with the percentage of treated ties in track on the increase, renewals were fewer, and (2) the dwindling mileage of U.S. railroads after World War II. The use of untreated ties declined from nearly 50 million in 1921 to about 12 million in 1930. This decline was slowed during the depression. Untreated tie insertions were practically nil

[151] [AREA '26, 708]
[152] [AREA '26, 705-709]
[153] [WPN 11-26, 148][RAG 1-9-26, 175-180]

after 1950.[154] One reason some major lines like the Santa Fe continued to use small numbers of untreated ties into the 1950's is that on some tight main line curves, where ties are often removed due to mechanical wear before they have a chance to decay, treatment would be a waste.

Into the mid-1930's the use of date nails mirrored tie preservation. There was a great rise in the use of nails in the 1920's, and a drop during the early depression. There was another drop coinciding with World War II. After 1950 nail use went through a long, steady decline terminating in 1971. After that practically no railroad has used date nails in North America. My guess is that two factors contributed to this decline: the perfection of treatment methods, and the reliance on stamps for records.

To this day the AWPA still recommends empty-cell creosoting for crossties. Their specifications call for six to eight pounds per cubic foot, which is really no different from the treatment received by Big Four ties in 1905. Other preservatives continue to be tested, and in some cases adopted under special circumstances, but the Lowry or Rueping creosoted tie has remained the standard for over seven decades.[155]

The average tie in 1900 lasted 12 years. By 1969 this life had increased to about 35 years, despite a great increase in both the speed and the weight of traffic.[156] It took over fifty years, beginning in 1880, for U.S. railroads to fully realize the necessity and value of treating ties with creosote. Certainly if railroads had conducted long-term price planning in the late 1800's they would have found that treating ties early would lead to savings in the long run. Even when untreated ties were the most economical choice, such a policy of using and discarding large amounts of wood necessarily leads to a bad shortage and high prices later on. As with any natural resource, proper management only becomes an issue for serious consideration when there is little left to manage. There were railroad officials who saw this crisis approaching, and who warned that this reckless stripping away of our natural resources would lead to problems, but for any railroad under financial constraints, the short-term solution was almost always the most attractive.

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154 [RA 5-86, 44]

155 AREA 1997 *Manual for Railway Engineering*, 3-6-10, 3-9-4

156 [Graham, 10]

New York, New Haven & Hartford	1880	Creosote	Bethell
Indianapolis & St. Louis	1880	Zinc tannin	Wellhouse
Chicago & Alton	1880	Zinc tannin	Wellhouse
Houston & Texas Central	1880-82	Creosote	Bethell
Central RR of New Jersey	1880/82	Creosote	Bethell
New York, New Haven & Hartford	1881	$CuSO_4$ & barium	
Santa Fe	1881-82	Zinc tannin	Wellhouse
Erie	1882	Zinc tannin	Wellhouse
Eastern	1881-91/2	$HgCl_2$	Kyan
Manhattan Elevated (Metropolitan)	1883		Vulcan
New York Central	1884	Creosote	Bethell
Santa Fe	1885	$ZnCl_2$	Burnett
Lehigh Valley	1886 (-90?)	Creosote	Bethell
Atlantic Coast Line	1887	Creosote	Bethell
Chicago & North Western	1888	Zinc tannin	Wellhouse
New York, New Haven & Hartford	1888	Creosote	Bethell
Pennsylvania	1889	Creosote	Bethell
Duluth & Iron Range	1890	Zinc tannin	Wellhouse
Pennsylvania	1891	Zinc tannin	Wellhouse
Central RR of New Jersey	1891-92	Creosote	Bethell
Illinois Central	1891-93	$ZnCl_2$	Burnett
Delaware & Hudson	1892		Vulcan
Delaware & Hudson	1892	Zinc tannin	Wellhouse
Pennsylvania	1892	Creosote	Bethell
Pennsylvania	1892	$ZnCl_2$	Burnett
Chicago, Burlington & Quincy	1894	$ZnCl_2$	Burnett
New York, New Haven & Hartford	1894	Dead oil of coal tar	
Galveston, Harrisburg & San Antonio	1894	$ZnCl_2$ & covered with creosote	
Galveston, Harrisburg & San Antonio	1894	$ZnCl_2$ & creosote	
Galveston, Harrisburg & San Antonio	1894	Tar oil	
Pennsylvania	1894-98	Creosote	Bethell
Pennsylvania	1896-99	$ZnCl_2$	Burnett
Unknown RR	1896	Carbolineum	[AREA '02, 116]
Boston Elevated	ca. 1897-1903	Carbolineum	
Pennsylvania	1897	Zinc tannin	Wellhouse
Norfolk & Southern	1897	Zinc tannin	Wellhouse
Norfolk & Southern	1897	$ZnCl_2$	Burnett
Norfolk & Southern	1897	Creosote	Bethell
Norfolk & Southern	1897		Vulcan
St. Louis Bridge & Tunnel	1897	Carbolineum	dipped, painted
Pennsylvania	1899	Zinc tannin	Wellhouse
Oregon Short Line	1899	Salt	

There may be many other early uses of treated ties I have not yet found.

Table II. Wood preserving plants operating in North America in the period 1880-1904.

Year Built	Location	Company	Process	Primary Wood	No. of Retorts
1848	Lowell, MA	Locks & Canal Co.	Kyan	Spruce, etc.	2
	Switched to the Burnett process in 1850, and back to Kyanizing in 1862. Otis Allen & Son is the company named as owner beginning 1904. This plant treated mainly canal and bridge timbers.				
1865	Somerset, MA	Old Colony RR	Bethell		1
	First creosoting works in the U.S. Built to treat bridge piles. Still in operation in 1885, but abandoned before 1901.				

Year Built	Location	Company	Process	Primary Wood	No. of Retorts
ca. 1870	Defiance, OH	American Wood Preserving Works	Thilmany		
	Treated paving blocks, bridge timbers, building timbers, and railroad ties. This plant treated ties in the Thilmany tests listed in Table I, and operated at least to 1885. It was gone by 1901.				
*1880	Portsmouth, NH	Eastern RR	Kyan	Spruce, etc.	4
	Kyanized ties from the opening of the plant in April, 1881 to 1891/92. Afterward no ties were treated. The plant was owned by Otis Allen & Son as of 1903.				
1876	W. Pascagoula, MS	Louisville & Nashville	Creosote	Pine, etc.	2
	Began creosoting bridge piles about March 1, 1876. Burned 1902, and rebuilt with three retorts.				
*1876	Houston, TX	Houston & Texas Central	Creosote	Pine	
	Possibly rebuilt or enlarged in 1883. Began treating ties by the Burnett process in 1887 for the Southern Pacific, moved to a different location near Houston in 1889, and rebuilt in 1890-91. The rebuilt plant is listed below under 1891.				
1878	Long Island City, NY	Eppinger & Russell	Creosote	Pine, etc.	4
*1879	St. Louis, MO	St. Louis Wood Preserving Co.	Wellhouse		
	This plant, run by Joseph P. Card, treated the Wellhouse experimental ties from 1879-1882 listed in Table I. The plant was probably closed at the time Card and Chanute started their Chicago plant in 1886.				
1879	Slidell, LA	New Orleans & North Eastern	Creosote	Pine	1
	Built for creosoting bridge timbers. Abandoned 1883, and revived in the latter part of 1902 by the Southern Creosoting Co.				
1881	Portsmouth, VA	Wyckoff Pipe & Creosoting Co.	Creosote	Pine	1
<1883	St. Louis, MO	American Wood Preserving Co.	Gypsum		
	"Our company has lately purchased the creosoting works of the former Western Wood Preserving Company, and having acquired the patent of E. Hagen for treating wood with tincture of zinc chloride and gypsum in one solution and charge, we now apply this process to railroad ties, car roofing and siding, etc..." (From a letter dated 11-3-83.)				
1884	Seattle, WA	Colman Creosoting Co.	Creosote	Pine	2
*1885	Las Vegas, NV	Atchison, Topeka & Santa Fe	Wellhouse	Pine, etc.	2
	Enlarged to three retorts before 1900.				
*1886	Chicago, IL	Card & Chanute	Wellhouse	Hemlock	4
	This plant, run by Octave Chanute and Joseph P. Card, was built to treat Rock Island ties. The company was also known as the Chicago Tie Preserving Co.				
1886	Laramie, WY	Union Pacific	Wellhouse	Pine	2
	Closed in 1887.				
1886	Perth Amboy, NJ	Lehigh Valley	Creosote		
	Built to treat piles and timbers, but they did treat a few experimental ties. They closed the plant in the latter part of 1898, and subsequently leased it to the Hasselmann Co., which probably began to treat wood by the Hasselmann process in 1901. After 1902 this plant does not appear in the lists.				
1888	New Orleans, LA	New Orleans Wood Preserving Co.	Creosote	Pine	1
1889	Oakland, CA	Southern Pacific	Creosote	Pine, etc.	2
1890	Perth Amboy, NJ	U.S. Wood Preserving Co.	Creo-resinate	Pine, etc.	4
	Treated mainly paving blocks.				
*1891	Houston, TX	Southern Pacific	Burnett	Pine, etc.	5
1892	Galveston, TX	Galveston Creosoting Co.	Creosote	Pine	1
1893	Bay City, MI	Michigan Pipe Co.	Creosote?		1
*1894	California & Oregon	Southern Pacific	Burnett	Pine, etc.	2
	Portable plant.				
1895	Lowell, WA	Puget Sound Wood Preserving Co.	Creosote	Pine, fir	2
	This plant also included a non-pressure open tank facility for boiling poles in creosote.				
1896	Buell, VA	Norfolk Creosoting Co.	Creosote	Pine, etc.	4

Year Built	Location	Company	Process	Primary Wood	No. of Retorts
1896	Indianapolis, IN	Republic Creosoting Co.	Creosote		1
*1897	Somerville, TX	Texas Tie & Lumber Co.	Wellhouse	Pine, etc.	6
	Treated ties for the Santa Fe beginning late 1897 or early 1898. Treated Rock Island ties beginning 1900. In 1902 supplied 500 ties to the Milwaukee Road for a test section.				
*1897	Beaumont, TX	International Creo. & Constr. Co.	Various	Pine, etc.	1
*1898	Bellemont, AZ	Atchison, Topeka & Santa Fe	Wellhouse	Pine, etc.	2
1898	Newark, NJ	American Creosoting Co.	Creosote	Pine	4
*1899	Mt. Vernon, IL	Chicago Tie Preserving Co.	Wellhouse	Black oak	1
	Portable plant. Treated Chicago & Eastern Illinois ties, as well as ties for other railroads.				
*1899	Edgemont, SD	Chicago, Burlington & Quincy	Burnett	Pine, etc.	2
	Plant moved to Sheridan, WY in 1901. At least to 1903, one month was set aside each year for treating ties by the Hasselmann process.				
*1901	Greenville, TX	Missouri, Kansas & Texas	Wellhouse	Pine, gum	3
*1901	Somers, MT	Great Northern	Wellhouse	Pine, etc.	4
	Plant opened early 1902. They switched to the Burnett process in 1903.				
*1901	Aguas Calientes, Mex.	Mexican Central	Wellhouse		2
1901	Norfolk, VA	Atlantic Creo. & Wood Pres. Co.	Creosote	Pine	3
*1902	Texarkana, AR	International Creo. & Constr. Co.	Burnett	Pine	2
	About half the sources say Texarkana, TX and half Texarkana, AR. In 1904 & 1908 the process is listed as "various". In 1909 Allardyce, Burnett, and Bethell.				
*1902	Alomogordo, NM	Alomogordo Lumber Co.	Wellhouse	Pine	2
	Probably opened 1903. Treated ties for the El Paso & Southwestern.				
*1902	Rawlins, WY	Union Pacific	Wellhouse	Pine	2
	Portable plant.				
1902	Southport, LA	American Creosote Works	Creosote	Pine	2
	Labrot process.				
*1902	Texarkana, TX	Southern Tie & Timber Treating Co.	Burnett	Pine	1
	Another retort was added between 1904 and 1908. The Bethell process is also listed in 1910.				
*1903	Carbondale, IL	Ayer & Lord	Creosote, Burnett	Oaks	6
	Another retort added 1904. Treated Illinois Central and Rock Island ties by the Burnett process. At least 1903 they supplied Burnett treated ties to the CB&Q, and possibly also to Grand Trunk.				
*1903	Escanaba, MI	Chicago & North Western	Wellhouse	Pine	3
*1903	Laramie, WY	Union Pacific	Burnett	Pine	2
*1903	Wyeth, OR	Oregon RR & Navigation Co.	Burnett	Pine, fir	2
	Portable plant. The ORR&NCo. was owned by Oregon Short Line.				
1903	Minneapolis, MN	Republic Creosoting Co.	Creosote		2
*1904	Grenada, MS	Ayer & Lord	Creosote, Burnett	Pine	2
	Treated Illinois Central ties.				
*1904	Terre Haute, IN	Chicago Tie Preserving Co.	Wellhouse	Black oak	1
*1904	Paris, IL	Chicago Tie Preserving Co.	Wellhouse	Various	2
	Zinc-creosoted ties were treated here 1904-1905 (and possibly later) for the Big Four Route.				
*1904?	Alamosa, CO	Denver & Rio Grande	Burnett or Wellhouse		3
1904	Eagle Harbor, WA	Pacific Creosoting Co.	Creosote	Fir	8
*1904	Chihuahua, Mexico	Chihuahua & Pacific	Burnett or Wellhouse		2

[ASCE 8-85, 247ff] [AREA '01, 107] [RG 3-21-02, 203] [AREA '04, 75] [AREA '08, 737] [AREA '10, 762] ['10, 138-140] ['11, 212-213] ['12, 284-286] ['13, 199, 448-460]

A * indicates a plant which treated ties regularly. Note that sometimes the year of construction is the year before the plant went into operation.

Table III. Railroads adopting zinc chloride

Railroad	Year commenced	Process	
Santa Fe	1885	Wellhouse	Four divisions
Rock Island Lines	1886	Wellhouse	
Southern Pacific	1887	Burnett	Atlantic System
Southern Pacific	1894	Burnett	Pacific System
Santa Fe	1898	Wellhouse	Majority of divisions
Chicago & Eastern Illinois	1899	Wellhouse	
Chicago, Burlington & Quincy	1899	Burnett	Western lines
Great Northern	1899	Wellhouse	Western lines (Maybe Burnett 1899-1901)
Chicago & Alton	1900	Burnett	
Big Four Route	1901	Wellhouse	
Missouri, Kansas & Texas	1901	Wellhouse	
Mexican Central	1901	Wellhouse	
Colorado & Southern	1902	?	
Milwaukee Road	1902	Burnett	Dakotas to Missouri
El Paso & Southwestern	1902/03	Wellhouse	
Chicago & North Western	1903	Wellhouse	
Illinois Central	1903	Burnett	
Oregon RR & Navigation Co.	1903	Burnett	
Union Pacific	1903	Burnett	
Denver & Rio Grande	1903/04	?	
Toledo, St. Louis & Western	1905	Burnett	
Wheeling & Lake Erie	1906	Burnett?	
Missouri Pacific	1911	Burnett	

The following switched to the Burnett process: Santa Fe (1901), GN (1903), MK&T (1903), Rock Island (1903?), and C&EI (1906). In 1906 the Mexican Central was considering switching.

Table IV. Railroads adopting empty-cell creosoting up to 1915

Lowry process		Rueping process	
Big Four Route	1905	Santa Fe	1906
Rock Island Lines	1907	El Paso & Southwestern	1906
Chicago & Eastern Illinois	1907	Illinois Central	1907
Frisco Lines	1907	Rock Island Lines	1908
Northern Pacific	1907	Missouri, Kansas & Texas	1909
Monon Route	1907/08	Pennsylvania	1909
Lake Shore & Michigan Southern,		Charlotte Harbor & Northern	1912
Michigan Central	1909	Central of Georgia	1915 or earlier
Kansas City Southern,		Pittsburgh & Lake Erie	1915 or earlier
International & Great Northern,			
Texas & Pacific	1910		
Delaware, Lackawanna & Western	1910		
Lehigh Valley	1910		
New York Central	1911		
New Orleans Great Northern	1912		
Chesapeake & Ohio	1915		

(Railroads grouped together acquired ties from the same plant.)

Table V. Railroads adopting zinc-creosote

Big Four Route	1904	Rütgers	Used to 1905, possibly to 1910
Cotton Belt Route	1905?		
Chicago & North Western	1908	Card	
Chicago, Burlington & Quincy	1908	Card	Eastern lines
Milwaukee Road	1908	Card	Eastern lines, possibly only to 1916
Baltimore & Ohio	1908/11	Card	

Table VI. Railroads adopting the Bethell process of creosoting

Oregon RR & Navigation Co.	1906	
New York, New Haven & Hartford	1906/07	
Indianapolis, Columbus & Southern Traction	1909	Low pressure
Buffalo, Rochester & Pittsburgh	1910	
Butte, Anaconda & Pacific	1910	
Rochester, Syracuse & Eastern	ca. 1911	
Central RR of New Jersey / Reading	1912	
Canadian Pacific	1912	

This list is possibly very incomplete. Perhaps many other electric railroads treated ties by the Bethell process.

Table VII. Railroads adopting creosote, process unknown

Fort Worth & Denver City	1907	Probably Rueping
Erie	1910	Probably Rueping
Louisville & Nashville	1910	Bethell?
Atlantic Coast Line	1912/13	Rueping or Bethell

Table VIII. Railroads which did not begin using creosote until the 1920's

Railroad	Adopted creosote	Process used until then
Baltimore & Ohio	1921/27	Card
Missouri Pacific	1922	Burnett
Southern Pacific	1923	Burnett
Great Northern	1924?	Burnett
Milwaukee Road	1924/27	Burnett & Card
Union Pacific	1927	Burnett
Chicago, Burlington & Quincy	?	Card & Burnett

Table IX. Methods of dating ties other than date nails

Central RR of New Jersey	1875-1876	Stamps	Test section
Santa Fe	1881-1882	Brass tags	Test sections
Allegheny Valley	1883-1887	Notches	All ties
Santa Fe	1885-1900	Stamps	All treated ties
Southern Pacific	1887-1909+	Stamps	All treated ties
Big Four Route	1892/3-ca. 1895/6	Stamps	All ties?
Lake Shore & Michigan Southern	1893-1900+	Stamps	All ties
Michigan Central	1893 up	Stamps	All ties?
Rock Island Lines	1895-1904+	Stamps	All treated ties
Peoria & Eastern	1898 (-1902?)	Stamps	All ties?
Chicago & Eastern Illinois	1899 up	Stamps*	All treated ties
Chicago, Burlington & Quincy	1899 up	Stamps*	All treated ties
New York Central	1901-1910	Notches	All treated ties?
Great Northern	1902-1903+	Stamps*	All ties?
Pere Marquette	1902-1911	Notches	All ties?
Milwaukee Road	1906-1908	Lead tags	All treated ties
Milwaukee Road	before 1913	Common nails	Test sections
Louisville & Nashville	1910-1920	Common nails	All (treated?) ties
New York Central	1912-1921	Notches	Untreated ties
Missouri, Kansas & Texas	±1914	Stamps*	All treated ties?

This table is probably very incomplete. Not included here are stamps made by automatic boring & adzing machines. "±" indicates that the marks were in use in the year indicated, and were probably used in years before and after. "+" indicates that the use of the marks could have persisted later. "*" indicates that the marks were used in conjunction with date nails.

Table X. The first railroads to use date nails

1897	Mississippi River & Bonne Terre	1906	St. Louis, Rocky Mountain & Pacific
1899	Great Northern	1907	New York, New Haven & Hartford
	Chicago & Eastern Illinois		Northern Pacific
	Chicago, Burlington & Quincy	1908	Frisco Lines
	Pittsburgh & Lake Erie		Milwaukee Road
1901	Big Four Route		Monon Route
	Missouri, Kansas & Texas		St. Louis, Iron Mountain & Southern
	Santa Fe	1909	Pennsylvania (had used nails also ca. 1904/05)
1902	Baltimore & Ohio		Tonopah & Goldfield
	Rio Grande, Sierra Madre & Pacific*	1910	Buffalo, Rochester & Pittsburgh
1903	Cotton Belt Route*		Delaware, Lackawanna & Western
	El Paso & Southwestern		Erie
	Long Island*		Kansas City Southern
	Southern Pacific*		Lehigh & Hudson River
	Union Pacific		Lehigh Valley
	Wabash		New York Central
1904	Rock Island Lines		Texas & Pacific
1905	Chicago & North Western		
	Oregon Short Line		
	Salt Lake Route		

*may have begun nail use earlier

I have sketchy information on other railroads. The Michigan Central was using nails before 1912, and the Lake Shore & Michigan Southern about 1910/11. It is likely that the Wabash quit using nails after 1905. This table is very incomplete, but is reliable for the major railroads.

Table XI. Railroads which established CB&Q-style test sections

Railroad	Stopped using nails	Test sections	Started using nails
Chicago, Burlington & Quincy	1909	1909	1928
Santa Fe	1910	1910	1921
Union Pacific	—	1910?	—
Great Northern	1911	1911	1924
Baltimore & Ohio	—	1911	—
Cotton Belt Route	?	1911	?
Chicago & Eastern Illinois	1910	1912	—
Illinois Central	1911?	1912?	1930, 1950
Atlantic Coast Line	—	1913	1930
Frisco Lines	1910	1914	—
Monon Route	1910	1914	—
Chicago & North Western	1913	1914	1923
Rock Island Lines	1913?	1914	—
Chicago & Alton	1913	1914/15	—
Pennsylvania	1911	1919	1924/25?
Northern Pacific	1918 or 1921	1919	—
Milwaukee Road	1910	—	1927
El Paso & Southwestern	1911	?	—
St. Louis, Iron Mountain & Southern	1911	?	—

"Stopped using nails" is the last year the railroad used nails in all treated ties. It was common for these railroads to continue to use date nails in test sections.

"Test sections" is the year the railroad instituted CB&Q-style test sections. Installations may have continued past the indicated year.

"Started using nails" is the year the railroad began again to use nails in all treated ties. A "—" indicates the railroad did not stop/start again using nails. A "?" indicates that I do not know if the event occured.

The Illinois Central began using nails in switch ties in 1930, and in all crossties in 1950.

Table XII. Railroads which did not stop using nails in the teens.

Big Four Route	New York Central
Buffalo, Rochester & Pittsburgh	New York, New Haven & Hartford
Delaware, Lackawanna & Western	Oregon Short Line
Kansas City Southern	Salt Lake Route
Lehigh & Hudson River	Southern Pacific
Lehigh Valley	Union Pacific

Railroads which might not have stopped using nails:

Colorado & Southern	Erie
Cotton Belt Route	Louisville & Nashville

This table is possibly very incomplete.

Table XIII. Twentieth century miscellaneous tests
(p) indicates a process, (c) indicates a chemical.

Carbolineum (c) (see also Table I, page 65, for other tests.)

ca. 1897-1903	Boston Elevated
1900-1903	Honolulu Rapid Transit
1905	Mexican Central
1905	Santa Fe (Pelican, TX test)
1908	Oregon-Washington Ry & Navigation Co.
1913-1914	Soo Line

Barshall salts (c) by the Hasselmann process

1902	Santa Fe (Pelican test)
1902-1903	Chicago, Burlington & Quincy

Allardyce (p)

1902	Santa Fe (Pelican test)
1902	Chicago & Eastern Illinois
1904	Kansas City Southern
1904	Chicago, Burlington & Quincy
1905	Chicago, Burlington & Quincy (U.S. Government test)
1905, 1911	Cotton Belt Route

(The Galveston, Harrisburg & San Antonio (SP) experimented with a similar process in 1894 and 1905-1907.)

Crude oil (c) [AREA '09, 472-474]

1902	Santa Fe (Pelican test)
1907	Mexican Central

Zinc chloride-crude oil emulsion (p) ['24, 160ff]

1902	Santa Fe (Pelican test)
1906	Southern Pacific
1914-1915	Houston East & West Texas
1915, 1917	Santa Fe

Diamond glue preservative (c)

1902	Santa Fe (Pelican test)
1907	Galveston, Harrisburg & San Antonio

Giussani (creosote) (p)

1905	Chicago, Burlington & Quincy (U.S. Government test)
1905	Frisco Lines
1905	Mexican Central

Cresol-calcium (c)

1910	Forest Products Lab (Tennessee Coal Iron & RR)
1910	Illinois Central

Water gas tar (c) ['21, 118]

1910-1914+	Public Service Railway Company of New Jersey
1914-1919	Baltimore & Ohio
ca. 1914+	Chicago, Burlington & Quincy
ca. 1914-1920	Pennsylvania
ca. 1914+	Reading
ca. 1914	Chicago & North Western
1917	Forest Products Lab (Milwaukee Road)
1927-1928	Baltimore & Ohio

Sodium fluoride (c)

1906	Southern Pacific ("zinc-fluoride")
1914	Baltimore & Ohio
1917	Forest Products Lab (Milwaukee Road)
1924-1925	Forest Products Lab (Milwaukee Road)

Cresoil (c)

1915	Milwaukee Road
1915	Spokane, Portland & Seattle
1924	Great Northern

Zinc-meta-arsenite (c)

1928	Forest Products Lab (Milwaukee Road)
1929	Chicago, Burlington & Quincy
1929	Illinois Central
1930	Canadian National
1932+	Great Northern

Penta (c)

1947	Union Pacific
1948	Illinois Central

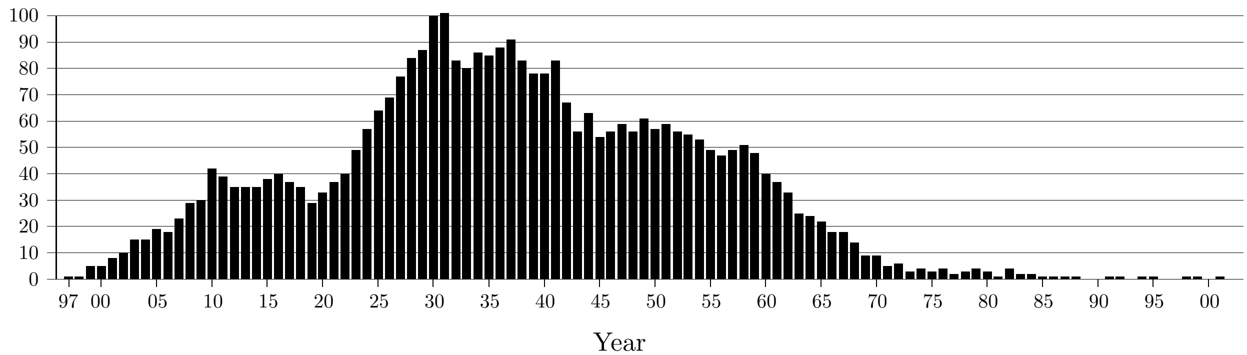
Chemicals and processes recorded for only one railroad

1901	Creo-resinate (p)	Pennsylvania
1902	Spirittine (c)	Santa Fe (Pelican, TX test)
1909	Spaulding (p)	Oregon Ry & Navigation Co.
1909	Asphaltic crude oil (c)	Indianapolis, Columbus & Southern Traction
1910	J. M. Long's Liquid (c)	Illinois Central
1911	Timber asphalt (c)	Baltimore & Ohio
1911	Semi-refined oil (c)	Forest Products Lab (Milwaukee Road)
1911	Mercuric chloride (c)	Forest Products Lab (Milwaukee Road)
1916	Gas oil (c)	Forest Products Lab (Milwaukee Road)
1917	Cecil Williams (p)	Baltimore & Ohio
1921	Pintsch gas-tar (c)	Forest Products Lab (Milwaukee Road)
1922	Aczol (c)	Forest Products Lab (Milwaukee Road)
1924-1925, 1927	$ZnCl_2$-fuel oil, two-step	Union Pacific
1925-1926	Basilit (c)	Forest Products Lab (Milwaukee Road)
1925-1926	Triolith (c)	Forest Products Lab (Milwaukee Road)
1927	Borax (c)	Forest Products Lab (Milwaukee Road)
1928	Arsenious acid (c)	Forest Products Lab (Milwaukee Road)
1928	Sodium dichromate (c)	Forest Products Lab (Milwaukee Road)
1929	Natural brine (c)	Forest Products Lab (Milwaukee Road)
1929	Wolman salts (c)	Illinois Central

Table I. Early tie treating experiments

Railroad	Date	Chemical	Process
South Carolina	1830-33	Tar & Turpentine	
South Carolina	1838-41	$HgCl_2$	Kyan
South Carolina	ca. 1838-42	$CuSO_4$ & $FeSO_4$	Earl
Northern Central	1838	$HgCl_2$	Kyan
Louisa	1840	$HgCl_2$	Kyan
Philadelphia & Columbia	1840	Lime	
Baltimore & Ohio	1842	$HgCl_2$	Kyan
Boston & Providence	1844	$HgCl_2$	Kyan
Old Colony	1845	$HgCl_2$	Kyan
Eastern	1846	$HgCl_2$	Pressure
Providence & Worcester	1847	$HgCl_2$	Kyan
New York Central	1849	$HgCl_2$	Kyan
Baltimore & Ohio	1850	Lime	Open tank
Belvedere Deleware	1850	Salt	
Reading	1851	$HgCl_2$	Kyan
Reading	1852	Tar	
Reading	1854	Coal tar	No pressure
Union RR of Cambridge	1855	$ZnCl_2$	Burnett
Boston & Providence	1856	$HgCl_2$	Kyan
Vermont Central	1856-59	$ZnCl_2$	Burnett
Boston & Albany	1860	$ZnCl_2$	Burnett
Erie (mostly bridge timbers)	1861-69	$ZnCl_2$	Burnett
Philadelphia, Wilmington & Baltimore	1863-?	$ZnCl_2$	Burnett
Union Pacific	1865-66	$ZnCl_2$	Burnett
Rock Island Lines	1866	$ZnCl_2$	Burnett
Reading	1867	$ZnCl_2$	Burnett
Lehigh & Susquehanna	1867-68	$ZnCl_2$	Burnett
Lehigh & Susquehanna	1867-68	Semi-refined oil	
Chicago, Burlington & Quincy	1868-69	Creosote	Seeley
Hudson River	1869	$FeSO_4$ & $CuSO_4$	Hamar
Cleveland, OH	1870	$CuSO_4$	Thilmany ['16, 328]
Memphis & Charleston	1871	Salt, arsenic, $HgCl_2$	Foreman
Chicago & North Western	1871	Salt, arsenic, $HgCl_2$	Foreman
Illinois Central	1871	Salt, arsenic, $HgCl_2$	Foreman
Rock Island Lines	1872	Creosote	Seeley
Central RR of New Jersey	1875-76	Creosote	Hayford
Central RR of New Jersey	1875/76	Petroleum	
Central RR of New Jersey	1875/76	$ZnCl_2$	Burnett
Houston & Texas Central	1877	Creosote	Bethell
Wabash	1877-78	$CuSO_4$	Thilmany
Reading	1878	Creosote	Hayford
Boston & Providence	1878	Creosote	Hayford
Louisville & Nashville	1878	Creosote	Bethell
Louisville & Nashville	1879	Creosote	Bethell
Central RR of New Jersey	1879	Creosote	Bethell
Baltimore & Ohio	1879	$CuSO_4$	Thilmany
Lake Shore & Michigan Southern	1879	$CuSO_4$	Thilmany
New York, Pennsylvania & Ohio	1879	$CuSO_4$	Thilmany
Pennsylvania	1879	$CuSO_4$	Thilmany
St. Louis, Iron Mountain & Southern	1879	Zinc tannin	Wellhouse
Illinois & St. Louis	1880	Zinc tannin	Wellhouse

Histogram I. Number of railroads using date nails, 1897-2001.



This histogram was generated by a computer program which took the railroad listings as input. If I know from documentation that a particular railroad used nails, say, in 1899, but none have been found, I added it to the data. If a railroad used several different nails in a particular year it still counts as one. Naturally nails from second hand ties and from other timbers are not included.

Several trends in tie preservation and record keeping can be seen in the histogram:

— The use of date nails follows pretty closely the rise in use of treated ties beginning 1899. This is consistent with the AREA recommendation that date nails be used.

— After 1910 there is a decline in nail use due to Angier's recommendation to concentrate records in test sections. The histogram includes even railroads which used nails only in test sections, making the drop remarkable.

— The creosote shortage due to World War I can be seen in the dip in nail use the late teens.

— After the war the rapid adoption of tie treating, along with the return to favor of date nails is seen in the steep rise in nail use.

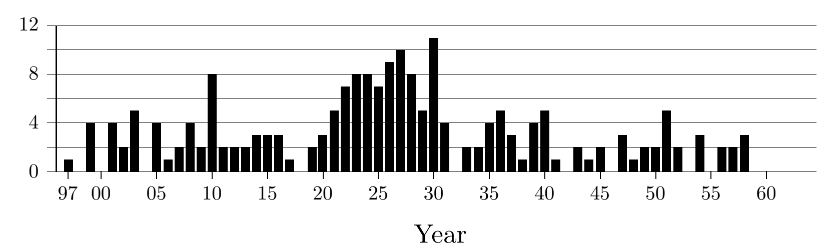
— There is a decline after 1931 due to the depression.

— A further decline can be seen because of World War II. Metals were being used more for military purposes.

— The long decline in nail use after 1959 is probably due to a good knowledge by railroads of the best woods and treatments to use, and by the reliance on stamps in the ends of ties for record keeping.

— By the time the Texas Date Nail Collectors' Association was formed in 1970, nail use was at a minimum.

Histogram II. Number of railroads starting the use of date nails, 1897-1958.



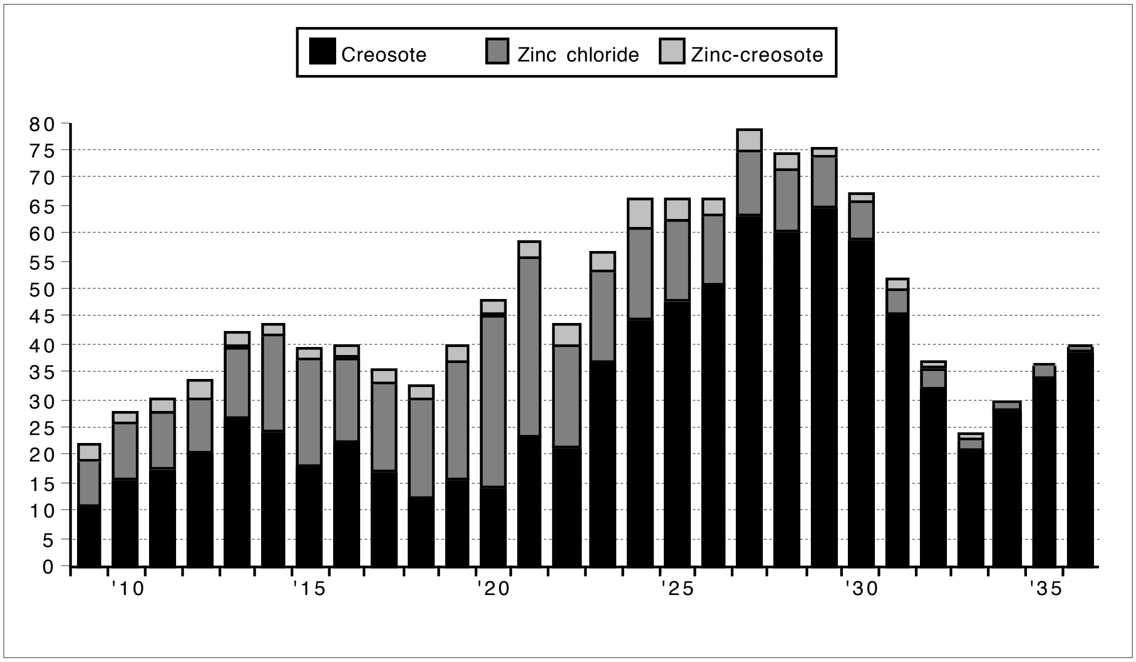
If a railroad stopped using nails, and started again a few years later, both dates are included. For example, the Lehigh Valley began using date nails in 1910, they stopped in 1921, and began again in 1940. The LV contributes to the 1910 and 1940 totals. The gap in LV nails for 1918 is not considered.

Again, I consider documentation, not just nail finds. The C&EI began using nails in 1899, though none have been found yet. I count the 1899 date.

The total for 1910 is high partly because several NY and PA lines began using nails that year.

Note: I only updated 1897-1910 with this printing. Its basic shape is reliable.

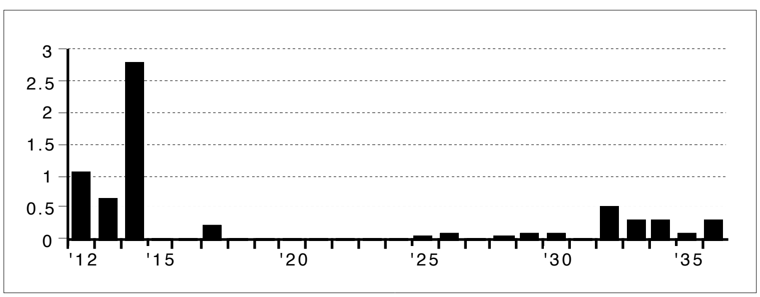
Histogram III. Treated ties installed in the U.S. by the three major processes, 1909-1936.



This histogram shows, in millions of ties, the numbers of crossties treated by the three major methods which were installed in the U.S. in the period 1909-1936. Zinc-creosoted ties were last used in 1934, and zinc chloride was on the way out by the mid-1930's.[1]

The use of treated ties saw a new peak during World War II, but after that numbers declined so that by the 1960's annual installments were roughly 20,000,000.[2]

Histogram IV. Ties treated by miscellaneous processes, 1912-1936.



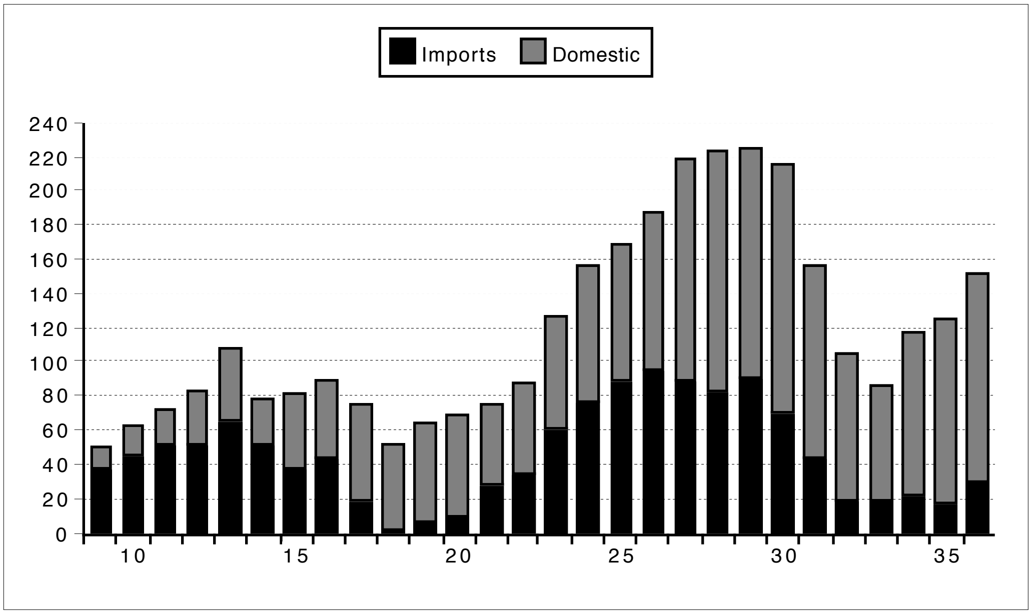
This histogram measures, in millions of ties, the number of ties treated by methods other than creosote, zinc chloride, and zinc-creosote. The 1914 peak represents the use of water gas tar. The higher figures beginning 1932 represent mainly installations of ties treated with zinc-meta-arsenite (ZMA).[3]

1 [H&G, 434-436]

2 [RA 5-86, 44]

3 [H&G, 436]

Histogram V. U.S. creosote consumption in millions of gallons, 1909-1936.



The dip in the late teens in creosote imports was caused by World War I. The dip in the early 1930's was probably caused by the depression.

Sources

Most statements are referenced by source and page number. When you see [DNC, 211], you should read "*Date Nails Complete*, page 211." [J-A '78, 2] means "The July-August 1978 issue of *Nailer News*, page 2". My notation, with square brackets, is not standard. I adopted it for my own use long ago, and if there is enough interest in the book, I will change it.

The sources are:

— — **Books** — —

[AS&W] American Steel & Wire Co., *Manual of Carpentry and Catalogue of American Nails, Wire[,] Barbed Wire [and] Staples.* March, 1923.

[B&O] *The Catalogue of the Centenary Exhibition of the Baltimore & Ohio Railroad 1827-1927*, second edition. Baltimore: Waverly press, 1927.

[Bethell] John Bethell, *Rendering Wood, Cork, and Other Articles More Durable, &c.* 1832. "London: Printed by George Edward Eyre and William Spottiswoode, printers to the Queen's most Excellent Majesty. 1857." Reprinted in *Pioneer Work in Wood Preservation: Bethel [sic] Boulton Chanute. Commemorating the Twenty-fifth Anniversary of the Founding of the American Creosoting Company.* Louisville, KY(?): 1929.

[Boulton] Sir Samuel Bagster Boulton, *The Antiseptic Treatment of Timber. A Paper Read before the Institution of Civil Engineers, 6th May, 1884, with an Abstract of the Discussion Thereon. With an Introduction by the Author Dated 10th December, 1909.* London: 1910. Reprinted in *Pioneer Work in Wood Preservation: Bethel Boulton Chanute. Commemorating the Twenty-fifth Anniversary of the Founding of the American Creosoting Company.* Louisville, KY(?): 1929.

[Camp] Camp, W. M., *Notes on Track: Construction and Maintenance.* Chicago: 1903.

[Cronin] Cronin, James E., *Hermann von Schrenck: A Biography.* Chicago: Kuehn, 1959. I discovered this book only in 2002, so I have made only superficial use of it. It makes for wonderful reading to compliment my History of Railroad Tie Preservation.

[DNC] Glenn Wiswell and John Evans, *Date Nails Complete.* WESIS Publications, 1976. This was the best book on date nails for over twenty years. The history of nails was hastily put together, and the list of nails used by each railroad is incomplete and error-ridden, but Wiswell and Evans did a fantastic job in organizing the nails by steel company, aided by shank markings. This made the identification of nails possible. Also, they have to be given credit for having put the book out in such a short time.

[Edson] William D. Edson, *Railroad Names: A Directory of Common Carrier Railroads Operating in the United States 1826-1992.* Third edition, revised March, 1993. From this book I took most of the creation, merger and abandonment dates.

[Goltra] William F. Goltra, *Some Facts about Treating Railroad Ties.* J. B. Savage Co.: Cleveland, OH, 1912-1913. This book is comprised of six parts:

[Goltra I] *Some Facts about Treating Railroad Ties.* 1912. This continues in [Goltra II].

[Goltra II] *Improved Method of Treating Ties and Timbers: Goltra Process.*

[Goltra III] *Essentials for Effective Work in Timber Treatment.* 1913.

[Goltra IV], [Goltra V], and [Goltra VI] are untitled. All were published in 1913.

[Graham] R. D. Graham, "History of Wood Preservation." in Darrel D. Nicholes, ed., *Wood Deterioration and its Prevention by Preservative Treatments*, Volume I. Syracuse University Press, 1973.

[GRB] Dr. H. Broese van Groenou, H. W. L. Rischen, and Dr. J. van den Berge, *Wood Preservation during the Last 50 Years.* Leiden (Holland): A. W. Sijthoff's Uitgevers-maatschappij N.V., 1951.

[H&G] George M. Hunt and George A. Garratt, *Wood Preservation.* New York: McGraw-Hill, 1938.

[HWP] American Wood-Preservers' Association, *Hand Book on Wood Preservation.* Baltimore: AWPA, 1916.

[Lewis I] Joseph W. Lewis, *Date Nails, Brought Up to Date.* Nacogdoches, TX: P&G Press, 1973. Lewis took photographs of people's nail collections by railroad, and published them in this book. There is virtually no text. He is not responsible for the numerous errors in many sets.

[Lewis] Joseph W. Lewis, *Date Nails Brought up to Date*, Volume II. Nacogdoches, TX: Lewis Enterprises, 1975. This is really the second edition of [Lewis I], and like its predecessor, contains primarily photos. Also like [Lewis I], it has many mistakes, but it is far more complete.

[MOWC] *Maintenance of Way Cyclopedia.* New York: Simmons-Boardman Co., 1921.

[Rowe] Samuel McMath Rowe, *Hand Book of Timber Preservation*, Souvenir Edition, revised. Chicago: Pettisbone, Sawtell & Co., 1904. Many items in this book are dated after 1904. The latest is a drawing from January 2, 1907.

[RS&E] William R. Gordon and James R. McFarlane, *The Rochester Syracuse and Eastern: "Travelectric", 1906-1931.*

[SCR] Samuel Melanchthon Derrick, *Centennial History of South Carolina Railroad.* Columbia, SC: The State Company, 1930.

[Shaw] Kenneth B. Shaw, *And Now it's Nail Time.* 1971. This is the first fairly comprehensive book on date nails. Shaw shows many railroad sets, and he even collected information from old railroad engineering journals. Unlike Lewis, Shaw *is* responsible for his mistakes, which occur on almost every page.

[Trat I] E. E. Russell Tratman, *Report on the Substitution of Metal for Wood in Railroad Ties, Together with a discussion on Practicable Economies in the use of Wood for Railway Purposes by B. E. Fernow, Chief of Forestry Division.* Bulletin No. 4, U.S. Department of Agriculture, Division of Forestry. Washington: Government Printing Office, 1890. Tratman submitted this work for publication January 31, 1890.

[Trat II] E. E. Russell Tratman, *Report on the Use of Metal Ties and on Preservative Processes and Metal Tie Plates for Wooden Ties.* Bulletin No. 9, U.S. Department of Agriculture, Division of Forestry. Washington: Government Printing Office, 1894.

[Wallis-Tayler] A. J. Wallis-Tayler, *The Preservation of Wood: A Descriptive Treatise on the Processes and on the Mechanical Appliances used for the Preservation of Wood.* New York: D. van Nostrand & Co., 1916(?).

[Watkins] J. Elfreth Watkins, *The Development of the American Rail and Track, as Illustrated by the Collection in the U. S. National Museum.* Washington: Government Printing Office, 1891.

[Weiss] Howard F. Weiss, *The Preservation of Structural Timber*, second edition. New York: McGraw-Hill, 1915.

[Williams] John Hoyt Williams, *A Great and Shining Road: The Epic Story of the Transcontinental Railroad.* New York: Times Books, 1988.

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[AREA] American Railway Engineering & Maintenance of Way Association (later the American Railway Engineering Association), *Proceedings of the Annual Convention*. Chicago.

[ASCE] *Transactions* of the American Society of Civil Engineers. New York. Specifically I referred to the following:

[ASCE 7-85] Octave Chanute (and Committee), "The Preservation of Timber: Report of the Committee on the Preservation of Timber, Presented and Accepted at the Annual Convention June 25th, 1885."

[ASCE 8-85] "The Preservation of Timber: Appendix to the Report of the Committee."

[ASCE 9-85] "Discussions. On the Report of the Committee on the Preservation of Timber, and on the Preservation of Forests. At the Annual Convention of the Society, June 24th, 1885."

[ASCE 6-01] Octave Chanute, "The Preservation of Railway Ties in Europe." October 17, 1900.

[ERJ] *Electric Railway Journal*. New York.

[e-NN] *Nail Notes*. An e-mail newsletter originally edited by myself, and now by Rolland Meyers. Back issues are available at:
http://facstaff.uindy.edu/~oaks/Resources.htm#NailNotes.

[R&ER] *The Railway and Engineering Review*. Chicago.

[RA] *Railway Age*. Chicago. In 1910 *Railway Age* and *Railroad Gazette* merged to form *Railway Age Gazette*. At a later date the name changed to *Railway Age*, which is published in Bristol, CT.

[RAG] *Railway Age Gazette*. New York.

[RG] *Railroad Gazette*. New York.

[RR] *The Railway Review*. Chicago.

[W-P] *Wood-Preserving*. Baltimore.

[WPB] *Wood Preserver's Bulletin*. Baltimore.

[WPN] *Wood Preserving News*. Washington.

[WSE] *The Journal of the Western Society of Engineers*. Chicago.

['14, 23] *Proceedings of the Annual Meeting of the American Wood-Preservers' Association*. Chicago. Until 1911 the organization was called the Wood Preservers' Association. References indicate the year and page only. For example, ['14, 23] refers to page 23 of the 1914 volume.

[S-O '80, 2], [Summer 2000, 15] *Nailer News*, the (originally) bimonthly magazine published by the Texas Date Nail Collectors' Association, is indicated by the months and year, with page numbers. "J-F" = January-February, "M-A" = March-April, etc. [S-O '80, 2] refers to page 2 of the September-October 1980 issue. Since 1999 it has been issued quarterly: Winter, Spring, Summer, Fall.

— — Papers — —

[C&NW] *Annual Report of Chicago and North Western Railway Company and Transportation Subsidaries to the Interstate Commerce Commission for the Year Ended December 31, 1967*. I have photocopies of pages 98 and 505. From Jerry Penry's collection.

[CB&Q 1] "Standard Practice Circular No. 22: Rules for Marking, Caring for and Inspection of Experimental Ties." A single typeset sheet with "Effective June 1st, 1930" typed by hand below the title. From Arn Kriegh's collection.

[CB&Q 2] Three track elevation diagrams, covering Edgemont, SD, Orin Jct., WY, and Crawford, NB. Revised 8-12-57. From Arn Kriegh's collection.

[CB&Q 3] "C.B.&Q.R.R. Co. Standard Adzing & Boring Templet for Ties for 100 to 131 lb. Rail" December 31, 1954. From Arn Kriegh's collection.

[NH] A two-page copy of a 1970 document titled "Standing Data NHRTI 10.1.1" which describes the 1922 Montowese, CT plant leased to the New York, New Haven & Hartford. Each page also reads "Copyright 1970 by NHRTIA, Inc." From John Iacovino's collection.

[SFe] A five-page document on Santa Fe date nails prepared in 1969 or later by someone who had access to Santa Fe records. The paper resides in the Sharlot Hall Museum in Arizona.

[Wiswell 77] Glenn Wiswell, co-author of *Date Nails Complete*, issued lists of nails for sale from 1977 to 1983. These contain much useful information not found in [DNC]. [Wiswell 81] is from the 1981 list. [Wiswell 80s] is from the supplement to the 1980 list.

The website: http://facstaff.uindy.edu/~oaks/DateNailInfo.htm

Here you will find a vast, illustrated introduction to date nails, including all back issues of my free e-mail date nail newsletter *Nail Notes*. Contact me via e-mail at oaks@uindy.edu if you would like to subscribe, or if you have questions or comments on date nails or tie preservation. Also on the site I maintian errata for the book, so you can read up-to-date corrections.

Acknowledgements

The following people contributed much of the information you find in these pages. I hope they will continue their support, and that this list will continue grow. (The list is current only to 1998.)

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J. H. Steury
Kyle Vernon
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Dale White
John Wickowitsch
Steve Worboys
Duane Zimmerman

Union Pacific / OSL / SLR

2 1/2 × 1/4	rnd I	stl	(01)	04,05,5,5:b,07,12,15	
2 1/2 × 1/4	rnd I	stl	(18B)	4,5,6,6,08	
2 1/2 × 1/4	rnd I	stl	(18A)	5,07,08,8,09,10	
2 1/2 × 1/4	rnd I	stl	(07)	05,5,06,6,07,7,08,8,09:b,9,9,10,10:c,11-17,18:b,19-21	
2 1/2 × 1/4	sqr I	stl	(18)	10-13,13:b,14,15,19	
2 1/2 × 1/4	sqr I	stl	(07)	11,12,14-17,19,19:b,20	
2 1/2 × 1/4	rnd I	stl	( )	12	
2 1/2 × 1/4	rnd R GM	stl	(07)	12-20	
2 1/2 × 7/40	rnd R gm	stl	(07)	12-14,17-20	
2 1/2 × 7/40	rnd R	stl	(07)	15-17	
2 1/2 × 1/4	rnd I	stl	(14)	15	
1 1/2 × 1/4	rnd R	stl	(07)	15-19	
1 1/2 × 1/4	sqr R	stl	(07)	15-19	
2 1/2 × 1/4	rnd R	stl	(07)	16,17	
2 1/2 × 1/4	rnd I	stl	( )	17	
2 1/2 × 1/4	sqr R	stl	(07)	18-20	
2 × 11/40	rnd R	stl	(07)	20,21	
2 × 1/4	rnd I	stl	(07)	21	
2 1/2 × 1/4	sqr R	stl	(18)	21-28	
2 1/2 × 1/4	rnd R	stl	(18B)	21:b,31	
2 × 1/4	rnd R	stl	(07)	22,23,23:b,25,27,34,34:b,36	
2 × 1/4	rnd R	stl	(18A)	24-26,28	
2 × 1/4	rnd R	stl	(18B)	24-29,35	
2 × 1/4	rnd R	stl	(17)	29,29:b,30-33,36	
2 × 1/4	rnd R	stl	(18C)	64	

Pole nails

Some regular UP nails can be found in poles along the railroad.

Code nails

2 × 1/4	rnd R gm	stl	(07)	0-6,7-9	(Set #6)
2 1/2 × 1/4	rnd R gm	stl	(07)	0-9	(Set #15)
2 1/2 × 7/40	rnd R gm	stl	(07)	0,5,6,7,8	(Set #31)
2 1/2 × 7/40	sqr R rs gm	stl	(07)	9	(Set #31)
2 1/2 × 7/40	rnd R gm	stl	(07)	8	(Set #32)
2 × 1/4	rnd R GM	stl	(07)	A #4,B #7,C #14,F #8,G #5,L #3	
2 × 1/4	sqr R	stl	(18)	L #2,V #7	

Switch nails

See pages 135-138 of Volume III. There are too many types to legibly write here.

This is the combined list of nails found on the Union Pacific, Oregon Short Line, and Salt Lake Route. Though these lines probably used different nails before the early 1920's, collectors have mixed them up for so long that it is impossible to adequately separate them. Some have made the effort, and here are nails I have encountered as being from OSL or SLR, but not UP:

Oregon Short Line

2 1/2 × 1/4	rnd I	stl	(01)	05,5,07	
2 1/2 × 1/4	rnd I	stl	(18B)	6	
2 1/2 × 1/4	rnd I	stl	(07)	10:c	(Possibly also UP)
2 1/2 × 1/4	sqr I	stl	(07)	19:b	(Possibly also UP)

Salt Lake Route

2 1/2 × 1/4	rnd I	stl	(18A)	07,10
2 1/2 × 1/4	rnd I	stl	( )	17
2 1/2 × 1/4	rnd R	stl	(18B)	21:b

Many other nails in the combined list belong only to OSL or to SLR, but they cannot be identified. See OSL and SLR for possibilities. After about 1921 all three railroads used the same nails.

Corporate info

The UP owned the Oregon Short Line, the Oregon-Washington RR & Navigation Co., and the Los Angeles & Salt Lake (Salt Lake Route). The OSL was owned by UP before 1900, and trackage rights were granted to the UP July 1, 1909. Final integration took place on July 23, 1936. The OWRR&NCo. was created in 1910 from the Oregon RR & Navigation Co., the Oregon & Washington, the Idaho Northern RR, and the Ilwaco. OSL/UP owned all these lines before 1900. The OWRR&NCo., a subsidary of OSL, became part of the UP January 1, 1936.

The LA&SL was a subsidary of the OSL, and came under direct control of the UP in April, 1921. It was fully absorbed unto UP in January, 1936.

John M. Hoffmann wrote a short history of the UP which appears in [Oct '76, 4] and was reprinted in [J-F '86, 8]. Also, the first few pages of [S-O '80] give a nice history of the UP, with a description of the nail sets of UP, Oregon Short Line, and Salt Lake Route.

Early tie treating

The UP began its westward expansion in 1865, and they constructed a plant at Omaha which began operating that year treating ties with zinc chloride. Constuction of such a long railroad required more ties than the plant could handle, and what ties managed to fit the equipment were treated with too strong a solution, resulting in brittle ties. The plant was abandoned in 1866.

It was not until 1886 that the UP again attempted to treat large numbers of ties. In that year the UP's Laramie plant opened. It was built by Octave Chanute's Chicago Tie Preserving Co., which also built the Santa Fe's Las Vegas plant (1885) and the Rock Island plant at Chicago (1886). Ties, primarily pine, were treated by the Wellhouse process beginning July 26.

After treating over 200,000 ties, the plant was shut down for temporary economy in 1887. It burned shortly afterward, and was not rebuilt. UP officials did not believe that treatment would pay. [AREA '05, 776]

Burnettizing ties, beginning 1903

It was probably the combination of the rise in price of timber at the end of the nineteenth century, together with the success of the ties treated at Laramie in 1886-1887, which convinced officials to build a new plant. "As the then [1887] operating department had no faith in tie-treating, no records were kept of the ties in the track, but some years afterwards [in 1898] they were found to have outlasted several administrations and the present one has built another tie-treating plant on the site of the one dismantled at Laramie, Wyo., and it is to be expected that the records will show that it is obtaining good results." [AREA '05, 776][AREA '01, 106]

The new Laramie plant began treating ties with straight zinc chloride near the end of 1903. The UP built a portable plant which went into operation in 1902 at Rawlins, WY. It also treated ties with $ZnCl_2$. Burnettized ties on the UP were treated with .4 lb/ft^3. [WPN 8-51, 98]

The Rawlins plant was moved to North Topeka, KS in 1909, and it was dismantled in 1916.

Bridge piles on the UP were first treated with creosote beginning 1902, probably at the new portable Rawlins plant. [AREA '09, 619]

Consolidating track maintenance, 1921-1923

Up to 1921 the UP, Salt Lake Route, and Oregon Short line maintained their own track, operated their own treating plants, and individually determined which treatment to use. For example, the OSL (ORR&NCo.) used large numbers of full cell creosoted ties beginning 1906, treated at their Wyeth, OR plant, while the UP was using only zinc chloride. ['16, 293]['20, 100]

In the early 1920's the UP assumed control of ties on both the SLR and the OSL. The chronology of tie treating events is as follows:

- 1920 On December 10, in time for 1921 tie installations, the UP completely revises its dating nail standard.
- 1921 In April the UP assumes direct control of the SLR.
  The UP's Laramie plant is upgraded.

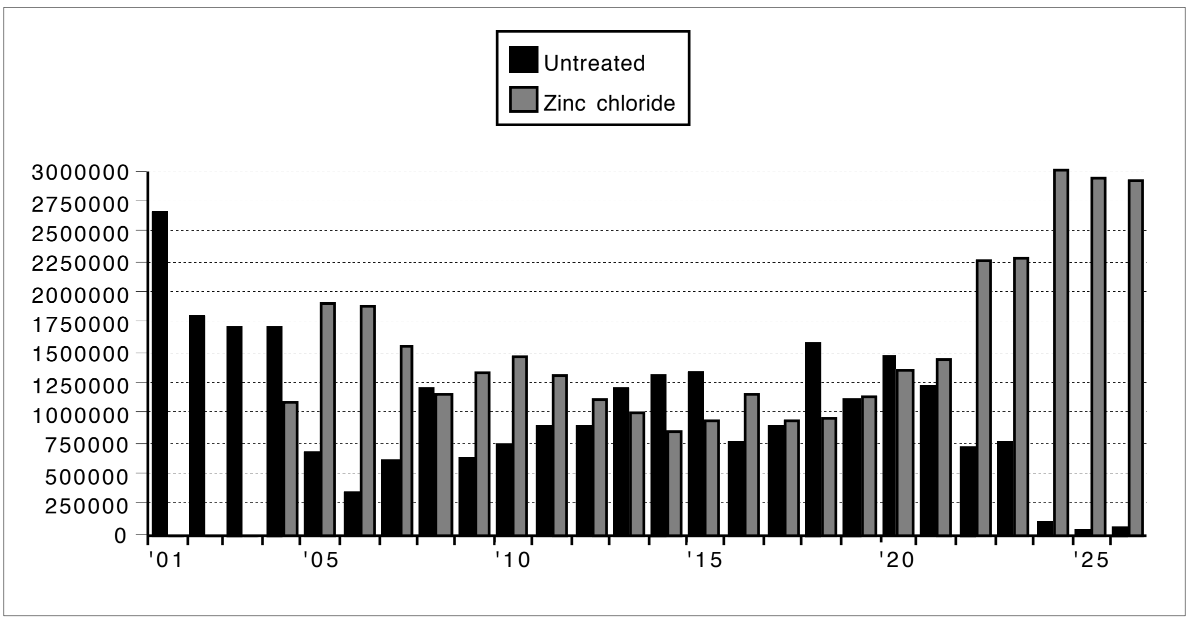
OSL builds its Pocatello, ID plant.
1921/22 UP assumes track maintenance of the SLR. [WPN 8-51, 100]
1922 OSL expands its Pocatello, ID plant.
1923 The UP assumes control of the OSL's treating plants.
UP moves the former OSL Wyeth, OR plant to The Dalles, OR.
UP abandons the Salt Lake Route's Zinc, CA plant.
Last year for large numbers of untreated ties on the UP.
1923-25 The UP establishes a series of comprehensive test sections on the OSL.
1924 The Laramie plant is again upgraded.

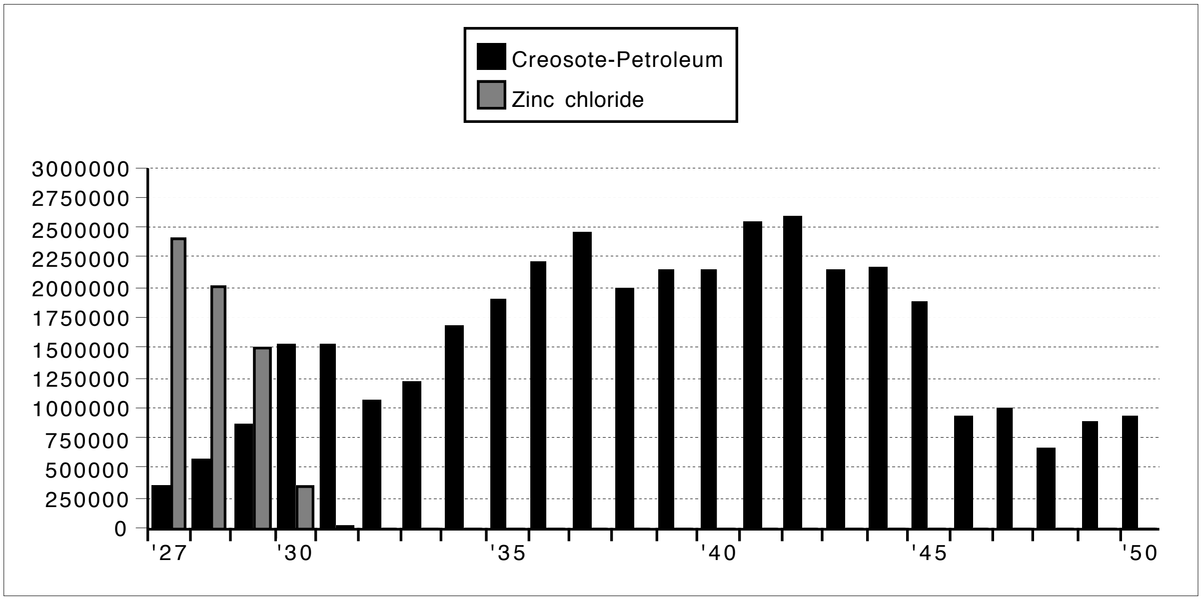
Date nails on the OSL, SLR, and UP become identical in 1921, so record keeping on the three railroads was certainly combined that year.

In the lists of treating plants published annually in the AWPA's *Proceedings*, the Salt Lake Route and OSL are listed as operating their own works through 1923. Beginning 1924 the former OSL plants are shown as UP, and the SLR's Zinc, CA plant is gone, abandoned by the parent company.

A footnote for the table of ties inserted by the UP (from which the bar graphs below were taken) says that in 1922 the Pocatello, ID plant was built, and the UP assumed track maintenance of the Salt Lake Route. Often such published dates are a year off, which explains why the two events are given as 1921 and 1923 respectively in the treatment plant lists. [WPN 8-51, 100]

Track consolidation of these three big railroads took from 1921 to 1923 to accomplish.





Ties laid by the Union Pacific, 1900-1950.

The bar graphs are from the table published in [WPN 8-51, 100]. The numbers of untreated ties installed are insignificant after 1923. We need to ask why zinc chloride treated ties begin in 1904 in the table. Perhaps, because the Laramie plant opened late 1903, the total for that year was lumped into the 1904 figure. Or "1904" might be the fiscal year 1903-04.

Tie treating, 1923 up

In the period 1923-1925 the UP established four extensive and varied test tracks on the OSL, with many ties being treated with creosote, some by Lowry's method, and some full cell. But still they did not veer from straight zinc chloride as their standard treatment until 1927.

"Creosote-petroleum treatment of crossties was initiated at Pocatello, Idaho and The Dalles, Ore. in 1927, and at Laramie, Wyo. in 1928." [WPN 8-51, 99] The treatment was 50-50 creosote-fuel oil by either the Rueping or Lowry process. After 1927 the proportion of zinc chloride treated ties declined rapidly, and the last year for the Burnett process on the UP was 1931.

"In June, 1942, as a war measure to conserve creosote," "treatment for crossties was changed from 50-50 creosote-petroleum to 30-70 creosote-petroleum. In February 1945, treatment was changed back to 50-50 creosote-petroleum." As of 1951 they were treating ties with 8 lb/ft^3. [WPN 8-51, 99-100]

Tie marking and record keeping

The UP, OSL, and LA&SL used their own nails through 1920. Presumably nails found on the OWRR&NCo. are the same as OSL's. Beginning 1921, with the exception of the LA&SL square 25 and 26 and the OSL 29 variation, the sets are identical. Even before 1921 there are similarities in the sets. This may be due to one railroad supplying ties to another, or to the UP reusing ties from one railroad on another after 1936. It is really impossible now to determine exactly which pre-1921 nails were used by which railroad.

Beginning with the opening of the new Laramie plant in 1903 date nails were driven into each treated tie at the plant. In 1903 J. Berry of the UP wrote "Nails, such as we would use, No. 3 galvanized wire, 2 1/2 in. long, with a head 1/2 in. in diameter, and a number on it..." [AREA '04, 99, 102] [DNC, 12] Later, in 1907, he said "We use a dating nail, two to a tie, about six inches from the end on opposite sides, so that we cannot get it wrong. We put the dating nails in at the tie plant." ['07, 43]

Many spurious nails have been attributed to the UP, and I have hopefully eliminated the vast majority of them from the nail list. In the process all the 1903 nails went. They were rnd I (01) 3, rnd I (18B) 03, and rnd I (07) 3. I do not know which of these, if any, the UP used.

It was probably about 1910 that the UP established a series of test sections on the model of those on the CB&Q and Santa Fe. One test section was established on each of six divisions. Given the absence of these tests from the test section lists, they were probably styled after the Santa Fe's 'renewal' tests. On the Santa Fe: "When the ties in these sections reach the limit of their service life, the replacement ties are taken into the records and these test installations are therefore perpetual in nature." ['41, 190]['14, table][DNC, 290]

Even after instituting these tests, the UP continued to put date nails in all treated ties. Untreated ties were not marked. ['14, table][DNC, 290]

In [Feb '74, 6] is a UP diagram titled "Common Standard Tie Dating Nail." It was adopted December 10, 1920 and was revised August 18, 1927. Nails were to be driven into Burnettized (zinc-chloride treated) ties 10" outside the rail, and for creosote-oil treated ties 10" inside the base of the rail. The drawing indicates that nails are to be 2 × 1/4" rnd R. This diagram is also shown in [Shaw, 137] and in [J-A '98, 11].

In [S-O '77, 3] are two letters by Union Pacific officials. Each of these shows just how misinfomed a railroad man can be about his own company. From the first (undated) letter: "...I find that marking of railroad ties with date nails was employed on Union Pacific from about 1903 to 1936, and was used to determine which wood varieties and which treatments provided the greatest longevity. The plus sign (+) on the head of a date nail indicated zinc chloride treatment while the "×" identified one treated with a 50-50 mixture of creosote and oil." Besides contradicting the 1927 document, this seems difficult to believe. Can you imagine trying to determine whether a nail reads × or +? No such nails have been found, and he may have been confusing the marks used in foremen's notes with the marks on date nails.

The second letter also appears in [Feb '74, 4], and was written by the Director of Public Relations in 1969: "As far as the Union Pacific is concerned, the practice of using date nails was initiated in 1903." "We stopped using date nails in 1936 and since that time have been stamping the necessary informaton on the ends of the ties." "A raised date figure on the nail was used for treated ties and a depressed figure was used for untreated ties." "All date nails were installed 10" outside the rail by section foremen." This last rule was modified in 1927 to account for creosoted ties, as seen above.

"In 1927 our standard was revised to eliminate the use of depressed figures and all nails used 1927 to 1936 had the raised figures." This statement deserves some commentary. The standard, as mentioned above, was revised in 1927 to account for creosoted ties by specifying the location of the nail in the tie, not to eliminate the use of depressed figures. Besides, the last year for depressed figures was 1921, not 1927. If "1927" in the letter is a misprint for "1920," the statement can make sense. It is likely that the UP gave meaning to indented vs. raised figures. Both were in use 1912-1921. If it is true that indented = "untreated" and raised = "treated," then the 1914 report which claimed that nails were used only in treated ties was a couple years out of date. Then the Standard Plan for date nails was re-drawn in 1920 to eliminate indented nails. Perhaps untreated ties on the UP were dated only in the period 1912-1921.

Continuing with the letter: "Our records indicate that switch ties were date nailed as far back as 1944. Since 1944 we have hammer stamped the ends of switch ties imprinting the year the tie was treated." This statement is also odd. Probably he was confusing switch nails with date nails. Interpolating backwards from his misreading of the documents, we can guess that switch nails were used up to 1944, after which the ties were stamped.

Certainly there was a difference between ties with square nails and ties with round nails, but the meanings are unknown.

Glenn Wiswell advertized several rare UP nails he acquired at an auction of a deceased UP maintenance-of-way man. Included was the rnd I (01) 04, which has probably not been found elsewhere. In his 1983 flyer, Wiswell advertized a rnd I (01) 8.

A few 1 3/4" rnd I (01) 15's have been found. They are probably factory errors.

The UP may have used a sqr I stl (18) 17. Charles Sebesta got one from a collector in Oregon.

Only one 2" rnd R (18A) 28 has been found.

Nails before 30 are difficult to find. The 2" (17) 30-33, 36, 2" (07) 34 (including variations), and 2" (18B) 35 are fairly common. Switch nails are now scarce.

The letter nails A-L have only recently surfaced (2002). They were probably used in a single test section. Nothing more is known about them. [Summer 2002, 3-4][Fall 2002, 6]

The 64 and the letters L and V are found together, each tie having a 64 and one letter nail. On the main line west of Evanston, WY the 64 and V are found in the middle of the tie. [S-O '88, 3]

The single-digit 7/40" nails are code nails. The date nails of this series run 12-22, and the 18-22 have gm. Because the code nails also have gm, they were probably used in 1918 or later. They are common on the OSL, so they may actually date from 1921 or later. This is also true of the other code nails, which are found on both UP and OSL.

Code Set #6 is very old. [DNC, 177]

Mel Smith found the 1/4" rnd R gm 5 inside the rail in switch ties. [N-D '88, 9]

Switch nails were driven into the ends of overlength ties at the treating plant to easily distinguish the various lengths of ties when inserting them at switches. After they were placed in the track they served no purpose.

Dates 26 through 28 are common in poles along the UP, and Arnold Smith found 06 and 07 in poles. [N-D '78, 2]

For an article on plastic date marks on concrete ties from the 1980's and 1990's, see Jerry Penry's article in [J-A '94, 9].

Articles: [N-D '78, 2],[S-O '80, 1-4], [J-F '86, 8] (a reprint), [M-J '86, 10-13], [S-O '88, 3], [N-D '88, 9-10], [M-J '89, 1-2], [M-A '90, 4]. See especially [Winter 2000, 6-11]

Treating plants

— Omaha, NE, 1865. This plant treated primarily cottonwood ties with zinc chloride for ties in the construction of the Transcontinental Railroad. With three retorts the plant was too small for the job, could not accept most ties because of their size, and too strong a solution was used. Some secondary sources give the years of operation as 1866-1867, but a contemporary account published in *Railway Record*, June 15, 1865, p. 205 stated that the plant was nearly ready to begin treating. It was abandoned Sometime October-December 1866. [RG 10-29-86, 737][WPN 8-51, 97][Trat II, 235][UP, 108-110]

For more comments and a photo of the plant in operation, see [Summer 2000, 11-12]. The photo can be seen better at

http://CPRR.org/Museum/Burnetizing.html

— Laramie, WY, 1886. This two cylinder plant was built by Octave Chanute's Chicago Tie Preserving Co. to treat primarily mountain pine ties by the Wellhouse process. It went into operation July 26, 1886. "Work was suspended in 1887 for reasons of temporary economy" [AREA '01, 106] The plant was "finally dismantled after a fire which destroyed one of the buildings." The fire occurred before August 10. [AREA '01, 106][AREA '05, 776][RG 10-29-86, 736-737][RA 2-3-05, 151]

According to [AREA '01, 106], about 250,000 ties were treated in 1886-1887. From ['16, 317] is a record of 242,000 Burnettized pine ties in Wyoming for 1886. "Burnettized" is surely a misprint for the Wellhouse process, but the number is close to 250,000. [Trat II, 235] says that 207,878 ties were treated at Laramie in 1886-1887. Perhaps Tratman's number is for pine only, and the 242,000 is the total number of ties treated.

— Rawlins, WY / North Topeka, KS, 1902. In the latter part of 1902 this two retort portable plant went into operation at Rawlins, WY. It was used to treat ties by the Burnett process, and was moved to N. Topeka, KS in 1909, where it was abandoned in 1916. [WPN 8-51, 97][AREA '04, 75] Because UP tie records begin in 1903, this plant may have treated only piles or other timbers in its first year.

— Laramie, WY, 1903. On the site of the 1887 plant the UP built a new one in 1903. Here ties, primarily pine, were treated in two retorts with straight zinc chloride. The plant went into operation sometime in the latter part of 1903. [AREA '04, 98][RA 2-3-05, 151]['10, 139]

The two retorts from the N. Topeka plant were moved to Laramie in 1916. In 1921 the two 1903 retorts were replaced with new ones. One of these was itself replaced in 1924, and in 1929 a fifth retort was added. The two N. Topeka retorts were abandoned sometime 1930-1934. ['22, 485]['24, 315]['30, 423]['34, 474]

Sometime 1934-1940 the plant was farmed out to the Forest Products Treating Co. ['40, 452]

— The Dalles, OR, 1903. Originally at Wyeth, OR, this was the Oregon RR & Navigation Co.'s two-retort portable plant. In 1905 two cylinders were added for treating ties and maybe other timbers by

Boultonizing (boiling in creosote), and in 1910 its ownership transferred to OSL. ['12, 285] The plant was moved to The Dalles, OR in 1923, when it became a UP plant. [WPN 8-51, 97-98][AREA '04, 75]

In 1933 a fire destroyed the works, and the following year it was sold to the Forest Products Treating Co., which operated three new retorts. A fourth, from Pocatello, was added in 1941, and between 1945 and 1952 the plant came into the hands of Baxco Corp., later J.H. Baxter. Later the plat was sold to Kerr-McGee Chemical Corp. [WPN 8-51, 97-98]['34, 474]['44, 430]['52, 394]

— Pocatello, ID, 1921-1922. This OSL plant was built with one retort in 1921 and was enlarged to two the following year. It became a UP plant in 1923, and in 1925 a third treating cylinder was added. In 1941 the 1922 and 1925 retorts were moved to The Dalles. (But only one was added at The Dalles that year according to the lists.) The last retort was abandoned in 1948. ['22, 484]['30, 423]['44, 433] [WPN 8-51, 98]

Early test sections

- Between Omaha and Columbus, NE, 1865-1866.

  "Burnettizing works were erected at Omaha by [the UP] in 1867-8 (sic), and run about one year on cottonwood ties... The works were abandoned as impracticable, as not one-tenth of the ties used could be put through the machine. Some difficulty was also found from the brittleness of the prepared ties, probably...from the use of too strong a solution in order to hasten the process." The plant really operated 1865-1866. [UP, 108-110][ASCE 7-85, 262][WPN 8-51, 97][Trat II, 235]

- Wyoming Territory, 1868.

  "Some years ago it was discovered that there was a strip of road in the track of the Union Pacific Railroad, in Wyoming Territory, about 10 miles in length, where the ties do not decay at all. The Chief Engineer, Mr. Blinkinsderfer, kindly took up a cottonwood tie in 1882, which had been laid in 1868, and sent a piece of it to the committee. It is as sound and a good deal harder than when first laid, 14 years before, while on some other parts of the road cottonwood ties perish in 2 or 5 years." [ASCE 7-85, 254]

  The ties were untreated and did not decay because of the high amounts of sodium, potassium chloride, calcium, and iron in the soil.

- West of Rawlins, WY, 1886.

  Some Wellhouse treated mountain pine ties, .78 lb/ft^3. ['16, 322][AREA '01, 106][AREA '04, 98]

- Other sites, 1886.

  These references are too sketchy to list as separate tests.

  — Some Wellhouse treated fir ties, .78 lb/ft^3. ['16, 293]

  — 150,000 Wellhouse treated hemlock ties, .3 lb/ft^3. [AREA '09, 618]['15, table]['16, 300] ['20, 106] (The latter source wrongly says NP, not UP.)

  The species cannot be solely hemlock, because mainly pine was treated at Laramie.

  From [RG 10-29-86, 736] the exact number of ties treated from July 26 to August 31, 1886 is given, and from it I estimate that the plant produced about 146,066 ties by the end of the year. Thus the number 150,000 might represent the production of the Laramie plant for 1886.

  — Wyoming: 242,000 Burnett treated pine ties. Also included in this number are spruce, Oregon fir, elm, ash, maple, and oak. ['16, 317]

  This must be a misprint for the Wellhouse process. According to [RA 2-3-05, 151], a total of about 250,000 ties were treated at Laramie in 1886-87, so 242,000 might reflect the total output of the plant.

Test sections 1902-1910.

- ?, 1902.

  Some Burnett treated fir and pine ties were laid. [AREA '09, 619]['16, 293]

- Nebraska, 1903.

  105 Burnett treated lodgepole pine ties. ['20, 122]

- Kansas, 1903.

  22 Burnett treated lodgepole pine ties. ['20, 122]

- Colorado, 1905.
  292 Burnett treated lodgepole pine ties. ['20, 122]
- Nebraska, 1905.
  508 and 510 Burnett treated lodgepole pine ties in two locations. ['20, 122]
- Colorado, 1907.
  752 Burnett treated lodgepole pine ties. ['20, 122]
- Wyoming, 1908.
  3,428 Burnett treated lodgepole pine ties. ['20, 122]
- Norfolk, NE, 1908.
  81 .4 lb/ft^3 Burnett treated Southern yellow pine ties. ['20, 112]
- Nebraska, 1908.
  233 .4 lb/ft^3 Burnett treated Douglas fir ties. ['20, 102]
- Kansas, 1910.
  164 .4 lb/ft^3 Burnett treated Douglas fir ties. ['20, 103]

The system of test sections, ca. 1910.

One test section was placed on each of these divisions: Nebraska, Wyoming, Western, Kansas, Central, and Colorado. The ties included both $ZnCl_2$ and untreated pine ties. It is impossible to determine when the test sections were established, because all we are given are the numbers of ties removed for 1922 and the average life in track. It is possible that they included some of the 1903-1910 tests above, but more likely they are tests established about 1910 in response to CB&Q and Santa Fe experiments. They were definitely in place as of 1914. ['14, table]['24, 251]

Tests beginning 1923

- Between Hammett and Reverse, ID, 1923-1924 (OSL).
  Full cell 30%-7.5%-62.5% creosote-coal tar-fuel oil treated ties.
  - 720 white fir and Engelmann spruce, laid December, 1923.
  - 741 Western yellow pine, laid December, 1923.
  - 633 mountain Douglas fir and western tamarack, laid November, 1923.
  - 625 lodgepole pine, laid December, 1923.
  - 766 Douglas fir, laid December, 1923.

  1/2 lb/ft^3 zinc chloride treated ties.
  - 782 white fir and Engelmann spruce, laid December, 1923.
  - 757 Western yellow pine, laid January, 1924.
  - 452 mountain Douglas fir and western tamarack, laid November, 1923.
  - 626 lodgepole pine, laid December, 1923.
  - 950 coast Douglas fir, laid December, 1923.

  80%-20% creosote-coal tar 10 lb/ft^3 full cell treated ties.
  - 170 lodgepole pine, laid December, 1923.
  - 64 Western yellow pine ties, laid December, 1923. ['25, 166]['31, 32]['37, 183]['53, 190, 193] [AREA '30, Table]
- Between Rogerson, ID and Wells, NV, 1924-1925 (OSL).
  Ties were installed in the construction of this new track from June through December, 1924.
  Two movement $ZnCl_2$-fuel oil (.5 lb/ft^3 $ZnCl_2$ and 3.5-4 lb/ft^3 oil, 8 hours between treatments) treated ties.
  - 3,147 Western yellow pine.
  - 3,169 Western fir and Engelman spruce (Dec. 1924).
  - 3,171 coast Douglas fir (Dec. 1924).
  - 5,743 mountain Douglas fir (1924-1925).
  - 2,303 lodgepole pine (Feb. 1925).

  .5 lb/ft^3 zinc chloride treated ties.
  - 5,131 lodgepole pine (Sep. 1924 & Jan. 1925).

3,203 white fir and Engelmann spruce (Dec. 1924).
5,713 mountain Douglas fir (1924-1925).
3,216 coast Douglas fir (Sep. 1924).
3,196 Western yellow pine.

8 lb/ft^3 full cell creosoted ties.

3,159 coast Douglas fir (Aug. 1924). ['26, 217][AREA '30, Table]

- From Orchard to Boise, ID, 1924 (OSL).

  In the main line the following ties were laid from February to June, 1924.

  780 50-50 4 lb/ft^3 creosote-4 lb/ft^3 fuel oil Lowry treated coast fir.
  782 30-70 3.6 lb/ft^3 creosote-8.4 lb/ft^3 fuel oil Lowry treated white fir.
  3,131 8.6 lb/ft^3 creosote-4 lb/ft^3 fuel oil Lowry treated white fir and spruce.
  3,081 8 lb/ft^3 creosote Lowry treated Idaho red fir.
  3,331 8 lb/ft^3 creosote Lowry treated lodgepole pine.
  2,579 8 lb/ft^3 creosote Lowry treated Western yellow pine.
  3,028 8 lb/ft^3 creosote Lowry treated coast Douglas fir.
  3,069 .5 lb/ft^3 zinc chloride treated Western yellow pine.
  2,915 .5 lb/ft^3 zinc chloride treated white fir and spruce.
  2,375 .5 lb/ft^3 zinc chloride treated lodgepole pine.
  3,145 .5 lb/ft^3 zinc chloride treated red fir.
  767 .401 lb/ft^3 zinc chloride treated lodgepole pine.
  3,037 .418 lb/ft^3 zinc chloride treated coast Douglas fir. ['31, 31]['37, 185]['53, 190-193] [AREA '30, Table]

- Wells Branch (Twin Falls, ID to Wells, NV), 1924-1925 (OSL).

  All are sawn ties, except as noted.

  .5 lb/ft^3 zinc chloride treated ties.

  3,197 white fir and spruce, laid December, 1924.
  3,210 west coast fir, laid September, 1924.
  3,186 Western yellow pine, laid December, 1924.
  3,150 Idaho red fir, laid July and August, 1924.
  2,538 hewn lodgepole pine, laid September, 1924.
  3,175 lodgepole pine, laid January, 1925.
  3,166 white fir and spruce, laid December, 1924.
  2,562 hewn Idaho red fir, laid January, 1925.

  .5 lb/ft^3 $ZnCl_2$-3.5 lb/ft^3 fuel oil, two movement treated ties.

  3,171 west coast fir, laid December, 1924.
  3,142 Western yellow pine, laid January, 1925.
  3,209 Idaho red fir, laid January, 1925.
  2,297 hewn lodgepole pine, laid February, 1925.
  2,526 hewn Idaho red fir, laid December, 1924.

  8.5 lb/ft^3 full cell creosoted ties.

  3,148 west coast fir, laid August, 1924. ['31, 32]['37, 182]['53, 190-192]

- Between Dietrich and Shoshone, ID, 1927 (OSL).

  In the second main track, the following lodgepole pine ties were laid in January, 1927. ['31, 34] ['37, 184][AREA '30, Table]

  780 .4 lb/ft^3 Burnett treated ties.
  799 .5 lb/ft^3 $ZnCl_2$, followed by 6 mo. seasoning, then 7.909 lb/ft^3 fuel oil treated ties.

- Near Laramie, WY, 1927.

  In cooperation with the U.S. Forest Service, the following ties, treated with .4 lb/ft^3 zinc chloride were laid in October, 1927. They were subjected to preliminary steaming. ['41, 277] [AREA '30, Table]

  100 hewn Engelmann spruce.
  400 lodgepole pine, both hewn and sawed.

- Wyoming, 1942.
  1,766 lodgepole pine ties treated by the Rueping process with a 50-50 creosote-petroleum mixture at 8 lb/ft^3. ['53, 193]
- Wyoming, 1946.
  932 lodgepole pine ties treated by the Lowry process with a 50-50 creosote-petroleum mixture at 8 lb/ft^3. ['53, 193]
- Oregon, 1946.
  657 Douglas fir ties treated with a creosote-petroleum-Penta solution by the Lowry process. ['53, 194]
- Northern Idaho, 1947.
  874 Douglas fir ties treated with a creosote-petroleum-Penta solution by the Lowry process. ['53, 194]
- West of Evanston, WY, 1964.
  The 64 and V were found in the middle of each tie in this stretch of track. [S-O '88, 3]