METHODS

OF

PRESERVING TIMBER

BY

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THESIS

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Analytical table of contents.

Chapter I. Introduction

1 - 15

Reasons for using preservatives 2 - 8
Extent of their use. 8 - 12
Reasons why not more extensively used. 12 - 14
Enumeration of Methods. 14

Chapter II. Description of Methods

15 - 67

Exosooting. 15 - 27
Burnishing (chloride of zinc. 27 - 36
Vulcanising 41 - 48
Hyazinising. 48 - 52
Wood Exosooting 52 - 54

Chapter III. Conclusion

67 - 68
Chapter 1. Introduction

Definition. By preservation of timber is meant the employment of artificial preparation whereby the life of timber is prolonged. The agencies employed vary from the simpler forms of paint, large headed tackle, sheet iron, etc. to the more complex forms either of steeping in, or impregnating with some chemical. The chemicals now commonly used are creosote, chloride of lime, tannin, sulphates of copper and zinc, and resin etc.

Plan of proposed discussion. The subject of timber preservation may be considered from two points of view, viz, (1) from the standpoint of a chemist and (2) from the standpoint of an economist. In the first case, the subject is considered with reference to the action of the various preservative liquids upon the constituents of the wood. A scientist only wishes to know the chemical and physical action of the preser-
natural, and consequently his researches will end with the attaining of this knowledge. From the economical standpoint, the question is considered with reference to the efficacy of the preservation of timber in reducing the cost of timber structures. Obviously, the engineer is interested principally in this phase and hence I shall consider timber preservation only from the economical standpoint.

Art. 1. Reasons for using preservatives. There are four reasons why timber preservatives should be used, viz: (1) because the life of timber is increased; (2) because the cost of renewals is decreased; (3) because cheaper woods may be employed more advantageously and (4) because treated timbers may be used where untreated timbers would fail. These advantages will be considered in order.

Increase of life of timber. The question of increasing the life of railroad ties and thereby securing the greatest economy has engaged the attention of engineers considerably of
late years. This question may be solved in either of two ways, 
(1) by the use of metal ties or (2) by the use of preserved wood ties.
The introduction of the metal tie to supplant the wooden one, is an effort in this direction. The N.Y.C. and A. E. Railroad has only 19000 of these metal ties, and this seems to be about the extent of their use on the railroads of the United States. The metal tie may be the tie of the future, but owing to the high cost of this form, it is not likely to come into extensive use very soon.

Use of preserved wood ties. Apparently the only means of reducing the cost of maintenance of railroad ties is to use preserved wood ties. Hence some chemical or mechanical agent which, applied to timber, will result in increasing its efficiency is of the highest importance to railroads. It has been shown that a saving of from 20% to 50% per year may be obtained in the maintenance of timber structures and railroad ties by treatment with preservatives.
The question as to whether it pays to preserve ties against decay has been positively answered in the affirmative by European engineers. In 1873, out of 60,000,000 ties on German railroads, 25,000,000 were impregnated. To compute the saving by this use of preserved ties, assume (1) that the ties are oak, (2) that the cost of an untreated tie in the track is $1 and its life is 13.6 years and (3) that the cost of an impregnated tie is $1.125 and its life is 19.5 years.

Total cost of 25,000,000 untreated ties @ $1 each = $25,000,000

Yearly expenditure (25,000,000 ÷ 13.6) = $1,857,143

Total cost of 25,000,000 impregnated ties @ $1.125 each = $28,125,000

Yearly expenditure (28,125,000 ÷ 19.5) = $1,439,995

Saving per year by use of treated ties = $421,148

This shows the efficiency of treated ties in Europe and the same might be true in this country, with the possible exception that the preserving agents, creosote, chloride of zinc, etc. are cheaper there than here.

* In Germany, timber is scarce and consequently expensive.
P. Collingwood, Member of American Society of Civil Engineers, has made the following comparisons respecting the cost of treated and untreated ties in the United States.

<table>
<thead>
<tr>
<th>Cost of untreated tie will last</th>
<th>Time it will last</th>
<th>Cost of preserved tie will last</th>
<th>Time it will last</th>
<th>Saving per mile of 2600 ties every 10 yrs in favor of treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>70°</td>
<td>5 yrs</td>
<td>95°</td>
<td>12 yrs</td>
<td>$2,000</td>
</tr>
<tr>
<td>70°</td>
<td>8</td>
<td>75°</td>
<td>12 yrs</td>
<td>$2,050</td>
</tr>
<tr>
<td>80°</td>
<td>8</td>
<td>105°</td>
<td>16 yrs</td>
<td>$2,400</td>
</tr>
</tbody>
</table>

As there are about 50,000,000 ties in use on the railroads in the United States, the saving by using soft preserved ties instead of unpreserved oak ties would amount to $34,000,000 per year. These figures are striking, and show apparent by great economy. Yet I am convinced that local conditions such as (1) the cost of ties, (2) the conditions of the ground, (3) the time during which a treated tie is estimated to last, etc., are so variable that the saving indicated by the above table could not be realized on all railroads.
Hence I conclude (1) that the saving can be determined in advance only approximately and (2) that the actual saving is less than that estimated above.

Decrease of cost of renewals. In addition to the increased life of timber, another advantage resulting from the use of timber preservatives is the reduction in the cost of tie renewals. The renewal of bridge timbers and railroad ties is a gigantic work costing much money and energy. Since the life of an average untreated tie on the railroads in the United States is eight years, there is approximately a renewal of 525,000,000 ties every eight years. The average cost of the renewal being five cents, the total cost amounts to $26,250,000. It is not certain just what proportion of the total timber renewal is tie renewal, but it is fair to suppose that the total far exceeds that of the renewals. The above gives some idea of the cost of renewals. In all cases, which I have noted,
the increased life of timber, by virtue of preservatives, is from 20% to 100% over the unpreserved wood.

Employment of cheaper wood. Soft woods are more suitable for treatment than hard woods because the removal of the sap from the former leaves more room for the injection of the preserving fluid. Therefore in localities where hard wood predominates, preservatives are not likely to be used, but in localities where only soft wood can be had, the use of preservatives is the usual resort. Geo W. Kittredge, Chief Engineer of the C.C.C. and H.L. RR, states that preservatives are gaining consideration, particularly on roads where only soft wood can be had.

Wider range of use. It has been found that preserved timbers are especially adapted to places where untreated timbers would utterly fail; viz, (1) places subjected to the ravages of sea worms, and (2) places where water is liable to gather and stand about the timbers.
The destruction caused by the Sniomia, teredo and other sea worms is enormous. Great numbers of pilings are cut down; wharves are ruined usually by the quick and sure action of these marine animals. Yet preserved timber successfully resists their attacks. It is a well known fact that if water is allowed to stand around timber, it soon becomes saturated and decay follows very rapidly. Railroad ties thus exposed have lasted for only a very short time. At Camden N.J., in the pathway of the drain of the yard, preserved black oak ties lasted two or three times as long as white oak ties.

Art. 2. Extent of the use of preservatives.

Preserved timbers are used largely (1) on railroads for ties, bridges and car construction, (2) on street railroads for poles, (3) for pavements and (4) for wharves, piers, bat hulls etc.
By railroads. Railroads use timber extensively and to determine the extent of their use of preserved timber, I addressed letters to the chief engineers of twelve leading railroads and have received replies from ten.

From these replies I learn that the following roads make no use of preservatives, viz. Georgia and Alabama, Union Pacific, C.C. and H.L., Southern Railway, Northern Pacific and C.M. and H.P.

From the same source I find that the Northern Pacific and C.M. and H.P. have discontinued the use of preservatives. The former road during the years 1886 and 1887 treated 250000 trees since which time the plant has been shut down.

From the above correspondence I learn that the following roads use preserved timber, viz. A.T. and H.E., King's County Elevated Railroad, Canadian Pacific and Plant System. Below are the summaries of some of
these letters.

James Dow, Chief Engineer of the A. S. and H Fe R.R. reports that works at Las Vegas, New Mexico have been in almost constant operation since 1885. He says the question of wood preservation is now receiving much attention from railroad companies.

C. O. Parker, Supt. of the Plant System, states that timber rapidly decays in this (Southern) climate and that wood preservatives are coming more into favor.

O. F. Balston, Chief Engineer of King County Elevated Railway Co. has used creosote and Carbolineum Aramis with success. He thinks that engineers generally favor some kind of wood preservative, the trouble being to get the companies to stand the cost in the first place as they want to get the construction down to the lowest figure.

P. A. A. Peterson, Chief Engineer of the Canadian...
Pacific R.R. Co. uses crossing on that road. He reports that timber preservatives is gaining in the estimation of engineers.

Andres Bevier, Gen'l Manager of the New York Wood Vulcanizing Co. says that the question of preservation is probably no more important than the question of increased hardness of ties, and that these questions are being agitated more and more in the last as the weight of engines are increased. From the above it would appear that preservatives are not extensively used on the railroads of the United States.

(2) Street Railroads. Street railroads employ treated poles etc. A vulcanized trolley pole makes an ideal one costing half that of the iron ones, it will last as long and be free from danger of breaking or bending.

(3) Pavements. In this country, wood pavements have been brought into disrepute. This is the result of a
few years' experience in the usage of anything in the shape of wood, poor or otherwise. Since the introduction of preservatives, the advantages of wooden pavements have been recognized. In Europe, wood is regarded a very valuable paving material, as long as it remains sound. The only question to be solved is, can wood be preserved from decay? There are various firms who preserve wood and guarantee it to be practically perfect until it is worn out.

Art 3. Reasons why preservatives are not more extensively used.

From some evidence*, I learn that only about 15% of the larger railroads use preservatives. The question then
naturally arises, why do not all railroads use treated timbers? I think there are two answers to the above question, viz: (1) Railroad managers hesitate about spending money in this way because of reasons involving finances and uncertainties, depending upon lack of confidence in the various methods. (2) A great many railroads are experimenting for themselves, and sufficient time has not yet elapsed to convince them that a more general use of these preservatives would result advantageously.

Timber preservation is of a comparatively recent date. New processes are springing up all the time, each claiming merits superior to the older processes such as Cresoting, Burmitizing etc. And in such a state of affairs, I see some obvious reasons why the railroads have not thus advocated an extensive use of preserved timber. The sentiment of all the letters which I have received is that they favor some kind of wood preservative...
and that the question is now receiving much attention from railroad companies.

Art 4. Enumeration of methods. The following are the methods which I shall consider in this paper, viz:

Art. 1. Bresotizing. [Chloride of zinc
Art. 2. Burnettizing. [Zinc tartrate
Art. 3. Vulcanizing.
Art. 4. Tyzning.
Art. 5. Wood bresotizing.

Art. 7. Miscellaneous

Carbolene
Armarius
Thilmanjo
Ferroline
Fludds
Fine
Earle's
Charring
Formans
Smith's
Chapter 2. Methods of Timber Preservation

Art. 1. Creosoting

History. As early as 1756, attempts were made to inject or impregnate timber with vegetable tar or extracts therefrom. The practical introduction of this method is due to Mr. John Bethell of England. He included among some of his substances a mixture of coal tar with about one third to one half of its own volume of seed oil. This seems to have been the origin of the creosoting process.

Chemical employed. Coal and wood tars and dead oil are the only substances used to any extent, although many resinous and tarry substances have been proposed. The antiseptic substances used in this process are obtained principally from the distillation of coal tar. The products of distillation come over almost in the order of their respective
volatilities, and are divided according to their specific gravity, into oils lighter than water, oils heavier than water, and pitch. The opinions of various engineers differ as to the relative merits of thin and heavy oils.

Mr. H.P. Burt, one of the pioneers in the employment of this process, used for years, by preference, the heavy London oils mixed with a small percentage of the thinner oil. It is a fact, acknowledged by inspectors, that the thinner oils are gaining in popularity. Inspectors prefer these because they are injected with less exertion and the timber looks cleaner afterwards. An analysis was made of several pieces of timber taken from the permanent way of the London and North Western Railroad, and the following conclusions were evident: (1) Only small percentage of oil distilling below 450° Fahr. remained in the wood, and (2) about 60% of the total substances retained in the wood did not distil until after a temperature of 600° Fahr. was reached. The
Conclusion of these experiments were that these timbers had been preserved by the action of the heavier and more solid portions of tar acids and that the other constituent had volatilized.

Noticing the volatility of oils employed in creosoting, Mr. D.C. Bridle was lead to make some experiment to determine the range of volatility. He experimented upon several pieces of wood, each of which was impregnated with 12 # of oil per cubic foot. The following shows the losses at the end of four weeks.

<table>
<thead>
<tr>
<th>No. piece</th>
<th>amount of oil before experiment (per cu. ft.)</th>
<th>amount of oil after experiment (per cu. ft.)</th>
<th>% reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12 #</td>
<td>10.77 #</td>
<td>17.3</td>
</tr>
<tr>
<td>2</td>
<td>12 #</td>
<td>9.55 #</td>
<td>20.0</td>
</tr>
<tr>
<td>3</td>
<td>12 #</td>
<td>9.53 #</td>
<td>20.0</td>
</tr>
<tr>
<td>4</td>
<td>12 #</td>
<td>8.72 #</td>
<td>29.0</td>
</tr>
</tbody>
</table>

These conclusions from this experiment are substantially those which
have been intimated above, viz.: (1) Creosote should be of heavy rather than a light consistency; (2) It should contain oils which are given off at high temperatures, and (3) As much creosote oil should be put into the timber as the timber can possibly absorb.

The function of the tar oil may be considered of a threefold nature, first, it acts physiologically, in making the wood poison; second, it produces a chemical change in coagulating the albumen; and third, it acts mechanically in excluding from the pores of the wood air, water and the germs of destruction.

**Description of the method.** All growing plants, in preparing the timber and injecting into it, the oil, employ the following general method. The timber is placed in enclosed cylinders and has the moisture driven from its cells by the application of superheated steam. Then by means of vacuum pumps, after the withdrawal of the sap and condensed steam.
a vacuum is produced. The temperature of the vacuum is held up by dry heat from steam pipes, and finally, oil at a temperature of at least 100° Fahr. is introduced into the fibers with sufficient pressure to obtain the desired result.

General specifications state that the temperature of the superheated steam shall produce, in the cylinder, a temperature of from 200° to 250° Fahr. The duration of the application of the live steam depends upon the quantity of sap in the timber. In treating timber which has been cut when the sap is ascending, superheated steam is turned on for six or eight hours and then live steam introduced with a pressure of 30# to 40# for six hours. If the timber is cut when there is virtually no sap in the tree, the use of live steam is generally dispensed with, and only superheated steam is used for 10 or 12 hours. The vacuum must be produced slowly in order to prevent the checking of the timber. The vacuum pumps should
The oil should never be worked for less than 10 hours and even as long as the discharge from the vacuum yields no decided odor and taste of turpentine. After the vacuum, the tank is filled with oil and then subjected to an oil pressure of 100 psi per sq. in. In all cressostaging, the aim should be to inject the oil into the timber by the strongest force pumps, after all the original juices have been extracted.

The amount of oil injected depends upon four things, viz: (1) upon the amount of seasoning; (2) upon local conditions, i.e., whether the timber is to resist the weather only, or whether it is to resist the serice navalis and other hurtful mollusks; (3) upon the shape and size, and (4) upon the desires of the engineer himself. In experimenting upon the amount of seasoning as affecting the quantity of oil to be injected, it has been found that there is some irregularity as to the pressure of oil and time of application; and furthermore, experience shows that
ties coming from the same cylinder after treatment are not alike impregnated. This fact is explained only by the non-uniformity of seasoning. It is not desirable at any of the crosscutting works to leave timber under pressure to the extent of having them fully saturated. Two gallons per cu. ft. is more oil than is desirable. The following table shows the practice in different localities with reference to the amount of oil necessary to be injected to guard against the varying destructive agencies.

<table>
<thead>
<tr>
<th>Locality</th>
<th>Amount injected</th>
</tr>
</thead>
<tbody>
<tr>
<td>England</td>
<td>10 to 12 per cu. ft.</td>
</tr>
<tr>
<td>France (against tub)</td>
<td>17 *</td>
</tr>
<tr>
<td>America (against Vereoc)</td>
<td>15 *</td>
</tr>
<tr>
<td>Middle Atlantic States</td>
<td>18 *</td>
</tr>
<tr>
<td>Southern States</td>
<td>16 to 20 *</td>
</tr>
</tbody>
</table>

Considering the quantity of oil a direct function of the price, it is
Known that the total cost of creosoting is from 14° to 24° per cu. ft. for pilings and lumber exposed to marine worms, while from 15° to 16° per cu. ft. is the total cost of impregnating timber to resist decay alone. While the quantities of oil used in the two cases are not exactly proportionally to the above quotations of prices per cu. ft.; yet it seems reasonable to state that the amount of oil required for protection against marine worms is from 30° to 50° more than that required to protect timber from decay alone. More oil is required proportionally for small timber than for pilings and large timbers, in order that there may be the same superficial penetration.

Cost. The following comparison of the cost of creosoted and uncreosoted timber, which, while not necessarily applicable to all parts of this country, seems to be consistent with the circumstances named below. I assume the life of a creosoted tie as 16 years, on a
Trunk line. I am warranted in using this time. Because on the New Jersey Railroad, as well as others, creosoted ties have lasted this long. I assume the cost of creosote as 10° per cu. ft. or 27° per average tie.

March 14, 1897. Cost of 2600 creosoted ties at 72° $1872.00

Compound interest on $1872.00 @ 6% for 16 yrs. $3196.00

Cost of 2600 best quality white oak ties @ 50° $1300.00

Compound interest on $1300.00 @ 6% for 16 yrs. $1976.00

Mar. 14, 1900. Cost of 2600 white oak ties (renewals) @ 50° $1300.00

Compound interest on $1300.00 @ 6% for 8 yrs. $768.00

Total cost of untreated ties on one mile of railroad in 16 yrs. $5364.00

Total cost of creosoted ties on one mile in 16 yrs. $5067.00

Balance in favor of creosoted ties, on one mile in 16 yrs. $297.00

Mr. B.W. Burchardt, of the Fernandina Oil and Creosote Works, says that the price of timber, treated by his company will at least be doubled, but its life will be from three to four times longer than in its unpreserved state. The cost of
cresoting in San Francisco, with a properly designed plant, and with current prices for labor, is about $20 per thousand feet (board measure). The cresote costs about 15¢ per gallon.

P. Alex. Peterson, chief engineer of the Canadian Pacific Railroad, uses cresoted timber, on that road, which costs about 10¢ per cube foot for cresoting. O. F. Balston, chief engineer of Kings County Elevated Railway Co., Brooklyn, N.Y., says the cost of cresoting on that road is about $8.00 per thousand feet (board measure). As cresote costs about one cent per pound in the United States, the total cost of cresoting may be estimated from 12¢ to 16¢ per cu. ft. Prices are some what cheaper in Europe, owing to cheaper cresote.

This process, accordingly, is used exclusively in England.

Examples. Col. W. Ludlow, Capt. of engineers, U.S. Army, once reported thus concerning timbers subjected to the ravages of the teredo and lumnea: "Under average conditions,
A pile or other piece of wood exposed to the treads in Delaware Bay is practically destroyed in three seasons. He experimented upon four blocks to show the relative resisting qualities of cresoted and uncresoted wood, as regards the attacks of the treads. The results are as follows:

<table>
<thead>
<tr>
<th>No. piece</th>
<th>Kind of timber</th>
<th>Weight per cubic foot before exposure</th>
<th>Weight per cubic foot after exposure</th>
<th>Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Natural Wood</td>
<td>16½ ″</td>
<td>11 ″</td>
<td>30%</td>
</tr>
<tr>
<td>2</td>
<td>Cresoted</td>
<td>21 ″</td>
<td>21 ″</td>
<td>0%</td>
</tr>
<tr>
<td>3</td>
<td>Natural</td>
<td>14½ ″</td>
<td>10 ″</td>
<td>31%</td>
</tr>
<tr>
<td>4</td>
<td>Cresoted</td>
<td>22 ″</td>
<td>22 ″</td>
<td>0%</td>
</tr>
</tbody>
</table>

The natural blocks were largely destroyed by the treads, while the cresoted ones were not. Thus the sound condition and absence of any change in weight of cresoted blocks, indicate that the oil had protected the wood from the treads, and had also resisted any chemical or mechanical tendency of the water to remove it.

- Exposure 720 days.
In 1848, Mr. Bethell cressoted the telegraph poles of a line from Foreham to Portsmouth, England, a distance of 20 miles. In 1874, these poles were found to be as sound as when they were first erected. W.H. Pierce makes a favorable report concerning the use of cressote on telegraph poles in England. Poles, treated by different processes, were put up, first, a plain pole, next a Boucherized pole, and next a cressoted pole. When the poles were examined 10 years later, none of the plain poles remained; only 70% of the Boucherized, while all of the cressoted poles remained.

Not only is the use of preservatives extended to bridge pier and wharf construction, but also to boat construction. Mr. G.K. Baker, in speaking of a lighter constructed by him, says, the timber used in the construction of the lighter was all selected sap, cressoted in 1886. The lighter has been used continually eight years in salt water; and nothing has been done to her in the way of cleaning, painting or repairing. She is now in first
I think this is conclusive evidence, that no comparison can be made between treated and untreated wood except most decidedly in favor of the treated timber. All the advantages are with the creosoted timber.

Conclusions. The following are my conclusions, concerning the efficiency of creosote oil as a wood preserving agency, viz:

1. Creosoting is probably the best method now in use.
2. It seems to be quite as effective as any other method, in resisting the attacks of the teredo navalis, limnoria, etc.
3. It is more expensive than the other methods.
4. By being more expensive here than in Europe, it is relatively less used in this country than in England.

Art. 20. Burnettizing.

History. Probably the closest competitor of creosoting, if not one superior to it, is Burnettizing. This process was proposed
by Mr. Burnett in 1838. It was introduced into the United States in 1850 and for the last 50 years has been used on our railroads. The original mode of application employed in this process was steeping the timber in a solution of chloride of zinc, in the proportion of one pound of chemical to four gallons of water. But this was not effective. It was tedious and required too much time. Not until Mr. Burnett adopted the injection process did his process become successful.

Chemicals employed. The impregnating fluid consists of one volume of chloride of zinc with thirty to sixty volumes of water. These proportions vary to a great extent, and it is a matter of considerable consequence what relative amounts are used. It has been found that greater success attends the use of milder solutions than of stronger ones. Mr. J. Stickley, former President of the P.W. and B. Railroad, found that some ties were very brittle.
and liable to break. The explanation offered, was that the solution was too strong; and the surplus zinc crystallized in the cap ducts and bursted them asunder. On the Philadelphia and Reading Railroad, the solution used, was \( \frac{3}{4} \) parts zinc to 100 parts water; while experience in Germany has thoroughly established the fact that, for railroad ties, the solution should not be over \( \frac{2}{3} \) parts zinc to 100 parts of water. The solution used on the Lehigh and Ohio bridge was \( \frac{1}{10} \) parts zinc to 100 parts of water.

Mr. John J. Isaacs, chemist for the Southern Pacific Co., states that practice limits the strength of the solution to a minimum of \( \frac{1}{5} \) parts zinc to 100 parts of water.

Conditions necessary for success. It has been found that there are conditions of the timber and methods of treatment, upon which the success of Burnettizing depends, viz.: (1) The sap must be properly cleared from the timber.
(2) The timber must be well seasoned. As an evidence of this fact, some bridge timbers which were not very well seasoned, had a hard crust formation from \( \frac{17}{24} \) inch thick all around the outside, while the center was rotten. On the other hand, some timbers were seasoned 8 months before being Burnettized, at Owego, for the Erie railroad. After they had been in the track for 9 years, there was not a particle of decay.

(3) There must be sufficient pressure. Some prominent engineers hold that the pressure should be 2000 lb per sq. in. and continue for 8 hours.

(4) There should be no undue haste in the treatment. It is often the case that orders for treating timbers are received just at the time when it is required. In consequence, timber is treated, seasoned or unseasoned, in winter or summer. Mr. H. D. V. Pratt, former Superintendent of the Erie Railroad, said that bridge timbers which
were Burnetized in the winter, were full of frost and that this process had the effect of confining the sap and making the timber decay much sooner than it would do otherwise.

(5) Some claim that the timber should be either wholly or partially covered with earth or other substance, in order to prevent the possible washing out of zinc by the rain.

Mr. John D. Isaacs experimented upon shavings of wood, saturated with the zinc solution. He found that wood considered in this most unfavorable way, lost an insignificant amount of the chemical, when exposed to running water. Even when the shavings were boiled in different changes of water, the chloride did not disappear. Mr. J. M. Hobart, formerly civil Superintendent of the Central Vermont Railroad, found that Burnetized ties, after having lain for 25 years in an old track, nearly covered with earth and weeds, were
well preserved from decay. The theory was that this debris kept the rain from washing out the ties.

D. J. Whittemore, one of the leading engineers of the country and chief engineer of the S. M. and St. P. Railroads, has used considerable Burnettized timber on his road. Having occasion once to examine the timbers thus treated, he employed C. Shaler Smith to analyze them. This analysis failed to reveal any traces whatsoever of the chloride of zinc.

E. A. Fuertes, engineer of the New-York Commission, in inspecting some paving blocks which were Burnettized about one year previous, decided to have a chemical examination made, and accordingly, blocks were sent to Prof. Chandler for his examination. The analysis failed to find any traces of the chemical.

Description of the method. The methods employed in Burnettizing are similar to those employed in creosoting.
Steam at a pressure of 30* is introduced into the closed cylinder containing the wood, until the wood has been robbed of its sap. Then the sap and steam are blown off and the vacuum pump employed to produce a vacuum of 20 to 24 inches of mercury. The fluid is introduced and forced into the wood under a pressure of 100* to 150* per sq.in. for 4 hours.

Cost. Mr. O'Charuita, of Chicago, one of the best authorities upon timber preservation, while chief engineer of the N.Y. L.E. and W. Railroad, made approximately the following report concerning the cost of Burnettizing; the best white oak tie costs 77¢ in the track, supposing them to last 1 year the annual, the annual charge is 11¢ per tie.

Burnettized hemlock ties cost as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>First cost of unprepared tie</td>
<td>$0.28</td>
</tr>
<tr>
<td>Hauling, distributing, and putting in track</td>
<td>$0.19</td>
</tr>
<tr>
<td>Burnettizing</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$0.72</td>
</tr>
</tbody>
</table>
Surfacing the life of these ties (Burnettized) is 12 years, the annual charge per tie is 6°. Thus there is a saving of 5° on first cost and 5° on yearly charge by the use of treated ties.

If we suppose two roads of the mileage of the Erie, i.e., with 1940 miles, on which there are approximately 5,000,000 ties, the one laid with Burnettized hemlock ties would save, over the other, $250,000 every 12 years, in the first cost, and $25,000 in the average annual charge for renewals of ties. This is equivalent to an annual saving of $27,000.

The average cost of this method east of the Rocky Mountains is $5 per thousand feet (board measure), while west of the Rocky Mountains, the price is about $3.

James Dunn, chief engineer of the A.T. and S.Fe Railroad reports that ties and bridge timbers on his road have been treated with chloride of zinc, tarmin, and glue at a cost of 12¢ to 13¢ per tie.

Experience with Burnettizing. Mr. Twining, former...
Roadmaster on the L and S division of the C Railroad of New Jersey, reports that ties, treated by this process have resisted decay almost perfectly during 16 years of service, but the rails have worn into them from 4 to 5 of an inch. An experiment was made with two boards, one Burnettized and the other untreated. These boards were placed in the ash pit of a boiler. At the end of 40 minutes, the untreated stick was entirely consumed while the treated stick was only charred one fourth (1/4) of an inch deep.

Conclusions. The following are the conclusions respecting the adaptability of Burnettizing to wood preservation, viz: (1) Burnettizing, being about one third cheaper than creosoting, is probably the most economical process. (2) It is more efficient than other methods, in preserving timbers, which are secluded or partially secluded from the sun light. (3) As zinc chloride has a great affinity for moisture
this process is valuable as a fire preservative.

(4) Two and one half (2½) parts of zinc to one hundred (100) parts of water seems to be the maximum limit, in mixing ingredients to attain the greatest utility.

(5) Solutions too weak, i.e., those in which the proportion of ingredients is less than 1:100, are liable to wash out.


History. This process, patented June 17, 1879, is a modification of Burnett's, in which the supposed washing out of the zinc is prevented. Experience in this process dates back only to 1881, when some ties were laid on the tracks of the A. T. and S. F. Railroad at La Junta, Colorado.

Chemicals used. The chemicals are similar to those given in the process of Burnettizing, with the addition of glue and tannin.

Jno. P. Card, President of the St. Louis Wood Preserving Co., used 1.9 parts of chloride of zinc to 100 parts
of water, together with glue and tannin, injecting the chloride of zinc and glue together, afterwards, subjecting the timber to a bath of tannin under pressure.

Description of the method. The timber is steamed in a cylinder from one to four hours according to the size of the pieces. After injecting the chloride of zinc and glue, the tannin is introduced under pressure. The object of injecting the glue and chloride of zinc together is to destroy all the tannic acid. At the same time, some of the glue is precipitated, forming an insoluble leathery substance for which the zinc seems to have an affinity. Afterwards, with a bath of tannin under pressure, that part of the glue which remains under the outer portions of the wood is precipitated, and consequently, there is left in the wood, more zinc than would be left otherwise.

Advises from chemists show, that in the severest tests to which the wood can be subjected, no zinc exudes from the
wood.

Quantities of chemicals injected is as follows:

<table>
<thead>
<tr>
<th>Kind of wood</th>
<th>Amount injected gallons per cask</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cypress</td>
<td>1/2 to 2</td>
</tr>
<tr>
<td>White pine</td>
<td></td>
</tr>
<tr>
<td>Quim</td>
<td></td>
</tr>
<tr>
<td>Cottonwood</td>
<td>3 to 4</td>
</tr>
<tr>
<td>Elm</td>
<td></td>
</tr>
<tr>
<td>Black oak</td>
<td>1 to 1 1/2</td>
</tr>
<tr>
<td>Water oak</td>
<td></td>
</tr>
<tr>
<td>White oak</td>
<td>1/2 to 3/4</td>
</tr>
<tr>
<td>Yellow pine</td>
<td></td>
</tr>
<tr>
<td>Hemlock</td>
<td>1/2 to 2</td>
</tr>
<tr>
<td>Mountain pine</td>
<td></td>
</tr>
</tbody>
</table>

Cost. The cost of treating timbers by this process is about $8 per thousand feet boardmeasure. In some cases, the cost of treating ties is from 20° to 25° per tie. The A.T. and S.F. Railroad has operated a plant at Las Vegas, New Mexico, almost constantly since 1885. James Dun, Chief
engineer of this road, writes that results so far have been very satisfactory. The cost of treatment varies from 11½° to 13° for an average tie of 4 cu. ft.

Geo. H. Peagram, chief engineer of the Union Pacific Railroad, says that about 250,000 ties were treated at their plant in Laramie, Wyoming at an average cost of 14° per tie, which includes unloading and reloading for shipment, but not for transportation.

Experience with this process. The following is a record of the first experiments in 1881, with the pine-tannin process. The ties were laid in the tracks of the A.T. and S.Fe rail-road at La Junta, Col.

<table>
<thead>
<tr>
<th>Kind of tie</th>
<th>Time when laid</th>
<th>Exposure</th>
<th>In the track in 1893</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Oak</td>
<td>1882</td>
<td>11 yrs.</td>
<td>96 %</td>
</tr>
<tr>
<td>Cottonwood</td>
<td>1882</td>
<td>11 yrs.</td>
<td>44 %</td>
</tr>
<tr>
<td>Colorado pine</td>
<td>1882</td>
<td>12 yrs.</td>
<td>40 %</td>
</tr>
</tbody>
</table>
Out of 50000 ties (oak) laid by the C.R.I. and P. Railroad on a new track in 1886, only fourteen and one half (14.5) percent had been changed in 1893; out of 21050 treated hemlock ties laid at same date, only three and sixteen hundredths percent had been changed in 1893. The following table shows the extent of treatment by this process, on the C.R.I. and P. Railroad.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Ties Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1885-6</td>
<td>148000</td>
</tr>
<tr>
<td>1887</td>
<td>257000</td>
</tr>
<tr>
<td>1888</td>
<td>209000</td>
</tr>
<tr>
<td>1889</td>
<td>210000</td>
</tr>
<tr>
<td>1890</td>
<td>253000</td>
</tr>
<tr>
<td>1891</td>
<td>340000</td>
</tr>
<tr>
<td>1892</td>
<td>325000</td>
</tr>
<tr>
<td>1893</td>
<td>406000</td>
</tr>
</tbody>
</table>

The St. Louis Wood Preserving Co. has treated gum wood, which at the end of four years was as sound as the day it was cut. The conditions were such that untreated gum would have decayed within 90 days.
Conclusions. The following are my conclusions concerning the adaptability of the new tannin process to the preservation of timber, viz:

1. Its use is limited, not being a sure preservative of timbers exposed to waters.
2. It is economical, being only one fourth as expensive as creosoting.
3. It is probably equal to Burnettizing in its efficiency in timber preservation.
4. Being of recent invention, its merits are not so well known as those of older processes.

Art 3. Vulcanizing.

History. I wrote to Mr. Andrus Bevier, Genl Manager of the New York Wood Vulcanizing Co., and our under obligations to him for the following information. The patents for this process were issued about 1879 and were renewed about 1893. Further than this I am unable to present any further facts concerning the history.
Chemicals. Vulcanizing is a process quite different in principle from all the other processes. Nothing is put into the wood but by the application of high heat and pressure the natural fluids are converted into an acid preservative compound which fills and seals the pores and completely saturates every fibre of the wood.

C. F. Chandler, Ph.D., of the School of Mines, Columbia College, examined two pieces of oak, one in the natural state and the other vulcanized. After treatment, the wood contained by virtue of high heating, the following substances, not found in the natural wood, viz.: 1) neutral oils, bitumens, etc. 0.36 % 2) phenols 0.17 % 3) resins, acids, and other bodies 10.10 %. The above substances are recognized by Dr. Chandler as antiseptic and preservative in nature. These antiseptics, generated thus by high heat, solidify upon cooling and remain fixed in the wood. Coagulation of the albumen is the first step in the process of vulcanizing. The second step ob-
tions when the albuminous sap is supplanted by crude pyrogallic acid, a strong antiseptic acid composed of a mixture of cresote, carbolic acid, wood alcohol etc.

Method of treatment. In vulcanizing, a pressure of from 100° to 200° to the square inch is maintained in the cylinder in which the wood is placed and the escape of the newly formed preservative fluid is effectually prevented. The solid contents of the fully matured wood cells, as well as the liquid in the sap wood, are melted together and mixed and thoroughly diffused throughout the stick. The process is equally successful with large and small timber. A longer time of treatment is required for the larger timber; heat will penetrate even to the center of the largest pieces.

Cost. The cost of vulcanizing depends upon the quantity of timber to be treated. The price varies from $8 to $10 per thousand feet (board measure). The following is an estimate of the relative cost of vulcanized and untreated
timber, assuming, (1) that a vulcanized tie will last for 18 years (I take this for granted, since there are corporations who will guarantee treated timber for this period, and (2) that the untreated tie lasts 6 years.

Assumed cost of untreated tie

Interest on $0.50 for 18 yrs. @ 6%

\[ \frac{0.50 \times 18}{2} = 0.99 \]  
\[ \frac{0.50 \times 6}{2} = 0.70 \]

Total cost for untreated tie

Cost = one year

Assumed cost of treated tie $0.65

Interest on $0.65 for 18 yrs. @ 6%

\[ \frac{0.65 \times 18}{2} = 1.98 \]

Total cost for treated tie

Cost = one year

Total difference in favor of treated tie $0.94

Difference per year $0.05

The above difference represents an annual saving per mile of $30 in
favor of the vulcanized tie, or it is an investment whereby interest of 25\% accrues.

Examples. Alfred C. Truax made some tests at Stevens Institute, Hoboken, to determine the effect upon yellow pine of the vulcanizing process. Two sets of experiments were made, viz., (1) compression and (2) transverse stress. The following is a recapitulation of the experiments.

(A) Compression.

<table>
<thead>
<tr>
<th>Length of piece</th>
<th>Average crushing of natural wood</th>
<th>Average crushing of vulcanized wood</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot;</td>
<td>5900 #</td>
<td>74.50 #</td>
</tr>
<tr>
<td>4&quot;</td>
<td>5483 #</td>
<td>7110 #</td>
</tr>
<tr>
<td>5&quot;</td>
<td>6333 #</td>
<td>7316 #</td>
</tr>
</tbody>
</table>

Increase in strength by vulcanizing 23\%.

The above experiment proves conclusively that vulcanizing increases the strength of the timber.
(b) Transverse (Length between supports, 30°)

<table>
<thead>
<tr>
<th>Condition of Wood</th>
<th>Dimensions</th>
<th>Actual Refraction</th>
<th>Breaking Load</th>
<th>Modulus of Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural</td>
<td>30° 0.965 0.965</td>
<td>0.182</td>
<td>1,083,805</td>
<td></td>
</tr>
<tr>
<td>Vulcanized</td>
<td>30° 0.960 0.930</td>
<td>0.150</td>
<td>924,197</td>
<td></td>
</tr>
<tr>
<td>Natural</td>
<td>30° 0.930 0.930</td>
<td>0.161</td>
<td>785,610</td>
<td></td>
</tr>
<tr>
<td>Vulcanized</td>
<td>30° 0.980 0.980</td>
<td>0.145</td>
<td>1,039,550</td>
<td></td>
</tr>
<tr>
<td>Natural</td>
<td>30° 0.930 0.970</td>
<td>0.161</td>
<td>761,980</td>
<td></td>
</tr>
<tr>
<td>Vulcanized</td>
<td>30° 0.980 0.980</td>
<td>0.150</td>
<td>1,212,075</td>
<td></td>
</tr>
</tbody>
</table>

These tests give the following average results:

1. Modulus of rupture, untreated wood: 10,762
   " " " " " vulcanized: 13,978

2. " " " " " elasticity, untreated: 877,098
   " " " " " vulcanized: 1,054,941

A committee appointed by Hon. B.F. Tracy, ex-secretary of the U.S. Navy, made investigations concerning the strength and durability of vulcanized timber and recommended that the
Hocking in one of the monitors be made of vulcanized yellow pine. The tests of this composite showed that the strength of yellow pine was increased 18% and the deflection decreased 13%.

The following are the results of tests of telegraph cross arms, made at the School of Mines, Columbia College.

October, 1892.

<table>
<thead>
<tr>
<th>No.</th>
<th>Kind of timber</th>
<th>Breaking Load untreated</th>
<th>Breaking Load vulcanized</th>
<th>% increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Norway pine</td>
<td>2600*</td>
<td>3000*</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>Cypress</td>
<td>1860*</td>
<td>2600*</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>Spruce</td>
<td>2400*</td>
<td>2700*</td>
<td>13</td>
</tr>
<tr>
<td>4</td>
<td>Basswood</td>
<td>2500*</td>
<td>2850*</td>
<td>11</td>
</tr>
</tbody>
</table>

F. H. Hain, Gen'l. Manager of the Manhattan Railway Co. writes that he considers vulcanizing far superior to any other known treatment for prolonging the life of timber. He further states that vulcanized timber holds spikes much better than crossdled wood and that spikes are as firmly fixed after the
Conclusions. The strength of wood is much increased by vulcanizing.

2. Vulcanizing makes wood stiffer and harder.
3. Spikes have a holding power in vulcanized wood unequalled in any other preserved wood.
4. The cost of treatment is commensurate with the results obtained.

Art. 4. Kyanizing.

History. The process of Kyanizing was patented in England by John Howard Kyan, March 31, 1832. It consists of impregnating the wood with a solution of bichlorate of mercury, commonly called corrosive sublimate.

Chemicals. The original proportions were one pound of dry salt to four gallons of water. The timber was impregnated with 1/2 of this mixture, per thousand feet board measure.
Recently a solution of 1 part of salt to 10 gallons of water was used of which the timber absorbed 2½ parts. Mr. J. B. Francis, chief engineer of the Proprietors of the Locks and Canals on the Merrimac river, used a solution, which contained 1½ parts of salt, of which the timber absorbed from 4 parts to 5 parts per thousand feet board measure. This latter seems to be the proper quantity to inject.

**Method of Treatment.** Kyanizing is not carried on very extensively in this country and the use of timbers treated by this process seems to be quite limited. In 1885 there were only two plants in the United States, which did Kyanizing, one at Lowell, Mass. and one at Portsmouth, N.H. The plant at Lowell, Mass. consists of two pits or tanks, built of masonry, 40 feet long, 7½ feet wide and 4 feet deep with a capacity of 10,000 feet board measure. The timber is allowed to steep one day for each inch of thickness, with one day additional. The plant at Portsmouth, N.H.
consists of four tanks, each 60 feet long, 9½ feet wide and 6 feet deep, built of granite laid in cement, and coated on the inside with coal tar applied hot. These tanks are filled with ties, and a solution of corrosive sublimate is pumped in from another tank. When the tanks are filled, the liquid is heated by blowing steam into it. The corrosive sublimate is dissolved in a large cauldron of boiling water. The concentrated solution is added to the liquid in the tanks to keep it of the proper strength as determined by a hydrometer.

Cost. The cost of impregnating depends largely upon the price of the corrosive sublimate, which has been much reduced lately. The cost of impregnating timbers, considering the price of salt 40° per pound, is $2.75 per thousand feet board measure, or about 15° per ordinary tie. The quality, size and state of dryness, influence the amount of corrosive sublimate absorbed and hence the cost of treatment.
Experience with Kyanized timber. Two sets of posts, one of which was Kyanized, were placed in the ground at Lowell, Mass. in 1862. In 1891, the untreated pieces were completely decayed, while the Kyanized timbers were in a fair state of preservation. Mr. W.P. Judson says that Kyanized timbers, with free access to air, and the absence of standing water, would be 80% sound after 40 years. He was influenced in his statement by the examination of Kyanized wood at Fort Ontario.

Conclusions. The following are conclusions concerning the use of Kyanized timbers, viz:

(1) Kyanizing is not extensively used.

(2) It is ineffectual in damp places, hence probably unfit for ties.

(3) Its cost equals that of Burnettizing.

(4) It has been deleterious to the health of those engaged in the process, hence this is a disadvantage, not common to most of the other methods. Carbolineum Arsenious only, is like Kyanizing in this respect.
Art. 5. Wood Crossing. (Woodline)

History. The compound used in this process is manufactured at Beverly, N.J., by the American Wood Preserving Co. It was patented in 1877. The writer regrets that, at this time, no fuller history can be given.

Process of treatment. The process of treatment is simple. The liquid is usually placed in a wooden or metal tank. Inside this tank is a coil of steam pipe used in heating the liquid to about 150° Fahr. The time of immersion, necessary to secure the absorption of one half gallon per tie is from ten to twelve minutes. Pressure is not required in this process, to force the liquid into the wood. The penetrating qualities of the liquid are so great that a hard white oak tie, placed in a bath, will absorb liquid as stated above. At Ravenna, N.J., April 2, 1896, the Pennsylvania Railroad experimented upon fourteen black oak ties for
the purpose of ascertaining the penetrating qualities of Woodiline.

The following are the results:

<table>
<thead>
<tr>
<th>Exposure of timber</th>
<th>Average temperature</th>
<th>Average time of immersion</th>
<th>Quantity absorbed</th>
</tr>
</thead>
<tbody>
<tr>
<td>In boiler room, 2 weeks</td>
<td>129°</td>
<td>10.6 min</td>
<td>4.2 #</td>
</tr>
<tr>
<td>In rain, 2 days</td>
<td>129°</td>
<td>10.6 min</td>
<td>3.4 #</td>
</tr>
</tbody>
</table>

**Cost.** The covering capacity of Woodiline is about 300 sq ft of dried timber surface per gallon. The price per barrel is $18.00, hence it is considerably cheaper than Carbolineum Amaranne or the ordinary heavy barn or red lead paint. This process is advantageous so far as cost is concerned, in that no expensive plant is required to carry on the work. The iron tanks such as are used by the Pennsylvania Railroad Co. may easily be carried from place to place by simply taking them apart.

It would be a very easy matter to construct, on a flat car, a tank, which could draw its supply of steam from the engine. In this way, ties could be treated at any point on the road.
and great economy result therefrom.

Experience with treated timber. In one case, woodlinc has prolonged the life of black oak ties two or three times that of white oak and in this case the black oak ties were subjected to most unfavorable influences, being covered with wet alluvial soil, in the yard of the Pennsylvania Railroad Co. at Camden, N.J. and were situated in the pathway of the drain of the yard.

Conclusions. I find that woodlinc seems to be an efficient method, (1) on account of the penetrating power of its liquid, (2) owing to the short time consumed in treatment (3) because its cost compares favorably with any other method (4) the facilities for treating the timber are unsurpassed.

Art. 6. Bouchierizing.

History. This process was invented by Dr. Bouchierie, a distinguished French chemist, about 1840. He sought to force the liquid through the pores of the wood by means of hydraulic
pressure. The solution which he first experimented with was pyrolignite of iron. Failing in this, he resorted to the employment of sulphate of copper. He conceived the idea that timber could be treated while standing in the living tree. Accordingly he tapped a tree and inserted some of the sulphate of copper, depending of course, upon the suction of vital sap to draw the chemical upward throughout all the pores of the wood. This was not successful. In another experiment, he sawed the logs nearly in two, piled the joint open and then inserted around the circumference of the log, a tarred rope or other sheathing. Then the joint of the log was allowed to close in on the sheathing and a diagonal hole bored so that this hole would terminate within the space of the joint and intersect to the sheathing. Then by means of a funnel, liquid under a head was sufficient to penetrate the pores longitudinally. This process was used for years in France with satisfactory results.
Chemicals. This process with a solution of about 1 of sulphate of copper to 100 parts of water, has been used quite a good deal, especially in France.

Conclusions. The following are conclusions which result from looking over the literature and experiments, concerning the efficacy of Boucherizing as a timber preserving process.

1. The process is used almost wholly in France, in which country, I understand, the process was used, as late as 1893.
2. It does not protect timber from the ravages of the teredo.
3. It is inconvenient, in that it must be applied to freshly cut logs in the forest.

Art. 7 Miscellaneous Processes

Introduction. I must necessarily be very brief in enumerating the various minor processes because there are almost as many of them as there are men who have given the subject any consider-
tain, and a detailed description of each would consume more

time than I am able to give to the subject. The processes

which are enumerated in this article may be divided into two

classes, viz., (1) those which are still in use and (2) those which

are abandoned. The greater number of them have been aban-
donned for years. The order of enumerating the methods

shall depend upon two things viz., (1) upon their success and

(2) the time they were used, preference being given to those meth-
ods which now exist.

Carbolinum Avenarius. This process was invented

by Mr. R. Avenarius. Having looked over the literature of turp

dite preservation and examined pamphlets from C. I. McKee, Manager of

the Carbolinum Wood Preserving Co., the writer is sorry to state

that he could find nothing concerning the history of this process

other than what is given above.

Constituent. The essential ingredient used in this process

is a carbamate of oil containing antiseptic qualities. This
liquid may be applied in either of two ways, viz., (1) by means of a brush or (2) by soaking. The effects of the action of the oil is partly chemical and partly mechanical. Chemically, the oil acts thus: having a specific gravity of 1.14, it coagulates the albuminous parts and prevents them from producing decay. It disinfects all parts touched by it and changes the nutritive bodies upon which microbes live. Mechanically, the oil, penetrating the wood, expels the water.

If the timber is green or wet, the oil is best applied hot, at a temperature from 250° to 300° Fahr. By using the oil hot, more of it penetrates the wood and a less amount is required to give certain protection.

Cost. The cost of Carbolicum Aversans is about $1.00 per gallon. One gallon of this fluid gives one coat to 300 sq. ft. of dressed lumber or 600 sq. ft. of rough lumber, or 100 sq. ft. of shingle roof. Its price and covering capacity is hence much the same as ordinary barn or steamboat paint.
Experience with the treated timber. J.L. Morten, constructing Engineer of the S. and W. railroad reports that timbers treated with Arsenious resist the attacks of the teredo very successfully. He further states that it gives satisfactory where applied to bridge timbers. He found the cost to be from $4.00 to $6.00 per thousand feet board measure.

O.T. Balsom, Chief Engineer of the Kings County Elevated Railroad Co. of Brooklyn, N.Y. treats all of his platforms with this liquid and is satisfied with the results.

Two pieces of timber, one treated with Barbolincum Amnurchus, the other untreated, were sunk in Tampa Bay where the teredo is very destructive. In two years the treated timbers remained sound, the other was reduced almost to nothing.

Conclusions. The general conclusions respecting this process as a timber preservative are:

1. That it is quite as effective as creosoting in pro-
testing timbers from the teredo.

(2) That it is used considerably on Southern railroads, wharves, piers etc.

(3) That its cost is such as to justify a wide use of it.

(4) As in Kyanizing, there is a liability of injury to health through the application of the liquid.

Thilmany's process. This process was patented by Mr W Thilmany about 1870 and is a modification of Dr. Boucheire's process. It was found that the liquid, sulphate of copper, became diluted with sap, and upon being introduced into the wood again, it was found that ammoniuous matter was reintroduced into the wood. To alleviate this trouble, he proposed a double injection; first of muriate of barytes and then of sulphate of copper.

Method of application. The timber is placed in long cylinders and the air exhausted therefrom. The cylin-
The wood is then filled with a solution of sulphate of copper or sulphate of zinc. Then a pressure of 100 lbs. per sq. in. is main-
tained until the wood is completely charged with the solution.

For the purpose of changing the soluble sulphate of copper into an insoluble salt of sulphate of baryta, the boiler is
filled a second time with a solution of chloride of baryta a little pressure maintained. The result of this is the
formation of a salt of sulphate of baryta, which fills and
perforates the pores of the wood.

Proportion of chemicals. A solution of 1½ ps. of blue
vitreol and 1½ of chloride of baryta has been found suf-

cient for the preservation of pine and white oak timbers.
The American Wood Preserving Co. of Defiance, Ohio, ad-
vocates a solution of 3½ ps. of zinc for timbers of a
swampy growth.

Cost. The cost is about 10¢ per cu. foot.
Fernoline. Fernoline is a product of distillation of yellow pine wood containing 50% of wood creosote, 10% of pine tar, and 40% of oil of turpentine. This liquid preservative was manufactured at Charleston S.C. until 4 years ago. At that time, the plant was burned and the company has discontinued the treatment of timber.

Method of Application. Fernoline should be applied with a brush, using two or more coats. When practical, economic results will be obtained by soaking the wood in the liquid.

Cost. The cost of this liquid, in lots of one or more barrels, is 25¢ per gallon. The manufacturers believe that two coats of this liquid, at a cost of six cents, will lengthen the life of a tie, two years. The life of blocking and stringers under station platforms is doubled at an increased cost of 5%.

Conclusions. Fernoline is used by several railroad com-
panies in the east and south for timbers employed in the
construction of cars, on tenons, mortises etc. It has likewise
been used successfully in the construction of cars by the Pullman
Palace Car Co.

(2) It has not been applied very much to ties.

(3) It is cheaper than Carbolicum Avenarius or
Woodline.

(4) It has proven efficient in protecting timbers from
marine worms.

**Fladd's Process.** In 1882, Col. H. Fladd of St.
Louis patented a process, which is the reverse of Dr. Bou-
cherie's process. Instead of forcing liquid through the
pipes, Mr. Fladd proposed that a suction pump be applied
at one end of the log, while the other end remained in a vat
of the liquid solution. He used sulphate of copper principally
and succeeded in increasing the life of timber quite ma-
terially.
Conclusions. This process, like Mr. Boucherie's will never be efficient owing to inconvenience in treatment, i.e., logs must be treated while green.

**Lime Process.** This process has been used in France to a considerable extent. Its use was suggested by the fact that boxes, used for mixing lime mortar, resisted decay quite well. Lime is absorbed quite readily by wood but is a comparatively weak antiseptic.

**Earle's Process.** This process consists in immersing timber in a hot solution of 1 lb. sulphate of copper and 3 lb. of sulphate of iron mixed in 20 gallons of water. The process was tried at Westerloch arsenal, where 63,000 cu. ft. of timber was treated at a cost of 7° per cu. ft. Although the life of the timber was increased, the process was abandoned about 1850, owing to the checking and warping of the wood.
Charring. The sap from the exterior is partly driven inward and then decomposed in the pores of the wood, thus vulcanizing it. Charcoal which composes the charred surface is indecomposable, resists the attacks of insects, and also acts as a filter. Charring may be accomplished by several agencies, viz. by fire, sulphuric acid, or gas or oil flame. Charring by means of sulphuric acid is quite superior to charring in any other manner but the cost by this method exceeds that of any other.

Charred timbers dipped in coal tar, prove efficient and have been known to last for 25 years. These timbers may be dipped into a hot mixture of raw linseed oil and pulverized charcoal, but linseed oil is not such an effectual agent as coal tar.

Foremanizing. This process was patented in 1865 by Mr. B. S. Foreman. The process consists of treating timber with a dry powder, composed of salt, arsenic, and corrosive sublimate. The mode of application adopted by Mr. Foreman was to bore
holes two inches in diameter, three fourths of the way through the timber, four feet apart, fill them with dry powder and plug up the holes. The result of this mode of application is that the powder attracts moisture and this moisture liquefies the compound. In consequence of this, the liquid is conveyed to all fibers of the wood by means of capillary attraction. The arsenic crystals will remain as long as any wood is left. This process was tried on the Illinois Central Railroad and the Chicago and Northwestern Railroad without success in either case. The ingredients are destructive to life. Cases are known where men have lost their lives by putting on shingles treated with arsenic and corrosive sublimate. The arsenic effloresced from the ties along the Memphis and Charleston Railroad. Cattle came and licked the ties for the sake of the salt, and they died.

Smith’s Process. In 1867, Mr. W. H. Smith patented a method of preserving timber by encasing it in vitrified...
earthenware pipes and filling the space intervening with a
grout of hydraulic cement. This process failed owing to
the breaking of the earthenware pipe and cement.

Chapter 3. Conclusion

The subject of timber preservation has as yet re-
ceived but little attention. This is due to the fact, that,
owing to the cheapness of timber in some localities, espe-
cially in the south, railroads have not considered it pro-
fitable to preserve the timber. This may explain the condi-
tions existing on our railroads, as seen in the report of
June, 1896, where it is asserted that out of 53 of the
leading railroads in the United States, only 8 use preserved
timber of any kind. I am not willing to suppose that
this is conclusive evidence respecting the impracticability of
the subject. Indeed, throughout this paper, I have enumerated
cases in actual practice, wherein preservation of timber was