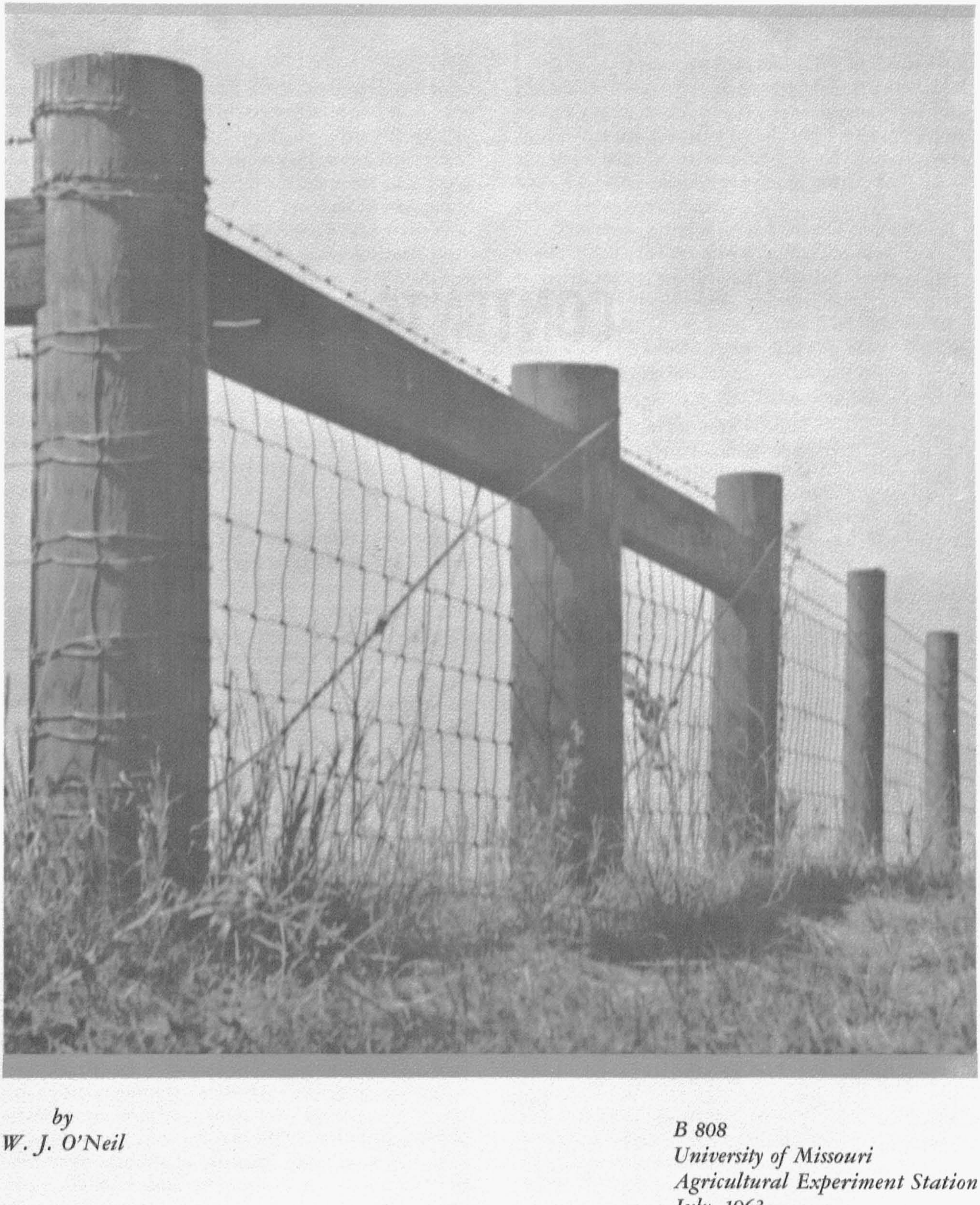
TESTS ON TREATED FENCE POSTS



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What native tree species yield fence posts that are most serviceable for farmers under Missouri conditions? What kind of preservative treatment, other than pressure, is most effective in lengthening the life of non-durable fence posts? What equipment does a farmer need for treating his own fence posts? What is the annual cost of using untreated posts as compared to treated posts? In 1938, the Department of Horticulture and Forestry in cooperation with the Department of Agricultural Engineering initiated a simple experiment to obtain answers to these questions. Since 1947, the research has been administered by the School of Forestry and was expanded considerably in 1955 by the addition of new preservatives and treatments and other species.

It is estimated that over 7,500,000 fence posts are used annually in the state of Missouri. During the peak year, 1946, over 20,000,000 posts were utilized. Approximately 80 percent of the posts used each year are replacements for posts rendered unfit for further service by insect and fungus attack. The rest of the posts are used for new fencing, which eventually will require replacements. Smith (1954) shows that the average Missouri farm requires 226 posts annually. A well constructed fence has a life expectancy of 25 years if posts of potential long life are used. Untreated posts of non-resistant heartwood often rot out in 3 to 5 years. If these non-durable posts can have their life extended by 20 years by an inexpensive preservative treatment, farmers could realize a considerable saving of time and money.

Experimental Procedure

This experiment was carried on in 2 different areas, one at Columbia commencing in 1938 and the other initiated near Weldon Spring in 1955.

Selection and Preparation of Posts—In the Columbia study the twelve species selected for study were basswood *(Tilia americana* L.), catalpa *(Catalpa speciosa* ward.), eastern redcedar *(Juniperus virginia* L.), American elm *(Ulmus americana* L.), slippery elm *(Ulmus rubra* Muhl.), hackberry *(Celtis occidentalis* L.), shagbark hickory *(Carya ovata* Koch), black locust *(Robinia pseudoacacia* L.), black oak *(Quercus velutina* Lamarck), chinkapin oak *(Quercus muehlenbergii* Engelm.), white oak *(Quercus alba* L.), and shortleaf pine *(Pinus echinata* Mill.). All of these species are readily available in Missouri. Three hundred twenty-two posts were used, of which 84 posts (seven of each species) were not treated.

The fence posts were cut during the period of October 1936, to May 1937, air-seasoned for several months, and treated in the fall of 1938. Posts were of two types, split and round. The slippery elm posts were split, while the posts of cedar, basswood, black oak, and hackberry were a mixture of split and round posts. Posts of all other species were round.

The posts were cut 6.5 feet long. They were measured carefully and the following data recorded: butt diameter in inches, top diameter in inches, number of annual rings in the last inch, and total number of annual rings. The size of the posts varied. The butt diameter ranged from 3.3 to 7.7 inches. The top diameter varied from 2.2 to 6.5 inches.

The fence posts in the Weldon Spring study were cut in 1950, 1951 and 1955. They were seven feet long. The following data were recorded: species, shape of posts, percent moisture content, diameter at the butt and top end, sapwood thickness, number of growth rings in the last inch and the total number of growth rings.

The following are averages for the data taken on posts in the Weldon Spring test.

Moisture content	14.48 percent
Butt measurements	
Diameter	4.77 inches
Thickness of sapwood	1.55 inches
Number of growth rings in last inch	7.81
Number of growth rings	17.72
Top measurements	
Diameter	3.76 inches
Thickness of sapwood	1.23 inches
Number of growth rings in last inch	7.02
Number of growth rings	16.61

The species tested were cottonwood *(Populus deltoides* Bartr.), Shagbark hickory, American sycamore *(Platanus occidentalist* L.), white ash *(Fraxinus americana* L.), black locust, shortleaf pine, American elm, and black oak.

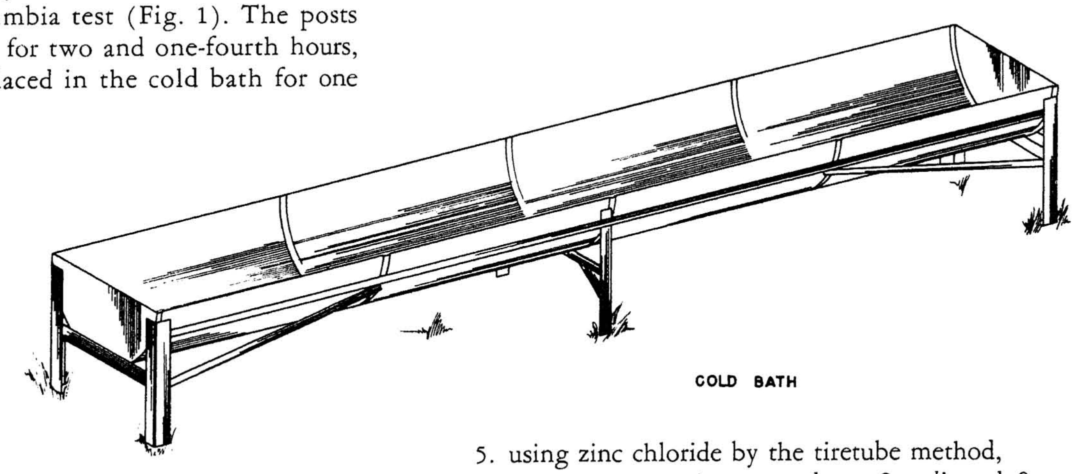
Types of Preservative Treatment—Most of the preservatives and treatments in 1938 commonly known which did not involve the use of pressure or expensive equipment were tested in this study. Since the experiment was initiated, several new preservatives have come on the market. Pentachlorolphenol, one of the best of the new preservatives, was used in the Weldon Spring test.

Because the hot- and cold-creosote bath treatment can be applied readily with simple inexpensive equipment, eight posts of each of eleven species (catalpa not included) received a hot bath of creosote at a temperature of 220°F., followed by a cold bath of creosote at air temperature in the Columbia test (Fig. 1). The posts were left in the hot bath for two and one-fourth hours, after which they were placed in the cold bath for one hour.

ed to drain for 24 hours by placing them across two parallel timbers so that the posts were elevated above the ground.

The other six treatments employed in the Columbia test were:

1. painting the posts with hot creosote,
2. painting the posts with carbolineum,
3. soaking the entire post in crankcase oil for one week,
4. soaking the entire post in a five percent solution of zinc chloride for one week,



5. using zinc chloride by the tiretube method,
6. using two proprietary products *Osmolit* and *Osmoplastic.*

The tiretube method consists of laying unpeeled green posts on an inclined stand or platform with the butt end elevated (Fig. 2). The butt end is then smoothed, and grease is applied so that the entire tube fits tightly around the posts. A zinc chloride solution equiva-

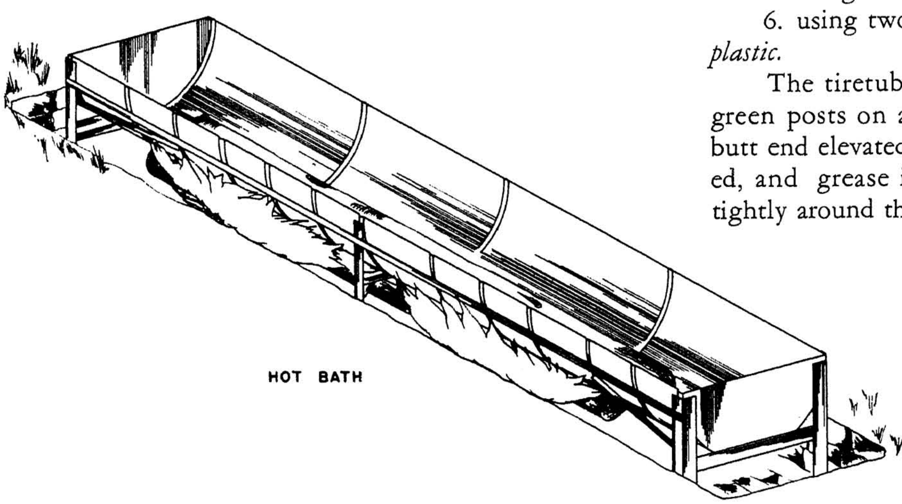


Fig. 1. Equipment needed for treating posts by the hot bath—cold bath creosote method.

Fourteen other treatments, designed to test more fully the most promising preservatives and methods on a relatively soft hardwood (basswood) and a relatively hard hardwood (black oak), was applied to 71 black oak and 71 basswood posts.

Eight different hot- and cold-bath creosote treatments were applied to two or three feet of the butt end of black oak and basswood posts. Treatments varied in the length of time that the posts were left in both the hot and cold bath. After treatment the posts were allow-

lent to a five percent solution (made by mixing 21 pounds of 50 percent zinc chloride solution in ten gallons of water) is poured into each inner tube. The solution is then carried by the force of gravity toward the small end of the post. The excess solution can be reclaimed as it drips out at the end of the post.

In using the Osmolit process, freshly cut posts must be peeled of all outer and inner bark. Osmolit is mixed with an equal part of water, and is then brushed over the entire outer surface of the post. The posts also may be

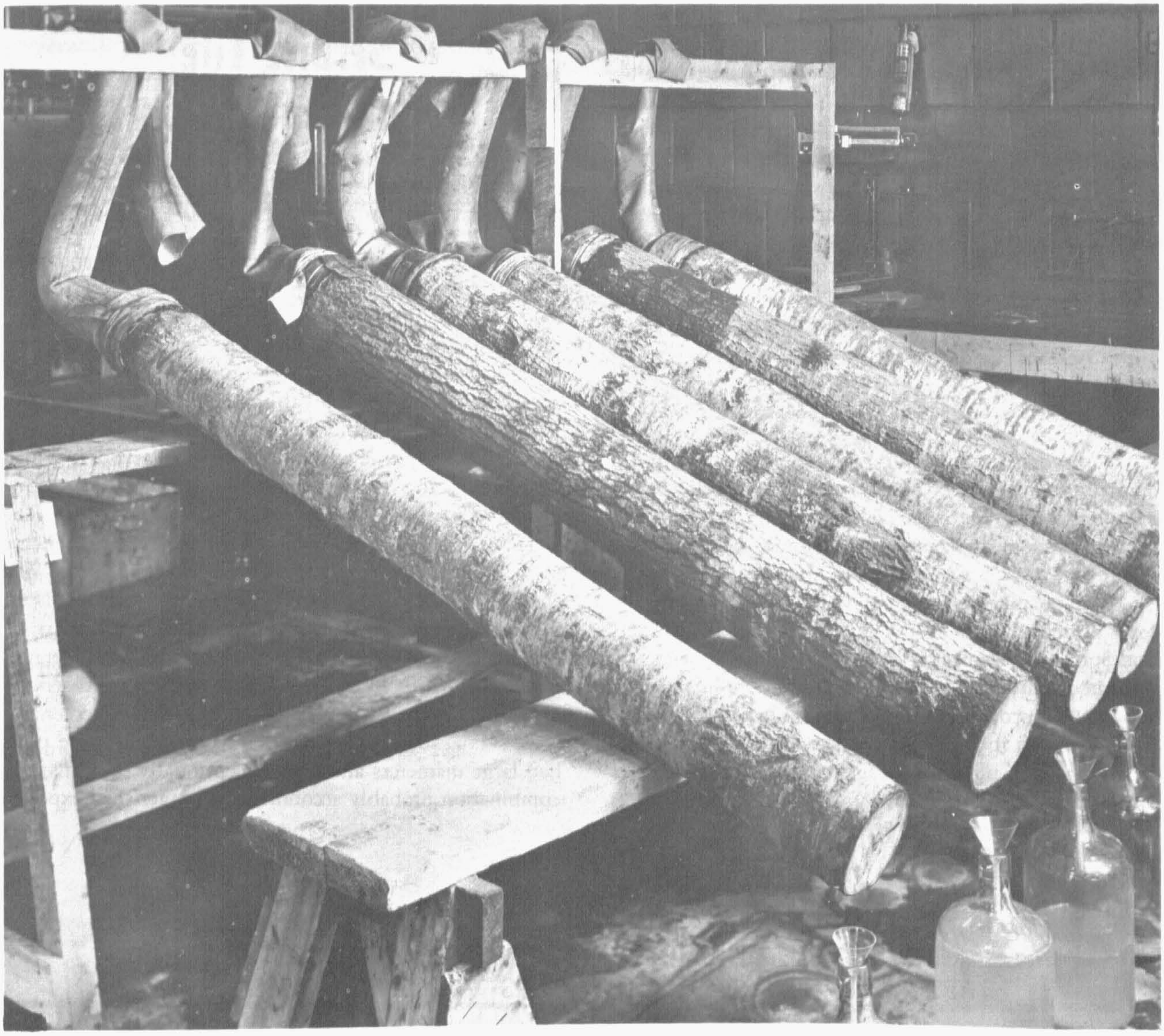


Fig.2. Treating posts with zinc chloride by the tire tube method. (Photo by U. S. Forest Service.)

dipped into the solution. In this experiment the posts were painted. When the posts are thoroughly covered with the solution, they are piled in a pyramid and covered with hay, straw or similar material to prevent rain from washing off the solution and to slow up the seasoning of the post. The posts must remain covered for three to four weeks.

In the Osmoplastic treatment, the bark is removed for a distance of four inches above and eight inches below what will be the ground line when the post is set for use in a fence line. The solution is brushed on the surface of the post. If the treated area is covered with a waterproof bandage, the treated posts may be set immediately; otherwise, the posts should be seasoned for two weeks before being set. In this study waterproof bandages were used.

In 1950, 246 posts were treated by 10 different treatments with a five percent solution of pentachlorolphenol in No. 2 fuel oil at Weldon Spring. The treatment consisted of three soaking periods of 24, 48 and 96 hours at various temperatures ranging from 2.5°C to 42°C. The species treated were white ash, American elm, black oak and black locust. Fourteen white ash posts were treated with creosote under pressure.

At a logging show in Missouri in 1953 the Forest Products Laboratory of Madison, Wisconsin, treated 75 posts by the double diffusion method. They included the following species: Black oak, shortleaf pine, sycamore and shagbark hickory. In the fall of 1954 and spring of 1955 one hundred and fifty-nine posts were treated at Weldon Spring by the double diffusion method. In the double diffusion method a one- to two-inch strip of bark is peeled from the four faces of green unseasoned posts, following which the posts are placed for 48 hours in a solution of 23 pounds of zinc sulfate and two pounds of arsenic pentoxide in 16 gallons of water. After removal from this solution the posts are placed for 48 hours in a solution of 18 pounds of sodium chromate in 16 gallons of water. A proprietary treatment called osmose salts was applied in 1955 to 75 posts of the following species: White ash, American elm, shagbark hickory, black oak and cottonwood.

Setting of Posts and Subsequent Examinations

Inspections of posts in the Columbia test were made annually in February or March since 1952. Previously inspections were made at intervals of one to three years. At each inspection, data on the condition of the posts were recorded.

The posts treated from 1950 to 1955 together with forty untreated posts of five species were set at the Weldon Spring Experimental Farm in 1955. Both treated and untreated posts of the following species were included in the test: ash, cottonwood, elm, hickory, and black oak. Species which included treated posts only were: black locust, shortleaf pine, and sycamore. The posts have been examined annually since 1955.

Service Life of Untreated Posts

The percentage of posts of each species in serviceable condition after different periods of time in the Columbia test is shown in Table I.

It is apparent that catalpa, eastern redcedar, and black locust were durable since most of the posts were serviceable for more than 15 years. No catalpa posts failed during the entire test period. The redcedar and black locust posts had serviceable lives averaging 19 and 17 years respectively. The generalization that a large amount of heartwood in a durable species increases post longevity is borne out by this study. The two cedar posts which were serviceable for less than 14 years had heartwood diameters at the butt end of less than three inches. The heartwood of the other cedar posts exceeded three inches in diameter. The smallest locust post failed first. The chinkapin oak posts were small in heart diameter particularly when compared to the split black oak posts.

The oaks and shortleaf pine proved to be moderately durable; most of the posts of these species were serviceable for at least five years, but only a small percentage were serviceable at the end of 15 years. The pine posts had large diameters and were exceptionally resinous; this combination probably accounted for longer-than-expected

TABLE I

PERCENTAGE OF UNTREATED POSTS SERVICEABLE AFTER VARYING PERIOD OF YEARS (COLUMBIA TEST)

Species	5 years	10 years	15 years	20 years	23 years
Catalpa	100	100	100	100	100
Eastern Redcedar	100	86	71	71	57
Black Locust	86	86	71	71	71
White Oak	86	43	14	14	None
Chinkapin Oak	86	43	None	None	None
Shortleaf Pine	57	29	29	None	None
Black Oak	100	29	29	None	None
Hackberry	14	None	None	None	None
Slippery Elm	None	None	None	None	None
Shagbark Hickory	None	None	None	None	None
American Elm	None	None	None	None	None
Basswood	None	None	None	None	None

serviceability of these species. The other species tested showed low durability. The results obtained in this study were somewhat similar to those reported by Blew and Champion (1956).

Analysis of the data indicated that there was no apparent relationship between durability and number of annual rings in the outside inch or the total number of growth rings in the post.

After seven years only a small portion of the untreated posts in the Weldon Spring test were serviceable. Twenty-five of the 200 posts (12½ percent) were serviceable after seven years. The percentage of posts still serviceable after seven years are as follows:

Species	Serviceable posts percent of original
White ash	7.5
Cottonwood	7.5
American elm	5.0
Shagbark hickory	0.0
Blackoak	50.0

Service Life of Treated Posts

The record of serviceability of creosote-treated posts is shown in Table II.

This treatment increased the serviceable life of posts of all species.

The basswood posts painted with hot creosote had an average life of approximately three years while those treated with zinc chloride by the tiretube method had an average life of 14 years. The black oak posts painted with hot creosote had an average life of seven and one-half years (two and one-half times that of similarly treated basswood) while the posts treated with zinc chloride (soaking post for one week) had an average life of over 11 years. Of the posts given two and one-fourth hours hot creosote treatment followed by cold creosote treatment for one hour, either treating the entire post or the butt and an additional one foot, one post of each was still serviceable after 23 years.

In the case of the non-durable species (elm, hickory, hackberry, and basswood) treated posts may be classified as moderately durable, lasting about five to ten years. The life of the moderately durable species (oaks and pine) was significantly improved by the treatments, most of the posts lasting close to 15 years. The naturally durable species such as locust, cedar and catalpa, were not improved by the treatment. Over half the untreated cedar posts were sound after 23 years and 50 percent of the treated posts were sound after 23 years. The untreated locust posts were 86 percent serviceable after 23 years

TABLE II

PERCENTAGE OF CREOSOTE-TREATED POSTS SERVICEABLE AFTER DIFFERENT PERIODS OF TIME (COLUMBIA TEST).

Species	Percentage of serviceable posts after 5 years	10 years	15 years	20 years	23 years
Catalpa	100	100	100	100	100
Eastern redcedar	100	100	50	50	50
Black Locust	100	100	88	63	63
White oak	100	100	88	75	75
Chinkapin oak	100	100	100	100	100
Shortleaf pine	100	100	100	63	63
Black oak	100	100	100	100	37½
Slippery elm	100	100	25	25	25
Hackberry	100	25	None	None	None
Shagbark hickory	100	37	None	None	None
Basswood	87½	25	None	None	None
American elm	87½	12½	None	None	None

while 63 percent of the treated posts were serviceable. Catalpa, locust, and redcedar are naturally durable. Preservative treatment of those species does not seem justified since they can be expected to give service in fence post form for at least 20 years without treatment.

The effectiveness of the various treatments on each species in the Weldon Spring test (1955) is shown in Table III. It is obvious that only the pentachlorolphenol and creosote treatments have given satisfactory results. After seven years both treatments have been effective. Too many failures of posts given other treatments have occurred to justify the cost of treatments. There is some indication that the effectiveness of the treatments varies somewhat with species. Whereas the double diffusion method was reasonably effective with white ash, cottonwood, American elm, and black oak, it was much less effective with shagbark hickory. On the other hand, the double diffusion method was quite effective on cottonwood, a species of naturally low durability. The effectiveness of the osmose salts treatment showed great variation among species, being ineffective with cottonwood, and reasonably effective with ash, oak and American elm. Since, at the end of seven years, only one of the 246 posts treated with pentachlorolphenol for variable periods at different temperatures had failed, there is no evidence that treatment for more than 24 hours or at any specific temperature affects post serviceability.

TABLE III

PERCENTAGE OF SERVICEABLE POSTS BY SPECIES AND TREATMENT AFTER 7 YEARS

Species	Pressure Creosote Percent	Penta Percent	Double Diffusion St. James Percent	Osmose Salts Percent	Double Diffusion Weldon Sp. Percent
White ash	100	100		80	67
Cottonwood		98		20	74
American elm		100		80	67
Shagbark hickory		100	40	60	54
Black Locust		100			
Black oak		100	86	73	71
Shortleaf pine			100		
Sycamore			100		

Cost of Installing and Replacing Posts

Cost of fence construction is composed of three items of cost:

1. the post
2. digging the hole
3. installation of the post and fencing.

Since items 2 and 3 are constant, the cost of the post and the length of its serviceable life will determine the annual cost of the fence.

Since the cost of digging post holes and of installing the post and fencing are not affected by the kind of post used, the initial cost of the posts and the length of their serviceable life will determine the annual cost of fence construction and maintenance. The effect of these factors on annual cost is shown below when an untreated post having a serviceable life of five years and a treated post having a serviceable life of 30 years are used:

Untreated post—life 5 years

Cost of post	\$0.20
Cost of digging hole	0.27
Cost of post and fencing installation	0.20
	\$0.67

Cost per year	**$0.13**

Treated post—life 30 years

Cost of post	$0.65
Cost of hole digging	0.27
Cost of post and fencing installation	0.20
	$1.12
Cost per year	**$0.037**

On a mile of fence with posts spaced 12 feet apart the difference in annual cost is $43.12. In 30 years this is a difference of nearly $1300.

Summary and Conclusion

1. The species may be grouped into three durability categories based on the results of this experiment:

Durable—Most posts will endure for 20 years. Catalpa, eastern redcedar, and black locust.

Moderately Durable—Most posts will endure from five to 15 years. Chinkapin oak, white oak, black oak and shortleaf pine.

Non-Durable—Most posts will not endure for five years. Ash, basswood, cottonwood, American elm, hackberry and hickory.

2. If untreated posts are used, they should be made from a durable species and should contain heartwood with a diameter of at least 3 inches at the butt end.

3. The most successful treatment was creosote pressure treatment. No failures have occurred after seven years.

4. After seven years 99 percent of the posts treated with Pentachlorolphenol are still serviceable.

5. The two and one-fourth hours hot bath followed by a one hour cold bath was the most successful non-pressure treatment. Forty-three percent of the posts treated by this method were serviceable after 23 years. This treatment gave an average life for all species of 15 years. Some of the more durable species treated in this manner are still serviceable after 23 years. This treatment prolonged the life of all species.

6. The two tests of posts given the double diffusion treatment gave similar results. After seven years, 88 and 79 percent of the posts were still serviceable.

7. The posts given Osmose-salts treatment were 59 percent serviceable after seven years.

8. The posts given the zinc chloride treatment where the entire posts were soaked for one week were serviceable for 11 years.

9. The zinc chloride tiretube method gave basswood a slightly longer life than black oak, 14 years against 13 years.

10. Basswood and black oak posts given the osmoplastic ground line treatment were serviceable for nearly five years and 15 years respectively. Applying the Osmolit treatment to the entire post of basswood and black oak resulted in a serviceable life of three and 14 years respectively. Both treatments obviously were ineffective on basswood but, were reasonably effective on black oak.

11. Painting posts with hot creosote or carbolineum is not effective in increasing the serviceable life of posts.

12. No treatment of basswood posts other than the zinc-chloride tiretube method increases the serviceable life enough to warrant the cost of treatment.

13. The service test of posts treated by the double diffusion method was not extended over a long enough period to justify a final appraisal of the results. However, it appears as though this method will not be as effective as the pentachlorolphenol or creosote methods in prolonging the serviceable life of posts.

14. For persons who wish to produce and treat their own posts, either creosote or pentachlorolphenol may be used as a preservative. If creosote is used, the seasoned posts should be left in a hot bath at 220°F for two hours, and then placed in a cold bath for one hour. If pentachlorolphenol is used the seasoned posts should be soaked in a five percent solution of the preservative in No. 2 fuel oil for no less than 24 hours.

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