park as elsewhere. They average about 150 ft. high and 3 to 5 ft. in diam. The wood is usually very hard and strong and is useful for ties as well as for heavy construction work, piles, etc. The Lodgepole pine is a very rapid growing tree, has a strong wood and is used a great deal for all kinds of construction purposes.

A number of the larger railways of the United States have been carrying out experiments with plantations of their own on their outlying and other lands. In Table II. is given some of the work done and the cost of planting the trees.

Table II.

Railway and Location.	Kind of Trees.	First cost per 1,000.	Cost of planting per 1,000.
A. T. and S. F. at San Deguito, Cal.	Eucalyptus	—	—
C. B. and Q., Ottumwa, Iowa	Catalpa	$10.00	$20.00
Pennsylvania, various	Locust and Red Oak	5.00	5.00
L. and N., various	Catalpa, Walnut, Locust, Poplar	5.00	23.00
D. L. and W. In N. J. and N. Y.	Yellow Locust	23.00	12.00
G. H. and S. A., Texas	Catalpa	16.70	12.00
Southern, Wolf Trap, Va.	,,	19.40	7.80
Mich. Cent., various	,,	—	—
N. and W., Ivor, Va.	,,		—
S. A. and A. P. Ry., Skidmore, Tex.	,,	12.65	10.46
St. L. and S. F., Farlington, Kan.	,,	11.60	27.10

It will be noticed that the catalpa, locust and eucalyptus (or red gum) trees are the ones most favored for the railway plantations. These are trees which were until recently little known or used, but owing to many kinds of trees which were formerly quite plentiful, becoming more or less scarce, attention had to be given to those trees which would give the best results under artificial conditions. These trees all have the same property of very rapid growth. On the Atchison, Topeka and Santa Fe Railway ranch at San Deguito, Cal., 500 trees are planted every year of the blue gum and eucalyptus species. This tree is a native of Australia, but is successfully reared in California. It grows in low, swampy ground and also equally well in dry, arid mountain plains. It needs a warm climate as the young trees cannot withstand more than 2 or 3 degrees of frost. Freshly cut, the wood is pale in color, heavy, hard, durable, and very difficult to split. It is expected that by the time the trees are 20 yrs. old, they will yield 8 ties per tree, in addition to a quantity of by-products. The catalpa tree is a native of the Mississippi Valley, but has been naturalized in many other localities east of the Rockies. The wood is coarse, brittle and not very strong, but is very durable in contact with soil. The trees grow from 40 to 60 ft. in height and 3 to 6 ft. in diam., with well formed trunks and large white, faintly mottled flowers. The yellow locust trees are widely cultivated in the States east of the Rockies. The wood is tough, durable, and unequalled for torsional strength. It has been classed in the first rank of American woods. The trees develop very rapidly but are subject to the depredations of insect borers. They grow from 50 to 70 ft. in height and 2 to 3 ft. in diam.

Protection of Ties From Mechanical Wear.—Many experiments have been made and remedies suggested for eliminating the damage done to a tie by such external agencies as the spike, rail-cutting, etc. When an ordinary cut spike is driven into a tie the wood fibres are broken, torn and generally disrupted. At the time the spike is first driven the damage is comparatively small, but as time passes decay sets in with greater rapidity and the tie becomes rotten around the spike. In Fig. 2 is illustrated the effect on an oak tie of driving into it an ordinary cut spike. In Fig. 3 is shown the resulting effects after one and 3 years' service. One method of obviating this damage to the wood structure of the tie is to bore a hole in the tie slightly smaller than the spike itself, so that when the spike is driven in the usual way there will be practically no damage to the wood fibres. The resisting power of a spike driven into a bored tie is very close to that of a spike driven in the ordinary way. (See Table III.). The comparatively small amount of damage that is done to the tie by a spike driven into a bored tie is shown in Fig. 4. Another method which has been largely experimented with is the substitution of a screw spike for the ordinary cut spike. The screw spike is being adopted as a standard by some of the railways in the States to be used in conjunction with tie plates. The screw spike can be used either as a direct fastening to the tie, or, as is almost invariably done in Europe, it can be screwed into a wooden plug or "dowel" first screwed into the tie. The question of the advantage or disadvantage of the dowel is one on which there is considerable difference of opinion, but the tests show that the screw has a greater holding power when used in conjunction with the dowel than when driven directly into the tie. Since the advent of chemically treated soft wood ties, the hardwood dowel has a distinct advantage of distributing the strain over a large area of the soft wood and also permitting the preservative chemical to reach the innermost pores of the wood at the point where it is most required. A standard screw spike used with and without a dowel is illustrated in Fig. 5. Table III. gives the holding power, as obtained by tests, of different kinds of spikes.

Table III.

	Mean. Lbs.	Maximum. Lbs.
Square spike in unbored tie	4,558	6,826
Round spike in unbored tie	2,478	6,066
Square spike in bored tie	4,082	5,810
Round spike in bored tie	4,108	6,940
Screw spike in bored tie	6,916	10,842
Screw spike in oak dowel	8,170	9,724

Tie Plates.—The use of tie plates is becoming more general on all the larger railways every year. A great many experiments have been made in order to determine the best type for use under varying conditions, but unlike track rails, the tie plate has not yet reached the stage of being standardized by any of the large engineering or railway institutions, and one well-known manufacturer of tie plates, who started with about 2 or 3 different styles, is now manufacturing 40 or 50 different kinds, some of them so similar that when placed side by side it is difficult to pick out the original plates from the more recent innovations. There is a great deal of difference of opinion on all the different points necessary to make an ideal tie plate. For instance, taking the under side, there are the questions of the proper number of flanges, their depth, position, and whether they should be longitudinal or transverse, or whether some form of claw is not preferable to a flange; or again, some advocate a tie plate with a perfectly smooth bottom. Taking the upper surface without considering the problem of the shoulders there are the questions, should it be smooth or corrugated, channelled or bossed? Even with regard to the spike holes there are points of difference in the standards of almost every railway.

The purpose of a tie plate is to distribute the load from the rail over a larger area of the tie than that covered by the base of the rail in order to reduce the abrasion of the tie by the cutting of the rail; to prevent decay of the tie from the same cause; and also to assist