# Contributions to the Knowledge of Vehicle Woods.

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It is admitted by both the forester and the manufacturer of vehicles that the supplies of hickory and like woods used in vehicle construction are becoming scarce. The quality is poorer and the price is higher each succeeding year. Indeed, the condition with respect to the supply of vehicle woods may be said to have become acute, and the various trade organizations have become aroused to such an extent that meetings have been held to discuss means of increasing the sources of supply and economizing on the construction.

Three ways in general are open:

First, an endeavor may be made to determine the availability of new species as substitutes for such woods as hickory and white oak.

Second, planting operations might be made a success.

Third, a more economical use may be made of the timber supplies now entering the mills for manufacture into wagon parts.

The present paper discusses lines of effort in the substitution of new and untried species, and in improving rules of grading in the mills so that excellent material, fully available for service, may not be thrown out, as is the case now, by incorrect rules of grading.

The Forest Service, United States Department of Agriculture, and the Purdue University Laboratory have for some years co-operated in the establishment of a timber testing station in the Laboratory for Testing Materials of Purdue University, at which studies have been made to determine the essential mechanical properties of various species of wood, and what effect various factors have upon these properties. Other studies to determine the correctness of the rules of grading for vehicle parts, and to examine into the merits of different designs of such parts as wagon axles, and to investigate the properties of possible substitutes, have a direct application to an important industry of the State. This Laboratory at Purdue University is one of a series of laboratories operated by the Forest

Service at such institutions as the Yale Forest School, and the Universities of California, Oregon and Washington. The writer of this paper has been in charge of this work since is inception in the year 1903.

### SUBSTITUTION OF NEW SPECIES.

The practice of substituting cheaper and weaker species for others which have become scarce and high priced has been increasing for some time. For instance, longleaf pine harvester poles have come into use in place of oak poles, and those parts of vehicles not bearing a great strain are now made of weaker woods. The successful introduction of species which are quite proper for the service is generally retarded by prejudice. Consumers have demanded certain species regardless of their actual fitness, and irrespective of the fact that other and cheaper woods might answer the purpose equally well. For instance, both poplar and red gum, which are now held in such high estimation, have both had to fight their way for a place on the market for such parts as wagon box boards.

It may be stated at the outset that there is probably none of our eastern species that can replace hickory for strength and general shock-resisting properties and permanence of shape after it is bent. The lines of endeavor must be to use hickory in only such parts of the wagon where great shock-resisting properties are required, and to correct the rules of grading so that minor defects which do not affect the strength of the wagon are not allowed to operate to throw a suitable piece of hickory out of use. A recent study of the properties of the eucalypts in California by the Forest Service seems to point to the value of some of these species for use in wagon construction. The blue gum (Eucalyptus globulus) is the most common species in California, and has competed with black locust for insulator pins, and has given satisfactory service in chisel and hammer handles, and has been used locally for wagon tongues, axles, shafts, spokes, hubs and felloes in California. The wood is hard, strong and tough, and grows very fast. In bending the modulus of rupture is 23,000 pounds per square inch for seasoned lumber, about equivalent to second-growth hickory. This eucalypts seems to be the most promising species upon which to draw for products requiring great strength, toughness and hardness.

### GRADING RULES.

An instance of the method of attack to determine the correctness of the grading is in the case of hickory wagon spokes, which are now graded

into six divisions: A, B, C, D, E and Culls. Five hundred spokes were procured from the Bannister Wheel Company of Muncie, Ind., and were tested under a direct load as shown in the diagram, and the maximum load, together with the amount of bending sidewise before fracture was noted. This combination of maximum load and amount of side bending gives a factor which represents toughness and shock-resisting capacity. The results from the spoke tests show more than 50 per cent. error in the present grading system, which is largely due to the traditional prejudice and consequent discrimination against red hickory. No red spokes are now allowed in the A and B grades, yet these tests show that a large proportion of the red spokes now included in the lower grades should be, because of their strength and toughness, included in the highest grades. It appears, also, that weight for weight, the red spokes and the mixed red and white spokes, are fully as strong as the entirely white spokes. These tests will be supplemented by tests on various hickory buggy shafts containing typical defects. Such tests have an interest not only to the genral public, in that a drain on a limited class of material is somewhat decreased, but they have an interest also to the grower of timber, because they increase the market value of a considerable portion of the product of the forests.

Tests have also been made on a number of wagon axles. Various species of woods, not only from the western forests, but from eastern forests, have been made up into axles at a mill and have been submitted to the laboratory for test. At the present time the series is complete upon hickory and maple axles of three different designs, and the method of attacking the problem and of determining the qualities of the axles by actual test will be of interest from a scientific standpoint. (Referring to the photograph of an axle under test, the method of loading and measuring and the behavior of the axle is shown in detail, and the various quantities entering into an estimation of the value of the axle are explained.)

Another example is in a series of tests to determine the proper grading of pine harvester poles. A large part of this material is shipped up from the south to such markets as Chicago, and is there graded by the manufacturers, the defective material being thrown out at a loss to the shipper, not only of the cost of the material, but of the freight. It becomes important, therefore, to know whether the poles thrown out might be used. Poles containing different classes of defects were tested, and it was found that at the present time there is an unjustifiable prejudice against the use of poles containing a considerable per cent. of sapwood.

Another series of tests on the relative strength of oak and yellow pine wagon poles is of interest, not only for the method of loading and measuring the quality of the pole, but from the light it throws on the essential difference between products from such woods as oak and such woods as yellow pine. (Referring to the diagram, the method of loading and measuring the various elements of the test were shown. The general results of the investigation are also shown by the diagram and table, from which it appears that while longleaf pine poles are as strong and elastic as the oak poles, yet they lack the toughness, and the effect of a cross grain is much more serious than in the case of oak.)

These various instances are brought forward to show the method of attack and scientific care in aiding the solution of a large commercial problem of this kind. The results of these tests will appear in a publication by the Forest Service.