other minor repair work. By the employment of a few night men in this way we save the time of a large number of men during the day, and also greatly facilitate the work. This is particularly true of work on cars which are being used during the day by survey parties.

Forestry

The roadside development work consists of trimming the existing trees and shrubs, planting new ones and miscellaneous other work, such as sodding, stabilizing sand banks by certain planting, etc. The entire county road system has been taken care of in this manner for about five years. It costs approximately $75 per mile to properly trim the roadside trees and shrubs the first time over but subsequent trimming is handled for approximately $5 per mile per year. Some planting has been done in the open spaces along our roadsides, but because of the abundance of natural roadside trees and shrubs now in existence the most of our planting work has been confined to our County Parks.

Another phase of our work which is placed under the supervision of our forester is that of controlling the location of new pole lines along the highways and any tree trimming work which is done by any of the pole line companies. These companies are required by law to obtain a permit from the highway authorities before doing any trimming work and consequently the details of this matter are left with our forester to work out. This system has forced the pole line companies to employ trained foresters of their own which results in a quality and kind of trimming work done by these companies which was never before realized. By the re-location of pole lines it is also possible to do away with all trimming on many long stretches of road.

RECENT DEVELOPMENTS IN ROAD MAINTENANCE METHODS

By A. H. Hinkle,
Supt. of Maintenance, Indiana State Highway Commission.

Each year we find new developments in the methods of repairing and maintaining the highways. Some of these methods prove to be valuable and remain as standard practice, while others prove to be useless and are displaced by still newer processes. It is only by experiment which may extend over a period of years that the worth of any new process can be fully proven. The length of time required for a field test to
fully demonstrate the relative value of any new type of road surface or method of construction is the one thing that makes progress along this line slow. Also it is this same slow process of proof that makes possible a field for promoters of new types and methods which frequently prove worthless.

Any new methods that I may enumerate here, therefore, are not given as proven better methods but they bear such ear marks of possible value that I deem them worthy of mention.

Protecting Slopes Against Erosion by Temporary use of Straw Followed by Growing Vines

A high fill to a bridge was made of a sandy loam. Due to the nature of the soil, erosion was excessive. During the heavy rains last fall gullies were washed into the fill bank as far as the wheel tracks on a half dozen occasions. To eliminate the expensive repairs, it was decided to protect the slopes against erosion. A layer of straw about 9 inches deep was spread over the surface. This was held in place by old wire fence, which a farmer had discarded, laid flat on the surface. A few stakes were driven into the ground to hold the fence in place. Small holes were opened in the spread of straw and three different kinds of vines planted. Honeysuckle was planted 6 feet apart; or Fox Grape was planted 10 feet apart; or Vincia Vine was planted 3 feet apart. It is expected that the vines will spread a dense mat over the entire ground surface by the time the straw is gone and thus eliminate future erosion. Grass seed will be sown in the spring that a sod might be produced on all bare places until the vines develop.

For ordinary soils a June Grass sod is very satisfactory. The growing of a sod may be "speeded up" by filling little gullies in the fill slopes with sod secured along the fence line.

Spring Treatment of Shoulders and Ditch Slopes, and Standard Shoulder Maintenance

Roadside mowing on all improved roads is now established practice. Debris such as pieces of wood, bones, wire frequently left by telephone companies, and every form of junk and trash finds a landing place along the roadside. Stakes and stones are raised each winter by frost action. All these together with stiff stubbles from the preceding year make roadside mowing expensive, unless special care in cleaning the roadside is taken each spring just preceding the starting of the growth. Not only must the loose pieces of foreign material be removed but some means must be taken to smooth the ground disturbed by frost action and wheels. This can best be done by dragging the shoulder and ditch slopes with some form of drag that will adjust itself to the curved surface. Especially designed drags and even heavy log chains may be used for this purpose. Some of our superintendents have
dragged rolls of discarded wire fence over the surface. The necessity for systematically mowing the roadside is an argument for making the roadbed slopes as flat as 4 to 1. If they are made so steep as to require hand mowing, a future added expense is imposed.

The rut that is formed by traffic along the edge of the pavement should be filled from time to time with gravel or stone. We have used this past year for this purpose a spreader box whereby the metal is spread to the proper width and thickness as the truck is driven along the pavement.

**Repairing Concrete Pavements with Quick Hardening Concrete**

During the past few years an innovation has taken place in the repair of concrete roads with quick hardening concrete. The *first* satisfactory method of doing this was with the use of Lumnite cement. The *second* improvement developed about two years ago, was in the use of a special mix of the ordinary Portland cement, thus making a concrete which could be opened to traffic after two days' placement. This special mix depended for its quick hardening properties on the following six factors:

2. Coarse sand and well graded aggregate.
3. A dry mix.
4. Longer time in mixing.
5. High atmospheric temperature.
6. Use of CaCl₂

A *third* and still greater improvement in making quick hardening concrete is the use of a quick hardening Portland cement which is now put on the market. It has such quick hardening properties that a concrete pavement of the standard mix can be opened to traffic in seven to ten days. This is ordinary Portland cement made by special refinement processes. By using this cement in the special formula described in the *second* method above, a concrete patch can be made during hot weather that can be opened to traffic after one day's placement. In other words, by the use of this quick hardening cement all the advantages of Lumnite cement can be had at a cost far below the cost of concrete made of the Lumnite cement. So far as I am able to conclude the making of this improved brand of cement of the ordinary Portland type reduces, if not entirely eliminates, the advantages of the Lumnite cement in patching concrete roads.

**Use of Penetration Macadam as a Base for Rock Asphalt and Bituminous Concrete Tops**

This past year we built two experimental sections of ½-inch rock asphalt on a penetration macadam base. The base
was built according to our standard specifications for bituminous macadam top course, except that less bituminous material was used. One and one-fourth gal. was used in the first coat; one-fourth gal. in the second; and the third coat was omitted entirely. Covering material was used only to the amount of about 1 cu. yd. to 200 sq. yds. of surface. This left a surface with large voids which provided anchorage for the rock asphalt, which was spread at the rate of 56 lbs, per sq. yd. or enough to make a compacted thickness of about \( \frac{1}{2} \) inch. (It is believed that the minimum amount of rock asphalt in such construction should be 75 lbs. per sq. yd.) This type might be used as a base for sheet asphalt, and other forms of bituminous concretes. Every indication points to this type of base being an improvement over waterbound macadam as a base for rock asphalt, sheet asphalt and various forms of bituminous concrete.

**Method of Smoothing Rock Asphalt Surface by use of Long Base Steel Drag or Planer**

A refinement in securing a smooth rock asphalt surface was developed by dragging it with a heavy metal drag. After the rock asphalt was laid, raked and gone over once with the roller, it was leveled by pulling this heavy metal planer or drag over the surface in practically the same manner as a gravel road is dragged. This planer shaved off the high places and deposited the rock asphalt thus cut off, into the low places. Where there was not sufficient loose material secured by the cutting, additional asphalt was dropped in front of the drag blades from time to time. The dragging and rolling was continued until a perfectly smooth surface was secured.

We experienced a good deal of trouble in securing a smooth riding road on this type of surface, but this process of smoothing, which costs very little, seems to solve this problem.

**Pulverizing Rock Asphalt and Other Bituminous Mixtures
With a Threshing Machine**

The cold weather late in the season made it almost impossible to properly rake the rock asphalt because of its lumpy condition. One of our contractors conceived the idea of pulverizing the rock asphalt by passing it through an old threshing machine. The cylinder and concave of this machine were properly mounted in a box about 5 feet high and a small engine attached. The asphalt was shoveled into the machine much in the same manner as grain is threshed. This broke up the hard lumps into a fine powder after which the rock could be readily raked, the raking even being easier than during warm weather. Amiesite was pulverized in the same manner when the material was brittle due to low temperatures.
Bituminous Concrete Top for Traffic Bound Gravel and Stone Roads, Sometimes Called a "Retread Top"

This form of top might be briefly described as an intermediate form of top between the surface treated gravel and a penetration top. Two to four inches of stone or crushed gravel ranging in size from 1 1/2 inches to 2 1/2 inches is uniformly spread over the old surface by the use of road graders and drags. A first coat of bituminous material of about 1/2 to 3/4 gal. per sq. yd. of Tar TM, TH or Liquid Asphalt AC is applied to the coarse stone. As the bituminous material stiffens, the stone is leveled with graders and long base planers and finally rolled when the surface is sufficiently hardened to bear the weight of the roller and be firmly compacted. This process may take two to six days depending on the grade of bituminous material used and air temperatures. This leaves the surface looking very much like a bituminous macadam surface after the first application of bitumen. The finishing process consists of two or more additional coats of Tar TH or Liquid Asphalt of about 1 to 1/3 gal. each. Each coat, after the first, may be covered with 3/4 inch aggregate, dragged and rolled.

After the first application of bituminous material, spots which show signs of breaking and which show clean stone are given a small additional amount of bituminous material. Such spots may develop where there is an extra depth of loose stone and where the surface has been disturbed by traffic.

CO-OPERATION ON INDIANA ROAD WORK

By W. J. Titus,
Chief Engineer, Indiana State Highway Commission.

The particular feature of our road work about which I want to talk for a few minutes is that provided in Section 33 of Chapter 3 and in Section 39 of Chapter 112 of the Acts of the 1919 General Assembly of the State of Indiana, more commonly known as the State Highway law and the County Unit Road law. These read as follows:

Submission of Plans to Commission for approval—Petition.

Sec. 33. "When it is proposed to improve any road, the cost of which improvement is estimated to be more than two thousand ($2,000.00) dollars per mile, or to construct or repair any bridge, the cost of which is estimated to be more than two thousand ($2,000.00) dollars, if a petition is filed, signed by fifty (50) or more freehold electors of the district to be assessed or taxed for the construction thereof, with the board