(Continued from page 4.)

on each side the road to carry off the subsoil water. While the surface water would be provided for by shallow gutters which would discharge either into the natural water courses or the subsoil drains.

WIDTH OF ROADWAY.—A good width for the roadway is thirty feet between ditches. This will give room for three drive ways and will be found cheaper to maintain than a narrower one besides making a safer road in winter.

EARTH ROADS.—To this class the great majority of our roads must always belong, and for limited traffic they are the best of roads when kept dry below the frost line. They can be cheaply maintained by unskilled labor— a common road scraper and roller being used for reforming the road bed, the labor and teams being procured from the neighboring farmers. The road machines with which many municipalities are now supplied are specially fitted for this class of work, and are of valuable assistance in the hands of an intelligent operator, but if they are used to heap the grass and sods from the side of the road into the centre—a method of which I saw an example last summer—one machine if industriously worked will cause more damage in a day than the road will recover from in a year. In the maintenance of earth roads all that is necessary is to keep the drains open so that the subsoil will be dry and the surface free from ruts, with the centre crowning to get rid of the surface water quickly.

On trunk roads where the travel is great, some more durable material must be used, but it will generally be sufficient to prepare a roadway eight feet wide in the centre leaving an earth road on each side for summer travel. Gravel in the past has been universally used, but on account of the cost of breaking, field stone has apparently never been considered as a material for road making. The cost of stone cutters now place them within reach, and an excellent road can be made by using these stone for a foundation, completing the road with broken stone and gravel. This roadway has no new feature, and is simply the old Telford road, the cost of which formerly placed it beyond our reach, but which I shall endeavor to show is under the conditions I have described the most economical road that can be built.

The subgrade should be formed at a depth of twelve inches below the intended surface of the road and should have the same crown as that proposed for the surface—about two inches in eight feet. The road bed should then be thoroughly rolled. Any depressions that appear should be carefully filled. A layer of common field stone should then be laid in courses at right angels to the roadway the longest diameter vertical, larger ends down and contiguous courses breaking joints. This layer should not be less than five nor more than seven inches thick. The stones should be well pounded with a heavy pounder, the interstices filled with chips firmly wedged by hand. On a foundation thus prepared place a layer of clean broken stone, four inches thick, of which the largest piece shall pass through a two and a half inch ring in all dimensions. This course should be thoroughly rolled. Cover the broken stone with a coat of clean coarse sand, which should be swept or washed into the interstices of broken stone. Finish the roadway by it with two inches of fine gravel, of which the largest stones should not exceed one inch in diameter, which should then be rolled until the surface is perfect. In rolling, commence at the sides and continue till the roadway is so consolidated that subsequent rolling in the centre could not crowd the material out. Use the roller without the load first, and gradually increase the weight until the maximum is reached.

The following estimate shows the cost of a mile of road, constructed as above described :—

Grading, 1564 cubic yds. at 25c.....	$ 391.00
Cobble stone, 782 cubic yds. at 50c...	391.00
Laying cobble foundation.....	235.00
521 cubic yds. crushed stone.....	442.00
Spreading stone and gravel.....	100.00
260 cubic yds. gravel...	130.00
Rolling.....	97.00
	$1786.00

The great bulk of this work would be done by the people of the neighborhood and the district through which the road passes, would in this way be benefitted by the distribution of the money expended on the work.

I am sure that the estimate I have given is far below those usually found in books on road construction, but you will perceive the chief difference is in the cost of material, which can be had as I have stated, practially for the cost of delivering it on the roadway, and the estimated cost of all the work except the rock crushing is based on the actual cost of similar work actually carried on under my direction.

MAINTENANCE.—The question of maintenance is second in importance only to that of construction. No matter how skillfully and thoroughly the work of construction is carried out no road can be erected to retain its efficiency without constant attention, and it will be found much more economical to keep it in repair than to put it in repair after it has begun to seriously deteriorate. The old saw of "a stitch in time" is especially true in road maintenance. A small rut appears; a shower fills it with water, which soaks into the surface of the road; each passing wheel makes the rut deeper until it becomes a mud puddle which requires a load of road metal to repair. Each rut or depression should be taken when it appears, the dust or mud raked out and filled to the surface of the road with metal. The metal should be used sparingly, not piled up higher than the surface of the road to cause an obstruction. Where several ruts occur in a short distance only the deepest should be filled first, when the material in these is packed fill the others. The places repaired in this manner should be rolled until quite firm. The best time to make repairs is in wet weather. Then every depression and spot that needs attention shows plainly, and the new material readily unites with the old. The drainage must not be forgotten, for the indispensable conditions for a stone road of any sort is an unyielding foundation, and this is impossible without thorough drainage. I cannot emphasize too strongly the necessity for the repairs being continuous. They can be made more cheaply when promptly done, and what is of more importance the road is always good, while under the plan of annual repairs the road is nearly impassable for one-half the year for want of repairs and impassable the other half because of the repairs.

It is of importance that the roads should not be too closely shaded. Shade trees should be trimmed high and where timberland adjoins the road the trees should be cut for two rods on each side the road allowance. The road must be exposed to the sun and winds in order to dry quickly after rains.

BROAD TIRES.—The width of tires has an appreciable effect on the cost of maintenance of roads. The narrow two and a half inch tires in general use when heavily loaded cut into the roadway like a knife and it has been proven by experiment that wheels with two and a half inch tires cause double the wear of wheels with four or four and a half inch tires. Morin's experiments indicate "on a paved or well built macadam road tractive force is independent of the width of the tire provided the same is more than three or four inches. *On compressible roads such as new gravel* or on a meadow, the tractive force diminishes with an increase in the width of the tires." The chief advantage therefore of narrow tires is on muddy roads where the thick mud has not so tenacious a hold when it was round the spokes and felloes. To counterbalance this we have easy draft on the farm and a great decrease in injury to our roads. The only rational reason for the existence of the narrow tires is custom, and I am afraid the use of broad tires will never become general until the width is regulated by law.

ROAD MACHINERY. A very essential implement in the construction and maintenance of earth roads is the reversible road machine. It is no exaggeration to say that the work of grading and shaping a road bed can be done by one of these machines for 50% of the cost under the old methods and the quality of the work is infinitely superior.

A serviceable rock crusher with a receiving capacity of fifteen inches by seven inches and having a product of six cubic yards per hour would cost, mounted on trucks, $1,000, and could be run by an ordinary portable engine of nine or ten horse power for about $20.00 a day including the cost of labor.

I am sensible of the advantages of a steam roller, and am willing to admit that for city streets it is indispensible, but when its disadvantages, such as breaking of culverts, scaring of horses and general interference with traffic are considered, I am of the opinion that a horse roller is better adapted for use on country roads. A roller weighing about 3600 pounds, three feet in length, four feet in diameter, made in three sections, with a frame strong enough to permit of its being loaded with one and one-half tons of pig iron, would I think, answer every purpose and the cost need not exceed $150.00.