On section two, as before described, there is a problem of grading, rather than of drainage. That is, the soil will readily dispose of water, but the grades must be reduced to a reasonable gradient and with a sandy material some method for compacting the road provided. The first to consider, then, is what shall be the maximum grade.

In this class of construction the writer proceeds backwards, rather than attempting to dictate an absolute gradient. That is, he takes the heaviest grade and sees to which per cent. he can reduce this with a reasonable amount of money, instead of saying arbitrarily that a 4 per cent. grade is the maximum, he figures how much it will cost for a 4 per cent., how much less for a 5 per cent. and what the saving would be, should even a 6 per cent. grade be allowed.

We will say that we may reasonable reduce the grade on this section to 5 per cent. This is established as a maximum and the other grades are brought to this maximum.

There will doubtless be considerable blasting on the large boulders to do on this section in order to properly widen the road, because the ordinary country road has no established width. In cutting the grades it will usually be found that a considerable portion of the material excavated in reducing the grade makes good surface material and almost the entire expense will be the shaping of the roadway and the drainage.

As we have imagined it, however, as the end of this section is approached you will have run through the gravel and into what is practically sand. Here the gravel on the other end will not properly compact or pack so as to make a suitable road surface and practically a sand-clay road must be built. The writer has not had good success with the sand-clay roads, unless he has practically telfordized the same by making the sub-base largely of metal.

In the treatment of this particular part of section two, we might endeavor, from the gravel pits used on the first part of it, to obtain the small boulders sufficient to build the entire bottom of the road to at least 6 inches in thickness of such pebbles. These might be filled with sand up to the top of the metal, then at least three alternating sections of clay and sand put on, repeating until the road is at least 10 inches thick, harrowing each section as it is built up, and seeing that the top surface is of sand rather than of clay. This portion of the section will doubtless cost much more than the sum per mile expended upon the gravel portion, but together they should leave the general average within the limit.

Section three, consisting largely of grade, is almost entirely a drainage proposition and it will be very necessary to practically tap the water coming from the side hill near the surface or originating within the road. It may be found necessary in many instances to run short drains for the express purpose of tapping the water holes, which come up in the road-bed proper, and it will doubtless be necessary on the inside of such a road to lay a side drain the entire length of every grade. A ditch should be dug on the upper side of the road to a depth of at least below frost line, a foot of sand being placed in the bottom and then an open drainage tile laid to as perfect a grade as possible, and the ditch filled in with sand, seems to be the most satisfactory way of cutting off this water.

Shaping the clay road is a comparatively easy matter, as such a road will retain its section and may be practically worked with a road machine and then covered with 2 inches or less of sand and gravel, harrowed in as thoroughly as possible. It is somewhat difficult upon a clay road to get the sand to work into it at first and the farther application during wet weather of at least 2 inches more will ordinarily give such a road a most desirable surface. The only caution is that the sand must not be applied in large quantities at a time, but this surface must be expected to require renewing frequently during the first two years.

We have assumed that we have now come to the ledge and boulder section and that all material must be drawn from a considerable distance to make a satisfactory road. Here, without question, the most feasible plan is to use a macadam roadway. The putting up of a local crusher and the macadam method of construction may facilitate building at a lower cost than would the use of the uncrushed material. Frequently, however, on such sections there is a great difficulty in getting sufficient water to properly flush a waterbound macadam road. The use of large quantities of water may be obviated by the use of bitumen, but this adds to the cost of your road.

Wherever macadam is used the same 21-foot section may be retained, though 15 feet should be the extreme width of the metalling. This will take 2,600 tons per mile of stone, and assuming the use of 2½ gallons of bitumen per square yard, the added cost will be something over $2,000 per mile. If water is fairly available, a waterbound road may be built and one-half gallon per square yard of bitumen applied as a cover coat at a cost of about $650 per mile, which will reduce the cost of the road for light traffic about $1,500 per mile. Unless there is considerable trouble about getting water, therefore, the use of waterbound macadam with the blanket coat is recommended.

The added cost of maintenance upon the macadam road, as compared with the cheaper forms, must also be considered, so that personally we should hesitate about using macadam whenever there is a possibility of using the cheaper surfacing.

Assuming a small apportionment available for the entire mileage needing improvement, the economic question is, what plan should be adopted for the treatment of such a highway? Will this 10 miles be practically completed with the money or will 3 miles of the higher type of roadway be built and the rest left unimproved? This seems to be the attitude adopted by most highway departments. They standardize their plans and specifications and are content with the small mileage of what they are willing to say is the best construction, and they dislike extremely to build for small cost what they term an inferior type of road.

The writer believes this to be a serious economic error and in most sections a road infinitely better than has previously existed may be built at a comparatively small cost to the great betterment of the roads in general and to the great help of the inhabitants of a community.

As far as automobile traffic is concerned, many of the inferior types of road are far more satisfactory to them in general than the highest type. The autoist cares little for a short section of the best possible road if at the end of it he plunges into what he is pleased to call an impassable road for three-quarters of the distance. The writer believes the development of roads in the future will be along the line of more mileage and less cost, and that this is the proper trend of development.

Cost of Maintenance.—Constant continuous maintenance is necessary upon all the types of roads that are built. It is indispensable, however, that upon the surfaces of the cheaper type of roadway the maintenance be both continuous and intelligent.