tained lightly. This tar is applied at a temperature of from 250° to 275° F. and rolled once.

The cost of the seal coat is from $450 to $500 per mile, while the entire expenditure is approximately $1,800 to $2,000 per mile.

The maintenance of a tar road is not expensive. It is probably best to retreat a surface of this type every 3 to 5 years. This will cost about $350 to $400 per mile for material. The patching required is a minor item.

In the past 20 years there has been much progress in road construction in the State of Indiana. But I say to you that there is yet much to be accomplished. There remain many hazards on the county roads, and this is also true of the state highways as well. Thousands of lives are lost because of the numerous narrow bridges and culverts, sharp turns, and many other dangerous places. These hazards can be eliminated only if funds are properly provided and spent intelligently. The motorists are looking to the roadmen for safe roads on which to drive. They pay the bills.

CUTBACK ASPHALT

W. M. Barnes,
Howard County Road Supervisor,
Kokomo

Bituminous material is of a cementive nature and includes such road construction products as solid asphalt, liquid or cutback asphalt, emulsified asphalt, and semi-solid and liquid tars. The valuable ingredient in any of the bituminous materials is the bitumen content, and is the only part of the material that actually will cement stone or gravels together. If these particles of stone or gravel are not thoroughly cemented together, then, of course, they will not be waterproof. After studying the conditions on some of our roads that had previously been constructed, I noticed at certain seasons of the year and after close examination that the particles of stone or gravel were slightly separated, which would indicate that there was not enough bitumen to waterproof the surface thoroughly.

After thoughtful consideration it is quite evident that a bituminous material is purchased only for two reasons, namely, to *cement* and *waterproof* aggregates when used in road construction. Any water in the material is of no value. Any excess dirt and lighter oils in the material are of no lasting value. The bitumen content in the material is the only thing of lasting value in our line of work. We are compelled to get enough bitumen into the road to cement and waterproof the aggregate thoroughly. Therefore, in getting better and longer wearing surfaces, this net bitumen content is the important factor, and not the total volume of the bituminous material used.

I have read with interest many articles written in the trade magaines about the construction of different kinds of bituminous roads, and most of them list the bituminous material used in gallons per square yard, rather than in terms of bitumen content per square yard. Good engineering and common sense must be used in the construction of any type of bituminous road, regardless of the simplicity of the specifications for construction. The first thing that comes to my mind is the necessity of getting enough cement or bitumen into the roads and not a definite number of gallons of bituminous material. Experienced hot-paving contractors, the fellows that generally put in pavements of the character of sheet asphalt or hot asphaltic concrete, tell me that in making the mixture they use anywhere from $10\frac{1}{2}$ per cent to $12\frac{1}{2}$ per cent of bitumen in order to get enough cement to cement all of the particles together for lasting quality. Yet many of us simply use a certain gross volume of bituminous material to a square yard without considering the net bitumen content of each gallon used.

The same idea applies in mixing Portland cement concrete. In every specification the designated amount of Portland cement is given. I believe that this same common-sense factor should control when using bituminous materials. If we do not get enough actual cement mixed with the aggregate, then we are going to have a job that is not thoroughly waterproof and is bound to develop trouble in one way or another, will cost more in maintenance, and will have a shorter life.

We should use only enough bitumen cement to cement the materials of stone or gravel together correctly, since an excess amount of this cement will cause trouble.

You may wonder how we are going to determine exactly the amount of bituminous cement required to cement aggregates together when there are so many different kinds and sizes of aggregates. The only way that I could answer this question would be to get my information from those engineers and chemists who have developed knowledge of the subject through years of practice and research.

In studying the literature and in talking with representatives of some of our large manufacturers of bituminous material, we discover that they recommend considerably more liquid or cutback asphalt to a given amount of stone or gravel than do a great many of the regular construction specifications. In fact, you can look over some of the standard specifications for bituminous work and find that they recommend from $3\frac{1}{2}$ per cent to $4\frac{1}{2}$ per cent bitumen content, while the manufacturers who make these materials and understand their structure and what they *will do* and what they *will not do*, generally recommend from $6\frac{1}{2}$ per cent to 8 per cent. As previously mentioned, the hot-mix paving contractors use from $10\frac{1}{2}$ per cent to $12\frac{1}{2}$ per cent.

Of course, the condition of the aggregate has a great deal to do with such recommendations. However, on the type of work that we are doing, I believe in taking into consideration the manufacturer's recommendation of the amount to be used, as well as the character and the body of the cutback asphalt to be used. Consequently, I have been able to turn out considerably improved construction with much lower maintenance costs over a period of time. This procedure seems more sound than to try and work these things out myself, thereby having job failures or wasting the money from motor-vehicle taxation that is donated to us to do our road work. I think that we all should ask more questions of the manufacturer from whom we purchase bituminous material, regardless of the type or kind that is purchased, and develop all of the information possible before starting the work contemplated in our programs. The more we can learn from them, the better will be the class of work turned out. This same condition applies not only to bituminous materials but to the stone and gravel used. These representatives should be able to tell one many things about aggregates and how they should be used. Such information will be invaluable to the men in charge of road work in our counties.

We must remember that road improvement has been going on for a long time before we took charge and that many of our pet ideas have been tried somewhere already and found to be either valuable or worthless. Yet with all of the brains working on this science of road building, we have not yet reached the pinnacle of a perfect highway.

It has been my practice in the past and will be in the future to get the very best quality cutback asphalt that we can buy. Even though the price on these materials may be the same from many companies, I carefully watch the specifications to see which cutback asphalt will give the best value for that price.

There are many things to be learned about bituminous materials before the actual use of them. No superintendent, supervisor, or engineer can excuse continued failures in bituminous surfaces when there are so many sources of reliable information to help him. It is up to you engineers or supervisors to take the initiative, and when this is done you will find the manufacturer willing and eager to assist and educate you in the handling and use of cutback asphalt for better and longer-lasting bituminous roads.

NORMAL PROCEDURE IN CLEANING OUT DRAINAGE DITCHES

Robert J. Pfleiderer,
Kosciusko County Surveyor, Warsaw

We surveyors are cleaning drainage ditches in our various counties under the 1933 and 1935 drainage laws. Naturally,