Specification for Tar No. 2.—Tar should be heated to 260° to 280° F. It should be derived from the carbonization of bituminous coal. Specific gravity at 15° C. should be 1.21 or may vary from 1.18 to 1.24. The tar shall be free from water and shall yield no distillate below 140° C., nor more than 3% of distillate up to 220° C. Between 140° and 300° C. it shall yield not less than 15%, nor more than 21% of the weight of the tar.

At this point it might be convenient to mention that in Great Britain there are over 231,000 miles of roads, some of which, it is said, are the finest in the world, and for which the cost of upkeep in 1892 was $42,500,000. But last year (1913) the cost of upkeep was over $90,000,000. The number of motor cars is estimated at 240,000.

Various Kinds of Roads.—The engineer's problem of to-day is how to build and maintain good roads.

Macadam Roads.—These, when properly built and maintained, form the safest, pleasantest and cheapest road surface known for suburban streets and country roads.

The Telford and Macadam methods have given best results in a rather wet locality where the water has aided in binding the materials, and its removal by drainage of the roadbed and surface was the most important point in the maintaining of a good road. The said methods carried out in a locality having little or no rain, drainage is unimportant, and the preserving of a well-bonded surface is of the greatest importance. This bonding may be secured with a bituminous binder.

Points to be observed in construction of macadamized roads:

(1) The removal from roadbed of all vegetable matter.

(2) Subsurface drainage.

(3) Use of the very best material afforded by locality, and if traffic warrants it, the importation of suitable material.

(4) Classification of stone, 2½ in. down ½ in. chippings.

(5) Complete exclusion of loam and clay from stones.

(6) Use of stone dust and screenings, same quality of stone used to fill interstices.

(7) Thorough consolidation of stone by using a 10-ton steam roller.

Quality of Stone.—The material used for this class of road must naturally vary according to locality. Local stone, owing to cost of haulage, must generally be used. Should the traffic be excessive it will be found more economical to procure a superior stone, even at a greater cost than the local stone, in all cases where traffic is great, the best material obtainable is the most economical.

The qualities required are toughness and hardness—ability to resist the breaking up action of the weather.

A well-made and formed limestone road will be more impervious to wet than any other, having a detritus which acts like mortar in binding stones together and will not break up so soon in dry weather. Hardness without toughness is of no use, as a stone can be hard, yet so brittle as to be crushed to powder under a heavy load, when a stone not so hard but tough will be uninjured.

The author advocates the rolling of foundation and of each coat or layer of stone, the finished surface to be of chippings and dust of same quality of stone used, this to be watered and rolled until consolidated.

Watering.—Water expedites the consolidation, lessens crushing under the roller, and aids the filling of interstices with binder. The spray should be fine, a sprinkler being used, and not thrown on in quantity or by use of hose. Excessive watering tends to soften foundation and great care should be taken in applying it.

Rolling.—A steam-roller has proved to be the most economical. There is no rutting by wheels of vehicles, or holes wherein water can lodge; resistance is reduced to a minimum, saving wear and tear of horses and vehicles, and comfort of people using the roads. Roads should be made for the traffic and not by it. The use of a 10-ton steam roller for all purposes except asphalt construction, is strongly advocated.

Breaking of Stone.—Stone should be broken by hand, a practice which finds favor with many engineers in Britain. With this method of breaking, stones are more uniform in size, have sharper edges, are not flaky with rounded edges, and are therefore better for compacting. The installation of the machine breaker or crusher has effected a great saving in cost and also increased the output considerably.

In Canada, where labor is very expensive, the breaking of stone by crusher is undoubtedly the best method. The hand-breaking method, though the best, is very expensive. The wear and tear of crusher and also the initial cost are very great.

To be a paying factor, the crusher must be kept in almost constant use. Great care must be taken in feeding and must be placed so as to reduce to a minimum the cost of handling the broken and unbroken stone.

In many places a fixed plant is used for crushing, the stone being brought to the crusher. The haulage in this case may be very great, which increases the cost considerably. It is, therefore, generally more economical to take the crusher to the stone, and this is done by having a crusher of portable type and using the steam-roller to haul it.

Surfacing of Macadam Roads.—The methods employed in re-surfacing are:

(1) The surface is cleared from dirt and new stone spread on and rolled in the same manner as a new construction.

(2) The surface is scarified before new stones are spread on.

The object of this is to enable the new stones to become more compacted with old material.

As to its advantage much difference of opinion exists. Some engineers maintain that it is not good to touch the compacted surface for the questionable advantage of securing better union of old stones with new. Others are of the opinion that the surface should be scarified, the stones sorted and cleaned, and relaid with the addition of new stones. In deciding which of these methods should be adopted it is necessary to consider all the circumstances. The thickness of existing surface and nature of roadbed must be considered. In the case of a thick surface, the surface should be scarified, but great care is necessary, as should surface be broken through tc roadbed the foundation is liable to be injured.

With a thin surface and weak foundation scarifying should not be done as it is liable to make the road weaker than before. The author having had experience in both methods has had good results from each, though he is in favor of not disturbing the existing surface, which is the general principle carried out in Britain.

Maintenance of Macadam Roads.—The opinion that no road is a good one unless when once laid it will take care of itself is ridiculous; there is no such road. The