sults in less frequent treatments being required, and the expense of maintenance of the surface by light bituminous treatments on bituminous bound macadam roads is not much over half of that for waterbound roads.

The bituminous macadam, however, being of a more plastic nature, is more easily displaced by swift-moving traffic, resulting in transverse waves developing in the body of the macadam, which are not as pleasing to ride over as the more rigid waterbound.

With reference to the cost figures submitted herewith, while they are the result of but one year's experience, it would seem that the large mileage represented would make the data of some value. This can be better appreciated when it is stated that the improved highways of New York, if laid down in a continuous line, would provide an improved highway from Boston to San Francisco, and from Maine to Florida, and thence to New Orleans.

With reference to the cost as expressed in units of miles, I would state that the standard width of pavement on our state and county highways is 16 feet, with earth shoulders of four to eight feet on each side of the pavement.

Referring to any statements which I have made which are contradictory to those of some of the other speakers, I wish to qualify my statements to the effect that they are simply the opinion of the speaker as gained by the observation of the maintenance of some 5,600 miles of improved highways.

As can readily be seen from the above data, the problem of maintenance has not as yet been mastered, but I believe, however, that the assembling in congress and conventions of this character, of men engaged in road work, where a free discussion of experience and ideas is permissible, will tend to and eventually be resultant in perfecting to a very large extent, the matter of road construction and the maintenance of same, and finally reducing it to a practical and economical basis.

The Jeffrey Manufacturing Co. have opened offices at Dallas, Texas, in the Commonwealth National Building. This office will be in charge of F. J. U. Jones.

Several bridges in the southern part of the province of Saskatchewan were damaged by the high water this spring. In one or two cases the bridges were entirely submerged so that the ice-flow passed over, but after the water had subsided it was found that the bridges had not been injured in any way.

The Dominion Government has decided to exclude all foreign lumber in connection with the public work carried on by it. At the present time the Parliament buildings at Ottawa are being rebuilt, but only Canadian lumber will go into the new structure. A short time ago the Canadian Pacific Railway issued a similar order. Both movements have been made for the purpose of encouraging the industry in the Dominion. Last year, although the country was at war, Canada imported 05,000,000 feet of southern pine, valued at over three million dollars. These figures were much below the previous year, but show something of the heavy importations of pine from the United States. Practically all our hardwood has been imported from south of the forty-ninth parallel, but according to the new arrangement, only Canadian hardwoods will be utilized in the public works of the Dominion. At the present time a number of important works are going on in addition to the rebuilding of the Parliament buildings, harbor improvements are being made at Montreal, Quebec, Toronto, and in connection with the Hudson Bay terminals. In these works Douglas fir will take the place of Southern pine, formerly used. For the interior decoration of cars and the wood used in their manufacture, Canadian woods will hereafter be used. It is said that the movement will spread and that big implement manufacturers will take it up.—*American Forestry*.

THE USE OF OIL ENGINES FOR PUMPING.*

By C. R. Knowles.

NTERNAL combustion engines using gasoline as fuel have long been in use for railway water service. The increased consumption of water, necessitating larger pumps and heavier power, together with the increase

in the cost of gasoline, has made it necessary to look to a cheaper fuel in the operation of water stations.

In order to utilize the existing equipment many of the gasoline engines now in service have been converted to kerosene and distillate engines by the addition of attachments for preheating the oil to or near the flashing point before the oil enters the cylinder. These attachments consist of generators or mixing chambers wherein the oil is heated by the exhaust of the engine. They are made in various sizes and types, both for throttling and for hit and miss governors. With these attachments the engine is generally started on gasoline and is allowed to run on this fuel until the cylinder and generator are heated, when the oil is cut in. On other types a retort is provided where the oil is converted into a vapor or gas by heating the retort with a blow torch. Either method requires from five to ten minutes to start an engine running on oil. Electric ignition is used, as with gasoline engines. Very little carbon trouble is experienced with the use of these attachments and the lubrication required is about the same as with a gasoline engine.

A series of tests of various fuels were made pumping against a total head of 61 feet, with an 8 x 10-inch single cylinder double acting pump direct connected to a 6-h.p., four-cycle, horizontal gasoline engine equipped to run on kerosene and distillates as well as gasoline, controlled by a throttling governor. This engine was one of the first gasoline engines ever equipped to operate on low-grade oils and has been continually operated on distillates from 36° to 32° Baumé for the past six years.

The fuels used were:

TABLE I.				
Distillate 40.0° Baur Methyl alcohol 40.5° Baun Kerosene 46.0° Baur Gasoline 62.0° Baur Motor spirits 58.0° Baur Efficier	né Flas né Flas né Flas né Flas né Flas né Flas ncy Fuel	n, 150 n and bur h, 124 n and bur n and bur Tests.	Burn, n at roor Burn, n at roor n at roor	145 n temp. 170 n temp. n temp. Motor
Distillate	Alcohol 1	Zerosene	Gasoline.	spirits.
Distinate.	7.0	60	7.0	6.0
Pints per nour 0.0	1.0	0.0	1	
hours fuel per	6.062	4.043	5.373	4.755
Pounds of fuel	0.001	4.913	0.0.0	
per h p h I OI	2.22	1.01	1.97	1.74
Pump r p m 43.35	43.32	43.54	43.72	43.79
Pumped gal	43.3-	13.51		
per min 175.0	177.8	176.8	176.8	178.1
Cost of fuel per		1. A. 2. (217)		
gal 0.04625	0.40	0.08	0.15	0.13
Cost fuel per	1			
hour 0.0347	0.35	0.06	0.1313	0.0975
Cost of fuel per			-	-arth
h.p.h 0.0129	0.1282	0.0220	0.0483	0.0350
Cost per 1,000	1993	IN LAND		
gallons 0.0033	0.0327	0.0056	0.0124	0.009ª
	Deg. 1	Deg. Deg	. Deg.	Deg.
Temp. of cylinder start	165	90 13	5 40	40
Temp. of cylinder run	145	145 14	5 130	60
Temp. of inlet air	IIO	125 124	00 0	00

As will be seen from the above figures the distillate is the most economical of the fuels used, the cost per water horse-power being 53 per cent. of the cost of pumping

*Presented at meeting of Illinois Section of the American Water Works Association.