necessary to act as a filler and binder, but more than this is apt to wash to the surface and cause a muddy and dusty road. It is not possible to get as compact or waterproof a road with gravel as with stone, and hence it is more suitable for the lighter types of traffic.

There are two types of construction in broken stone roads, i.e., macadam and telford, named after the English highway engineers who first used them. The difference lies in the fact that in a macadam road the layers of small stone (up to ¾-inch in size) forming the filling material are laid directly on the subgrade, whilst in a telford road a layer of large stones is first laid on the subgrade and the smaller stones laid on these. Thus, when we speak of a macadamized road we mean one in which a 16-foot strip (more or less) in the centre is filled 6 in. to 8 in. deep with small, broken stones laid in layers on a rolled subgrade, each layer rolled and compacted, and the whole held together with the pulverized dust, which, when mixed with water, forms a cementary paste.

Not all stone is suitable for this purpose. Hardness, toughness and a cementary action on the part of the dust is necessary. It is possible, experimentally, to determine the characteristic of any proposed stone, and this should be done before any great outlay is undertaken. In fact, it might be safely said that a properly operated experimental department is an essential to any broad scheme of roadway improvement.

The comparative tractive efficiency of a hard road with a smooth surface and an unyielding roadbed is shown by the study of the following loads, which could be hauled at two and a half miles per hour on the level by a 3,000-pound team drawing an ordinary well-lubricated farm wagon with 2-inch tires: Brick pavement, eleven tons; asphalt pavement, six tons; macadam road, five tons; gravel road, four tons; ordinary earth road, two and a half tons; ordinary sand road, two tons. In using such comparisons in estimating purely financial benefits full loads only should be calculated, and the necessary cost in grade reduction and bridge construction to allow of heavier loads on the improved roadway must be allowed for. As has already been pointed out in the first article, the cost per ton mile to a farmer and a freighter are not the same, and deductions which apply to the latter cannot be used in their entirety in calculating the saving to the former. The ease, speed and frequency of intercommunication with neighbors and with local centres, which does so much to ameliorate agricultural conditions of life, should be kept prominently to the forefront when discussing road improvements.

The cost of both gravel and broken stone roads is comparatively large. Local conditions affect the cost materially, but for purposes of general comparison with earth roads it might be said that where material can be obtained locally the cost of a gravel road would be from $1,000 to $2,000 and the cost of a broken stone road $4,000 to $6,000 per mile. The cost of upkeep for a gravel road might be placed at $75 and for a broken stone road at $200 per mile per year. The problem which has to be faced in Alberta is that over the greater portion of the Province stone and gravel are conspicuous by their absence, and there would have to be a large additional cost to cover freight charges. Just to illustrate this, the cost for gravel alone at $1 per cubic yard for a road 16 feet wide, with a 1-foot depth of gravel, would be over $30,000 per mile. It would seem, therefore, that there exists an excellent opportunity for experimental work looking toward the utilization of other available material.

As has already been suggested in regard to earth roads, a judicious mixture of sand and clay might solve to some extent the difficulties met with in so many places where the material in place is either sand or clay, neither of which makes satisfactory roads. The clay expands with moisture, becomes very soft and plastic, and when dry contracts, leaving cracks in the roadbed. If rutted, the dried clay ridges are difficult to work down again into a smooth surface. Sand, on the other hand, expands and runs easily when dry and contracts when wet. A judicious mixture of the two would counteract the adverse tendencies of each, and so make a roadbed with a more permanently compact body which would withstand the action of the rain, be easier to work into proper shape when rutted, and possess a surface giving a better grip than does a clay road in wet weather.

In conclusion, it might be said that much remains to be done along the lines of improving existing earth roads and experimenting with mixtures of material locally available. A great improvement can be brought about by so simple a thing as systematic dragging. It will be some time before we are justified in seriously undertaking the construction of roads equivalent to the macadamized highways of older countries, where rock is more plentifully distributed than it is in Alberta.

MEASURING THE DISCHARGE THROUGH A VENTURI TUBE WITH A DIRECT READING METER.

A new method has been described by J. Dejust in Comptes Rendus, in which the usual apparatus for measuring the pressure difference between the full and the contracted sections of the tube and the integrating mechanism are replaced with an ordinary meter. The difference in pressure between the large and small sections of the tube causes a discharge between these two points.

The intake of the meter is directly connected to the full up-stream section of the tube; between the outlet and the down-stream contracted section of the tube a diaphragm is introduced. The algebraic expression of the ratio of the discharge through the tube to that through the by-pass containing the meter shows that this ratio is not constant. By adjusting the section of the by-pass tube and its diaphragm, however, the terms which are not constant can be reduced to a negligible value and the ratio made substantially constant for various rates of discharge. The constancy of this ratio has been tested on a line 100 mm. in diameter, provided with a Venturi tube having a contraction of 16 to 1, with a by-pass 20 mm. in diameter, a meter orifice of 12 mm., and a diaphragm calculated to make the ratio of meter discharge to flow through the line, 1 to 100. By varying the velocity in the line from 0.16 meter to 1.23 meters, the ratio varied from 103.82 to 105.53; that is to say, 1.65 per cent. of the smaller number. Reckoning from the mean of these two values, 104.675, the maximum error will be 0.82 per cent. of the true discharge.

Statistics show that since 1908 the increase in the use of creosoted wood block in the United States has been very rapid. For example, in 1908, 1,260,000 cubic feet are reported to have been laid, which amount was increased to a total of 10,000,000 cubic feet in 1911. Recent years have shown even greater increases, 1914 alone approximating 4,800,000 cubic feet of wood pavement.