in speed and economy, as the changing of pipe from form to form is included in the working time. The pouring of concrete by compressed air has gained much of its prominence from the success attending its use on tunnel work.

In applying this method to railway tunnels a concreting car has been developed on which is mounted a mixer, water tanks, and material bins of a capacity to make 25 cu. yds. of concrete without refilling. The car is a standard 40-ft. flat, material bins being placed at each end, sloping to the centre where the mixer is placed. In charging the mixer, a gate allows the material to flow by gravity from the bins to a hopper beside the mixer. The hopper is raised and dumped by an air piston and cable. The conveyer pipe runs under the car, turning up at the end to a convenient height for discharging directly into the forms. The crew of 4 men is divided as follows: 1 man operating the gates of the storage bins; 2 men on the cement; 1 mixer operator. With this crew and equipment a rate of 25 cu. yds. per hour has been commonly attained.

Following up the idea of portability, it would seem that on light construction work of considerable magnitude, such as aqueducts, sewers and light retaining walls, in which the point of operation is constantly progressing, a portable outfit could be used to good advantage.

For depositing concrete under water this method has been used successfully with good economy and, somewhat in line with this is the work, in which it has been employed, of forcing grout into slipping strata of rock or earth which are failing under heavy load.

Attention given to the distribution end of the pipe is amply repaid by the reduced cost of operation. Cost of pipe handling can be reduced to a minimum by having spare elbows ready placed at the point of pipe change, by the use of "bootlegs" and chutes to distribute over a wide area from one pipe position, and by portable "goose-necks" the arm of which can be swung in an arc to cover several adjacent separate forms. The "goose-neck" is usually mounted on a raft so that the entire stand-pipe and arm can be moved as a unit.

On first consideration, it perhaps seems that the cost of power for mixing and placing is excessive, as it amounts to more than that required by a rotary type of mixer. However, the actual cost per cubic yard is very low, on account of the large amount of concrete placed in unit time and also on account of the fact that the power used is applied most economically, both mixing and placing being done almost instantly, in one operation. Taking a figure from an installation of one 700 c.f.m. compressor located in a central power plant, which furnished air for a ½-yard pneumatic mixer pouring about 250 cu. yds. per day, the cost per cu. yd. was 3 to 3½ cents. In extreme cases with power at a high rate and by wasteful methods of operation, the power charge might double this figure. However, this latter figure should not be attained in actual work. On the other hand, in favorable circumstances, a lower figure than that here given might easily be reached.

The approximate labor cost can be well judged by a review of the typical jobs mentioned, where a list is given of the number of laborers used, with the speed of pouring. The crew rarely exceeds 10 men, who attend to all work in connection with the mixing, conveying, pipe changing, etc. This number of laborers has proven sufficient on jobs where the rate of pouring has been as high as 60 cu. yds. per hour. Except where the concrete is delivered by gravity chutes or on small reinforced concrete work, no spading or tamping is required as all air is forced out and spaces filled by the impact of the discharge. On account of the many variable quantities entering into the cost of operation for different jobs, narrow limits for the cost of pouring by this method cannot be given. However, comparison has been made of costs on a number of jobs of each type with results as follows: For work composed of small isolated quantities and for work requiring a portable outfit, the cost of labor and power ranges between 20 cents and 40 cents per cu. yd.; tunnel lining has been done for 25 cents to 50 cents; and on large mass work where full advantage of rapid operation is obtained, costs of from 6 cents to 15 cents per cu. yd. represent common limits.

The equipment to be obtained consists of the air compressor and conveyer pipe, with suitable storage or loading plant. The cost of the bins will not be more than for bins of equal size used with other methods. The first cost of the compressor might seem to be enough to force the contractor to consider other methods for small jobs, but the depreciation on that class of machinery is so small that the actual cost chargeable against any one job for the use of the compressor is very small. Conveyer pipe fitted with steel flanges can be estimated to cost, delivered, $1 to $1.25 per foot, including bends and fittings. A depreciation charge per cu. yd. to take care of the pipe can be approximately determined when the average length of shot and the total yardage is known. This figure varies from 2 cents to 5 cents, depending on the material used, and on the average shot. The mixer is leased to the contractor on a yardage basis depending on the type and size of job.

The average daily capacity of the ½-cu. yd. mixer can be taken as 300 cubic yards, when working quite steadily, but this machine has mixed and placed 60 cu. yds. per hour for long periods of time, often working at the rate of 72 cu. yds. per hour, when there is sufficient air. A record showing the capacity of this mixer to handle quantities of concrete has been taken from a job not yet finished. At a distance of 150 feet, and raising the concrete a height of 25 feet, 435 cu. yds. was mixed and placed in a working time of 7 hours.

The leasing rights in Canada for the MacMichael Pneumatic Mixer are held by the Pneumatic Concrete Placing Company of Canada, Limited, whose head offices are in Montreal.

ROAD INSTRUCTION IN MANITOBA.

It has been decided to hold a short course of instruction and convention commencing March 3rd, at the Manitoba Agricultural College, for the benefit of those interested in highway construction and maintenance in Manitoba. Hon. Dr. Montague has assured the College that the new course will have the fullest support of the Department of Public Works. The course as planned, will be made as practicable as possible, and will deal with such subjects as road drainage materials for culverts, road surveys, surfaces, repairs, and cost of building and maintaining various classes of highways. Prominent road builders from Ontario and the United States will be present to supplement the local engineers in lecturing upon and demonstrating the various subjects. Many municipal councils throughout the province have assured their co-operation, while the Manitoba Good Roads' Association has signified its intention of fully supporting this educative movement.