of canal, exclusive of the Lachine, suffice for the whole route. In his elaborate report, giving quantities and prices of all works required, he sets the cost of a 12-foot channel at $12,057,680. Mr. Clarke's report was made in the beginning of 1860, and is also affected by the improved communication, and other considerations referred to above. Much of the rock excavation he estimated at $2.50 per cubic yard. He gives as the total quantity of rock to be excavated 2,370,190 cubic yards at a cost of $3,940,875, or $1.66 per cubic yard. With improved machinery rock excavation has been done on the Chicago drainage canal as low as 30 cents per cub. yd. Even the crystalline rocks of the Ottawa region should not average six times that in cost of excavation. Mr. Smith says of this report as a whole: "I think some of the prices were too low for that date, but with the present improved facilities, if the quantities can be relied on, the estimate cannot be far out. I should, however, add for contingencies, such as that which prevents the raising of Lake Nipissing and other unforeseen difficulties, not less than 20 per cent., making the estimate in round numbers $14,500,000. Thus Mr. Smith puts the cost approximately at $15,000,000; and in so doing agrees with Mr. Wicksteed, R. Adams Davy and other engineers, among whom the general concensus of opinion is to the effect that a navigation of the scale required, viz., with a ten-foot channel, can be completed on this route in three years time at a cost not to exceed $15,000,000. Differences of opinion exist as to the exact scale of navigation most suitable. Mr. Shanly recommended 10 feet of water, Mr. Clarke 12, being on the largest scale for canals constructed at that time. More extended surveys may show some other scale to be better adapted to a modern canal suited to future as well as present needs. Several prominent engineers have often expressed the belief that this route will be found eminently well adapted for a deep water navigation for large vessels. Mr. Wellington says on this point: "My conviction is a fixed one that the Ottawa River *affords the best opportunity on the globe for a well-planned ship canal.*"

(*To be continued.*)

For The Canadian Engineer.

KEROSENE MOTORS.

Their Method of Action as Applied to Vehicles, &c.

BY J. H. KILLEY, HAMILTON.

Not having seen in any periodical a description of the method of action of kerosene motors when attached to vehicles or yachts for propelling purposes, I have thought that it might interest some of your readers to have an explanation of what takes place when these motors are in motion, and the very beautiful and simple method adopted to operate them. The motors run in one direction at an ordinary speed of 600 to 700 revolutions per minute; this speed is not varied no matter what may be the grade of the road. I will endeavor to explain the method of connection between the motor and the road wheels on one of the best vehicles yet constructed. It will be seen that no gears are rendered necessary; there are five grades of power: this, in the instance I refer to, is brought about by a friction discover which a friction pulley one-fourth of the diameter of the disc moves the pulley. The disc is covered with materials that very largely increase its frictional action. When the pulley is running on the outside face of the disc it takes six revolutions of the motors on vehicles to one of the driving wheels to overcome steep grades, say 8 per cent. ones, yet it is claimed that 10 per cent. ones have been surmounted, of course at proportionally slower speeds; 20 miles an hour can easily be made on ordinary level roads, the average on all roads being from 10 to 15 miles per hour. The action of the pulleys and discs is as follows: as the pulley is pulled by the hand lever with which it is connected toward the centre of the disc the speed of the road wheels is increased, increasing the speed of the carriage; when the pulley is its own diameter from the centre of the disc, it runs at the same speed as the motor, and three to one of that of road wheels; in this way the carriage would approximate 20 miles per hour; the disc is attached to the road wheel axle by chain and sprocket wheels, as in bicycles. When the pulley is at the centre of the disc, the motion of the wheel ceases, as it is clear of the pulley at this point; when it passes over the centre to the opposite side the motion of the wheels is reversed, and the carriage backs up at a speed in proportion to the position of the pulley on the disc. It will be seen that the carriage will be under perfect control of one lever in the hands of the person in charge, as far as speed is concerned. The motor governs itself, never exceeding the normal speed. This is done by a very simple governor acting on the oil supply. The motor is kept in motion during the whole time of the trip, whether the car is at rest or not; the whole work of the attendant is to steer the vehicle and handle the regulating lever; the motor requires no attention further than filling the tank with oil once in every 200-mile run.

The reversing and regulating motion referred to is now being used on engine lathes; it takes the place of *the cone pulleys, the counter-shaft, the loose and fast* pulleys, the two belts for continuing and reversing the motion; it is found to answer well, and will, before long, come into general use.

To perfect a motor adapted to the propulsion of high road vehicles, and for many other purposes, is a problem that has received a large amount of attention from engineers and others, many failures having been made in the attempt to meet the difficulties that presented themselves to those endeavoring to accomplish the wished-for result. Since the steam high road carriages, the Automaton and the Autopsy, ran from the Bank in London, England, to Paddington, some fifty years ago, and were withdrawn, many unsuccessful and costly attempts have been made; the weight of the boiler, engines, tanks, water and coal, and the heavy vehicle required to carry these, together with the passengers, rendered steam out of the question. Electric traction has also been unsuccessful by reason of the great weight of the storage batteries, and the time and trouble of recharging them, etc.

The light and powerful kerosene motor, small weight of oil fuel required, and comparatively light vehicles, met the required conditions in a perfectly satisfactory manner, with the prospects of still further success, by anticipated improvements in the present motor. At the present time they are the lightest, smallest and most powerful motors known, with no outside source of power, being a unit within themselves; the four-seated motor car runs over all grades with an average of two quarts of oil per hour. This I have taken from the printed records of the tests. Motors are now being built in Europe and the United States for street railway cars