

copper, secured to the cross-arms on porcelain insulators. When the lines reach Kingston, they are conducted to the Tramway Company's station in Orange st., & are led through a similar set of transformers to those at the power house at Bog Walk, but with an opposite effect. The current enters them at the high pressure of the transmission line, & leaves them at the low pressure of about 350 volts. Passing through & being controlled by the apparatus on the switch-board, the power enters the rotary converters, by whose action the 3-phase alternating current is converted into a direct current flowing in one continuous stream. From the rotary converters the current passes to the feeder cable on the system of tramways throughout the city, from the feeder cables to the overhead trolley wires, & thence to the cars & motors.

The system of tramways in Kingston needs very little description, as it is already familiar to everyone. But this may be said for it—that in the point of substantial construction, improved appliances & general adaptability to its purpose, there is nothing of the kind to excel it, or even equal it, in America or elsewhere. The Co. has throughout prosecuted its work in the most liberal spirit. Expense has not been spared where necessary, with the result that to-day we see the practical completion of an admirably constructed & useful system of tramways.

Mechanical Traction by Electricity.

G. C. Cunningham, formerly Manager of the Montreal St. Ry., & now Manager of the Birmingham, Eng., Tramway Co., recently read a paper on this subject before the Institution of Civil Engineers, in which he gives his preferences in power house equipment & summarizes the results obtained in the plants

under his management. It is pointed out that the financial superiority of electric traction all lies in the saving in power, & for this reason the power house is the point on an electric system to which the skill & intelligence of the engineer should be mainly devoted.

Horse traction—by which is meant the cost of horse-keep, wages of grooms, shoeing, veterinary expenses, but excluding drivers' wages—is 3½d. per car-mile in Glasgow & 5d. in Liverpool. Glasgow is level & the annual car mileage is 7,000,000; Liverpool is hilly & the annual car mileage 4,000,000. As opposed to these figures the cost for fuel, wages, oil & maintenance of the plant is placed at a little less than ½d. per car-mile for a level city & a little more than ½d. for a hilly city. Mr. Cunningham continues: "But in order to insure this low cost of working, every care must be taken in the power house. In choosing its site, it should be placed close to a plentiful supply of water, where all that is requisite for condensing purposes may be had at a nominal charge, or merely for the cost of pumping. A river, canal, pond or the sea, would afford what is needed. It should be conveniently situated for the supply of coal from railway line, canal, or wharf, so as to save the charges of handling fuel. One shilling a ton saved in cartage would amount to a very considerable sum in a year in a large traction station. But, needless to say, the most important matter is the type of engines, boilers & heat-savers to be used. The writer favors low-speed (70 revolutions) compound condensing engines, such as are built by numerous firms; boilers of the Lancashire or Galloway type, with Green's economizers. A plant of this character was constructed & worked under my charge on the Montreal Electric St. Ry., with the result that the cost of producing current was a little under our farthing per kilowatt-hour, & the cost per car-

mile less than a half-penny in the open months of the year, when coal could be obtained for 9s. a ton. The consumption of coal was 3.38 per kw. h., or 2.60 lb. per e. h.p.h., & this was maintained during months of working. The average for a whole year was only 2.75 lb. per e. h.p.h. It is not pretended that this is a phenomenally low rate of consumption. On board many of the large ocean-going steamers as low as 1.50 lb. of coal per h.p. has been reached with triple-expansion engines, but I believe that few electrical power houses have been able to show better results than those mentioned. Nor is the result to be attributed to a very large output; precisely similar results can be obtained by using similar appliances on a smaller scale. In the Montreal house there were six 800-h.p. engines, & the daily output of current averaged 43,000 units. But I have recently obtained similar results with a small cable plant on the Birmingham cable system. In 1897 this plant consisted of a pair of single-cylinder engines running at 53 revolutions of 287 maximum horse-power, with Galloway boilers, & no special heat-saving appliances. It was necessary to increase the engine power to meet increased traffic. I put in a pair of superposed compound condensing engines of 400 h.p., running at the same speed as before, & obtained condensing water from a well in conjunction with a tank & cooling tower. The result was that the consumption of fuel was reduced from about 325 tons a month, or 8.9 lb. a car-mile, to 6.5 lb. a car-mile; & the introduction of Green's economizers has further reduced the consumption to 4.7 lb. per car-mile, or to about 3 lb. per h.p.h. On the Birmingham small cable system, the saving does not amount in money to a large sum, but on a great electric system running, say, 7,000,000 car-miles in the year, 4 lb. of coal saved per car-mile, at 9s. a ton, amounts to £5,625 a year, & it is this

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