There were six 800-HP. engines, and the daily output of current averaged 43,000 units. Similar results had recently been obtained also on the Birmingham small cable tramway, which had previously had a pair of single-cylinder engines running at 53 revolutions per minute and giving 287 HP. as a maximum, with Galloway boilers but no special heat-saving appliances. By the addition of a pair of superposed compound engines of 400 HP., running at the same speed, with condensing water from a well in conjunction with a tank and cooling tower, and by the introduction of Green's economizers, the fuel consumption had been reduced from 8·9 lbs. to 4·7 lbs. per car-mile, or to about 3 lbs. per HP.-hour. The whole cost of working a large electric tramway should be under fivepence per car-mile, which result could be obtained only where the cost of the current at the generating station was cut down to a minimum by the use of engines and boilers that would do their work with a low consumption of fuel.

"Economical Transmission and Distribution of Electricity from a Distance."[1]

By HORACE FIELD PARSHALL, M. Inst. C.E.

(*Abstract.*)

In the economical generation of electricity, so far as the electrical conditions were concerned, it was stated by the Author that the difference was but small between continuous-current, alternating-current, and multiphase generators, in respect of efficiency, cost, and maintenance. In multiphase transmission, intensifying or step-up transformers might be found commercially more satisfactory than generators working at a high pressure.

Economical transmission, so far as concerned the cost of conductors and the efficiency, resulted directly from increasing the voltage in overhead lines. For underground cables 20,000 volts might be taken as the present safe limit.

Economical distribution was determined by the conditions to be maintained in the consumers' circuit. Whether continuous or alternating currents were preferable, or a combination of both,

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[1] *The Engineer*, vol. lxxxvii. p. 612; *Engineering*, vol. lxvii. pp. 769 and 796; *The Electrical Review*, vol. xliv. pp. 966 and 1014; *The Electrical Engineer*, vol. xxiii. p. 727.

only a small voltage drop could be permitted either for electric lighting or in earth returns for electric traction. A number of small electric sub-stations were commercially more economical than the same number of complete generating stations; they also occupied less space, and could be built free from objectionable vibration and noise. Though they involved lower efficiency in transformation, higher first cost, and heavier charges for attendance, a saving was effected both in feeders and in distributors, and feeder losses were smaller.

The single-phase motor had not been a success; where single-phase transmission had been adopted, arrangements were being generally made for supplying continuous current for power. Multiphase transmission with rotary converters and continuous-current distribution was now looked to for supplying large power over an extensive area. Three-phase transmission required only three-quarters the weight of copper necessary for two-phase currents; and with rotary converters the transformers might be connected for six-phase transformation instead of three-phase, with advantage in practical working. Early difficulties with the rotary converter had been largely overcome by more careful design both in the converter itself, and also in the prime mover, in which the production of constant angular velocity was requisite. Besides the multiphase currents already in use in Dublin and Middlesbrough, multiphase generation was now in progress of adoption for the Central London Railway, the London United Tramways, and the Glasgow and Metropolitan.