ELECTRIC-LIGHTING STATIONS IN EUROPE, AND THEIR LESSONS.

PROFESSOR GEORGE FORBES read on Feb. 28, before the English Institute of Electrical Engineers, a paper with the above title, which gave the results of his inspection of the electric-lighting stations at Berlin, Rome, and Milan. He first described the Berlin central stations. There are three of these, using a direct-current, low-pressure system, and connecting with the same network of mains. Of the three stations, that on Markgrafen Strasse is the most important. It contains six engines of 160 horse-power each, each driving an old-fashioned Edison dynamo; with four other engines of 400 horse-power each, driving a new type of dynamo direct, at 80 revolutions per minute. These last dynamos are worthy of notice: they are multipolar Gramme machines, with radial poles inside the Gramme ring armature. There are ten poles; the armature is 3 metres in diameter; the commutator is 1½ metres in diameter. There are ten brushes, and the different circuits are connected in parallel. The advantage of this type of dynamo, provided it is an advantage, is in the slow speed at which it can be run. The capacity of the station is about 2,600 horse-power, which gives about 26,000 lamps of 16 candle-power. In the system of distribution employed, the two-wire plan is adopted, although in the later additions that are being made the three-wire system is to be used. The network of mains is supplied at intervals by "feeders," which are used to equalize the pressure at all points and times, there being no less than forty-two pairs of feeders. The cables consist of stranded wires covered with jute prepared with a bituminous compound, enclosed in lead, then covered with tape and a preservative compound, and finally armor-plated with two crossed spirals of iron ribbon. The cost of the underground cables for the whole system has so far amounted to about £90,000; the greatest variation of pressure allowed in the mains is 1½ per cent; the loss in the feeders at maximum load is 15 volts. The performance of the cables for three years was excellent; but Professor Forbes states that lately water has penetrated the lead, has percolated to the copper, which is then destroyed. "Whatever the cause may be, the fact seems to be established that such a cable will not stand underground electric-light work for more than about three years. These cables generally run under the footways without any casing."

The second of the three Berlin stations is in the Mauer Strauss. Besides supplying incandescent, it supplies arc lamps. The low-tension outfit consists of four Edison machines and six multipolar machines, supplying altogether 11,000 lamps.

The third station is small, and contains four Edison machines driven by the same number of 75-horse-power Armington & Sims engines. Fifty-two men are employed at the three stations in eight-hour shifts. The company which does the central-station work paid last year a dividend of 7½ per cent.

In the central station at Milan, both arc and incandescent lamps are supplied. Of the former, there are 350 of the Thomson-Houston system; of the latter, there are 16,000, fed by both the direct system and the alternating system. For the continuous system, Edison meters are used, and give great satisfaction. The distribution is on the two-wire system, as in Berlin, the current being supplied from ten Edison dynamos. The high-tension alternating system is the Zipernowski-Deri system, there being two machines, each of 2,000 volts and 40 ampères.

The capital of the company is $600,000, of which $120,000 has been spent in conductors Wages is one-fifth of the total working expenses; coal, one-half; lamp renewals, 7 per cent. The company has paid dividends for several years. The last was 4 per cent, and it is increasing. There is a large reserve fund.

The central station in Rome was started by the gas company there. The alternating system is used for both arc and incandescent lighting. At present 9,000 incandescent and 200 arc lamps are supplied. The number of alternations is 83 a second, or 41 complete periods a second. The greatest distance to which current is at present supplied is about three miles. The voltage in the primary circuit is 2,200; in the secondary, 110 volts. The converter is an anchor ring built up of iron disks wound over with the primary and secondary circuits. The dynamos are of two sizes. The smaller are of a size to supply 1,000 lamps. There are 20 poles, and the machine makes 250 revolutions a minute. The larger size have 40 magnet-poles, and make 125 revolutions. "When the machine is illuminated by an arc light, to which it supplies current, a curious optical effect is produced. The arc being periodically made and broken, the revolving magnet-poles are seen fixed in position, and the amount of lag with different loads can be seen distinctly. The efficiency of these machines is said to be 90 per cent, including the exciting current. There are 50 converters now at work, each of 10 horse-power. The efficiency of these converters is 95 per cent at full load; of the 5-horse-power converters, 92 per cent; of the 2½-horse-power, 88 per cent. After describing these stations, Professor Forbes proceeded to draw from his observations some lessons which will be of use to English engineers in the remarkable extension of electric lighting which is going on in that country, especially in London. He called attention to the fact that the continental low-pressure systems used a two-wire instead of a three-wire distribution: this he condemned as causing a great and needless expenditure for copper. Again the importance of feeding-wires was emphasized. Professor Forbes contrasted the variation in the potential of the lamps that would occur at a point 960 yards distant from the central station, using conductors which carried 1,000 ampères per square inch. For a two-wire system, the variation would be 48 volts in 100; a three-wire system, 12 volts; a three-wire system with feed-wires, the total amount of copper being the same as in the last case, 1 volt. The first two would evidently not be practical systems; the last would be satisfactory. In this connection, Professor Forbes pointed out that feeding-wires were also necessary in the high-potential alternating system, in order that the lamps should maintain a uniform brilliancy, and referred to the unsatisfactory showing of the Grosvenor Gallery Station, where the alternating system is used, and where no feeders are employed. Professor Forbes seems inclined to take a somewhat pessimistic view of the future of underground cables. Those in Berlin, he states, only last three years, and, "on looking through the testimonials of makers, he does not find that cables, when placed under ground, have ever worked electric-light circuits satisfactorily beyond the three years fixed by the Berlin people as being destructive." On this side of the water the Edison Company has done much better than this with their insulated copper rods carried in iron pipes. As the result of his observations on this point, however, Professor Forbes says, "At the present moment it seems to me that the only types of underground cables proved suitable for permanent work are either bare copper supported on insulators, or else vulcanized India-rubber, or perhaps okonite. Especial care must be taken to avoid an insulator which is injured by the gases which permeate the soil of a town, or which has the property, like pitch, of becoming viscous, and so letting the copper become decentralized.

It seems the experience of most electrical companies, that it pays better to use a meter on the consumer's premises, and charge for the actual amount of current consumed, than to supply light by contract. Of the different types of meters, the Edison and Avon meters can be used for continuous currents; the Schallenberger meter, for alternating currents. Professor Forbes thinks that the efficiency of converters for the alternating system is overrated. While the maximum efficiency might be from 90 to 95 per cent, yet the efficiency is much less on small loads, and he would be surprised if the average efficiency for all except two types would be over 70 per cent.

A great difference between the practice in this country and abroad is in the speed of the dynamos. Here very high speeds are used; abroad low speeds are aimed at. The advantage of the former is in the greater output and efficiency from the same-sized machine; the disadvantage is in the greater liability to accident; but, as these are extremely rare, the possibility of failure can hardly be regarded as balancing the advantages.

To an American reading the paper, there is the satisfaction that our own central stations are far in advance of those described; while nearly, if not quite, all of the recommendations are in the direction of the established practice in this country.