the required head room will place these openings sufficiently high to produce the circulation. Unlike the window method of ventilation, this plan will operate during all kinds of weather.

Noise from the machines, especially where substations are located in residence sections, is the next consideration. A noisy substation may become a nuisance, rendering it possible for neighbors to obtain injunctions causing shutdowns. The method of ventilation mentioned above is particularly recommended from the noise standpoint.

While the window area should not be excessive, the building should be well lighted by day to facilitate repairs and inspection. The use of ribbed glass is very desirable, as it eliminates glare and thus facilitates the reading of instruments, gages, etc. Artificial illumination should approach natural lighting, as repairs often have to be made at night. Arrangement of the lighting units should be made with particular reference to the easy reading of switch-board meters, transformer and machine-bearing oil gages, thermometers, etc.

The building should be constructed throughout on a fireproof basis. In some cases it may be desirable either to secure reduction in insurance rates or to provide a greater insurance against interruption, to increase the cost of the building by installing a fire wall to isolate the transformers and oil switches from the converters and switchboards.

Every provision should be made for possible extension of the substation, even though at the time the design is made it appears that no future extension will be necessary. This refers to symmetrical arrangement of apparatus on the unit system and to the proper construction of roof framing.

The building should be simple and substantial, with just sufficient paneling on the exterior to relieve the monotony of a plain wall. An attractive building can be erected at the same cost as an unattractive and poorly designed one if sufficient attention is given to this point.

French Commission Returns

One Member Comments on American Electrifications and Compares Conditions with Those Which Are to Be Found in Europe

THE visit of a commission of French railway engineers to this country last spring to study American electrification installations and methods was mentioned in this paper at that time. The party was thirteen in number, and a greater part of the mission left Paris on April 15 and returned on July 22. The *Journal Official* on Aug. 13 contains a report of the trip by A. Mauduit, one of the members. A copy of this report appears in *Le Génie Civil* for Aug. 30. While an unofficial communication, the report says that the conclusions expressed are in general representative of those of the other members. All of the heavy electric traction installations were visited, including those in the neighborhood of New York; the Norfolk & Western; the Pennsylvania; the Baltimore, Washington & Annapolis; the Chicago, Lake Shore & South Bend, and the Chicago, Milwaukee & St. Paul.

One principal object of the trip was to learn whether there was any system of electric traction for trunk lines so superior to the others that it could be used for all of the proposed electrifications in central and southern France.

The studies of the commission were devoted to the single-phase, three-phase, single-phase-three-phase ("monotriphase") and high-voltage direct-current systems. The commission had examined the three-phase system in detail in Italy before coming to America. In that country it is used largely, but not to an appreciable extent elsewhere. The single-phase system, also, had been examined on the Midi Railway in France and the Loetschberg line in Switzerland, and is in immediate prospect on the Swiss Federal Railways, which have adopted it for the progressive electrification of their entire system and have the Gothard line under actual construction. The other systems mentioned exist only in America, hence were the principal objects of investigation by the commission. At the same time the opportunity was taken to study the 25-cycle single-phase system for sake of completeness, the French lines being 16 cycle.

The result of this study was in favor of high-voltage direct current after seeing what the writer called the "remarkable results" obtained by the Chicago, Milwaukee & St. Paul Railway. In fact, he says that he does not hesitate to express himself formally in favor of the adoption of this system, which he believes to be actually the only one suitable for trunk-line operation. It is possible, he concluded, that the single-phase system which presents at first sight the advantage of being adopted to a large variety of combinations, will reach one day a satisfactory condition, but without doubt this point has not yet been reached.

Direct current presents the disadvantage of being a little more expensive at the start on account of the rotary substations, although it ought to be said that to gain any economy in this respect with the single-phase it would be necessary to generate the latter at the low frequency of 16 cycles.

As regards the expenses of operation, only a carefully prepared comparison would determine this question exactly, but the writer does not think the difference would be so great as to determine the choice of system. The complete absence of telephonic and telegraphic interference, however, is a very great advantage possessed by the direct-current system.

Commenting on the different installations, Mr. Mauduit compliments the skill with which the difficulties of the early years on the New Haven were overcome. These difficulties consisted largely of short-circuits on the trolley line or feeders, and inductive interference with neighboring telephone and telegraph lines. The cost of doing so, however, has been great, maintenance cost is still high and the motors are delicate. This electrification was interesting because, save for frequency, it is analogous to the French Midi system.

After reviewing the means employed by the New Haven to mitigate inductive interference Mr. Mauduit says that these are complicated and difficult to maintain although they solve the problem. The arrangement of thirty auto-transformer compensators insures low voltage drop, an advantage as compared with the "suction transformers" (*transformateurs-sucuers*) used to confine return current to the rails on the Midi system.

The motors on the Pennsylvania Railroad are of a more modern type and of better commutation. Inductive interference has been overcome to a considerable extent though not entirely.

Taking the single-phase system as a whole Mr. Mauduit does not consider it as far advanced in America as in Europe, due to the higher frequency which must be employed here and to what he considers the less satisfactory development of the single-phase motor in this country. On the other hand, he praises the catenary contact wire suspension as used here and says that the struggle against inductive interference with telephone and telegraph lines has been pushed to a considerable degree. This last-named item would be considered very important in the selection of a system for France.

On the Norfolk & Western Railway the locomotives were

found to be flexible and powerful, but the mechanical design of the locomotives was criticised. The transmission of power from the motors to the axles, by jackshaft and connecting rods, occasions rapid wear of the bearings, disalignment of the trucks or fractures of the crank pins, because of the enormous power transmitted. From the electrical standpoint the principal points criticised were that the phase converter did not give equally balanced phases and the water rheostat did not equally divide the load between the motors, thus causing high maintenance cost. Moreover, the phase converter because of its magnetizing current reduced the power factor. To overcome these troubles, excepting the inequality of load distribution among the motors, the designers are proposing the use of a synchronous converter, although its actual value for this purpose remains to be determined.

Summing up the situation regarding the single-phase-three-phase system, while he feels that the system has been somewhat of a disappointment, the principle at first sight is very interesting. It permits the use of single-phase locomotives or motor cars for use direct with light or high-speed trains, and the single-phase-three-phase locomotives with heavy and slow trains, all fed from the same contact wire.

Some of the comments made on the Milwaukee installation by Mr. Mauduit have already been mentioned. In emphasizing the freedom of neighboring telephone and telegraph lines from inductive disturbance, he says that telephonic communication is good without protective devices, although the telephone wires parallel the railway line for the entire distance. He also mentioned a test made with a multiple telegraph printing circuit normally operating between Spokane and Helena, a distance of 170 miles. The metal side of this circuit was switched over so as to be carried on an unused wire on the railway pole line while the other side of the circuit remained, as usual, an earth connection. Nevertheless, the telegraph circuit worked perfectly for eight days in spite of the fact that three short-circuits were made intentionally between the railway trolley wire and the rail, in the immediate neighborhood of the telegraph wire.

Commenting on other operating points of the Milwaukee system, the author says that with a double contact wire and double shoe (four contacts) it has been possible to collect by pantograph without difficulty 1500 to 2000 amp. at speeds of from 50 to 60 m. p. h. and 4000 amp. at 16 m. p. h.; also that, although the traffic is light—only two passenger and three or four freight trains each way a day—the consumption of energy at the substation amounts to 39.2 watt-hours per ton-mile. This corresponds to an over-all efficiency, from the point at which energy is purchased to the point where it is used, *i. e.*, at the locomotive drawbar, of 50 per cent.

Mr. Mauduit concludes his *Génie Civil* article with this summary of economic considerations with regard to electric traction: "From the economic point of view the information which we have brought back from America is much less complete and exact than the technical data.

"On the other hand, it is necessary in applying American experience to the future of European electric traction to make considerable modifications in the data on account of the two constant principles which differentiate the developments in the two countries:

"First, in America the couplers employed have a rupturing strength of about 149 tons (of 2000 lb.) and it is permissible to use tractive efforts up to 44 tons. In Europe the couplers are of two types, with rupturing strengths respectively of 38½ and 61 tons, and the tractive efforts are limited to 11 tons, although under exceptional circumstances 13 to 16½ tons drawbar pull is permitted in Switzerland.

"Second, in America all passenger and freight cars are equipped with air brakes.

"The result of the above is that in America locomotives are employed that are two or three times more powerful than those in Europe, the freight trains are correspondingly long and heavy and the crews are relatively larger. Exact calculations made by the companies, and above all the results of the pioneer electrifications carried out and the consideration of the actual cost of coal, alone will permit us to determine under what conditions electric traction will be more economical than steam. It is known, however, that the economy will be greatest on the lines with steep grades and heavy traffic and it is probable that on many lines where these conditions do not exist electric traction would be more burdensome than steam.

"Above all the increasing necessity for economizing coal and the great advantage of electric traction which are well known render necessary the most rapid prosecution of the electrification now under way in France, in view of the progressive electrification of the Paris-Lyons-Mediterranean and the Midi railways."

Association News

Chicago Section Resumes Work

ONE HUNDRED members attended the opening meeting of the Elevated Railways company section in Chicago on Sept. 16. The following diversified program was given: Dr. H. E. Fisher, chief surgeon, spoke on first-aid work with the aid of lantern slides; J. H. Mallon, general superintendent of transportation, followed with a brief talk on the necessity for keeping fire apparatus in proper working condition; E. J. Blair, organization engineer, gave an illustrated story of his army experiences in France, and finally there were, as entertainment features, some amusing songs and stories. A nominating committee was appointed to make recommendations to be acted upon at the October meeting.

Connecticut Company Section Considers New Zone System

THE program of the meeting of the Connecticut Company section, held on Oct. 21, was taken up practically entirely with a discussion of the details of the zone system of operation which is to be inaugurated on that property on Nov. 2. The speakers were L. S. Storrs, president of the company; J. K. Punderford, general manager; W. J. Flickenger, assistant to the president, and C. H. Chapman, chairman of the section. By means of diagrams the essential features of the new plan were explained. These will be covered in an article to be published in an early issue of this paper.

A personal feature of the meeting was the presentation of appropriate gifts to Harold Bates, assistant construction engineer, who is leaving the employ of the company to join the technical staff of the Winchester Repeating Arms Company. Charles R. Harte, construction engineer, described the fine work which Mr. Bates has done for the company during the more than ten years during which he has been connected with the engineering department.

As usual the meeting was preceded by a dinner, during the serving of which there was instrumental and vocal music. This meeting was held at New Haven.