N.E.L.A. Discusses Heavy Traction

At Pasadena Convention, Held May 18 to 22, Committee on Electrification of Steam Railroads Presented Symposium Covering Electrification from Several Angles

THE forty-third convention of the National Electric Light Association was held at the Hotel Huntington, Pasadena, Cal., from May 18 to 22. Of the many reports of committees and addresses several bear more or less directly on the electric railway field. This is conspicuously true of the report of the committee on electrification of steam railroads, of which F. M. Kerr, vice-president Montana Power Company, is chairman. This committee includes also in its membership A. H. Armstrong, chairman electrification committee General Electric Company; R. Beeuwkes, electrical engineer Chicago, Milwaukee & St. Paul Railway; H. H. Cochrane, chief engineer Montana Power Company; Peter Junkersfeld, engineering manager Stone & Webster; F. H. Shepard, director of heavy traction Westinghouse Electric & Manufacturing Company, and J. E. Woodbridge, resident engineer Ford, Bacon & Davis, San Francisco.

A part of this symposium is abstracted this week, and the abstract will be concluded in early issues of the ELECTRIC RAILWAY JOURNAL. Abstracts will also be given of the reports of the committees on prime movers, electrical apparatus, overhead systems, underground systems and other subjects.

THE HEAVY TRACTION SYMPOSIUM

In introducing the symposium, Mr. Kerr explained that the committee found it advisable to submit its report in this form rather than as a unified joint report and had arranged for papers presenting the case for electrification from the points of view of the purchaser and the seller of electrical energy for railway purposes. Papers were also secured from representatives of manufacturers and consulting and operating engineers. While most of the papers are from members of the committee, men prominent in the industry were invited to contribute pertinent comments and the committee presented abstracts from a number of letters received in response.

From his own point of view, Mr. Kerr stated that he considered the experimental stage of railway electrification to be past. The Chicago, Milwaukee & St. Paul Railway and the Montana Power Company have demonstrated, in Montana, the entire practicability and the great superiority of electric power for the operation of a heavy trunk-line railway by more than four years of 100 per cent operation. The demonstration has been so satisfactory that the question of applying electric operation to other roads is a matter only of securing the necessary capital.

The change from steam to electric operation means more than a mere change in type of locomotive used. It means a change in the entire conception of the art of railroad transportation. The old limitations of boiler capacity and the handicaps of low-grade fuel, impure water and zero weather are all swept away. The locomotive becomes a device for hauling trains and nothing more. By adopting electrification the railroad is relieved entirely of the business of generating power and is enabled to concentrate on its main business of transportation.

Mr. Kerr said that the energy required for railroad electrification can best be supplied by the power companies of the country. The power companies have had years of experience in the application of electric power and understand its capabilities to a much greater extent than do the steam railroads. For this reason the power companies should take the initiative in bringing before the railroads the fact that electric power, which during the last quarter century has been gradually superseding other forms of power, now stands ready to take one more step and relieve the transportation systems of the burden of maintaining the obsolescent reciprocating locomotive steam engines.

Mr. Kerr pointed out the following items, which should not be lost sight of in discussing the operating economies of electric as against steam operation:

1. The cost of coal should be taken at its actual market value delivered at the point of use.
2. Comparisons of maintenance cost should include not only locomotives but also cars, for especially on mountain divisions where regenerative braking is used the rolling stock of a road is subjected to much less abuse with electric than with steam operation.
3. The cost of obtaining, and frequently of treating, water for boiler feed is an item of considerable importance chargeable to steam but not to electric operation.
4. The higher speed at which cars can be hauled over roads with electric operation allows the same amount of freight to be handled with considerably fewer cars.
5. With the size and speed of trains increased by electric operation the item of train labor is reduced. Roundhouse and shop labor is reduced even more.
6. The cost of purchasing electric energy is in some cases given undue prominence by roads considering electrification. That this is not necessarily a controlling item is indicated by the following figures: The total yearly cost of operation on the Chicago, Milwaukee & St. Paul Railway averages about $11,000 per mile for the entire system of 10,000 miles. The cost of electric energy purchased for the Rocky Mountain division is $1,600 per mile, or less than 15 per cent of the average total cost for the system.

THE ELECTRIFIED RAILROAD AS A POWER CONSUMER

Mr. Cochrane discussed the power end of the electrification problem on the basis of experience obtained in supplying power to the Butte, Anaconda & Pacific and the Chicago, Milwaukee & St. Paul Railways. He explained why he believed that the purchase of power from existing systems, either hydro-electric or steam, is more economical for the railroads than the generation and distribution of their own power.

For example, if the Chicago, Milwaukee & St. Paul Railway had undertaken to generate its own power for the 440 miles electrified in Montana by means of water-power development it would have had to make two 25,000-kw. developments to provide a reasonable reserve for future growth and to allow one spare generating unit in each power plant. It would also have had to build high-voltage feeders from its plant to feed points not more than 100 miles apart on the electrified division

in addition to its so-called bus line, paralleling the track and tapping in at each substation. This would have called for approximately 700 miles of high-voltage line.

By taking power from the Montana Power Company the railroad was able to deliver power to the substations on its two 220-mile divisions by building approximately 400 miles of high-voltage line, while the power company built 200 miles, which is used partly for transmitting power to the railroad and partly for other purposes. The plant required for this purpose is of approximately 30,000-kw. capacity.

The saving in plant capacity is due partly to the diversity factor between the railroad load and the balance of the power company's load and partly to the fact that it is unnecessary for the power company to provide any more spare capacity for growth and for other purposes with the railroad load than would be necessary without it. Furthermore, it would have been difficult for the railroad to find power sites suitable in size and location for its requirements.

In the case of the Butte, Anaconda & Pacific Railway the economic advantages of purchasing power are even more marked, because this road is so situated that the entire system could be supplied by two substations, one at Butte and the other at Anaconda. The power company already had large substations at these points and the railway requirements were taken care of by merely installing motor-generator sets in them.

Mr. Cochrane suggested that in future electrification projects the power company own all high-voltage lines, switches and transformers and deliver power to the railway at a suitable voltage for its converting apparatus. With this arrangement the power company would own all the equipment necessary to supply consumers other than the railroad along the electrified sections. All towns in which substations are located could be supplied with practically no additional investment except for the necessary local distribution systems. He sees no reason why the power company should not own and operate the railroad substations entirely, selling power to the railroad in the form required by it and delivering directly to its contact wire. This would cut the railroad's investment to that required to cover overhead construction and rail bonds.

Shifting a part of the investment from the railroad to the power company will, of course, necessitate a higher rate for power. It should be immaterial to the railroad whether the expense is met in the form of fixed and operating charges on equipment or in the form of an increased power bill.

Power Rates for Electrified Railroad

Mr. Cochrane pointed out that a rate should be flexible enough to allow quite a wide variation in the amount of power taken and in the load factor without penalizing the railroad to such an extent that it will restrict its operations in order to save on power.

The ideal rate from the railroad point of view is a straight kilowatt-hour rate. Such a rate is hardly feasible from a power company's standpoint, for a peak load can be taken without let, hindrance or compensation, and such a load at times might prove burdensome. A reasonable compromise can be reached by basing the major part of the charge on the small amount of energy taken, but with a small maximum-demand charge, just sufficient to offer an incentive to the railroad to keep its demand as low as good operation will permit.

Perhaps the most prominent characteristic of a railroad load, said Mr. Cochrane, is its lack of any outstanding characteristics. The two electrified divisions of the Chicago, Milwaukee & St. Paul Railway take peak loads of about 15,000 kw. each and the Butte, Anaconda & Pacific takes about 8,000 kw. These peak loads do not come at the same time, in general, and the fact that they exist is ascertained by referring to the records rather than by any physical effect which they have on the power system. The power factor is about unity and the load is so scattered that fluctuations in railroad loads have practically no effect on voltage regulation.

Mr. Cochrane showed a typical daily load curve of one of the St. Paul substations indicating a load factor of about 20 per cent. The load factor on the entire Rocky Mountain division was 50 per cent. The Missoula division takes a load very similar to the Butte, Anaconda & Pacific Railway, except that the latter "peaks" at about 8,000 kw. and has a load factor of 30 per cent. Taking the three loads together, however, the total load factor is higher than that of any constituent part. Combining a total railway load with that of the balance of the Montana Power Company's system makes a total with a daily load factor which frequently exceeds 90 per cent, typical figures at present being 144,000 kw. average and 160,000 kw. maximum.

The Power Contract in More Detail

Mr. Junkersfeld went into detail regarding the requisites of an equitable power contract in this field. He said that during the four years since the 1916 report of the committee was prepared the economic advantages of centralized production of electrical energy have become better understood by all parties interested. The 1916 report contained a section under the heading "Form of Equitable Contract for Energy in Bulk." The form suggested tended toward approximations of investment cost and of operating cost from time to time. The extraordinary experience in the meantime and the present outlook would indicate that this suggestion or tendency should now be given further consideration.

Mr. Junkersfeld pointed out that in the sale of power by a power company to a railroad both parties to the transaction are public service corporations. Each should share in the financial benefits resulting from the co-ordination of the power supply systems. The contract for power should provide automatically for wide fluctuations in cost of labor, fuel and other principal elements. This may take the form of a simple rate, perhaps a "block" rate, based upon both demand and consumption, with a provision for revision at suitable intervals at the option of either party to correct it for unforeseen conditions, for changes in the art, in the purchasing power of money, in the interest rates and in taxes, and for other factors which may affect the cost.

Additional provisions may be introduced, such as coal clauses, labor clauses, etc., to apply corrections for anticipated changes in cost, without the delay incident to periodical revision. It would appear wise to lay down clearly the intentions of the contracting parties and the principles upon which charges are to be based from time to time, keeping the relationship in a simple and easily understood form.

In order to minimize the effect of any uncertainty of termination of the contract, for which the seller must charge and the purchaser must pay, the contract