Results of Steam Railroad Electrification

At Annual Electrical Meeting of New York Railroad Club Electrical Engineers of Two Recently Electrified Roads Give Valuable Operating Data

THE New York Railroad Club held its annual "electrical night" on March 16. As is usual on electrical nights the attendance was very large, in spite of the threatened railroad strike which prevented the attendance of some members. E. B. Katté, chief engineer of electric traction New York Central Railroad, presided, and papers prepared by C. H. Quinn, chief electrical engineer Norfolk & Western Railway, and R. Beeuwkes, electrical engineer Chicago, Milwaukee & St. Paul Railway, were presented.

President L. E. Johnson of the Norfolk & Western had expected to describe the operating features of the electric division of that road, but he was prevented from doing so and Mr. Quinn delivered the paper in his stead. Mr. Quinn's paper is abstracted below. Mr. Beeuwkes prepared his paper and went to New York to deliver it but was called home on account of the labor situation. His paper was read by A. H. Armstrong, chairman electrification committee General Electric Company. The paper is abstracted elsewhere in this issue. Both papers were illustrated with lantern slides and moving picture films.

Replacement of Steam Locomotives in Electrification*

On the Norfolk & Western Railway More Than Four Mallet Engines Have Been Displaced by Each Electric Locomotive

BY C. H. QUINN
Chief Electrical Engineer Norfolk & Western Railway

ELECTRIC operation on the Norfolk & Western Railway was started on Jan. 1, 1914. With the introduction of the electric locomotive the increase in speed of tonnage trains from 7 m.p.h. to 14 m.p.h. up the grade, as well as the prompt handling of these trains through the Elkhorn Tunnel, had an immediate effect on the keying up of the entire traffic moved over this section of the line. With the exception of two through passenger trains, any of our electrically-handled coal trains can now keep out of the way of any steam movement in the same direction on the grade. The resulting elimination of delay incident to the necessary time to clear local passenger and time-freight trains represents a very considerable improvement over the time necessary to cover the same distance under steam operation. Further than this, the absence of delays incident to the taking on of coal and water for the three steam locomotives originally required on tonnage trains has not only materially reduced the running time but likewise has eliminated cause for delays to other trains usually found around main-line coal wharves and water plugs.

The inherent characteristics of the type of locomotive that is used on the Norfolk & Western Railway which permits us to maintain the constant speed of 14 m.p.h. up grade, as well as the same speed characteristics in regenerating and holding to a constant speed the trains moving down the grade, has enabled our telegraph operators, tower men and dispatchers to figure very closely on these tonnage movements. It is the daily practice to handle these trains directly ahead of local passenger and time freight trains, as the case may be, giving the tonnage train a five-minute margin with which to clear the passenger or time-freight train at the single-track tunnel at the summit of the grade. With a speed of 14 m.p.h. the electric locomotive will clear the tunnel in approximately three minutes. This comparatively short time element, coupled with the total absence of stalled trains and the reliability of the electric service in both directions, as compared with steam, has eliminated this single-track tunnel as a factor governing train movement. The tower operators that handle the movement through this tunnel figure the time on these tonnage trains after they strike the track indicators to within one or two minutes, and with this advance information and the certainty of the movement, they will permit an east-bound or west-bound train the right of track, without preference, through the tunnel, and yet can avoid any interruption to the movements in either direction.

The result directly brought about by the improvement in movement of coal tonnage trains on the Norfolk & Western electric zone has been primarily a very marked reduction in the time necessary for the crews to get over the road. Under steam operation, the average miles per day approximated 60 per locomotive. For the electric engines this mileage has been increased to 100, with comparatively slight increase in time in service per day for the engine crew. The short terminal time layover for our electric locomotives, which will average forty-five minutes per engine, permits us very closely to double-crew these engines every twenty-four hours. As a direct result of this increased mileage per engine crew, as well as the short terminal time allowed the electric locomotive, we have been enabled to reduce the number of locomotives handled out of Bluefield from seventeen steam engines to five electric locomotives. The number of pusher engines on the ruling grade has been reduced from a total of seven steam locomotives to two electric engines.

In view of this great increase in schedule speed it may be of interest to explain why the railroad company selected running speeds of 14 m.p.h. and 28 m.p.h. for the equipment. Briefly speaking, the location of a large part of the electric zone is through a comparatively narrow valley with resulting encroachments, on either side of the right-of-way, from buildings, coal tipples, coke ovens, and the property lines of the mining companies. Approximately 60 per cent of the trackage in this particular section is on curves, and there are fifty-four localities for switching movements from the main line. Thus it is imperative that all trains handled through this section should be under control. With shifting crews working in and out of the coal operations, where the movements require them to cross over and flag against traffic, and with the limited amount of passing siding and middle track that exists, it is virtually necessary that all slow freight trains operating in this section should be handled practically under yard board conditions.

Fourteen miles an hour, we believe, represents the maximum safe speed at which these heavy trains can be handled through this particular section of the railroad. In selecting this speed, we are enabled to double

*Abstract of a paper read before the New York Railroad Club, March 16, 1917.

the rate at which the movements were made previously with the steam locomotive. At a constant speed of 14 m.p.h. the electric locomotive does not have any difficulty in keeping out of the way of local passenger trains, as well as time-freight trains, particularly when moving up the grade. The 28 m.p.h. operating speed, which is used when double-heading passenger trains, as well as when handling the freight tonnage over the lighter grades, has likewise proved very satisfactory. By way of explanation, I should further state that over this latter section of the road, the absence of mine operations and the comparatively few points where main line switching can take place, permits us to use a running speed of 28 m.p.h. for a 3250-ton train.

With a fixed tonnage to be handled by these locomotives, the matter of horsepower developed per locomotive corresponds directly with the rate of speed in miles per hour. With a service requiring as much as 8000 hp. per train for the purpose of accelerating up to running speed and a continuous demand of 6000 hp. per train for operating at 14 m.p.h., it will necessitate the transmission of an equivalent amount of energy from the substation to the locomotive. With these requirements the running speed of 14 m.p.h. has worked out with great satisfaction, and even under 28 m.p.h. operation, with full load conditions imposed on these engines, the operation of the pantograph current-collecting system has been eminently satisfactory.

The following extract from the records of the train sheets, as well as the data collected from the car record office, will verify the wisdom of the railroad company in its decision to accept and install the electrical system now in use. The figures are taken from the operating sheets for the year 1914, which represented the last complete annual period of steam locomotive operation, and from the data covering the complete electric operation for the year ending Dec. 31, 1916:

	Steam 1914	Electricity 1916	Per Cent Change
Maximum east-bound tonnage for any twenty-four-hour day—gross tons	51,226	59,543	16
Maximum east-bound loaded cars for any twenty-four-hour day	675	757	12
Total east-bound loaded cars for year	132,618	165,689	22
Total east-bound ton-miles for year (millions)	467	592	27
Maximum number of locomotives required for heaviest day	43	9	*79
Total locomotive-hours required for year's business	93,625	44,112	*53
Normal number of locomotives in service	24	7	*71

*Decrease.

In this table note should be made of the great increase in traffic that was handled in 1916 as compared with 1914. Under the limited speed and track conditions previously referred to it is doubtful whether this volume of traffic could have been successfully handled with steam operation if only for one day of twenty-four hours. With nine electric locomotives as the maximum number that have been in service at one time and with an average of seven in use to handle the business as represented by the normal traffic in 1916, it is not difficult to understand whereby the capacity, without any increase in track facilities in this district of the Pocahontas division, may be considered to have been doubled, as compared with what we were able to do under our best steam operation.

In general, the cost of the electrification does not exceed, to any great degree, the value of such physical improvement to the roadbed and right-of-way as would have been necessary to put this division of the railroad in a position to handle the additional traffic with steam locomotives. The operating cost of the electric system is well within the original estimate. The production of energy in our steam power plant has more than passed our expectations. The ability of the electric locomotive to stand up under the heavy and exacting duties in pusher service, requiring the use of full power to hold the train slack while at a standstill, and to handle its rated tonnage according to the specifications under which they were purchased, is being demonstrated in every-day service. The present rating of engine, after being in use for two years, is identical with the figures quoted in the contract. The electric engine has more than met our expectations in the way of giving us more engine-miles per twenty-four hours than was expected. The operation of the electric transmission system, the substations and the overhead trolley wire, has been entirely successful. Consequently, the general operating improvement as described, coupled with the data which I have given, can only indicate that the electric locomotive service on this portion of the Pocahontas division has not only increased the capacity of the track at least 100 per cent, with a very conspicuous reduction in operating costs, but is likewise paying a return on the net cost of the installation. Putting this in different language, I feel that we can safely state that the installation is an engineering, an operating and a financial success.

As a further evidence of the value of this installation as a factor in the development of the railroad necessary to handle an increased volume of business, we have authorized, and have under construction, the electrification of an additional 11 miles of double-track main line, and 12 miles of branch line. The authority includes the purchase of additional locomotive equipment, as well as substation and power-house apparatus, to take care of the increased load requirements.

New Clearance Regulations Adopted by Illinois Commission

New clearance regulations have recently been issued by the State Public Utilities Commission of Illinois to supersede the former ruling as noted in the issue of the ELECTRIC RAILWAY JOURNAL for Aug. 7, 1915, page 228. The new rules relate to minimum clearances applicable to all new construction on railroads of the steam type, railroads of the electric type, and street railroads, but provide that no railroad shall be required to change existing track centers.

For street railroads the following provisions are among those included in the order: (1) Distance between centers of two main tracks shall give a clearance of not less than 2 ft. 6 in. between faces of cars; (2) distance between centers of main and subsidiary tracks shall give a clearance of not less than 3 ft. between faces of cars; (3) except where noted, subsidiary passenger tracks shall have centers spaced to give clearance of not less than 2 ft. between faces of cars; (4) lateral clearance at bridges between faces of cars and side of bridge shall be 2 ft. 6 in.; (5) lateral clearance between main track and adjoining buildings shall be not less than 2 ft. 6 in. to faces of cars; subsidiary tracks, 2 ft.; (6) distance between trolley poles and faces of cars shall be not less than 3 ft.; (7) building material or supplies shall be spaced not less than 3 ft. 6 in. from faces of cars on main tracks, 3 ft. on other tracks; (8) overhead clearances of electric circuits shall be as specified in the commission's General Order No. 30; (9) clearances are to be compensated for curves; (10) clearances stated are for cars of maximum width; (11) windows shall be equipped with bars or screens, and vestibule doors shall be kept closed when authority is given allowing clearances of less than 2 ft.

Operating Data on the Milwaukee*

The Author Submits Figures Covering Operation Under Steam and Under Electricity on the Electrified Divisions of the Chicago, Milwaukee & St. Paul Railway and Comments on the Experiences Obtained with the Locomotives and Power Distributing System

By R. BEEUWKES

Electrical Engineer Chicago, Milwaukee & St. Paul Railway

THE 440-mile electrified section of the Chicago, Milwaukee & St. Paul Railway is divided into two operating divisions, of which one has been in service long enough to permit the collection of reasonably reliable data regarding it. I may say, however, that on the other division we have been handling 3000-ton trains as a standard through the worst winter months and the entire operation is working out very successfully.

Although the figures for electric operation are very favorable, it should be remembered that they can hardly as yet be considered as final, because the steam figures represent the results of many years of effort and experience, while those for electricity are based on the use of apparatus that is entirely new in important respects, and on an operating experience of less than a year.

With regard to the operating organization, substation operating forces and line and locomotive maintenance forces have been added but, otherwise, no change, except in the way of reduction, has been made in the original steam organization and personnel. This includes the engineers and their helpers on the locomotives.

Operating Experiences

The change from steam to complete electric operation was made in the course of a few months with remarkable facility, its rapidity being governed entirely by the rate at which the manufacturer was able to supply the electric locomotives. The instruction of the engineers was done by having on the ground four or five General Electric men who had assisted in testing the locomotives at the works and who were thoroughly familiar with the electrical details. These men spent all their time for some months riding the different locomotives and explaining their electrical operation to the engineers, this being done on trains in regular operation.

Harlowton, Mont., is the Eastern terminus of the Rocky Mountain Division and the station where electric operation begins. Here are located the usual roundhouse facilities, a portion of which has been partly reconstructed to accommodate the electric locomotives. Three Forks separates the division into the East and West subdivisions and was a former steam engine division point. Deer Lodge is the western terminus of the Rocky Mountain Division.

With the introduction of electricity we were able to double what I may call the cruising radius of our locomotives. As far as the railroad is concerned we have eliminated Three Forks entirely. All locomotives run the entire 226 miles from Deer Lodge through to Harlowton, with only a very light inspection at Three Forks for bearings and pantographs. The shop and roundhouse are entirely closed down, seven or eight miles of tracks have been removed from the yard, and the comparatively large round house force previously employed has been replaced by a single electrician. All locomotives and cabooses are pooled, the men being given suitable locker space to store their lanterns, flags, tools, etc. Through-freight trains do not leave the main track and often are not switched at all. At Harlowton the engine is given a rough inspection and any light repairs made that are necessary. Detailed inspection and maintenance work is done at Deer Lodge.

The same change in operation has been effected on the Missoula Division, Avery to Deer Lodge; in this case Alberton being the steam engine division point eliminated.

Power consumption has been found on a typical day to vary from a maximum of 20,000 k.w., to a minimum of less than zero at times when regenerative braking is taking place to a sufficient extent to supply all the railroad system demands and actually return some power to the power company's supply system. How much this is we cannot tell as the curve-drawing meters do not register negative kilowatts.

Under the present conditions, we are running with a monthly load factor—ratio average load to maximum load—of about 40 per cent, but expect within a few months to have installed a so-called power-indicating-and-limiting system, which will automatically indicate to the dispatcher the exact amount of power which the whole system is drawing at any instant and will automatically within certain limits hold the maximum down to a certain, predetermined amount. This has the object of keeping as low as possible the maximum amount of power which we have to contract with the power company to furnish us.

Causes of Train Delays

A comparison of passenger train delays for the Rocky Mountain Division for October, November and December under steam operation for 1915 and electric operation in 1916 indicates the comparative reliability of service under the two systems. The passenger service consists regularly of two through, heavy, steel, eight-car trains each way per day and one three-car local each way between Butte and Harlowton. In this connection it should be borne in mind that the schedule time of the through trains under electricity was reduced forty minutes from that under steam, and that during the months of electric operation the amount of freight business done was for one month 40 per cent and for three months 29 per cent greater than the corresponding months of steam operation, a circumstance which renders the electrical showing all the more favorable. The number of trains run under steam and electricity, respectively, is practically the same.

The records show a great decrease in operating delays. This indicates, among other things, that the dispatcher, as has been found to be the case, is better able, under electric operation to plan and predict train movements. This may be accounted for on the basis of less varying speed, lower number of trains for a given business (that is, freight trains), and fewer trains delayed. In any event, in these three corresponding months steam passenger trains waited for the right of way 1910 minutes as against 254 minutes for electric trains.

Delays on account of extra-heavy trains were only one-ninth as great under electricity as under steam. Our

*Abstract of an address made before the New York Railroad Club, March 16, 1917 electric engines will handle ten or eleven steel cars on the 2 per cent Piedmont grade very comfortably.

In speaking of bad weather conditions in our electrified territory we generally have in mind extremely low temperature, sometimes 50 deg. below zero in places for days at a stretch, or the heavy snows which occur in the Bitter Root Mountains. It might have been expected that such low temperatures would result in many trolley and transmission troubles due to contraction of wires and cables, but the construction is particularly suited to such conditions and we now have but little trouble on account of them. The records for the three months in question show 445 minutes delay to passenger steam engines, and none to electric engines, this bearing in mind that many of the trains during the cold weather had to be run double-headed. We have never, under any conditions, required the use of more than one electric engine on any passenger train.

Electric engine failures have caused more delay than steam engine failures. We have had more trouble with electric motor bearings than we expect to have ultimately as there has been some difficulty in obtaining proper lubricant and the packers have had to acquire new experience in handling the high speed bearings involved. In connection with the electric engines, much delay has been due to difficulties with the flash boiler and parts used for train heating. A great deal of experimental work has been and is still being done on this apparatus, which is the only portion of the locomotives not as yet entirely successful. However, on account of regenerative braking there has been a marked reduction in waits to repair brake rigging and change shoes.

Of the electrical troubles, exclusive of those on the locomotive, most are due to the pantograph in some way fouling the overhead construction either because of the trolley wires or the track getting out of alignment or one track rail being low. Failure of power, either on trolley or transmission side of sub-stations, except for the interval required to throw in an automatically opened circuit breaker, is practically negligible. The minutes of delay attributable to the electric system, outside of the locomotives, amount to about 8 per cent.

In this connection it might be stated that the best organization of maintenance forces and means of transporting these forces to the location of troubles has not yet been determined upon, and the percentage of delays due to trolley troubles is therefore considerably higher than we ultimately expect it to be. Also the troubles themselves should diminish, as not only were our poles set in all kinds of weather conditions, but also much new rail was laid and ballasting done during the process of electrification and it will take some time before the poles and track get finally settled into permanent position.

The total minutes of delay is about the same for the two systems, but the number of trains delayed is reduced about 40 per cent under electricity. Of the trains delayed under electricity about 85 per cent were delayed about the same length of time as the average steam train was delayed, the remaining 15 per cent suffered considerable delay mainly on account of accidents and derailments to other classes of trains. About the same number of trains ran in schedule time under steam and electricity while the number of trains making up time increased about 60 per cent and the time made up about 150 per cent under electricity.

Delays due to electrical features of the locomotives are comparatively slight, a rather surprising and gratifying fact considering the number of new features, such as the use of 3000-volt direct current and direct-current regeneration, which are incorporated in the locomotive and, further, considering that only a year ago the engineers operating these locomotives were all driving steam engines. I may add that the double trolley wire construction as used by us has proved very successful, absolutely sparkless collection of current being obtained under all conditions of speed and amount of current. Twenty-six per cent of the total minutes of delay was attributable to the electric system as a whole.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY DATA ON OPERATION UNDER STEAM LAST THREE MONTHS IN 1915 AND UNDER ELECTRICITY LAST THREE MONTHS IN 1916

Rocky Mountain Division

Passenger Service	Steam	Electricity
1—Train or train engine-miles	119,330	119,237
2—Helper engine-miles	24,752	.....
3—Number engines	13	7
4—Train-miles per engine	9,190	17,040
5—1000 kw.-hr. at power company's meters	.....	34,785
6—Kilowatt-hours per train mile	.....	29.1
7—Coal, total tons	11,260	.....
8—Coal, pounds per train-mile	188	.....
Freight Service		
9—1000 ton-miles	282,862	364,087
10—Train-miles	176,937	186,010
11—Helper engine-miles	56,363	20,157
12—Number engines	43	15
13—1000 ton-miles per engine	6,745	24,260
14—*Number trains	792	855
15—Ton-miles per train-mile	1,600	1,960
16—Total time, hours	17,825	14,535
17—Minutes per 1000 ton-miles	3.78	2.39
18—1000 kw.-hr. at power company's meters	.....	14,343
19—Kilowatt-hours per 1000 ton-miles	.....	39.4
20—Total tons coal	39,050	.....
21—Pounds coal per 1000 ton-miles	276	.....

*Trains over entire division of 226 miles.

LOCOMOTIVE PERFORMANCE

The accompanying table shows for the Rocky Mountain Division a comparison of locomotive performance for October, November and December, under steam operation in 1915 and electric operation in 1916. It should be understood that the figures, while sufficiently correct for comparative purposes as they are taken from the same report forms, are not to be considered as strictly accurate when considered individually. The forms are those from which the data could most conveniently be obtained in the short time available.

The figures of item 3 give the number of engines actually assigned to passenger service, both on the road and in shops, by the District Master Mechanic. The electric engines include five double units and two split locomotives. The number can probably be reduced when train heating apparatus is gotten into shape and minor electrical improvements completed, which matters have required more shopping than will ultimately be necessary. The number of steam engines, on the other hand, is a minimum, as freight engines in helper service were often used to help passenger trains, a fact which is not taken into account in the figures shown. Therefore, less than half as many electric as steam engines are required for the passenger service.

The item 4, train-miles per engine, is derived from the preceding figures and, on basis of what has just been mentioned, the figures are high for steam and low for electricity. Our record for an electric engine is 9052 miles made in June, 1916.

Item 5, or thousands of kilowatt-hours recorded at power companies meters, shows the actual electric energy purchased and chargeable against this service. Every electric engine is equipped with a kilowatt-hour meter, which on each trip is read at points of commencement of motoring and again at commencement of regeneration, giving a record of the engineer's performance as regards use of power. The figures shown in the table are the net energy read as the locomotive increased by a suitable amount for line and substation losses. The efficiency of the system from the power company's meters to the locomotives is running now between 67 per cent and 70 per cent.

For freight operation item 9 shows an average increase in ton-miles during the months of electric operation of 28.8 per cent over that of steam. For the month of November the increase was 40 per cent. In this connection the superintendent of the division has said that to handle the 1916 business either electrification or double tracking would have been necessary. The latter would still, of course, have required extra motive power. Possibly, the superintendent did not intend his statement should be taken literally, but, in any event, it is reasonable to assume that under the business conditions which existed during the electrical months, and the resulting congestion, the given figures would be, for steam, too favorable.

The figures of item 11 show that for the same ton-miles there would be over three times as many helper engine miles under steam as under electricity. No account is here taken of the return trips of helpers or their otherwise running light. This is a considerable item under steam, but is small for electricity.

Item 12 shows a number of engines that is possibly a little high for steam on account of some of these engines being at times used in passenger helper service. The number of electric engines given is the number purchased for this service and considered sufficient. We are, unfortunately, obliged to use only our judgment in this matter, as many of the locomotives purchased for the Missoula Division, not then under electrical operation, were available and used. Twenty-eight locomotives are now easily handling business for the two divisions.

Using the figres as they stand and deducing from them item 13—1000 ton-miles per engine—we find that the electric engine handles about three and one-half times as many ton-miles per month as the steam engine. From item 17, or minutes per 1000 ton-miles, it appears that the electric engine cuts 30 per cent from the time to do a given business, partly by faster running and partly by heavier trains.

Item 14 shows that there were an average daily number of trains involved of 8.6 for steam and 9.3 for electricity.

Item 15, ton miles per train-mile, is about the same as tons per train, and is 22 per cent greater for electricity than steam. The electric train, it might be considered at first glance, ought by comparison to be heavier, but it should be remembered that the steam train has two locomotives during a considerable part of the time. The tonnage of through-freight trains is greater than is indicated, the average figures shown being considerably reduced on account of the comparatively light local freights that are included.

Items 18 and 19, showing consumption of electric energy are derived in the same manner as previously described for passenger service. In conjunction with items 20 and 21 they give a comparison of relative amounts of coal and electricity used to handle a given business. Under present conditions we are paying for our electricity on a kilowatt-hour basis and it is costing considerably less than coal did.

As to the effects of regeneration on the power consumption, this varies more or less, but for the month of November, the amount of regenerated power measured at the locomotives was 11.3 per cent of the total power consumed at the motors. Tests on a 2 per cent grade with a passenger train have shown a return as high as 42.8 per cent of the consumption at the motors. Some of this power goes over the trolley direct to locomotives which are motoring, and the rest goes through the substations, reversing the motor generators and either flowing into the power company's transmission system or along the railway company's line to other substations. The power saving feature of regeneration, however, is not considered so important as the increased safety and ease with which trains are handled on the heavy mountain grades and the saving in wear and tear on brake shoes and equipment.

Wisconsin Association Holds Annual Meeting

Papers on Fair Return on Investment and on One-Man Car Operation of Interest to the Railway Field

THE ninth annual meeting of the Wisconsin Electrical Association held at the Pfister Hotel, Milwaukee, on March 14 and 15 and presided over by President W. E. Haseltine, general manager Ripon Light & Water Company, was occupied principally with subjects of primary interest to the electric lighting properties of the State. Two papers were presented, however, of particular interest to electric railway men, one by Mr. Erickson on "What Constitutes a Fair Return on Utility Investment?" and one by Mr. Smith on "The One-Man Car," which was read by J. P. Pulliam, Oshkosh, in the author's absence. The paper by Mr. Smith was published in the JOURNAL last week. That by Mr. Erickson will appear in a later issue.

FAIR RETURN ON UTILITY INVESTMENTS

R. B. Brown, Milwaukee, in discussing Mr. Erickson's paper, said that the financing of future extensions and replacements was the greatest problem before the utilities of the country and one which was becoming steadily greater. Investors were formerly willing to buy securities on the strength of the immediate return expected, but they now demanded to know not only the present status but great detail of the past earnings and future prospects of the company. This makes it practically essential to have surplus earnings so that any unforeseen contingency may be overcome or discounted by using this surplus to pay the dividends during a lean year. He said the public utility operators should see to it that the public knows more about this financing problem of the utilities.

In answer to a question as to what were the elements which go to make up a fair rate of return, Mr. Erickson replied that for rate making purposes, this included the cost new of the property, plus the going value, plus the necessary working capital. He said that depreciation was looked upon by many as a form of amortization and could therefore be deducted from the cost new when computing the investment upon which fair return should be expected. This, of course, was wrong, as a depreciation reserve is not made for that purpose and could not be so considered unless it was turned over to the investors. If a depreciation fund were turned over to the investors, then there would later be no funds available for replacements as equipment wore out. Taking a hypothetical case, Mr. Erickson said that if a 20 per cent depreciation reserve were deducted from the cost new, and the fair return was based on this investment, then the interest received would be a fair return on 20 per cent less than the capital invested, which would in reality be a confiscation of property.

Dean Treat, La Crosse, read some discussion on Mr. Smith's paper prepared by R. M. Howard, Winona. Mr. Howard said he had found a singularly unanimity of opinion among railway men as to the advantages of the one-man car. After three years' operation of these cars in Winona, he said that they had not developed any new classes of accidents and that the concentration of responsibility had had a tendency to lessen accidents. All his cars were equipped with air brakes, and he believed this had been of importance because of the advantage it gave the motormen in coping with the carelessness of automobile drivers, who were responsible for 60 per cent of the accidents. The betterment of service possible by using one-man cars through the improved schedule and reduction of accidents, he thought, war-